Appetite xxx (2015) 1–9

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Healthy eating habits protect against temptations

Pei-Ying Lin, Wendy Wood*, John Monterosso

University of Southern California, USA

ARTICLE INFO

Article history:
Received 6 November 2015
Accepted 9 November 2015
Available online xxx

Keywords:
Self-control
Habit formation
Health
Food choice
Ego-depletion

ABSTRACT

Can healthy food-choice habits protect people against temptations of consuming large portion sizes and unhealthy foods? In two studies, we show that the answer is yes, good habits serve this protective role, at least in contexts in which people are not deliberating and thus fall back on habitual responses. In the first study, participants trained with unhealthy habits to approach eating chocolate, but not those trained with healthy habits, succumbed to temptation and ate more chocolates when their self-control resources were depleted. Study 2 extended and clarified these findings by demonstrating the role of environmental cues in eliciting healthy habits when self-control resources are depleted. Participants who had been trained to choose carrots habitually to a pictorial stimulus (i.e., habit cue) subsequently resisted choosing M&Ms as long as the cue was present. This effect of habit cues on healthy food choices suggests the usefulness of manipulating such cues as a means of meeting self-regulatory goals such as portion control.
© 2015 Elsevier Ltd. All rights reserved.

1. Healthy eating habits protect against temptations

How do people maintain healthful eating patterns in modern obeseogenic environments? One answer, consistent with established theories of self-control, involves exerting effortful willpower to override goal-incongruent motivations and to choose long-term health goals over short-term gratifications. This active form of self-control is illustrated by restrained eaters who attempt to maintain a desired weight by limiting their food consumption (Johnson, Pratt, & Wardle, 2012). Although such efforts may be effective in the short-run, they can be counterproductive over longer periods, given that rigid control over eating is difficult to sustain and potentially has negative consequences (e.g., binge eating, van Strien, Herman, & Verheijden, 2014).

A very different understanding of how people make healthy choices is emerging from research on automaticity. A number of automated self-control strategies, including choice architecture (Thorndike, Sonnenberg, Riis, Barraclough, & Levy, 2012), social norms (Salmon, Fennis, de Ridder, Adriaanse, & de Vet, 2014), and implementation intentions (van Koningsbruggen, Stroebe, Papies, & Aarts, 2011) are promising tools to support goal-congruent behavior. Healthy habits provide yet another means of automating food choices and consumption amounts (Adriaanse, Kroese, Gillebaart, & de Ridder, 2014; Galla & Duckworth, 2015). Habits are cognitive associations between context cues and responses that develop as people repeatedly perform a response (e.g., eating fruit) in contiguity with a context cue (e.g., after a meal). Once eating habits form, the practiced response is accessible in memory, and people tend to act on the response in mind (Wood, Labrecque, Lin, & Rűnger, 2014).

In the present research, we tested the extent to which healthy habits keep people on track to meet their health goals even in contexts in which they are tempted by unhealthy indulgences. In two experiments, we trained participants to form healthy and unhealthy habits, and we evaluated the psychological mechanisms involved in relying on those habits. Specifically, Study 1 evaluated whether limited executive control resources affected reliance on food habits, and Study 2 tested the role of visual cues in activating eating habits.

1.1. Habit performance is triggered by context cues

People develop food consumption habits as they repeatedly eat the same types and amounts of food in the same ways at the same meals (van't Riet, Sijtsema, Dagevos, & De Bruijn, 2011). According to experience sampling estimates, over 45% of eating activities are potentially habitual, given that they are repeated almost every day in the same context (Wood, Quinn, & Kashy, 2002).

When people have formed healthy eating habits of consuming

* Corresponding author. Department of Psychology, University of Southern California, Los Angeles, CA 90089, USA.

E-mail addresses: pyl715@gmail.com (P.-Y. Lin), wendy.wood@usc.edu (W. Wood), johnrmon@usc.edu (J. Monterosso).

http://dx.doi.org/10.1016/j.appet.2015.11.011
0195-6663/© 2015 Elsevier Ltd. All rights reserved.

small portions of food and choosing healthy options, the impetus to repeat these habits could maintain responses even when people are tempted to do otherwise. In evidence that associative learning can bias food preferences, Watson, Wiers, Hommel, and de Wit's (2014) incidental context cues associated with popcorn or chocolate in a food choice task appeared to bias participants toward choosing the associated food even when they had just eaten it to satiety. Suggesting more directly that habits bias food choices, participants with a habit to choose a specific snack (e.g., chips) continued to make that choice over other options (e.g., M&Ms), even when they had eaten the habitual food until it was no longer pleasant (Tricomi, Balleine, & O'Doherty, 2009).

Research also has begun to demonstrate the importance of naturalistic context cues in activating health-related habits. For example, following bans on smoking in bars in the UK, bar patrons with stronger smoking habits were more likely to unintentionally light-up a cigarette, despite general knowledge that it was now illegal (Orbell & Verplanken, 2010). Eating habits can similarly be activated by context cues regardless of current motives. For example, movie-goers with strong habits to eat popcorn in the theater consumed significant amounts of popcorn even when it was stale and they reported not liking it (Neal, Wood, Wu, & Kurlander, 2011). However, these popcorn-eating habits were not elicited when participants were watching a music video in a meeting room on campus, and participants ate popcorn only when it was fresh and tasty.

In summary, past research suggests that habit cues can trigger associated responses despite people's current intentions and goals—and perhaps despite their desire to indulge in temptations. That is, habits may be activated relatively directly by associated context cues without strong input from motivations. However, none of the extant research has addressed the possibility that healthy eating habits can help people to resist temptations of eating excessive portion sizes or unhealthy foods.

1.2. Benefits of healthful habits when people are not deliberating

When context cues bring a habitual response to mind, the response is not obligatory, and people can make a decision to act in nonhabitual ways. Yet, such decisions require executive control, and the capacity to exert control is readily impaired by distractions, simultaneous tasks that impose a cognitive load, and prior tasks that deplete willpower or self-control resources (Hofmann, Schmeichel, & Baddeley, 2012). In daily life, executive control could be reduced in these ways when people are making food choices at a party, deciding what to make for dinner while helping kids with homework, or purchasing food in the grocery store after a stressful day at work. With lowered control, people are likely to rely on automated responses instead of making decisions about what to do. Often, they might succumb to the visceral cues in unhealthy food temptations (e.g., Salmon et al., 2014). However, automated responses are not always unhealthy. When people have formed healthy eating habits, reduced deliberation might instead increase tendencies to fall back on the habit in mind. In this way, healthy eating habits could be especially impactful in protecting against the visceral factors that control eating when people are not deliberating.

The idea that depletion can, under some circumstances, impede transgressive behaviors is not new. For example, participants in one study were especially likely to comply with a cued social norm to choose healthier foods when their willpower was reduced (Salmon et al., 2014). Similarly, manipulations reducing participants' capacity to deliberate lead to more desirable behavior when immediate cues signaled those responses (Westling, Mann, and Ward, 2006).

More direct support for the idea that reduced decision making capacity increases the impact of habits comes from research by Neal, Wood, and Drolet (2013). After self-control resources were depleted by performing an initial inhibition task, participants were more likely to make habitual snack choices from a set of healthy snacks (e.g., apple, yogurt) as well as to make habitual choices from a set of unhealthy snacks (e.g., candy bar, cookies). However, this research did not evaluate self-control dilemmas in which participants with a healthy habit are tempted to indulge in an unhealthy eating. Thus, more direct evidence is needed for the idea that, by automating healthy choices, people can arm themselves against the pull of unhealthy temptations that can be especially pernicious when willpower is low.

1.3. The present research

The present research investigated whether healthful food choice habits can protect against the tendency for people to indulge when executive control is impaired. The two studies evaluated different aspects of this process, with Study 1 manipulating depletion of willpower and Study 2 manipulating the presence or absence of habit cues. We anticipated that participants would fall back on healthy habits primarily when self-control was reduced (Study 1) and when context cues activated habits (Study 2).

Participants in both studies underwent initial training to develop healthful or unhealthful food choice habits. Habit training in Study 1 involved vicariously consuming—or not consuming—chocolates. In this novel task, participants acquired unhealthy habits by repeatedly pulling a joystick closer to pictures of people eating chocolates (i.e., vicarious consumption) or healthy habits by repeatedly pushing these pictures away (i.e., vicarious rejection). Healthy and unhealthy eating habits were developed incidentally in this task, given that the explicit task instructions did not involve eating. Instead, participants were told to judge whether or not the pictures involved facial muscle movements. Following this training, half of the participants completed a task designed to deplete executive resources. Finally, participants were given an opportunity to eat chocolates, with our primary dependent measure being the amount of chocolate they consumed. Our predictions would be evident in a significant interaction between habit formation and level of depletion such that the tendency to consume bigger portions of chocolate when depleted should be mitigated or even reversed given a healthy habit.

2. Study 1

2.1. Method

2.1.1. Participants

Fifty-nine participants (49 women) volunteered for a product evaluation study from introductory psychology classes (received course credit) or from campus flyers (received $10), with average body mass index of 21.66 ($SD = 2.41$).

To ensure that participants would experience a self-control dilemma in deciding whether to follow their health goals or consume more chocolate, they were selected via prescreening to: (a) not be on a diet (so as to be willing to consume some chocolate), (b) be concerned about health ($M = 5.47$, $SD = 0.89$, 7-point scale with 7 = extremely concerned, (c) strongly like chocolate ($M = 6.02$, $SD = 0.76$, 7-point scale with 7 = like extremely), and (d) consider chocolate to be very unhealthy ($M = 2.69$, $SD = 0.57$, 7-point scale with 7 = extremely healthy). One additional participant claimed to consume an unrealistic amount of chocolate per week (approximately 8 standard deviations above the sample mean) and was excluded from the analyses.

2.1.2. Procedure

Sessions were conducted individually, and participants were instructed to abstain from food for three hours before the lab session. All reported abstaining for at least two hours.

2.1.3. Habit training

Participants were randomly assigned to develop an *unhealthy habit of eating chocolate* or a *healthy habit of not eating chocolate*. We designed this novel task to form unhealthy habits through a simulation of repeatedly consuming chocolate or healthy habits through a simulation of repeatedly rejecting eating chocolate.

The habit formation task supposedly involved visual processing of pictures. The task was constructed so that eating habits were formed as an incidental byproduct of decision making about the pictures. All participants were repeatedly shown three images of people eating the chocolates to be sampled in this study, and three of people playing string instruments. Each image appeared 20 times in a random order, yielding a total of 60 habit training trials. Participants in the unhealthy habit/consumption condition were instructed to "pull the joystick close to you" if the image showed an action that required facial muscle movement (i.e., eating chocolates) and "push the joystick away from you" if the action in the image did not require facial muscle movement (i.e., playing string instruments). Participants in the healthy habit/avoidance condition did the reverse, and pushed the joystick away from themselves to images of eating chocolates.

2.1.4. Implicit evaluations: manikin task

To determine whether the habit formation task influenced implicit evaluations of eating chocolates in addition to habitual responding to chocolates, we adapted Krieglmeyer and Deutsch's (2010) manikin task. Following their procedure, we interpreted reaction times to move a manikin on a screen toward or away from the phrase, "eating chocolates," as indicating implicit positive or negative evaluations of chocolate consumption.

2.1.5. Resource depletion task

All participants watched a 7-min comic video. Those in the *depletion* condition were instructed to inhibit their facial emotion expressions. Those in the *nondepletion control* condition were instructed to watch the video as they would normally (Vohs, Baumeister, & Ciarocco, 2005).

2.1.6. Chocolate consumption

In a supposedly unrelated marketing study, participants sampled and evaluated for 10 min three kinds of sugar-free chocolates (Hershey®, Dove®, Russell Stover®) from 3 plates, each consisting of 5 pieces of each type (sugar-free label removed). Sugar-free chocolates were used because of the possibility that sugar affects decision making and restraint (Gailliot, Baumeister, DeWall et al., 2007). Participants explicitly evaluated each chocolate on the following 7-point scales (7 = extremely satisfying): sweetness ($M = 4.86$, $SD = 0.86$), milky-ness ($M = 4.49$, $SD = 1.06$), flavor ($M = 4.97$, $SD = 0.87$), smoothness ($M = 4.66$, $SD = 0.85$), smell ($M = 4.68$, $SD = 0.94$), and overall tastiness ($M = 4.93$, $SD = 0.81$). The number of consumed chocolates was counted after participants left the lab, with partially-eaten chocolates counted as 0.5.

2.1.7. Dessert choice

To examine whether our manipulation of chocolate-eating habits affected healthful food choices in general, participants chose a snack from 4 cupcakes and 4 granola bars in a basket. Because dessert choice was unaffected by depletion, habit manipulation, or their interaction, $ps > .70$, it will not be discussed further.

2.1.8. Survey and interview

After evaluating the chocolates, participants completed a questionnaire about their height, weight, and the effectiveness of the depletion manipulation. A principle components analysis on the depletion items revealed 2 factors with eigenvalues greater than one, with the negatively and positively phrased items loading on the first and second factors, respectively. A composite factor score was formed from the four negatively phrased items about the video watching task ($\alpha = .60$): (a) "How hard did you try to complete this task?" (b) "I felt drained when I was done." (c) "I felt mentally exhausted when I was done." (d) "When done, I was in a bad mood." A separate score was formed from the two positively phrased items ($\alpha = .86$), (a) "When done, I felt like I could accomplish my goals." (b) "When done, I felt confident in my abilities."

Finally, participants gave their impressions of the purpose of the joystick task and described potential purposes for the study other than emotions and product evaluation. Sixteen participants (included in the reported analysis) identified the purpose of the study to be self-control, but none correctly identified the purpose of the joystick task.[1]

2.2. Results

The hypotheses were evaluated with a 2 (depleted vs. non-depleted control) x 2 (healthy/avoid vs. unhealthy/consume chocolate habit) analysis of variance design. Means and standard deviations on all measures are given in Table 1.

2.2.1. Depletion manipulation check

On the negatively-phrased items, the depleted group ($M = 0.28$, $SD = 0.93$) was significantly more depleted than the control group ($M = -0.27$, $SD = 1.01$), $F(1, 55) = 4.88$, $p = .031$. Neither the training effect nor the Training × Depletion interaction were significant, $ps > .08$. Furthermore, no significant effects emerged on the positively phrased depletion items, $ps > .35$.

2.2.2. Chocolate consumption

Overall, men ate more chocolate ($M = 4.40$, $SD = 1.05$) than did women ($M = 3.44$, $SD = 1.47$), $t(17.20) = 2.45$, $p = .025$ (equal variances not assumed given unequal *N*s). All analyses on chocolate consumption thus controlled for participant sex. In support of our primary prediction that depletion would enhance the influence of habits, a significant interaction emerged between habit training and depletion, $F(1, 54) = 9.18$, $p = .004$ (see Table 1). Simple effects tests to decompose the interaction revealed that the unhealthy, consumption habit group ate more chocolates when depleted than when not depleted, $F(1, 54) = 9.13$, $p = .004$, whereas depletion did not have a significant effect on amount consumed in the healthy habit condition, $p = .210$. No other effects were significant. Supporting our decision to retain the 13 participants who suspected the purpose of the study involved self-control, the interaction between training and depletion remained significant after excluding them, $F(1, 41) = 7.55$, $p = .009$.

2.2.3. Evaluations of chocolate

Given that the manipulation formed habits, explicit evaluation of the chocolates was not influenced by habit training, the depletion manipulation, or their interaction, all $ps > .25$ (see Table 1). Nonetheless, suggesting that evaluations were meaningful,

[1] A number of additional measures that might have moderated habit effects did not yield any interpretable results and are not discussed further: trait self-control (Tangney, Baumeister, & Boone, 2004), personality (Big Five Inventory, John & Srivastava, 1999), drive for thinness (Garner et al., 1983), and goal to be healthy.

Please cite this article in press as: Lin, P.-Y., et al., Healthy eating habits protect against temptations, Appetite (2015), http://dx.doi.org/10.1016/j.appet.2015.11.011

Table 1
Means (SDs) Given self-control resource depletion and training of consumption or avoidance of chocolate eating habits: Study 1.

		Habit to consume chocolates		Habit to reject eating chocolates	
		Depletion	Control	Depletion	Control
Pieces chocolate consumed		4.33 (1.33)	2.93 (1.00)	3.21 (1.09)	3.90 (1.88)
Explicit evaluation of chocolate		4.88 (0.76)	4.99 (0.95)	4.71 (0.74)	5.11 (0.80)
Implicit evaluation on manikin task	Approach chocolate	0.99 (0.20)	0.99 (0.29)	1.27 (0.60)	1.01 (0.25)
	Reject chocolate	1.28 (0.43)	1.67 (1.09)	1.66 (0.68)	1.25 (0.26)

Note. Higher numbers reflect more pieces of chocolate consumed during the taste-test evaluation, greater explicit liking of chocolate (7-point scale with 7 = extremely satisfying), and longer reaction times (secs) to approach or avoid eating chocolate. (*N*s within condition range from 14 to 15).

participants who rated the chocolates more favorably also consumed (marginally) more of them, $r(56) = .25$, $p = .058$. In additional evidence that habit training did not affect consumption by influencing evaluations, the predicted interaction between depletion and training remained after controlling for chocolate evaluation, $F(1, 52) = 8.31$, $p = .006$. Finally, analyses also revealed that habit training did not influence implicit evaluations of chocolate consumption, as tapped through Krieglmeyer and Deutsch's (2010) manikin task (see Table 1): consumption, $t(55) = -1.42$, avoidance, $t(55) = 0.10$ ($ps > .16$).

2.3. Discussion

This first study demonstrated that healthy habits to reject eating chocolate can serve a protective function in a self-control dilemma. For participants in our study, the opportunity to eat chocolate presented a self-control dilemma because they strongly liked chocolate, wanted to be healthy, and believed that chocolates were very bad for their health.

The study used a novel task to train chocolate consumption habits involving responding repeatedly to pictures of eating chocolates. Participants were then given an opportunity to consume the chocolates used in the habit training pictures. To establish conditions under which participants would be likely to fall back on their habits, half of our participants had their executive control resources depleted by performing a self-control task prior to eating chocolate. The other half of participants, in the no-depletion control group, were better equipped to deliberate about how much to eat.

Consistent with our predictions, the reduction in executive control increased the amount of chocolate eaten among the unhealthy, consumption-habits group. However, it did not significantly influence the amount eaten among those with healthy, avoid-consumption habits. In fact, among those with healthy habits, participants with reduced executive resources consumed somewhat less chocolate than those who were in the no-depletion control condition (although not significant). Our results contribute to a growing body of evidence that lowered executive control does not necessarily leave people vulnerable to unhealthy food cues (Neal et al., 2013). This pattern provides a broader framework in which to interpret prior research indicating that people make impulsive or myopic choices, including consuming more alcohol and unhealthful foods, when they lack executive resources (see review in Baumeister, Vohs, & Tice, 2007). Although this pattern emerged in our research among participants trained with an unhealthy habit, those trained with a healthy habit were protected from temptation when their willpower was reduced.

This study demonstrated further that habits and evaluations can independently guide portion sizes. Thus, habit training did not influence participants' explicit evaluations of the chocolates during the taste-test evaluation or their implicit evaluations, as assessed in our manikin reaction time task. Furthermore, the predicted interaction between habit training and depletion remained significant even after explicit chocolate evaluation was included as a covariate. These patterns are consistent with our claim that our novel habit formation task did in fact establish response habits and not evaluative tendencies toward eating chocolate.

Our innovative habit training procedure used a joystick task to repeatedly simulate consuming or rejecting chocolates. In contrast, a different method of joystick training has been used to manipulate goals in past research (e.g., Fishbach & Shah, 2006). Unlike this prior work, participants in the present study were trained to react to images on the basis of a criterion (facial muscle movement) irrelevant to the behavior of interest (consuming chocolate). Thus, participants' decision rule for pulling or pushing the joystick was unrelated to healthy eating, and in fact participants' goals to be healthy were unaffected by habit training ($p = .75$). Given that the training had the anticipated effects on participants' chocolate consumption and did not have extraneous effects on evaluative measures, we can be confident in tracing our obtained effects to food consumption habits.

3. Study 2

Despite the success of the habit training manipulation on portion sizes in Study 1, our second study adopted a different training method and provided additional documentation of its effects. In Study 2, the joystick movement was randomized between participants, so that some participants won food by repeatedly pulling the joystick and others by pushing it. To provide additional evidence that this task established habits, we assessed habit strength using a standard self-report measure of automaticity, the Self-Report Behavioral Automaticity Index (SRBAI, Gardner, Abraham, Lally, & de Bruijn, 2012).

Study 2 also provided a more direct test of the protective effects of habits in self-control dilemmas by evaluating the role of context cues in activating habit performance. Food choice habits in everyday life are activated by a variety of cues, including the physical locations of eating, time of day, prior actions, as well as the features of the food itself. Study 2 evaluated whether the activation of habitual responses by such cues would gain additional traction over behavior so as to not only reduce unhealthy food choices, as in Study 1, but also increase healthy choices.

During habit training, participants repeatedly chose baby carrots to one pictorial cue and potato chips to another cue. Because these cues signaled the possible availability of a particular food item, the cues served as *discriminative stimuli*, referred to here as habit cues. Then, during a subsequent task, participants chose one of these foods from a pair that involved a new food choice. In this subsequent choice task, carrots were always paired with M&Ms in order to establish a self-control dilemma, given that our participants strongly liked M&Ms but also wanted to be healthy and believed carrots were extremely healthy and M&Ms extremely unhealthy. Potato chips were always paired with popcorn. These two food choices did not represent a dilemma because neither food was especially healthy. Participants chose between food pairs in the presence of the previously learned habit pictorial cues or novel images. We predicted a stronger tendency to choose the habitual food in each pair—regardless of whether the foods presented a self-control dilemma or not—when the associated habit cues were present than when novel cues were present. Nonetheless, we also suspected that the effect of habit training would be stronger for the non-dilemma trials because participants were not balancing health against taste in their choices.

Study 2 also provided direct documentation that our initial training trials established food choice habits. One indicator of automaticity is speed of decision, and we anticipated that habitual choices would be executed more rapidly than nonhabitual ones. Specifically, participants should be faster to make the habitual choice when activated by the appropriate pictorial cue. As a second indicator of habit, we anticipated that habitual choices would reflect greater self-reported automaticity (SRBAI, Gardner et al., 2012). Specifically, participants' reported automaticity should direct food choices when responding to the habit pictorial cue.

3.1. Method

3.1.1. Participants

A total of 56 women completed a 2-session study on food preferences. Participants were recruited from undergraduate psychology classes (received course credit) or flyers distributed on campus (compensated $45). Thirteen of these participants performed the tasks in an fMRI scanner to provide pilot imaging data for a separate investigation. Three additional participants were excluded from the analysis because they indicated at the experimental session that they did not want the foods in the study.

Participants were selected via prescreening to not be dieting (so that they would not be restricted in their choices) and to experience a self-control dilemma in choosing between carrots and M&Ms. That is, they (a) liked all foods in the study (baby carrots, $M = 5.91$; M&Ms, $M = 6.21$; potato chips, $M = 5.91$; popcorn, $M = 5.80$; with 7 = like extremely), (b) cared about health when choosing foods ($M = 4.91$, 7 = extremely concerned about health), (c) considered baby carrots to be healthy ($M = 6.29$, 7 = extremely healthy), and (d) considered M&Ms to be unhealthy ($M = 2.23$, 7 = extremely healthy). As can be seen in Table 2, these judgments stably persisted in the post-experiment survey.

3.1.2. Procedure

In individual sessions, participants completed a food choice task in which they won food by pushing or pulling a joystick during habit training. Participants were randomly assigned to the push or pull conditions. In a second session 2–4 days later, participants completed more habit training, a task to deplete executive control resources, and the critical choice test between pairs of foods. Participants were asked to abstain from food for four hours before each session, and all reported abstaining for at least three hours.

3.1.2.1. Session 1. Habit training. Participants learned habit associations between pictorial cues (i.e., fractal images) and responses (i.e., push/pull a joystick) to obtain a food reward of baby carrots or potato chips. The push/pull instructions were manipulated between participants, so that some learned to pull the joystick for baby carrots and push for potato chips, whereas others learned the reverse.[2] Carrots were won on some trials and chips on others. The type of food was signified by an image of it and the pictorial cue. The specific fractal cues, foods, and motor responses were randomized across participants to yield all possible combinations.

As shown in Fig. 1, pictures of the food were always displayed on the screen below the image cue (for pulling) or above (for pushing). Although participants could only win carrots or potato chips on the training trials, the alternative food in each pair was also displayed during training in order to keep the stimuli as constant as possible between training and test trials. Thus, for participants randomly assigned to pull the joystick to win carrots, the picture of carrots was below the fractal cue, and they had to pull the joystick inwards in order to win food. A trial was ended if participants did not respond within 2 s or if they moved the joystick incorrectly. After a correct response, participants received feedback on whether they had won the food. Participants received a quarter of a baby carrot or 1 potato chip with each winning trial. Food rewards were delivered with 40% probability, and participants received all food at the end of the experimental sessions ($M = 17.8$ baby carrots and 70.4 chips). In the first session, 180 habit training trials were completed for each of the 2 foods.

To enhance attention and effective differentiation of fractal cues, two other fractals were used as time-counting signs on separate trials. Specifically, on 36 randomly inserted trials, participants could win 25¢ or avoid losing 25¢ by pressing a button on the joystick between 4 and 6 s after the image appeared. Training sessions took approximately twenty minutes. Participants earned on average $3.75.

3.1.2.2. Session 2. Resource depletion task. After a habit training refresher of 180 trials each for choosing carrots and popcorn, participants formed an impression of a woman in a 6-min muted video clip while inhibiting the automatic tendency to read words that scrolled at the bottom of the screen (see Schmeichel, Vohs, & Baumeister, 2003).

3.1.2.3. Food choice. Participants chose between food pairs composed of a habitual food and a novel alternative—either the dilemma choice of baby carrots vs. M&Ms or the non-dilemma choice of potato chips vs. popcorn. Before the testing trials, participants received M&Ms and popcorn to match the amounts of baby carrots and potato chips they had won in training. In this way, food choices during testing did not depend on the amounts of food won in the training trials (e.g., choosing only M&Ms at test because they had already won enough carrots).

Each trial began with a fixation cross, followed by a fractal cue and food pictures identical to the training trials (Fig. 1). On novel cue trials, these same foods were displayed on the left and right

Table 2
Mean (SD) explicit and implicit evaluations and experienced automaticity scores for food choices: Study 2.

Measure	*M* (*SD*)
Explicit evaluation of baby carrots	5.64 (1.09)
Explicit evaluation of M&Ms	5.82 (1.22)
Explicit evaluation of potato chips	5.98 (1.04)
Explicit evaluation of popcorn	5.38 (1.23)
Implicit evaluation of baby carrots	0.40 (0.23)
Implicit evaluation of M&Ms	0.42 (0.24)
Implicit evaluation of potato chips	0.44 (0.23)
Implicit evaluation of popcorn	0.45 (0.23)
Experienced automaticity: Baby carrots	2.48 (0.94)
Experienced automaticity: M&Ms	2.33 (0.76)
Experienced automaticity: Chips	2.78 (0.76)
Experienced automaticity: Popcorn	2.40 (0.86)

Note. Higher numbers reflect more favorable evaluation of each food explicitly (on 7-point scales with 7 = like extremely) and implicitly via the Affect Misattribution Procedure (scores ranged from 0 to.94). Experienced automaticity was measured with SRBAI's 5- point scale on which higher numbers represent greater automaticity.

[2] Because analyses revealed no effects of pushing versus pulling the joystick, this manipulation is not discussed further.

Please cite this article in press as: Lin, P.-Y., et al., Healthy eating habits protect against temptations, Appetite (2015), http://dx.doi.org/10.1016/j.appet.2015.11.011

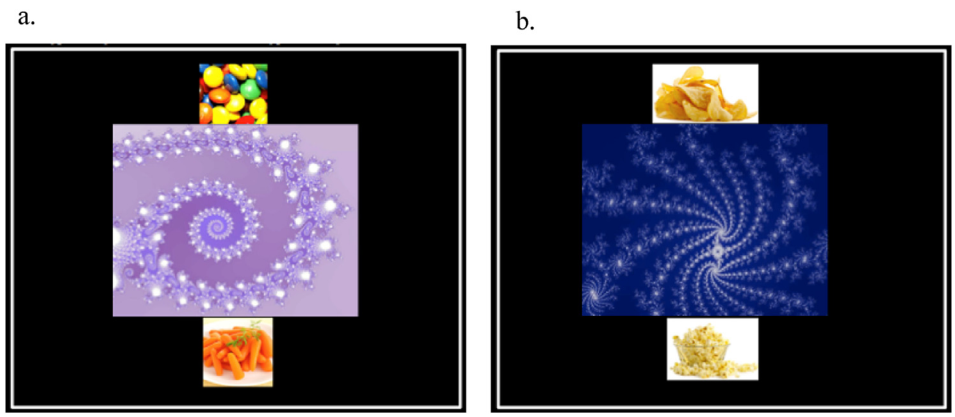

Fig. 1. Example habit training trials in Study 2. For (a) trials, participants pulled the joystick to try to win baby carrots, and for (b) trials, participants pushed the joystick to try to win potato chips. For the other half of the participants, the push/pull and food pictures were reversed.

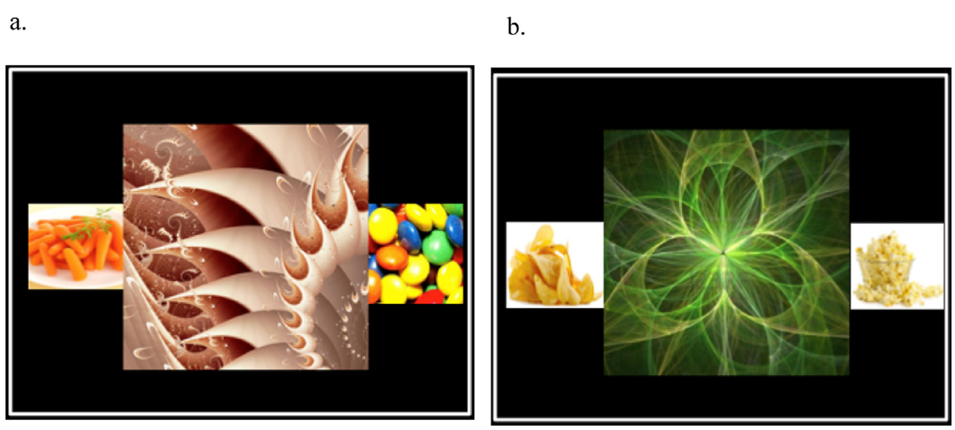

Fig. 2. Example food choice trials in Study 2. For (a) trials, participants moved the joystick to the left to try to win baby carrots or moved the joystick to the right to try to win M&Ms. For (b) trials, participants moved the joystick to the left to try to win chips or moved the joystick to the right to try to win popcorn.

sides of the fractal cue (see Fig. 2), and participants moved the joystick left or right to select the foods. Thus, the novel cue condition displayed new fractal images, and participants moved the joystick in a novel direction (left or right). Each fractal cue/food choice display was presented for 16 trials, yielding a total of 64 food selection trials per session.

Similar to the habit training phrase, participants had two seconds to make a choice. Following a valid response, they were informed whether or not they won the food chosen in that trial. To ensure that the two foods in a pair remained similarly appealing, a titration procedure decreased the probability of winning a given food by 5% each time it was chosen, and increased it by 5% each time the other option was chosen. As in the training sessions, participants also completed 16 randomly inserted time-counting trials in which they could win money.

3.1.2.4. Implicit evaluation: affect misattribution procedure (AMP). Participants' implicit evaluation of each of the four foods was assessed using the AMP (Payne, Cheng, Govorun, & Stewart, 2005). In a task supposedly measuring pattern preferences, participants first saw a briefly presented picture of a food, ostensibly to signal the start of a trial, followed by an inkblot. They reported their gut feelings of like or dislike for the inkblot. Implicit evaluation of each food was calculated from the proportion of inkblots that participants judged favorably following the food primes.

3.1.2.5. Survey and interview. The manipulation check on depletion included the six questions from Study 1. Analysis again yielded two factors reflecting the four negatively worded items ($\alpha = .73$) and the two positively worded ones ($\alpha = .77$). These ratings did not vary across condition and are not discussed further.

Participants rated how much they were concerned about health and taste and their drive for thinness (Garner, Olmstead, & Polivy, 1983). Reflecting a stronger effect of healthy habit cues among participants concerned about their weight and health, analyses on frequency of choosing baby carrots when pitted against M&Ms revealed significant interactions between the manipulation of habit vs. novel cue and drive for thinness, $F(1,54) = 4.55$, $p = .037$; and concern about health, $F(1,54) = 4.90$, $p = .031$. These effects are consistent with other findings suggesting that habit formation is more pronounced among people who are intrinsically motivated to perform the habitual behavior (Wiedemann, Gardner, Knoll, & Burkert, 2014). It may be, then, that rewards help to stamp in associations between contexts and responses, with the result that participants were especially likely to act on habit learning in contexts involving habit cues.

For each of the four foods, participants also rated automaticity on the SRBAI items (Gardner et al., 2012) that included: *do automatically*; (b) *do without having to consciously remember*; (c) *do without thinking*; and (d) *start doing before I realize I'm doing it* (alphas = 0.91, 0.84, 0.89, and 0.90, for baby carrots, M&Ms, chips, and popcorn, respectively).

Finally, all participants indicated in free-response format their interpretations of the study, were debriefed, and were excused.

Please cite this article in press as: Lin, P.-Y., et al., Healthy eating habits protect against temptations, Appetite (2015), http://dx.doi.org/10.1016/j.appet.2015.11.011

Table 3
Mean percentages (standard deviations) of trials for each food choice in Study 2.

	% Trials (*SD*) chose baby carrots over M&Ms	% Trials (*SD*) chose chips over popcorn	% Trials (*SD*) chose habitual foods
Habit cue	55 (21.97)	54 (21.24)	55 (14.67)
Novel cue	37 (18.50)	46 (21.21)	42 (15.99)

Note. Percentages of trials (out of 32 total) in which participants chose the habitual food instead of the novel food in each condition. The final column of habitual food estimates collapse across the self-control dilemma (carrots vs. M&Ms) and nondilemma (chips vs. popcorn) trials.

Food choices of the twelve participants who recognized the study involved habit formation did not differ from choices of unaware participants, and these individuals were retained in the analyses.[3]

3.2. Results

The analyses were conducted using a Pictorial Cue (Habit vs. Novel) x Food Type (Self-control dilemma trials involving carrots or M&Ms vs. Non-dilemma trials involving potato chips or popcorn) analysis of variance design, with both factors within participants (see means and standard deviations in Table 2).

3.2.1. Food choices

Consistent with our hypothesis that context cues would activate the habitual choice among the food pairs, participants were more likely to choose habitual foods in the trials with habit cues and responses compared with trials involving novel cues and responses, $F(1,55) = 21.61$, $p < .001$ (see Table 3). Also as anticipated, food type had no significant main effect on choices. An unexpected interaction between cue and food type, $F(1, 55) = 5.89$, $p = .018$, reflected that the cue effect was stronger in the dilemma choice between baby carrots and M&Ms than in the non-dilemma trials pairing chips and popcorn. Nonetheless, the cue effect was significant within both food choice types when evaluated separately, dilemma: $p < .001$; non-dilemma: $p = .026$.

Indicating that habit training influenced food choices directly and did not have effects through influencing participants' evaluations of the food, the cue effect on the dilemma choice trials remained significant after including implicit evaluation (AMP) and explicit evaluation as covariates in the model, $Fs(1, 54) = 7.80$ and 25.10, $ps = .007$ and $< .001$, for implicit and explicit evaluation, respectively.

3.2.2. Food choice as habit

3.2.2.1. SRBAI. Given that the experienced automaticity scale was not assessed in the context of specific pictorial cues, we did not expect that it would capture our procedure of training habitual choices to pictorial cues. In support, mean scores were largely in the midpoint of the scale regardless of habit training (see Table 2). On trials when habit cues were present, however, participants' food choice habits should have been activated to guide their responses. We tested this possibility by computing, separately for habit cue and novel cue trials, the correlations between (a) the frequency of choosing carrots over M&Ms/potato chips over popcorn, and (b) the difference between the experienced automaticity of choosing carrots vs. the automaticity of choosing M&Ms/difference between automaticity of potato chips vs. automaticity of popcorn. Consistent with our hypotheses, in the presence of a habit cue, higher automaticity of carrots (vs. M&Ms) was associated with more frequent choice of carrots (vs. M&Ms), $r(54) = .36$, $p = .007$. However, on trials with the novel cue, experienced automaticity was unrelated to choice, $r(54) = .17$, $p = .225$. Similarly, in the presence of a habit cue, greater automaticity of potato chips (vs. popcorn) was associated with (marginally) more frequent choice of potato chips (vs. popcorn), $r(54) = .25$, $p = .068$. However, on trials with the novel cue, experienced automaticity was unrelated to choice, $r(54) = .16$, $p = .247$.

3.2.2.2. Reaction times. As predicted, analyses yielded only a main effect of habit cues, indicating that habitual choices were made more quickly when habit cues were present ($M = 0.71$ s) compared with novel cues ($M = 0.75$ s), $F(1,55) = 23.98$, $p < .001$ (Fig. 3). Thus, habitual choices were made especially quickly to habit cues within dilemma trials, $p < .001$, and nondilemma trials, $p = .027$.

3.3. Discussion

Study 2 provided a stringent test of the potential for healthy habits to promote desired food choices. All participants in this study were depleted in order to reduce their capacity to deliberate about their food choices, and all were faced with a self-control dilemma in a computerized choice task between a habitually chosen healthy food (baby carrots) and an unhealthy but tempting treat (M&Ms). Despite showing a marked preference for M&Ms on trials without the pictorial cue to respond habitually, participants were more likely to make their habitual healthy choice of carrots when the habit cue was present and they could move the joystick as they had practiced during habit learning. Thus, healthy habits protected participants against the pernicious influence of food temptations. On other trials, participants made food choices that did not involve a self-control dilemma but instead pitted a habit to choose potato chips against the novel option of popcorn. As would be expected given that the nonhabit food was not a relatively tempting treat, in the absence of the habit cue, participants did not markedly prefer popcorn. Nonetheless, when the cue was present, they responded habitually and tended to choose chips.

In addition to demonstrating the protective power of healthy habits, the second study offered clear validation that our training procedure established habitual food choices. That is, participants

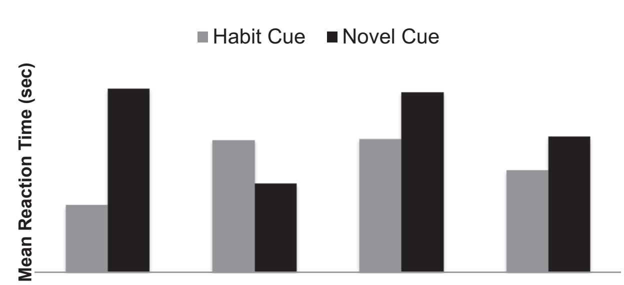

Fig. 3. Mean reaction time (secs) representing the speed of choosing a food under habit and novel context cues in Study 2.

[3] Continuous Performance Task (Riccio, Reynolds, Lowe, & Moore, 2002), Brief Implicit Association Task (Sriram & Greenwald, 2009), personality (Gosling, Rentfrow, & Swann, 2003), trait self-control (Tangney et al. 2004), Mindfulness Scale (Lau, Biship, Segal, Buis, Anderson, et al., 2006), and novelty seeking (Cloninger, Przybeck, Svrakic, & Wetzel, 1994).

Please cite this article in press as: Lin, P.-Y., et al., Healthy eating habits protect against temptations, Appetite (2015), http://dx.doi.org/10.1016/j.appet.2015.11.011

ARTICLE IN PRESS

who reported higher experienced automaticity for habitual choices on the SRBAI (Gardner et al., 2012) also were more likely to choose the habitual food when the habit cue was present but not when it was absent. In addition, reaction time assessments indicated that the habit cue facilitated choices by quickly activating the practiced response in mind. Thus, habit cues guided participants to act on their carrot habit instead of succumbing to the unhealthy temptation of M&Ms.

Our study importantly demonstrated the effects of context cues in activating habits. Cue effects in habit processes have been demonstrated largely in studies of already-formed habits (e.g., Neal et al., 2011), and only a few experiments have directly evaluated the role of context cues in habit formation (e.g., Judah, Gardner, & Aunger, 2013). Study 2 provided an experimental demonstration with a highly controlled habit formation task along with cues in the form of pictorial stimuli. Furthermore, by capturing the automated mechanism underlying participants' propensity to rely on habit cues, our results support more naturalistic studies implicating cues in habit formation and performance (Lally, Wardle, & Gardner, 2011). Research on cues points to performance contexts as important in triggering the performance of healthy habits and thereby maintaining long-term healthy behavior. In everyday contexts, such cues could provide automated guides to healthy choices and small portion sizes.

The present results also suggest a potential role for motivation in habit formation. Unexpectedly, on the dilemma trials, the effects of habit formation were stronger for participants who were more concerned about health and weight. It could be that such individuals found the choice of carrots especially rewarding when pitted against M&Ms and thus responded more strongly to the habit formation experience. Although this finding was not anticipated, it potentially has exciting implications in suggesting that habit formation can be leveraged in service of behavioral goals.

Finally, the paradigm used in Study 2 allowed us to differentiate habit formation from motivated approach and avoidance goals (e.g., Fishbach & Shah, 2006). To choose foods, half of the participants were randomly assigned to push and half to pull the joystick. The absence of effects of this manipulation indicates that the training did not activate systematic goals. As in Study 1, when indices of explicit and implicit evaluations were included in statistical models predicting food choice, habits remained significant.

4. General discussion

In recent years, researchers have begun to articulate the power of habits and other automatic processes in promoting healthy behavior (e.g., van't Riet et al., 2011). This new approach to understanding healthy eating coincides with the ways that people maintain a healthy diet and eat moderate portions in daily life. Research is showing that people who are especially effective at meeting their health goals establish healthy eating habits so that they do not have to struggle to inhibit unwanted desires (Galla & Duckworth, 2015; Hofmann, Baumeister, Förster, & Vohs, 2012). Thus, people effective at controlling their eating outsource dietary decisions so that healthy options and smaller portions are triggered automatically by recurring eating contexts.

In daily life, people form health habits much as they did in our experiments, by repeating behaviors over time in recurring contexts. People are especially likely to repeat behaviors that are rewarded, and thus rewards play an important role in promoting initial repetition into a habit. Rewards also may promote the habit learning process itself, and the connection of responses to contexts (Wood & Rünger, 2016). Under the highly controlled conditions in our experiments, habits were formed in Study 1 for chocolate consumption across 60 trials and in Study 2 for choice of different foods across 360 trials. In daily life, some healthy behaviors are easy to learn and might become automated in as few as 18 repetitions, whereas for other people and other behaviors, habit learning can require daily repetition for the better part of a year (Lally, VanJaarsveld, Potts, & Wardle, 2010).

Our studies built on this emerging evidence that healthy eating can be activated by context cues (e.g., time of day, presence of others). We demonstrated that, once people formed healthy habits, these habits perpetuated consumption of small portions and healthy choices despite the draw of unhealthy temptations. Our studies also revealed the conditions under which habits have most effect. In Study 1, healthy habits were protective when executive control had been drained by an earlier task, and participants were not able to deliberate about their food choices. In Study 2, all participants were depleted in this way, and healthy habits were protective when activated by context cues.

The present results suggest important ways in which habits may be leveraged to further self-regulatory goals. The tendency for people to backslide when self-control falters has been observed in a variety of health domains, including choice of food among dieters (Kahan, Polivy, & Herman, 2003), exercise among athletes (Dorris, Power, & Kenefick, 2012), consumption of alcohol among social drinkers (Muraven, Collins, & Neinhaus, 2002), and prescription of medications by physicians (Linder, Doctor, Friedberg et al., 2014). In our research, healthy habits protected against the unhealthy consequences often associated with reduced executive control. Habits thus can maintain healthy choices and small portions when people are not prepared to deliberate.

Habits are broadly insensitive to dynamic effects that undermine self-regulation. In the present study, as in prior research (Neal et al., 2013), habits proved to be largely insensitive to current food temptations. That is, once a habit is formed, it tends to perpetuate despite changes in preferences and goals (Wood & Rűnger, 2016). Thus, the formation and performance of healthy habits provide an important mechanism to protect against regulatory failures that arise when initial healthy commitments falter, health goals fade, and the fried foods that once seemed unthinkable again become a tempting alternative. Through automated responses to habit cues, people potentially can maintain health behaviors long after the initial impulse wanes that led them to cultivate the habit. In the same way that *choice architecture* (Thaler, Sunstein, & Balz, 2013) has provided new insights into behavior change, we suggest that *habit architecture* may yield dramatic benefits for maintaining health. Ironically, for people with healthy habits to eat small portions and choose healthy foods, the most reliable way to meet their health goals is to not think about what they are doing.

Acknowledgments

This research was made possible through the support of a grant from the John Templeton Foundation (Grant # 52316). The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the Foundation.

References

Adriaanse, M. A., Kroese, F. M., Gillebaart, M., & De Ridder, D. D. (2014). Effortless inhibition: habit mediates the relation between self-control and unhealthy snack consumption. *Frontiers in Psychology, 5*. Article 444 http://dx.doi.org/10.3389/fpsyg.2014.00444.

Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science, 16*(6), 351–355. http://dx.doi.org/10.1111/j.1467-8721.2007.00534.x.

Cloninger, C. R., Przybeck, T. R., Svrakic, D. M., & Wetzel, R. D. (1994). *Manual of the temperament and character inventory (TCI): A guide to its development and use*. St. Louis, Missouri: Washington University (Center for Psychobiology of

Personality).
Dorris, D. C., Power, D. A., & Kenefick, E. (2012). Investigating the effects of ego depletion on physical exercise routines of athletes. *Psychology of Sport and Exercise, 13*, 118–125. http://dx.doi.org/10.1016/j.psychsport.2011.10.004.
Fishbach, A., & Shah, J. Y. (2006). Self-control in action: Implicit dispositions toward goals and away from temptations. *Journal of Personality and Social Psychology, 90*, 820–832. http://dx.doi.org/10.1037/0022-3514.90.5.820.
Gailliot, M. T., Baumeister, R. F., DeWall, C. N., Maner, J. K., Plant, E. A., Tice, D. M., & Schmeichel, B. J. (2007). Self-control relies on glucose as a limited energy source: willpower is more than a metaphor. *Journal of Personality and Social Psychology, 92*, 325–336. http://dx.doi.org/10.1037/0022-3514.92.2.325.
Galla, B. M., & Duckworth, A. (2015). More than resisting temptation: beneficial habits mediate the relationship between self-control and positive life outcomes. *Journal of Personality and Social Psychology, 109*, 508–525. http://dx.doi.org/10.1037/pspp0000026.
Gardner, B., Abraham, C., Lally, P., & de Bruijn, G. J. (2012). Towards parsimony in habit measurement: testing the convergent and predictive validity of an automaticity subscale of the Self-Report Habit Index. *International Journal of Behavioral Nutrition and Physical Activity, 9*, 102. http://dx.doi.org/10.1186/1479-5868-9-102.
Garner, D. M., Olmstead, M. P., & Polivy, J. (1983). Development and validation of a multidimensional eating disorder inventory for anorexia nervosa and bulimia. *International Journal of Eating Disorders, 2*, 15–34.
Gosling, S. D., Rentfrow, P. J., & Swann, W. B., Jr. (2003). A very brief measure of the big-five personality domains. *Journal of Research in Personality, 37*, 504–528. http://dx.doi.org/10.1016/S0092-6566(03)00046-1.
Hofmann, W., Baumeister, R. F., Förster, G., & Vohs, K. D. (2012). Everyday temptations: an experience sampling study of desire, conflict, and self-control. *Journal of Personality and Social Psychology, 102*, 1318–1335. http://dx.doi.org/10.1037/a0026545.
Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences, 16*, 174–180. http://dx.doi.org/10.1016/j.tics.2012.01.006.
John, O. P., & Srivastava, S. (1999). The Big Five trait taxonomy: History, measurement, and theoretical perspectives. *Handbook of Personality: Theory and Research, 2*, 102–138.
Johnson, F., Pratt, M., & Wardle, J. (2012). Dietary restraint and self-regulation in eating behavior. *International Journal of Obesity, 36*, 665–674. http://dx.doi.org/10.1038/ijo.2011.156.
Judah, G., Gardner, B., & Aunger, R. (2013). Forming a flossing habit: an exploratory study of the psychological determinants of habit formation. *British Journal of Health Psychology, 18*, 338–353. http://dx.doi.org/10.1111/j.2044-8287.2012.02086.x.
Kahan, D., Polivy, J., & Herman, C. P. (2003). Conformity and dietary disinhibition: a test of the ego-strength model of self-regulation. *International Journal of Eating Disorders, 33*, 165–171. http://dx.doi.org/10.1002/eat.10132.
van Koningsbruggen, G. M., Stroebe, W., Papies, E. K., & Aarts, H. (2011). Implementation intentions as goal primes: boosting self-control in tempting environments. *European Journal of Social Psychology, 41*, 551–557. http://dx.doi.org/10.1002/ejsp.799.
Krieglmeyer, R., & Deutsch, R. (2010). Comparing measures of approach-avoidance behaviour: the manikin task vs. two versions of the joystick task. *Cognition and Emotion, 24*, 810–828. http://dx.doi.org/10.1080/02699930903047298.
Lally, P., Van Jaarsveld, C. H., Potts, H. W., & Wardle, J. (2010). How are habits formed: modelling habit formation in the real world. *European Journal of Social Psychology, 40*, 998–1009. http://dx.doi.org/0.1002/ejsp.674.
Lally, P., Wardle, J., & Gardner, B. (2011). Experiences of habit formation: a qualitative study. Psychology,. *Health & Medicine, 16*, 484–489. http://dx.doi.org/10.1080/13548506.2011.555774.
Lau, M. A., Bishop, S. R., Segal, Z. V., Buis, T., Anderson, N. D., Carlson, L., & Devins, G. (2006). The Toronto mindfulness scale: development and validation. *Journal of Clinical Psychology, 62*, 1445–1467. http://dx.doi.org/10.1002/jclp.20326.
Linder, J. A., Doctor, J. N., Friedberg, M. W., Nieva, H. R., Birks, C., Meeker, D., et al.Fox, C. R. (2014). Time of day and the decision to prescribe antibiotics. *JAMA Internal Medicine, 174*(12), 2029–2031. http://dx.doi.org/10.1001/jamainternmed.2014.5225.
Muraven, M., Collins, R. L., & Neinhaus, K. (2002). Self-control and alcohol restraint: an initial application of the self-control strength model. *Psychology of Addictive Behaviors, 16*, 113–120. http://dx.doi.org/10.1037/0893-164X.16.2.113.
Neal, D. T., Wood, W., & Drolet, A. (2013). How do people adhere to goals when willpower is low? the profits (and pitfalls) of strong habits. *Journal of Personality and Social Psychology, 104*, 959–975. http://dx.doi.org/10.1037/a0032626.
Neal, D. T., Wood, W., Wu, M., & Kurlander, D. (2011). The pull of the past: when do habits persist despite conflict with motives? *Personality and Social Psychology Bulletin, 37*, 1428–1437. http://dx.doi.org/10.1177/0146167211419863.
Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: habit as cue-contingent automaticity. *Health Psychology, 29*, 374–383. http://dx.doi.org/10.1037/a0019596.
Payne, B. K., Cheng, C. M., Govorun, O., & Stewart, B. D. (2005). An inkblot for attitudes: affect misattribution as implicit measurement. *Journal of Personality and Social Psychology, 89*, 277–293. http://dx.doi.org/10.1037/0022-3514.89.3.277.
Riccio, C. A., Reynolds, C. R., Lowe, P., & Moore, J. J. (2002). The continuous performance test: a window on the neural substrates for attention? *Archives of Clinical Neuropsychology, 17*, 235–272. http://dx.doi.org/10.1016/S0887-6177(01. http://dx.doi.org/10.1016/S0887-6177(01)00111-1.
van't Riet, J. V., Sijtsema, S. J., Dagevos, H., & De Bruijn, G. (2011). The importance of habits in eating behaviour. An overview and recommendations for future research. *Appetite, 57*, 585–596. http://dx.doi.org/10.1016/j.appet.2011.07.010.
Salmon, S. J., Fennis, B. M., de Ridder, D. T. D., Adriaanse, M. A., & de Vet, E. (2014). Health on impulse: when low self-control promotes healthy food choices. *Health Psychology, 33*, 103–109. http://dx.doi.org/10.1037/a0031785.
Schmeichel, B. J., Vohs, K. D., & Baumeister, R. F. (2003). Intellectual performance and ego depletion: role of the self in logical reasoning and other information processing. *Journal of Personality and Social Psychology, 85*, 33–46. http://dx.doi.org/10.1037/0022-3514.85.1.33.
Sriram, N., & Greenwald, A. G. (2009). The brief implicit association test. *Experimental Psychology, 56*, 283–294. http://dx.doi.org/10.1027/1618-3169.56.4.283.
van Strien, T., Herman, C. P., & Verheijden, M. W. (2014). Dietary restraint and body mass change. A 3-year follow up study in a representative Dutch sample. *Appetite, 76*, 44–49. http://dx.doi.org/10.1016/j.appet.2014.01.015.
Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*, 271–322. http://dx.doi.org/10.1111/j.0022-3506.2004.00263.x.
Thaler, R. H., Sunstein, C. R., & Balz, J. P. (2013). Choice architecture. In E. Shafir (Ed.), *The behavioral foundations of public policy* (pp. 428–439). Princeton, NJ: Princeton University Press.
Thorndike, A. N., Sonnenberg, L., Riis, J., Barraclough, S., & Levy, D. E. (2012). A 2-phase labeling and choice architecture intervention to improve healthy food and beverage choices. *American Journal of Public Health, 102*, 527–533. http://dx.doi.org/10.2105/AJPH.2011.300391.
Tricomi, E., Balleine, B. W., & O'Doherty, J. P. (2009). A specific role for posterior dorsolateral striatum in human habit learning. *European Journal of Neuroscience, 29*, 2225–2232. http://dx.doi.org/10.1111/j.1460-9568.2009.06796.x.
Vohs, K. D., Baumeister, R. F., & Ciarocco, N. J. (2005). Self-regulation and self-presentation: regulatory resource depletion impairs impression management and effortful self-presentation depletes regulatory resources. *Journal of Personality and Social Psychology, 88*, 632–657. http://dx.doi.org/10.1037/0022-3514.88.4.632.
Watson, P., Wiers, R. W., Hommel, B., & de Wit, S. (2014). Working for food you don't desire. Cues interfere with goal-directed food-seeking. *Appetite, 79*, 139–148. http://dx.doi.org/10.1016/j.appet.2014.04.005.
Westling, E., Mann, T., & Ward, A. (2006). Self-control of smoking: when does narrowed attention help? *Journal of Applied Social Psychology, 36*, 2115–2133. http://dx.doi.org/10.1111/j.0021-9029.2006.00097.x.
Wiedemann, A. U., Gardner, B., Knoll, N., & Burkert, S. (2014). Intrinsic rewards, fruit and vegetable consumption, and habit strength: a three-wave study testing the associative-cybernetic model. *Applied Psychology: Health and Well-being, 6*, 119–134. http://dx.doi.org/10.1111/aphw.12020.
Wood, W., Labrecque, J., Lin, P.-Y., & Rűnger, D. (2014). Habits in dual process models. In J. Sherman, B. Gawronski, & Y. Trope (Eds.), *Dual process theories of the social mind* (pp. 371–385). New York: NY: Guilford Press.
Wood, W., Quinn, J. M., & Kashy, D. A. (2002). Habits in everyday life: thought, emotion, and action. *Journal of Personality and Social Psychology, 83*, 1281–1297. http://dx.doi.org/10.1037/0022-3514.83.6.1281.
Wood, W., & Rűnger, D. (2016). Psychology of habits. *Annual Review of Psychology, 16*.