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A Case for Thinking Without Consciousness

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Abstract
People can engage in prolonged thought processes, such as when they are facing an important decision or when they are working on a scientific discovery. Such thought processes can take months or even years. We argue that while people engage in such thinking, they make progress not only when they consciously think but also sometimes when they are consciously thinking about something else—that is, while they think unconsciously. We review the literature on unconscious thought (UT) processes and conclude that there is indeed quite some evidence for UT. Conceptualized as a form of unconscious goal pursuit, UT is likely to be especially fruitful for thought processes that are complex, important, or interesting to the thinker. In addition, we discuss other characteristics of the UT process. We end with proposing Type 3 processes, in addition to Type 1 and Type 2 (or Systems 1 and 2) processes, to accommodate prolonged thought processes in models on thought.

Keywords
unconscious, consciousness, decision making, thought

Recently, one of us asked a group of undergraduate students how long it had taken them to make the decision to start studying psychology. The answers ranged from a few hours to a few years, with the majority indicating that it had taken them a couple of months. The fact that people indicate that they sometimes take months—and, in the case of some students, even years—to reach an important decision raises an interesting question: How exactly do people make such important decisions or solve such big problems? What do people do during the months that they ponder on a decision?

The simple answer is that people think. If they need to choose a study major, if they have to decide what to prepare for an upcoming dinner party, or if they are in the process of understanding gravity—as Newton was a couple of centuries ago—people think to reach a solution. In Newton's case, the thought process leading to the solution encompassed more than a decade. The question we would like to address here is whether this thinking takes place only consciously or, at times, also takes place unconsciously. We define *conscious thought* as cognitive or affective decision-related processes that take place while one is consciously aware of the decision-making process. For example, one may consider two potential majors and consciously think, "Technical engineering has great job prospects, but the subject seems quite boring." *Unconscious thought* (UT), however, refers to cognitive or affective decision-related processes that take place outside conscious awareness—that is, while people are consciously occupied with something else. You may compare two potential majors and be undecided which to choose. Next, you may put the problem aside for a few days, and then, at a later moment, you suddenly realize "It will be psychology!" The question we address here is whether there is indeed such a thing as UT and, if so, what it does. To turn back to Newton, did he only make scientific progress during the moments that he was consciously focusing on understanding gravity, and did progress stop the moment he consciously started thinking about something else? Or did he also make progress on other occasions, such as when he was shaving, or having dinner, or when he was just staring out the window

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doing nothing? In the present article, we make a case for the second possibility—that is, for thinking unaccompanied by conscious awareness of the object of thought.

We have been advocating the possibility of UT for 10 years now (see, e.g., UT theory; Dijksterhuis & Nordgren, 2006). During lectures and seminars, we discovered that the concept of UT is—from a phenomenological perspective—appealing to most people. Many researchers and theorists have postulated that finding the solution to a creative problem often follows the same sequence of processes: First, you devote attention to the problem by consciously thinking about it, reading about it, or discussing it with others. Second, you start to do something else and put the problem to rest for a while—a process that is often called *incubation* (Wallas, 1926). Third, a solution pops into consciousness, sometimes rather suddenly (e.g., Andreasen, 2005; Baars, 1997; Claxton, 1997; Koestler, 1964; Poincaré, 1913). This, we noticed, is a process that most people recognize. Laypeople and scientists alike tend to find it easy to come up with examples from their own experience.

Anecdotes about famous scientists and artists experiencing the earlier described sequence of events exist in large numbers (see Andreasen, 2005; Ghiselin, 1952). The composer Peter Ilych Tchaikovsky claimed that the germ of a new composition always comes unexpectedly after a period of doing something else. The poet Stephen Spender said that the first line of a poem "drops into the poet's mind." The vision of a snake biting its tail, which supposedly revealed the true structure of the benzene ring to the German chemist Friedrich Kekule, is famous. Some stories about sudden insights are wonderfully fantastic. Samuel Taylor Coleridge "wrote" his very famous poem "Kubla Khan" while he was sleeping. He simply dreamt it. Andreasen (2005), who reviewed the literature on creative insight in creative problem solving, concluded the following: "The solution occurs in a flash. It may occur after a 'rest period,' during which ideas lie fallow, and then suddenly take root and sprout" (p. 48).

The idea that unconscious processes work on a problem in the absence of conscious guidance has often been used strategically by many great artists and thinkers, such as Mozart, Schopenhauer, or Ernest Hemingway (e.g., Hemingway, 1964; Schopenhauer, 1970). The mathematician Henri Poincaré only worked on math 4 hr a day (from 10:00 a.m. to 12:00 p.m., and from 5:00 p.m. to 7:00 p.m.), convinced that for the rest of the time his unconscious was thinking and that, at some point, his unconscious would present a solution to the problem he was studying.

That being said, anecdotes do not count as scientific evidence, and although intuitively appealing to most, they merely show that many great thinkers think that they think unconsciously. Our claim that there exists an intelligent UT process has raised considerable debate among decision researchers. The debate does not revolve around the notion that conscious and unconscious processes are involved in many actions in everyday life. For example, the fact that people's visual and auditory systems preattentively integrate complex information from the environment has been accepted for centuries (see, e.g., Von Helmholtz's, 1867/1925, early notion of unconscious inference). However, the idea that unconscious processes serve a significant explanatory role in theories of decision making and the evidence that we and others have provided to support this claim are still highly contested (e.g., Newell & Shanks, 2014; Nieuwenstein et al., 2015). Moreover, one may also argue that the claim that people only think consciously (and, hence, that UT does not exist) is to some extent also intuitively appealing. After all, and by definition, the only time you are consciously aware that you are thinking about something is when you think consciously. Asking people to search for instances during which they think unconsciously is, to quote Julian Jaynes (1976), like "asking a flashlight in a dark room to search around for something that does not have any light shining upon it" (p. 23).

Attention Without Consciousness

As people rarely get something for nothing, it is safe to assume that thought—or for that matter, all higher cognitive processes—requires at least some attention or some processing capacity. Hence, before answering the question as to whether people can think unconsciously, it is fruitful to first investigate whether people can devote attention to higher cognitive processes without conscious awareness of the object of attention.

Wegner and Smart (1997), who wrote about the notion of attention without consciousness quite some time before neuroscientific research confirmed their general idea, postulated the idea of "deep activation." Partly on the basis of Wegner's (1994) theory of mental control, Wegner and Smart reasoned that processes or pieces of information can be highly active or accessible—and can indeed affect behavior—without currently being the object of conscious awareness. A burgeoning neuroscientific literature indeed shows that attention and conscious awareness are distinct psychological processes (Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006; Koch & Tsuchiya, 2007; Lamme, 2003; Van Gaal, De Lange, & Cohen, 2012; see also Dijksterhuis & Aarts, 2010). Whether people can be conscious of something without paying attention to it is the object of an interesting debate (see, e.g., Cohen, Cavanagh, Chun, & Nakayama, 2012; Koch & Tsuchiya, 2012); however, the reverse—that people attend to things without being consciously aware of them—is seen as a given by most theorists. It is also supported by recent

findings that show that attention and conscious awareness arise from distinct brain circuitry (Van Boxtel, Tsuchiya, & Koch, 2010; Watanabe et al., 2011).

In the forthcoming years, it will most likely become clear exactly which cognitive operations can be done unconsciously. A recent review on unconscious cognitive control revealed that subliminal (i.e., too brief to be consciously seen) information affects many functions that were previously seen as belonging to the domain of consciousness (Van Gaal et al., 2012). For example, response inhibition (i.e., stopping an already initiated action), task switching (i.e., flexible adaptation to changing task instructions), and error correction (i.e., noticing that one has made a mistake and correcting it) can operate unconsciously. Most important for the present purposes, people can unconsciously integrate information—that is, form coherent and meaningful representations of disjoined pieces of information (e.g., compute the approximate average of several digits presented separately on a computer screen). Although Van Gaal et al. (2012) also concluded that conscious awareness often improves cognitive control (e.g., it speeds up information integration, reduces the number of mistakes), many important processes related to complex decision making do not seem to require consciousness (see also Hassin, 2013, for a related view).

Additional evidence for attention without consciousness comes from the literature on goal pursuit. Various experiments have shown that motivation can be increased by subliminally activating reward cues (e.g., Bijleveld, Custers, & Aarts, 2009; Lau & Passingham, 2007; Pessiglione et al., 2007). Hassin and colleagues (Hassin, Bargh, Engell, & McCulloch, 2009; see also Soto, Mäntylä, & Silvanto, 2011) have shown that working memory functions can operate without conscious guidance. Recently, Marien, Custers, Hassin, and Aarts (2012) showed that goals that are activated outside conscious awareness rely, to some extent, on executive functioning. In a series of experiments, they primed some participants with a goal (such as socializing) and then showed that this goal impaired performance on various secondary tasks in which executive functioning was assessed. They also showed that an unconsciously activated goal consumed as much executive processing capacity as a consciously activated goal; however, the extent to which an unconsciously activated goal led to decreased performance on a secondary task depended on the extent to which participants indicated that they personally endorsed the goal. This latter finding echoes the anecdotes about artistic achievements and scientific discoveries discussed earlier. People seem to continue to work on a problem or decision unconsciously but only when it pertains to matters of importance (see also Orlet, 2008).

The conclusion of the recent literature on attention as well as on goal pursuit is that goal-directed higher order cognitive processes can ensue outside conscious awareness. This makes it perfectly reasonable to assume that thought processes in the service of decision making and problem solving can, in principle at least, also take place unconsciously.

Evidence From the UT Paradigm: Methods, Materials, and Control Conditions

Clearly demonstrating that UT takes place is not easy. In the research on UT in decision making (Strick et al., 2011; see also Bargh, 2011; Dijksterhuis & Nordgren, 2006; Nieuwenstein & Van Rijn, 2012) and on incubation in creativity (see Sio & Ormerod, 2009, for a review), participants are often distracted for a certain period of time with a task that occupies consciousness but that is assumed not to interfere (too much) with UT. Typically, participants are first presented with a problem or with information pertaining to a decision. For example, participants are asked to read information about four apartments, with the aim to later choose the most desirable one. They are then distracted for a while, and afterward they make a decision. In some initial experiments on UT (e.g., Dijksterhuis, 2004; Dijksterhuis, Bos, Nordgren, & Van Baaren, 2006), we found that participants who were distracted made better decisions than participants who were allowed to think about their choice consciously (called the UT effect) or than participants who made their choice immediately after reading the decision information.

Table 1 provides an overview, in chronological order, of some of the major studies in which a UT effect has been reported. As UT has been studied by researchers using many different tasks and materials, Figure 1 depicts some of the materials used and, thereby, illustrates the diversity of decision problems to which UT theory has been applied.

In Table 1, we also note how the quality of decisions in the studies was evaluated. In UT studies, the quality of decisions may be defined according to either an objective or a subjective criterion. Under the objective criterion, the best choice option contains attributes that are more positive or less negative (on the basis of expert ratings or a separate pretest) than the other options, and the quality of the decision is defined as the tendency to choose the best option. Under the subjective criterion, the best option is created on the basis of each participant's preexperimental ranking of the attributes (see, e.g., Usher, Russo, Weyers, Brauner, & Zakay, 2011) and is defined as the option that provides the highest

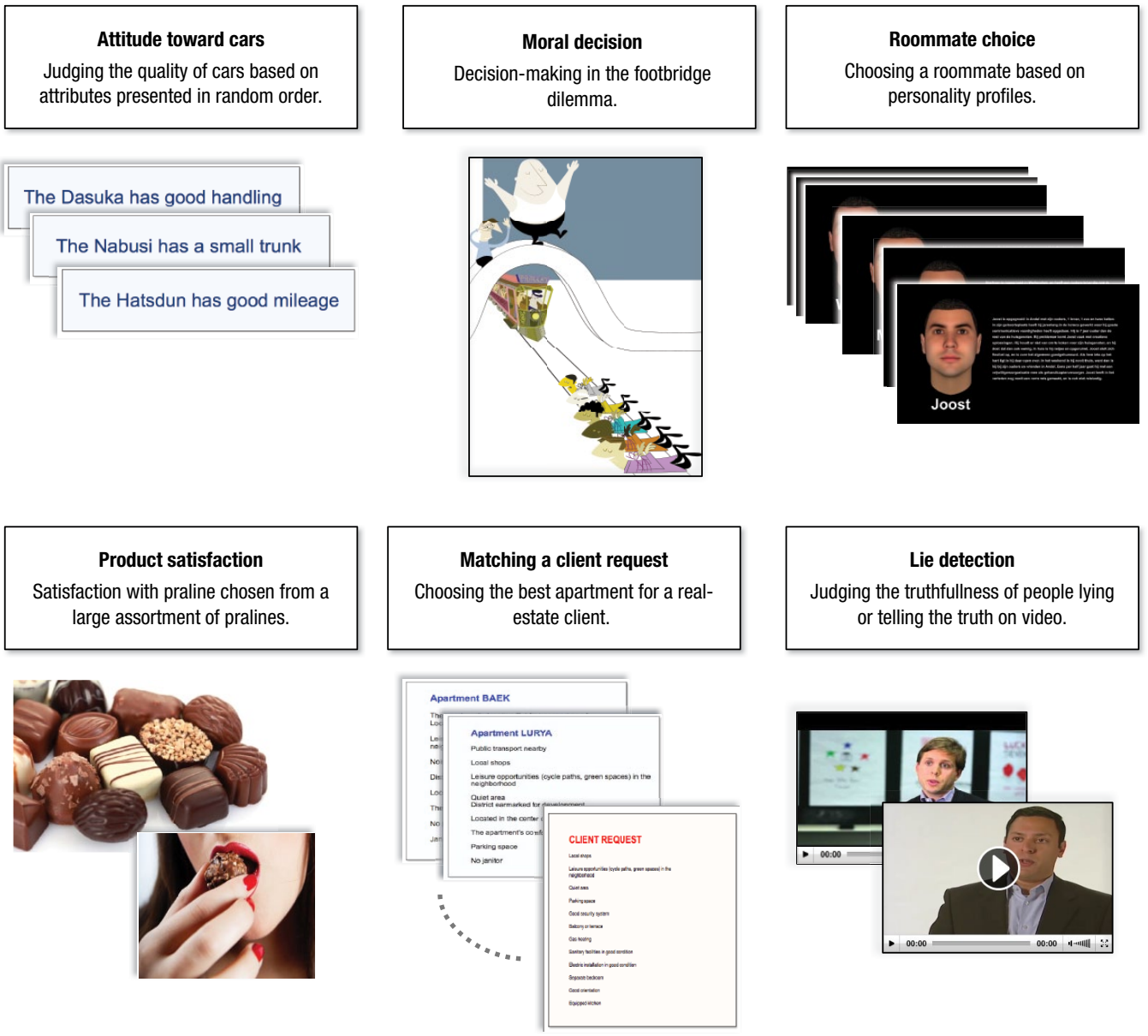

Fig. 1. Illustration of types of decisions and materials used in unconscious thought studies by Dijksterhuis, Bos, Nordgren, and Van Baaren (2006; top left); Ham and Van den Bos (2010b; top middle); Strick, Dijksterhuis, and Van Baaren (2010; top right); Messner and Wänke (2011; bottom left); Abadie, Waroquier, and Terrier (2013; bottom middle); as well as Reinhard, Greifeneder, and Scharmach (2013; bottom right). The cartoon of the footbridge dilemma (top middle) is by John Holbo and is reprinted with permission.

postchoice satisfaction (Dijksterhuis & Van Olden, 2006; Messner & Wänke, 2011).

Finding the Right Control Condition

To prove that active UT took place while participants were distracted, one needs to carefully choose a control condition. This has proven not to be easy. Figure 2 depicts the control conditions typically used in UT research.

UT versus conscious thought

In many studies, the quality of decisions after UT was compared with those of people who thought about the decision consciously for the same amount of time (conscious thought condition; see Figure 1). However, even if one shows that distracted participants make better decisions than conscious thinkers (i.e., the UT effect; see Strick et al., 2011, for a meta-analysis), it does not yet show that distracted people thought unconsciously. It is very well possible that conscious thought decreases the

Table 1. Chronology of Major Studies and Findings on Unconscious Thought (UT)

Author(s) and year of publication	Domain/decision	Findings	Criterion for decision quality
Dijksterhuis (2004)	Apartments, roommates, person impression formation	Initial demonstration of UT effect (i.e., higher decision quality after unconscious than conscious thought); evidence for enhanced organization of information in memory (i.e., polarization, clustering) after UT	Objective (± attributes)
Dijksterhuis, Bos, Nordgren, and Van Baaren (2006)	Various consumer decisions	Several replications, also in a field setting; actual shoppers are more satisfied with complex products when decisions had been made with little, rather than much, conscious thought	Objective (± attributes) and subjective (postchoice satisfaction)
Bos, Dijksterhuis, and Van Baaren (2008)	Cars, person impression formation, roommates	The UT effect is goal directed—the effect does not occur without a decision goal	Objective (± attributes)
Zhong, Dijksterhuis, and Galinsky (2008)	Creativity	UT increases the accessibility of correct answers in the Remote Associates Test but does not necessarily lead them into consciousness	Objective (performance on the Remote Associates Test)
Ham, Van den Bos, and Van Doorn (2009)	Justice judgment	First conceptual replication of the UT effect in a wholly different domain	Objective (number of just/unjust aspects)
Dijksterhuis, Bos, Van der Leij, and Van Baaren (2009)	Predicting outcomes of the World Cup soccer tournament	UT increases reliance on highly diagnostic information (i.e., the world ranking list)	Objective (accuracy of predictions)
Lerouge (2009)	Notebooks	UT increases evaluative coherence of consumer products in memory but only for consumers who tend to perceive products as coherent entities	Objective (± attributes)
Lassiter, Lindberg, Gonzalez-Vallejo, Bellezza, and Phillips (2009)	Cars	Replicated the UT effect for participants who formed an impression of the decision information but found the opposite (conscious thought better than UT) for participants who merely memorized the information	Objective (± attributes)
Usher, Russo, Weyers, Brauner, and Zakay (2011)	Cars, holiday packages, roommates	UT effect is replicated when best and worst alternatives are defined according to subjective preferences of the participant	Objective (± attributes) and subjective (subjective importance of attributes)
Abadie, Waroquier, and Terrier (2013)	Finding an apartment that matches a client request	UT effect is accompanied by enhanced memory for the gist of decision-relevant attributes; UT is more effective when a low-demand distraction task is used	Objective (number of matching/nonmatching attributes)
Creswell, Bursley, and Satpute (2013)	Apartments, houses, backpacks, cars	First neural evidence for UT, showing that in the distraction (i.e., UT effect) stage, the same regions are activated as during the information encoding stage	Objective (± attributes)
Reinhard, Greifeneder, and Scharmach (2013)	Lie detection	UT improves lie detection by better integration of the particularly rich information necessary for accurate lie detection; there is also evidence for reduction of reliance on nondiagnostic cues	Objective (accuracy of lie detection)

Note: ± attributes = number of positive and negative attributes.

quality of a decision. For instance, conscious thinkers may be forced to think longer than they normally would (see Payne, Samper, Bettman, & Luce, 2008), or conscious thinkers may experience problems recalling the decision information encoded earlier (Shanks, 2006). If indeed conscious thought jeopardizes the decision process, better performance of distracted participants does not yet constitute evidence for an active UT process.

The fact that many UT experiments (including some of our own; e.g., Dijksterhuis et al., 2006) have been conducted with just two conditions (i.e., a UT condition and a conscious thought condition) may have contributed to the fact that some researchers (Lassiter, Lindberg, Gonzalez-Vallejo, Bellezza, & Phillips, 2009; see also Waroquier, Marchiori, Klein, & Cleeremans, 2010) proposed an alternative explanation for the UT effect in

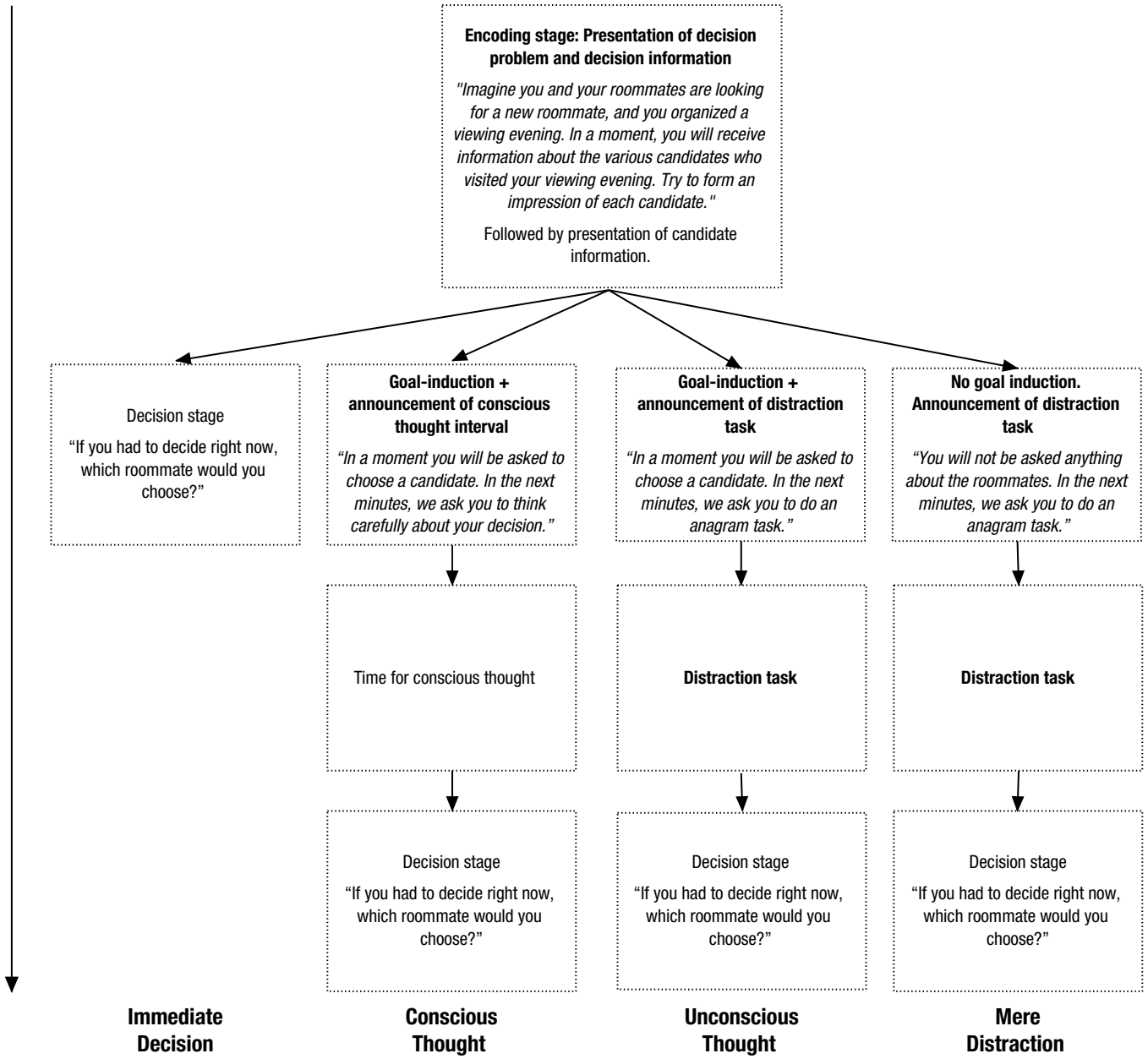

Fig. 2. The experimental conditions used in unconscious thought experiments. Instructions of the immediate, conscious, and unconscious condition are based on Strick, Dijksterhuis, and Van Baaren's (2010) study, and instructions of the mere distraction condition are based on Bos, Dijksterhuis, and Van Baaren's (2008) study.

which no active UT has to be assumed to take place. Their reasoning is that while participants encode the decision information they form a relatively accurate online impression. In the UT condition, this impression is simply recalled after participants have been distracted. The fact that conscious thinkers make relatively poor decisions is because they interpret instructions to "think carefully" as a directive to abandon their online impression and to form new judgments based on the specific decision information they recall. However, because they had been asked to form impressions in the first place, and because the originally presented information was disorganized and was presented only briefly, their recollection of the information and the subsequent memory-based judgment are impaired.

As we also argued elsewhere (Strick et al., 2011; Strick, Dijksterhuis, & Van Baaren, 2010), it is very well possible—indeed likely—that some participants in some experiments indeed merely recalled an impression that they formed online after they were distracted. However, this alternative explanation is at odds with many other findings in the UT domain, and it can easily be refuted as a more

general explanation of the UT effect. Concretely, it cannot explain why unconscious thinkers outperform participants who are merely distracted (as reviewed later), why the representation of objects changes during the distraction period when people unconsciously think (as reviewed later), why effects of UT show up on implicit measures (Ham & Van den Bos, 2011; see also Mealor & Dienes, 2012; Zhong, Dijksterhuis, & Galinsky, 2008), and—perhaps most crucial given the sheer amount of counterevidence—why unconscious thinkers often outperform immediate decision makers (e.g., Abadie, Waroquier, & Terrier, 2013; Bos, Dijksterhuis, & Van Baaren, 2011; Dijksterhuis, 2004; Ham & Van den Bos, 2010a, 2010b, 2011; Ham, Van den Bos, & Van Doorn, 2009; Handley & Runnion, 2011; Hasford, 2014; Lerouge, 2009; Li et al., 2014; McMahon, Sparrow, Chatman, & Riddle, 2011; Messner & Wänke, 2011; Reinhard, Greifeneder, & Scharmach, 2013; see also Strick et al., 2011).

UT versus immediate decisions

In many experiments, distracted participants were compared with participants who made a decision immediately after reading the decision information (immediate decision condition; see Figure 1)—a comparison that is also often made in research on creativity. However, this comparison does not yet prove an active UT process either because distraction may simply lead participants to forget aspects of the relevant information. For example, if people have to decide between two job offers, distraction may lead them to forget the unimportant information while they keep in mind the vital information. In such a case, distracted participants may indeed make better decisions but not because of an active UT process.

Another documented benefit of distraction is that it results in unblocking from fixation on wrong solutions (Schooler & Melcher, 1995; Smith & Blankenship, 1989). When you are writing, it sometimes feels as if you cannot come up with a satisfactory opening of a new paragraph because you seem to be "stuck"—like a needle in a groove—using a sentence that does not quite feel right. Taking a brief walk or grabbing a cup of coffee can solve this problem because it allows you to forget the unsatisfactory sentence and start afresh. However, in such a case, showing that distraction leads to better results than no distraction (i.e., working on a problem without interruption) is no proof of active UT either.

The best control condition: UT versus mere distraction

In addition to comparing distracted participants with participants who thought consciously or who did not think at all, in some recent studies, researchers used yet a new control condition—called *mere distraction* (see Figure 2)—that we believe does make more far-reaching conclusions possible. In typical UT studies, participants, after encoding the decision problem and information, are told that they have to make a decision later on. In other words, they receive a goal to further process the decision information. When the mere distraction condition is used in studies, participants in the UT condition are compared with participants who are also distracted and who encode the same decision problem and information; however, they are told right before the distraction task that they will not be asked to make a decision. Participants in both conditions are presented with the same decision problem and information and, hence, have equal opportunity to form online impressions. In both conditions, participants are distracted from further conscious thought about the problem. Thus, the potential damage inflicted by conscious thought after an initially accurate online impression, which some researchers asserted could have been the driving force behind the UT effect (Lassiter et al., 2009; Payne et al., 2008), is precluded in both conditions. Furthermore, the potential benefit of distraction per se—for example, distraction leads to beneficial forgetting of irrelevant information (e.g., Shanks, 2006) or unblocking from fixation (e.g., Smith & Blankenship, 1989)—should lead to enhanced performance in both conditions. Yet, a growing number of experiments show that participants in the UT condition outperform those who are merely distracted.

Bos and colleagues (e.g., Bos, Dijksterhuis, & Van Baaren, 2008) presented participants with information on four decision alternatives and showed (as before; e.g., Dijksterhuis et al., 2006) that participants who thought unconsciously for a few minutes made better decisions than participants who thought consciously. More important for the present purposes, participants who thought unconsciously also outperformed participants who were merely distracted. In a second study, in which participants were forming an impression of a person, participants formed better integrated representations of the target person after UT than after being merely distracted. In their final experiment, more evidence for goal-dependent UT was obtained by pitting two goals against each other. Participants read information on two decision problems (choosing among cars and choosing among roommates), and before they were distracted, some participants were given the goal to decide among the cars, whereas others were given the goal to decide among the roommates. Indeed, participants made better decisions on the decision problem for which they were given a goal.

Later work by researchers using a mere distraction condition showed that UT leads people to automatically engage in weighting the relative importance of decision

attributes (e.g., Bos et al., 2011). In these experiments, participants chose among alternatives (mostly cars) with many unimportant positive characteristics and a few important negative ones, as well as alternatives with many unimportant negative characteristics and a few important positive ones (the paradigm was based on Alba & Marmorstein's, 1987, study), and the results showed that unconscious thinkers engaged in more weighting (i.e., preferring the alternatives with many unimportant negative characteristics and a few important positive ones) than participants who decided immediately or who were merely distracted.

In yet other research in which a mere distraction condition was used, participants were given difficult Remote Associates Test (RAT; Mednick, 1962) items to solve. In the RAT, participants are presented with three words and are asked to find another word they all connect to. For example, the words "fountain," "baking," and "pop" all connect to the word "soda": "soda fountain," "baking soda," and "pop soda." After a period of UT, the correct answers were activated (as shown by lower reaction times to the target words); however, this was not the case after mere distraction (Zhong et al., 2008).

In a clinical application of UT theory, participants were shown a stressful film (Krans & Bos, 2012; Krans, Janecko, & Bos, 2013). Such films are used to investigate effects of posttraumatic stress disorders and are known to lead to intrusions afterward as long as the trauma memory is disorganized and not integrated in autobiographical memory. As UT has been shown to help organize memory representations (Abadie, Waroquier, & Terrier, 2013; Bos et al., 2008; Dijksterhuis, 2004), the researchers hypothesized that UT would reduce later intrusions. This was indeed the case, as in two experiments it was shown that UT reduced the number of intrusions compared with mere distraction or conscious thought.

Recently, UT theory was successfully applied to lie detection (Reinhard et al., 2013). In five experiments, participants saw short film clips in which people either lied or told the truth. When people responded immediately or thought for a while consciously, they were not better than chance in discovering deception. However, under UT conditions, accuracy was about 65%–70% rather than 50%, whereas mere distraction did not help at all—that is, accuracy was 50%. These findings are impressive, as it is notoriously difficult to improve lie detection (Hartwig & Bond, 2011).

One may remark that the different effects of UT versus mere distraction can, like the differences between UT and immediate responses, still be caused by differential forgetting. Perhaps participants in a UT condition forget less than participants in the mere distraction condition. It is indeed theoretically possible that UT leads to less forgetting than mere distraction. However, in several experiments, recall was indeed measured, and no differences between UT and mere distraction emerged (Bos et al., 2008, 2011; Krans & Bos, 2012; Krans et al., 2013). In other experiments (Reinhard et al., 2013; Zhong et al., 2008, see also Abadie, Waroquier, & Terrier, 2015), memory was not a relevant explanatory factor to begin with. In sum, the comparisons between UT and mere distraction conditions across a variety of decision tasks provide evidence for true, active thought taking place unconsciously.

More Evidence From the UT Paradigm: A Closer Look at the UT Process

The evidence discussed thus far pertains to the outcome of a UT process—such as a decision. In addition to outcomes, the unconscious processes themselves that take place during the distraction period have also been studied. These experiments provide additional evidence for the UT process and, at the same time, shed light on the characteristics of UT.

Neural activation

Recently, the first neuroscientific evidence for UT was published (Creswell, Bursley, & Satpute, 2013). The study showed that unconscious thinkers made better decisions than conscious thinkers and than immediate decision makers. To differentiate the neural activity involved in UT from the neural activity involved in performing the distraction task, Creswell et al. (2013) had the participants perform the distraction task separately, and they subtracted the neural activity from neural activity during UT. The functional magnetic resonance imaging data showed that UT was associated with activation in the right dorsolateral prefrontal cortex and left intermediate visual cortex. These areas were already involved in the encoding of the information in the first place, and Creswell et al. proposed a neural reactivation account for UT, indeed demonstrating unconscious processing to continue after encoding. Neural reactivation in the regions mentioned previously was predictive of decision quality of unconscious thinkers.

In our view, the comparisons between UT and mere distraction as well as the neuroscientific evidence from Creswell et al.'s study constitute the strongest evidence to date for the existence of true UT processes, at least within the confines of the UT paradigm.

Changed mental representations

Other strong evidence for UT is provided by experiments that show that the mental representation of the object of thought (such as decision alternatives) changes while

people are assumed to think unconsciously. Such evidence has been obtained in various experiments.

In one study (Dijksterhuis, 2004, Experiments 4 and 5), participants were provided with information about four potential roommates and were asked to choose among these four. In a task in which speed of recognition for the decision information was measured, unconscious thinkers—compared with conscious thinkers and participants who were not given time to think—responded faster to the positive aspects of the most desirable roommate and to the negative information of the most undesirable roommate than to the other information, suggesting that their impressions polarized—that is, they became more extreme. In addition, participants who formed an impression of a target person on the basis of behavioral information indicative of three different personality traits showed more clustering—that is, better organization in memory—after UT rather than after conscious thought. These findings were later replicated and extended by Bos et al. (2008).

In recent research, Abadie, Waroquier, and Terrier (2013) integrated UT theory with fuzzy-trace theory. Fuzzy-trace theory posits that when people encode information, they store the information in two different ways (Reyna & Brainerd, 1995). Verbatim representations are detailed and contain the exact information, whereas gist representations represent the meaning of information. The latter representations are primarily used in advanced reasoning. In two experiments, Abadie et al. demonstrated that UT leads to better gist memory (and better decisions) than conscious thought or immediate decision making.

In other experiments, researchers found evidence for changes in the representations of recently acquired knowledge on an unconscious level. In a typical implicit learning paradigm, Mealor and Dienes (2012) taught their participants artificial grammar. Participants were probed for their knowledge of the newly learned information either after UT, after conscious thought, or immediately. On some trials participants had to guess, as they claimed they did not know the answers, but unconscious thinkers were still correct more often than what was expected by chance. This was not the case in other conditions. Zhong et al. (2008) presented participants with difficult RAT items and showed that after UT, and not after conscious thought or after mere distraction, the answers were more accessible.

Evidence From Other Paradigms

In addition to the findings reviewed earlier, there is evidence from other types of experiments, such as experiments on incubation or problem solving. The UT paradigm was, in part, based on the research on incubation in creativity (e.g., Wallas, 1926; see Orlet, 2008, for a recent conceptual review). Perhaps sparked by the many anecdotes on sudden insight and the assumed role of unconscious processes in creativity, many researchers have compared performance of people who are asked to solve a creative task immediately with people who are interrupted or distracted for a while before they finish their task. Sio and Ormerod (2009) recently reviewed this literature and indeed concluded that a period of incubation helps creative problem solving. However, the moderators they discovered do not really speak to whether the effects should be explained by real UT—that is, an active thought process—or merely by other consequences of a period of distraction (e.g., forgetting of nondiagnostic information or wrong cues) without the need to assume active UT (see also Orlet, 2008).

However, there are individual experiments on insight that do suggest true UT. Hans Teeuwen, a famous Dutch comedian, once remarked that he sometimes feels that he is about to crack a good joke before he is actually consciously aware of this joke (Busato & Van Harreveld, 2006). This remark is reminiscent of various experiments on problem solving done in the late 1980s. In one study, participants were asked to identify target words on the basis of successive hints, such as an associated word (Bowers, Regehr, Balthazard, & Parker, 1990; see also Metcalfe & Wiebe, 1987). After each hint, participants were asked to guess the target word. It turned out that participants often feel as if the answer comes to them suddenly, as the target word seems to pop up in consciousness out of nowhere. However, the researchers found that participants' successive guesses converged toward the correct answer. The unconscious seemed to be closing in on the correct answer some time before the answer was accessible to consciousness.

There is more evidence demonstrating that people can integrate large amounts of information unconsciously. In a series of interesting experiments (Betsch, Plessner, Schwieren, & Gütig, 2001), participants watched TV ads shown on a computer screen, and they were instructed to watch these ads very carefully. However, the numerical increases and decreases of five hypothetical shares on the stock market were shown simultaneously at the bottom of the screen. Participants were presented with a total of 75 pieces of information that were only briefly presented. Not surprisingly, participants could not correctly answer specific questions about the five shares, such as what the average money returns were. When they were merely asked to indicate their attitudes, they did surprisingly well. Somehow, they knew what the best and worst shares were. Participants had developed a liking or disliking toward each the shares, indicating that they had processed and integrated the information while they were attending to the TV ads. The findings were later replicated with nonnumerical stimuli (Plessner, Betsch, Schallies, & Schwieren, 2008).

Another study obtained evidence for unconscious cognitive processing in a very different experimental paradigm, and its findings may be interpreted as evidence of UT on a microscale (Vlassova & Pearson, 2013). The study used dynamic random-dot-motion displays, commonly used in very basic decision-making research (e.g., Shadlen & Newsome, 1996). Such displays show a large number of small dots moving slowly in a 6° angle, whereby some dots move to the left, and others move to the right. The participants' task is to judge quickly whether most of the dots move to the left or right. Generally, participants become more accurate when the dot movements are more coherent and when the duration of the presentation of the display increases. However, the authors showed that a blank interval after a brief presentation of a display also increased accuracy, and they concluded that processing of the display continued after the display had disappeared. Intriguingly, it was also observed that a blank delay did not improve performance under conditions in which concurrent working memory was occupied, thereby mirroring some of the findings of the UT paradigm (i.e., that UT does require attention, as reviewed later).

In another microscale study, participants were repeatedly presented with a stream of five arrows, each of which could point to the left or right with equal probability (De Lange, Van Gaal, Lamme, & Dehaene, 2011). Participants were asked to quickly decide (or guess) whether the majority of arrows pointed to the left or the right. On each trial, all five arrows were either highly visible (i.e., the conscious condition) or almost invisible (i.e., the unconscious condition). The results showed that in both conditions, decisions became more accurate with more arrows pointing in the same direction, indicating that people can accumulate information both consciously and unconsciously. Only in the conscious condition did the impact of the final arrow decrease with more already accumulated evidence (e.g., the impact of the final arrow on decisions was minimal when it followed four arrows pointing to the left). In contrast, in the unconscious condition, the impact of the final arrow remained stable with more accumulated evidence. These results point to an interesting characteristic of unconscious processing: It weights all pieces of evidence equally. This characteristic is rather unhelpful in a simple decision task such as this (i.e., additional arrows were processed even after conclusive evidence had been gathered), but it may be quite beneficial in more complex decision-making contexts, such as choosing a major, as it helps to avoid premature conclusions.

Recently, in two lines of research, Ric and Muller (2012) and Sklar et al. (2012) have independently reported initial evidence for the exciting possibility that people can do simple arithmetic unconsciously. Ric and Muller primed people with simple additions (two single digits with a maximum sum of 6) subliminally and showed that the correct sums were activated. Sklar et al. presented their participants with slightly more taxing additions or subtractions subliminally and showed that the correct answers were more accessible (i.e., could be verbalized faster) than incorrect answers. To recap, evidence from various other research areas also demonstrates that processes that people would have no hesitation to call thought processes were they conscious can ensue unconsciously.

Characteristics of UT

Given the strong evidence for UT processes that we now have from multiple research areas, it is justified to delve deeper into the characteristics of UT. Next, we review recent findings on what we currently know about these characteristics.

Most early research on UT centered around the claim that UT can lead to better decisions than conscious thought (e.g., Dijksterhuis, 2004; Dijksterhuis et al., 2006). Indeed, in many experiments, researchers did find that unconscious thinkers outperformed conscious thinkers; however, in an equally large number of other experiments, researchers failed to find an advantage of UT over conscious thought (for reviews, see Nieuwenstein & Van Rijn, 2012; Nieuwenstein et al., 2015; Strick et al., 2011). In addition, the bold claim that UT leads to better decisions than conscious thought was the object of perhaps an equally bold critique by others who maintained that UT simply does not exist (e.g., Gonzalez-Vallejo, Lassiter, Bellezza, & Lindberg, 2008). However, it seems that after having postulated a clear thesis and antithesis, the area moves forward in the direction of synthesis: Many researchers in the UT area started to investigate moderators, and some of these studies have been very insightful regarding the process of UT.

UT organizes information

As already alluded to earlier, representations become better organized and more polarized, and memory becomes more gist-based. UT theory postulates that UT leads to a process of weighting whereby the importance of information is assessed. This idea was supported in some experiments (Bos et al., 2011; Usher et al., 2011) but not in others (Ashby, Glöckner, & Dickert, 2011; Pachur & Forrer, 2013), and it awaits further study. Recently, Li et al. (2014) demonstrated that participants who engage in UT are able to equally integrate information presented in two separated sessions, whereas conscious thinkers overemphasized information from the second session. Taken together, the findings make it

tempting to suggest that UT is a process whereby disorganized information becomes more and more organized until some kind of equilibrium is reached and the conclusions can be transferred to consciousness. Recent research that is consistent with this idea showed that, in a creativity task, 3 min of UT led to better results than both 1 and 5 min of UT (and also better than 3 min of conscious thought), suggesting that people can unconsciously "overthink" (Yang, Chattopadhyay, Zhang, & Dahl, 2012).

UT does require attention

A second important characteristic of UT is that it does require some attention. Various experiments have shown that a relatively light distraction task leads to better UT results than a more taxing distraction task. If one sees UT as a form of unconscious goal pursuit, then one should also assume (see the work by Marien et al., 2012; referred to earlier) that UT uses at least some attention or some processing capacity. This indeed seems to be the case (Abadie, Villejoubert, et al., 2013; McMahon et al., 2011; Strick et al., 2011).

That being said, matters may be more complex. In addition to experiments done with the UT paradigm, Baird et al. (2012) also found evidence for the importance of the nature of distraction task in creative problem solving. In their experiment, participants completed the unusual-uses task either without a break, after a period of rest, after an undemanding distraction task, or after a demanding distraction task. Not only did participants who performed an undemanding task outperform participants who did a very taxing task but they also outperformed participants who merely rested for a while and participants who did not take a break in the first place. Hence, it indeed seems to be true that a light task is better than a taxing task, but a light task is also better than no task at all (perhaps because resting leads people to consciously think about the problem).

UT works best with high-quality information

In addition, UT seems to work best when the information it has to work on is very useful—for instance, because it is particularly important or diagnostic for a certain decision. Purchasing decisions after UT are better than after conscious thought when they are based on high-diagnosticity information but not when they are based on low-quality information (Gao, Zhang, Wang, & Ba, 2012). Unconscious thinkers were better able to differentiate between strong and weak arguments (or in other words, between high- and low-quality information) than conscious thinkers in a persuasion experiment (Handley & Runnion, 2011). More research is needed before more firm conclusions can be drawn, but UT may turn out to conform to the "garbage in, garbage out" axiom.

UT works best with alternative-based rather than feature-based representations

Various studies showed that UT is more fruitful when the mental representation of each decision alternative after encoding is holistic rather than feature-based. When the decision information is presented blocked per choice option, the UT effect is larger than when the decision information is presented completely randomized (Strick et al., 2011; see also Abadie et al., 2015). Lerouge (2009) found that UT produced better results when people process the decision information holistically—leading to a coherent representation—than when they compare alternatives with respect to individual features. Lassiter et al. (2009) showed an UT effect after people formed an overall impression of the decision information but not when participants were merely asked to memorize the information. In a recent study, Abadie et al. (2015) used a process-dissociation procedure to disentangle the respective roles of recollection and familiarity (sometimes referred to as remembering vs. knowing) of decision information in the UT paradigm. The results showed that recollection was uncorrelated with decision quality in the UT condition, whereas it did correlate with decision quality in the conscious thought condition. This suggests that decisions after UT are not based on recollection of individual attributes (but, very likely, on holistic representations of the alternatives; see also Dijksterhuis, 2004).

UT does not deal well with numerical information

UT theory postulates that UT is not able to follow propositional rules and, hence, that it does not do well with arithmetic. Recent evidence on unconscious math (Ric & Muller, 2012; Sklar et al., 2012) may well point at the fact that this aspect of the theory is wrong. However, it does seem to be the case that UT does not do well when the information it has to work with is numerical. Ashby et al. (2011) and Payne et al. (2008) studied the outcome of gambles and only found evidence for the UT effect under very specific circumstances. In most of their experiments, conscious thinkers outperformed unconscious thinkers. Later studies confirmed that conscious thinkers outperform unconscious thinkers on decisions in which the aspects are represented numerically but not when they are presented qualitatively (Abadie, Villejoubert, Waroquier, & Vallée-Tourangeau, 2013). Finally, in a recent study, the UT effect was found when decision information was presented purely in terms of overall

valence ("battery life is good"). However, when decision information was very specific ("battery lasts for 12 hours"), conscious thought improved up to the level of UT (Hasford, 2014).

UT works best for complex problems

We have already shown (e.g., Dijksterhuis et al., 2006) that UT works well for complex problems—in this case involving a lot of information—but not for simple problems, and this effect was confirmed in a meta-analysis (Strick et al., 2011). This meta-analysis also showed that the effect size of the UT effect is especially large when the decision information is both verbal as well as pictorial rather than only verbal (see also Rusou, Zakay, & Usher, 2013).

UT seems to work best in more ecological paradigms

Ironically, the effects obtained in the initial UT paradigm (e.g., Dijksterhuis, 2004) are often not replicated (see Nieuwenstein et al., 2015, for recent evidence), whereas it seems that some later paradigms are more robust—at least in terms of effect sizes. Larger UT effects seem to be obtained in judgments situations that are more ecologically valid (i.e., more relevant for real-life situations), which is encouraging from the perspective of UT theory. The studies by Ham and Van den Bos on justice and morality (Ham & Van den Bos, 2010a, 2010b, 2011; Ham et al., 2009) are good examples, and the same can be said about the recent research by Reinhard et al. (2013) on lie detection.

Bargh (2011) noted that the demonstrations of the UT effect in these ecologically valid situations are consistent with the view that unconscious processes are especially fruitful in domains in which evolution gave people innate processing mechanisms, such as person perception, morality, and the detection of deception. More generally, these findings support the view—and this was one of the foundations on which UT theory was built in the first place—that cognitive processes can best be seen as unconscious by default and that one should assume the necessity of consciousness only when there are strong empirical reasons to do so (e.g., Dijksterhuis, Van Knippenberg, Holland, & Veling, 2014; Hassin, 2013; Van Gaal, Lamme, Fahrenfort, & Ridderinkhof, 2010). Indeed, the findings are inconsistent with the converse, old Cartesian view that humans were created as exclusively conscious beings.

In the forthcoming years, it is likely that more characteristics of UT will be discovered. These may help researchers to better explain the UT process, and they may also help researchers to understand why the UT effect is notoriously unpredictable. Initial new findings that may turn out to be enlightening—provided that they are confirmed in further experiments—were obtained by Wang, Xie, Zhu, Chen, and Yuan (2013), who found that the UT effect showed up among people in a negative or a neutral mood but not among people in a positive mood. Other preliminary evidence shows that the UT effect depends on individual differences in preference for the use of intuition or rational thinking (Zakay & Amichai, 2014).

An Update of UT Theory

On the basis of the reviewed findings we can formulate an update on the characteristics of the UT process:

- UT organizes (i.e., clusters, polarizes), weights, and extracts gist from decision information.
- UT operates on holistic representations of the options rather than on recollection of individual attributes.
- UT seems to work best on high-quality information in complex judgment situations with high ecological validity. While doing this, it does use some attentional resources, making a lighter distraction task more fruitful than a taxing one.
- Finally, UT does not seem to work well with numerical or quantitative information, at least not relative to conscious thought.

How does this update relate to the original UT theory formulated 10 years ago? In the original work on UT theory, the main focus was on showing the benefits of UT over conscious thought in complex decision making; however, it has become increasingly clear that conscious thought and UT often perform equally well and are also constrained by similar factors (e.g., limited motivation, limited cognitive resources). This observed similarity parallels research on goal pursuit, which has shown high correspondence among the functions, outcomes, and underlying processes of conscious and unconscious goal pursuit.

As other unconscious processes, UT seems to be more productive when the information it has to work on is inherently motivating. Motivation was considered an important aspect of UT from the start, but initially this referred to *external* motivation—that is, the presence of a decision goal (Bos et al., 2008). Later research illustrates that UT is more likely to process issues that are *inherently* interesting (Hassin, 2013)—that is, problems that are ecologically appealing and that relate to issues that people naturally care about (e.g., social stereotypes, moral problems). The findings of the past years suggest that UT needs to be stimulated not only by an external goal but also by intrinsic interest.

The recurring finding that the UT effect is stronger when the attributes are presented in a structured, coherent format (e.g., blocked by choice option) rather than in an unstructured format is rather surprising in light of initial work on UT. After all, in the early studies, researchers focused on the benefit of UT in integrating large amounts of disorganized information into coherent representations (e.g., Dijksterhuis, 2004; Dijksterhuis et al., 2006). One may even argue that with structured options, the decision becomes less complex. How can this be incorporated in UT theory, which posits that UT is especially fruitful in complex decision situations? One possibility is that although UT organizes unstructured information, this is not its best feature. Its best feature, compared with conscious thought, is perhaps that it integrates and evaluates particularly rich information (e.g., complex stimuli with verbal and nonverbal aspects) while leaving the holistic representations intact. Conscious thought, however, leads to a decomposition of representations into specific attributes, which may lead to a narrow focus and ensuing weighting problems (overestimating features that are easy to verbalize, e.g., Wilson & Schooler, 1991; overestimating features that are most dissimilar among options, e.g., Hsee & Zhang, 2004). More research is needed to investigate this issue.

However, as UT theory evolved, its most important proposition remains unchanged: We believe that people think unconsciously as well as consciously. In fact, research over the last 10 years has provided an overwhelming body of evidence confirming this idea.

Proposing Type 3 Thinking

As alluded to in the opening paragraphs of this article, students take, on average, a few months to decide on their major, and Newton took more than a decade to understand gravity. It is reasonable to assume that these thought processes are neither fully conscious nor fully unconscious. Instead, such real-life, prolonged thought processes have both conscious and unconscious elements, and conscious thought and UT seem to alternate. You think about a decision consciously, you sleep on it for a while, you then think a bit more after you have encountered relevant new information, you then again delegate it to your unconscious for a while, and so forth.

Such a process does not fit well with the current theoretical models on thought. The most common distinction made is between Type 1 (or System 1) and Type 2 (or System 2) processes (Kahneman, 2003; Stanovich & West, 2000; in line with Evans & Stanovich, 2013a, 2013b; we prefer the term "Type" over "System," as the latter implies some sort of circuitry, and such a characterization feels premature). Recent views of dual-process theories maintain that the defining characteristics of Type 1 processing are autonomy and independence from working memory (Evans & Stanovich, 2013a, 2013b). These processes are also typically fast, associative, and unconscious. The defining features of Type 2 processing, however, are the ability for cognitive decoupling (i.e., inhibiting an immediate response while mentally simulating alternative responses) and a heavy load on working memory. These processes are typically slow, logical and rule-based, and conscious.

Thinking about a study major for a few months overlaps with Type 1 processing in the sense that it can operate autonomously after being triggered by stimuli in the environment (e.g., a group of master's-level students walking by), but unlike other Type 1 processes, it is not completely effortless. It overlaps with Type 2 with respect to its load on working memory—although it probably does not use up much of the available resources—but it is unlikely that cognitive decoupling takes place when the topic is simmering in the back of one's thoughts. Thinking about a study major for a few months is also much slower than most typical Type 2 (and, of course, Type 1) processes.

To accommodate such real-life thought processes that take place over longer periods of time in our theories, one may find it useful to postulate a separate type—namely, Type 3 (see also Claxton, 1997; Dijksterhuis, Strick, Bos, & Nordgren, 2014). Type 3 processes, we propose, are very slow; are periodically conscious as well as periodically unconscious; and during the unconscious phases—but not during the conscious ones—are largely, but not wholly, effortless. As for other characteristics, Type 3 processes do not seem to be rule-based, but they also do not seem to be merely associative. Type 3 processes organize and polarize and—as Newton would hopefully have agreed with—are exploratory or perhaps even playful.

Whether we truly need a third type of thought or whether we can adjust Type 1 or Type 2 characteristics so that they can accommodate prolonged thought processes awaits further thinking and research. However, we do hope that the current analysis conveys that it is time to make room for UT—and for UT as part of prolonged thought processes—in future theories and research.

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