Published in final edited form as:

Psychol Addict Behav. 2001 September ; 15(3): 268–271.

Effects of Smoking Opportunity on Attentional Bias in Smokers

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Abstract

The emotional Stroop task was used to examine the influence of opportunity to smoke on attentional bias to smoking-related stimuli. At the outset of the study, 92 nicotine-deprived smokers were told that they (a) would, (b) would not, or (c) might be able to smoke during the experiment. Next, participants completed an emotional Stroop task, in which they were presented with smoking-related or -unrelated words in an unblocked format. Smokers demonstrated interference to the smoking words, relative to matched neutral words, $F(1, 87) = 18.0, p < .0001$. Moreover, smoking opportunity affected the degree of interference, $F(2, 87) = 4.35, p < .02$, with participants who had been told they would be able to smoke during the study showing the most interference. The results suggest that smoking opportunity affects the salience of smoking-related stimuli among nicotine-deprived smokers.

There is an emerging literature examining the role of cognitive processing in drug urge (Sayette, 1999; Tiffany, 1990). One approach has been to investigate biases in addicts' processing of drug-related information. Specifically, addiction may be related to increased sensitivity to drug-related cues (Robinson & Berridge, 1993; Sayette, 1999). One method to assess sensitivity to drug-related cues is the emotional Stroop task, which has detected attentional biases for clinically relevant words in patient samples (Williams, Mathews, & MacLeod, 1996).

Gross, Jarvik, and Rosenblatt (1993) used the emotional Stroop task to assess attentional bias in smokers. This task requires participants to name the color of the letters of a stimulus word while ignoring word content. An increase in response time to stimulus words, relative to control words, indicates an attentional bias. Gross et al. provided smokers with word lists that were blocked, such that words from a certain group (e.g., smoking-related words) were presented together. Participants named word colors as quickly as possible, and the response time for each word list was recorded. Interference effects emerged for smoking words among abstinent smokers but not among nonabstinent smokers (see also Johnsen, Thayer, Laberg, & Asbjornsen, 1997).

Waters and Feyerabend (2000) used a computerized emotional Stroop task that allowed latencies to be recorded for each word and permitted a comparison of drug-related items that were blocked and unblocked. (In contrast to blocked formats, the unblocked format presented smoking-related and neutral words in a mixed random sequence, thus combining items into a single block.) The blocked-format results replicated those of Gross et al. (1993): Abstinent smokers showed greater emotional Stroop effects than did nonabstinent smokers. There was no evidence, however, that abstinence increased response latencies for smoking-related words in the unblocked format. It is unclear why the unblocked task failed to detect enhanced drug cue interference among abstinent smokers (see Waters & Feyerabend, 2000). Although this

format may be less sensitive than blocked formats to interference effects, a number of studies that have used unblocked stimuli with other patient samples have found evidence of attentional bias (Williams et al., 1996). Nevertheless, potent shifts in attentional bias may be needed for the unblocked format to detect interference effects.

In a recent review, Wertz and Sayette (2001) found that perceived drug use opportunity affected urge ratings, such that addicts who perceived an opportunity to consume their drug reported higher urges than those who did not anticipate use. It is unclear whether perceived drug use opportunity affects underlying cognitive processing associated with drug urge or simply the reporting of urge (Juliano & Brandon, 1998). In this study we evaluated the effects of smoking opportunity on attentional bias using an emotional Stroop task. We hypothesized that response times would be longer for smoking-related words than for matched words. On the basis of the hypothesis that smokers expecting to smoke would be especially likely to selectively process smoking-related information, we predicted that smokers receiving instructions that they could smoke during the study (Yes condition) would show greater interference to smoking-related words than would smokers instructed that they could not smoke (No condition). We posited that smokers for whom smoking opportunity was uncertain (Maybe condition) would show interference effects between the Yes and No conditions.

Method

Participants

Ninety-two smokers aged 18-46 years ($M = 20.1$, $SD = 4.1$) enrolled in introductory psychology classes received course credit for participation. They reported smoking 14.4 cigarettes a day ($SD = 5.2$) for 58.3 months ($SD = 44.5$) and were randomly assigned to three opportunity-to-smoke conditions: Yes ($n = 31$), No ($n = 31$), or Maybe ($n = 30$). The groups did not differ in age, cigarettes per day, length of time smoking, time to first cigarette each day, or degree to which they reported currently wanting to smoke (all F s < 1 , p s $> .10$).

Materials

Smoking information form—Participants reported the number of cigarettes they smoked per day, how long they had smoked, and how long after waking that they typically smoked their first cigarette. They also rated how much they wanted a cigarette at that moment (“want to smoke”) on a scale that ranged from 0 (*not at all*) to 6 (*very much*). (*Want*, rather than *urge*, was used to assess baseline urge, with the hope that it might minimize a potential anchoring effect on the urge scale used later in the study. Previous studies have shown that participants respond virtually identically to *want* and *urge* [Sayette et al., 2000].)

Positive and Negative Affect Schedule—We used the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), a 20-item scale of state affect, to assess participants’ baseline mood.

Self-reported urge—Participants rated their urge to smoke on a scale that ranged from 0 (*no urge to smoke at all*) to 100 (*strongest urge to smoke I have ever felt*).

Emotional Stroop task—On each trial, a word appeared in one of four colors (red, yellow, green, or blue). It remained on screen until the participant responded; then the screen became blank. Three word groups were used: 9 smoking words; 9 words matched to the smoking words for word length, frequency, and initial phoneme (Carroll, Davies, & Richman, 1971); and 18 distracter words.¹ Each word appeared four times, once in each color, for a total of 144 stimulus trials, 108 (75%) of which were unrelated to smoking.

For each trial, a row of white asterisks appeared in the middle of the screen for 351 ms. After another 351 ms, a word appeared in letters 1 cm high. The word remained on the screen until the participant named the word color, or for a maximum of 1,500 ms. A 1,500-ms interval occurred between trials. A voice-activated relay switch (Gerbrands, Inc., Model G1341T) signaled occurrence of voice to a Computer Boards CI0-CTR05 counter-timer interface that measured intervals accurate to 1 ms. Response latency was operationalized as time between onset of word presentation and detection of vocal response. A 30- to 40-s break occurred halfway through the task. Words were presented in fixed random order, with the restrictions that all words were presented twice before the break, each color could appear for a maximum of three consecutive trials, and smoking words were not presented consecutively.

Procedure

Participants reported to the laboratory between 10:00 a.m. and 12:00 p.m. They were told to stop smoking at 11:00 p.m. the previous night and to bring a pack of their cigarettes. On arrival, they completed the smoking information form and reported the time that they had last eaten, drunk alcohol, and smoked. An expired air alveolar carbon monoxide sample was collected to check abstinence compliance ($M = 10.8$ parts per million, $SD = 4.1$). Samples over 20 parts per million resulted in rescheduling.

Participants were seated in a comfortable chair at a table. The computer monitor for the emotional Stroop task sat on a desk to their right. After describing the equipment, the experimenter presented the opportunity to smoke instructions. Yes-group participants were told they would be able to smoke during the study (no specific time was given); the No-group members were told they would not be able to smoke during the hour-long experiment; and the Maybe-group participants were told that soon a coin flip would determine if they could smoke, thus they had a 50% chance of smoking. Participants then rated their urge to smoke.

Participants next completed the PANAS and were given instructions for the emotional Stroop task, which included naming the color of the word as quickly and as accurately as possible. Several practice trials preceded the task. Finally, they performed the emotional Stroop task, which lasted approximately 8 min. Before being debriefed, participants completed several measures unrelated to this study.

Results

Emotional Stroop Task

Response times for each word trial were averaged across the four colors, and we calculated mean scores for the smoking words and the matched words. Response latencies briefer than 200 ms, or longer than 1,500 ms, were excluded. (Exclusions occurred for less than 1% of total word trials and were evenly distributed over word type and participant group.) Distracter words were included only to reduce the percentage of smoking words and were not analyzed. Equipment difficulties resulted in data loss for 1 participant (in the Yes group), and data for 1 participant (in the Maybe group) were removed because of extremely long latencies ($>3 SD$ above the mean) for both types of words. (Inclusion of this participant does not change the pattern or significance of results.) Therefore, the analyses included 90 participants.

We conducted a repeated measures analysis of variance on verbal response times, with group (Yes, No, or Maybe) as a between-subjects factor and word type (smoking or matched) as the repeated measure. Results revealed a significant effect of word type, $F(1, 87) = 18.0, p < .0001$,

¹The smoking words were tobacco, cigarette, smoke, ashtray, pack, puff, drag, inhale, and *nicotine*; the matched words were tomatoes, citizen, smile, aspect, paint, pump, draw, infant, and *necklace*; and the distracter words were drive, locate, vision, coiled, blend, index, hero, feature, author, warm, develop, letter, copy, program, month, back, national, and *resource*.

such that smokers had longer response times to smoking words ($M = 643.7$ ms, $SD = 77.8$) than to matched words ($M = 631.2$ ms, $SD = 75.8$). There was no main effect of group. The Group $\times$ Word Type interaction was significant, $F(2, 87) = 4.35$, $p < .02$.

Examination of the group means (see Figure 1) indicates that interference to smoking words (difference between smoking and matched words) was greatest for the Yes group ($M = 23.7$ ms, $SD = 27.0$), followed by the No group ($M = 11.0$ ms, $SD = 27.8$) and the Maybe group ($M = 2.5$ ms, $SD = 28.5$). Both Yes and No interference effects were significant ($ps < .05$). Simple effects tests for differences between groups indicated that the Yes and Maybe groups were significantly different ($p < .01$), whereas the difference between the Yes and No groups approached significance ($p < .08$). The No and Maybe groups did not differ significantly ($p > .24$).

Affect and Urge

Analysis of PANAS scores revealed no group differences on the Positive or Negative subscales ($F_s < 1.3$, $ps > .29$). PANAS subscales were uncorrelated with interference, and analyses of covariance, with PANAS scores as covariates, continued to reveal significant effects of group on interference.

We also examined urge ratings after opportunity-to-smoke instructions. We expected Yes group members to report the strongest urges, followed by the Maybe and No participants. To control for pre-instruction desire to smoke, we conducted an analysis of urge scores using baseline “want to smoke” scores as a covariate. Although in the expected direction, the analysis of covariance did not reveal a significant effect of group ($F = 1.1$; Yes: $M = 51.0$, $SD = 16.3$; No: $M = 45.0$, $SD = 16.3$; Maybe: $M = 48.7$, $SD = 16.3$). The lack of significance may be due in part to inclusion of light smokers. When the 10 participants who reported smoking fewer than 10 cigarettes per day were excluded, Yes-group members reported significantly higher urges, adjusting for baseline levels of want to smoke ($n = 29$, $M = 52.4$, $SD = 15.7$), than did those in the No group ($n = 28$, $M = 43.7$, $SD = 15.8$, $p < .05$). The Maybe smokers reported urges between the other two groups ($n = 25$, $M = 49.0$, $SD = 15.8$). Reported urge to smoke was uncorrelated with interference on the emotional Stroop task for all three groups ($rs < .21$, $ps > .29$).

Discussion

As hypothesized, nicotine-deprived smokers showed increased response latencies for smoking words relative to matched words. This effect was most pronounced for Yes smokers; was weaker, although still present, for No smokers; and did not appear for Maybe smokers. These data suggest that smoking opportunity may affect attentional bias. Our hypothesis that interference effects for Maybe smokers would fall between those of the Yes and No conditions, however, was not supported. Although urge ratings did not significantly differ across groups, when the lightest smokers were excluded the Yes-group participants reported higher urges than did those in the No group, with the Maybe group falling in between. The direction of these ratings parallels data from a recent study in which drug availability was manipulated across repeated trials (Carter & Tiffany, 2001). Reported urge was uncorrelated with interference effects, which is consistent with the position that craving-related changes in cognitive processing may be independent of self-reported drug motivation (Tiffany, 1990).

These emotional Stroop findings using an unblocked format are compatible with those reported by Waters and Feyerabend (2000). Smokers in the latter study were informed that they might or might not be required to smoke during their 1-hr experimental session. These instructions most closely resembled those for the Maybe group in the present study (A. J. Waters, personal communication, September, 2000). Neither the Maybe condition data in the present study, nor

the unblocked-format data from Waters and Feyerabend's study revealed interference effects. In contrast, Yes smokers in the present study showed the greatest interference for smoking-related words using the unblocked format.

The results of this study suggest that smoking opportunity affects the selective processing of drug-related information. Such processing shifts may be important in understanding drug relapse (Sayette, 1999). Future research manipulating smoking opportunity is indicated to determine the specificity of these effects (e.g., would smokers show similar interference to alcohol- or food-related words?). Manipulation of both smoking abstinence and perceived smoking opportunity in the same study would help clarify the contribution of these factors to attentional bias. Inclusion of tobacco chippers and heavy smokers might identify potential differences in cognitive processing across smokers. Although data suggest that attentional bias effects are not specific to smoking (Sayette, 1999; Williams et al., 1996), the impact of drug use opportunity across other drugs of abuse has not been evaluated. Finally, attempts to replicate the present findings might be conducted using blocked trials, as responses to blocked groups of words may reflect different underlying mechanisms than those found with unblocked trials (Waters & Feyerabend, 2000).

Acknowledgements

This research was supported by a grant from the National Institute on Drug Abuse (R01 DA10605) awarded to Michael A. Sayette. We thank Annie Peters, Jason Keenan, and Rachel Palmieri for their assistance in data collection as well as the entire staff of the Alcohol and Smoking Research Laboratory at the University of Pittsburgh. We are grateful to Andrew Waters for his comments on a previous version of the article and for his assistance in selecting the smoking-related words for the Stroop procedure. We also thank Michael Eddy for technical assistance.

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Figure 1. Perceived opportunity to smoke affected the degree of attentional bias to the smoking-related words, with participants who were told they would be able to smoke showing the greatest interference to the smoking words relative to the matched words. Yes = can smoke during study, No = cannot smoke during study, Maybe = 50% chance of smoking during study.