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ORIGINAL ARTICLE

Does unconscious thought improve complex decision making?

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Abstract In a recent study, Dijksterhuis et al. (Science 311:1005, 2006) reported that participants were better at solving complex decisions after a period of unconscious thought relative to a period of conscious thought. They interpreted their results as an existence proof of powerful unconscious deliberation mechanisms. In the present report, we used a similar experimental design with an additional control, immediate condition, and we observed that participants produced as good (and even descriptively better) decisions in this condition than in the "unconscious" one, hence challenging the initial interpretation of the authors. However, we still obtained lower performances in the "conscious" relative to the "immediate" condition, suggesting that the initial result of Dijksterhuis et al. was not due to the action of powerful unconscious thought processes, but to the apparent disadvantage of further conscious processing. We provide an explanation for this observation on the basis of current models of decision making. It is finally concluded that the benefit of unconscious thought in complex decision making is still a controversial issue that should be considered cautiously.

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Introduction

We are faced daily with complex decisions. These decisions range from purchases that involve a large amount of money, such as buying a car or an apartment, to choosing among various life options. These complex decisions have individual consequences, but may also have collective implications. In their everyday practices, judges, company managers or even army officers are faced with complex decisions that can have dramatic consequences for other individuals. Making the right choice in face of these complex situations is obviously a fundamentally important issue.

Common belief holds that thorough conscious thought leads to the best decision. Following a Cartesian tradition, conscious deliberation allows us to find the clearest ideas and to produce the best analyses of a given situation. When facing an important choice, thinking about it as carefully and as exhaustively as possible, by, for example, assigning pluses and minuses to the different arguments, is the best strategy to make the right choice.

Another side of popular wisdom holds that leaving a complex problem aside for some time is a good strategy to reach the best decision. "Sleeping on it" sometimes improves one's decision making. Research on incubation provides several different explanations of this phenomenon. Ever since Woodworth (1938), delaying problem solving has been thought to improve decision making, either because of periodic conscious work on the problem, inadvertent priming of the correct solution, diminution over time of interference from incorrect solutions, reduction in fatigue, or even because of unconscious work.

This last factor, unconscious work, has been recently put forward to explain increased performance in decision making. Dijksterhuis et al. (2006) have argued that a period of unconscious thought, (that is, thought in the absence of conscious attention directed to the problem), is useful for making sound decisions. In one of these experimental studies, participants were given information about four cars characterized by a set of 12 attributes which could be either positive or negative. The proportion of positive attributes was distributed so that one car, the best, had 75% positive attributes, two cars had 50% and the last one had only 25%. Participants were informed that they would later have to choose the car they would hypothetically purchase. Half of them had to make the decision after a short period of conscious thought. The other half was distracted during the same period of time before making their decision. In this "unconscious" condition, participants had to perform a distraction task that prevented them from devoting conscious attention to their decision. Interestingly, participants made the best decisions in the "unconscious" condition (by choosing the best car more frequently) compared to the conscious condition.

According to these authors, their results suggest that we should probably revise our views on the strengths and weaknesses of conscious and unconscious thought during complex decision making. According to Dijksterhuis (2004; see also Dijksterhuis & Nordgren, 2006), complex decisions usually involve several alternatives and require integrating a large set of information. This would be a particularly difficult task for conscious thought, given that consciousness has a limited processing capacity. When people are presented with a high amount of information, the resulting representation in memory is likely to be disorganized because of the limited capacity of consciousness. In contrast, according to Dijksterhuis (2004), the processing capacity of the entire cognitive system (combining its conscious and unconscious parts) is enormous. It would then follow that unconscious thought has a larger processing capacity and that it is better designed to help us face complex decisions more effectively.

Advocating a crucial role to unconscious thought in complex decision making may lead to a genuine revolution in the way we conceive mental activities and, once again, this may have dramatic consequences in situations in which human lives are at stake. These issues should thus be considered with great care and caution.

Present experiment

Before drawing strong conclusions on the power of unconscious thought, one should probably start by clarifying the empirical evidence. In the study reported above (Dijksterhuis et al., 2006), the results revealed a better performance in the "unconscious" condition (60% of the participants chose the best car) compared to the "conscious" one (25% chose the best car). Two comments are needed here.

First, in order to state unambiguously that the "unconscious" condition had a positive impact on complex decision making, it would be useful to compare it to a control condition in which participants give their choice immediately, without any period of thought (conscious or unconscious). Such a condition appeared in recent studies comparing the influence of conscious and unconscious thought on creativity (Dijksterhuis & Meurs, 2006) and on post-choice satisfaction (Dijksterhuis & van Olden, 2006). In the domain of complex decision making, Sweklej, Pochwatko, Balas, and Godlewska (2007) recently observed no advantage of the unconscious condition relative to the immediate one, with the unconscious condition even leading to a decreased performance. Finally, Dijksterhuis (2004) reported three other experiments which included an immediate condition, but the comparison with the unconscious condition led to mixed results or was not always possible.[1] Therefore, the advantage of the unconscious condition relative to the immediate one still appears to be empirically debatable.

Second, the data not only show a striking advantage of the "unconscious" condition but also a surprisingly low performance in the "conscious" condition. Why did participants in the "conscious" thought condition have problems making the best decision? One reason could be the highly interfering nature of the material used in this experiment. Indeed, the four cars are described by similar sentences listing their attributes. Remembering which car has a given attribute can be a very difficult and artificial memory task. Trying to remember this set of sentences (during the four minutes given to reflect in the "conscious" condition) may therefore accentuate the interference instead of facilitating the decision. This could explain why participants performed so badly in the "conscious" condition. Therefore, in order to avoid these memory problems, participants should be able to consider all of the correct information within the "conscious" deliberation condition (as it is usually the case in ecological decision making situations). The present experiment precisely addresses these two critical points.

[1] Indeed, in Experiment 1 and 3 from Dijksterhuis (2004), the author only reported an analysis performed on the difference between the best candidate and the worst one and no information was given on the proportion of responses for each candidate in each experimental condition, making the comparison between the unconscious and the immediate conditions impossible. In Experiment 2, mixed results were reported. On the one hand, the proportion of responses for the best car tended to be higher for the unconscious condition relative to the immediate one (but there was no difference between the critical conditions, i.e., the unconscious and conscious conditions). On the other hand, the strategy adopted by participants appeared to be different between the unconscious and the conscious conditions (but this time, there was no difference between the unconscious and the immediate conditions).

Table 1 Display of the 12 car-attributes

Attributes	Cars				Score
	Best (Hatsdun)	Medium 1 (Kaiwa)	Medium 2 (Dasuka)	Worst (Nabusi)	
1. (poor/good) gas mileage	+	+	–	–	18.3
2. (poor/good) handling	+	–	+	–	16.5
3. (poor/good) for the environment	+	+	–	–	15.6
4. (poor/good) sound system	–	–	+	–	14.6
5. (poor/good) service	+	+	–	–	14.3
6. (easy/difficult) to shift gears	–	+	+	–	12.9
7. (small/large) trunk	+	+	–	–	12.3
8. (little/plenty of) legroom	–	+	–	+	11.8
9. (old/new) car	+	–	+	–	10.2
10. available in (few/many) colors	+	+	–	+	6.1
11. (has/has no) sunroof	+	–	+	+	5.9
12. (has/has no) cup-holders	+	–	+	–	1.6

The table displays the 12 car attributes used in the experiment, the distribution of positive attributes across the four different cars and the mean scores of influence obtained by each attribute in the questionnaire with French University students

Method

Participants

Ninety-six students from the University of Bourgogne participated in this experiment.

Material and procedure

The reported experiment used exactly the same material and procedure as in Dijksterhuis et al. (2006). Participants were first presented with information about four different cars. The cars were characterized by 12 attributes, the best car having 75% of positive attributes, two medium cars having 50% and the worst having 25%.[2] The same car names, attributes and distribution of positive and negative attributes were used in order to replicate as closely as possible Dijksterhuis et al. (see Table 1). After reading the 48 sentences describing the four cars (presented in a random order, one at a time for 8 s), participants were distributed across three different conditions (they were 30, 30, and 36 participants in the "immediate", "unconscious", and "conscious" conditions, respectively). In the first condition, immediately after being exposed to the 48 sentences, participants had to choose their preferred car. This "immediate" condition can be conceived as a control condition. If participants really benefit from a period of "unconscious" thought, then we should observe a better performance in the "unconscious" condition compared to the "immediate" one. The second condition was identical to the "unconscious" condition from Dijksterhuis et al.; participants had to perform anagrams (the distraction task preventing them from paying attention to the choice) during 4 min before making their choice. Finally, the third condition was a variant of the "conscious" condition from Dijksterhuis et al. In the present "conscious" condition, during the 4 min of conscious thought, the 48 sentences describing the cars were written on a sheet of paper and were given to the participants. If the problem of the "conscious" condition is a memory problem then it should be eliminated in this new "conscious" condition.

Results

The results are displayed in Fig. 1. Chi-squares were used to test the main effect of cars, conditions, and the interaction between cars and conditions. The main effect of cars was calculated on the proportion of responses for each car across conditions and led to a significant difference ($\chi^2(3, N = 96) = 88.9, P < 0.001$), indicating that the best car has been selected more frequently than the other ones (contrast: best vs. others, $\chi^2(1, N = 96) = 76.6, P < 0.001$). The main

[2] After running the experiment, we noticed that one of the two medium cars described in the material section of Dijksterhuis et al. (2006) did not have precisely 50% of positive attributes, but 58% (i.e., 7 positive attributes out of 12; Ap Dijksterhuis indeed confirmed that for the Kaiwa, it was difficult, rather than easy, to shift gears). Since we used exactly the same material as the one published in this study, our experiment includes this discrepancy. However, we decided to avoid running again the complete experiment because this discrepancy does not change fundamentally the experimental design, the best car still having more positive attributes (9 out of 12) than the other cars. Hereafter, we label "medium 1", the car with 58% of positive attributes and "medium 2", the car with 50% of positive attributes.

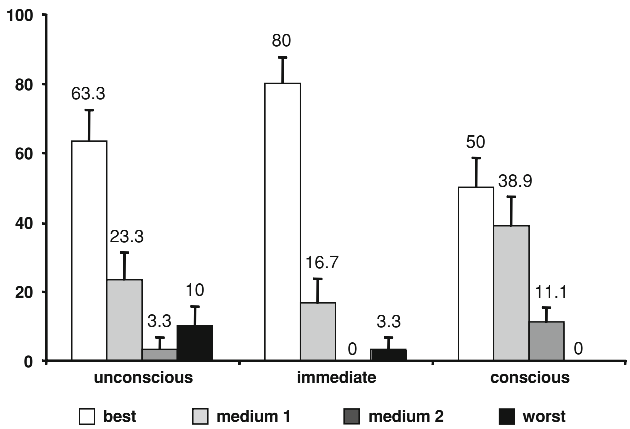

Fig. 1 Percentage of participants who chose the best car (having 75% of positive attributes), the two medium cars (having 58 and 50% of positive attributes and respectively labeled medium 1 and 2) and the worst car (having 25% of positive attributes) in the “unconscious”, “immediate” and “conscious” conditions. *Error bars* correspond to standard errors

effect of condition, calculated on the proportion of responses for the best car, was also significant ($\chi^2(2, N = 96) = 12.8, P < 0.01$), indicating that there were differences in the participant performances between conditions. The interaction between cars and conditions, calculated on the proportion of responses for the best car against the proportion of responses for the other ones, was also significant ($\chi^2(2, N = 96) = 6.4, P = 0.04$). Finally, systematic comparisons were computed between the immediate control condition and each of the other conditions. These comparisons showed, first, that performances were descriptively better in the “immediate” condition (80%) relative to the “unconscious” condition (63.3%), although this advantage did not reach significance ($\chi^2(1, N = 60) = 2.05, P = 0.15$). Second, the “conscious” condition led to a significantly lower score (50%) relative to the “immediate” condition ($\chi^2(1, N = 66) = 6.4, P = 0.01$). Note that the difference between the “unconscious” and “conscious” conditions was not significant ($\chi^2(1, N = 66) = 1.2, P = 0.28$).

Discussion

To summarize, the present experiment is characterized by two main results. First, there was no advantage of the “unconscious” condition relative to the control “immediate” condition, suggesting that a period of unconscious thought does not seem to help solve complex decisions. We also failed to replicate the advantage of the “unconscious” relative to the “conscious” condition, but this might be due to the fact that the present “conscious” condition is slightly different from the one used in Dijksterhuis et al. (2006). Second, the “conscious” condition still led to lower scores relative to the control “immediate” condition. Although participants had all the information available about the cars (contrary to Dijksterhuis et al., 2006), which should have eliminated the disadvantage of the “conscious” condition by removing any potential memory problem, this condition nevertheless led to the worst decisions. Thus, a question remains: why does conscious deliberation generate such an impoverished performance?

We would like to suggest the following response: under certain conditions (like the “conscious” condition), participants might use a decision making strategy for which the so-called “best car” is no longer the best choice. Over the last two decades, several studies in the domain of decision making have indeed provided evidence and demonstrations that human reasoning is not strictly constrained by the rules of the rationalist tradition and that “human rational behavior is shaped by a scissors whose two blades are the structure of task environment and the computational capabilities of the actor” (Simon, 1990). Depending on tasks and context variables, individuals might not adopt the strategy implicitly assumed by Dijksterhuis et al. (i.e., counting the number of positive attributes and choosing their favorite car on the basis of this simple—or apparently simple—count), but rather adopt a more adaptive decision strategy that takes into account environmental constraints and the bounded capacities of the human information processing system (e.g., Gigerenzer & Goldstein, 1996; Payne, Bettman, & Johnson, 1988; Simon, 1990).

The recent literature on decision making indeed contrasts the *rational* approach to decision making to the *bounded rationality* approach. According to the *rational approach*, people make decisions by combining *all* of the available information in some optimal way (assuming that they are able to integrate and process it *all*). Alternatively, the *bounded rationality* approach stipulates that decision making strategies are dependent both on human computational limitations and on environmental constraints. According to this approach, in order to discriminate among alternatives, people might not process *all* available information, but rather only a restricted set, such as the most relevant information (Gigerenzer & Goldstein, 1996).

As suggested by Lee and Cummins (2004), instead of strictly opposing these two types of approaches (rational and bounded rationality), it is possible to use a model of decision making unifying the two by considering them on a continuum and as special cases of a sequential-sampling decision-making process. The basic idea is that in the rational approach, all of the available evidence is taken into account, whereas in the bounded rationality approach, the first piece of evidence that favors one decision is sufficient. Therefore, these two strategies can be placed at the opposite extremes on a continuum varying in the amount of information that people take into account in order to make a decision (for a similar description, see Newell, 2005).

On the basis of this unifying model of decision making, one can now contrast two different views of conscious and unconscious thought. According to Dijksterhuis and colleagues, only few attributes can be processed in the "conscious" thought condition, due to the limited capacity of conscious processing. Inversely, in the "unconscious" thought condition, many *if not all* attributes will be taken into account, due to the larger unconscious processing capacity. Let us call this view the *powerful unconscious* view. On the contrary, recent theories of consciousness assign a central role to conscious attention in guiding our perception, representation, and comprehension of the environment (Dulany, 1997; Logan, 1988; Perruchet & Vinter, 2002; Tzelgov, 1997; see also Searle, 1992). Critical to this view is the amount of time allocated to conscious processing. If this amount is low, as is the case in the "unconscious" thought condition, people will only be able to process a few attributes. If this amount is high, as in the "conscious" condition, many *if not all* attributes will be considered in the decision process. Let us call this alternative view the *conscious attention* view.

Figure 2 provides a schematic description of these differing views within the unifying model of decision making presented above, with each view clearly leading to opposite predictions. While the powerful unconscious view predicts that participants will take into account fewer attributes in the "conscious" than in the "unconscious" condition, the opposite prediction is made by the conscious attention view. These opposite predictions are now tested within this model by varying the number of attributes taken into account to generate a decision.

To relate the model predictions to the present paradigm, we adopted the following implementation. Firstly, attribute sampling is supposed to be ordered according to the influence each attribute has on decision making. The most influential attributes are supposed to first enter the sampling

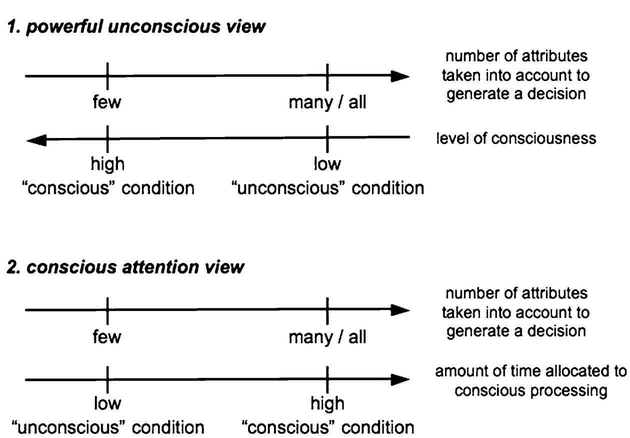

Fig. 2 Schematic description of the opposite predictions made by the *powerful unconscious* view and by the *conscious attention* view

decision process. To estimate attribute influence, we created a questionnaire with the 12 attributes used in the experiment and we asked a group of 18 independent French students from our university to rate these attributes on a 20-point scale depending on how influential they thought these attributes would be in choosing a car (0 = very low influence and 20 = very strong influence). A *mean value of influence* was then calculated for each attribute (Harte, Koele, & van Engelenburg, 1996). For example, the mean value for the cup-holder and the gas mileage attributes were 1.6 and 18.3, respectively, indicating that on average, participants considered these attributes to have a weak and a strong influence on their decision, respectively. The influence score for each of the 12 attributes are given in Table 1. Secondly, decisions were assumed to be based on an *evaluation score* computed for each car, taking from one to 12 attributes into account. This computation was done in the following way. Starting from the most influential attribute, if a car has a given attribute then it receives a positive value corresponding to the attribute's score of influence. For example, gas mileage being the most influential attribute, cars possessing this attribute receive a positive value of +18.3. Likewise, cars that do not have this attribute receive a negative value of −18.3. The same procedure is then applied for the second attribute, and so on. The values obtained for each car are then averaged in order to obtain a *mean evaluation score*. For example, if three attributes are entered in the sampling decision process (i.e., the three most influential attributes, i.e., 1. gas mileage; 2. handling and 3. environment), since the "best" car possesses all these attributes, it has a mean evaluation score of (18.3 + 16.5 + 15.6)/3 = 16.8. Similarly, since the car "medium 1" has good gas mileage, poor handling and good environmental characteristics, its mean evaluation score in the three-attributes condition is (18.3 − 16.5 + 15.6)/3 = 5.8. Thirdly, given that the mean evaluation scores for car medium 2 (i.e., the Dasuka) and for the worst car (i.e., the Nabusi) were always negative (because these cars were described negatively for the most influential attributes) and that car medium 1 (i.e., the Kaiwa) was the strongest competitor relative to the best car (i.e., the Hatsdun), we will only consider the scores for these last two cars. Figure 3a displays the mean evaluation scores for the best car and for car medium 1 as a function of the number of attributes entered in the sampling decision process and Fig. 3b represents the evolution of the difference between these two scores. For example, when three attributes are used in the sampling decision process, the best car and car medium 1 have a mean evaluation score of 16.8 and 5.8, respectively, and the difference between the two cars is: 16.8 – 5.8 = 11, leading to a strong advantage of the best car. Conversely, when the nine most influential attributes are used, the difference becomes: 5.31 – 4.88 = 0.43, indicating that the two cars

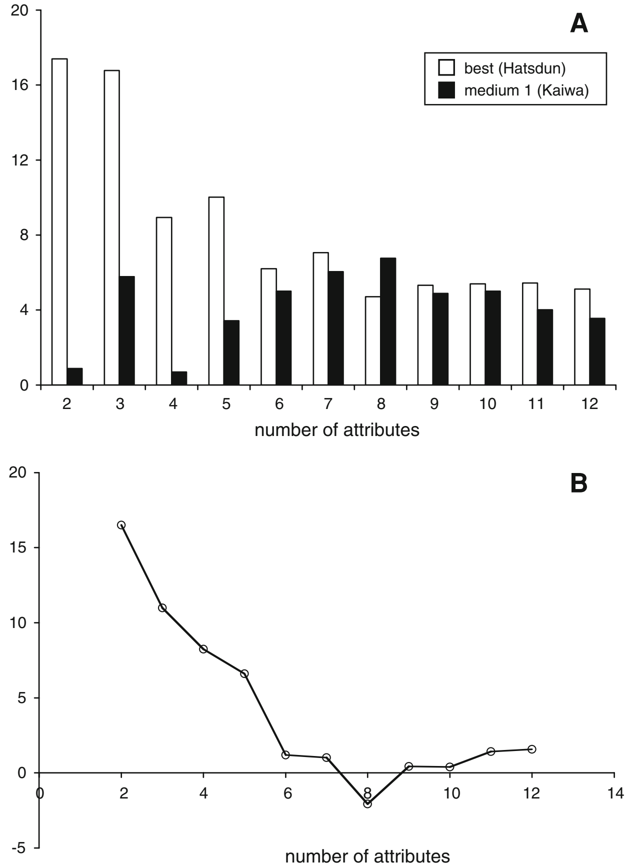

Fig. 3 **a** Mean evaluation scores of the best car (i.e., the Hatsdun) and the car medium 1 (i.e., the Kaiwa) as a function of the number of attributes. **b** Difference between the mean evaluation scores of the best car and car medium 1 as a function of the number of attributes

now have very similar evaluation scores and are practically indistinguishable.

This analysis clearly shows that, depending on the amount of information (i.e., the number of attributes) considered in the sampling decision process, the difference between the two cars changes significantly. While the so-called "best" car undoubtedly wins the race when two to five[3] of the most influential attributes are considered, this advantage completely disappears when six or more of the most influential attributes are considered (note that for eight attributes, the difference is even negative). This general trend is supported by a significant correlation between the number of attributes and the difference between the two cars ($r = -0.81$, $F(1,9) = 17.07$, $P = 0.0026$]. Although the "best" car displays the highest cumulative total of positive attributes, when attributes are weighted by their reported influence on decisions and are considered in ranked order, this advantage almost disappears.

The model therefore predicts that participants tend to choose the "best" car preferentially only when few attributes get into the sampling decision process.[4] Alternatively, the "best" car is selected less when participants are able to process many attributes. In the present experiment, participants chose the "best" car more frequently in the "unconscious" condition than in the other condition, suggesting they are only able to process and integrate few attributes, contrary to the "powerful unconscious" view. Alternatively, consistent with the "conscious attention" view, participants can process many attributes in the "conscious" condition, leading to a decrease in the selection of the "best" car.

General discussion

The present data provide a clarification on two important aspects concerning the claim about unconscious thought made by Dijksterhuis et al. (2006). First, compared to an immediate control condition, the period of unconscious thought did not increase decisions for the "best" car. Second, predictions derived from a model of decision making were inconsistent with the "powerful unconscious" view defended by Dijksterhuis and colleagues. The data are more in line with a "conscious attention" view, showing that decisions vary as a function of the conscious attention dedicated to the available information. An increase in conscious attention leads to an increase in the number of attributes that enter the sampling decision process. Following what the model predicts, decisions toward the "best" car tend to decrease while conscious attention increases.

The results obtained in the control immediate condition are clearly inconsistent with the idea that a period of unconscious thought is beneficial for complex decision making. In fact, given that these conditions led approximately to the same pattern of results, participants in these two conditions likely performed the task in a similar way. After receiving the information about the four cars, participants may have selected one of the cars by taking into account some of the most influential attributes. In the immediate condition, participants gave their choice immediately while in the unconscious condition, they simply delayed their response, keeping the name of the selected car in memory during the distracting task. The difference between these conditions and the conscious one probably lies in the 4-min period of conscious attention during which participants could weight their decision by taking into account more attributes. In this case, since the difference between the so-called "best" car

[3] Note that it only makes sense to calculate mean evaluation scores on at least two attributes because the most influential attribute (i.e., good gas mileage) is shared by both the best car and car medium 1.

[4] Besides, in the marketing domain, it has been recently proposed that, under certain conditions, providing fewer attributes make choices easier (Fasolo, McClelland, & Todd, 2007).

and car medium 1 almost disappears, participants tend to choose randomly between these two cars.

This alternative interpretation of the results that we propose refutes the conscious/unconscious dichotomy proposed by Dijksterhuis (2004) by appealing to a different and more continuous perspective in which only the amount of conscious attention determines the content of decision processes. In the present situation, it is proposed that decision processes are modulated by the amount of conscious processing of the information. The more time allocated to conscious processing, the greater the number of attributes considered by participants. As a consequence, the best choice varies as a function of the number of attributes that are considered and so does the performance of participants.

Compared to the "powerful unconscious" approach, the present framework has the advantage of being directly connected to current theories of decision making (e.g., Bergert & Nosofsky, 2007; Lee & Cummins, 2004; Newell, 2005). The present explanation indeed follows recent unifying advances in the modeling of decision making, assuming a simple sampling decision process. According to this approach, participants use various decision strategies depending on how task requirements are combined with cognitive capacities. If task constraints are weak, allowing more time dedicated to conscious processing, participants are more likely to use more rational decision strategies which take into account all the available information. On the contrary, if task constraints induce limited conscious processing, then participants will approximate optimal behavior by adopting bounded decision strategies and by basing their decision on a restricted set of information.

A second advantage of the present framework is that it provides an explicit and testable computational account of the results. It predicts that decisions will vary as a function of the amount of conscious attention allocated to the problem. Conversely, referring to unconscious thought is, at best, computationally unclear. It would indeed be useful to understand how participants could effectively benefit from a period of unconscious thought. What are the content and the dynamic of these unconscious processes? If they allow a better processing of a complex set of information, how does it work? How can we link these processes to current decision making theories? Unfortunately, the tenants of the unconscious thought approach do not yet provide any clear and testable answer.

As for the question of complex decision making and the popular wisdom that we benefit from "sleeping on it", this might still be a good strategy, but for different reasons (see Mandler, 1994). Not paying a conscious attention to a problem for some time may, for example, allow us to forget some parts of our initial reasoning and to perceive, analyze, and organize the same problem in a different way (Schooler & Hertwig, 2005). Our initial argumentation and segmentation of the problem might have been wrong or inappropriately based on a non-optimal heuristic. Reconsidering a problem after some time offers the possibility of finding new arguments that were initially hidden or unattended. In any case, the best decision remains the product of conscious attention and invoking unconscious thought for complex decision making is, at present, still an unfounded belief.

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