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The Pull of the Past: When Do Habits Persist Despite Conflict With Motives?

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Abstract

To identify the factors that disrupt and maintain habit performance, two field experiments tested the conditions under which people eat out of habit, leading them to resist motivational influences. Habitual popcorn eaters at a cinema were minimally influenced by their hunger or how much they liked the food, and they ate equal amounts of stale and fresh popcorn. Yet, mechanisms of automaticity influenced habit performance: Participants ate out of habit, regardless of freshness, only when currently in the context associated with past performance (i.e., a cinema; Study 1) and only when eating in a way that allowed them to automatically execute the response cued by that context (i.e., eating with their dominant hand; Study 2). Across all conditions, participants with weaker cinema-popcorn-eating habits ate because of motivations such as liking for the popcorn. The findings reveal how habits resist conflicting motives and provide insight into promising mechanisms of habit change.

Keywords

attitudes, automatic processes, health, self-regulation

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Habits develop when people give a response repeatedly in a particular context and thereby form associations in memory between the response and recurring context cues. Theories of automaticity illuminate the cognitive mechanisms behind habits. When people have a strong habit, perception of recurring context cues activates the response in memory and may additionally deactivate alternative responses (Danner, Aarts, & de Vries, 2008; Neal, Labrecque, Wood, & Lally, 2011). For example, when habitual runners were subliminally primed with words relating to the contexts in which they ran (e.g., *gym, forest*), the act of running became strongly accessible in thought (Neal et al., 2011). Suggesting that this context cuing process may be minimally influenced by motivations, subliminally priming participants' personal goals for running did not make running habits more accessible.

Habits initially are likely to form through goal pursuit—as people repeatedly perform actions that yield desired outcomes. However, once habits have developed, they are performed with only limited influence from supporting motivations (Triandis, 1977, 1979). Nonetheless, experimental tests of how these mechanisms play out with real-world behaviors have not yet been provided. The present research provides these tests by independently manipulating motivational and contextual factors across two field experiments with a socially significant behavior, habitual eating.

The basic question in our experiments is: What disrupts habit performance? The design pitted negative attitudes toward stale food against established habits to eat in a given context. If people continue to perform habits despite this substantial conflicting motive, then habits are resistant to changes in attitudes and goals. Although habits may not be easily influenced by motives, their dependence on context cues should make them vulnerable to disruptions in automaticity. That is, habits should not be *activated* automatically outside of their typical performance context and should not be *executed* automatically when responses are performed in novel ways (e.g., using the nondominant hand). By manipulating the factors that do and do not control habits, we can test whether strong habits become responsive to current motivations when automaticity is disrupted.

Evidence of the Automaticity Guiding Habitual Behavior

Social psychological experiments have largely focused on types of automaticity that flexibly accommodate to current

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goals and attitudes (Kruglanski et al., 2002). Yet, research in neuroscience, animal learning, and correlational studies of everyday behavior has focused primarily on cued actions that are not influenced by current motives (reviewed in Wood & Neal, 2007, 2009).

In neuroscience research on the brain systems activated during behavioral tasks, performance of stimulus–response habits is localized in the basal ganglia, especially the putamen, whereas control of goal-directed actions is localized in other brain regions, often involving the prefrontal cortex (Balleine & O'Doherty, 2010; Yin & Knowlton, 2006). Thus, habit formation involves neural shifts from "largely evaluation-driven circuits to those engaged in performance" (Graybiel, 2008, p. 362). Furthermore, the different brain systems controlling habits and goal-directed behavior often compete in guiding action such that activity associated with goal-directed control may be actively suppressed during performance of habitual behavior (Balleine & O'Doherty, 2010; Poldrack et al., 2001). Animal learning research also differentiates habits from goal-directed actions, primarily in terms of behavioral reactions to rewards. Specifically, extended training at a task such as lever pressing for a food reward produces habitual, continued responding to the lever cue even after the reward is devalued (e.g., the animal is sated, the food has been associated with a toxin; Dickinson & Balleine, 1995).

The minimal influence of motivations on habit performance also is a central finding of correlational studies of everyday behavior, including *behavior prediction* (Triandis, 1977) and *habit discontinuity* (Verplanken, Walker, Davis, & Jurasek, 2008). Across a range of everyday behaviors—from bus travel, to fast food consumption, to exercise—motivational factors (e.g., attitudes, intentions, self-concept, attitude accessibility) predicted future performance for nonhabitual behaviors but had limited predictive power for strong habits (Ouellette & Wood, 1998). Furthermore, consistent with the idea that habits are cognitively represented as context–response associations, habit strength had these effects only when habits were assessed from frequent performance in stable contexts—the specific conditions that enable the formation of habit associations in memory (Aldrich, Montgomery, & Wood, in press; Danner et al., 2008). Discontinuity studies that assess naturally occurring context changes find that participants continue to perform habits with minimal influence from goals, but only so long as they continue to live in the same context (Verplanken et al., 2008; Wood, Tam, & Witt, 2005). When participants move house to a new location without cues to habit performance, they apparently are freed to act on their goals.

The findings from neuroscience, animal learning, and correlational research on everyday behavior suggest that, once developed, habits are performed with limited influence from motivations. It may be that strong habits are directly brought to mind by the context cues (e.g., settings, preceding actions) associated with prior performance. Then, through ideomotor processes, people may act on the accessible behavior in mind (Bargh, 1994). According to this view, for example, a person's habit to snack on crackers at night may come to be directly cued by sitting in front of the TV, and changes in motivational states of hunger and liking for food may have little influence on how much the person eats.

Attitudes and Goals Flexibly Guide Behavior

The insensitivity of habit performance to current motives outlined in the preceding research might seem surprising to social psychologists given the field's focus on the flexible operation of attitudes and goals. Although strong goals and attitudes are known to have enduring influence, they usually guide responding in a given context depending on the expected outcomes of an action and the value placed on those outcomes (Eagly & Chaiken, 1993). Thus, people act on strong food preferences in a given context depending on what food is available and how tasty it is. Even *automatic goal pursuit*—in which goals are activated and guide responding outside of awareness—yields "not a static behavioral response, but an automated *strategy* for dealing with the environment" (Bargh & Barndollar, 1996, p. 461, italics in original). Similarly, automatically activated attitudes often are malleable and context dependent (Dijksterhuis, Smith, van Baaren, & Wigboldus, 2005).

The flexible influence of implicit goals and attitudes is evident in research that opposes implicit against explicit motives. For example, Macrae and Johnston's (1998) participants responded to implicit priming of a helping goal by offering assistance to someone in need, except when the implicit helping goal was inconsistent with their explicit goal of being on time. In other research, participants carried out implementation intentions to study—a form of automatic goal pursuit in which people plan to perform a particular response upon encountering a particular cue—only when they held the explicit goal of studying (Sheeran, Webb, & Gollwitzer, 2005). In an experiment related to our present focus on eating habits, implicit goals relevant to thirst increased the amount that participants drank during a beverage taste test, but only when they were thirsty (Strahan, Spencer, & Zanna, 2002). Nonetheless, conflicts between explicit and implicit goals are not always resolved in favor of explicit ones (Shah & Kruglanski, 2002). Instead, these dispositions combine in dynamic ways to shape responding in goal pursuit.

Habits contrast with the flexible pattern of responding characteristic of motives. Unlike automatic goals and attitudes, performance of strong habits may not be dynamically responsive to current motives. Thus, a strong habit to eat a particular food in a given context may be insensitive to current hunger levels or the palatability of the food.

The Present Research

To test the factors that can alter habit performance, we conducted two field experiments varying the conditions under which people consume popcorn at a movie cinema. Some participants in our research had strong habits to eat popcorn at the cinema (i.e., a history of frequent popcorn consumption in that setting), whereas others had weaker habits. We chose to study eating behavior in part because it is a significant social problem and in part because eating provides a strong test of the sensitivity of habits to changes in motivations. People believe that their eating behavior is largely a motivated activity in response to the way food tastes (e.g., Vartanian, Herman, & Wansink, 2008). Indeed, 17 of 22 participants in a pilot study provided "tastes good" or a close synonym when asked why they ate popcorn at the cinema. Thus, in the present experiments, we manipulated attitudes toward the food through its palatability. For some participants, the popcorn was fresh, whereas for others it was 7 days old and stale (adapted from Wansink & Kim, 2005).

To test the effects of changes in motivations, we first assessed whether participants with strong and weak habits evaluated the popcorn in the same way. It is possible that strong-habit participants would report more favorable attitudes even toward stale popcorn. By assessing attitudes toward the specific popcorn served and not toward popcorn in general, we evaluated the immediate, proximal attitude relevant to participants' eating. We also assessed participants' reported hunger and, in Study 2, their perceptions of social norms. Our second test of the susceptibility of habits to shifts in motivations involved assessing how much popcorn participants ate. Specifically, we evaluated whether participants with strong habits ate more of the liked, fresh popcorn than the disliked, stale popcorn and ate more when they were hungry.

Even if habits are not responsive to changes in motives, they should be disrupted by challenges to habit cuing. In Study 1, participants were tested either in the context relevant to their habit (watching movies in a cinema) or in a novel context (watching music videos in a conference room). We anticipated that habits would be automatically brought to mind only in the cinema context. In Study 2, all participants ate in the habit-related context of a cinema, and we manipulated whether they ate in their typical way (with their dominant hand) or in a novel way (using their nondominant hand). Using one's nondominant hand has been shown to impede the automatic, smooth performance of habitual responses (Sakai, Kitaguchi, & Hikosaka, 2003), presumably because it brings the action under intentional control. Thus, eating habits should be automatically executed only when eating with the dominant hand.

If habits resist changes in motives but can be disrupted by changes in automatic cuing, then we anticipate the following three-way interaction: Participants at the cinema with strong popcorn habits should be guided by the action in mind and eat similar amounts of fresh and stale popcorn. In contrast, participants with weak or moderate habits should eat more of the fresh popcorn that they like. Alternatively, when automatic cuing is disrupted by eating in a novel context or eating in a cinema but in a novel manner, then even strong-habit participants are likely to fall back on their attitudes and consume more fresh than stale popcorn.

Study 1

Method

Design and participants. Study 1 used a Context (cinema vs. meeting room) × Food Attitudes (fresh vs. stale) between-participants design. Habit strength for eating popcorn at the movies was an additional, continuous predictor. For the cinema context, 98 participants (57 males) were recruited immediately before the showing of a regularly scheduled feature film at a campus cinema. For the meeting room context, 60 participants (35 males) were recruited through flyers and participated in a campus meeting room near the cinema. Participants were paid $6 for completing the study.[1]

Procedure

Participants in the cinema setting were told that the study examined personality differences in movie interests and that they would rate a series of movie trailers. Sessions were conducted in groups of around 15. Before entering the theater, participants rated their current feelings (hunger, time since last meal, several filler items) and were given a 591-ml bottle of water and a box of popcorn. Participants were randomly assigned to receive popcorn that was either fresh (popped 1 hr before the session) or stale (popped 7 days before the session). Each box was discretely numbered so that it could be matched to participants' survey responses. Boxes were weighed before and after distribution on a digital scale, with initial amount averaging 61.73 g (SD = 6.74).

Participants entered the theater with their popcorn and water and, to reduce potential social influence, sat as far as possible from other participants. The lights immediately dimmed, and a series of six movie trailers for unreleased films was shown, totaling 15 min of viewing time. All popcorn boxes and water containers were collected immediately after the final trailer. Participants then moved to the cinema foyer and completed the survey, which, to maintain the cover story, first assessed their interest in seeing each film and then included a personality inventory and the liking and habit strength measures (see below).

Participants in the meeting room condition followed a similar procedure with one critical modification. The study was conducted in a campus meeting room and involved watching and rating music videos, a novel setting not associated

Table 1. Mean Liking of Popcorn Received in Studies 1 and 2 as a Function of Experimental Condition

	Fresh		Stale	
Habit cuing manipulation	*M*	*SD*	*M*	*SD*
Study 1				
Cinema	3.51	(0.93)	2.60	(1.16)
Meeting room	3.60	(0.96)	3.03	(0.89)
Study 2				
Eating with dominant hand	4.18	(1.42)	3.10	(1.42)
Eating with nondominant hand	4.50	(1.31)	2.72	(1.36)

Higher numbers reflect more positive ratings of the popcorn on a 7-point scale ranging from *very bad* (1) to *very good* (7).

with prior popcorn eating. A pilot test ($N = 22$) confirmed that the music videos were equivalent to the movie trailers in terms of their interest value and attentional involvement ($ts < 1$). Instead of rating their interest in watching each movie, participants rated their interest in owning each music video. All other aspects of the design were identical to the cinema setting (e.g., lighting levels, popcorn boxes, time since last major meal, number and visibility of other participants).

Hunger ratings. Before watching the videos, participants rated their current hunger on a 5-point scale (anchors *not at all* to *extremely*).

Ratings of popcorn attitude. On a 7-point scale, participants rated their liking for the popcorn they received (anchors *very bad* to *very good*).

Habit strength. On a 7-point scale, participants indicated how frequently in the past they ate popcorn in movie theaters (anchors *always* to *never*, reverse scored).

Results and Discussion

Our primary hypotheses were tested via regression models with the following predictors: context (cinema vs. meeting room), popcorn freshness (stale vs. fresh), habit strength to eat popcorn in theaters, and all two- and three-way interactions. Gender was a control variable in all analyses.

Reported attitudes and hunger. To establish that the experiment was constructed appropriately to test our hypotheses, we first used the regression model to predict participants' liking of the popcorn they received. As expected, the model yielded only a main effect of the freshness manipulation, $B = 0.54$, $t(141) = 1.98$, $SE = 0.27$, $p = .05$, establishing that fresh popcorn was liked significantly more than stale. Importantly, this effect was not qualified by any interactions with context or habit strength.[2] Mean liking of fresh popcorn was close to the scale midpoint ($M = 3.56$, $SD = 1.23$), and mean liking of stale popcorn was below the midpoint ($M = 2.72$, $SD = 0.91$), demonstrating that participants decidedly disliked the stale popcorn (see Table 1). No other differences in liking or in self-reported hunger emerged across conditions. Thus, participants in the meeting room had similar levels of hunger to those in the cinema, $t(144) = 1.57$, $SE = 0.16$, $p = .117$. Furthermore, the comparable ratings of popcorn in both contexts suggests that participants in the meeting room did not pay any closer attention to the popcorn than those at the cinema, $t(144) = 1.30$, $SE = 0.18$, $p = .194$.

Factors influencing performance of eating habits. The percentage of popcorn participants consumed was then analyzed with the regression model. Significant main effects emerged for gender (men ate more), $B = 14.37$, $t(142) = 3.32$, $SE = 4.32$, $p = .001$; context, $B = 27.20$, $t(142) = 4.53$, $SE = 6.00$, $p = .001$; and freshness, $B = 15.96$, $t(142) = 2.27$, $SE = 7.05$, $p = .025$. The latter two effects were qualified by the predicted three-way interaction between habit strength, context, and freshness, $B = 11.36$, $t(142) = 2.04$, $SE = 5.56$, $p = .043$, and no other effects were significant. To test whether strong-habit participants' eating was activated automatically in the cinema context with little regard for freshness, we calculated simple regression slopes between percent of popcorn consumed and freshness of the popcorn separately for participants with weak, moderate, and strong consumption habits in the cinema (Cohen, Cohen, West, & Aiken, 2003; see Figure 1).

In the cinema context, participants with weak habits—who infrequently ate popcorn at cinemas—ate significantly less popcorn in the stale than in the fresh conditions, $B = –30.03$, $t(90) = 4.28$, $SE = 7.01$, $p = .001$. Those with moderate popcorn eating habits also ate less stale than fresh popcorn, $B = –19.87$, $t(90) = 4.94$, $SE = 4.02$, $p = .001$. Importantly, as predicted, those with strong popcorn eating habits ate the same percentage of stale as fresh popcorn when located in the cinema environment, $B = –9.72$, $t(90) = 1.41$, $SE = 6.89$, $p = .162$.

In the meeting room context, an effect of freshness was evident at every level of habit strength. Specifically, people ate (at least marginally) less stale than fresh popcorn, whether they had weak habits, $B = –11.24$, $t(90) = 1.86$, $SE = 6.04$, $p = .074$; moderate habits, $B = –17.21$, $t(90) = 4.09$, $SE = 4.21$, $p = 0.001$; or strong habits, $B = –23.17$, $t(90) = 3.03$, $SE = 7.65$, $p = .001$. Critically, this pattern demonstrates that when tested in a novel environment, participants with strong popcorn consumption habits ate less stale than fresh popcorn.

Habit performance did not depend on motives. We conducted separate analyses to evaluate directly whether habit performance depended on participants' hunger and liking for the popcorn. To evaluate hunger as a moderator, we included this factor as a predictor in the model. Although hungrier participants ate marginally more in general, $B = 4.01$, $t(142) = 1.7$, $SE = 2.36$, $p = .092$, the critical interaction between hunger and habit strength was not significant ($t < 1$), suggesting that habit effects did not depend on this motive. Even more importantly, after including hunger and the Hunger × Habit Strength interaction, the predicted three-way interaction maintained between habit strength, context, and freshness, $B = 12.27$, $t(142) = 2.17$, $SE = 5.66$, $p = .032$.

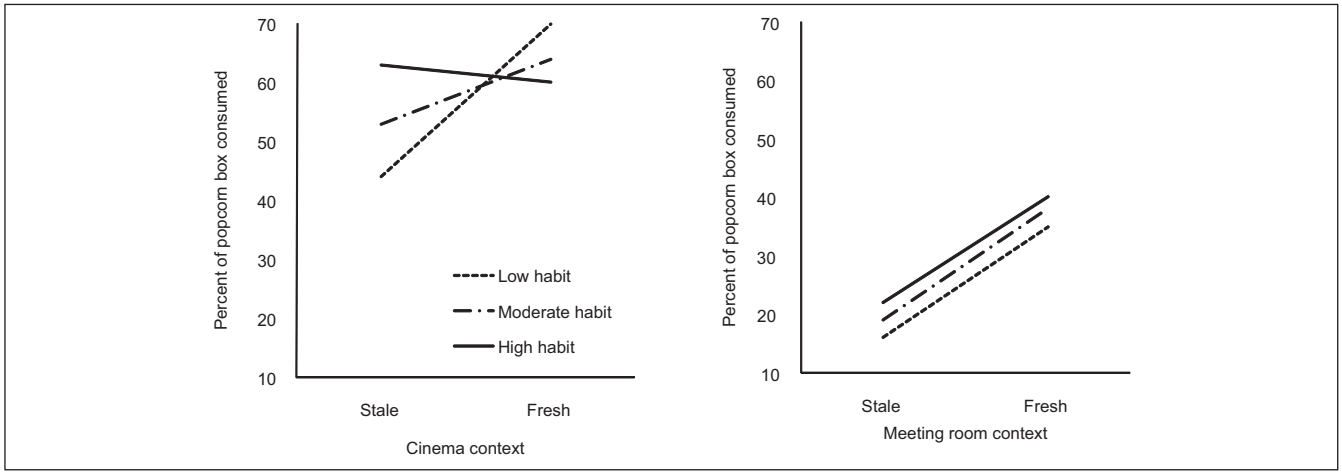

Figure 1. Percentage of popcorn eaten during 15 min of movie trailers in the cinema and 15 min of music videos in the meeting room (Study 1)

Simple slopes depict percent consumed of stale and fresh popcorn for those with strong (mean + 1 *SD*), moderate (mean), and weak (mean – 1 *SD*) habits for eating popcorn at cinemas.

We then conducted analyses evaluating liking as a moderator. Again, this motivation had a main effect, with participants eating more popcorn when they liked it more, $B = 8.32$, $t(142) = 3.95$, $SE = 2.11$, $p < .001$, but the interaction between liking and habit strength was not significant ($t < 1$), suggesting that habit effects did not depend on this attitude. Furthermore, the three-way interaction between habit strength, context, and freshness remained close to significant after including these effects in the model, $B = 9.69$, $t(142) = 1.80$, $SE = 5.35$, $p = .07$.

In general, the overall pattern suggests that habit performance resists shifts in attitudes but can be disrupted by shifts in habit cuing. It is important to note that strong-habit participants experienced the shift in motivation as a function of the food's freshness. They rated the fresh popcorn as more likable than the stale, and thus they did not value the popcorn more than those with weak habits. Because we assessed liking for the specific popcorn in the experiment and not popcorn in general, we evaluated the attitude toward the object most closely linked to consumption of this particular food. Although strong-habit participants experienced this motivational shift, their eating was not guided by it. That is, when in the cinema so that eating was activated automatically by the context, these participants consumed about 63% of the popcorn regardless of its palatability. Furthermore, tests of whether the habit effects depended on liking for the popcorn or current hunger revealed that these factors did not moderate the effects of habit strength on eating.

The eating behavior of strong-habit participants was, however, disrupted by features associated with automatic cuing. When in the meeting room watching movie videos, cinema-popcorn habits were not automatically activated, and strong-habit participants' behavior was brought under intentional control. Then, like the weak-habit participants in all conditions, they ate about half as much stale popcorn compared with fresh popcorn. Thus, participants' habitual eating was resistant to changes in motivational states but influenced by variations in habit automaticity.

Study 2

Study 2 replicated the test of insensitivity of habit performance to motivational states and tested an additional disruption of habit automaticity—whether the response could be repeated as in the past or had to be performed in a novel way. We anticipated that participants performing the response in a novel way would be unable to act automatically on any habitual response triggered by the cinema context. To test this idea, half of the participants were instructed to use their nondominant hand to eat. This disruption in the fluid execution of habitual eaters' consumption should not affect their judgments of the popcorn. Instead, the manipulation should hinder the automatic execution of the habitual response and bring behavior under intentional control—so that participants can be guided by their motivations and eat more fresh than stale popcorn. Thus, we tested whether participants with strong cinema-popcorn habits, when eating with their nondominant hand at the cinema, would be hindered in automatically repeating their past behavior and instead would become responsive to food freshness, consuming only popcorn they liked.

The study also assessed several potential alternative explanations for the predicted effects. To see whether the hand manipulation affected consumption by prompting people to attend more to the popcorn's freshness (and perhaps especially so for those with strong habits), we tested people's recall for specific details of the movie trailers. We reasoned that participants attending closely to the popcorn would, by definition, be attending less to the trailers and thus would recall fewer specific details. Also, based on prior work in

action identification theory (Vallacher & Wegner, 1989) and construal level theory (Trope & Liberman, 2010), we tested whether the hand manipulation encouraged people to construe popcorn consumption at a lower, more concrete level, thereby highlighting lower level, immediate outcomes such as taste. Finally, we assessed participants' perceived norms to eat popcorn and tested whether variation in normative beliefs could explain the effects of habit. Thus, Study 2 tested for changes in attention, construal level, and perceived norms as possible explanations for the predicted effects.

Method

Design and participants. The design of Study 2 was identical to Study 1 except that the context manipulation was replaced by a manipulation to eat with a particular hand. Thus, the design was a Hand Used to Eat (dominant vs. nondominant) × Food Freshness (fresh vs. stale) between-participants design. Eighty-nine participants (47 males) were paid $6 for completing the study.[3]

Procedure

Participants were recruited and participated just before the showing of a feature film at a campus cinema. Procedural details mirrored the cinema condition of Study 1, with the exception of the manipulation of the hand participants used to eat. For this manipulation, we designed a modified popcorn box with a vertically aligned handle on one side. Participants were instructed to slide one hand in-between the handle and the box and hold the box in that manner throughout the session. This instruction was embedded in several other methodological details and framed as necessary for experimental control. Testing sessions were randomly assigned such that, in half, participants were instructed to hold the box in their left (vs. right) hand.

In the follow-up survey, participants completed the Edinburgh Handedness Inventory (Oldfield, 1971). This enabled us to code participants according to whether they had eaten with their typical, dominant hand or their atypical, nondominant hand. Ambidextrous participants ($N = 4$) were coded as dominant hand eaters, but excluding this group did not alter the results reported below. At the study conclusion, participants were asked for an anonymous, honest estimate regarding the percentage of eating time in which they had actually used the instructed hand to eat. Estimates were made on an 11-point scale (*0% of the time* to *100% of the time*). Compliance with the hand manipulation was good. Ninety percent of the sample reported complying 100% of the time. Those who deviated did so an average of only 10% of the time. Excluding these participants or including compliance as a control variable did not alter the reported results.

Normative beliefs. To evaluate the extent to which habit performance depends on social norms, in the final survey participants rated on a 7-point scale the extent to which "other people important to them think that it's normal to eat popcorn at the cinema" (anchors *strongly disagree* to *strongly agree*). Because this item was not a close-to-significant predictor of consumption, it is not discussed further.

Attention to the trailers. To assess how much attention participants paid to the movie trailers, they answered nine difficult questions about the trailers (e.g., "What color did the main character in 'Whip It' dye her hair?"). The only close-to-significant effect in the analyses on factual recall was a trend for slightly worse recall among strong-habit participants, $B = –0.41$, $t(80) = 1.78$, $SE = 0.23$, $p = .07$. This pattern counters the possibility that strong-habit participants were not attending to the popcorn and were able to attend more closely to the movie trailers.

Level of construal of popcorn eating. Three questions assessed whether people construed the act of eating popcorn in the study at a higher, more abstract level versus a lower, more concrete level. Modeled after Vallacher and Wegner's (1989) research, each question involved choosing between a more concrete description of eating popcorn (i.e., chewing, holding a box, placing food in your mouth) and a more abstract one (i.e., part of the movie experience, sharing something with other people, a healthful snack). The sum of abstract choices (range = 0-3) served as the measure of construal level. Consistent with action identification theory and construal level theory, more habitual eaters preferred more abstract descriptions of popcorn consumption, $B = 0.14$, $t(81) = 2.51$, $SE = 0.07$, $p = .036$. However, the interaction between habit strength and hand used to eat did not significantly predict construal ($t > 1.2$). Thus, the predicted effects of the manipulation cannot be explained by changes in construal level.

Results and Discussion

The hypotheses were tested using a regression model with the following predictors: hand used to eat, popcorn freshness, habit strength to eat popcorn in theaters, and all two- and three-way interactions. Gender was a control variable in all analyses.

Reported attitudes and hunger. The model predicting participants' liking of the popcorn they received yielded only a main effect, reflecting that participants disliked the stale popcorn ($M = 3.43$, $SD = 1.59$) more than the fresh ($M = 4.35$, $SD = 1.59$), $B = 1.02$, $t(81) = 3.44$, $SE = 0.30$, $p = .001$. Importantly, this effect was not qualified by any interactions with context or habit strength.[4] As can be seen from the liking means in Table 1, no other differences emerged across conditions. Thus, mean liking did not vary with the hand used to eat, $t(85) = 0.78$, $SE = 0.33$, $p = .44$. Prestudy hunger levels also were identical among those eating with their dominant versus nondominant hand, $t(85) = 000$, $SE = 0.26$, $p = 1.00$.

Factors influencing performance of eating habits. The model predicting percentage of popcorn consumed yielded a main

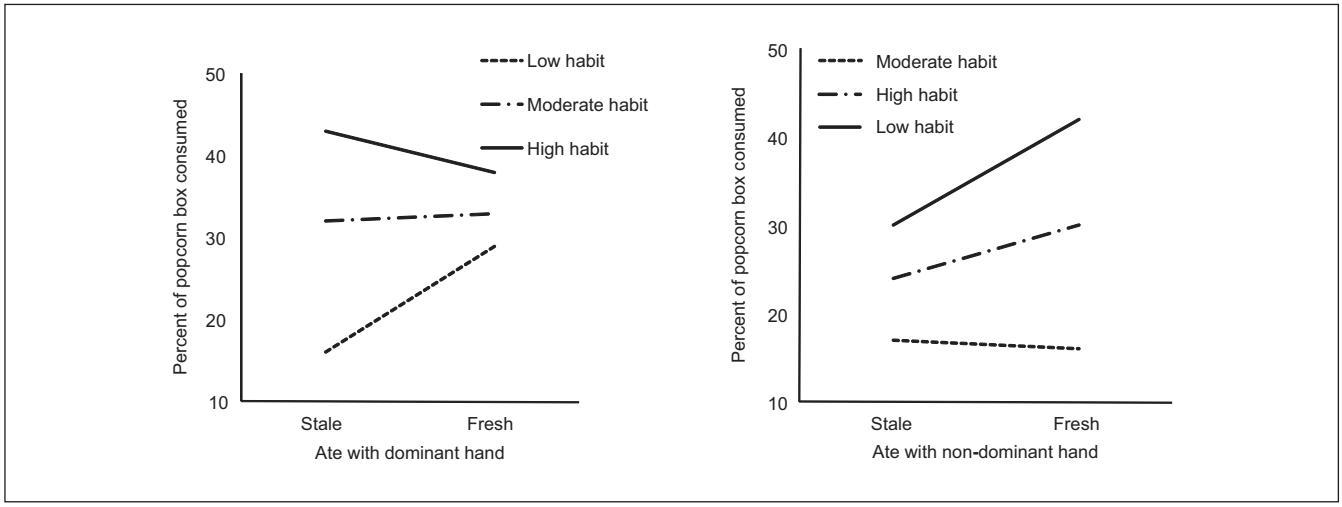

Figure 2. Percentage of popcorn eaten during 15 min of movie trailers in the cinema when participants were eating with their typical, dominant hand or atypical, nondominant hand (Study 2)
Simple slopes depict percent consumed of stale and fresh popcorn for those with strong (mean + 1 *SD*), moderate (mean), and weak (mean – 1 *SD*) habits for eating popcorn at cinemas.

effect of habit strength, $B = 6.74$, $t(81) = 2.55$, $SE = 2.64$, $p = .013$, and a marginal effect of hand used to eat, $B = 8.27$, $t(81) = 1.67$, $SE = 4.95$, $p = .094$. These main effects were qualified by the predicted three-way interaction between habit strength, hand used to eat, and freshness, $B = 8.52$, $t(81) = 2.22$, $SE = 3.84$, $p = .029$. To test whether strong habits were executed automatically— regardless of freshness— only when participants used their dominant hand, we calculated simple regression slopes between percent of popcorn consumed and freshness of the popcorn separately for participants with weak, moderate, and strong consumption habits as a function of the hand they used to eat (Cohen et al., 2003).

As predicted (see Figure 2), using the dominant versus nondominant hand to eat popcorn apparently enabled or disrupted habit cuing. That is, habitual eaters using their dominant hand automatically executed the response activated in the cinema context. The same amount of fresh and stale popcorn was eaten by participants with moderate habits, $B = –1.41$, $t(81) = 0.46$, $SE = 3.07$, $p = .647$, and strong habits, $B = 8.81$, $t(81) = 1.55$, $SE = 5.68$, $p = .13$. Only participants with weak habits ate significantly less stale than fresh popcorn when eating with the dominant hand, $B = –11.64$, $t(81) = 1.99$, $SE = 5.84$, $p = .053$.

Participants eating with their nondominant hand, in contrast, did not respond habitually to the cinema context and were influenced by popcorn freshness. Specifically, those with moderate habits ate significantly less stale than fresh popcorn, $B = –6.44$, $t(81) = 2.04$, $SE = 3.16$, $p = .048$, and those with strong habits ate marginally less, $B = –12.89$, $t(81) = 1.91$, $SE = 6.75$, $p = .063$. Unexpectedly, those with weak habits did not eat less stale than fresh popcorn when eating with their nondominant hand, $B = 0.02$, $t(81) = 0.01$, $SE = 2.00$, $p = .998$. However, inspection of the consumption rates for this group suggests a floor effect, such that eating with the nondominant hand was at such a low rate among these individuals that the stale popcorn could not induce further declines.

Habit performance did not depend on motives. As in Study1, we tested directly whether habit performance depended on participants' hunger and liking for popcorn. Although hungrier participants ate marginally more in general, $B = 2.72$, $t(79) = 1.76$, $SE = 1.55$, $p = .08$, the critical interaction between hunger and habit strength was not significant ($t < 1$), suggesting that habit effects did not depend on this motive. Even more importantly, after including hunger and the Hunger × Habit Strength interaction in the model, the predicted three-way interaction maintained between habit strength, context, and freshness, $B = 7.75$, $t(79) = 2.01$, $SE = 3.86$, $p = .048$.

In the analyses on liking as a moderator, this motivation yielded a main effect, with participants eating more popcorn if they liked it more, $B = 3.90$, $t(79) = 2.52$, $SE = 1.34$, $p = .014$. However, the interaction between liking and habit strength was not significant ($t < 1$), suggesting that the habit effects did not depend on this attitude. After adding these additional terms to the model, the critical three-way interaction between habit strength, context, and freshness dropped below significance, $B = 5.54$, $t(79) = 1.50$, $SE = 3.69$, $p = .13$. However, the low power to detect effects in this model may have contributed to this nonsignificant finding.

In general, just like Study 1, habitual cinema-popcorn eaters did not like the popcorn any more or less than nonhabitual eaters. Everyone disliked the stale popcorn and expressed neutral attitudes toward the fresh. It is also interesting that strong-habit participants expressed the same normative beliefs about eating popcorn in the cinema as weak-habit participants. Also, the slightly lower recall of the movie

trailers among strong-habit participants suggests that their attention was not unduly captured by these presentations, and thus they could attend to the quality of the popcorn as much as weak-habit participants. Finally, although strong-habit participants did favor more abstract descriptions of popcorn consumption, this tendency was not altered by the hand use manipulation, making changes in construal level an unlikely explanation for the results.

Despite the comparable subjective judgments of participants with strong and weak habits, striking differences emerged in their eating patterns. Strong-habit participants, when they could eat automatically with their dominant hand, repeated their past responses regardless of the palatability of the food. However, when strong-habit participants were forced to eat in an atypical way, their behavior was brought under intentional control, and—like the weak-habit participants in all conditions—they ate little of the stale popcorn.

General Discussion

Two field experiments tested the factors controlling a socially significant habit, eating behavior. In both experiments, participants' eating habits were resistant to changes in attitudes and goals. Strong habits persisted regardless of whether participants were hungry and whether the popcorn was fresh and palatable or stale and distasteful. Thus, when in the context associated with frequent past consumption, strong-habit participants rigidly carried out their past responses. Unlike the motivated types of automaticity studied most often in social psychology, habit responses were not sensitive to participants' current motivational states. Instead, strong-habit participants acted on habitual responses in memory to such an extent that they ate even food they disliked.

Habitual eating, although not influenced by motivations, was disrupted by factors that we anticipated would block the processes of habit automaticity. That is, participants in an environment not associated with past consumption (a meeting room) should not have the habitual response automatically brought to mind. Also, participants at the cinema eating in a novel way (with their nondominant hand) should not have been able to automatically carry out the response in mind. Our experiments thus directly manipulated the critical mechanisms that enable habit performance. When habit automaticity was apparently disrupted, participants' eating came under intentional control. That is, participants ate more when they were hungry and when they liked the popcorn—yielding greater consumption of fresh than stale popcorn. The findings thus echo prior research showing that people relying on their habits were less responsive to the outcomes of their behavior (Ji & Wood, 2007; Verplanken, Aarts, & van Knippenberg, 1997). By disrupting habitual eaters' automatic activation and execution of their past behavior, the present research reveals further that responsiveness to outcomes can be restored.

Importantly, the different eating patterns of strong- and weak-habit participants could not be explained by differences in the subjective evaluation of the popcorn. Habitual eaters recognized that the stale popcorn was not palatable, and they reported disliking it just as extremely as did nonhabitual eaters. It is striking, then, that these negative attitudes only curtailed habitual eaters' consumption when habit automaticity was disrupted. At the process level, the results do not appear to be due to changes in attention, social norms, or construal level across experimental conditions. Our check on recall of the details of the movie trailers in Study 2 revealed that the hand use manipulation did not change how much attention people paid to the popcorn, either as a main effect or through an interaction with habit strength. Also, all participants held similar norms to eat popcorn in the cinema. Finally, the hand use manipulation did not alter whether people thought about their popcorn consumption at a more abstract versus a more concrete level. Thus, it appears unlikely that the manipulation to disrupt habit automaticity worked through these alternative mechanisms.

The present study contributes to growing evidence that performance settings can serve as direct cues to habitual behavior. Habitual runners have been found to have strong cognitive associations between the location in which they typically trained and mental representations of running (Neal et al., 2011). Similarly, in behavior prediction studies, strong-habit participants tend to repeat responses independently of intentions when they are in familiar performance contexts (Ji & Wood, 2007). Based on this earlier research, we anticipated that the actual location of the theater might serve as a trigger to habit performance. Yet, the actual triggers might include a variety of aspects of the cinema setting and the evening show time. Because we had participants sit some distance from each other in the cinema, we doubt that movie companions were triggers for consumption in the present studies. Furthermore, because we used the same popcorn and the same bags in the cinema and meeting rooms, these features cannot have triggered habit performance. However, the exact nature of the triggering cues is a question for future research.

In general, our findings expand on work conducted by Wansink and colleagues in which the quantity of food people consume is influenced by simple manipulations of environmental cues such as plate and serving size (e.g., Sobal & Wansink, 2007; Wansink & Kim, 2005). Our results suggest that such environmental cues are likely to be most influential when people have developed habits to respond in particular ways to the cue. The current results also suggest a possible role for eating habits in Schachter's (1968) externality hypothesis, which stipulated that obese individuals are more driven by external cues and less by internal cues than are nonobese individuals (see also Wansink, Payne, & Chandon, 2007). Obesity has been linked to eating patterns such as nocturnal snacking that are repeated consistently at particular times of day (Berg et al., 2009). Thus, obese individuals may rely less than nonobese people on internal cues partly

because their eating behavior is more habitual, leading them to respond as cued by environments of past consumption.

Finally, our findings suggest ways to gain traction on the difficult problem of habit change (see Rothman, Sheeran, & Wood, 2009; Verplanken & Wood, 2006). Consistent with the idea that habits are a form of non-goal-dependent automaticity (see Bargh, 1994; Moors & De Houwer, 2006), habits may not be especially sensitive to alterations in motivational states but instead may best be disrupted by changes in triggering contexts. Habit change may thus require impeding habit activation or interrupting fluid habit execution. Although our findings suggest that both avenues are effective, it is not always possible for dieters to avoid or alter the environments in which they typically overeat (see Quinn, Pascoe, Wood, & Neal, 2010). More feasible, perhaps, is for dieters to actively disrupt the execution of the activated eating sequence by simple manipulations such as eating with the nondominant hand and, in so doing, bring their eating under their personal control.

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Notes

1. In Study 1, 16 additional participants (7 in the cinema context, 9 in the meeting room context) were excluded from the analysis because they either declined the popcorn or did not eat any and thus were not exposed to the freshness manipulation.
2. To further test for possible effects of habit strength on liking, we created high- and low-habit groups via a median split of the habit variable. As with the continuous measure, strong-habit participants liked the fresh popcorn ($M = 3.66$, $SD = 0.77$) significantly more than the stale popcorn ($M = 2.70$, $SD = 1.11$), and weak-habit participants also liked the fresh popcorn ($M = 3.33$, $SD = 1.14$) more than the stale popcorn ($M = 2.83$, $SD = 1.05$). An ANOVA on this dichotomous measure of habit strength yielded only a main effect of freshness, $F(1, 146) = 18.58$, $p < .001$, and the Habit × Freshness interaction term was not significant ($F < 2$).
3. In Study 2, 15 additional participants (8 in the right-hand condition, 7 in the left-hand condition) were excluded because they either declined the popcorn box or did not eat any popcorn and thus were not exposed to the freshness manipulation.
4. As in Study 1, we used a median split of habit strength to explore potential differences in liking. Again, strong-habit participants liked the fresh popcorn ($M = 4.38$, $SD = 1.76$) significantly more than the stale popcorn ($M = 3.00$, $SD = 1.60$), and weak-habit participants also liked the fresh popcorn ($M = 4.25$, $SD = 1.12$) more than the stale popcorn ($M = 2.84$, $SD = 1.18$). An ANOVA on this dichotomous measure of habit strength yielded only a main effect of freshness, $F(1, 83) = 19.16$, $p < .001$, and the habit and Habit × Freshness interaction terms were not significant (Fs > 1).

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