Title
A process-dissociation examination of the cognitive processes underlying unconscious thought

Journal
Journal of Experimental Social Psychology, 49(2)

ISSN
0022-1031

Authors
Damian, Rodica Ioana
Sherman, Jeffrey W

Publication Date
2013-03-01

DOI
10.1016/j.jesp.2012.10.018

Peer reviewed

Journal of Experimental Social Psychology 49 (2013) 228–237

Contents lists available at SciVerse ScienceDirect

Journal of Experimental Social Psychology

journal homepage: www.elsevier.com/locate/jesp

A process-dissociation examination of the cognitive processes underlying unconscious thought

Rodica Ioana Damian *, Jeffrey W. Sherman

University of California, Davis, USA

HIGHLIGHTS

► Conscious and unconscious thought invoke both intuitive and rule-based processing.
► Process dissociation can be used to independently measure the underlying processes.
► Conscious and unconscious thought invoke the same degree of intuitive processing.
► Conscious thought invokes more rule-based processing than unconscious thought.
► Tasks and manipulations are not process-pure.

ARTICLE INFO

Article history:
Received 26 May 2012
Revised 5 October 2012
Available online 21 November 2012

Keywords:
Unconscious thought
Decision-making
Process dissociation
Rule-based processing
Intuitive processing

ABSTRACT

Conscious and unconscious thought have been previously found to differentially impact decision-making quality. However, little research has directly measured the processes underlying these modes of thinking. We propose that both thinking modes are characterized by rule-based and intuitive processing. In two experiments, we used the Process Dissociation Procedure to independently measure these cognitive processes. We tested three competing hypotheses: (a) conscious thinking evokes both increased rule-based and decreased intuitive processing compared to unconscious thinking; (b) conscious and unconscious thinking evoke similar levels of intuitive processing but conscious thinking enhances rule-based processing; and (c) conscious and unconscious thinking evoke similar levels of rule-based processing but unconscious thinking enhances intuitive processing. Experiment 1 used base-rate and law-of-large-numbers decision-making problems, whereas Experiment 2 used decision-making problems similar to the "apartment" problem that is often used in unconscious thought studies. In both experiments we found support for hypothesis (b).

Introduction

Research has shown that changes in attention allocation—the extent to which we devote our conscious awareness to the task at hand—may impact the quality of our decisions (e.g., Dijksterhuis, 2004; Wilson & Schooler, 1991). When tasks require the application of rules, deliberation *with* attention (conscious thought) leads to better decisions. In contrast, when tasks require the holistic integration of a large amount of information that is not rule-bound, deliberation *without* attention (unconscious thought) leads to better decisions. This finding is referred to as the Unconscious Thought Effect (Dijksterhuis, 2004; Dijksterhuis & Nordgren, 2006). Finally, when tasks require both the application of a rule *and* the holistic integration of information, a combination of conscious and unconscious thought leads to better decisions (Nordgren, Bos, & Dijksterhuis, 2011). Although these effects have been supported by a large number of studies, little research has investigated the cognitive processes that underlie conscious and unconscious thought. What happens during deliberation with or without attention at a cognitive level?

In explaining these effects, researchers have focused on the roles of rule-based and intuitive processes.[1] Rule-based processing is a top-down process that affects decisions via the application of rules that define the determinant features of quality. In contrast, intuitive processing is a bottom-up process that affects decisions via the holistic integration of information about different options. Not surprisingly, rule-based processing is believed to facilitate decisions that require the application of a rule (Dijksterhuis & Nordgren, 2006). In contrast, intuitive processing has been argued to be critical for making decisions that require the integration of many features of different options (Dijksterhuis, 2004; Dijksterhuis & Nordgren, 2006).

* Corresponding author.
E-mail address: ridamian@ucdavis.edu (R.I. Damian).

[1] Although unconscious thought researchers typically do not use the term "intuitive processing," we used it in this paper to refer to the same type of processing (intuitive, holistic, integrative, bottom-up, divergent, and high capacity) characterized by Dijksterhuis and Nordgren (2006) as "unconscious thought." We could not use the term "unconscious thought processing" because we wanted to distinguish unconscious thought from its underlying processes.

0022-1031/$ – see front matter
http://dx.doi.org/10.1016/j.jesp.2012.10.018

Given that conscious thinking improves performance on rule-based decisions and that unconscious thinking improves performance on holistic decisions, the expectation follows that conscious thinking evokes rule-based processing, whereas unconscious thinking evokes intuitive processing (e.g., Dijksterhuis & Nordgren, 2006).

One complication with this account of decision quality under conscious and unconscious thought is that experimental tasks are not process-pure. Rather, any given task reflects the operation of multiple component processes (e.g., Ferreira, Garcia-Marques, Sherman, & Sherman, 2006; Jacoby, 1991). As such, instructions to think consciously or unconsciously likely evoke both rule-based and intuitive thought processes. Thus, conscious thinking may both enhance rule-based processing and diminish intuitive processing compared to unconscious thinking. If rule-based processing improves rule-based decisions, whereas intuitive processing hinders the effective use of rules, then effects on either processing component may explain why conscious thinking produces superior decisions on rule-based tasks. That is, conscious thinking may promote quality rule-based decisions by increasing rule-based processing, decreasing intuitive processing, or both, compared to unconscious thinking. Likewise, if intuitive processing improves decisions requiring the integration of information, whereas rule-based processing interferes with such decisions, then effects on either processing component may explain why unconscious thinking produces superior decisions on integrative tasks. That is, unconscious thinking may promote quality integrative decisions by increasing intuitive processing, decreasing rule-based processing, or both, compared to conscious thinking.

There is precedent for expecting that rule-based processing may interfere with integrative decisions. Applying rules in the context of integrative decisions, for which a large number of attributes must be integrated, could lead to mental fixation on a limited number of attributes. In turn, this mental fixation could cause people to overlook other relevant attributes and lead to inferior decisions. In other words, by using rules, people may end up focusing on the "wrong" aspects of the problem, or on an incomplete set of information, which may cause them to make poor decisions. As a result, conscious thought would be detrimental when making integrative decisions (Schooler & Melcher, 1995; Schooler, Ohlsson, & Brooks, 1993; Wilson, Lisle, Schooler, Hodges, Klaaren & LaFleur, 1993; Wilson & Schooler, 1991). Similarly, there is precedent for expecting that intuitive processing may interfere with rule-bound decisions, as in the case of almost all the standard heuristics. The base-rate and law-of-large-numbers problems are examples of cases in which intuition leads to poor decisions, as are most of the examples of representativeness and availability (Kahneman & Tversky, 1972).

Of course, it also is possible that conscious and unconscious thinking do not differ in the extent to which they evoke rule-based and/or intuitive processing. For example, intuitive processing may not differ between the conditions, and variation in decision quality may be related solely to differences in the extent of rule-based processes. Alternatively, rule-based processing may not differ between the conditions, and variation in decision quality may be related solely to differences in the extent of intuitive processing.

Research on the processes underlying conscious and unconscious thought

Because the extent of rule-based and intuitive thinking cannot be inferred from the manipulation of conscious and unconscious thinking, these competing possibilities cannot be examined within the standard methods of studying conscious and unconscious thought. To exemplify this point, it is instructive to consider previous studies that have examined the processes underlying conscious and unconscious thinking.

Dijksterhuis (2004) showed that, compared to conscious thought, unconscious thought leads to more polarization and clustering of information. That is, when considering decision alternatives unconsciously (as opposed to consciously), positive alternatives become more positive and negative alternatives become more negative over time, and pieces of information that load on the same dimension become more clustered. These findings seem to suggest that unconscious thought leads to more "intuitive processing," a type of holistic processing that favors a better organization of large amounts of information. But this is not the only possibility. It is also possible, for instance, that unconscious thought (as opposed to conscious thought) leads to better organization due to decreased rule-based processing. According to previous research (Wilson & Schooler, 1991), rule-based processing may hinder a good and efficient organization of large amounts of information, because it focuses people too much on a limited number of rules. Thus, although this research showed important outcomes of unconscious thought, it did not independently measure the underlying processes.

Further characterizing the outcomes of unconscious thinking, Bos, Dijksterhuis, and van Baaren (2011) showed that unconscious thought, as opposed to immediate decision-making, leads to an automatic weighting process in which important decision attributes receive more weight and unimportant decision attributes receive less weight. However, the same problem described earlier applies: evidence for effective weighting following a period of unconscious thought does not unequivocally support the idea that unconscious thought is characterized by more intuitive processing, as opposed to less rule-based processing. Better weighting under unconscious thought may result from increased intuitive processing, decreased rule-based processing, or both.

Another attempt to identify the underlying processes of conscious and unconscious thought was made by Usher, Russo, Weyers, Brauner, and Zakay (2011), who showed that deliberation without attention (i.e., the distraction manipulation that is regularly used to elicit unconscious thought) has the same effect on decision-making as instructing participants to "use their intuition or gut feeling." To be precise, participants thinking unconsciously and participants instructed to "use their intuition" made better decisions than participants who thought consciously. The authors conclude that unconscious thought is characterized by increased intuitive processing, but in so doing, they assume that telling people to use their intuition has only one outcome; that is, to increase people's intuitive processing. However, it also is possible that both unconscious thought and the instruction to use one's intuition lead to decreased rule-based processing, and this might be the process driving the effects.

Although the above findings have undoubtedly enriched our understanding of unconscious thought and its effects on decision-making, they do not reveal the extent to which manipulations of conscious and unconscious thinking evoke rule-based and intuitive thinking. To address this issue directly, we need a means to derive independent estimates of rule-based and intuitive processing following the imposition of conscious and unconscious thought. This was the goal of the present research.

Process Dissociation Procedure

One technique for measuring the operation of multiple processes within a single task is the Process Dissociation (PD) procedure developed by Jacoby (1991; Jacoby & Dallas, 1981; Jacoby, Toth, & Yonelinas, 1993). Though originally developed for estimating the contributions of recollection and familiarity to memory performance, a variation of the PD procedure has been developed to estimate the contributions of rule-based and intuitive processes to decision making (Ferreira et al., 2006). The fundamental logic of PD is to design experiments that include both *congruent* conditions, in which the two processes of interest act in concert, and *incongruent* conditions, in which the two processes oppose each other. In the PD procedure that Ferreira et al. (2006) developed for use in the context of decision-making, a congruent problem is one in which both rule-based processing and intuitive processing lead to the same correct answer. In this case, the probability of a correct response is the probability of using rule-based processing (RB), plus the probability of using intuitive processing (I) when the use of rules fails, I(l − RB):

$$\text{Congruent} = \text{RB} + \text{I}(l - \text{RB}).$$

In contrast, an incongruent problem is one in which rule-based processing predicts the correct answer and intuitive processing predicts the wrong answer. In this case, the probability of an incorrect response is the probability of using intuitive processing when the use of the rule fails:

$$\text{Incongruent} = \text{I}(l - \text{RB}).$$

Given these two equations, we can now estimate intuitive and rule-based processing independently.

$$\text{RB} = \text{Congruent–Incongruent} \quad (1)$$

$$\text{I} = \text{Incongruent}/(1\text{–RB}). \quad (2)$$

This procedure was validated and applied across four experiments by Ferreira et al. (2006). The authors showed that rule-based and intuitive processing are independent cognitive processes that may be separately enhanced through various manipulations in the context of decision-making. For example, dividing attention while participants made decisions reduced estimates of rule-based processing, but did not affect intuitive processing. However, encouraging participants to use intuitive processing during practice trials increased intuitive processing during test trials, but did not affect rule-based processing.

Similar dissociations have been observed when using PD in the context of human memory and implicit attitudes. For example, studies have shown that a controlled use of memory (similar to rule-based processing) is strongly affected by variables such as divided attention, depth of processing, speeded responding, and aging. In contrast, automatic influences of memory (similar to intuitive processing) tend to be affected by variables such as perceptual fluency, conceptual fluency, and habitual responses (for reviews, see Payne, 2008; Yonelinas, 2002).

Hypotheses

The present research used the PD procedure to directly and independently measure the extent to which rule-based and intuitive processing characterize conscious and unconscious thought in the context of decision-making. Given the existing assumptions regarding the processes underlying conscious and unconscious thought (e.g., Dijksterhuis, 2004; Wilson & Schooler, 1991), three competing hypotheses were identified. First, it may be that conscious thinking evokes both increased rule-based and decreased intuitive processing compared to unconscious thinking. Second, it may be that conscious and unconscious thinking evoke similar levels of intuitive processing but that conscious thinking enhances rule-based processing. Finally, it may be that conscious and unconscious thinking evoke similar levels of rule-based processing but that unconscious thinking enhances intuitive processing.

As mentioned previously, the PD procedure requires the use of complex decision-making problems in which intuitive and rule-based processes are working either in concert or in opposition. In other words, rules are presented in both the unconscious and conscious thought conditions, adding to the complexity of the problems. In such cases, unconscious versus conscious thought does not produce better decision-making (in fact, a combination of the two appears to lead to optimal decisions; see Nordgren et al., 2011). We therefore did not predict that unconscious thought would lead to better decision-making. If anything, because correct answers were defined in terms of the use of rules, conscious thought might be expected to lead to better decisions. However, this does not affect our ability to measure the extent to which conscious and unconscious thought elicit rule-based and intuitive processing, the goal of our research.

Experiment 1

Overview

In Experiment 1, we investigated the impact of thinking mode (conscious versus unconscious) on rule-based (RB) and intuitive (I) processing by obtaining process dissociation estimates of the two processes. Participants were first randomly assigned to one of two experimental conditions (conscious versus unconscious thought), and then completed four decision-making problems (base-rate problems and law-of-large-numbers problems) to which the Process Dissociation procedure has been effectively applied (Ferreira et al., 2006). The base-rate problems were similar to the classic lawyer–engineer problem used by Kahneman and Tversky (1972). Specifically, participants were asked to make a decision relying on either base rates (reflecting rule-based processing) or on the description of the target (reflecting intuitive processing). Law-of-large-numbers problems (Fong, Krantz, & Nisbett, 1986; Nisbett, Krantz, Jepson, & Kunda, 1983) asked participants to make a decision relying on either the basis of a large sample (reflecting rule-based processing) or on the evidence from a vivid anecdote (reflecting intuitive processing, based on representativeness).

Method

Participants and design

Eighty-two undergraduates (46 female) from the University of California, Davis participated in exchange for course credit. They were randomly assigned to either the conscious thought or the unconscious thought condition.

Procedure

Upon arrival, participants learned that they would complete several studies on decision-making and attention. They each received four decision-making problems, the order of which was randomized for each participant. For each problem, participants underwent the standard procedure employed by Dijksterhuis and colleagues (e.g., Dijksterhuis, 2004; Dijksterhuis & Nordgren, 2006). First, participants were shown the decision-making problem. They were given 1 min for each problem, which pre-testing showed to be sufficient for reading the problems, but not for solving them. Then, participants were informed that they would have to solve the problem later, thus being given the goal that is necessary to induce unconscious thinking (Bos, Dijksterhuis, & van Baaren, 2008). In the conscious thought condition, participants were asked to "think very carefully about the problem for the next four minutes." During this time, the computer screen was blank. In the unconscious thought condition, participants performed the *2*-back task (Jonides et al., 1997) for 4 min, as a distractor aimed at encouraging unconscious thinking and preventing conscious thought. In this task, participants saw a series of digits ("1" through "9"), and for each digit they had to decide whether it matched the digit that preceded it by *two* places. This task is highly demanding and impairs executive functioning, which is why it is assumed to direct attention away from the primary judgment task, thereby encouraging unconscious thinking (e.g. Dijksterhuis, 2004). After 4 min elapsed, participants in both conditions saw the problem again and had a chance to solve it by choosing one of two potential answers.

Materials and dependent measures

To enable our use of the Process Dissociation procedure, participants had to complete a minimum of two congruent and two incongruent versions of the base-rate and law-of-large numbers problems. In the congruent versions of these problems, both processes (rule-based and intuitive) predicted the same correct answer, whereas in the incongruent versions, the two processes predicted opposite answers (RB predicting the correct answer). For example, in congruent problems, participants were given the base-rate information (e.g., "in a group of 100 men, 80 of these men are officers, and 20 are privates") and several other pieces of information to be holistically integrated (e.g., "Amos is one of these 100 men. He is a veteran from other battles against the Cyclons. He is often called for special missions. Last year he was decorated by the French President for his accomplishments in the army"). Then participants were asked to decide whether Amos was a private or an officer. In this case, both the base-rate (reflecting rule-based processing) and the other integrated pieces of information (reflecting intuitive processing) predicted that Amos was an officer. In contrast, for incongruent problems, participants were given the opposite base-rate information (e.g., "in a group of 100 men, 20 of these men are officers, and 80 are privates"), and the same set of pieces of information to be integrated. In this case, the base-rate information (reflecting rule-based processing) predicted that Amos was a private, whereas the other integrated pieces of information (reflecting intuitive processing) predicted that Amos was an officer (see Appendix 1 for problem examples).

Each participant received two base-rate problems (one congruent and one incongruent) and two law-of-large-numbers problems (one congruent and one incongruent). There were several problems, from which both congruent and incongruent versions were derived. The presentation of congruent and incongruent versions of each problem was counter-balanced across participants, and the participants never saw the same problem twice.

To arrive at the RB and I estimates used as dependent measures, the proportions of incorrect answers to incongruent problems and correct answers to congruent problems were obtained for each participant across problems. Following Ferreira et al. (2006), estimates of RB and I were computed as follows:

$$\mathrm{RB} = P\Big(\text{correct answers}_{\text{congruent problems}}\Big) - P\Big(\text{incorrect answers}_{\text{incongruent problems}}\Big). \quad (1)$$

$$\mathrm{I} = P\Big(\text{incorrect answers}_{\text{incongruent problems}}\Big)/(1-\mathrm{RB}). \quad (2)$$

Results

Because neither problem version nor gender influenced any results, analyses collapsed across these factors. In order to test the effect of thinking mode (conscious versus unconscious) on processing style, we conducted two independent samples t-tests on the two processing style estimates (RB and I). The first t-test showed that rule-based processing (RB) differed marginally between thinking mode condition ($N=82$, $t(80)=-1.76$, $p=.082$, $g=.39$), with participants under conscious thought demonstrating more rule-based processing ($M=.45$, $SD=.37$) than participants under unconscious thought ($M=.27$, $SD=.54$). The second t-test showed that intuitive processing (I) did not differ between thinking mode conditions ($N=82$, $t(80)=-.12$, $p=.908$; conscious thought $M=.70$, $SD=.32$; unconscious thought $M=.70$, $SD=.26$).[2]

In the above analyses, we computed processing style estimates (RB and I) for each individual participant, and then compared the resulting t-distributions between the conscious and unconscious conditions. One potential problem with this analysis is that it includes a number of subjects with negative RB scores, which are theoretically problematic. This outcome is more likely when there are few types of each trial, as in the current research. A common solution to this problem is to conduct analyses on data that are aggregated across participants (Curran & Hintzman, 1995; Ferreira et al., 2006; Toth, Reingold, & Jacoby, 1994). And, in fact, when there are few observations per participant (as in the current case), processing style estimates derived from aggregated data have been shown to be more accurate than processing estimates derived from each participant separately (e.g., Cohen, Sanborn, & Shiffrin, 2008).

For the aggregate analyses, we computed the proportions of correct and incorrect answers on compatible and incompatible trials across all the participants in each of the two experimental groups (see Table 1). Using the same rule-based and intuitive processing formulas presented earlier, we computed processing style estimates at an aggregate level (for the entire samples, as opposed to for each participant). As expected, the aggregate processing estimates were very similar to the group averages across individual processing estimates. Participants under conscious thought had an aggregate rule-based estimate of .46, whereas participants under unconscious thought had an aggregate rule-based estimate of .28. The aggregate intuitive processing estimates were again very similar between the two conditions: .75 under conscious thought and .70 under unconscious thought. To examine whether these aggregates estimates differed significantly, we conducted two-tailed z-tests from confidence intervals generated with the standard error of the difference between proportions (Curran & Hintzman, 1995; Ferreira et al., 2006). This analysis produced the same results as the analyses based on individual-level data. More precisely, rule-based processing was marginally higher under conscious versus unconscious thought ($SE=.107$, $p=.087$, $g=.36$), and intuitive processing did not differ between the two experimental conditions ($SE=.099$, $p=.579$; see Fig. 1).

Discussion

These results provide initial support for the hypothesis that unconscious and conscious thought evoke the same degree of intuitive processing, but that conscious thought evokes more rule-based processing than unconscious thought.

One might wonder, however, whether the processes involved in the problems we chose reflect the same types of rule-based and intuitive processing as are assumed to operate in other research on unconscious thought. According to Unconscious Thought Theory (Dijksterhuis & Nordgren, 2006), rule-based processing represents the conscious application of a simple (often mathematical) rule. This definition certainly applies to the base-rate and law-of-large-numbers problems we used in Experiment 1. However, according to the same theory, intuitive processing represents the holistic integration of a large amount of information. Although the tasks we used in Experiment 1 were ideal for applying the Process Dissociation procedure, they did not require the integration of a large amount of information and, therefore, may not be representative of previous research on unconscious thought. For each problem, the participants had to integrate at most five or six facts. Therefore, what we assumed to be "intuitive processing" in Experiment 1 might represent a different type of processing than what previous studies on unconscious thought have assumed.

In order to address this possibility, we conducted a second experiment in which we used a decision-making problem that is often employed in unconscious thought studies. This problem requires participants to integrate a large amount of information (several positive and negative statements regarding three different apartments, cars, or roommates) in order to choose the best option (e.g., Bos et al., 2008; Dijksterhuis, 2004; Dijksterhuis, Bos, Nordgren, & van Baaren, 2006). In Experiment 2, we used four such problems (choosing between three apartments, between three cars, between three roommates, and

[2] Although decision-making performance was not central to our research question, one may wonder about the performance results in Experiment 1. We found that participants performed marginally better under conscious thought ($M=2.93$, $SD=.76$) than under unconscious thought ($M=2.56$, $SD=1.10$), $t(80)=-1.76$, $p=.082$. This was to be expected, given that, in order to apply the Process Dissociation procedure, we defined rule-based answers as "correct."

Table 1
Aggregate proportions of correct and incorrect answers on congruent and incongruent trials, split by experimental condition. Data from Experiment 1 (males and females).

Condition	Total number of problems	Congruent trials				Incongruent trials			
		Number correct	Number incorrect	Proportion correct	Proportion incorrect	Number correct	Number incorrect	Proportion correct	Proportion incorrect
UT	82	64	18	0.78	0.22	41	41	0.5	0.5
CT	82	71	11	0.87	0.13	49	33	0.6	0.4

between three vacation destinations) to further examine rule-based and intuitive processes.

Experiment 2

In Experiment 2, we sought to replicate Experiment 1 using decision-making problems that were more similar to those used in previous unconscious thought studies (e.g., Bos et al., 2008; Dijksterhuis, 2004; Dijksterhuis et al., 2006). Once again, we investigated the impact of thinking mode (conscious versus unconscious) on intuitive (I) and rule-based (RB) cognitive processing by obtaining process dissociation estimates of these two processing styles. In order to do so, we introduced a rule into problems that were otherwise identical to those previously used in unconscious thought studies.

Method

Participants and design

One hundred fifteen undergraduates (88 female) from the University of California, Davis participated in exchange for course credit. They were randomly assigned to either the conscious thought or the unconscious thought experimental condition.

Procedure

The procedure was the same as in Experiment 1, except for the type of decision-making problem that the participants solved.

Materials and dependent variables

As described above, this experiment used four decision-making problems modeled after the "apartment" problem. In the apartment problem, the participants are presented with a series of 36 positive and negative statements regarding three different apartments. Each apartment varies in the proportion of positive relative to negative statements, thus rendering one of the apartments as the objectively best choice, one as the objectively worst choice, and one as the neutral choice. After reading all 36 randomized statements, participants in the conscious thought condition were told to think hard about the best choice for four minutes, whereas participants in the unconscious thought condition were given the *2*-back task for four minutes. At the end of this time period, participants in both conditions were asked to choose between the best and worst apartments.[3] In the present experiment, participants had four such decision-making problems: they had to choose between three apartments, between three cars, between three roommates, and between three vacation destinations. The order of the four problems was randomized for each participant. Each of these problems included 18 positive and 18 negative statements that were pre-tested and matched on valence and importance.

Because this type of problem did not have an inbuilt rule, we had to create one. Therefore, we introduced names of people as sources of information for each of the statements. For example, instead of presenting participants with the statement "Apartment 1 is in a noisy neighborhood," we presented them with "*Joe says*: Apartment 1 is in a noisy neighborhood." For each decision-making problem, half of the 36 statements came from Joe and the other half came from Bill (we used two new names for each of the four decision-making problems; names were all single-syllable and male). After encoding all the information but before receiving the unconscious or conscious thought manipulation, participants were informed that one of the two male sources was a liar and that they should discard all the items coming from this person before making their decision (they never knew ahead of time who would turn out to be the liar). Consequently, in the context of these problems, the intuitive processing would be reflected in the holistic integration of all the statements, whereas rule-based processing would be reflected in the ability to apply negations and select out the statements coming from the liar.

To enable our use of the Process Dissociation procedure, participants had to complete 2 congruent and 2 incongruent versions of these problems. In the congruent versions of these problems, both processing styles (RB and I) predicted the same correct answer, whereas in the incongruent versions, the two processing styles predicted opposite answers (with RB predicting the correct answer). For example, a congruent apartment problem consisted of three apartments: Apartment 1 had eight positive and four negative characteristics, Apartment 2 had six positive and six negative characteristics, and Apartment 3 had four positive and eight negative characteristics. Furthermore, for Apartment 1, four of its positive characteristics and two of its negative characteristics came from the liar, which left Apartment 1 with four positive and two negative trustworthy characteristics. For Apartment 2, three of its positive characteristics and three of its negative characteristics came from the liar, which left Apartment 2 with three positive and three negative trustworthy characteristics. Finally, for Apartment 3, two of its positive characteristics and four of its negative characteristics came from the liar, which left Apartment 3 with two positive and four negative trustworthy characteristics. Thus, by holistically integrating the

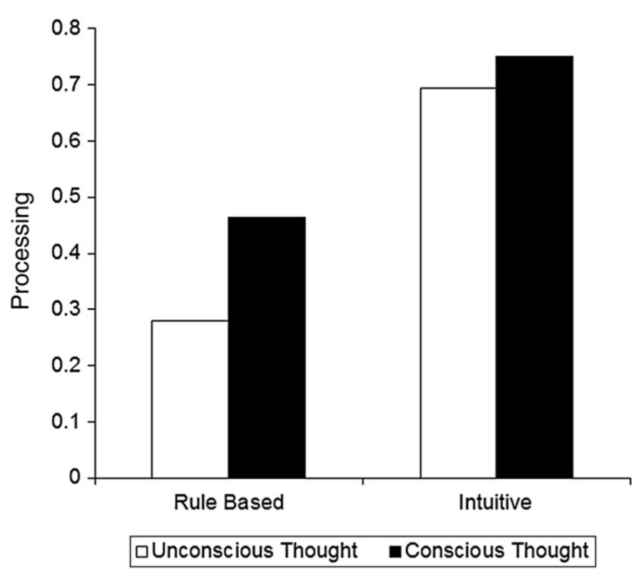

Fig. 1. Aggregate-level results of Experiment 1 ($N = 82$).

[3] Despite the fact that participants were presented with the information from all three choices and were told that they would have to pick from the three choices for each of the problems, at the time of the actual choice, we only presented them with two options: the best and the worst choice. This was necessary because the Process Dissociation procedure formulae apply only to two-choice responses. Though we did not offer the neutral choice, we included them in the initial presentation of the options in order to follow Dijksterhuis' paradigm as closely as possible.

36 characteristics of all the apartments (reflecting intuitive processing), Apartment 1 was the objectively best choice. Similarly, by applying the rule of ignoring the 18 characteristics that came from the liar (reflecting rule-based processing), Apartment 1 was still the objectively best choice (see Appendix 2 for examples).

For incongruent problems, we kept the statements the same, but changed which statements came from the liar. For Apartment 1, six of its positive characteristics came from the liar, which left Apartment 1 with two positive and four negative trustworthy characteristics. For Apartment 2, three of its positive characteristics and three of its negative characteristics came from the liar, which left Apartment 2 with three positive and three negative trustworthy characteristics. Finally, for Apartment 3, six of its negative characteristics came from the liar, which left Apartment 3 with four positive and two negative trustworthy characteristics. Thus, by holistically integrating the 36 characteristics of all the apartments (reflecting intuitive processing), Apartment 1 was still the objectively best choice. However, by applying the rule of ignoring the 18 characteristics that came from the liar (reflecting rule-based processing), Apartment 3 was now the objectively best choice (see Appendix 2 for examples).

Results and discussion

Because there were no effects of problem version, analyses collapsed across this factor. We conducted two separate 2 (thought condition: conscious versus unconscious) × 2 (gender) ANOVAs that included rule-based and intuitive processing, respectively, as the dependent variables. We found that thought condition interacted significantly with gender in impacting rule-based processing ($F(1, 111) = 5.8$, $p = .018$) and intuitive processing ($F(1, 111) = 4.1$, $p = .045$). Therefore, we analyzed the data separately for females and males.

In order to test the effect of thinking mode (conscious versus unconscious) on processing style, we conducted two independent samples t-tests on the two processing style estimates (RB and I). For the female sample, the first t-test showed that rule-based processing (RB) differed significantly between thinking mode condition ($N = 88$, $t(86) = -2.20$, $p = .031$, $g = .46$), with participants under conscious thought demonstrating more rule-based processing ($M = .27$, $SD = .47$) than participants under unconscious thought ($M = .03$, $SD = .55$). This finding replicates Experiment 1. The second t-test showed that intuitive processing (I) did not differ between thinking mode conditions ($N = 88$, $t(86) = -1.41$, $p = .163$; conscious thought $M = .64$, $SD = .34$; unconscious thought $M = .54$, $SD = .34$). This also replicates Experiment 1. For the male sample, however, there were no significant effects.

As in Experiment 1, we also conducted aggregate analyses (for proportions of correct answers, see Table 2). Gender interactions cannot be tested in the context of z-tests of the difference between proportions. However, we conducted the analysis in two ways: for females only, and for females and males together. With this method, the results replicated the individual-level results for the female sample (greater rule-based processing in the conscious condition; no differences in intuitive processing between conditions). As seen in Fig. 2, for the combined sample of female and male participants, the aggregate analysis demonstrated a marginally significant effect of greater rule-based processing in the conscious ($M = .25$) than unconscious ($M = .12$) condition, ($SE = .073$, $p = .080$, $g = .34$). The aggregate intuitive processing estimates were again very similar between the two conditions: .62 under conscious thought and .55 under unconscious thought, and this difference was not significant ($SE = .092$, $p = .442$).[4]

[4] In terms of performance, Experiment 2 showed trending effects in the same direction as those present in Experiment 1. We found that participants performed slightly better under conscious thought ($M = 2.50$, $SD = .96$) than under unconscious thought ($M = 2.25$, $SD = 1.09$), $t(113) = -1.33$, $p = .187$ (the effect was significant only for the female sample, $t(86) = -2.20$, $p = .031$). Once again, these results were to be expected, given that we defined rule-based answers as "correct."

Combined and meta-analytic results across Experiments 1 and 2

We conducted additional analyses across Experiments 1 and 2 to further explore the strength of our findings regarding rule-based processing. First, if we combine the data from Experiment 1 and Experiment 2 (which are conceptual replications of one another), the results show greater rule-based processing in the conscious (as opposed to unconscious) thought condition. This is the case for both the individual-level and the aggregate-level analyses, when including all participants (male and female) from both experiments. For the individual-level analysis, a t-test showed that rule-based processing differed significantly between thinking mode condition ($N = 197$, $t(195) = -2.10$, $p = .038$), with participants under conscious thought demonstrating more rule-based processing ($M = .33$, $SD = .45$) than participants under unconscious thought ($M = .18$, $SD = .54$). Furthermore, there was no interaction between thought condition (conscious versus unconscious) and gender ($F(1, 193) = 1.19$, $p = .277$), or between thought condition and the source of the data (Experiment 1 versus Experiment 2), $F(1, 193) = .15$, $p = .699$. Similarly, for the aggregate-level analysis that combined the data from both experiments, rule-based processing was significantly higher in the conscious ($M = .34$) than unconscious ($M = .19$) condition, ($SE = .063$, $p = .017$).

Second, although the p-values within each study reflect marginal significance (when both male and female participants are included), the effect sizes for these findings are consistent, and of a moderate strength. For the individual-level data, the effect sizes for rule-based differences across conditions are $g = .39$ for Experiment 1 and $g = .25$ for Experiment 2 (when both males and females are included). A meta-analysis across the two studies shows that the overall effect size is significant, $g = .31$, $p = .030$. The same conclusion can be drawn from the aggregate-level data. The effect sizes for rule-based differences across conditions are $g = .36$ for Experiment 1 and $g = .34$ for Experiment 2 (when both males and females are included). A meta-analysis across the two studies shows that the overall effect size is significant, $g = .35$, $p = .015$. Altogether, these analyses indicate that the effect of greater rule-based processing in the conscious than unconscious thought condition is reliable and moderately strong.

General discussion

Numerous studies have shown that the extent to which we devote our conscious attention to the task at hand (conscious versus unconscious thought) may impact the quality of our decisions (e.g., Dijksterhuis, 2004; Wilson & Schooler, 1991). The goal of the present research was to shed light on the processes evoked by conscious and unconscious thought.

In two experiments, using the Process Dissociation procedure, we tested three competing hypotheses: (a) conscious thinking evokes both increased rule-based and decreased intuitive processing compared to unconscious thinking; (b) conscious and unconscious thinking evoke similar levels of intuitive processing but conscious thinking enhances rule-based processing; and (c) conscious and unconscious thinking evoke similar levels of rule-based processing but unconscious thinking enhances intuitive processing. Experiment 1 used base-rate and law-of-large-numbers decision-making problems to test these hypotheses, whereas Experiment 2 used decision-making problems similar to the "apartment" problem that is often used in the context of unconscious thought studies. In both experiments we found support for hypothesis (b) using both individual-level and more robust aggregate-level analyses. One caveat is that the male sample in Experiment 2 did not produce this effect in individual-level analyses. It is unclear why this gender difference was observed in Experiment 2, but it should be monitored in future studies.

We believe that the present paper makes several contributions to the literature. First, we introduce a new method for investigating the cognitive processes underlying conscious thought (CT) and

Table 2
Aggregate proportions of correct and incorrect answers on congruent and incongruent trials, split by experimental condition. Data from Experiment 2 (males and females).

Condition	Total number of problems	Congruent trials				Incongruent trials			
		Number correct	Number incorrect	Proportion correct	Proportion incorrect	Number correct	Number incorrect	Proportion correct	Proportion incorrect
UT	114	69	45	0.61	0.39	59	55	0.52	0.48
CT	116	83	33	0.72	0.28	62	54	0.54	0.46

unconscious thought (UT). Specifically, we show how the Process Dissociation procedure can be used to examine the underlying processes directly, without relying on a priori assumptions about the processes that are instigated by CT and UT manipulations. Previous research concluding that the effects of UT are due to increases in intuitive processing assumed that the UT manipulation only influences the extent of intuitive processing.

A related important feature of process dissociation is that it does not assume that the intuitive and rule-based processes are exclusive of one another (i.e., either/or) or that they operate in a hydraulic fashion (i.e., more of one necessarily means less of the other). These assumptions are common features of dual-process models, but they are problematic in many ways (e.g., Sherman, 2006; Sherman et al., 2008), and provide additional impetus for adopting a process dissociation approach.

Another implication of our findings is that intuitive processing may not be the cause of better decision-making under unconscious thought. Previous research on the unconscious thought effect (e.g., Bos et al., 2008; Dijksterhuis, 2004; Dijksterhuis et al., 2006) has proposed that the effect is mainly due to increased intuitive processing under unconscious thought. However, our data indicate that unconscious thought instructions do not increase intuitive processing, but only decrease rule-based processing, relative to conscious thought instructions. Given that decreased rule-based processing may help decision-making (Schooler & Melcher, 1995; Schooler et al., 1993; Wilson & Schooler, 1991; Wilson et al., 1993), decreased rule-based processing under unconscious thought is a possible explanation of the beneficial effects of unconscious thought on decision-making.

Although our experiments provide a new method of independently measuring the underlying processes of conscious and unconscious thought, they do not directly address the question of which type of processing leads to the beneficial effects of unconscious thought on decision-making. This is because, for the problems we used, the rule-based answer was always correct and the intuitive answer was either correct (in congruent problems) or incorrect (in incongruent problems). This setup was necessary for application of the Process Dissociation procedure. Thus, these are not the sorts of problems that would presumably most benefit from unconscious thinking. Indeed, they may benefit from conscious thinking, given that rules always predicted the correct answer. Nevertheless, our studies are informative as to the cognitive processes initiated by conscious and unconscious thinking instructions.

Another potential caveat of our method is that the results might differ for decision problems that do not include any rules, such as those used in typical studies on unconscious thought. Although we do not know why the same instructions would evoke different processes depending on the nature of the problem, it is possible that the unconscious thinking instructions lead to more intuitive thinking than the conscious thinking instructions when there are no rules present in the structure of the decision problem. Unfortunately, this possibility cannot be addressed using the Process Dissociation procedure, which requires the presence of a rule.

Understanding and dissociating the underlying processes of conscious and unconscious thought may help us understand when and why these thinking styles predict better decision-making. Future studies may use the Process Dissociation methodology proposed here to investigate the relative importance of intuitive versus rule-based processes in decision-making, and explain when and why conscious or unconscious thought might lead us to the best decision.

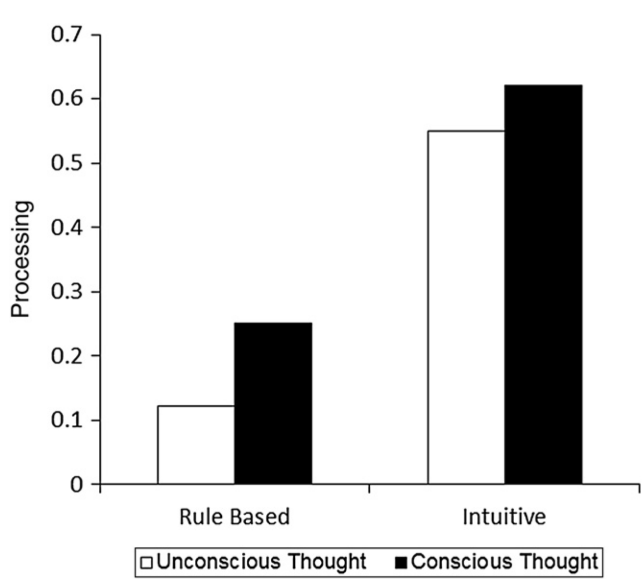

Fig. 2. Aggregate-level results of Experiment 2 ($N=115$).

Acknowledgments

We would like to thank Alison Ledgerwood for her helpful comments on earlier versions of this paper, Maarten Bos for helping us with the stimuli selection, and Courtney Soderberg for her useful feedback.

Appendix 1. Problems used in Experiment 1

Base-rate congruent problem (RB and I predict the same correct answer "a")

In the year 2467, after fifty years of war against the Cyclons (an alien species), the Human Race is about to be defeated. One hundred men from the United Nations Army special forces were selected for a dangerous secret mission in a last war effort. 80 of these men are officers, and 20 are privates. Amos is one of these 100 men. He is a veteran from other battles against the Cyclons. He is often called for special missions. Last year he was decorated by the French President for his accomplishments in the army.

Which of the following is more likely?

a) *Amos is one of the 80 officers in special forces selected for the mission.*
b) Amos is one of the 20 privates in the special forces selected for the mission.

Base-rate incongruent problem (RB and I predict different answers, only RB predicts the correct answer "b")

100 people participated in a public debate about the possibility of more systematic US army support in fighting forest fires. 15 of the

participants were military and 85 were university professors of forest studies. One of the 100 participants is Joe. Joe is 38 years old and he is single. He had a rigid education, and he is considered by some as quite an assertive and inflexible person. His hobbies are playing chess and taking long walks in the country.

Which of the following is more likely?

a) Joe is one of the 15 military people who participated in the debate
b) *Joe is one of the 85 forest studies professors who participated in the debate.*

Law-of-large-numbers congruent problem (RB and I predict the same correct answer "b")

In a prestigious Department of Geography there are two introductory courses and a small advanced course. The selection of the students for the advanced course takes into account the students' evaluations in the two introductory courses. In one of these courses (COURSE 1), students are evaluated by just one large final examination. In the other introductory course (COURSE 2), students' evaluations are based upon 5 small examinations that they have to go through during the course. Sean and Nathan are two students who have just finished the introductory courses and applied for the advanced course. Sean was graded 'very good' in the final examination of COURSE 1 and was graded 'very good' in each of the five examinations of COURSE 2. Nathan was graded 'mediocre' in the final examination of COURSE 1 and was graded 'mediocre' in each of the five examinations of COURSE 2.

What do you think is more likely?

a) Nathan has a better possibility of being selected.
b) *Sean has a better possibility of being selected.*

Law-of-large-numbers incongruent problem (RB and I predict different answers, only RB predicts the correct answer "b")

Students in their final year of graduation in theatre are chosen to act in a play to be presented at the end of the year. For this year's play, the professors have to decide between two students (Suzanne and Amy) for who is going to have the main role in the play. Suzanne played brilliantly in several main roles during the 3 years of the theatre course but her audition for the present main role was mediocre. Amy's performance in several main roles during the course was mediocre but her audition to the present main role was brilliant.

What do you think is more likely?

a) Amy has a better possibility of being selected.
b) *Suzanne has a better possibility of being selected.*

Appendix 2. Problems used in Experiment 2

*Congruent roommate problem (RB and I predict the same correct answer, Roommate 1)**

1. + *Andy says:* Roommate 1 has nice friends.
2. + *Andy says:* Roommate 1 drinks alcohol in moderation.
3. + *Andy says:* Roommate 1 has reasonable requests.
4. + *Andy says:* Roommate 1 has the same tastes as you have.
5. + *Kyle says: Roommate 1 is very funny.*
6. + *Kyle says: Roommate 1 keeps the volume down.*
7. + *Kyle says: Roommate 1 lives a healthy life style.*
8. + *Kyle says: Roommate 1 is always on time.*
9. − *Kyle says: Roommate 1 is not very tidy.*
10. − *Kyle says: Roommate 1 does not have a good aesthetic sense.*
11. − *Andy says:* Roommate 1 does not have a balanced life.
12. − *Andy says:* Roommate 1 is not a lot of fun.
13. + *Andy says:* Roommate 2 keeps the volume down.
14. + *Andy says:* Roommate 2 has a balanced life.
15. + *Kyle says: Roommate 2 has the same tastes as you have.*
16. + *Kyle says: Roommate 2 has a good aesthetic sense.*
17. − *Kyle says: Roommate 2 is not very tidy.*
18. − *Kyle says: Roommate 2 has boring friends.*
19. − *Kyle says: Roommate 2 drinks a lot of alcohol.*
20. − *Kyle says: Roommate 2 lives an unhealthy lifestyle.*
21. − *Andy says:* Roommate 2 is not very funny.
22. − *Andy says:* Roommate 2 is often late.
23. − *Andy says:* Roommate 2 is not a lot of fun.
24. − *Andy says:* Roommate 2 has unreasonable requests.
25. + *Andy says:* Roommate 3 drinks alcohol in moderation.
26. + *Andy says:* Roommate 3 is a lot of fun.
27. + *Andy says:* Roommate 3 lives a healthy life style.
28. + *Kyle says: Roommate 3 has a good aesthetic sense.*
29. + *Kyle says: Roommate 3 is very funny.*
30. + *Kyle says: Roommate 3 has the same tastes as you have.*
31. − *Kyle says: Roommate 3 is often late.*
32. − *Kyle says: Roommate 3 has unreasonable requests.*
33. − *Kyle says: Roommate 3 does not have a balanced life.*
34. − *Andy says:* Roommate 3 is rather noisy.
35. − *Andy says:* Roommate 3 has boring friends.
36. − *Andy says:* Roommate 3 is not very tidy.

Instructions: "It turns out Kyle is a liar. Please discard all the statements coming from Kyle before making your decision."

*Congruent car problem (RB and I predict the same correct answer, Car 2)**

1. + *John says:* Car 2 can handle rough roads.
2. + *John says:* Car 2 has a nice stereo.
3. + *John says:* Car 2 has an easy transmission.
4. + *John says:* Car 2 has a lot of storage space.
5. + *Mark says: Car 2 has a fast acceleration.*
6. + *Mark says: Car 2 comes with a lot of service.*
7. + *Mark says: Car 2 is environment friendly.*
8. + *Mark says: Car 2 is fashionable.*
9. − *Mark says: Car 2 does not have comfortable seats.*
10. − *Mark says: Car 2 is old.*
11. − *John says:* Car 2 does not have a sunroof.
12. − *John says:* Car 2 does not have cup holders.
13. + *John says:* Car 1 has an easy transmission.
14. + *John says:* Car 1 has a sunroof.
15. + *Mark says: Car 1 can handle rough roads.*
16. + *Mark says: Car 1 comes with a lot of service.*
17. − *Mark says: Car 1 has a slow acceleration.*
18. − *Mark says: Car 1 does not have a nice stereo.*
19. − *Mark says: Car 1 has little storage space.*
20. − *Mark says: Car 1 is not very environment friendly.*
21. − *John says:* Car 1 does not have cup holders.
22. − *John says:* Car 1 does not have comfortable seats.
23. − *John says:* Car 1 is not very fashionable.
24. − *John says:* Car 1 is old.
25. + *John says:* Car 3 comes with a lot of service.
26. + *John says:* Car 3 has comfortable seats.
27. + *John says:* Car 3 has a nice stereo.
28. + *Mark says: Car 3 has a fast acceleration.*
29. + *Mark says: Car 3 is fashionable.*
30. + *Mark says: Car 3 can handle rough roads.*
31. − *Mark says: Car 3 is not very environment friendly.*
32. − *Mark says: Car 3 does not have cup holders.*
33. − *Mark says: Car 3 has a difficult transmission.*
34. − *John says:* Car 3 does not have a sunroof.
35. − *John says:* Car 3 is old.
36. − *John says:* Car 3 has little storage space.

Instructions: "It turns out Mark is a liar. Please discard all the statements coming from Mark before making your decision."

*Incongruent Vacation Problem (RB and I predict opposite answers. RB predicts the correct answer, Destination 3, whereas I incorrectly predicts Destination 1)**

1. + Rick says: Destination 1 has good public transport.
2. + Rick says: Destination 1 has good local food.
3. + *Dave says: Destination 1 has affordable restaurants.*
4. + *Dave says: Destination 1 has a good temperature.*
5. + *Dave says: Destination 1 has many locals who speak English.*
6. + *Dave says: Destination 1 has good parking available.*
7. + *Dave says: Destination 1 has a varied landscape.*
8. + *Dave says: Destination 1 has many museums.*
9. − Rick says: Destination 1 does not have very hospitable locals.
10. − Rick says: Destination 1 is not exotic.
11. − Rick says: Destination 1 has a boring night life.
12. − Rick says: Destination 1 does not have nice cultural landmarks.
13. + Rick says: Destination 3 has good local food.
14. + Rick says: Destination 3 has a fun night life.
15. + Rick says: Destination 3 has good public transport.
16. + Rick says: Destination 3 has many locals who speak English.
17. − *Dave says: Destination 3 is not exotic.*
18. − *Dave says: Destination 3 does not have good parking available.*
19. − *Dave says: Destination 3 does not have nice cultural landmarks*
20. − *Dave says: Destination 3 does not have many affordable restaurants.*
21. − *Dave says: Destination 3 does not have many museums.*
22. − *Dave says: Destination 3 does not have a good temperature.*
23. − Rick says: Destination 3 does not have very hospitable locals.
24. − Rick says: Destination 3 has only one type of landscape.
25. + Rick says: Destination 2 has a varied landscape.
26. + Rick says: Destination 2 has affordable restaurants.
27. + Rick says: Destination 2 has hospitable locals.
28. + *Dave says: Destination 2 has nice cultural landmarks.*
29. + *Dave says: Destination 2 is exotic.*
30. + *Dave says: Destination 2 has good parking available.*
31. − *Dave says: Destination 2 does not have many museums.*
32. − *Dave says: Destination 2 has a boring night life.*
33. − *Dave says: Destination 2 does not have a good temperature.*
34. − Rick says: Destination 2 has poor public transport.
35. − Rick says: Destination 2 does not have many locals who speak English.
36. − Rick says: Destination 2 does not have good local food.

Instructions: "It turns out Dave is a liar. Please discard all the statements coming from Dave before making your decision."

*Incongruent Apartment Problem (RB and I predict opposite answers. RB predicts the correct answer, Apartment 1, whereas I incorrectly predicts Apartment 3)**

1. + *Bill says*: Apartment 3 is rather spacious.
2. + *Bill says*: Apartment 3 has a dishwasher.
3. + *Joe says: Apartment 3 has two bathrooms.*
4. + *Joe says: Apartment 3 is in a quiet complex.*
5. + *Joe says: Apartment 3 is close to the bus station.*
6. + *Joe says: Apartment 3 has locks for each room.*
7. + *Joe says: Apartment 3 has been renovated.*
8. + *Joe says: Apartment 3 is close to campus.*
9. − *Bill says*: Apartment 3 does not have a microwave.
10. − *Bill says*: Apartment 3 is far from the supermarket.
11. − *Bill says*: Apartment 3 does not have a laundry machine.
12. − *Bill says*: Apartment 3 does not have a gym.
13. + *Bill says*: Apartment 2 is close to the supermarket
14. + *Bill says*: Apartment 2 is close to campus.
15. + *Bill says*: Apartment 2 has locks for each room.
16. + *Joe says: Apartment 2 has a dishwasher.*
17. + *Joe says: Apartment 2 is close to the bus station.*
18. + *Joe says: Apartment 2 has a laundry machine.*
19. − *Joe says: Apartment 2 has only one bathroom.*
20. − *Joe says: Apartment 2 is rather small.*
21. − *Joe says: Apartment 2 has not been renovated.*
22. − *Bill says*: Apartment 2 is in a noisy complex.
23. − *Bill says*: Apartment 2 does not have a microwave.
24. − *Bill says*: Apartment 2 does not have a gym.
25. + *Bill says*: Apartment 1 is in a quiet complex.
26. + *Bill says*: Apartment 1 has a gym.
27. + *Bill says*: Apartment 1 is close to campus.
28. + *Bill says*: Apartment 1 has two bathrooms.
29. − *Joe says: Apartment 1 is far from the bus station.*
30. − *Joe says: Apartment 1 does not have locks for each room.*
31. − *Joe says: Apartment 1 does not have a laundry machine.*
32. − *Joe says: Apartment 1 has not been renovated.*
33. − *Joe says: Apartment 1 does not have a microwave.*
34. − *Joe says: Apartment 1 is far from the supermarket.*
35. − *Bill says*: Apartment 1 is rather small.
36. − *Bill says*: Apartment 1 does not have a dishwasher.

Instructions: "It turns out Joe is a liar. Please discard all the statements coming from Joe before making your decision."

**Note*: The plus and minus signs did not appear with the statements for the participants. They were simply included here for ease of understanding. Furthermore, the participants never saw the full lists as presented here. They only saw the individual statements one at a time.

References

Bos, M. W., Dijksterhuis, A., & van Baaren, R. B. (2008). On the goal-dependency of unconscious thought. *Journal of Experimental Social Psychology*, *44*, 1114–1120.

Bos, M. W., Dijksterhuis, A., & van Baaren, R. B. (2011). The benefits of "sleeping on things": Unconscious thought leads to automatic weighting. *Journal of Consumer Psychology*, *21*, 4–8.

Cohen, A., Sanborn, A., & Shiffrin, R. (2008). Model evaluation using grouped or individual data. *Psychonomic Bulletin and Review*, *15*, 692–712.

Curran, T., & Hintzman, D. (1995). Violations of the independence assumption in process dissociation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 531–547.

Dijksterhuis, A. (2004). Think different: The merits of unconscious thought in preference development and decision making. *Journal of Personality and Social Psychology*, *87*, 586–598.

Dijksterhuis, A., Bos, M. W., Nordgren, L. F., & van Baaren, R. B. (2006). On making the right choice: The deliberation-without attention effect. *Science*, *311*, 1005–1007.

Dijksterhuis, A., & Nordgren, L. (2006). A theory of unconscious thought. *Perspectives on Psychological Science*, *1*, 95–109.

Ferreira, M. B., Garcia-Marques, L., Sherman, S. J., & Sherman, J. W. (2006). Automatic and controlled components of judgment and decision making. *Journal of Personality and Social Psychology*, *91*, 797–813.

Fong, G. T., Krantz, D. H., & Nisbett, R. E. (1986). The effects of statistical training on thinking about everyday problems. *Cognitive Psychology*, *18*, 293–328.

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Memory and Language*, *30*, 513–541.

Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology. General*, *110*, 306–340.

Jacoby, L. L., Toth, J. P., & Yonelinas, A. P. (1993). Separating conscious and unconscious influences of memory: Measuring recollection. *Journal of Experimental Psychology. General*, *122*, 139–154.

Jonides, J., Schumacher, E. H., Smith, E. E., Lauber, E. J., Awh, E., Minoshima, S., et al. (1997). Verbal working memory load affects regional brain activation as measured by PET. *Journal of Cognitive Neuroscience*, *9*, 462–475.

Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. *Cognitive Psychology*, *3*, 430–454.

Nisbett, R. E., Krantz, D. H., Jepson, C., & Kunda, Z. (1983). The use of statistical heuristics in everyday inductive reasoning. *Psychological Review*, *90*, 339–363.

Nordgren, L. F., Bos, M. W., & Dijksterhuis, A. (2011). The best of both worlds: Integrating conscious and unconscious thought best solves complex decisions. *Journal of Experimental Social Psychology*, *47*, 509–511.

Payne, B. K. (2008). What mistakes disclose: A process dissociation approach to automatic and controlled processes in social psychology. *Social and Personality Psychology Compass*, *2*, 1–20.

Schooler, J. W., & Melcher, J. (1995). The ineffability of insight. In S. M. Smith, T. B. Ward, & R. A. Finke (Eds.), *The creative cognition approach* (pp. 97–134). Cambridge, MA: MIT Press.

Schooler, J. W., Ohlsson, S., & Brooks, K. (1993). Thoughts beyond words: When language overshadows insight. *Journal of Experimental Psychology. General*, *122*, 166–183.

Sherman, J. W. (2006). On building a better process model: It's not only how many, but which ones and by which means. *Psychological Inquiry*, *17*, 173–184.

Sherman, J. W., Gawronski, B., Gonsalkorale, K., Hugenberg, K., Allen, T. J., & Groom, C. J. (2008). The self-regulation of automatic associations and behavioral impulses. *Psychological Review*, *115*, 314–335.

Toth, J., Reingold, E., & Jacoby, L. (1994). Toward a redefinition of implicit memory: Process dissociations following elaborative processing and self-generation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *20*, 290–303.

Usher, M., Russo, Z., Weyers, M., Brauner, R., & Zakay, D. (2011). The impact of the mode of thought in complex decisions: Intuitive decisions are better. *Frontiers in Psychology*, *2*, 37.

Wilson, T. D., Lisle, D., Schooler, J. W., Hodges, S. D., Klaaren, K. J., & LaFleur, S. J. (1993). Introspecting about reasons can reduce post-choice satisfaction. *Personality and Social Psychology Bulletin*, *19*, 331–339.

Wilson, T. D., & Schooler, J. W. (1991). Thinking too much: Introspection can reduce the quality of preferences and decisions. *Journal of Personality and Social Psychology*, *60*, 181–192.

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language*, *46*, 441–517.