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Brief report

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Cue Reactivity in Converted and Native Intermittent Smokers

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Abstract

Introduction: Nondaily, or intermittent smokers (ITS), who constitute a substantial fraction of U.S. smokers, are thought to smoke in response to cues. Previous cue reactivity research showed no difference between ITS and daily smokers in response to cues. This report examines whether "converted" ITS (CITS) with a history of past daily smoking differ from "native" ITS (NITS) in craving and smoking in response to cues.

Methods: A total of 146 CITS (who previously smoked daily for at least 6 months) and 73 NITS participated. Participants were exposed to 5 active cues (smoking, alcohol, negative affect, positive affect, and smoking prohibitions) and a control neutral cue, in separate sessions. Changes in craving were assessed pre–post cue exposure. Smoking behavior (smoking [y/n], smoking latency, number of cigarettes, number of puffs, and increase in carbon monoxide [CO]) was observed. Analyses contrasted response to each active cue compared to the neutral cue and controlled for order effects and for time since last cigarette, which differed between groups.

Results: Regardless of cues, CITS reported higher craving and greater change in craving, were more likely to smoke, tended to progress faster to smoking, and showed greater increases in CO when they did smoke. NITS and CITS showed similar cue reactivity on most measures, though NITS took more puffs after viewing smoking cues (compared to neutral) than did CITS.

Conclusions: Though CITS show some remnants of their history of daily smoking, CITS and NITS demonstrate similar cue reactivity, suggesting that they would not require different behavioral approaches to help them quit.

Introduction

The nicotine regulation model[1] accounts for the pattern of heavy daily smoking seen in the last century. Today, as many as 38% of U.S. adult smokers are nondaily or intermittent smokers (ITS; Substance Abuse and Mental Health Services Administration[2]). ITS abstain one out of 3 days and engage in runs of abstinence averaging 5 days.[3]

Smoking patterns analyzed using Ecological Momentary Assessment showed that ITS do experience craving on smoking occasions[4] and that their smoking is more closely tied to certain stimuli, such as alcohol and other smokers, than that of daily smokers (DS; Shiffman et al[5]). On this basis, ITS were expected to be more reactive to cues than DS. A laboratory cue reactivity study[6] evaluated this hypothesis by exposing ITS and DS to each of five active

cues—smoking cues, alcohol cues, negative affect, positive affect, and cues associated with smoking prohibitions—compared to a neutral cue. ITS showed cue reactivity, increasing craving in response to smoking and alcohol cues, and decreasing craving in response to positive affect cues, but their responses did not differ significantly from those of DS, either in craving or in smoking.

While the prior analyses evaluated differences between ITS and DS, they did not examine an important source of potential heterogeneity among ITS. About half of ITS have previously been DS.[3,7] Such "converted" ITS (CITS) share many characteristics with "native" ITS (NITS)[3]: they are equally likely to have made a quit attempt, experience similar levels of smoking restrictions, and show similar levels of craving.[4] However, CITS and NITS also differ in numerous ways. CITS are older, have shorter periods of abstinence, smoke on a greater percentage of days, smoke more heavily on those days, and score higher in nicotine dependence.[8] Importantly, CITS make 30% more quit efforts than NITS, yet both groups have success rates not much better than those seen in DS.[9] ITS' surprisingly low rates of quit success suggests they may benefit from smoking cessation treatment, perhaps focused on the situations where they are most likely to crave and smoke cigarettes. Thus, the question arises whether CITS and NITS may differ in how they are affected by various cues, and thus might require different treatment approaches. Accordingly, this paper examines differences between CITS and NITS in craving and smoking in response to cues (cf., Perkins[10]).

Methods

Subjects

Subjects were 239 volunteers from Pittsburgh, PA. Participants had to be at least 21 years old, smoking for ≥3 years and at their current rate for ≥3 months, and not planning to quit within the next month. ITS had to smoke 4–27 days per month, regardless of quantity. CITS were those who reported previously smoking daily for 6 months or more. The sample included 146 CITS and 73 NITS. This sample is a subset of that reported in Shiffman et al[3] and Shiffman et al[6], which discusses demographic and smoking history differences between CITS and NITS in detail. Briefly, NITS were slightly younger than CITS (32.70 vs. 36.39 years old), more likely to be Caucasian (75.34% vs. 60.27%) and male (59.57% vs. 43.62%), smoked fewer cigarettes on the days they smoked (3.46 vs. 5.55), and had smoked for fewer years (13.06 vs. 18.39). NITS and CITS had similar educational attainment (32% and 29% graduated college), while NITS reported slightly higher incomes ($34.8 thousand vs. $27.5 thousand). CITS had last transitioned from daily smoking an average of 7.4 (8.8) years ago (median = 4 years, interquartile range = 2.0–7.9 years).

Procedures

Procedures are described in more detail in Shiffman et al[6] and Shiffman et al[11]. Briefly, cue exposure occurred over six separate sessions, with at least 1 day between sessions. One of six cue types (smoking, alcohol, smoking prohibition, negative affect, positive affect, and neutral cues) was shown in each session; order was randomized and counterbalanced. Subjects smoked ad libitum prior to the session, and after a 30-min no-smoking period, subjects were brought into the cue reactivity laboratory. Following a 3-min acclimation period and pre-cue craving ratings, 30 cue images were displayed for 6 s each. Cues were still images drawn from various sources (see Shiffman et al[11]). After a postexposure craving assessment, there was a 15-min free-smoking period during which subjects could smoke while the 30 cue images continued to be displayed in rotation. Procedures were automated and video-recorded.

Measures

The brief 10-item Questionnaire on Smoking Urges[12] assessed craving before and after cue exposure, yielding scores (scaled from 1 to 49) for appetitive craving and distress relief craving. After the post-cue assessment, subjects were provided with two cigarettes, and their smoking behavior (smoking one or two cigarettes, latency to smoking, number of puffs, and time puffing) was coded from video.[13] Exhaled carbon monoxide (CO) was assessed before cue exposure and after the smoking period.

Analysis

Most subjects completed the full six-cue series (n = 204; 93.15%); an additional 15 subjects who had data for the neutral stimulus and at least one active cue (60% missing just one cue) were included. Difference scores (pre–post cue exposure; square root-transformed to limit skewness) were used as an index of cue-induced craving.

NITS/CITS differences were analyzed using mixed models (Brown and Prescott[14]; SAS ProcMixed; SAS Institute) for continuous variables (craving, number of puffs, and CO change); generalized estimating equations (logit link) for dichotomous variables (smoking, lighting a second cigarette); and recurrent event models specifying a Gompertz survival function (Stata streg; StataCorp) with provisions for frailty[15] for latency to smoke. Cue effects were assessed as contrasts in comparison to the neutral control condition.

We also analyzed within-subject variation in craving response across cues, an index of cue specificity.[6] To control for differences in mean craving, we used the Coefficient of Variation (CoV), which expresses variation in terms of the mean, and contrasted the group CoV values via a nonparametric median test. All models controlled for session number, minutes since last cigarette (log-transformed), and stimulus (except pre-cue craving, assessed prior to stimulus exposure), and were weighted by race to account for oversampling of African American smokers (recurrent events had no provision for weighting). Analyses of likelihood of smoking a second cigarette among those who smoked also controlled for latency to smoke the first cigarette.

Results

Baseline Differences

CITS had smoked more recently than NITS (220 [SE = 28.65] vs. 611 [SE = 105.60] min; $p < .0001$) and presented with higher initial CO concentrations (8.46 [SE = 0.60] vs. 5.50 [SE = 0.84] parts per million [ppm]; $p < .01$). CITS also had higher craving prior to cue exposure (Table 1).

Craving

CITS showed greater increases in craving pre-to-post cue exposure compared to NITS, averaging across all cues. However, CITS and NITS showed similar cue reactivity. That is, their response to active cues—compared to the neutral cue—was similar (Table 1). NITS and CITS also did not differ in the median within-subject cross-cue CoV, either for appetitive (CITS: 2.34; NITS: 2.36, $p = .85$) or distress relief craving (CITS: 2.45; NITS: 2.45, $p = .69$).

Table 1. Craving and Smoking Parameters by Cue

	CITS						NITS						CITS–NITS main effect[a]	CITS–NITS × cue interaction
	Neutral	Smoking	Alcohol	Positive	Negative	Smoking prohibited	Neutral	Smoking	Alcohol	Positive	Negative	Smoking prohibited		
	M (*SD*)/%	*M* (*SD*)/%	*M* (*SD*)/%	*M* (*SD*)/%	*M* (*SD*)/%	*M* (*SD*)/%	*M* (*SD*)/%	*M* (*SD*)/%	*M* (*SD*)/%	*M* (*SD*)/%	*M* (*SD*)/%	*M* (*SD*)/%	*p*	*p*
n	146	137	140	140	144	141	73	72	72	72	72	73		
Craving														
Appetitive craving														
Pre-cue	19.64	17.88	18.10	20.19	19.13	16.63	15.05	15.60	14.85	13.42	14.14	14.93	.003	–
	(15.04)	(15.41)	(15.30)	(14.62)	(15.04)	(14.71)	(13.28)	(14.48)	(14.05)	(12.11)	(13.57)	(13.52)		
Post-cue	20.44	21.59	2.057	19.62	20.29	18.44	15.03	16.09	16.98	13.09	14.40	15.42	.001	.38
	(15.31)	(16.93)	(16.07)	(15.09)	(16.02)	(15.95)	(13.38)	(14.58)	(14.91)	(13.17)	(14.66)	(14.12)		
Distress relief craving														
Pre-cue	7.90	7.63	7.78	8.63	8.05	7.46	5.79	5.78	5.35	5.30	5.07	5.69	.013	–
	(9.39)	(9.44)	(9.72)	(9.44)	(9.97)	(9.40)	(7.09)	(7.60)	(6.84)	(6.43)	(6.59)	(6.54)		
Post-cue	8.66	10.18	10.01	8.33	9.96	8.94	6.09	6.13	6.13	5.39	6.16	6.24	.003	.56
	(9.99)	(12.16)	(11.70)	(9.13)	(11.61)	(10.85)	(7.23)	(7.77)	(7.53)	(7.04)	(8.68)	(7.55)		
Smoking parameters														
% Who smoked	60.66	59.74	60.68	61.56	58.42	56.94	44.20	51.97	46.16	41.11	46.54	46.67	.048	.67
% Who lit second cigarette[b]	15.50	13.87	17.10	16.34	15.43	12.83	5.30	26.85	16.98	16.97	8.35	11.46	.59[c]	.10[c]
Median latency to smoke (s)[b]	41.50	33.00	43.00	52.00	43.00	43.00	48.00	39.00	43.00	47.00	37.00	37.00	.052	.09[d]
Number of puffs[b]	14.24	14.24	14.71	13.61	14.46	14.05	12.20	15.73	13.54	13.82	13.71	14.01	.54	.009
	(6.40)	(6.59)	(6.53)	(6.53)	(6.24)	(5.94)	(5.76)	(12.20)	(8.20)	(11.57)	(8.73)	(10.30)		
Total puff time (s)[b]	20.23	20.64	20.18	19.41	21.30	20.29	17.65	22.97	19.77	18.41	20.48	18.66	.54	.10
	(12.56)	(13.17)	(9.91)	(10.22)	(10.72)	(11.54)	(11.74)	(15.01)	(14.11)	(14.19)	(15.20)	(11.43)		
CO change post–pre cue (ppm)[b]	2.75	2.63	3.17	2.89	3.37	3.33	2.29	3.06	2.59	1.77	2.42	2.92	.01	.11
	(2.41)	(2.36)	(2.21)	(2.37)	(2.10)	(2.39)	(2.56)	(2.68)	(2.59)	(3.36)	(3.01)	(2.27)		

All statistics were weighted by race. CITS = converted intermittent smoker; CO = carbon monoxide; DS = daily smoker; NITS = native intermittent smoker; ppm = parts per million.

[a]Test of mean differences, controlling for order, stimulus, and time since last cigarette.

[b]Among those who smoked (CITS: $n = 521$ sessions, $n = 121$ participants; NITS: $n = 204$ sessions, $n = 51$ participants).

[c]Analysis controlled for log latency to light the first cigarette, which affected the time available to light a second.

[d]All interaction effects between history of DS and active stimuli compared to neutral condition were $p > .35$.

Smoking

Across cues, CITS were more likely to smoke (odds ratio = 1.63, 95% confidence interval [CI] = 1.01–2.63; $p < .05$), and there was a trend for them to progress to smoking more rapidly than NITS (hazard ratio = 1.95, 95% CI =1.00–2.23; $p = .052$; median time to smoke: 74.44 vs. 135.87 s). When they smoked, CITS demonstrated a slightly greater increase in CO (+0.82 ppm [*SE* = 0.32]; $p = .01$). However, CITS and NITS were equally likely to light a second cigarette, took similar numbers of puffs, and had similar puff times.

CITS and NITS reacted similarly to active cues—compared to neutral—in likelihood of smoking, latency to smoke, number of cigarettes lit, and puffing time (see Table 1). However, there were cue-related differences in puffing behavior (interaction $p < .01$): NITS took 41% more puffs after the smoking cue, compared to the neutral condition (14.75 [*SE* = 1.12] vs. 10.45 [*SE* = 1.15]; $p < .0001$), whereas CITS demonstrated no difference (13.32 [*SE* = 0.73] vs. 13.52 [*SE* = 0.72]; $p = .76$). There were no significant differences in CO boost. The pattern of data (Table 1) suggests that the observed differences in puffing behavior are primarily driven by NITS having taken 2.26 fewer puffs after the neutral cue ($p < .02$); number of puffs after the smoking cue was similar for NITS and CITS (pairwise comparison of smoking cue means for CITS vs. NITS: $p = .28$).

Discussion

An analysis of CITS' and NITS' response to cues showed they did not differ in how cues affected their craving, nor in how cues affected the likelihood of smoking, how quickly they progressed to smoking, whether they lit a second cigarette, or how much their CO increased when they smoked. Nor were there differences in how much their craving varied across cues.

There was, however, one indication of greater cue response among NITS: when they did smoke, NITS took more puffs after being exposed to smoking cues, compared to their neutral cue response. This is consistent with the tendency of smoking cues to increase craving.

Differences in puffing response to the smoking cue need to be interpreted with caution, however, as they are due, in part, to NITS' taking fewer puffs in the neutral condition. As Sayette and Tiffany[16] note, the laboratory setting itself may function as a cue, and CITS may have reacted more strongly to this weak, diffuse cue, a difference that could have been overshadowed in the active cue conditions. Notably, CITS also showed greater increases in craving when exposed to any cues, including neutral cues, which had no smoking-relevant content.

The study also provided an opportunity to compare CITS' and NITS' craving and smoking, independent of cues. Despite the fact that CITS smoke more and show greater signs of dependence,[8] they did not show greater propensity to smoke on all measures of smoking: when they did smoke, NITS and CITS took similar numbers of puffs, puffed for similar amounts of time, and were equally likely to light a second cigarette. However, CITS' greater propensity for smoking was evident: when they presented for the study, CITS had smoked more recently, and had higher CO levels. Despite this, CITS also reported higher craving, were more likely to smoke, tended toward shorter latency to smoke, and demonstrated greater CO increases when they did smoke. In other words, they behaved like the heavier smokers they were and are.

As there were no robust differences in cue reactivity, the data suggest that behavioral treatment of NITS and CITS can focus on similar cues as potential triggers for relapse, without differential treatment for these two subgroups. However, CITS' heavier smoking, greater dependence[8] and greater tendency to smoke when the opportunity arises, suggests that they may need more intensive treatment than NITS.

The study was limited by the use of specific pictorial cues, which produced modest reactivity. Also, NITS/CITS classification relied on self-report and could have been incorrect. The local sample of volunteers may not be representative.

The study suggested that among current ITS, a history of past daily smoking did not influence smokers' sensitivity to cues in most respects. As seen in other measures,[3] CITS' behavior is more consistent with their current nondaily smoking than with their past history, suggesting that they have largely left that past behind. Better understanding of how daily smokers convert to ITS, and how the past does or does not continue to influence them, warrants further research.

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Declaration of Interests

None declared.

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