Habits in Dual Process Models

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Habits structure much of people's everyday activities. Eating habits are some of the most striking. People seem to eat about 91% of the food on their plates regardless of whether they are eating from a large or a small plate of food. Specifically, when given large plates, people served themselves and ate about half again more food as when given small plates (Wansink & Cheney, 2005). Thus, plate-cleaning habits persisted despite the amount of food involved. People also develop habits to eat certain types of food. People with habits to eat popcorn at the movies consume approximately the same amount regardless of whether it is fresh and tasty or stale and spongy. Specifically, when popcorn was stale, habitual eaters at the cinema reported disliking it, but they consumed just as much as when it was fresh (Neal, Wood, Wu, & Kurlander, 2011). Thus, popcorn eating habits persisted despite the palatability of the food. What propels people to eat habitually in this way, with minimal regard for the amount consumed or the way it tastes?

The answer to this question comes from an understanding of the nature of habits. Eating, like much of human behavior, can be repeated so that it becomes habitual. Habits are dispositions to give a response in a particular context. As people pursue goals in daily life, they experience myriad covariations between their actions (e.g., eating) and cues in the performance context (e.g., food on plate, popcorn in bag). Habit learning occurs when people repeat the same behavior in a specific context, so that associations between the behavior and the contextual cues can be formed. Once a habit is firmly established, perceiving relevant cues—the food on one's plate and the popcorn in the bag at the cinema—is sufficient to trigger the associated behavior.

In this chapter, we first develop a process-based account of habitual responding (see Wood & Neal, 2007, 2009), and then we consider the role of habits in dual-process theories. The remainder of the chapter focuses on the factors that promote or impair habitual control of action in relation to other action control mechanisms.

Processes of Habit Automaticity

Following William James's (1890) notion of ideomotor action, we assume that a memory representation of the habitual response intervenes between cue perception and habit performance (see Figure 1). Due to the frequent repetition of the response, this representation is likely to be highly accessible in the sense of being strong, stable, and distinct. In addition, the frequent pairings of the context and the response produce a particularly strong associative link between the memory representation of the context cues and that of the response. As a result, whenever an individual perceives the relevant cues, the habit representation is strongly and reliably activated.

Habitual responses have a high probability of being executed when their triggering conditions are met. One reason is the simple strength of habit representations in memory—they likely exceed the activation level of alternative actions. Contributing to this effect, alternative responses may decrease in accessibility as people repeatedly retrieve a particular response from memory (McCulloch, Aarts, Fujita, & Bargh, 2008; see retrieval induced forgetting, Anderson, 2003). Also contributing to habit performance, people may misattribute externally-cued representations to their own natural response to the situation, that is, to their internal preferences and desires (Loersch & Payne, 2010). With this misattribution, habitual responses can seem to be promoted by goals and intentions (see section, "**Experience of Habits**"). Nonetheless, as responses become more habitual, they come more directly under the control of the stimulus context and thereby lose sensitivity to the value of the consequences of that response.

The context cues that activate habits range from simple elements of the environment that covary with a response—including physical locations, other people, internal states, and preceding actions in a sequence—to complex conjunctions involving multiple such factors. The cuing process may proceed as envisioned in models of routine action, in which each response in a sequence is triggered by the current internal state given the response sequence, in conjunction with perceptions of the state of the environment (Botvinick & Plaut, 2004). Thus, when making coffee habitually, people may have learned that adding cream and the perception of the lighter color together cue the next response of adding sugar. In this view, habit learning amplifies aspects of context cues that were in the past informative for action selection. Thus, performance is not tied solely to a specific cue in a specific time and place (your own coffee cup) but to other, similar context cues that share important features (other cups). Habit performance thereby can be triggered by a class of cues that might vary in irrelevant features.

Rewards for habit performance may be important initially to promote learning of context-response associations, but these consequences of responding become relatively unimportant once habits have developed (Neal, Wood, & Quinn, 2006). Thus, people with the relevant habits eat stale popcorn in the cinema despite its taste and eat all of the food on their plates regardless of whether they are still hungry. The stimulus-cued nature of habits yields this insensitivity to outcomes of the response.

The term, habit, is sometimes used interchangeably with automaticity. In contrast with this view, we argue that habits are characterized by a specific subset of the features that are commonly used to diagnose automaticity (De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009). Broadly speaking, habits are triggered by a relatively rigid form of context cuing that integrates with but is not flexibly responsive to people's goals and intentions. Habitual responses are initiated automatically in the sense that they are stimulus driven, require only minimal or sporadic conscious monitoring and thus are largely autonomous, and they do not depend on a goal for performance.

Despite these features of automaticity, habit responses are largely controllable. As illustrated in Figure 1, people do not necessarily act on a habit representation once it is brought to mind in a given context. Given an explicit goal that is incompatible with a habit, people can alter their responses in several ways (see Quinn, Pascoe, Wood & Neal, 2010). Much like a dieter deciding to eat only half of the food on his plate, people can make decisions to inhibit an unwanted response. Also, when people are aware of the link between contextual cues and an unwanted habit, they can deliberately avoid habit triggers. Thus, dieters can decide not to go to a favorite donut shop and, if they are aware of the tendency for cues to generalize on important dimensions, should probably decide not to go to other restaurants filled with the sight and smell of donuts.

Habits in Dual Information Processing Systems

In dual-process models, habit performance is mediated by a fast, automatic, unconscious processing system that reflects associations learned through experience. This automatic system typically is contrasted with slow, deliberative, conscious processing that requires access to a working memory system of limited capacity (Evans, 2008). A variety of dual-process models have been proposed, each providing a broad distinction between two partially independent processing systems, and each offering slightly different interpretations of automatic and deliberative processes (see Evans, 2008). The heterogeneous types of fast, automatic learning and retrieval capacities considered in these models are grouped under general labels such as *System 1* (Kahneman, 2003), the *impulsive system* (Strack & Deutsch, 2004), and the *reflexive* *system* (Lieberman, Gaunt, Gilbert, & Trope, 2002). This type of system includes habits, other features of automaticity, and low-effort processes such as relying on heuristic judgment rules.

It is surprising that few dual-process models identify habits as a distinct mechanism of action control. Habit also is largely absent from social psychology more generally. For example, the chapter on automaticity in Fiske, Gilbert, and Lindzey's (2009) *Handbook of Social Psychology* does not, according to the volume index, make even one mention of habit. Similarly, few textbooks in social psychology currently recognize habits, although this may change given the popular resurgence of interest (e.g., Duhigg, 2012).

Historically, habits were a central principle in William James's (1980) understanding of the mind. In the ensuing years, habits became linked with mechanistic approaches to learning, serving as a cornerstone of early learning models (Hull, 1934; Skinner, 1953). Squire and Zola-Morgan's (1991) classic model of memory systems differentiated skills and habits from other types of nondeclarative (implicit) processes including priming, simple classical conditioning, and nonassociative learning. Building on these insights, Evans's (2008) review of dual-process models identified habit as one of three distinct types of low effort, automatic processes. Recently, habits are an important component of many neural models of memory systems (see section, "**Habits in Neural Models of Memory**"), and a number of theoretical analyses have outlined how habit mechanisms integrate with other aspects of action control (e.g., Wood & Neal, 2007; Yin & Knowlton, 2006).

By outlining the processes of habit automaticity, the present chapter moves beyond global automatic-versus-controlled distinctions in understanding action control. We argue that habits involve characteristic neural mechanisms and cognitive representations, and that these characteristics are evident in particular patterns of response. In the next section, we explain how the neural mechanisms associated with habit memory subserve this automatic responding.

Habits in Neural Models of Memory

Evidence of the neural substrates of habit performance comes from diverse research conducted on human and nonhuman primates as well as rodents. Although it might seem that, in humans, habit memory is degraded or dependent on deliberative, higher cortical functions, research with selectively brain-damaged patients and with normal participants on a variety of tasks reveals that this learning mechanism is in fact well developed (Bayley, Frascino, & Squire, 2005). A common theme across these various research literatures is that repeated action and the formation of habits is accompanied by dynamic shifts in neural activity, especially in cortico-basal ganglia circuits (Graybiel, 2008; Yin & Knowlton, 2006). The functional neuroanatomy of the cortico-basal ganglia system underlies many of the characteristic features of habit automaticity, especially the cuing of responses by contexts with minimal responsiveness to goals.

As people repeat a response so as to form a habit, two cortico-basal ganglia loops are particularly important (Graybiel, 2008; Yin & Knowlton, 2006). The first, *associative loop*, supports working memory functions and goal-directed actions. This loop links the prefrontal cortex and associated areas with the caudate nucleus and to the anterior portion of the putamen. The second, *sensorimotor loop,* is thought to support the formation of inflexible stimulus-response associations that underlie automatic, habitual behaviors. This loop links the somatosensory and motor cortex with the medial and posterior portions of the putamen. The formation of habits and development of stimulus-cued responding is thought to involve a shift in behavioral control from the associative cortico-basal ganglia loop to the sensorimotor loop (Graybiel, 2008; Yin & Knowlton, 2006).[1]

Evidence of the relative involvement of these two cortico-subcortical loops in the development of stimulus-driven responding comes from research on simple sequential motor tasks. In a 3-month study, monkeys practiced different sequences in a button-pressing task, with some new and some standard, habitual sequences (Miyachi, Hikosaka, Miyashita, Kárádi, & Rand, 1997). When the monkeys' associative striatum was temporarily inactivated (via muscimol injection), they were less able to perform the newly learned sequences but still able to enact the habitual ones. In contrast, inactivation of the sensorimotor striatum selectively disrupted performance of habits. Comparable shifts emerged in a month-long study in which people practiced a sequence of finger movements (Lehéricy et al., 2005). With training, neural activation deceased in the associative loop systems linked with goal-directed actions (i.e., premotor and prefrontal cortical areas, anterior cingulate cortex, associative territories of the basal ganglia), whereas activation increased in the sensorimotor regions of the basal ganglia.

From a functional perspective, then, the goal-independence of habits is linked to the architecture of the basal ganglia, in particular the lack of reward-based modulation of neural activity in the sensorimotor loop. Evidence of this link comes from Tricomi, Balleine, and O’Doherty’s (2009) research on habit formation in a button-press learning task. Participants received either chips or candy as a reward for pressing a button when one of two target images

[1] Initial, goal-directed learning does not appear necessary to guide habit formation in all tasks. With repetition, people may form habits to successfully perform complex tasks even when they cannot reason deliberatively about how to reach the correct outcome (Bayley et al., 2005).

was presented. After extensive practice and habits had formed, participants continued to press the buttons to the target images regardless of whether or not they had just eaten their fill of the associated food reward. Importantly, the sensorimotor striatum was linked to this absence of reward modulation. Across their extensive training, participants showed increased neural activity in relevant sensorimotor territories of the basal ganglia.

Other features of habits, such as inflexible performance, also can be traced to particular neural substrates. Inflexibility arises in part from the unitization or *chunking* of action sequences over time. A chunk is an integrated memory representation that can be selected as a whole and executed with minimal attentional involvement. Research on the neural substrates of chunking has identified neural markers for the start and end points of action sequences, presumably at the start and end of the learned progression of responses, and minimal neural responding in the middle, suggesting an integrated sequence representation (Fujii & Graybiel, 2003).

Given the current research, it is tempting to conclude that the sensorimotor loop is responsible for the long-term retention of habits. This conclusion is challenged, however, by some evidence that habit performance, especially after especially extended learning, continues despite deactivation of the sensorimotor striatum (e.g., Desmurget & Turner, 2010). With such extensive training, control of habitual behaviors may be further consolidated in transfer to extra-striatal areas, including the cortex. A neurocomputational model of automaticity in perceptual categorization by Ashby, Ennis, and Spiering (2007) offers an elegant account of this hypothesized transfer of control. The model assumes two pathways connecting sensory association areas with premotor cortex—a slow re-entrant cortico-basal ganglia loop and a fast, direct cortico-cortical projection. Early performance is governed by goal-directed learning in the basal ganglia circuit. As training progresses, the appropriate cortico-cortical synapses are strengthened via Hebbian learning, and control is gradually transferred from the basal ganglia loop to the exclusively cortical network. This neural progression in learning was demonstrated in a procedural category learning task in which performance depended primarily on cortical areas once it became thoroughly automatic (Waldschmidt & Ashby, 2011). It may be, then, that the basal ganglia are not involved in the long-term storage of habitual behaviors. Their primary function in the development of automaticity could consist in training the direct cortico-cortical pathway.

In general, habits gradually develop as goal-responsive neural systems relinquish control to the sensorimotor system, and perhaps ultimately to cortical systems that control habits. Given that many everyday behaviors draw on multiple memory systems, their performance probably involves a combination of habit and other types of learning. Thus, the neural systems subserving habits are integrated with a variety of other substrates involved in action control. This interaction is enabled by neural architecture in which the sensorimotor striatal system associated with habit performance is embedded in broader cortico-basal ganglia circuits that facilitate both stimulus-driven, habitual responding and more flexible goal-oriented actions (Yin & Knowlton, 2006). Given interactions among these neural systems, habits interface with other action control systems to guide responding.

In the next section of the chapter, we discuss the features of automaticity that comprise habit responding. We then address the multiple ways that habits integrate with other action control mechanisms.

Habits are Directly Brought to Mind by Context Cues

Evidence of habit automaticity. To test the cognitive associations that underlie habits, Neal, Wood, Labrecque, and Lally (2012, Study 1) assessed how quickly habitual runners detected the words ‘running’ and ‘jogging’ when presented in a lexical decision task. Before each detection trial, runners were subliminally primed with their personal: (a) running locations (e.g., forest, gym) that they usually frequented, or (b) goals (e.g., weight, relax) that motivated them to run. After subliminal exposure to their locations, runners with stronger habits were faster to detect running words. This suggests that their habitual behaviors were mentally linked with the contexts in which they performed that action. Also, suggesting that habits do not require goals, subliminal exposure to running goals did not activate thoughts of running for strongly habitual runners. Instead, a curvilinear association emerged between habits and goals. Specifically, for runners who were still developing habits, goals seemed motivating and thus activated thoughts of running. Strongly habitual runners, however, relied on context-response associations rather than goals to activate running responses.

Additional evidence that habits are triggered directly by context cues comes from a study of sports fans. Reasoning that fans who frequently go to sports stadiums have acquired a habit of speaking loudly, Neal et al. (2012, Study 2), primed some participants with pictures of the stadiums they habitually visited. Control participants were primed instead with pictures of kitchens. The loudness of participants’ speech was assessed from their verbal responses to a search task. Participants with stronger habits to attend sports stadiums spoke more loudly after being primed with stadiums but not kitchens. Furthermore, indicating that this direct context-response tie did not depend on a motivating goal, participants with strong habits spoke loudly regardless of whether or not they had a goal to visit the stadium. Across these two studies, then, cognitive representations of a habitual response as well as performance of the response were activated directly by context cues without relying on a supporting goal.

Habits and other automatic processes. Habit associations between contexts and responses have different features from the automaticity commonly studied by social psychologists. Automaticity in social psychology typically involves activation of concepts or goals. Even research on behavioral priming tests how activating a general construct in memory influences behavioral responses.

Concept priming occurs when activation of traits or other categories (e.g., elderly) brings to mind associated beliefs, plans, and schemas, and these in turn can influence a variety of responses (e.g., cognitive wisdom, physical feebleness). These effects occur because priming a concept (a) activates a rich, complex array of associated constructs in memory (Wheeler & DeMaree, 2009) that may (b) bias interpretation of a variety of situational factors to provide answers to primary current concerns (Loersch & Payne, 2011). In contrast, habit automaticity involves the cuing of a particular learned response or sequence of response.

Variability in response also typifies goal priming, in which environmental cues activate a particular need along with a potential variety of responses to meet that need. For example, the goal of going shopping may activate associated behaviors (for Europeans, traveling by bicycle) that are a means of attaining that goal. Yet because of goal *equifinality*—or substitutability in the behavioral means to a goal, any one goal can activate a variety of behaviors (e.g., driving a car, walking). Even strongly desired goals that stably characterize people's motives yield a strategic orientation and not necessarily repetition of any behavioral means. Also, activated goals are moderated in their influence by a variety of factors. For example, people's explicit goals can moderate the influence of implicit goals such as implementaion intentions (Sheeran, Webb, & Gollwitzer, 2005). Thus, unlike habits, automated goal pursuit does not necessarily promote repetition of particular responses to particular cues.

In summary, habits produce a characteristic pattern of responding that differs from other types of automated processes. The repetition of habit responses can be contrasted with the variability of responses that results from automatic activation of concepts and goals.

Habits Interface with Other Types of Action Control

Habits arise from context–response learning that is acquired slowly with experience. The slow time course of such learning is likely functional because it insulates habit dispositions against short-term changes in behavior that might be generated as people respond to current goals or enact nonhabitual responses. Only with extended repetition in stable contexts are behavior patterns likely to be represented in habit learning. By reflecting the recurring features of people's past experiences, such systems shield existing knowledge against potential disruption from being overwritten or unduly distorted by new experiences.

Features of habits structure action control. These conservative features of habits provide a framework that organizes the interface between habits and other action control systems. Because habits are represented in slow-learning neural and cognitive systems that directly link contexts and responses, habit dispositions do not merge flexibly with other guides to action. Although habit learning initially may be guided by goal pursuit, the relatively separable nature of habit and other learning is suggested by double-dissociation studies of the neural systems underlying performance of habit-related versus other types of tasks (e.g., Knowlton, Mangels, & Squire, 1996). Specifically, amnesic patients with medial temporal lobe damage who could not easily memorize rules nonetheless performed normally on tasks that involved habit learning. In contrast, patients with Parkinson's disease and neostriatal impairment were challenged to learn habit associations through repetition despite having intact capacities for other learning processes.

Habits also represent a separable source of memory in *process dissociation* studies using a cued-recall paradigm (Yonelinas & Jacoby, 2012). In completing this task, participants rely on habits developed through repeated practice or on conscious recollection of the correct response. Dissociations have been documented in the factors that influence these types of performance: Amnesiacs with selective hippocampal damage, the elderly, and people who are distracted or under time pressure during performance tend to perform the task by relying on habit-type knowledge, whereas younger people and those without distractions or time pressure rely more on conscious recall (Yonelinas & Jacoby, 2012).

Dissociations in neural mechanisms and in the factors that influence performance provide elegant ways to demonstrate separable habitual, automatic versus more deliberative, controlled systems. However, we suspect that these kinds of dissociations emerge primarily with particular tasks and with particular moderating factors. In daily life, it is more likely that habits interact in a variety of ways with other memory systems in guiding responding.

Habits cooperate with other systems. Habit learning and other forms of action control often interact cooperatively in the sense that both systems provide compatible guides to responding. Illustrating this cooperation, some actions that initially are goal-directed (e.g., a new exercise regimen) become habitual over time. In this sense, habits can be a vestige of past goal pursuit.

Perhaps because many everyday habits originate in goal pursuit, habitual actions often correspond with what people intend to do. Habits may blindly carry out the work of the goal that initially prompted people to respond repeatedly and thus to develop the habit. In support, Ouellette and Wood's (1998) meta-analysis across 33 studies revealed, for a variety of everyday behaviors, habit strength (as reflected in frequency of past performance) was positively correlated with favorability of behavioral intentions ($r = .43$, $p < .01$). For these behaviors, performance could reflect habit systems or other forms of action control, including explicit or implicit goal pursuit.

Habits conflict with other systems. Habits also interact with other forms of action control when they conflict with people's goals. By definition, unwanted or bad habits counter current goals. Also, people sometimes slip and inadvertently perform habits when they intend to perform another response (Reason, 1992). We have argued that "good" and "bad" habits are guided by common psychological mechanisms--they differ primarily in terms of consistency with current goals (Neal, Wood, & Drolet-Rossi, in press). However, we suspect that people are especially aware of their bad or unwanted habits because of the challenges they experience trying to control or change them. Attempts to change unwanted lifestyle habits such as overeating, overspending, and addictive responses drain large amounts of people's time, energy, and money.

Conditions Promoting and Impairing Habitual Responding

Research on habit mechanisms tends to capitalize on instances in which habitual response tendencies (e.g., to eat most food on your plate) are not in line with other forms of action control (e.g., belief that eating less is healthy). Research has used this contrast strategy to isolate habits from other mechanisms guiding behavior. Then, to the extent that people are acting habitually, they are countering their deliberate intentions. To more directly pit habits against other, conflicting forms of action control, research in this tradition also evaluates moderators (e.g., habit strength, willpower) that are likely to decrease more deliberative reasoning or affect the strength of habit cues. By testing for these kinds of moderators, habit research conforms to the basic structure of other work on dual-process models (Evans, 2008) while providing insight into the nature of stimulus-driven automaticity.

Habit strength. Behavior prediction research with everyday behaviors highlights the moderating role of habit strength. In a typical study, researchers evaluate whether habits or explicit behavioral intentions are better predictors of future behavior. The basic finding is that, regardless of people's intentions, strong habits tend to predominate for riding bicycles, voting in national elections, drinking milk, eating snack food, watching TV, exercising, and purchasing fast food (Aldrich, Montgomery, & Wood, 2011; de Bruijn, Kremers, Singh, van den Putte, & van Mechelen, 2009; Danner, Aarts, & De Vries, 2008; Ji & Wood, 2007; see meta-analysis in Ouellette & Wood, 1998). Thus, people tend to repeat strongly habitual actions even given conflicting input from intentional systems.

Additional evidence that strong habits typically predominate over intentions comes from a meta-analysis of 47 studies of persuasive appeals and other interventions designed to change behavior (Webb & Sheeran, 2006). These intervention studies significantly changed people's intentions, and the question was whether they would change actual behavior. Suggesting that strong habits maintained, behaviors that people could repeat into habits (e.g., seat belt use) changed only minimally following changed intentions, whereas behaviors not conducive to habit formation (e.g., course enrollment) changed to correspond with new intentions. Thus, people continued to repeat habits despite having adopted conflicting intentions.

Experimental evidence that strong habits persist despite conflicting goals comes from Neal et al.'s (2011) research on popcorn eating mentioned at the beginning of the chapter. Movie-goers with strong cinema-popcorn habits ate comparable amounts of stale and fresh popcorn, despite reporting that they disliked it when stale. Thus, when in the cinema, movie-goers acted on strong habits even when these habits countered their evaluations.

People tend to act on strongly habitual dispositions upon perception of associated cues because, as we argued in the introduction to this chapter, the cues are strongly associated with clear, distinct action representations in memory. In addition, not acting habitually can require effort, given that people have to inhibit the salient response tendency and make a decision to perform another response or no response (Quinn et al., 2010). As we explain below, deliberative forms of action control can be derailed by limited reasoning ability, absentmindedness, stress, and fluctuations in willpower and as a result these factors can increase reliance on habits.

Limited reasoning ability. When reasoning skills at a task are not very sophisticated, people may instead rely on simpler, habitual processes. This moderation of habits by skills was demonstrated with respect to navigation, as participants in a study learned a route through a maze (Marchette, Bakker, & Shelton, 2011). Some participants spontaneously developed a response-learning, habit strategy (e.g., first turn left, then turn right), whereas others used a more flexible, cognitive mapping strategy of orienting toward the goal. The habitual, response-learning strategy was especially marked among participants with poor deliberative skills, defined as low scores on a test of spatial perspective taking. At the neural level, a habitual, response-learning strategy was subserved by activation in the bilateral caudate nucleus, whereas relying on the flexible mapping strategy was subserved by the hippocampus. At the behavioral level, participants using a habit strategy tended to repeat the specific response pattern they had learned even on trials in which shortcuts appeared that provided a faster route. In contrast, participants with better mapping skills were more likely to take advantage of available shortcuts. This study differs from what we described as the standard paradigm for habit research in that both habits and skilled reasoning yielded comparable responses. Nonetheless, behavioral and neural data indicated greater reliance on habits among participants with poor spatial reasoning skills.

Absentmindedness and distraction. Habit performance also might be heightened when people are temporarily distracted and thus unable to deliberate about how to act. Evidence comes from research on *action slips*, or instances in which people find themselves performing an unintended action (Norman, 1981). People tend to slip in this way when they are in settings in which they might typically perform a habit. In such settings, they may respond to habit triggers even when intending to engage in another action. A standard example is finding oneself on a weekend driving the route to work when actually intending to drive to the store. In Reason's (1979) experience-sampling studies of everyday behaviors, such *habit intrusions* or *capture errors* comprised up to 40% of all action slips. In evidence that amount of thought moderates habit performance, people were particularly likely to fall prey to such intrusions when they were distracted and thinking about something other than what they were doing (Reason, 1979, 1992).

Habit intrusions may be relatively common in daily life. They impede attempts to change behavior, as people fall back on old habits despite best intentions to adopt a healthier lifestyle (Danner, Aarts, Papies, & de Vries, 2010). Habit intrusions even contribute to the challenges of introducing new products into the consumer market. New products may fail to gain traction when consumers cannot kick old habits. Fully 25% of the instances in which consumers failed to use a new product were due to habit interference (Labrecque, Wood, Neal, & Harrington, 2013). In these instances, product use failures were not due to disliking a product or the difficulty of using it. Instead, consumers suffered *product slips* and simply forgot to use the products, instead reverting back to past habits. As with action slips in general, participants were especially likely to suffer product slips when they were not thinking about what they were doing and thus were susceptible to habit triggers.

Stress. The experience of stress, or psychological strain, also can promote habit performance because stress limits deliberative capacity. That is, stress is associated with restricted attention, heightened arousal, and corresponding reliance on more routinized behavioral responses. Demonstrating the moderating role of stress on habit performance, Schwabe and Wolf (2009) trained participants in an instrumental task to respond to different fractal images for a food treat. Some participants had earlier undergone a cold-pressor task that heightened their stress levels. When stress was raised in this way, participants increased their habitual responses to the fractals regardless of their desire for the food treat. That is, stress increased participants' habitual responses regardless of whether they had already satiated on the relevant food. Stress thus seemed to limit participants' ability to deliberate about what response they wished to give.

Willpower. Variations in willpower also affect habit performance by influencing the capacity to act on intentions. When willpower is low, people may fall back on performing habits because they have limited ability to inhibit the activated response in mind or to decide to engage in an intended action (Hagger, Wood, Stiff, & Chatzisarantis, 2010). In line with this idea, participants who had lowered willpower because they first performed a demanding task were less able to modify their habitual levels of self-disclosure to fit situational demands (Vohs, Baumeister, & Cicarocco, 2005). Thus, after willpower was lowered in this way, low-disclosure participants acted in a habitual, reticent way regardless of social demands to share information about themselves. Similarly, in a 3-week field study of habitual social drinkers, participants consumed more alcohol on days when they experienced more self-control demands and thus were more depleted (Muraven, Collins, Shiffman, & Paty, 2005).

Given that habit automaticity does not require a supporting goal, lowered self-control can promote reliance on habits that are congruent or incongruent with goals. Although people may have different reasons for countering good, goal-congruent or bad, goal-incongruent habits, the underlying habit cuing mechanism is the same in both instances. People may decide to counter good habits for reasons such as conforming to the preferences of others and trying something new, whereas decisions to counter bad habits are typically to achieve a long-term goal. Demonstrating that self-control boosts habit performance, Neal et al. (in press) showed that, for example, depleted participants made more habitual choices when presented with healthful food options or with unhealthful food options. Additional evidence comes from a study that experimentally trained good and bad eating habits (Lin, Wood & Monterosso, in progress). Good habits to avoid chocolates were trained by having participants push away a joystick to photos of eating chocolates, and bad habits to approach chocolates were trained by having participants pull a joystick toward themselves to the photos. Some participants were then depleted by performing a demanding self-control task, and finally all participants ate as many chocolates as they desired in the guise of a consumer study. When depleted, approach-trained participants ate more chocolates, whereas avoidance-trained ones showed a trend to eat less. Thus, much like with naturally-occurring habits, depleted participants fell back on their experimentally-formed habitual responses.

In summary, the relative influence of habits and more deliberative guides to action depends on a variety of moderating factors. In research designs that pit habitual responses against other forms of action control, habits predominate when they are stronger rather than weaker and when circumstances limit people's ability to deliberate about their actions. Specifically, habits are promoted by circumstances that are distracting, heighten stress, reduce reasoning ability, and lower willpower, presumably because of people's lowered capacity to inhibit cued, habitual responses and to make decisions to do something else (or nothing at all). Also, the increase in arousal linked to stress, and perhaps to other factors limiting deliberation, likely promotes performance of dominant, habitual responses. Although habit performance appears robust despite these limitations on deliberative ability, we explain in the next section of the chapter that habit performance is sensitive to shifts in context cues.

Habit Performance Depends on Recurring Contexts

Habit performance can be disrupted by experimental manipulations of cues as well as by naturally-occurring changes in life circumstances (Rothman, Sheeran, & Wood, 2009). These context changes break the automatic cuing of habit and promote responsiveness to intentions and newly acquired information (Verplanken & Wood, 2006). Building on the insight that controlling cues provides a way of controlling habits, smokers may improve their chances of quitting by removing items from their home or workplace that remind them of smoking (Prochaska & DiClemente, 1983). Eating habits also can be modified through changes in the structure of eating environments (van't Riet, Sijtsema, Dagevos, & De Bruijn, 2011). Tendencies to eat mindlessly or habitually are less likely to be triggered when food is out of reach, out of sight, and available in small portions or serving amounts (e.g., Wansink & Cheney, 2005). Thus, behavior change experts recommend that people take control of their local performance environments in order to control unwanted habits (van't Riet et al., 2011).

Experimental evidence that changes in context cues disrupt habit performance comes from Neal et al.'s (2011) popcorn-eating study mentioned previously. When in the movie cinema, participants with strong habits continued to eat fresh or stale popcorn, but habits were not cued in this way when participants were in a conference room watching music videos. In this novel environment without strong habit associations, participants ate what they liked, and consumed more fresh than stale popcorn.

Along with experimental demonstrations, a growing literature addressing *habit dissociation* illustrates how naturally-occurring context changes disrupt habit cuing and enable people to act on their intentions. In one study, college students transferring to a new university reported one month before and one month after the transfer on their habits to exercise, read the newspaper, and watch TV (Wood, Tam, & Guerrero Witt, 2005). Students maintained their habits at the new campus when performance contexts were similar across the transfer (e.g., exercising at the gym in their apartment complex). However, when the context changed significantly, strong habits were disrupted. Without cues to habitual responding, students were guided by their current intentions so that, for example, they exercised only if they intended to do so. For students without habits, the similarity between pre- and post-transfer contexts had little effect on performance, and instead behavior was guided by intentions in both contexts. In other discontinuity research, moving to a new location disrupted car driving habits and increased use of public transit among new residents with strong environmental values (Verplanken, Walker, Davis, & Jurasek, 2008). This change in context provided the window of opportunity for new residents to adopt travel options in line with their values.

In summary, changes in performance contexts appear to disrupt habits but not other guides to action. Given the rigid structure of habits, a change in context can remove triggers to performance and lead to a collapse in habit learning (Bayley et al., 2005). In the absence of a ready habitual response, people are likely to respond in the new context based on their current motives and beliefs. In general, the moderator research we have reviewed suggests that the factors that influence habit performance are relatively separable from the factors that influence more deliberative forms of action control.

Experience of Habits

People are only occasionally aware of the influence of habits within broader mechanisms of action control. As we noted earlier, people are likely most aware of habits that conflict with their current goals and intentions. It is not uncommon to hear people try to account for habit performance with, "I can't help it, it's just a habit." Thus, habits inconsistent with current goals may be acknowledged as a relatively autonomous guide to action.

More commonly, habits are consistent with goals (Ouellette & Wood, 1998), and thus people experience coherence in the forces guiding their behavior. Adding to this coherence, people may make inference about their habits that highlight their consistency with goals. When people do not have direct access to the cognitions and motives guiding action, they draw inferences about such states by observing their behavior and external cues (Neal et al., 2012). Despite this limited insight, people may reason that, "I do this often, so I must like to do it." Such reasoning is similar to situated inferences in which interpretation of experiences is influenced by current mental contents (Loersch & Payne, 2011), but in the case of habits these interpretations often occur following behavior performance and thus have limited impact on actual responding.

Inferences that goals motivate habit performance could be correct in a historical sense because people might accurately remember the goals that initially guided habit formation. After all, people are most likely to repeat and thereby form habits for behaviors that attain desired goals or avoid undesired ones. In addition, people might generally be disposed to form positive evaluations of habits given the ease with which they are performed. Consumers often have a rational preference to stick with habitual products and actions over novel, more difficult ones (Labrecque et al., 2013). Such preferences also might emerge from the positive affect generated by processing fluency that signals familiarity over uncertainty and success at processing and understanding. This positive affect could generalize to current activities (Reber, Schwarz, & Winkielman, 2004), yielding affective responses supporting habit performance.

The goals and cognitions that people infer to account for repeated behaviors become largely epiphenomena as habits form and responses come to be cued directly by features of the performance context. Such inferences can make habits seem compatible with intentions. For example, inferences about the reasons for habitually listening to the radio while driving (e.g., liking music) could mask that listening is actually cued as part of the driving experience. Suggesting that such inferences mask dissociations between habits and current intentions, participants in behavior prediction research were more certain of their intentions to perform strong than weak habits, despite that their intentions for strong habits did not predict future behavior (Ji & Wood, 2007). That is, individuals behaved according to their strong habits, whether or not they intended to do so. Additional evidence comes from Neal et al.'s (2012) study of goal inferences made by habitual and nonhabitual runners. More habitual runners more strongly believed and rapidly inferred that their running was influenced by their goals, despite that goals did not activate their thoughts of running. Thus, inferences that align cognitions and motives with habits can promote a sense of volition for habitual responding (Labrecque.

In daily life, people often may not attend to habitual responses and not try to explain them. Even when performing a novel, implicit learning task, participants did not seem to be aware of repeating the same sequence of actions (Rünger & Frensch, 2008). However, participants were more likely to seek out explicit, reportable knowledge about their regular response patterns when they experienced an unexpected but systematic disruption in the task. It may be, then, that people generally do not attend to repeated behaviors or associated cues until some disturbance or unexpected event prompts them to make inferences about the nature of habit performance.

In summary, people may become aware of the influences of habits, especially unwanted habits. More commonly, habit performance is likely not explained at all or is attributed to corresponding motivations and cognitions that provide a volitional purpose behind the response.

Conclusion

In this chapter, we have argued that habit automaticity is stimulus-driven and largely autonomous, especially in that it is not dependent on goals. Understanding these distinctive features of habits in comparison with other types of action control is important given the prevalence of habits in daily life. In experience-sampling diary research in which participants reported once per hour on what they were thinking, feeling, and doing, about 45% of the behaviors participants listed tended to be repeated in the same physical location almost every day and thus were potentially habitual (Wood, Quinn, & Kashy, 2002). Although habits appear to be a cornerstone component of everyday human learning and performance, dual process models rarely include habits, and instead tend to focus on the multiple ways that concepts and goals can guide responding.

Much as in nonhuman animals, habit learning is a robust mechanism in humans that gradually develops as goal-responsive neural systems relinquish control to the sensorimotor-basal ganglia system, and perhaps ultimately to exclusively cortical systems that control habits. Although habits are rigidly represented in non-goal-directed memories, they interact in various ways with other types of automaticity and more deliberative, thoughtful processes. In daily life, this interaction takes the form of strong habits predominating, in part because of the strength of the cuing mechanism and in part because of limitations that can naturally occur in deliberative processes. Lack of reasoning skills, inattention or distraction, stress, and limited willpower all boost habit performance. When deliberation is restricted in these ways, people are not able to easily inhibit a habitual response and make a choice to respond differently.

Understanding habits is important from the applied perspective of human health and welfare. It is increasingly becoming evident, for example, that much of the global burden of disease comes from everyday lifestyle behaviors of overeating, smoking, addiction, and social isolation. As Marteau, Hollands, and Fletcher (2012) argued in a recent article in *Science*, behavior change interventions that encourage people to deliberate about their behaviors are unlikely to be successful at addressing such lifestyle diseases. Instead, effective interventions need to recognize the automatic, habitual processes that promote such responses regardless of people's best intentions.

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Figure 1. Processes by which habits are automatically triggered by contexts and then integrate with goals to guide responding.