Incidental Exposure to No-Smoking Signs Primes Craving for Cigarettes: An Ironic Effect of Unconscious Semantic Processing?

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The present study tests whether incidental exposure to no-smoking signs may ironically boost craving for cigarettes in smokers. Smokers viewed photographs in which no-smoking signs were either inconspicuously embedded (prime) or edited out (control). Participants then used a joystick to make quick approach vs. avoid motions while viewing smoking-related and neutral stimuli on a computer screen (Chen & Bargh, 1999). We hypothesized that primed smokers, but not controls, would show an automatic reach bias toward the smoking-related stimuli. The data supported our prediction. Possible mechanisms for the effect are discussed, as well as implications for public health policy, negation-based social campaigns in general, and our understanding of the unconscious processing of semantic information.

INTRODUCTION

No-smoking signs are ubiquitous. Part of a wide-reaching social, legal, and public health movement meant to discourage smoking in public places, they can be found nearly everywhere people are: train stations and bus stops, book stores and coffee shops, restaurants, airplanes, schoolyards—and even some taverns and bars (Quenda, 2009). These typically unassuming icons are now so commonplace that it is easy to take them for granted. Fading into the background, they become just another part of our day-to-day environment.

This does not mean that they do not affect us, however. Decades of research on automatic priming effects have confirmed that our everyday physical environment is a rich source of influence on our unconscious minds, shaping everything from our mood to our social judgments to our very behavior, and often in surprising ways (cf. Bargh & Chartrand, 1999). Rain outside our window can make us feel dissatisfied with our whole lives (Schwarz & Clore, 1983). The mere presence of a briefcase in the room can boost our economic drive (Kay, Wheeler, Bargh, & Ross, 2004). Holding a warm cup of coffee makes us likelier to trust a stranger (Williams & Bargh, 2008a). Washing hands may assuage guilt (Zhong & Liljenquist, 2006). And the relative placement of dots on a grid may alter how distressed we are by violence on TV (Williams & Bargh, 2008b). In each of these cases, the physical stimulus from the immediate environment exerts its influence outside of our conscious awareness or control.

In addition to perceiving objects like a briefcase, or the tactile experience of holding a coffee cup, exposure to semantic content—usually in the form of words—can affect us subconsciously as well. For example, covertly exposing study participants to words that are stereotypic of the elderly causes them to walk slower and perform less well on memory tasks (Bargh, Chen, & Burrows, 1996; Dijksterhuis, Bargh, & Miedema, 2000). Priming the stereotype of a professor boosts performance on a general knowledge test, while semantically activating the idea of a soccer hooligan impairs performance (Dijksterhuis & Van Knippenberg, 1998). And administering a modified Stroop task with words related to drunkenness causes undergraduates to quaff more beer (Roehrich & Goldman, 1995). Many of these results can be explained by a direct and pervading link between perception—including unconscious semantic perception—and behavior: monkey see, monkey do (cf. Bargh et al., 1996).

But what does this tell us about no-

This research was funded by Grant RO1-MH60767 from the National Institute of Mental Health to JAB. Thanks are due to Molly Priedeman for research assistance. This research is an undergraduate thesis submitted in 2010 by the first author in partial fulfillment of the degree of B.A. in Cognitive Science, Yale University. The first author can be reached at brian.earp@gmail.com or at Oxford Uehiro Centre for Practical Ethics, Suite 8, Littlegate House, St. Ebbes St., Oxford OX1 1PT.

smoking signs? Since such signs are background fixtures of many public environments as well as physical objects with semantic content, they are just the sort of item one could expect to exert an influence on the unconscious mind. Drawing on the priming literature just cited, as well as research into the nature of unconscious semantic integration (discussed below), we hypothesized that incidental exposure to these signs will ironically *increase* smoking behavior in nicotine-addicted individuals. To understand why, we need to consider the seeming inability of the unconscious mind to factor *negation* into its semantic analyses (cf. Greenwald & Liu, 1985).

The Problem of Negation

In 1925, Sigmund Freud published an article entitled simply "Negation" (Freud, 1925). As an opening illustration, he asks his reader to imagine an exchange with a patient:

> "You ask who this person in the dream can have been. It was *not* my mother." We emend this: so it was his mother. In our interpretation we take the liberty of disregarding the negation and of simply picking out the subject-matter of the association. It is just as though the patient had said: "It is true that I thought of my mother in connection with this person, but I don't feel at all inclined to allow the association to count" (p. 367).

Freud's thesis, then, is that negation is not a faculty of the unconscious mind, but rather a tool of repression and inhibition exerted over it by the ego. "We never discover a 'No' in the unconscious," he writes (p. 371). If Freud is right, this fact would have obvious implications for our question about no-smoking signs. Specifically, it might mean that the unconscious mind would treat "*no* smoking"' on a par with its opposite—"smoking"—in much the same way that "It was *not* my mother" means (according to Freud) that it almost certainly was.

Modern psychological research seems to supports this view—i.e., that the unconscious mind does indeed show a deficit in handling negation. Deutsch, Gawronski, and Strack (2006), for instance, used an evaluative priming task to show that negated, positively-valenced prime words had the same effect on target judgments as affirmed primes: in both cases, the target evaluation showed a positive-valence bias. As far as the unconscious mind is concerned, then, "*not* good" means the same as its opposite; the negation is effectively dropped. Gawronski, Deutsch, Mbirkou, Seibt, and Strack (2008) extended these findings to anti-stereotype training regimens, showing that the desired outcome—namely a fully automatized positive stereotype in place of an original negative one—was attainable only through repeated affirmations of the counterstereotype, and not by constant negation of the original. The latter method perversely yielded the opposite effect. That is, repeated negations of a negative stereotype serve only to facilitate stereotype-consistent judgments.

These findings are consistent with a dual-process theory of mind according to which unconscious reasoning systems are computationally associative—and therefore incapable of rule-based manipulations like negation—whereas it is the *conscious* mind that is rule-based and systematic and thus able to inhibit or repress automatic associational outputs (e.g., Sloman, 1996). But even the conscious mind struggles with negation. In a classic demonstration, Wason (1959) showed that participants are slower and more error-prone when performing logical operations involving negation compared to

operations that are meaning-identical but framed affirmatively. Gilbert (1991) provides evidence that while "the acceptance of an idea is part of the automatic comprehension of that idea," the conscious negation of an idea "occurs subsequent to, and more effortfully than, its acceptance" (p. 107). And Fyodor Dostoevsky (1863/1997), as penetrating a psychologist as any, gives the following case study: "Try to pose for yourself this task," he writes in *Winter Notes on Summer Impressions*, "*not* to think of a polar bear—and you will see that the cursed thing will come to mind every minute" (p. 49, emphasis added). That is, even when we consciously *try* to negate, we often fail. The relevant concept, once introduced by the negation-based prompt, blithely remains activated despite our best efforts. This paradoxical nature of conscious thought suppression has been thoroughly confirmed in numerous laboratory settings over the past thirty years (for a review, see Wenszlaff & Wegner, 2000).

Both conscious and unconscious mental systems, then, seem to treat negations differently from affirmations—processing them more reluctantly in the first case or not at all in the second. Accordingly, we have some clear parameters for the sort of prediction we should make about the case at hand, namely the likely effect of incidental exposure to no-smoking signs in a typical public environment. Either the signs will be perceived unconsciously, in which case the "no" in "no-smoking" should be totally discounted; or else they will be processed with some degree of conscious awareness, in which case the negation will be handled more or less effectively depending upon the degree of awareness and the available cognitive resources. Either way, we should expect incidental exposure to the signs to induce (relatively) increased salience of the concept "smoking" (through relatively *decreased* processing of the "no"), and for individuals who are predisposed to evaluate smoking-related cues positively—i.e., habitual smokers—to exhibit corresponding evidence of boosted affect toward those cues.

THE PRESENT STUDY

The present study is our attempt to test this hypothesis. For the IV task, participants viewed a series of photographs on a computer screen, and were asked (as a cover) to judge whether the pictures were taken by a professional or amateur photographer. The photographs included images of everyday scenes in which no-smoking signs were either inconspicuously embedded (prime condition) or edited out (control condition). The "professional vs. amateur" distraction task was meant to conceal the nature of the prime as well as to preclude participants from focusing on any one aspect of the pictures, in particular the no-smoking signs themselves, to ensure that exposure was truly "incidental" and essentially consistent between participants.

For the DV task, participants used a joystick to make quick approach vs. avoid motions while viewing smoking-related and neutral stimuli on a computer screen. This task was adapted from Chen and Bargh (1999; see also Krieglmeyer, Deutsch, De Houwer, & De Raedt, 2010), who showed that moving a lever toward a stimulus is treated by the motor system as a "pushing away" or avoidance motion (participants are quicker to move the joystick in this direction in response to *negative* stimuli), while pulling a lever toward oneself activates muscle patterns associated with approach (i.e., pull-

ing the stimulus closer to oneself, which participants are quicker to do in response to *positive* stimuli). We hypothesized that smokers in the prime condition would be slower than controls to make avoid motions, and faster to make approach motions, in response to the smoking-related stimuli. Thus the joystick task functions as a craving or motivational measure without participants' awareness of what is being assessed.

Method

Participants

Participants were students and community members recruited on or near a college campus in the Northeastern United States. Recruitment consisted of a poster and email campaign asking, "Are you a smoker?" and which described the experiment as a "Health Attitudes" study. Compensation of $15 for approximately 20 minutes' participation was advertised. Of the total respondents, 20 men and 12 women (n = 32) met the pre-screen requirements and were invited to participate in the study. Participants were aged 18 to 49 years old (M = 26.17).

Materials and procedure

Prior to being invited to join the study, potential participants were sent an email in which they were given the following information:

> We're doing research on the health attitudes of different people, so we're looking at different groups: students, community members, smokers, non-smokers, people with different diet and exercise habits, and so on. If you're eligible for the study, you will come into the lab for just about 20-30 minutes and complete two brief computer tasks as well as fill out a short questionnaire. Compensation is $15.

The study was described in this way to minimize participants' ability to guess the particular theme or hypothesis of our research. That is, by framing participants' smoker identity as constituting just one of multiple demographic qualities of interest, we aimed to reduce vigilance for smoking cues on the day of actual study participation, with only minimal deception. After reading the above paragraph, potential participants filled out a brief health questionnaire, also by email. This questionnaire included an item asking about the recent (within 48 hours) consumption of a number of products, including our pre-screen item: a cigarette. Participants who indicated that they had consumed at least one cigarette within the past 48 hours were invited to join the study.

On the day of the study, participants were brought into the lab and seated at a large table outside the testing cubicle. Before signing the consent form, participants were once again given the "multiple demographics" and broad "health attitudes" cover story, but this time with absolutely no mention of the word "smoking." Again, this was meant to divert any suspicion that the study might have to do with smoking or craving behavior in particular, and to minimize the chance for any extraneous priming effects outside the IV task.

After the experimenter had delivered the cover story and collected the consent form, participants were led into an adjacent 3 × 3 meter testing room and seated in front of a 800 × 600 pixel Dell Plug and Play CRT Monitor running on a 2.8 GHz Pentium® 4 CPU. The monitor was positioned at the participant's eye level, approximately 60 cm from the face, and a standard computer key-

board was placed between the monitor and the participant.

Participants were then told that they would be shown a series of images, and that their task was to determine whether each image had been taken by a professional or an amateur photographer. Each image would appear for 1.5 seconds, and then the screen would show a prompt, at which point participants were to use the keyboard to press "p" for "professional" or "a" for "amateur." Participants were explicitly told that this first task was *not* a speed task, and that they should look at each image for the full 1.5 seconds and wait for the prompt before pressing any keys. The experimenter remained in the cubicle while the participant executed 5 practice trials on neutral images, confirmed that the instructions were fully understood, and then pressed a key to start the experimental trial before leaving the cubicle.

In the experimental trial, participants were shown 23 images of everyday scenes selected from a Google image search, one at a time, in randomized order (different for each participant). Images appeared on the screen for 1.5 seconds, after which time the screen refreshed to show the prompt. After participants registered their judgment, the next image appeared, again for 1.5 seconds, and so on through the rest of the images. In the prime condition, 13 of the 23 images included no-smoking signs. The control condition included all of the same images in randomized order, but with the no-smoking signs discretely edited out.

For the DV task, the experimenter brought out a Logitech® ATK3 gaming joystick that was connected to the computer's USB port, and instructed participants on its use. Participants were told the following:

> This task is different from the task you just did in a couple of ways. First of all, speed is really important – this is a reaction speed test, and your one goal is to react as quickly as you can. Various images will pop onto the screen, and your job is, as soon as you any image at all, whatever it is, to "knock it off the screen" by moving this joystick.

The DV task was divided into two blocks: a "forward" block and a "backward" block. Each participant completed both blocks, counterbalanced for order. Statistical analysis revealed no effect of order on the data (UNI-ANOVA of prime by order, $p = .802$), so this design feature will receive no further discussion. In the forward block, participants were instructed to move the lever *toward* the monitor in order to "knock the images" off the screen, which Chen and Bargh (1999) showed involves an implicit "pushing away" or avoid motion. In the backward block, participants were told to move the lever *away* from the monitor, an implicit "pulling toward" or approach motion. It is important to note that no actual mention was made of "pushing" or "pulling" the lever, as this might activate corresponding conscious motivations; only the goal-neutral words "forward" and "backward" were used in the task instructions.

After 5 practice trials (3 for the second block), the experimenter pressed a key to start the first block of experimental trials and left the cubicle. Participants were then shown a series of 25 stimuli, 21 of which were images of neutral objects like soccer balls and can openers, and 4 of which were "smoking-related" images like lit cigarettes. Each stimulus appeared after a variable interval ranging from 2 – 7 seconds, and disappeared in response to joystick movements in the appropriate direction depending on block. Response times for each image were

recorded by the computer. After completing the first block, participants were instructed to do the very same task once again, but to "knock the images off the screen" by moving the joystick in the opposite direction.

After completing both DV blocks, participants were led back into the main lab room and given a brief nicotine addiction questionnaire (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). The experimenter then administered a careful funnel interview (Bargh & Chartrand, 2000) to test for awareness or suspicion of the hypothesis. Participants were then compensated and debriefed.

Results

Scores on the FTND ranged from 0 to 5 (M = 1.00, SD = 1.39) out of a possible 8 points, indicating relatively low levels of nicotine addiction among this group. Participants in the control and prime conditions did not differ in level of nicotine addiction (p = .81). Due to the positive skew in response time data, all response latencies were log transformed (Chen & Bargh, 1999), however, for ease of interpretation, we report original millisecond response times. For each participant, we subtracted the mean response time of approach trials from the mean response time of avoid trials for both smoking-related and neutral images. Because participants would be *faster* to make an approach motion in response to stimuli they are motivated to approach, and *slower* to make an avoid motion, a higher *avoid-minus-approach* score indicates a behavioral tendency to approach the stimulus. Conversely, a lower or negative avoid-minus-approach score indicates a less-pronounced approach tendency or a behavioral tendency to avoid the stimulus. We conducted an Analysis of Covariance (ANCOVA) with a between-subjects comparison of avoid-minus-approach scores for smoking stimuli (prime versus control condition). For this analysis we covaried avoid-minus-approach scores for neutral stimuli in order to control for individual differences in relative pushing versus pulling speed, and in chronic tendencies to approach or avoid stimuli in general.

Data from two participants were excluded from the final analysis: one for failing to follow task instructions, the other due to a computer malfunction that lost the participant's data. Overall, participants displayed a modest tendency to approach smoking-related stimuli (M = 8.6 ms, SD = 104) versus neutral stimuli (M = -14.0 ms, SD = 73), $t(29) = 1.63$, $p = .11$.

Results of the ANCOVA confirmed that exposure to no-smoking signs increased approach tendencies toward smoking-related stimuli, $F(1, 28) = 4.02$, $p = .055$, $\varphi = .13$. In addition, this approach tendency toward smoking-related stimuli was significantly higher after participants had been primed with no-smoking signs, $t(14) = 2.51$, $p = .03$, but not after neutral primes, $t(15) = .22$, $p = .83$ (see Figure 1). These findings support our hypothesis that incidental exposure to no-smoking signs increases automatic approach tendencies of smokers toward smoking-related stimuli.

Preliminary Discussion and Supplementary Analyses

We expected some variability in the level or type of priming (incidental exposure to the no-smoking signs) experienced by participants in the experimental condition. Since participants were free to cast their gaze over the IV photographs in whatever manner they saw fit, it is possible that some participants,

to a greater or lesser degree, consciously *noticed* the signs. Indeed, the funnel interview identified seven participants in the experimental condition who noticed the no-smoking signs in the photographs (but could not guess the experimental hypothesis).

Consistent with our earlier reasoning, we would expect that these participants, compared to those who did not notice the signs, would be more able to engage in conscious or rule-based processing and hence more able to account for the negation. This would predict that participants who noticed the signs would show *less* activation of the concept "smoking"—and therefore smaller avoid-minus-approach scores. To test for this, we ran another ANCOVA between-subjects analysis, controlling for responses to neutral stimuli as before. Surprisingly, there was no significant difference in these scores between participants who did and did not notice the signs, $F(1, 14) = .61$, $p = .45$.

Given our theoretical framework, there are at least two ways to account for this result. The first way has to do with the fact (noted earlier) that "even the conscious mind struggles with negation." On this account, "noticing" the no-smoking signs while engaged in a cognitively loading distracter task may involve insufficient processing resources, even conscious ones, to fully account for the "no" in "no-smoking." This would be an "up-stream" explanation saying in essence that the negation was never fully registered, even at the outset, and so failed to have an inhibitory effect on craving.

The second way has to do with the general nature of unconscious priming effects, namely that they can occur even if the stimulus is perceived, so long as the *effect* of the stimulus on behavior takes place outside of awareness (Bargh & Chartrand, 2000). Importantly, none of our participants reported awareness of the nature of the DV task, namely that it was designed to assess crav-

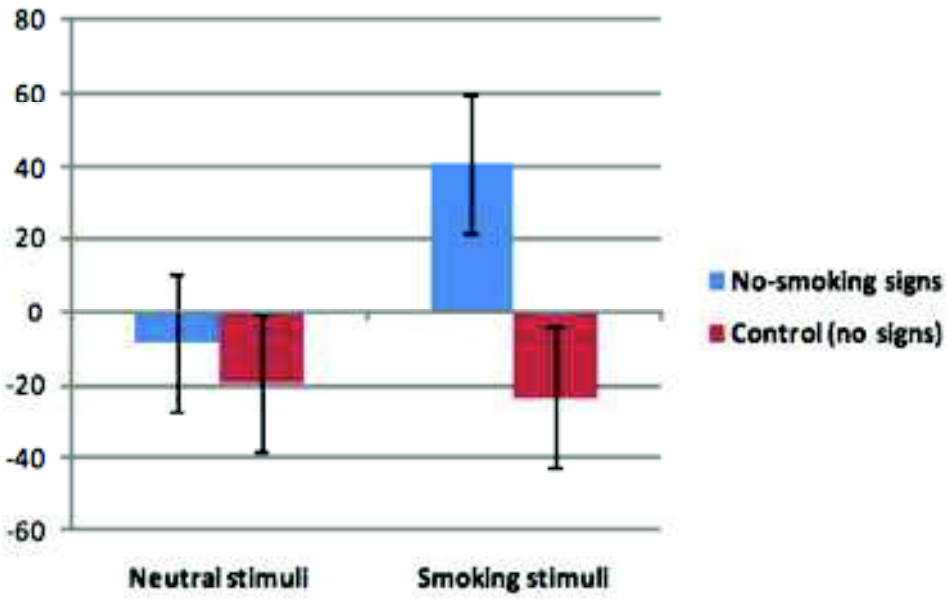

Figure 1. Differences in avoid-minus-approach scores for neutral versus smoking stimuli. Y-axis is response time in milliseconds.

ing, nor an understanding of the relationship between the IV and DV tasks. Thus it is possible that the "no" in "no-smoking" *was* fully registered by conscious mental systems, but failed to integrate with the rest of the sign's message somewhere "downstream" during unconscious semantic processing. This would be consistent with the work of Greenwald and Liu (1985), who demonstrated that for evaluative priming, two-word phrases such as "enemy fails" did not function as positive primes (as they should if the meanings of the individual words were integrated into a single concept), but rather as 'double negative' primes (in the above example, each of the words in isolation has a negative connotation).

Both of these explanations would count as "ironic" effects of unconscious semantic processing, involving the activation of a negated concept, and its subsequent effect on behavior. However, another conceivable explanation side-steps our unconscious/negation model completely. Perhaps nicotine addiction is so robust that *any* smoking-relevant cue—positive or negative, conscious or unconscious—is sufficient to prime craving. Harris, Pierce, and Bargh (in prep), for example, found that exposing smokers to televised anti-smoking ads actually increased smoking behavior, even when the ads were consciously remembered, and regardless of ad valence: even grotesque images of blackened, cancerous lungs caused participants to light up cigarettes during a break between study tasks. However, as nicotine addiction levels in our sample group were quite low, the "unconscious semantic processing" hypothesis seems better able to account for our reported results. Future research should investigate these explanatory avenues in more detail. Whatever the mechanism, we report no difference in cigarette-approach behavior between participants who consciously noticed the no-smoking signs and those who did not.

GENERAL DISCUSSION

We may summarize our findings as follows: incidental exposure to no-smoking signs appears to boost implicit motivation to approach smoking-related stimuli. This motivation is evidenced by increased stimulus-approach movements by self-identified smokers after exposure to the primes. Furthermore, this automatic approach bias seems to occur regardless of the level of conscious processing of the no-smoking signs.

What does this mean for real life? The question of ecological validity is an important one. Let us assume that our findings are valid, that is, that incidental exposure to no-smoking signs through a computer task can increase the rate of cigarette-approach movements by several milliseconds, outside of participant awareness. This, of course, does not mean that every smoker who walks past a no-smoking sign on her way to the gym will find herself reaching for a pack of smokes and lighting up. In other words, the craving measure used in the present study is potentially so sensitive, and our prime so robust (participants in the experimental condition were exposed to 13 separate no-smoking signs over a short period of time), that the effect we report might not translate to actual smoking behavior. Nevertheless, having taken a first, controlled step in establishing this effect, we hope to have opened a door for future researchers to try blunter, noisier, and more ecologically valid meth-

ods in teasing out the real-life limits of the phenomenon.

Even if our effect turns out to be weak, however, it may still have important public health implications. A weak influence on behavior is still enough to tip the balance when an individual is on the edge between one course of action and another. With millions of smokers worldwide passing by multiple no-smoking signs several times per day, there is surely a fair chance that even the smallest boost in craving could have compound consequences from year to year, including increased sales for tobacco companies—one cigarette at a time. If this turns out to be the case, it might be prudent to reevaluate the widespread posting of no-smoking signs as a measure aimed at reducing public smoking.

There are broader implications still. How often do we attempt to influence others' attitudes and behavior by recruiting a negative frame—*don't* believe this; *stop* doing that—instead of by affirming the target judgment or action? Once called to mind, a concept is liable to stick there—whether it's preceded by a negation or not. The present research lends credibility to affirmation-based persuasion strategies, whether the domain is parenting, education, or public health, and raises a caution against discouragement based on "no."

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