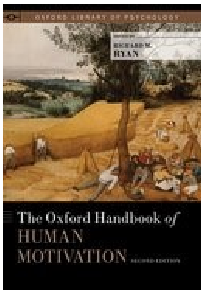

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CHAPTER

15 Does Goal Pursuit Require Conscious Awareness?

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Abstract

Human behavior is directed at goals. Although goal pursuit is traditionally regarded as an endeavor that requires conscious awareness, experimental evidence in psychology suggests that human goal pursuit can originate and unfold in the unconscious. Accordingly, goal-directed behavior could be motivated outside conscious awareness in the current situation or environment. This chapter reviews past and current research examining the evidence for such unconscious motivation of goal-directed behavior. The review is organized around two themes. The first theme deals with research that analyzes goal pursuit as automated behaviors, thereby addressing the operational function of repetition for motivated processes in directing and controlling behavior in the absence of conscious awareness. The second theme concerns the quest of understanding the unconscious sources of human goal pursuit and includes a discussion of recent work on *reward cueing*, aimed at addressing the question of how reward signals in the environment can motivate behavior outside awareness.

Keywords: rewards, unconscious processes, motivation, regulation, priming

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p. 269 Any meaningful behavior humans engage in is goal directed. Humans do not behave randomly; they behave to realize specific states or outcomes they find desirable. From taking a walk in the park to buying groceries or making coffee, they pursue outcomes, which requires keeping an eye on the prize, choosing the right courses of action, and monitoring their progress. Although conscious processes play an important role all the way from planning to the execution of behavior, this role may decrease as individuals plan and execute particular goal-directed actions repeatedly in the same context. Most people make their morning coffee absentmindedly, pondering what the day is going to bring, instead of engaging in careful deliberation or planning the process of coffee making. Consciousness, then, may drop out of the equation for such well-rehearsed goal-directed behaviors. Although such examples are numerous, it is less clear how goal pursuit is possible without much assistance of consciousness.

In the current chapter, we aim to clarify how goal pursuit might emerge largely outside awareness. We will depart from the literature on habits and ideomotor theory, arguing that stimuli in the environment can activate outcome representations that, in turn, can trigger the associated actions that have produced these outcomes in the past. However, we assume that for goal pursuit to be supported by the effort it requires, rewarding properties of the outcome play a crucial role. We will review recent work that investigates how such motivational properties can motivate behavior without much conscious intervention. We believe that a more thorough understanding of how goal pursuit may operate under the radar of conscious awareness is beneficial for understanding and intervening in human behavior because the majority of the goals we pursue day to day are repetitive in nature, in terms of how we aim to attain them as well as the context in which we do so.

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Goal Pursuit Without Awareness: Some Preliminary Thoughts and Findings

Modern theories of goals consider goal pursuit mainly a conscious affair: In the event of a challenge or opportunity, we compare potential courses of actions to determine which one to pursue to produce the desired outcome, mainly based on the expected value of the outcome that motivates the pursuit (Deci & Ryan, 1985; Keeney & Raiffa, 1976). We then deliberate and select the means that will produce the outcome and monitor the progress toward the goal as we engage in them (Gollwitzer, 1990). However, several lines of research suggest that different aspects of goal pursuit may operate fairly automatically, without much thought and under the radar of conscious awareness.

First, there is a rich literature on judgment and decision-making suggesting that affect plays a key role in the formation of attitudes, expected value, and choice, often bypassing deliberative processes. Such an *affect-driven* influence on human behavior has been demonstrated in several research programs. For instance, people can implicitly form attitudes on the basis of simple evaluative conditioning procedures in which neutral stimuli (CS) are linked to affective stimuli (UCS), sometimes without being aware of the conditioning process (de Houwer, Thomas, & Baeyens, 2001; Hofmann, de Houwer, Perugini, Baeyens, & Crombez, 2010). Furthermore, studies employing decision-making tasks suggest that judgment and choice are nearly impossible without emotional processes. Human subjects have been shown to approach decision options and avoid others based on their bodily sensations and feelings that accompanied the decision-making process, an effect that does not seem to rely on consciousness and has been dubbed the somatic marker hypothesis (Damasio, 1994). A nice illustration of this hypothesis pertains to the act of flipping a coin to decide what to do (e.g., when one needs a new car and one can choose between a Skoda or a Volvo). It turns out that a certain positive or negative sensation can become manifest when tails or heads determines one decision of a specific course of action, indicating a preference was already present.

Second, rooted in Murray’s (1938) concept of needs and its role in personality, a substantial research program on social motivation suggests that specific patterns of preferences and decision-making can be driven by implicit motives. Implicit motives are defined as motivational dispositions that operate outside of people’s conscious awareness and are aimed at the attainment of specific classes of incentives (McClelland, Koestner, & Weinberger, 1989; Schultheiss et al., 2008). These motives are presumed to build on evolutionarily old systems (midbrain structures) that appear to develop in a preverbal stage and are guided by what is pleasant and aversive during socialization experiences. Self-attributed motives, that is, motives that a person can express and report on explicitly, are thought to depend on evolutionarily more recent systems (cortical structures) that develop later in childhood and are sensitive to language via verbal commands from others, self-instructions, and explicit knowledge about norms and values. As a result of the early, nonverbal way in which they are acquired, implicit motives tend to develop independently from conscious awareness and hence are difficult to articulate. Self-attributed motives, in contrast, are suggested to rely on consciousness and are therefore readily accessible to verbal reports. Accordingly, implicit motives must be assessed indirectly, for example, with projective instruments such as the Thematic Apperception Test (see Schultheiss & Brunstein, 2001). Self-attributed motives can be measured directly with instruments that rely on the capacity for introspection, such as self-report questionnaires.

Research on implicit motives largely focuses on three main social needs, namely achievement (i.e., the desire to prosper and gain success), power (i.e., the desire to influence and control others), and affiliation (i.e., the desire for friendly social interactions). Once these motives are established, they orient, select, and energize behavior (McClelland, 1985). Indeed, several studies reveal that people's behavior can be reliably predicted by achievement, affiliation, and power motives that are measured by the Thematic Apperception Test or alternative projection measures (for an overview of different measures of implicit motives, see Schultheiss & Pang, 2007) and this predictive value does not necessarily correspond with the predictive value of explicitly generated motives.

Finally, others have argued that such implicit motives can be acquired as a situational goal state. Situational goal states are shaped by direct experience and other types of learning to act in a goal-directed way (e.g., I want to earn money) in a specific context (e.g., when I enter the office), such that after some repetition the context is able to trigger the pursuit of the goal at hand (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001). Such priming effects (effects in which the mere exposure to information renders knowledge, such as a psychological concept, ready for later use) are proposed to build on knowledge structures including the context, the goal itself, and actions as well as opportunities that may aid goal
p. 271 pursuit (Aarts & Dijksterhuis, 2000, 2003; Bargh & Gollwitzer, 1994; Kruglanski et al., 2002). ↳ For example, the goal of consuming fruit may be related to eating a banana while having lunch in the university cafeteria. Or, a visit to an exclusive restaurant or bar may be connected to interacting with good friends and the desire to socialize and go out. Thus, when activating or priming a goal by the associated context (e.g., eating fruit when going for lunch in the cafeteria), we do not access a single concept, but rather a rich structure containing, among other things, cognitive, affective, and behavioral information.

There is a long list of studies that seem to underscore the notion that goal pursuit can be triggered by the environment outside awareness. Such environment-driven goal pursuit can be evoked either directly, for example, by exposure to goal information, such as words associated with achievement (Bargh et al., 2001; Bongers, Dijksterhuis, & Spears, 2010; Eitam, Hassin, & Schul, 2008; Engeser, Wendland, & Rheinberg, 2006; Hart & Albarracín, 2009; Oikawa, 2004; Shantz & Latham, 2009), or indirectly, for example, by exposure to specific aspects in the social environments, such as significant others or observation of another's behavior (Aarts, Gollwitzer, & Hassin, 2004; Dik & Aarts, 2007; Friedman, Deci, Elliot, Moller, & Aarts, 2010; Loersch, Aarts, Payne, & Jefferis, 2008).

Although the evidence for unconscious goal pursuit is mounting, the findings have been criticized on two grounds: First, whereas this research suggests that goal pursuit can be triggered by the environment, the claim that this occurs outside awareness has been questioned. Specifically, tests of unawareness rely on checks that ask participants to assess whether they have seen goal-relevant stimuli (relevant for controlling the unconscious processing of input) or to explicitly report in retrospect whether the presented environment or stimuli influenced them. These measures have two problems: (a) subjects might simply have forgotten what happened before in the study or they are not willing to reveal their experiences of being influenced (or not); and (b) apart from recollection and motivational problems, the evidence for unconscious processes is said to be provided when there is no relation between the manipulation, awareness checks, and dependent variable. In other words, the test of awareness is based on a null effect. Whereas null effects can exist, inadequate sample sizes and small effects might produce a Type 2 error (Vadillo, Konstantinidis, & Shanks, 2016), such that one fails to reject a false null hypothesis.

Second, in line with a general concern for robustness of research findings (Gelman & Loken, 2014; Ioannidis, 2005; Simmons, Nelson, & Simonsohn, 2011), it has become clear over recent years that one should not take evidence of an effect as solid proof or facts. Several nonreplications of psychological experiments have demonstrated that not all studies are as easily replicated (Doyen, Klein, Pichon, & Cleeremans, 2012; Hagger et al., 2016; Klein et al., 2014; Newell & Shanks, 2014). In this, research on unconscious processes in goal pursuit is no exception, with a recent joint replication effort involving many labs finding that only 36% of studies psychology-wide produce the same results when repeated (Klein et al., 2014). For one, these failures to replicate have statistical and methodological reasons. Most studies use small samples and are thus susceptible to noise. In combination with selective reporting of successful studies (i.e., the file drawer problem; Ioannidis, 2005) and researchers having too many degrees of freedom to analyze and report data (Gelman & Loken, 2014; Simmons et al., 2011), the prevalence of environmental control of goal-directed behavior may have been heavily overestimated. Nonetheless, a recent meta-analysis of the effects of behavior priming established a small effect (Cohen's *d* of 0.33) across several studies that in one way or another show that action words can trigger actual behavior (Weingarten et al., 2016). Most notably, priming effects were stronger when actions were more subjectively valued or desirable. Despite the methodological concerns, this is encouraging.

Apart from these methodological concerns, the priming literature offers a fairly heterogeneous pallet of studies. Although research participants are commonly exposed to priming-sensitive information, the relation between the primes and the actual representation of the concept that is assumed to be activated comprises substantial variation. Primes can be words, observed behavior of others, objects related to a goal of actions, and so forth. At the same time, it is not always clear how goals or action-related concepts are assumed to be represented (e.g., amodal knowledge, embodied action, or outcome representations), so it is hard to predict whether a relevant representation will be activated in the first place. Moreover, motivational factors are often overlooked. That is, primed behavioral constructs may be related to an individual's goal and therefore priming effects may differ from one concept to another and from one person to the next (see, e.g., Custers & Aarts, 2007; Ferguson, 2007). Because most studies do not take into account such motivational moderators, priming effects on behavior may be present or absent. Finally, there is little agreement about the behavioral measures to detect p. 272 ↳ priming effects and these measures may differ in their sensitivity, the exact properties of behavior they pick up (direction of behavior, invested effort, etc.), and the match with the behavioral effects.

It appears, then, that there is not consensus about either conceptual analyses or experimental procedures to be able to offer a clear operational definition of the topic under investigation. Such clarity might help to understand and appreciate (some of) the findings on environmental control of goal pursuit that possibly occurs outside awareness. But what, then, are the mechanisms that produce these effects? In the next section we present a possible account for these findings.

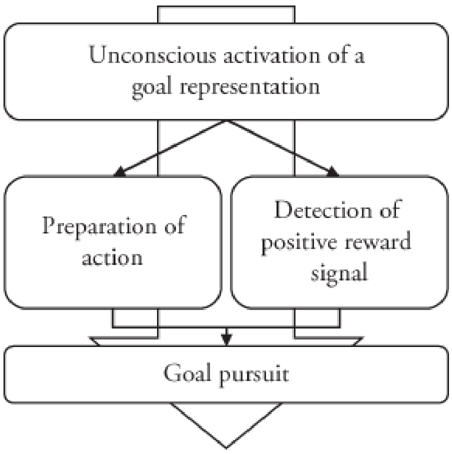
Goal Pursuit as Automated Behaviors

In recent years, we have developed an account in which goal pursuit as automated behaviors can be understood. This account is called ADORE (goals as action–(desired) outcome representations) and has been presented previously in different versions (see Figure 15.1; Custers & Aarts, 2010, 2014). The main goal of ADORE is to promote a better understanding and examination of how the covertly operating brain–cognition interface controls observable human behavior: behavior (e.g., pressing a lever or keys on the keyboard) that can be clearly classified as goal directed; actions that are executed to obtain a valued outcome (getting food or producing letters on the computer screen).

In line with others (Hommel et al., 2001; Jeannerod, 1997; Prinz, 1997), ADORE assumes that action–outcome representations are a natural consequence of repeatedly performing actions and experiencing their outcomes. These action–outcomes form the basis for goal-directed behavior. More formally, action–outcome representations are formed that allow responses (*r*) to occur and actions to be selected by activating the representation of the outcome (o'), which eventually makes this outcome (*o*) happen ($o' \rightarrow r \rightarrow o$). Crucially, the account also holds that when positive affective information is represented in the outcome ($o^{+\prime}$), then this can act as a reward signal, which may boost effort invested in the behavior, essentially motivating behavior to obtain the actual rewarding outcome (o^{+}). Thus, the acquisition of genuine human goal pursuit relies on a representation of a rewarding outcome, a response, and the actual experiences of the rewarding outcome ($o^{+\prime} \rightarrow r \rightarrow o^{+}$; Custers & Aarts, 2010).

Accordingly, priming the representation of the desired outcome moves the body to result in obtaining the actual rewarding outcome. To understand how responses can be automatically triggered, we first turn to the literature on habits, spelling out the difference between purely habitual responses and goal-directed behavior that is initiated outside awareness.

Figure 15.1



Action–(desired) outcome representations (ADORE) framework for understanding priming effects on goal pursuit based on Custers and Aarts (2010).

Habitual Action Selection

At the lowest level of analysis, habits can be regarded as stimulus–response (*s*–*r*) links that are established and reinforced by rewards that follow certain responses to a stimulus. If, for example, one always wakes up to the alarm clock, takes a shower, and finds comfort in doing so, the sound of the alarm clock may become associated with the response of taking a shower. Eventually, when the behavior has repeatedly been executed in response to the certain stimulus and the stimulus–response association has become well established, the perception of the stimulus may automatically trigger the execution of the associated behavior ($s \rightarrow r$).

This view suggests that, after sufficient practice, behavior becomes completely stimulus controlled and eventually operates independent of the rewards (e.g., the comfort of the shower) that initially reinforced the behavior. This perseverance of an *s*–*r* relation after reward removal or devaluation (e.g., one keeps walking to the shower in response to the alarm clock even if the shower only provides cold water) is taken as evidence that the behavior is no longer driven by rewards (or the anticipated desired outcome) and is truly habitual (Dickinson, Balleine, Watt, Gonzales, & Boakes, 1995).

Action–Outcome Learning

However, actions can also be triggered through outcome representations. Such action–outcome p. 273 learning capitalizes on the human capacity of learning to ↳ associate a stimulus-triggered response with an outcome that follows the response ($s \rightarrow r \rightarrow o$; e.g., a sound triggers the act of moving one's arm to the left, which results in shutting down the alarm clock). Stimuli in the environment would, then, trigger a response not directly, but through the representation of an outcome that is associated with the response ($s \rightarrow o' \rightarrow r \rightarrow o$).

Important support for such a perspective comes from the empirical observation that humans represent their actions in terms of their observable effects or outcomes and establish associations between the outcomes and the motor programs that produce the outcome (s–o; Hommel et al., 2001; Jeannerod, 1997; Prinz, 1997; Vallacher & Wegner, 1987). As a consequence, action can follow from an ideomotor principle (James, 1890): Merely thinking about or activating a representation of a certain outcome (o') moves and programs the human body in the service of achieving that outcome without a conscious decision to act ($o' \rightarrow r \rightarrow o$). In addition, representing actions in terms of their potentially desirable outcomes allows people to direct their behavior at the level of the specific outcome, in that they serve as reference points that guide and adjust ongoing actions toward producing the desired goal.

Evidence from such automatic effects comes from outcome-priming studies. In such paradigms, participants usually must react to two different stimuli with two different responses that each produce their own outcome. When outcomes are primed just before the imperative stimuli, action selection (speed and accuracy) is biased by the primes. For instance, in a seminal study by Elsner and Hommel (2001), participants learned that left/right keypresses yielded low/high tones in a learning phase. In the test phase, presenting low/high tones just before people's responses biased actions in the direction of the primes.

Such outcome-priming effects are also apparent in mimicry. Mimicry could be seen as a specific case of ideomotor behavior in which perceived behavioral outcomes in others trigger the same behavior in the observer. For instance, perceiving a smile may activate an outcome representation (o') that is associated with a particular pattern of motor responses (i.e., contracting specific facial muscles), which produces the outcome in the observer. It has even been argued that mirror neurons that have been observed in monkeys (i.e., neurons that are activated on execution of an action as well as perceiving its outcome) reflect a learned overlap in action and outcome representations on the single-cell level (Heyes, 2010).

In an attempt to extrapolate the principles of ideomotor behavior addressed above to a more conceptual level of analysis, researchers have tested whether behavior and language comprehension are closely connected, such that words (semantic information) referring to actions lead to activation of the motor programs that produce them. Such semantic motor resonance (Zwaan & Taylor, 2006) has also been demonstrated in functional magnetic resonance imaging studies where subjects were exposed to action words. It was found that merely reading words related to finger, mouth, or foot movements produced activation in the same areas in the premotor cortex that were activated when performing the actual corresponding actions (Pulvermüller, 2005). This demonstrates that reading words related to action–outcomes triggers the corresponding motor programs, which provides a mechanism by which more complicated semantic information related to outcomes may trigger behavior that produces them.

It is worth noting that these studies demonstrate that motor resonance as a result of observing others' goals or reading abstract descriptions of action–outcomes implies that actions and their outcomes are hierarchically organized. Consider that reading the word *kick*, for instance, triggers the corresponding action of bending the knee and then swinging the leg forward. The word kick, then, triggers not one response, but a pattern of responses that are chained together (Custers & Veling, 2009), in that one response (bending) triggers the next (swinging), and hierarchically, in the sense that the behavioral outcome of kicking is the result of simpler actions (bending and swinging) that are, in turn, caused by even simpler actions (contracting specific muscles). The more abstract the behavioral outcomes (e.g., earning money, helping), the more steps it takes to cascade down to the motor level. This hierarchical organization implies that each action can be seen as the outcome of simpler actions, and hence the concepts of goals and means can be used interchangeably depending on the level of explanation. The proposal of such a hierarchical structure of actions has been widely accepted in several areas of psychological research (Carver & Scheier, 1981; Gallistel, 1985; G. A. Miller, Galanter, & Pribram, 1960; Mischel, 1974; Powers, 1973; Schank & Abelson, 1977; Vallacher & Wegner, 1987).

The precise implementation of such abstract outcomes as earning money or helping can never be fully the result of action–outcome associations that are retrieved from memory. This implementation must be p. 274 influenced by bottom-up processes in the ↳ specific behavioral context as well. Through such *situated cognition* (Barsalou, 2016), the specific instantiation of "helping" may depend on which behaviors are afforded by the situation. Thus, depending on the (social) context, activating the mental representation of helping can lead to picking up dropped pens or holding a door for someone. Assuming that both action patterns are overlearned, it is still plausible that the context already determines the specific action pattern that is triggered by the abstract outcome representation. Hence, abstract outcome representations could—when activated—in principle, produce behavior in a rather flexible way, rendering the behavior adaptive in the context at hand.

Can Stimuli Trigger Motivation?

Although the theories previously outlined explain how stimuli can trigger responses, mediated by outcome representations or not, they are silent when it comes to the question of whether, besides directing behavior, such stimuli can also motivate this behavior outside awareness. For goal pursuit to operate, behavior must also be furnished with the necessary effort.

Incentive Learning

Early findings from research on incentive learning provide some evidence showing that stimuli may also incentivize or motivate behavior. Incentive learning theories were inspired by remarkable findings in different animal labs that shed new light on the role of reinforcement in learning processes following the *s–r* habit paradigm (Skinner, 1953; J. B. Watson, 1925). For instance, operant stereotypes or misbehaviors were discovered during operant conditioning experiments (Breland & Breland, 1961). One such behavior is autoshaping (Brown & Jenkins, 1968; Williams & Williams, 1969). For example, it has been shown that pigeons, for which free presentation of food is repeatedly paired with a light signal, start to vigorously pick at the light bulb although this behavior is not explicitly reinforced. This phenomenon, in which the animal's behavior is automatically shaped without specific reinforcement, occurs because the positive affect or pleasure aroused by the food has now become linked to the light bulb, which triggers a motivational approach in the animal as if the stimulus were an incentive.

Pavlovian-to-Instrumental Transfer

A similar phenomenon is the case of general Pavlovian-to-instrumental transfer in the animal-learning literature (Estes, 1948; Rescorla & Solomon, 1967). In the classic Pavlovian-to-instrumental transfer paradigm, an animal learns that a neutral stimulus predicts a particular positive outcome (an $s–o^{+}$ relation formed by Pavlovian conditioning, say, a bell predicts food). In addition, it also learns separately that a particular response leads to the outcome (an $r–o^{+}$ relation formed by instrumental learning, say, that pushing a lever produces food). When the result of learning is tested under extinction (neither the stimuli nor the responses produce the reward any longer), it is found that the stimulus evokes the response ($s \rightarrow r$), even though this association has never been explicitly reinforced. That is, the Pavlovian conditioning transferred to the stimulus, so that it now is associated with, and evokes, the response. In general Pavlovian-to-instrumental transfer, this effect is shown to be nonspecific, in that the stimulus appears to motivate any response, even responses that have never been associated with the outcome.

Biological grounding of this transfer of motivational value from the outcome to the stimulus comes from research suggesting that so-called pleasure centers in the brain (mainly targeting the nucleus accumbens) are involved in the mechanism that creates incentives (Shizgal, 1999). For example, rats that have learned to perform an arbitrary behavior such as pressing a lever in a cage that is followed by electrical stimulation of the mesolimbic brain area become highly motivated to perform that behavior (as the behavior activates the brain's pleasure center and, hence, triggers positive affect; Olds & Milner, 1954). It appears as if pushing the lever becomes a goal in itself. Illustrative of the motivational strength of this type of incentive learning, it has been established that animals run uphill, leap over hurdles (Edmonds & Gallistel, 1974), and cross electrified grids (Olds, 1958) to engage in the behavior. Importantly, such enhanced effort effects occur even in the absence of physiological deprivation states such as thirst or hunger (Shizgal, 1997). This research demonstrates that practice not only leads to automatic stimulus–response rules, but also can endow stimuli with motivational power.

Understanding the Unconscious Source of Human Goal Pursuit

In humans, motivation has been mostly studied as a function of monetary rewards. In daily life, most people deal with money every day, several times a day, and in small and large amounts. Accordingly, it is no surprise that money is a powerful motivator for human decision-making and behavior and that p. 275 ↳ people are willing to work for it (e.g., see Bijleveld & Aarts, 2014, for a summary on the role of money in people's lifes). Interestingly, money seems to act just as other more basic acquired rewards, such as food, water, and sex. Neurobiological studies have shown that a variety of reward cues, including money, are encoded by the same brain areas (specifically, the ventral striatum accommodated in the mesolimbic system). Accordingly, the striatum has also become known as the reward center implicated in the motivation of human cognition and behavior.

There is ample evidence showing that monetary rewards affect cognition and behavior in several ways. In human subjects it has been demonstrated that money improves their performance on several cognitive tasks, such as visual attention, working memory, and response conflict (Bijleveld & Aarts, 2014). In addition, the value of money has been shown to play a crucial role in the assessment of expected values and decision-making and that one is more willing to spend effort when more money is at stake.

It is important to emphasize that, despite its profound and pervasive effects, most research that addresses the question of how money affect people's mind, brain, and behavior explicitly conveys or communicates to subjects what amount of money can be earned by increasing their task performance. Thus, the question of whether reward cues also impinge on human performance outside conscious awareness has not been directly addressed. In the section "The Power of Reward Cues," we review a line of research that investigates this, employing an experimental method in which task performance is tested after suboptimal (i.e., hard to consciously perceive) presentation to reward cues (coins).

The Power of Reward Cues

A growing literature suggests that stimuli in the environment that signal an opportunity for obtaining a reward can indeed motivate behavior in the absence of awareness. The first study to demonstrate this was provided by Pessiglione and colleagues (Pessiglione et al., 2007), who invited participants to perform a task in which they could earn money by squeezing a handgrip. Before each squeeze, the money that could be earned was indicated by displaying the picture of a 1-pound or 1-penny coin on the screen. Participants were told that the harder they squeezed, the larger the percentage of the reward at stake they would earn. The coin pictures were masked (for a review on masked priming, see van den Bussche, van den Noortgate, & Reynvoet, 2009) and either presented for a very short (suboptimal) or long (optimal) interval. Regardless of whether participants could consciously perceive how much money was at stake, they deployed more force for the high-value coins. Congruently, skin conductance responses—used as an index of sympathetic nervous system activity—were higher to suboptimally presented images of 1 pound compared to those of 1 penny.

A similar effect has been demonstrated for cognitive effort, looking at physiological markers of effort. Bijleveld, Custers, and Aarts (2009) asked participants to memorize digits and then to recall them verbally. At the beginning of each trial, a high reward (50 cents) or a low reward (1 cent) was at stake and was presented either suboptimally or optimally. Pupil dilation, a physiological measure related to the mobilization of mental effort, was used. Participants showed an increase of pupil dilation—related to an increase of mental effort invested—on highly rewarded trials, and this held regardless of whether the rewards were presented suboptimally or optimally.

Crucially, this effect was only obtained for difficult trials (memorize five digits) and not for easy trials (memorize three digits). This finding segues well with the classical features of effort mobilization (Brehm & Self, 1989; Wright & Gendolla, 2012; Wright & Kirby, 2001): People mobilize no more energy than necessary to achieve a goal when performing an easy task. However, when task difficulty is high, individuals will strive to reach the highest possible performance level that is necessary to ensure goal attainment.

Capa and colleagues (Capa, Bouquet, Dreher, & Dufour, 2013) obtain more direct evidence for the role of effort mobilization in response to suboptimal reward cues. In their experiment, participants were instructed that, if they responded correctly to each trial of a run of 13 trials, they would receive the money displayed at the beginning of the run. Participants exhibited better performance, as shown by percentage of correct runs, for a higher than for a lower reward displayed, regardless of whether they were presented optimally or suboptimally. This better performance was likely to be the result of a greater mobilization of resources, as suggested by a stronger suppression of frontocentral alpha activity. Reduced alpha activity over different cortical areas, from frontal to parietal sites, has been reported during the performance of mental tasks (Gevins, Smith, McEvoy, & Yu, 1997) and is inversely related to the amount of cortical resources allocated to task ↳ performance. Because the mean time of the run was 40.74 seconds, this study also demonstrates that suboptimal reward cues can have an effect lasting over several seconds. Importantly, no differences in performance and alpha activity were observed between the beginning and end of each run, suggesting that although null-effects do not allow firm conclusions, the effect of unconscious reward had not collapsed over time.

The finding that reward cues can mobilize mental effort outside awareness has been replicated by others (Bijleveld et al., 2014; Bijleveld, Custers, & Aarts, 2010, 2011; Capa et al., 2013; Capa, Cleeremans, Bustin, & Hansenne, 2011; Zedelius, Veling, & Aarts, 2011, 2012; Zedelius, Veling, Bijleveld, & Aarts, 2012). However, the studies described above demonstrate a similar effect for conscious reward cues and reward cues that were allegedly presented without being accompanied by awareness. Although at first sight this seems to provide evidence for the idea that conscious and unconscious reward cues motivate behavior in the same way, it also leaves the door open for important criticism. That is, if conscious and unconscious reward cues always have the same effect, it could also be the case that even though stimuli were presented briefly between masks, participants were still able to consciously perceive them. Stronger evidence for unconscious effects would be provided by studies that seek to produce a dissociation between the effects of conscious and unconscious reward cues.

Such a dissociation was provided by Zedelius, Veling, and Aarts (2012). In this experiment, not only the presentation of the reward cues was manipulated, but also the attainability of the reward. That is, at the beginning of every trial, participants were informed whether a subsequently presented reward would be attainable or unattainable. Efficient performance thus required the trial-by-trial integration of reward value and attainability. It was found that suboptimal cues signaling high rewards enhanced performance, even when these rewards were unattainable. In contrast, optimal high-reward cues only improved performance when the rewards could be attained. This suggests that optimally presented rewards are used more strategically in effort preparation, whereas suboptimal cues just seem to boost effort regardless of whether this is helpful in attaining the reward (Bijleveld, Custers, & Aarts, 2010; Veling & Bijleveld, 2015; Zedelius, Veling, Bijleveld, et al., 2012).

The findings discussed above have been captured in a framework for understanding and examining human reward processing and its similar or distinctive effects on task performance (see Table 15.1; Bijleveld, Custers, & Aarts, 2012b). This framework mainly addresses the processing of monetary reward cues, but it can also be applied to other reward cues. In more detail, this framework proposes that people first process rewards in rudimentary, subcortical brain structures.

Table 15.1 Framework for Reward Processing

Type of reward processing	Required intensity of reward	Phenomenological experience of reward	Functionality and potentially involved brain structures	Behavioral outcomes
Initial	Low	Reward is not consciously experienced	Rudimentary: VS and its immediate outputs	Facilitation of performance
Full	High	Reward is consciously experienced	Rudimentary: VS and its immediate outputs; higher level: MPFC, ACC, DLPFC	Facilitation of performance; strategic decision-making and reflections on rewards

Note. VS = ventral striatum; MPFC = medial prefrontal cortex; ACC = anterior cingulate cortex; DLPFC = dorsolateral prefrontal cortex. Based on Bijleveld, Custers, and Aarts (2012a).

One of these structures is the striatum—a cerebral structure that is also activated by suboptimal reward cues (Pessiglione et al., 2007). As observed in several studies, this initial processing can facilitate task performance directly by prompting the recruitment of effort in the service of reward attainment. This initial processing of reward cues requires little perceptual input and is not consciously experienced. When participants are aware of the reward at stake, rewards may undergo full processing. In that case, brain structures that are engaged may involve higher level cognitive functions located in the frontal brain, in addition to the rudimentary structures already engaged by initial reward processing, such as the anterior cingulate cortex, the dorsolateral prefrontal cortex, and the medial prefrontal cortex. These cerebral
p. 277 structures are related to cognitive functions such as strategy and decision-making ↳ (LeDoux, 1996), executive control, and maintenance of reward information over time (Haber & Knutson, 2010). Thus, full reward processing may lead individuals to consciously choose a strategy.

It is important to note that the framework briefly discussed above is related to research in the area of emotional processes and working memory. Specifically, in a substantial contribution to theory and research on fear processing and motivated behavior, LeDoux (1996) has distinguished two routes of emotional processing: the low (direct) route and the high (indirect) route. The direct route is considered to operate unconsciously and involves the limbic brain system that processes emotional information rapidly and superficially. The high route involves conscious processing and is more slow and precise in dealing with specific information processed in cortical areas. Accordingly, emotional information is initially processed in a crude way to prepare the body and further processed in a more analytical way to produce a proper response.

In another domain relevant for understanding goal-directed behavior, Baars (2002) proposed a global workspace theory to account for the role of working memory in supporting the control and execution of behavior. According to this theory, unconscious processes can run in local brain networks that operate in parallel with limited communication between them, but they can form “coalitions” to broadcast messages throughout the brain. This coalition formation and respective broadcasting is supposed to occur in the global workspace, which co-occurs with consciousness. The global workspace might be used to exercise executive control to perform voluntary actions, thereby increasing the likelihood of achieving goals.

In short, then, several lines of research suggest that goal pursuit can originate in the unconscious: Motivational and emotional information is initially processed in the mesolimbic system and goal-relevant information is handled by independently operating local brain networks that support goal-directed behavior. Further processing in cortical areas and communication between local networks might promote effective decision-making and goal pursuit that is accompanied by conscious awareness of the goals one pursues.

When Outcome + Reward Information Are (Re)presented in One Instance

The notion that a variety of reward cues are encoded by the same brain system to motivate cognition and action and can be processed unconsciously has led to the proposal that a positive reward signal associated with outcomes plays a crucial role in the unconscious origins of goal pursuit (Custers & Aarts, 2010). Specifically, when a desired outcome or goal is primed, activation of the mental representation of this outcome is immediately followed by the activation of an associated positive affective tag, which acts as a reward signal for pursuing the primed goal. The positive reward signal attached to a goal thus unconsciously facilitates the actual selection of the goal and the subsequent mobilization of effort and resources to maintain the goal, unless other (e.g., more rewarding) goals gain priority. This affective–motivational process relies on associations between the representations of outcomes and positive reward signals that are shaped by one's history (e.g., when a person was happy when making money or performing well). In this case, the goal is said to preexist as a desired state in the mind. Priming this goal representation not only prepares the appropriate instrumental actions associated with the goal, but also motivates behavior, rendering it persistent and flexible, directed at attaining the desired outcome.

A recent set of studies investigated the role of this positive reward signal attached to a goal in the effects of goal priming in teenagers and young adults (Custers & Aarts, 2007; Ferguson, 2007). For instance, Custers and Aarts (2007) exposed participants to suboptimally presented words related to the goal of going out socially. Next, they performed a mouse-click task that, if sufficient time was left, was followed by a lottery in which they could win tickets for a popular student party. Thus, working hard (or fast) on the task can be seen as a means to get to the goal of socializing. It was established that participants put more effort into the instrumental task to attain the goal state when the goal concept of "socializing" was primed and that this effect was more pronounced when the goal concept was more positive (which was assessed in a separate implicit affective association task). These findings show that goal-priming effects on motivated behavior and action control are conditional on the positive valence attached to the primed goal. Similar effects of positive reward value attached to a goal have been documented for other, perhaps more consequential behaviors. Priming an egalitarian goal, for instance, changes people's voting behavior to the extent that this goal is represented as positive or rewarding (Ferguson, 2007).

The findings presented above indicate that nonconscious goal pursuit may result when a preexisting desired p. 278 goal is activated, which, because of its association with positive affect, sets off a positive reward ↳ signal. In theory, this process could be simulated by externally triggering the affective signal just after activation of a neutral goal concept (i.e., a goal concept that provides a reference point for action but does not designate a current desired state that people are motivated to pursue). This ability to respond to the mere coactivation of goal representations and positive affective cues is thought to play a fundamental role in social learning (N. E. Miller & Dollard, 1941) and is considered basic in motivational analyses of human behavior (Shizgal, 1997). Thus, when a child observes its mother's smile upon munching homemade cookies, a student witnesses a hilarious joke upon entering the classroom, or a person strolling around in the mall hears people laugh while reading on a billboard "Start your holiday here," this can cause the goal representations that are primed by those situations (eating candy, achieving at school, booking a vacation) to acquire an intrinsic reward value, which prepares and regulates goal-directed behavior.

This hypothesis that mere coactivation of a neutral goal concept and positive affect simulates the acquisition of desired goals and produces nonconscious goal pursuit has been tested as well (Aarts, Custers, & Marien, 2008; Aarts, Custers, & Veltkamp, 2008; Aoyama et al., 2017; Blakemore, Neveu, & Vuilleumier, 2017; Custers & Aarts, 2005; Holland, Wennekers, Bijlstra, Jongenelen, & van Knippenberg, 2009; Takarada & Nozaki, 2014, 2017; Veltkamp, Aarts, & Custers, 2008; Veltkamp, Custers, & Aarts, 2011). In these studies, goal concepts were paired with positively valenced information outside conscious awareness by exploiting the evaluative conditioning paradigm (de Houwer et al., 2001). For instance, it has been shown that repeated pairing of the representation of a neutral goal concept (e.g., words such as *drinking*, *cleaning up*, *doing puzzles*) and positive affect (e.g., words such as *summer* or *nice*) motivates participants to work harder on an intervening task to secure engagement in the behavior (Custers & Aarts, 2005). In another study, effects of linking the behavioral concept of drinking to positive affect were compared with the deprivation of water on the amount of water that was consumed in a tasting task. The results of this study showed that deprivation increased the amount of drinking and that shaping drinking as more positive caused participants to drink more water only when they were not deprived. These findings indicate that linking neutral goal concepts to positive affect simulates effects of actual needs (Veltkamp, Aarts, & Custers, 2009).

A recent study examined the effects of coactivating goal representations and positive reward signals on the preparation and motivation of behavior in more detail. In this study, healthy young adults had to squeeze a handgrip in response to a start sign while the timing and persistence of their behavior were measured (Aarts, Custers, & Marien, 2008). Prior to this task, words pertaining to the goal of physical exertion were suboptimally presented (or not) together with positive words that signal rewards (e.g., good, nice) or not. In line with the ideomotor principle, research participants who were suboptimally primed with the goal of exertion started to squeeze earlier. However, only participants for whom the goal was coactivated with a positive reward signal recruited more resources to execute this goal, as evidenced by more forceful and persistent squeezing. Consciously reported motivation did not show any relation with the suboptimal goal-priming manipulation. Hence, activating a goal representation gives behavior a head start, whereas the accompanying reward signal motivates behavior outside awareness (for replications, see Takarada & Nozaki, 2014, 2017).

In an examination of the role of affective information in the context of ideomotor learning, Eder and colleagues (Eder, Rothermund, de Houwer, & Hommel, 2015) taught their participants to process positive and negative pictures after performing a specific action. Thus, the assumption here is that a positive and negative event is represented in terms of an outcome of specific actions, and hence, participants should be more motivated to select the action that leads to positive events than the action that leads to negative events. Their research established two findings. First, they showed a compatibility effect of priming in a response facilitation paradigm. That is, they found that anticipating positive events automatically triggered the associated action, but anticipating negative events did so as well. However, automatically selecting an action in response to anticipating negative outcomes and then producing them does not seem functional for an organism that controls action to satisfy needs and desires by realizing favorable events and avoiding aversive ones (Eder & Hommel, 2013; Elliot, 2013). Interestingly, testing the ideomotor learning effect in a free-choice task yielded a response selection bias toward positive consequences. This latter effect provides suggestive evidence for the idea that positive events that follow actions are represented as desired outcomes.

p. 279 In another ideomotor learning study exploring a specific case of the Pavlovian-to-instrumental transfer ↳ effect, Marien, Aarts, and Custers (2015) tested the interactive role of action–outcome learning and positive signal processing in motivating human goal-directed behavior. Specifically, they addressed different stimulus–response order conditions to examine whether a specific action (e.g., pressing the spacebar with the left index finger) that is followed (rather than preceded) by neutral stimuli motivates individuals to obtain these stimuli when the neutral stimuli are accompanied by positive sensations. In an action–outcome learning paradigm, they manipulated whether a neutral object (e.g., a pencil) appearing on the computer screen was conceived of as an outcome (*o*) of response (*r*) by asking participants to press the spacebar before or after the presentation of the stimulus. Furthermore, they independently presented neutral (s^0) or positive (s^+) auditory stimuli upon visual presentation of the object (neutral auditory stimuli were words such as *because* or *there*; positive auditory stimuli were words such as *good* or *nice* that are central to the human nature of social learning and reinforcement; Bandura, 1986; N. E. Miller & Dollard, 1941). Results showed that actual effort to obtain the object was only enhanced when the action was followed by the object and presented with a positive signal. The findings suggest that people represent stimuli as outcomes when a stimulus follows action performance and become motivated to attain them when this stimulus is accompanied by a positive signal.

In sum, research has demonstrated that (a) priming people with outcomes causes them to perform the relevant associated actions with more effort or vigor when these outcomes are more strongly associated with positive affect and (b) priming neutral outcomes together with positive reward cues has the same effect. Hence, this provides converging evidence for the idea that both the recruitment of associated action patterns and the reward signals evoked by primes or cues in the environment related to outcomes play a central role in the manifestation of goal pursuit.

Conclusion and Future Directions

In the present chapter, we presented our ADORE framework in an attempt to shed more light on the role of conscious awareness in goal pursuit. In doing so, we brought together two largely independent lines of research: first, the literature on action–outcome learning, which claims that cues related to outcomes can activate associated action representations, serving as an explanation for ideomotor effects on behavior; and second, the literature on the motivating power of cues that signal prospective rewards. Drawing on paradigms borrowed from evaluative conditioning research, studies from our own as well as other labs were discussed that demonstrated that coactivating outcome representations and reward cues in a controlled manner in the lab promotes goal pursuit, even when people are unaware of this coactivation.

The current framework advances our understanding of priming effects on motivated behavior, not only by demonstrating such priming effects, but also by offering a testable definition of goal representations: Although representing actions in terms of their outcomes may be enough for ideomotor action, our framework holds that this outcome must have rewarding properties (i.e., be desirable) for motivational effect to occur. Although the action–outcome learning literature has largely ignored the role of the desirability of the outcome (but see Eder et al., 2015), rewards and outcomes have nearly always been conflated in research looking at the motivational power of cues (see, e.g., Talmi, Seymour, Dayan, & Dolan, 2008; P. Watson, Wiers, Hommel, & de Wit, 2014). By looking at how action–(desirable) outcome representations are learned, the ADORE framework has opened up new avenues for research on how cues in the environment may shape human behavior outside awareness.

Our account also offers that reward cues in the environment may be processed at different levels as a result of the strength of the input of the reward signal. Although initially rewards may be processed in a rudimentary way, mainly by the ventral striatum, full reward processing may involve the medial prefrontal cortex, the anterior cingulate cortex, and the dorsolateral prefrontal cortex (see Bijleveld et al., 2012b). Although it is hard to say whether conscious awareness plays a causal role in this spread of activation, it is certainly in line with theories on the function of consciousness (Baars, 2002). Understanding this role of conscious awareness may help to predict whether reactions to reward cues may be a boost in invested effort or whether more complicated strategic behavior may unfold.

Although our framework builds on findings from different paradigms and various labs, it is important to note that much of the support for the motivating effects of cues that signal prospective rewards uses money as reward. Although money is an important all-round motivator with which each of us has a long history, we do not believe that the obtained effects are necessarily driven by preexisting associations between
p. 280 money and effort. Although ↳ other studies suggest that just priming the concept of money may have an effect on behavior (Vohs, Mead, & Goode, 2006), rewards in the work discussed here are always relative, pitting the effects of a low reward (1 cent) against those of a higher reward (10 or 50 cents). It is worth

emphasizing that the effects of those high(er) rewards have been found to be dependent on the level of difficulty. Although, relative to the low reward, high-reward cues boost motivation in difficult conditions, they do not in easy conditions where no effort is required. Therefore, whether reward cues boost motivation depends not only on the reward cue itself, but also on interact with the situation at hand.

Although our framework maintains that cues can evoke motivated behavior outside awareness, the question remains whether people are truly unaware of the cues that affect their behavior. Although the majority of the studies we described use suboptimal presentation of cues, it is still possible that some results are driven by some participants who consciously perceive the cues on some of the trials (Vadillo et al., 2016). Hence, the question remains whether suboptimal presentation in those studies is, in fact, subliminal (i.e., below the threshold of conscious awareness).

This assumption is debatable because it relies on the notion that there is one clear threshold for *all* participants and is the same for *all* trials. Even if the threshold is determined for the actual participants in the reported study (which is not always the case), it is often determined in a separate detection test that may differ from the actual experiment in many ways (e.g., time of execution, goal of the task number of trials). Hence, a failure to find an effect on a cue-detection task does not necessarily have to mean that participants were not aware of the (or some of the) cues in the actual task (Shanks, 2017). Moreover, it has been noted that the strategy of relying on a null effect to demonstrate an absence of conscious awareness is inherently problematic (Vadillo et al., 2016). Hence, stronger methods aiming to assess the involvement of consciousness in more detail (Overgaard, 2015) are necessary to support claims about awareness and separate conscious from unconscious processes.

Such methods would also help to look at the interplay between conscious and unconscious processes. It has, for instance, been proposed that a potential role for consciousness may lie not in the starting and steering of behavior, but in stopping it. Whereas the brain is designed to realize desired outcomes, in the early 21st century the well-being of the individual may in large part be dependent on the ability to prevent oneself from engaging in rewarding behaviors that have undesired personal and social long-term consequences (e.g., eating junk food, derogating others). Although it is known that ongoing and impulsive behaviors can be inhibited directly by environmental stimuli or well-learned stop rules (Chen, Veling, Dijksterhuis, & Holland, 2016; Verbruggen & Logan, 2009), we do not yet know whether and how people can express an unconscious volitional veto (Brass & Haggard, 2007) or whether consciousness as a relatively new knack of human evolution is required to overrule the labor of the older reward system involved in unconscious goal pursuit.

Recently, researchers have started to explore the role of negative affect in this process, and it turns out that negative stimuli that are merely processed when having a goal in mind can put goal pursuit on hold (Aarts, Custers, & Holland, 2007; Boksem, Ruys, & Aarts, 2011; Clore & Huntsinger, 2009; Knight, Brewer, Ball, DeWitt, & Marsh, 2015; Veling, Aarts, & Stroebe, 2011; Zedelius et al., 2014). Importantly, this modulating effect of negative affect on the cessation of goal pursuit may not be so general, because other studies suggests that people can also be motivated by negative affect, such as when goals are associated with anger (Aarts et al., 2010; Angus, Kemkes, & Schutter, 2015; Carver & Harmon-Jones, 2009). It remains to be seen, then, whether and how negative affect accompanying the activation of goals serves as an unconscious veto to not engage in goal pursuit itself.

Finally, ADORE may play a role not only in the instigation of goal pursuit, but also in the subjective experiences arising from it. Activated representations of outcomes play a role in the predictive process that shapes perception of the observed outcomes (Clark, 2013). Moreover, the match between a predicted and experienced outcome may give rise to experiences of agency (Aarts, Custers, & Wegner, 2005). Hence, people may ironically perceive agency over actions that are put in motion by external cues in the environment and reward signals may only strengthen these effects (Aarts, Custers, & Marien, 2009). Hence, the control of the environment over our goal pursuits may be more prevalent than our experiences would suggest.

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