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Resisting Tempting Foods and Smoking Behavior: Implications From a Self-Control Theory Perspective

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Abstract

Objective—Individuals may desire to diet or restrain from eating certain foods while attempting to quit smoking out of concern for weight gain. However, previous research and clinical tobacco treatment guidelines suggest that concurrent dieting may undermine attempts to quit smoking. The current study applied the self-control strength model, which posits that self-regulation relies on a limited strength that is consumed with use, to test whether resisting tempting sweets would lead to a greater likelihood of subsequent smoking.

Design—Participants were 101 cigarette smokers randomly assigned to resist eating either from a tempting plate of sweets or from a plate of less tempting vegetables. All participants were then given a 10-min recess.

Main Outcome Measures—Whether participants smoked during the break, measured with a breath carbon monoxide sample, served as the primary dependent variable.

Results—As predicted, participants who resisted sweets were more likely to smoke during the break (53.2%) than those who resisted vegetables (34.0%), $\chi^2(1, N = 101) = 3.65, p < .05$.

Conclusions—The findings support the tenets of the self-control strength model and suggest the mechanism by which dietary restraint may harm efforts at quitting smoking.

Keywords

cigarette smoking; self-control; self-regulation; weight management; health behavior

Tobacco is the second leading cause of death in the world (World Health Organization, 2006), accounting for about 5 million deaths annually, equivalent to 1 in 10 adults worldwide. In the United States, more than 400,000 people die each year from cigarette smoking. Despite these statistics, concerns over weight gain are often grounds for initiation of smoking behavior, reluctance to quit smoking, and smoking relapse (Gritz & Crane, 1991; Klesges, Meyers, Klesges, & La Vasque, 1989; Perkins, Epstein, Fonte, Mitchell, & Grobe, 1995).

Clinical tobacco treatment practice guidelines recommend that individuals concentrate on smoking cessation rather than caloric restriction until they are confident that they will not relapse (Fiore et al., 2008). Studies with animals (e.g., Carroll, Stotz, Kliner, & Meisch, 1984) and humans (e.g., Cheskin, Hess, Henningfield, & Gorelick, 2005; Hall, Tunstall, Vila, & Duffy, 1992) have demonstrated that concurrent dieting may undermine attempts to quit smoking. Hall and colleagues (1992) found that individuals who received either an individualized diet plan intervention or general nutritional educational treatment combined with smoking cessation counseling had higher smoking rates at follow-ups compared with a

group receiving only smoking cessation counseling. Similarly, a controlled experiment conducted in an inpatient research ward demonstrated that patients smoked 8% more cigarettes while on a 6-day low-calorie diet compared to their smoking while on a 6-day normal calorie diet (Cheskin et al., 2005).

The current study focuses on the importance of self-control to understanding both dieting and smoking behaviors. Self-control is defined as overriding or inhibiting behaviors, urges, or desires that would otherwise interfere with goal directed behavior (Barkley, 1997; Baumeister, Bratslavsky, Muraven, & Tice, 1998). Without self-control, an individual would carry out his or her normal or automatic behavior or engage in immediate, short-term focused actions, unable to delay immediate gratification (Hayes, Gifford, & Ruckstuhl, 1996; Rachlin, 2000). The ability to exert self-control is critical for successful smoking cessation because smoking becomes an automatic pattern of behavior and someone who typically smokes and wishes to quit must exert self-control to resist that urge and break the habit (Brown, 1998; Tiffany, 1990). Similarly, with weight loss efforts, self-control is essential to successfully restrain from eating various foods (Herman & Polivy, 2004). Problem eating, specifically binge eating, has been associated with poor general self-control (Ricciardelli, Williams, & Finemore, 2001).

An innovative model of self-control, the self-control strength model (Muraven & Baumeister, 2000) may offer an explanation for the detrimental effects of dietary restraint on smoking behavior. The self-control strength model suggests that individuals have a limited resource, self-control strength, to use for various volitional exertions such as resisting temptations. According to this model, exerting self-control consumes or depletes this resource for a short time and as a result individuals are prone to perform more poorly on subsequent tasks that require self-control. Psychological experiments using a variety of self-control depletion techniques have demonstrated support for the self-control strength model and shown that exerting self-control on one task impairs further performance for a range of subsequent tasks that require self-control (e.g., Baumeister et al., 1998; Vohs & Heatherton, 2000). For instance, a study of social drinkers exposed to the sight and smell of their favorite alcoholic beverage, but instructed to resist drinking it, performed more poorly on a difficult handgrip task and a self-stopping reaction time measure, compared to their performance after resisting water (Muraven & Shmueli, 2006). In another set of studies, participants' whose self-control strength was depleted were more likely to cheat on a test than those who were not depleted (Muraven, Pogarsky, & Shmueli, 2006; Shmueli & Muraven, 2007). Thus, according to the self-control strength model, two seemingly unrelated tasks that demand inhibition can affect one another because they both require and deplete the same self-control strength or resource.

The current study explored the implications of the self-control strength model for the co-occurring self-regulation demands of cigarette smoking and caloric restriction. In the testing paradigm, participants were exposed to tempting foods (e.g., cookies, candy) or raw vegetables and asked to resist eating from them. Previous research indicates that craving for food can be elicited by exposure to food cues, such as the sight and smell of food. Following the self-control strength model, resisting the urge to eat tempting foods should deplete self-control strength and impair subsequent attempts to override the urge to smoke. There is evidence linking food-related cue exposure and subsequent self-control performance in areas other than smoking. Participants who were exposed to but instructed to resist eating from a tempting plate of chocolate chip cookies performed more poorly on a subsequent self-control task of frustration tolerance, compared with a control condition instructed to resist eating radishes (Baumeister et al., 1998). Another study demonstrated that dieters who resisted the temptation of candy were more likely to subsequently break their diet than dieters who did not have to resist that temptation (Heatherton & Vohs, 1997).

The current study assessed whether cue exposure involving sweets leads to a greater urge for cigarettes and a greater likelihood of subsequent smoking. We hypothesized that: (a) the task of resisting tempting sweets rather than raw vegetables would deplete participants' self-control resources leading to a greater likelihood of their smoking during an assigned study break; and (b) participants who resisted tempting sweets would report higher urges to smoke cigarettes than those who resisted raw vegetables. If depletion of self-control strength is the mechanism underlying the detrimental effects of dietary restraint on smoking behavior, the findings will support the current clinical guidelines, which suggest delaying dieting when initially quitting smoking (Fiore et al., 2008) and provide an explanation for why they are important.

Method

Participants and Recruitment

The sample consisted of 101 smokers from the San Francisco Bay Area. Recruitment was done using flyers and ads posted in the community section of Craigslist. Inclusion criteria were legal smoking age (≥ 18 years old) and smoking a minimum of one cigarette a week. The study aimed to recruit a range of heavy and light smokers out of concern that heavy smokers would take the opportunity to smoke during the break, regardless of their experimental condition. Participants with allergies, sensitivities, or health conditions (e.g., diabetes) adversely affected by the potential consumption of sweets (chocolate chip cookies, brownies, hard candy, or any ingredients therein) or vegetables (radishes or broccoli) were excluded. Participants who were non-English speaking or had below an eighth-grade education were excluded because of the quantity and reading level of the questionnaires.

Procedures

Participants were told that the purpose of the experiment was to test whether smokers are able to resist the urge to eat from different foods when exposed to their sight and smell. The study followed American Psychology Association ethical standards in the treatment of the participants, all procedures were approved by the Institutional Review Board of the University of California, San Francisco, and participants provided informed consent. Participants were tested individually in sessions lasting approximately 1 hr ($M = 49.3$ min, $SD = 8.62$).

First, participants completed a set of pre-experimental measures, detailed below, which included an expired air carbon monoxide (CO) sample. Participants then underwent the cue exposure phase of the study. Following standard cue reactivity assessments used in similar studies (Monti, et al. 1993) participants were presented with a large plate of either tempting sweets (high fat sweets such as brownies and chocolate chip cookies) or vegetables (radishes and broccoli), according to a predetermined randomized order. Participants were instructed to resist eating from the food while the experimenter left the room. During that time, they were to follow a 5-min prerecorded tape with a series of bell rings (the duration between rings varied, $M = 15$ s). Every time the bell rang they were to lift the plate and smell the food for a few seconds before putting it back down. They also were instructed to think about the temptation involved in resisting the food, although it was emphasized that they should try not to actually eat any of it.

Immediately following the cue exposure task, participants completed a nine-item manipulation check assessing perceived interest, difficulty, and pleasantness of the task. Participants were then given a 10-min intermission, before continuing with the rest of the study. They were asked to leave the room so that the experimenter could prepare the next phase of the study, but given no restrictions as to what to do during the break. The testing room was located on the ground floor of a medical center with a large lobby and easy access to the sidewalk outside. Thus, participants' potential alternatives were to remain in the indoor lobby waiting area or go

outside. Unknown to the participants, whether they chose to smoke during the break was the primary dependent variable of the study. On their return to the room, participants were asked to provide another expired CO sample. Participants then completed a set of postexperimental measures, detailed below.

Finally, participants were debriefed, paid \$30 for their time, thanked for their participation in the study, and provided a referral list for smoking cessation programs. To reduce potential priming of smoking behavior, following each participant's departure from the clinic, the experimenter cleaned any discarded cigarette butts from outside the clinic vicinity.

Measures

Pre-experimental measures—Pre-experimental measures included a Bedfont Smokerlyzer to evaluate participants' expired CO levels and obtain a specific personalized reading of the level of carbon monoxide in participants' lungs in measures of parts per million (range 1 to 80 ppm). This measure used in clinical tobacco cessation trials provides an unbiased and reliable indicator of recent smoking (e.g., Irving, Clark, Crombie, & Smith, 1988; Jarvis, Belcher, Vesey, & Hutchinson, 1986). Participants also completed a demographic form; Smoking Stage of Change Scale (DiClemente et al., 1991; 5 items), assessing readiness to quit smoking and categorizing smokers into one of the three pre-action stages (precontemplation, contemplation, and preparation); Fagerström Test for Nicotine Dependence (FTND, Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991; 6 items) assessing smoking behaviors indicative of physical dependence; and a Food Questionnaire (Muraven, Shmueli, & Burkley, 2006; 18 items), assessing participants' hunger and general liking of and desire for sweets and vegetables at that moment with additional items assessing the time of participants' last cigarette and last meal.

Postcue exposure measures—Postcue exposure measures completed after participants resisted either sweets or raw vegetables included a Manipulation Check developed for the current study, which assessed perceived interest (2 items, $\alpha = .68$), difficulty (4 items, $\alpha = .93$), and pleasantness (2 items, $\alpha = .80$) of the task with participants in both conditions. Three additional items assessed participants' perception of the temptation involved in the task, their attention to the task, and whether they followed instructions by looking at the food and thinking about the temptation involved. In addition, participants completed the Minnesota Nicotine Withdrawal Scale (MNWS; Hughes & Hatsukami, 1986), a 13-item scale assessing the severity of a broad range of symptoms associated with nicotine withdrawal (e.g., craving), (Cronbach's $\alpha = .81$ in the current sample). The original MNWS was expanded for this study to include 7 items pertaining to foods (e.g., urge for salty food) so as to better conceal the nicotine-related questions.

Postexperimental measures—Postexperimental measures completed after the break included a second CO reading and the Questionnaire of Smoking Urges–Brief (QSU–Brief; Cox, Tiffany, & Christen, 2001), a 10-item measure assessing smoking urges shown to have good validity and reliability (Toll, Katulak, & McKee, 2006), with Cronbach's $\alpha = .93$ in the current sample. The primary dependent variables of the study were changes in CO levels from baseline to the reading taken after the break and reports of smoking urges. A CO change score greater than zero was used to indicate smoking during the break. Participants also were asked to self-report whether they smoked during the break. The proportion of agreement between self-reported smoking and categorization of smoking based on change in CO level was $\kappa = .88$, $p < .001$. Using change in CO level was deemed preferable because this continuous variable yields greater power for detecting an effect. All but one of the discrepant cases involved participants reporting smoking during the break, and CO readings indicating that they did not. These discrepancies may have been due to demand characteristics, as the self-report measure

was given after the CO reading, after which participants may have formed an interpretation of the experiment's purpose.

Statistical Analyses

Descriptive statistics were calculated for participants' demographic and smoking characteristics. As a manipulation check, *t* tests were used to explore differences between the experimental and control conditions on perceptions of the food cue exposure task. Of concern, 4 of the 101 participants did not follow the food exposure directions and hence did not experience the appropriate manipulation: 3 participants ate cookies during the cue exposure task, stating they could not resist them, and a fourth participant attempted to fast-forward the prerecorded tape with the bell rings, to reduce the time he or she had to resist eating from the plate of cookies and sweets. For tests of the two main hypotheses, these 4 participants were removed from the analyses. An analysis of variance (ANOVA) and chi-square test were used to test Hypothesis 1, specifically whether participants in the experimental (cookies) condition were more likely to smoke during the break in the study compared to those in the control (vegetables) condition. That is, the primary dependent variable "smoking" was examined both as a continuous measure of difference score between the two CO readings, and as a dichotomous variable classifying participants into those who smoked during the break and those who did not. Hypothesis 2 was investigated using *t* tests exploring differences between the experimental and control conditions on urge to smoke. Correlations, ANOVAs, chi-square, and logistic regression also were run to examine variables associated with urge to smoke and likelihood of smoking during the break, and the relationship between participants' hunger and their perception of the temptation involved in the food cue exposure task.

Results

Sample Characteristics

The sample was demographically diverse with 41% White, 35% African American, and 25% reporting another racial category, including multiracial. In addition, 8% of the sample reported being Hispanic. Of the 101 participants, 54 were men, 41 were women, and 6 reported being transgender. The mean age of the sample was 42 years old ($SD = 12.93$), 84% had completed high school, and 16% were married or cohabiting. Participants reported smoking a mean of 13.6 ($SD = 8.9$, range 0 to 48) cigarettes the day prior to testing. Participants reported their usual cigarettes per day as 10 or fewer (34%), 10 to 20 (48%), 20 to 30 (17%), and over 30 (1%). Scores on the FTND averaged 3.6 ($SD = 2.2$). Over half (58%) reported smoking within 30 min of waking. Nearly half the sample (45%) reported no intention to quit smoking in the next 6 months (i.e., precontemplation stage), 40% intended to quit in the next 6 months (i.e., contemplation), and 12% were preparing to quit in the next 30 days. There were no statistically significant differences in the demographic or tobacco use characteristics of participants assigned to the experimental versus control groups (see Table 1).

Cue Exposure Manipulation Check

The two groups (cookies or vegetables) did not differ in ratings of the tasks' level of difficulty $t(98) = -.77$, *ns*, or pleasantness, $t(99) = -.68$, *ns*. There also was no significant difference in ratings of interest, $t(98) = -1.96$, $p = .053$, although the marginally significant trend demonstrated that participants who resisted the cookies found the task more interesting than participants who resisted the vegetables. In addition, there was no significant difference in how much participants looked at $t(99) = -.82$, *ns*, or thought about $t(99) = -.84$, *ns*, the food during the task.

There was a significant difference in participants' rated temptation of the food. Participants who resisted cookies reported the food was more tempting ($M = 26.10$, $SD = 3.08$) than

participants who resisted the plate of raw vegetables ($M = 23.90$, $SD = 3.69$), $t(98) = -3.24$, $p < .05$. This suggests that the food manipulation, designed to generate different magnitudes of temptation using two different assortments of food, succeeded. Regardless of condition, there also was a significant correlation between how hungry participants were before starting the food cue exposure and how tempting they perceived the task to be, $r = .37$, $p < .001$. There was no difference between the experimental (cookie) and control (vegetable) groups in how hungry they reported being prior to the cue exposure task, $t(76) = .22$, ns .

Smoking Behavior

The primary variable of interest in the study was whether participants smoked during the 10-min study break. As predicted, smokers who resisted sweets had a significantly greater mean increase in their CO level ($M = 1.09$, $SD = 3.69$) compared to those who resisted vegetables ($M = -0.32$, $SD = 2.39$), $t(95) = 2.24$, $p < .05$. For smokers in the experimental condition, the mean CO level increased from a baseline of 19.45 ppm ($SD = 13.07$) to 20.53 ppm ($SD = 12.85$) after the break. For smokers in the control condition, the mean CO level decreased from a baseline of 17.24 ppm ($SD = 12.24$) to 16.92 ppm ($SD = 12.38$) after the break.

In addition, examined as a dichotomous variable, based on an increase in CO level from baseline to postbreak, participants who resisted sweets were more likely to smoke during the break (53.2%) than those who resisted vegetables (34.0%), $\chi^2(1, N = 97) = 3.65$, $p < .05$. A consistent trend was found when calculating smoking behavior using self-report rather than the CO measure, although it did not reach significance. In the experimental group 51.1% of participants reported smoking during the break, compared with 42% in the control group, $\chi^2(1, N = 97) = 8.0$ ns .

Regardless of condition, a logistic regression indicated a statistically significant relationship between smoking dependency and likelihood of smoking during the break, $\chi^2(1, N = 97) = 4.66$, $p < .05$. Every one unit increase in participants' FTND score increased the odds that participants smoked by 22.6%. Similarly, participants who smoked less than 10 cigarettes per day were less likely to smoke (26.5%) compared to moderate and heavy smokers who smoked over 10 cigarettes per day (52.4%), $\chi^2(1, N = 97) = 6.04$, $p < .05$, and smokers in the precontemplation and contemplation stages were more likely to smoke (45.7%) compared with smokers in preparation (25%), although this trend did not reach significance, $\chi^2(1, N = 93) = 1.82$, $p = .177$. These findings may indicate that lighter smokers (i.e., those who are less dependent, smoke fewer cigarettes per day, and are in the preparation stage of change) are more actively attempting to quit smoking.

However, there were no differential effects found when testing for interactions. Neither smoking dependence, $F(1, 93) = 2.09$, ns , smoking quantity, $F(1, 93) = 1.81$, ns , or smoking stage of change, $F(1, 93) = 1.49$ ns , showed significant interactions with the experimental manipulation. That is, level of smoking, nicotine dependence, and stage of change did not moderate the relationship between temptation condition and smoking behavior, demonstrating generalizability of the findings.

Nicotine Withdrawal Symptoms and Urge to Smoke

On the MNWS completed prior to the study break, participants in the experimental condition reported experiencing the same level of nicotine withdrawal symptoms as control participants, $t(95) = -.03$, ns . There also were no significant differences in their scores on the seven additional items pertaining to desire for various foods.

Similarly, participants' total scores on the QSU-Brief, completed after the break, revealed no difference in smoking urge by condition, $t(95) = 1.22$, ns . Urge to smoke was positively

correlated with how difficult, $r = .42, p < .001$, and unpleasant $r = .41, p < .001$ participants perceived the food cue exposure task. Similarly, participants who reported liking sweets more, $r = .25, p < .05$, and who were more heavily dependent on smoking $r = -.44, p < .001$, showed higher urges to smoke, regardless of condition.

Discussion

In the current study, smokers who resisted tempting sweets were more likely to smoke a cigarette during a break in the study, compared to smokers who resisted raw vegetables. That is, participants whose self-control strength was depleted by the initial task of inhibition were more likely to smoke when given an opportunity to do so in the ensuing break. This pattern of one self-control task impairing a subsequent self-control related task is consistent with previous work on successive attempts at self-regulation (e.g., Baumeister et al., 1998). What the current study adds is application of the self-control paradigm to understanding the competing demands of tobacco use and dietary restraint, providing empirical support for tobacco treatment clinical practice guidelines, which discourage concurrent dieting during cessation attempts.

It is important to note that nearly half of the smokers in the study (46%) did not report intentions to quit smoking, and therefore may not have been trying to inhibit their smoking behavior. In that case, it may imply that resisting temptation may subsequently increase individuals' automatic behaviors or habits (i.e., smoking), even for those who are not actively trying to inhibit or control their behavior, thus making the results applicable to smokers who are not actively attempting to quit smoking.

The study findings may help explain how fighting against a temptation affects subsequent smoking behavior. Exposure to a tempting substance, such as sweets in the present study, triggers an automatic inclination to eat from the food, and requires self-control to inhibit that behavior. This exertion of self-control may deplete an individual's self-control strength or capacity and put him or her at risk for subsequently increasing habitual behaviors such as smoking.

The findings have implications for understanding co-occurring self-regulation demands in daily life and may be particularly relevant for multiple-health behavior change interventions with smokers. Epidemiological studies have shown that tobacco users, in particular, tend to have poor behavioral profiles, with about 92% of smokers engaging in at least one additional risk behavior (Fine, Philogene, Gramling, Coups, & Sinha, 2004; Klesges, Eck, Isbell, Fulliton, & Hanson, 1990). Innovative interventions designed to address multiple risks in tobacco users may need to consider staggering or delaying secondary change efforts.

The study findings hold specific relevance to the issue of co-occurring dietary restraint and smoking cessation. Many instances may involve simultaneous restriction of certain foods and tobacco use: A 45-year-old patient is advised by his physician to stop smoking cigars and resist consumption of fast foods after suffering a heart attack; a pregnant woman decides to quit smoking and begins to reduce her intake of sweets out of concern of excessive weight gain; an optimistic couple vow to begin a diet and quit smoking as their New Year's resolution. The present findings suggest that because inhibiting one behavior may impair the other, it would be best to focus on only one behavior initially. This is consistent with research that suggests that intervention success is greater when behavior changes are initiated sequentially rather than simultaneously (Spring et al., 2004). The study findings support the current clinical practice guidelines (Fiore et al., 2008) that recommend smokers focus solely on smoking cessation and ignore weight management until they are confident that they will not relapse. Other experiments also have supported the idea that dieting during smoking cessation may increase the risk of relapse, and longitudinal studies have demonstrated that weight gain during early abstinence

is predictive of long-term abstinence rather than relapse (Borrelli, Papandonatos, Spring, Hitsman, & Niaura, 2004; Hall, Ginsberg, & Jones, 1986; Ockene et al., 2000). The results of the study support previous research and clinical practice guidelines and also provide an explanation of why they are important. Specifically, dietary restraint may deplete an individual's self-control resources, leaving them more prone to fail on the additional self-control task of smoking inhibition.

The results of the current study could provide valuable insight regarding potential interventions for smoking cessation and other addictions. Most prominently, if depletion of self-control strength is responsible for difficulties controlling smoking, then increasing or replenishing self-control strength should help to prevent that effect. Ultimately, this could lay the foundation for an intervention for individuals attempting to manage co-occurring regulatory demands such as dietary restraint and smoking cessation. Furthermore, a better understanding of the association between food cues and smoking urges and behavior may be useful for clinicians. Specifically, a measure assessing the environmental cues participants experience in their daily lives (e.g., tempting foods in their home, quantity of food advertisements participants perceive) may assist in explaining and increasing patients' successful smoking cessation.

In the current study, participants who resisted tempting sweets and those who resisted vegetables did not differ in their self-report of withdrawal symptoms or urge for cigarettes. The finding is in contrast to the evident difference in actual smoking behavior. Several factors may account for this discrepancy. As in any self-report measure, there is a risk that participants are not able to accurately assess their own internal states or that they are not reporting them honestly. In a comprehensive review of methodological approaches to measurement of craving researchers were also cautioned to be sensitive to issues of misattributions, individual differences in response styles, and other craving irrelevant influences when utilizing self-report measures (Sayette et al., 2000). For example, self-consciousness and social desirability may influence participants' responses on measures associated with addiction, including craving (Baker & Brandon, 1990).

Apart from methodological explanations, the issue of discrepancy between self-reported urges and actual substance use has also been addressed on a more theoretical level. Specifically, some researchers propose that substance use simply operates independently of the processes controlling craving (Tiffany & Carter, 1998; Tiffany & Conklin, 2000). The cognitive model of drug urges and drug-use behavior (Tiffany, 1990) proposes that drug use among addicts represents a behavior controlled primarily by automatic processes, conceptualized as following action schemata and completed without the person's deliberate intention and in the absence of awareness. Thus, the inconsistency in our study findings may stem from a fundamental difference in processes underlying urges and actual behavioral responses.

Limitations of the study include logistical, methodological, and measurement issues. Logistically, eight participants reported a desire to smoke but were unable to do so for lack of cigarettes ($n = 5$) or enough time during the break ($n = 3$). Seven of the eight participants were in the experimental condition. Providing participants with cigarettes was not considered in the study design. Our broad inclusion criteria led to about a third of the sample (34%) reporting smoking less than 10 cigarettes a day. These social or light smokers may have been less likely to carry cigarettes with them, and in fact four of the five participants who stated a desire to smoke but had not brought cigarettes with them were light smokers. In future studies it would be interesting and important to replicate the findings with a sample of heavy smokers. In addition, it may be useful in future studies to instruct participants to refrain from eating or smoking for several hours before the experiment.

Methodological limitations include the use of a between-subjects design, potential priming of smoking behavior, and the operationalization of dieting. Although the use of a within-subjects design has clear benefits, it would have been difficult due to the nature of the dependent variable: smoking assessment. Participants in the study were unaware that their choice to smoke during the break was a significant variable in the study or that it would be documented or measured, until they returned to the lab and were asked to provide a second CO reading. Had they been given an additional break, after a second cue exposure using the other food, they would no longer be naïve to the study's purpose, thus introducing the possibility of experimental demands, and corresponding behavior change. In future studies it may be beneficial to conduct the study in an area in which it is possible to unobtrusively view or videotape participants during the break, thus allowing for a within-subjects design.

For the purposes of the study, dieting was operationalized as dietary restraint, involving temporarily resisting the urge to eat from tempting sweets. This is conceptually different from more chronic dietary restriction that may occur in daily life, and thus the results may be unique to the temporary restraint we imposed in the lab. Another methodological concern involves the possibility that completing measures addressing smoking and smoking cessation may have primed smoking behavior and made participants in both conditions more likely to smoke during the break. Though for the full sample, only 43.3% smoked during the break.

Another caveat involves the assessment of self-control strength or resources. Currently, there exists no direct method to observe whether self-control strength has been depleted. In this study, as in previous research, we measured self-control strength indirectly, by measuring performance on a subsequent self-control related task (i.e., smoking). With advances in experimental technology there may be more direct methods of assessing self-control in the future. It would be particularly informative to investigate electrophysiological and functional imaging evidence of self-control depletion resulting from effortful inhibition, such as resisting temptations. Meanwhile, the results of our study are consistent with the self-control strength model and indicate that after exerting self-control on one task (i.e., resisting tempting sweets) participants were more likely to smoke during the break. Thus, the self-control strength model tested in this controlled randomized study demonstrates that self-control resource depletion may be a mechanism underlying the detrimental effects of dietary restraint on smoking behavior. This recent model of self-control may help explain chronic tobacco use and offers promising new directions for clinical interventions.

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Table 1
Sample Characteristics by Experimental Condition

Characteristic	Experimental cookie group ^a	Control vegetable group ^b
Gender		
Male	28 (54.9)	26 (52.0)
Female	21 (41.2)	20 (40.0)
Transgender	2 (3.9)	4 (8.0)
Ethnicity		
White	23 (45.1)	18 (36.0)
African American	14 (27.5)	21 (42.0)
Other	14 (27.5)	11 (22.0)
Hispanic	6 (11.8)	2 (4.2)
Marital Status		
Married/cohabitating	6 (11.8)	10 (20.0)
Divorced, separated, or widowed	16 (31.4)	11 (22.0)
Never married	29 (56.9)	29 (58.0)
Education		
<High school degree	8 (15.6)	8 (16.0)
High school or GED	20 (39.2)	28 (56.0)
Associate or vocational degree	11 (21.6)	6 (12.0)
College degree	10 (19.6)	6 (12.0)
Graduate studies	2 (3.9)	2 (4.0)
Employment status		
Employed	16 (31.4)	17 (34.0)
Unemployed	17 (33.3)	24 (48.0)
Student, homemaker, or retired	18 (35.3)	5 (10.0)
No response	0 (0.0)	4 (8.0)
No. of cigarettes smoked day prior to testing	12.7 (7.51)	14.4 (10.18)
FTND score	3.57 (2.26)	3.66 (2.26)
Smoking stage of change		
Precontemplation	21 (41.2)	24 (48.0)
Contemplation	23 (45.5)	17 (36.0)
Preparation	6 (11.9)	6 (12.0)
No response	1 (1.9)	3 (6.0)

Note. $N = 101$. Frequency given as percentage. Standard deviations given in parentheses. GED = general educational development test; FTND = Fagerström Test for Nicotine Dependence.

^a
 $n = 51$.

^b
 $n = 50$.