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The magnitude and reliability of cue-specific craving in nondependent smokers

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ABSTRACT

Background: Cue-reactivity is a robust phenomenon in regular cigarette smokers (Carter and Tiffany, 1999), but it has not been widely investigated in nondependent smokers. Further, most research on cue-specific craving assesses response to cues in a single experimental session. As such, investigations of cue-specific craving have primarily measured state-like but not trait-like responses to smoking stimuli.
Methods: This study measured general and cue-specific craving in nondependent smokers and assessed the within-session and cross-session reliability of these two facets of craving. Participants ($n = 154$) attended five laboratory sessions over the course of three months and completed multiple cue-reactivity trials (using smoking and neutral in vivo and photographic stimuli) during each study visit.
Results: Results indicated that smoking cues elicited significantly stronger craving than neutral cues across study sessions, and that craving ratings following smoking cues decreased across subsequent sessions. Within-session and cross-session reliability was extremely high.
Conclusions: Overall, findings indicate that nondependent smokers experience reactivity to smoking cues, and that this response is quite reliable within and across sessions. Further, the magnitude of cue-specific craving was comparable to what has been observed in heavy, dependent smokers.

1. Introduction

A substantial number of individuals smoke at rates lesser in quantity and frequency than smoking levels observed in heavy, dependent smokers. Up to 40% of people who smoke do so on a nondaily basis, and 52% of individuals who report smoking in the past 30 days do not fall in a dependent taxon (Substance Abuse and Mental Health Services Administration, 2011; Goedeker and Tiffany, 2008). Research studies recruiting nondaily smokers utilize various smoking rate cut-offs, with many studies employing a cap on the average number of cigarettes smoked per day (e.g., five) or number of days per month smoked. While nondaily cigarette users (i.e., those who smoke between 1 and 29 of the past 30 days) endorse smoking 2.4 cigarettes on an average smoking day (Substance Abuse and Mental Health Services Administration, 2011), the range of quantity and frequency of cigarette use in nondaily smokers has yet to be well captured in empirical research.

When regular, daily smokers are presented with smoking related cues they typically respond with marked increases in craving to smoke. Cue-reactivity is a robust phenomenon in cigarette smokers (Carter and Tiffany, 1999), but has not been widely investigated in smokers who are not nicotine dependent. Cue-specific craving, or the difference between craving in response to smoking cues (i.e., stimuli that have previously been paired with cigarette smoking) and neutral cues, may be of theoretical and clinical importance in smokers who do not fit the "pack-a-day" prototype. Nondependent smokers have a less extensive history of pairings between drug-related cues and nicotine administration, and thus may experience more limited reactivity to smoking cues than do regular, heavy users. Conversely, reactivity may be less pronounced in smokers as they progress to more habitual use, resulting in an inverse relationship between level of use and cue-specific craving. Several studies have demonstrated that very low-level smokers exhibit significant reactivity to smoking cues (Sayette et al., 2005, 2001), but these studies tend to recruit "chippers" or those who smoke fewer than five cigarettes per smoking day. While this allows for a contrast between heavy, dependent smokers and very infrequent smokers, no research to date has examined cue-specific craving across a wide distribution of nondependent smokers.

Most studies examining cue-reactivity in cigarette smokers assess responses to cues in a single experimental session (see LaRowe et al., 2007; Shiffman et al., 2013a,b, for exceptions). As such, investigations of cue-specific craving have primarily

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measured *state* levels of cue-reactivity, which is useful when identifying how a drug user might respond to a certain set of cues on one occasion. For example, cue-reactivity might be measured once during the course of a treatment study to examine the impact of pharmacotherapy on cue-specific craving (Tiffany and Wray, 2012). However, if a more trait-like estimate of cue-specific craving were of interest (i.e., a person's general, cross-occasion reactivity to drug-related cues), assessment across multiple sessions over an extended period of time would be necessary. A stable estimate may be desired when relating this measure to other trait-like variables, such as level of dependence or genetic factors that might contribute to cue-reactivity (e.g., Tang et al., 2012). Further, the extent to which nondependent smokers endorse stable patterns of reactivity to cues has not been established. Stability (or instability) may be particularly important in a sample with limited previous exposure to smoking cues.

Like heavy smokers, nondependent smokers endorse general craving for cigarettes (i.e., craving that is not cue driven). Research in the natural environment of smokers has demonstrated that chippers and heavy smokers report equivalent craving ratings during assessments completed while smoking, but that chippers report significantly lower craving than heavy smokers when assessed during non-smoking occasions (Shiffman and Paty, 2006). Further, regular smokers report greater abstinence-induced craving than do less dependent smokers (Shiffman et al., 1994).

The current study examined the extent to which smokers who are not nicotine dependent endorse reactivity to cues over multiple sessions. Further, we investigated the within-session and cross-session reliability of general and cue-specific craving in this sample.

2. Methods

Participants were recruited through local newspaper/radio advertisements and flyers in Buffalo, NY. Individuals were screened over the telephone to determine eligibility. Invited participants were between the ages of 18–45, smoked between 1 and 29 days of the past 30 and fewer than 15 cigarettes on an average smoking day, had smoked 25 or more lifetime cigarettes, and had an expired carbon monoxide (CO) level below 15 ppm at the start of the first study visit. Eligible individuals had not made a quit attempt in the past month, did not intend to quit over the next two months, and had not used nicotine or tobacco products other than cigarettes in the past year. Due to requirements of the parent study (which involved hair toxicology; Wray et al., in preparation), participants were excluded if they had predominately gray or white hair, if they had hair shorter than 1.25 inches, and if they were unwilling to forego hair-coloring treatment over the next two months.

Eligible participants were invited to attend six laboratory sessions over the course of three months. Sessions occurred at the same time and on the same day each week for 5 weeks (Sessions 1–5), and participants returned for a final session (Session 6) 12 weeks after Session 1. Sessions ranged in length from 60 to 120 min. Participants were paid up to $300 for completion of all study sessions. A variety of tasks were completed during each session; only those procedures relevant to the current study will be described.

At the start of Session 1, a CO sample was collected and information about demographics and smoking history was collected via self-report measures. Participants completed a demographics questionnaire, the Nicotine Addiction Taxon Scale (NATS; Goedeker and Tiffany, 2008), and the Questionnaire on Smoking Urges (QSU; Tiffany and Drobes, 1991). Next, cue-reactivity trials (described below) were completed.

Cue-reactivity trials were administered during Sessions 1, 2, 3, 4, and 6 and were based on procedures used in Wray et al., 2011. Before these trials, participants were instructed to take out one cigarette and one neutral object. Cigarettes of the participant's preferred brand were provided if they were not carrying cigarettes. A neutral object was described as an item that participants did not associate with smoking (e.g., keys, a pen). Each item (one cigarette and one neutral object) was placed under a separate box located behind the participant. Participants were seated in front of a 24-inch computer screen. A response box with buttons numbered 1–7 was placed on the table in front of the screen in order for participants to answer questions presented during the cue-reactivity trials.

Before cue presentations, participants completed the Craving Questionnaire (a four-item subscale of the Questionnaire of Smoking Urges, see Carter and Tiffany, 2001). The item order of the Craving Questionnaire was randomized at each administration. The average of these four items was used as the measure of baseline craving.

Cues with smoking and neutral content were delivered through photographic and in vivo modes of presentation. During photographic trials, a picture with either smoking or neutral content was displayed on the computer screen for 10 s. The stimuli used were selected from photographs used in our previous research (Warthen and Tiffany, 2009; Wray et al., 2011). Smoking photos depicted smoking stimuli, such as cigarettes, ashtrays, cigarette packs, and people smoking. Neutral photos depicted everyday objects that are not often associated with smoking (e.g., pencils, scissors, tools). Smoking and neutral photos were matched on the presence versus absence of people, faces, and hands, and whether those depicted were male or female. Participants were presented with a unique photo during each trial throughout the course of the study.

During in vivo smoking trials, participants were asked to take their cigarette out of the box, hold and examine the cigarette until the sound of an alarm (which occurred 10 s after the start of the trial), and to then put the cigarette back under the box and out of sight. Procedures were identical during in vivo neutral trials, except participants were asked to take out, hold, and view the neutral cue. After a cue was presented, participants responded to the Craving Questionnaire items based on how they felt during the stimulus presentation. Participants were also asked how carefully they looked at the photograph or object, and how distracted they were during the cue presentation.

Between trials, participants were instructed to close their eyes and focus attention on their breathing in order to promote a shift in focus away from the previously displayed cue. A total of 12 trials with 3 of each type and mode of presentation (in vivo smoking, in vivo neutral, photographic smoking, and photographic neutral) were delivered in a randomized order during each session.

Cue-reactivity trials were presented following the collection of a CO sample during sessions 1, 2, 3, 4, and 6; these particular sessions were selected as they would allow us to (1) replicate prior multiple session cue-reactivity laboratory work (e.g., LaRowe et al., 2007; Shiffman et al., 2013a,b), and (2) extend this work by adding in a final session at a later point in time. During Session 5, participants completed the Nicotine Dependence Syndrome Scale (NDSS; Shiffman et al., 2004). Finally, the Timeline Follow Back interview (TLFB; Sobell and Sobell, 1996) was administered by trained staff in order to quantify smoking behavior over the first 28 days of the study.

2.1. Data reduction and analyses

Craving ratings collected immediately before the cue manipulation were averaged and used as the participant's level of baseline craving. Craving ratings given after each trial type (in vivo smoking, in vivo neutral, smoking photograph, neutral photograph) were collapsed across like trial types within each session. We conceptualized "cue-specific" craving in two ways: (1) as the difference between craving after smoking related and after neutral content cues, and (2) as the difference between craving after smoking related cues and baseline levels of craving (Carpenter et al., 2009). Within-subjects ANOVAs were conducted to analyze the effect of stimulus type (smoking versus neutral, or smoking versus baseline), mode of presentation (in vivo or photographic), and study session (1–5) on craving. Total number of days smoked in the past 28 days were extracted from the TLFB. The total score for the NATS was calculated and used to exclude participants who met criteria for nicotine dependence. The NATS is an empirically validated instrument that has identified a categorization of nicotine dependence (versus nondependence) based on two large sample replications generated from a nationally representative dataset (The National Survey of Drug Use and Health; Office of Applied Studies, 2004; see Germeroth et al., 2013 for another example of the NATS used to categorize dependence versus nondependence).

Reliability was calculated in two ways: (1) *within-session reliability* was estimated as the internal consistency (Cronbach's alpha) of the trials of comparable cue content administered at each session (i.e., six smoking cue trials and six neutral cue trials during each session), and (2) *cross-session reliability* was estimated as the internal consistency of the average craving response for each cue type (smoking and neutral) across the five cue-reactivity sessions. This latter coefficient provides an estimate of the aggregate stability of craving responses across the multiple sessions. We conceptualized "state" craving as ratings taken during a single study session and "trait" craving as craving ratings collapsed across all study sessions.

3. Results

Of those who attended Session 1, 88% completed all five cue-reactivity sessions. Participants who scored in the dependent range of the NATS (i.e., >14.33 total score, $n = 27$) were excluded from the sample in order to ensure a focus on lower level smokers, leaving 154 participants (51% male, 62% White) for inclusion in data analyses. Participants averaged 25.1 years of age (range 18–45, $SD = 6.1$) and had been smoking for approximately 9.0 years (range 0–30, $SD = 7.1$). Baseline CO levels at the start of each visit did not differ across sessions ($M = 4.5$ ppm, range = 4.3–4.8 ppm). According to data collected via Timeline Follow Back during Session 5, participants smoked an average of 19 of the previous 28 days (range = 4–28, $SD = 7.9$) and smoked 2.7 cigarettes on an average