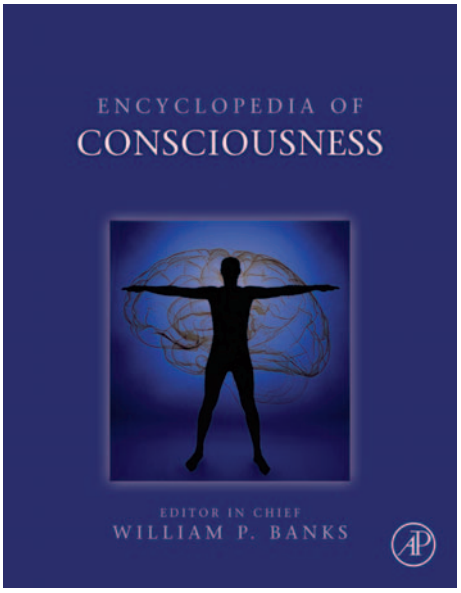

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Habit, Action, and Consciousness

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Glossary

Action-chaining – Learning of action sequences by associating each response with the next.
Attention – Selectively focusing on one aspect of the task or environment while ignoring other things.
Closed-loop process – Process that uses information about its outcomes as input.
Goal – An internal representation of a desired state, such as a behavior or an outcome.
Intention – An explicitly formulated plan to perform a specific behavior or attain a specific outcome.
Open-loop process – Process that does not use information about its outcomes as input.
Reinforcement – Strengthening of an S–R link by rewards.
Sensemaking – The process of creating situational awareness and understanding in ambiguous situations in order to make decisions and to gain self-insight.
Skill – Overlearned behavioral routine resulting from practice.
S–R habit – A learned habit to react to a particular stimulus with a particular response.

Introduction

People are creatures of habit. A major part of our behavioral repertoire is frequently exhibited in the same physical and social environment and has taken on a stable character. The concept of habit has a long-established history and rich tradition in the study of human conduct. Given this history and tradition it is not easy to define the concept of habits in one specific way. For instance, early sociologists conceived of habits as well-structured patterns of behavior that are supposed to result from the interaction between society and individuals and thus serve to control people and to produce civilization and culture. They used a broad definition of habits to account for the stability of social institutions that is known by terms such as customs, traditions, social norms, or values. The term habit was also used by theorists who published about evolutionary processes who used the concept to denote the elementary behaviors of lower species. The evolution theorists' work was related to the instinct literature of that time revealing an interest in the inherent dispositions of living organisms toward a particular behavior that are not based upon prior experience, such as reproduction, animal fighting and courtship behavior, building a nest and feeding. It was in this sense that evolution theorists spoke of such things as the 'feeding habits of British insects.' Later, the term habit was used for reflex actions, which were conceived of as motor responses activated by nerve cells excited by stimuli external to the organism. The term habit, then, refers to stable behavioral patterns that evolve from biological and social processes.

In psychology, much theoretical and empirical research on habits focuses on the individual level of analysis and examines the mental processes underlying the formation and performance of habits and the involvement and disengagement of consciousness in these processes. In general, two issues can be distinguished in examining the role of consciousness in habit and action: the dysfunctionality of habits that has been demonstrated by the limited role of the conscious will in the counter-regulation of habits; and the functionality of habits tested in studies showing decreased reliance on conscious attention and intention as a result of learning and practice. Accordingly, the study on habit, action, and consciousness aims to understand how people manage to act against one's habits, such as overcoming the well-practiced routine of taking the elevator rather than the stairs to

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reach the second floor or resisting the habitually driven temptation to eat junk food, and how such habits are learned and can be executed outside conscious awareness in the first place.

In this article, we first briefly address the role of consciousness in overcoming habits by presenting research in which habits are opposed to the will. Next, we discuss theories and research on the development and performance of habits, and examine evidence showing how habits can be performed without conscious attention and intention. Finally, we focus on the relationship between habits and sensemaking by discussing how people can use their habits to gain insights into their conscious goals and other personal dispositions.

Habit versus the Will

Early theorists proposed that people's behavior is governed by the will. The will, it was argued, plays a causal role in goal setting, striving, and attainment, and should especially be important in overcoming habits (the tendency to respond in a specific way to a specific stimulus as a result of strong associations between the two). Thus, habits were conceived of as reflexive processes that, once activated, follow a ballistic route to completion and, as such, are uncontrollable unless an inner force could take a hold of them. This inner force pertaining to the will has also been labeled in several other ways, such as volition, self-determination, and commitment, and forms the core aspect of modern views on the role of consciousness in self-control and the regulation of behavior. Examining the human ability to counteract habits by the will thus promotes a better understanding of when and how habits may intrude and produce errors and action slips that go against the will.

In the study of human control to overcome habits, so-called 'combined method' experiments are commonly used in which habit and the will operate in opposition. In this method, participants are first taught specific stimulus–response associations to establish a habit (or the habit is assumed to preexist before they engage in the experimental task). After some practice, the same stimulus is presented but a different response is required. Practice leads to direct associations between stimuli and responses, so that presenting the stimulus later on automatically activates the habitual response. If this response is not the correct one, it is up to the person (or the will) to counteract the now dysfunctional habit and to make sure that the intended response is produced. If the learned habit is strong enough, then this extra demand suffers from proactive interference of the habit, that is, the tendency to produce the previously associated but now incorrect response.

Although such studies show that people exhibit control over habits to some degree, occasionally they make mistakes or slow down, and these accuracy and speed effects vary as a function of task (e.g., cognitive load, amount of practice, or automation) and personal variables (e.g., frontal lobe damage, subjective importance of negating the habit). One reason for these failures of the will has to do with the notion that the S–R links established by practice can be very strong. Accordingly, once the response is triggered by the stimulus it may be hard to control it by selecting and producing another counter-habitual response, especially when the response time window is short and attention is located elsewhere. Another reason for the limited control over habits by the will concerns the fact that specific aspects of the habit are deeply encapsulated in the information processing system and operate independently from higher level cognitive processes such as acting on the conscious will. This dissociation between habit and conscious will is reflected in dual process models of cognition and behavior that make a distinction between two separate systems (e.g., implicit or nondeclarative memory vs. explicit or declarative memory) that independently contribute to human performance. Thus, even when we consciously try to put new good intentions into place, those previously learned habits remain stronger in more automatic, unconscious forms of memory.

Habit, Learning, and Performance: From Stimulus-Driven to Goal-Directed Action

In order to gain insight into the role of the conscious will in overcoming habits, researchers have focused on how habits are formed and established

as a function of practice. In this area of research, habits are often conceived of as skills that are extremely useful, as they enable us to perform our actions in a mindless, automatic fashion. That is, the more actions we can delegate to the unconscious, the more room there is to do things that necessarily require conscious processing. Writing an article would be a more difficult affair if typing (and driving, and taking a shower, and even brushing our teeth) required conscious planning and awareness of the processes involved in producing the relevant actions. The scientific study of the formation and establishment of habits thus seems relevant to understand the role of consciousness in human behavior.

The understanding and examination of the contribution of conscious and unconscious processes in habitual behavior depends on how one conceptualizes habits, and particularly the underlying structure and mechanism that give rise to the automation of behavior as a result of practice. In general, there are two different approaches to this issue that can be characterized as representing either low level stimulus–response learning and performance or a higher cognitive level of goal-directed learning and performance.

Habits as Stimulus–Response Links

At the lowest level of analysis, habits can be regarded as mere stimulus–response links. According to behaviorist S–R theories, in essence all learning involves associations between stimuli and response, and such links can be established and reinforced by rewards that follow responses to a stimulus. If a child, for instance, picks up the phone after it rings and enjoys the conversation that follows, the response of picking up the phone becomes more likely to occur upon the ringing sound. If these rewards consistently follow a particular response to a particular stimulus an S–R link develops that can be considered a basic habit.

Rewards that play a crucial role in the development of S–R links may arise from different sources. They may, for instance, be administered by other people to promote the development of basic skills. Using operant conditioning, the frequency of a voluntary performed response can be increased by rewarding it. Through classical or Pavlovian conditioning techniques, more complex relations can be learned between non-rewarding and rewarding stimuli. As a result, a dog – for instance – may be trained to sit at a particular command by rewarding the proper response with cookies or strokes. These conditioning techniques reflect the basic learning mechanisms that are responsible for the formation of S–R habits.

These mechanisms also operate unasked for in everyday life. The rewards that drive it are assumed to mainly result from basic biological and social needs. In the light of these needs, certain objects or behaviors that have been learned to reduce the need may acquire incentive value (i.e., become associated with potential rewards) and motivate actions that as a consequence may satisfy the need. Drinking a glass of water, for example, may prove rewarding when one is thirsty and hence the sight of such a glass may evoke the action.

Although rewards play a crucial role in the development of S–R habits, they may at some point no longer be needed for the execution of a response to a stimulus once the habit is formed and stored in memory. As a result of the repeated execution of an action in response to the presence of a stimulus, cognitive associations develop that tie the two events together. When the association is sufficiently strong, perception of the stimulus activates the memory code or mental representation of the response that, in turn, triggers the corresponding bodily response because these representations match with the sensory-motor cortex that controls the motor programs. At this point, the incentive value that at first motivated the behavior may drop out of the equation as behavior follows the cognitive pathways that were worn out by its motivating power in the past.

Even though habits may rely on such preformed cognitive structures, research has revealed that these structures are not as rigid as one may think. Most notably, some S–R links appear to be conditional on a particular goal or context, and as such promote the translation of goals in behavior. Upon hearing the sound of the alarm clock, someone may stumble to the shower on a workday when she has to get to the office, but may without much thought stumble downstairs to pick up the Saturday paper on the weekend. Depending on the person's goal (work or leisure), the same stimulus

thus may set off a different response that promotes the completion of the goal at hand. This flexibility in switching between different S–R relations is reflected in work demonstrating that people are able to quite easily switch between different well-learned S–R rules according to task instructions and execute them with the efficiency that characterized habitual behavior. In this way, many habits can be regarded as goal-dependent.

Habits as Skills Organized and Directed by Goals

Whereas considering habits as single responses to stimuli may work well for basic actions such as walking to the door when the bell rings, most actions in daily life – such as making coffee or driving to work – are far more complicated. Nonetheless, these actions can be executed in a habitual manner without much conscious thought. How do these skills develop and what do their underlying structures look like?

One way to consider these skills is to regard them as a chain of responses instigated by a particular goal. The habit or skill of making coffee after dinner may then be triggered by activation of that goal and set off a chain-reaction in which each response triggers the next. Putting in the filter may trigger fetching the coffee bin, which in its turn triggers the action of filling the water reservoir. The execution of such response chains, however, has a ballistic character in the sense that previous responses and not the actual behavioral outcomes determine the next action. Relying on such an open-loop mechanism, which does not take into account the result of the performed responses, may be the only way to execute complex behavioral patterns when there is no time to process such feedback information (e.g., when playing a fast sequence of notes on a piano). However, this mechanism only works when the exact same sequence of responses is required. Any small change in the environment or execution of previous actions will lead the mechanism astray and cause the chain to break.

As such changes occur more often that not, researchers have proposed that complex actions are guided by internal models in which top-down and bottom-up processes interact in producing behavior. These models are assumed to be hierarchical and rely on closed-loop processes in which lower order actions are directed by higher order goals. Because of these internal models, perceived results can be compared to their anticipated consequences and subsequent actions can be selected and tuned to produce the desired effect. When driving a car to work for example, the required actions are largely the same (starting the car, turning right at the traffic light, etc.), but slightly different on subsequent occasions (the traffic light is red instead of green, or there is a nasty side wind). Because of closed-loop mechanisms that use perceptual feedback as input for the selection and fine-tuning of responses, people are able to obtain the same goals under different circumstances.

This pivotal role of goals in complex behaviors does not mean that their executions necessarily rely on conscious processes. When learning to drive a car, for instance, conscious selection of actions may be required at first, but conscious involvement may drop out of the equation when this skill becomes overlearned. Although the behavior still relies on a closed-loop mechanism, execution becomes much more efficient and much less dependent on conscious attention. This increased efficiency can be explained in several ways. First, execution of multiple steps can occur faster and more reliable because knowledge about this procedure is efficiently stored in memory and is therefore readily available. An example of such procedural knowledge are scripts that specify the fixed patterns of actions that are executed in much the same manner in recurrent situations. The script of brushing your teeth, for example, may describe the usual sequence of actions of unscrewing the cap of the tooth paste, putting the paste on the brush, putting the cap back on, brushing teeth, gargling, and checking your teeth in the mirror. Once retrieved, this knowledge can guide the execution of the different steps without deliberation on what is going to be the next step. Second, during repeated execution of actions different strategies can develop that produce the same effect by a different route. In order to shift to the proper gear in a car, for example, one first keeps an eye on the velocity and uses certain rules to shift to a particular gear at a certain speed. After practice however, one simply relies on the sound of the

engine and shifts to a higher or lower gear based on its pitch. This simplified rule or shortcut produces the same results through a far more efficient route. In different ways, these processes contribute to the habitualization of complex actions.

At still a more abstract level, realizing a particular goal or outcome may not just require the execution of a sequential behavioral pattern that has to be adjusted to situational changes, but the execution of totally different competing action patterns. Getting to the university, for example, may be accomplished by means of a bike or a bus, which each require a different complex pattern of actions (i.e., unlocking the bike, taking the right route, walking to the bus stop, buying a ticket, etc.). Thus, realizing this goal starts with the selection of one of those two means. After repeated and consistent selection of one particular means, not only the behavior itself, but also the choice for that particular means may become automated. That is, it becomes associated with the goal representation and is therefore triggered when the goal is activated. It has indeed been demonstrated that people respond faster to bike-related words upon presentation of the word university when the goal to go to the university is activated and that the magnitude of this effect increases with the frequency with which that action is used to reach that goal. As such, habitual processes may also involve the selection of habitual means in reaction to the activation of a goal. Hence, habits can not only be goal-dependent, but also goal-directed.

The idea of habits as a form of automatic goal-directed behaviors has been pushed even a bit further. Specifically, although most models on goal-directed behavior assume that goal setting is characterized by a conscious reflection process, and that goal striving is associated with conscious intent, it is suggested that goals are mentally represented and can be activated outside of conscious awareness themselves to then have their effect on behavior. Recurrent and consistent pursuit of a goal upon perception of a specific (social) situation is thought to strengthen the link between the representations of the situation and the goal. Consequently, the mere perception of the situation or environment causes the goal-directed behavior to be triggered directly. Importantly, theory and research on this type of nonconscious goal pursuit considers goals and intentions as distinct concepts that can operate independently from each other, served by different processes. Whereas intentions are the product of conscious deliberation to engage in a behavior or to attain a goal, goals as mental representations of desired states that have become linked to specific means or skills allowing for effective goal attainment without conscious intervention. Therefore, the mere priming of these goal representations causes the person to recruit the associated means or skills directly, and thus goal-directed behavior is launched and guided in the situation at hand without conscious intent and thought.

Habit and Nonconscious Processes

William James once aptly said 'habits diminishes the conscious attention with which our acts are performed.' This notion captures the essence of research that examines the relation between habits and nonconscious processes, that is, processes that do not require conscious attention and intention in order to occur. The role of conscious and nonconscious processes in habits have been investigated with several methods. Some research scrutinizes the ability to efficiently perform habits without attentional control in a dual task paradigm, measured by the reduction or lack of interference of habits and skills during performance of a task that demands conscious attention. Other studies have examined the way habit formation and practice modulate the activation in cortical areas involved in controlled (conscious) and automatic (nonconscious) processes. Apart from inferring nonconscious processes of habits from interference tasks and neuroimaging data, there is also research that considers the limited role of explicitly expressed intentions and other subjectively introspective insights of behavior in the prediction and control of habitual behavior. Whereas each method has its own merits and drawbacks, together they may offer a good picture of how our mental life shifts from a conscious to a nonconscious status during forming, establishing, and performing habitual behaviors.

Habits and the Lack of Interference in Dual Tasks

Many habits require several information processing steps in order to become efficient and automated. For instance, the seemingly simple task to push a designated key in response to a specific stimulus among an array of others presented on the computer screen involves the ability to keep the task goal in mind, to encode the proper stimulus, to select the right response and to monitor and process feedback to check whether it produced the desired effect. Things get even more complicated when the task calls for sequential actions (e.g., typing text, playing piano, or riding a car) that need to be orchestrated in the right order and requires the inhibition of a recently performed action in order to switch to the next one. The control of these information processing steps are supposed to rely on several operational components in a processing system that have been labeled in terms such as 'working memory' or 'executive control.' Given that these control processes are often considered to be inevitably conscious and hence, require conscious attention, there should be a connection with the observation that habit practice leads to greater skill at applying the information processing steps up to the level that attentional control is no longer required to perform the sub-steps involved in the habit.

A well-accepted way to examine this idea is to subject participants to a skill learning task in which they either repeat the task until it becomes habitual according to some behavioral criterion (e.g., no further improvement in terms of speed or accuracy). Next, participants are given a secondary additional task that requires attentional control (e.g., short-term-memory task), and performance on both tasks is assessed. In such a dual task setting, interference may result from a single-channel constraint that allows processes to run serially or capacity sharing of resources for different tasks. Thus, interference produces impairment (in speed or/and accuracy) on one of the two tasks when concurrent processes (e.g., monitoring or feedback processing) have to be used to perform both tasks or when processing resources are allocated to one task that leaves a little less for the other task.

By and large, results that show up in this kind of studies are that when one task is overlearned, the participants can perform the other task at the same time with little interference; but there is considerable interference between the additional task and the skill learning task when the learning task is new or not overlearned. Assuming that the amount of interference in a dual task setting represents a measure of conscious control, the findings that performance of a well-learned set of behavioral responses and schemas does not seriously affect the performance of the other task suggest that habits can run and interact with the environment without conscious attention to the processes producing the behavior.

Habits and Decreased Attentional Control in the Brain

Another area of research that may reveal the role of conscious and nonconscious processes in habits concerns studies that employ modern neuroimaging methods such as positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) to map the functional anatomy underlying practice and skill learning. Thus, several studies have started to explore the changes in brain activity that occur as a result of practice on a range of motor, visuomotor, perceptual, and cognitive tasks. A common framework proposed in this research is that the prefrontal cortex (PFC), anterior cingulated cortex (ACC), and posterior parietal cortex (PPC) are the main areas taking care of attentional and control processes, consistent with theories of PFC function and the involvement of these areas in the distributed working memory system. According to this framework, the cortical areas involved in attentional and control processes are recruited (and hence, activated) to cope with unskilled, nonhabitual actions. After the action has been sufficiently practiced and has become habitual, processes (e.g., feedback processing) and associations that are involved in the control of the habit are more efficiently stored and accessed in the brain and the attentional and control areas fall away, evinced by decreased activation in these areas. On the other hand, increased activation associated with highly practiced performance is primarily seen in task-specific areas such as the primary and secondary sensory and motor cortex. This change in patterns of cortical activations accompanied with practice is

called functional redistribution due to pruning of attentional and control areas.

In one study, for example, participants performed a sequential motor action (producing a specific sequence of finger movements, such as done when playing piano), while the neural correlates of task performance were monitored up to the point that the task was overlearned and thus comprised features of a strong habit. Results demonstrated the functional redistribution of activation pattern: activations in the prefrontal attentional and control areas decreased during skill learning, while increased activations were observed in task-specific motor areas. Interestingly, when participants were asked to consciously reattend to the performance of the overlearned motor task, there was a reactivation of prefrontal areas while the activation in the motor areas was unaffected. These findings thus indicate the association between conscious attention to task performance and the PFC, and the association between implicit or nondeclarative aspects of task performance and brain areas involved in the habit or skill itself.

It should be noted that redistribution of activation patterns is not the only cortical plasticity associated with skill learning and habits. The assumption underlying functional redistribution is that practice and habit formation causes people to develop greater skills in applying the cognitive process required to perform the action or task at issue, or in terms of cortical plasticity, practice facilitates neural efficiency. However, there are studies showing that practice may indeed decrease the activation in the prefrontal attentional and control areas, but sometimes it also leads to activation of cortical areas that were not involved in the initial stage of the task itself.

For example, in a study on effects of the practice of semantic processing on changes in cortical activation, PET was used to image brain activity while participants repeatedly generated verbs to a list of nouns until it had become overlearned. Subsequently, participants had to generate verbs to both the original list and a new list of nouns. The data of this study showed decreased activation of the PFC (in line with the idea that less conscious attention and control is needed to do the task), but increased activation of the Sylvian-insular cortex (an area aiding the automatic production of a verbal response during language processing) that was not involved during the initial stage of the task. These findings suggest that there was a switch away from conscious attentional, semantic processing and selection from an unlimited set of responses to episodic memory-based associations to nouns that minimized attentional semantic processing and the set of possible responses. This increased pattern of activations of brain areas initially not involved in the task has been called functional reorganization, and reflects the situation in which the person has learned a new cognitive skill or shortcut during practice and habit learning to deal with the task at hand.

Both functional redistribution and reorganization of cortical activity patterns facilitate the nonconscious operation of well-practiced skills or habits, but the cognitive processes by which the individual accomplishes this can reflect efficiency in applying a single strategy or learning a new strategy. Furthermore, it has been suggested that specific properties involved in habits have their own time-course of change with practice (e.g., some habits may evolve faster from conscious to nonconscious cognitive processes than from nonefficient to efficient skill performance of the perceptual-motor components of the task). While the study of the neurological underpinnings of habits is in its infancy, these new advances and insights open the possibility to examine how habit formation across different kinds of tasks and behaviors causes people to switch from a more conscious mode of thought and action (e.g., select a means from a set of options to attain a goal) to a more nonconscious mode (e.g., memory-based access to associated habitual means), and how this switch is neurologically implemented and consciously experienced by people.

The Role of Habit and Intention in the Prediction of Behavior

The idea that habits diminish the role of conscious processes has also been examined in research dealing with the prediction of behavior. The main question addressed in this research concerns the extent to which human behavior is under intentional or habitual control. From this perspective, a variety of different behaviors have been investigated that share

the characteristic of being repetitive in nature, such as students' class attendance, purchasing fast food, physical exercise, condom use, drug use, seat belt use, watching TV, commuting with the car, and recycling. In a typical study, people are asked to explicitly express their intentions to engage in a specified behavior and the strength of their existing habits (reflected in frequency of past performance in a given context) and future performance are assessed. Structural equation modeling is used to predict future performance from people's conscious intentions and their habits. The standard result is that habit strength and intentions are independent predictors of the extent to which people perform activities.

The independent contribution of intention and habit in the prediction of behavior suggests that some parts of the behavior involve conscious attention and other parts are subserved by nonconscious processes. For instance, a person may set the conscious plan to watch TV and subsequently execute the action in an automatic, ballistic way controlled by an open-loop mechanism (e.g., switching on the TV and watching soaps until falling asleep). Or, upon having the goal to go to office one automatically takes the car and drive to work in a skilled, routinized fashion, but from time to time one relies on a feedback control system to make sure that one reaches the desired travel goal. In other words, performance of relatively complex habitual behavior or skills is often contingent on a current goal. However, the question here is whether habitual goal-directed behaviors can also be instigated and guided by nonconscious processes or always require conscious attention and intention in order to occur.

A few studies using the structural equation modeling technique may offer an answer to this intriguing question. In approaching the issue of habitual control of behavior from a slightly different but important view, these studies hypothesized that as the same behavior is more frequently executed in the past and increases in habit strength, it is less guided by conscious intention and attention to perform that behavior. Habit strength thus moderates the relationship between intentions and subsequent goal-directed behavior: a hypothesis that requires a test showing that habit and intention interact in their prediction of later behavior – instead of merely showing that habit predicts behavior over and above a measure of intention. In a study exploring this possibility, inhabitants of a village nearby a larger city filled out a survey that required them to indicate their intentions and habit strength of using the car to commute to the city. Next, the respondents' travel behavior was monitored for a few weeks so that their car use could be predicted by their intentions and habit strength. Results clearly demonstrated that a measure of habit indeed interacted with intentions in the prediction of future travel behavior: when habit was strong intentions did not predicted car-commuting behavior, whereas the behavior was predicted by intentions when habit was weak.

This interactive pattern of habit and intention in predicting behavior has also been observed for other types of human conducts, such as social interactions in interpersonal relations, fast-food consumption in cafeterias, and drinking alcohol when going out, and especially shows up when the goal-directed behavior is repeatedly and consistently performed in the same context. The importance of context stability in triggering goal-directed behavior without conscious intent underscores the idea that habitually pursued goals can guide associated means and skills without much involvement of conscious attentional processes when entering and interacting with the context at hand.

Habits and Subjective Reports of Consciousness

A fourth area of research that investigates the conscious and nonconscious parts of habitually performed behavior resorts to operationalizations that typify consciousness, such as verbal reportability. For instance, an extensive literature on implicit learning shows that, while intentionally repeating actions in line with the experimenter's instructions, people learn associations between stimuli and responses and even rules of responding to complex sequences of stimuli without awareness of what is being learned. In a task often used to investigate implicit learning, the serial reaction time task, participants tap a key when a stimulus appears on the screen. The stimulus can appear in one of four locations, corresponding to four response keys. Unannounced to the participants,

the stimuli appear in a repeated sequence or not. In general, participants seem to learn the sequence of spatial locations (i.e., get better at the task with practice when there is a repeated sequence) even when they are not able to verbally describe it.

Implicit learning research suggests that people can acquire knowledge relevant to establish skills in the absence of conscious awareness. Many of our habits or skills performed in daily life involve closed-loop or feedback processes to have their desired effects. Some parts of our habits and skills are difficult to mentally access, as they are represented in nondeclarative memory. Other parts are represented in declarative memory, and thus can be more easily reflected on. For instance, if one writes a letter it may be impossible to report on how one controls the muscles of one's hand and fingers when moving the pen, but one may become aware (even with one's eyes closed) of the curves that one makes to shape certain letters (e.g., try it with the letter P). Similarly, car-driving may involve actions that vary in the ease with which they can be recalled from explicit memory. Based on this distinction, most researchers agree that some parts of adjustment processes underlying skill performance occur outside of awareness but other in the presence of awareness.

However, there is evidence suggesting that adjustments of which we can become aware of remain unconscious, hence questioning whether our conscious experiences tell us the true story about how we regulate parts of our skills and habits. In a study on hand movement monitoring, participants were given the goal of drawing a straight line on a computer screen (a well-practiced skill that most people already learn early in their life). Participants could not see their hand or arm, and received false visual feedback via a mirror presentation of the computer screen about the trajectory of their hand movement. Thus, participants had to make considerable deviations to achieve their goal of drawing a straight line. Whereas participants displaced their hand in the opposite direction for producing the desired goal state (a straight line), verbal reports showed that participants were unaware of making deviant manual movements in response to the false feedback – in fact, they claimed to have made straight movements. These findings indicate that people adjust their skilled actions in response to deviations but that this type of action control underlying the achievement of goals can occur without conscious awareness.

The findings that people can control their skilled actions and habits in the absence of awareness indicate that, when goals are pursued regularly, the need to pay conscious attention to details dwindles. In fact, they show that when specific well-practiced responses are bound to fail, conscious processes are not always called to the fore to complete the skill and to attain the goal. According to the idea that habits are a form of automatic goal-directed behaviors however, it may even be possible that the goals directing the skill themselves are activated nonconsciously, and hence, people are not even aware of controlling the habitual behavior as a result of the goal. Several studies have tested this possibility.

Capitalizing on the notion that people habitually recruit and execute different skills to attain their goals to achieve and perform well, in one study the relation between achievement priming and actual performance was studied. Participants were exposed to words such as 'strive' and 'succeed' as part of a word search task to prime the goal of achievement. Next, they were offered the opportunity to display their performance skills (finding as many words as possible in an anagram puzzle task). Results indicated that participants primed with the achievement goal outperformed those who were not primed with the goal. Of importance, after the experiment participants offered insights into their explicit thoughts about their commitment to perform well on the task, and these conscious ratings were unrelated to the priming effects. These results indicate that goals facilitate the utilization of skills and habitual procedures without conscious awareness of the activation and the operation of the goal, even though these skills have not been previously applied to the task at hand. Similar findings have been reported in other studies that identified the social triggers that repeatedly influence people to pursue goals (e.g., performing well, earning money), such as the observation of another person's goal pursuit or the mere perception of important others (e.g., partners, parents) who have frequently encouraged us to pursue specific goals in the past.

The observation that explicit thoughts about behavior do not mediate the environmental priming effects on actual goal-directed habit performance suggests that goals can guide action schemas nonconsciously. However, explicit thought may not mediate the effects for other reasons than the outsourcing of cognitive processes to the unconscious. First, as there is a time-lag (often more than one minute) between action performance and the verbalization of explicit thoughts, it may be the case that people have forgotten all about why they performed the behavior. Second, even though participants may be able to recall the goals causing their behavior, it may also be the case that they are not willing to report them accurately (due to social desirability or demand characteristics). In other words, the source that is responsible for the emergence of goal-directed habits is conscious, but people are not able or motivated to report this conscious (goal) source.

One way in which researchers have tried to circumvent this problem is to render the triggering source of goal-directed habits unconscious itself. For example, in a study on the utilization of social perception skills, participants were subliminally primed either with an impression formation goal or not by exposing them to words such as impression, evaluate and judgment presented outside the most sensitive part of the retina (parafoveally) for very short time intervals. Crucially, subliminality tests showed that participants could not consciously perceive the stimuli. Next, to explore whether the nonconscious goal encouraged participants to rely on their social perception skills, they read trait attributes of a fictitious person. It is known that explicit task goals to form impressions cause individuals to form evaluative judgments as soon as information is provided about a target person. When a subsequent judgment of the target is required, they rely on the available judgment that was formed online, or otherwise consult memory of the target to arrive at the judgment. The subliminal presentation study showed that goal priming indeed led to more online rather than memory-based judgments. Other studies using different subliminal priming tasks have documented similar results for other habitually pursued social goals, such as achievement, cooperation, and socializing. Whereas effects of subliminal stimulation on cognition and behavior are still open for debate, especially social behavior resulting from higher mental processes such as our goal pursuits, the findings alluded to above provide compelling evidence in support of the hypothesis that people can engage in habitual behavior instrumental in attaining their goals without awareness of the source of these effects, that is, whereas we may reflect on, and become aware of the behaviors that we habitually perform, it does not mean that we are conscious of the causes and the processes underlying them.

Habit and Sensemaking

Although habits may be controlled by the situation and emerge from nonconscious goal-dependent processes, people can use their habits to gain insights in their goals and other personal dispositions. In that case, the causal pathway between habits and consciousness is reversed such that people reflect on the products of higher mental processes in the form of their own past behavior and outcomes to infer personal attributes and arrive at self-insight. As a general rule, self-insights manifest themselves if personal beliefs and desires gain access to consciousness, and such access is gated by focus of attention that occurs when people are, for example, directly asked to indicate their current goals (e.g., What do you want to drink or eat?) or are otherwise forced to reflect on their experiences (e.g., when the situation is ambiguous and calls for a speedy decision). The notion that self-insights are affected by knowledge of habits is so obvious that it comes across as fairly trivial. After all, it would be a waste not to use our past experiences and the contents of memory. However, in the context of habits there are three mechanisms typical for the working of the mind that offer intriguing insight into the way of how reflection on habits promotes self-insight: self-perception, experienced ease of retrieval and authorship ascription.

Self-Perception

People often have limited introspective access to the causes and processes of their habits. When internal causes of behavior are weak or ambiguous, people may be forced to draw inferences about

them from their own behavior and the situation in which it occurs. Indeed, such self-perception processes are rather pervasive. When we are not sure how we feel about a specific behavior, or we do not know whether we want to engage in it, our own behaviors may offer an answer. For instance, when one is asked whether one likes spicy peanuts and does not know the answer, one could turn to observing one's own behavior (e.g., I frequently ate spicy peanuts in the past, so I must find eating them desirable).

Importantly, people judge whether their feelings really reflect their potential causes of habits or whether it was the situation that made them perform them. When an external cause can be identified (e.g., I only frequently eat spicy peanuts because they are served for free in the local pub), information about the frequency of behavior is discarded. Thus, only when no external cause can be brought up, self-perception of habits is likely to provide information about internal causes of ones own behavior. These self-perception effects have been demonstrated in many studies, including the observation that frequency of past behavior often correlates fairly with attitudes and intentions to perform the behavior. Interestingly, attitudes and intentions that follow from self-perception do not always predict future behavior. Instead, frequency of past behavior predicts future behavior directly, suggesting that actual behavior is under control of habitual, nonconscious processes.

Experienced Ease of Retrieval

Rather than assessing and relying on information about the frequency or amount of previous behaviors, habits may inform people about their goals and other personal dispositions by the experienced ease of retrieving instances of the behavior from memory. In this case, cognitive fluency or the experiential state accompanying the working of the mind, rather than the content of the recall itself may serve as a source of information to arrive at self-insights.

In a study demonstrating this effect, participants were asked to list either 6 or 12 instances in which they behaved assertively. Pretests indicated that recalling 6 examples was experienced as relatively easy, while recalling 12 examples was experienced as difficult. After retrieving the examples, participants rated how much difficulty they had experienced retrieving the examples and evaluated their assertiveness on a 10-point scale. If participants were merely to rely on the content of recall, they would report higher assertiveness after recalling 12 rather than 6 examples. However, this is not what happened. Self-ratings of assertiveness showed that participants perceived themselves as more assertive after recalling 6 rather than 12 examples of assertive events. Apparently, participants who were asked to retrieve 6 instances concluded that they were pretty assertive simply because retrieving the instances was experienced to be easy.

According to the principle of ease of retrieval, then, habits can produce self-insight in two ways: if previous instances of the occurrence of a habit are easy to retrieve, positive feelings about the habitual behavior may emerge, whereas experiencing difficulties in retrieving these instances may tell one that the behavior is not a future goal one wants to engage in. Whereas the former effect implies that people have access to the occasions or situations in which they performed the habit, the latter suggests the absence of such access. In that case, people may rely on the frequency or amount of previous behaviors to arrive at self-judgments.

Authorship Ascription

While self-perception and experienced ease of retrieval point to the human capacity (and willingness) to arrive at the content of conscious goals by reflecting on one's own habitual behaviors performed in the past, they are not the source of people's every day life experience of causing their actions and outcomes, that is, the experience of authorship. The experience of authorship is derived in part from interceptive sensations of the body's movement that occur both before and after action. Such sensations are supplemented by visual and auditory feedback, as we can often see and hear the consequences of our actions. Although the absence of experiences of agency and goal achievement is an essential part of habits (even of goal-directed ones), people frequently have these experiences. So, if we assume that our habits arise from nonconscious sources and operate outside our awareness how do we arrive at

experiences of agency and hence, believe that conscious will causes behavior?

Our belief in agency or willful causation is thought to originate from the human capacity to foresee events, and hence, to anticipate goal attainment. When the goal is attained that we intended to pursue, we are likely to infer that we caused it because it matches our previously activated goal state. In more conceptual terms, one experiences personal causation of an observed action effect (where action effect refers to any possible outcome that may arise from concrete skilled actions) because the representation of the effect is primed before one performs the given action. Whereas this matching process of predicted and actual goal attainment offers a key to understanding how people establish a sense of agency, it can guide these experiences independently of direct sensation and actual causation, resulting in illusory experiences.

In a study illustrating this possibility, participants practiced a computer task in which they themselves and the computer independently controlled a rapidly moving square on a display. At a certain point in time, participants had to stop the movement by a simple key-press. The stopped position of the square could either be caused by the computer or the participant. Accordingly, the stopped position could be conceived of as the desired effect that matches the goal controlling participants' action of pressing the key. The location of this position was subliminally primed just before participants pressed the key and saw the presented square. Results showed that priming of the position of the presented square produced a sense of agency associated with stopping the square that was independent of actual control.

It should be noted though, that in the studies discussed above, the prime occurred always briefly before participants performed the skilled action. People can hold an item in short-term memory for no longer than a few seconds without rehearsal. This brief time window suggests that a prime that appears far in advance may not yield the experience of agency. Indeed, it has been shown that the effects of priming on agency experiences only show up if effect information is primed 5 or 1 s in advance, but not with a time interval of 30 s. This suggests that the feeling of agency during action performance derives from a match between the prime and observed effect occurring close in time. Because individuals have limited or no direct conscious access to the operating procedures guiding their actual habits, the matching signal of primed and observed effect information is a key source for grasping a sense of agency, especially when the two events are close together in space and time and thus are more likely to be perceived as causally related.

Conclusions

Habits are the result of practice. They provide us with a well-learned set of skills and schemas that are often contingent on, and orchestrated by current goals and can run and interact with our environment without us paying conscious attention or forming an explicit intention or plan to perform the behavior. Accordingly, habits are commonly accompanied by decreased awareness of the environmental events and action components involved, which suggests that we delegate habits to the unconscious. Such habits may be difficult to overcome by an act of conscious will. Furthermore, although many of our habits can occur without conscious intervention, people sometimes reflect on their habits. Such reflection produces self-insights that offer information about our goals and enhance our feelings of agency. However, our sense of agency may be tricked, as we are prone to falsely infer that our goals cause the execution of our skills or habits when these goals are observed as outcomes after performing them. We can therefore never trust our insights as to whether our habits are goal-directed or not, especially because these goals can operate outside of conscious awareness themselves.

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Biographical Sketch

Henk Aarts is trained as an experimental social psychologist at Nijmegen University where he worked on habit and decision making and received his PhD in 1996. He worked at Eindhoven University of Technology and Leiden University. Since 2004 he has been a full professor in social psychology at Utrecht University. His work deals with several topics related to the role of goals in automatic processes of social cognition and behavior and is published in fundamental and applied journals. One recent discovery in his research program concerns the notion that in contrast with what often is assumed, conscious intentions do not play a strong causal role in behavior as well as that people infer goals from their own and others' behavior. This suggests that although goals play a pivotal role in human behavior, these goals may well operate outside of consciousness. In his research he tries to unravel core aspects of this intriguing and important topic.

Ruud Custers received an education in human–technology interaction at Eindhoven University of Technology, where he graduated Cum Laude on work investigating the role of memory in the formation of judgments about environments. Subsequently, he moved to Utrecht University to pursue a PhD in experimental social psychology. He received his PhD Cum Laude in 2006 for his dissertation on the underlying mechanisms on nonconscious goal pursuit, which mainly focused on the role of affective signals in this process. He published several papers in fundamental journals, of which one was regarded as the best paper of the year on social cognition by the International Social Cognition Network in 2006. As an assistant professor at Utrecht University, he continues to study the processes that allow people to pursue goals without conscious awareness.