Does thinking make you biased? The case of the engineers and lawyers problem

Kinga Morsanyi (km574@cam.ac.uk)
Department of Experimental Psychology, University of Cambridge
Downing street, Cambridge, CB2 3EB, UK

Simon J. Handley (S.Handley@plymouth.ac.uk)
School of Psychology, University of Plymouth
Drake Circus, Plymouth, PL4 8AA, UK

Abstract

In this study we examined the cognitive processes involved in engineers and lawyers-type problems, using a novel method (i.e., asking for liking ratings). We were particularly interested in how participants process information about personality descriptions and base rates, which are provided in the problems. In line with previous research, we found that people detect the conflict between descriptions and base rates. Nevertheless, when instructed to reason logically, instead of relying on base rates, participants resolved the conflict by showing higher preference for description-based responses.

Keywords: conflict detection; dual-process theories: engineers and lawyers problem; heuristics and biases; instruction manipulation; liking ratings.

Dual process theories of reasoning and decision making (e.g., Evans & Over, 1996; Stanovich, 1999) propose that higher order cognition is based on two qualitatively different types of process. Type 1 (i.e., heuristic) processes are assumed to operate fast and automatically with little demand of cognitive capacity, whereas Type 2 processes are slow, conscious, and demanding of computational resources. The tasks used in the heuristics and biases literature (see e.g., Kahneman, Slovic & Tversky, 1982) can be answered by giving a heuristic-based response, or a response which corresponds to a normative rule of probability (although some theorists have questioned the assumption that giving probability-based responses to these problems is more normative than giving description-based responses – see e.g., Hertwig & Gigerenzer, 1999). Kahneman and Frederick (2005) used these tasks as illustrations for Type 1 and 2 processes at work. For example, consider the classic engineers and lawyers problem (Kahneman & Tversky, 1973; see Table 1.). In the original (conflict) problem, base rate information, which strongly favors lawyers, is presented together with a stereotypical description of an engineer. When participants are asked to decide if the person is more likely to be an engineer or a lawyer, they tend to give the response which corresponds to the description.

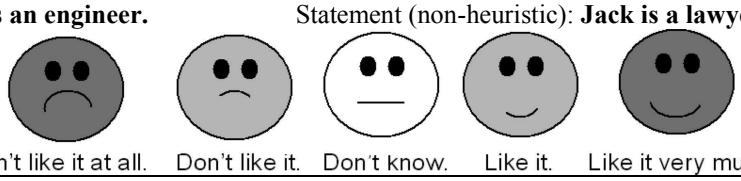
An interesting question is whether participants experience a conflict while they solve these tasks, or if they just give the first response that comes to mind. Dual-process theorists (e.g., Evans, 2006) assume that, as Type 1 processes operate quickly and automatically, all participants are inclined to give a Type 1 response by default. Nevertheless, some individuals (usually the ones of higher cognitive ability – see e.g., Stanovich & West, 2000) are able to inhibit this initial response tendency, and give a response which is based on Type 2 computations. Thus, participants who eventually give a normative response are expected to experience a strong conflict between Type 1 and 2 response tendencies. However, what happens in the case of the majority of the participants who give a heuristic response (which is supposed to be delivered by Type 1 processes)? Do they experience any inner struggle, or do they simply give the first response that comes to mind without ever considering probabilistic information?

In a number of recent studies De Neys and colleagues (e.g., De Neys, Cromheeke & Osman, 2011; De Neys & Glumicic, 2008) used different versions of the engineers and lawyers problem (see Table 1 for illustrations). Besides the original version, they also developed a *non-conflict* task where base-rates and the description pointed to the same response, and they also used a *neutral* task where base rate information was presented together with a description which had no relevance to the choice options. Note that *neutral* problems typically elicit the response of "both options are equally likely" (which is considered a heuristic response). The reason that participants ignore base rates even when they are not provided with any other useful information is, presumably, that they try to base their response on the description (which they automatically assume to be relevant, although it is not). Thus, providing an irrelevant description is enough to draw participants' attention from the base rates.

De Neys and Glumicic (2008) stated that even people who eventually give a description-based response show signs of conflict detection, although they are not consciously aware of this. They demonstrated that whereas in verbal protocols there was no mention of experiencing a conflict, less explicit measures showed signs of differential processing of base rates in conflict and non-conflict problems.

The purpose of the present study was to investigate further how people process base rate-information in the presence of base rate-congruent, incongruent, and neutral descriptions. In the experiment that we report below we used the problems developed by De Neys and Glumicic (2008) which we slightly modified to make them more appropriate for UK participants. However, instead of asking participants to generate a response, we provided them with a response (which we called a statement), and we asked them

Table 1: Different versions of the engineers and lawyers problem (based on De Neys & Glumicic, 2008).

Conflict: Incongruent *description and base rates*
(Part 1:) In a study 1000 people were tested. Among the participants there were 5 engineers and 995 lawyers. Jack is a randomly chosen participant of this study. ***(Part 2:)*** Jack is 36 years old. He is not married and is somewhat introverted. He likes to spend his free time reading science fiction and writing computer programs. Statement (heuristic): **Jack is an engineer.** Statement (non-heuristic): **Jack is a lawyer.**  Don't like it at all. Don't like it. Don't know. Like it. Like it very much.
Non-conflict: Congruent *description and base rates*
(Part 1:) In a study 1000 people were tested. Among the participants there were 995 sixteen-year olds and 5 fifty-year olds. Ellen is a randomly chosen participant of this study. ***(Part 2:)*** Ellen likes to listen to hip hop and rap music. She enjoys wearing tight shirts and jeans. She's fond of dancing and has a small nose piercing. Statement (heuristic): **Ellen is sixteen.** Statement (non-heuristic): **It is equally likely that Ellen is sixteen or that she is fifty.**
Neutral: *Base rates plus* ***neutral*** *description*
(Part 1:) In a study 1000 people were tested. Among the participants there were 4 who live in Manchester and 996 who live in Liverpool. Chris is a randomly chosen participant of this study. ***(Part 2:)*** Chris is 28 years old. He has a girlfriend and shares an apartment with a friend. He likes watching basketball. Statement (heuristic): **It is equally likely that Chris lives in Liverpool or that he lives in Manchester.** Statement (non-heuristic): **Chris lives in Liverpool.**

to evaluate the statement, using a 5-point rating scale of smiley faces, ranging from "don't like it at all"=1 to "like it very much"=5 (see Table 1). This procedure was modelled on Topolinski and Strack (2009a). Liking ratings are sensitive to both conscious and unconscious influences (e.g., explicit preferences, affective priming, etc.), and they are ideal for detecting subtle changes in participants' judgments (cf., Morsanyi & Handley, 2012). Thus, even if participants are unaware of being influenced by base rates / descriptions, these influences should be reflected in their liking ratings. Moreover, liking ratings convey more information than response choices. For example, it is possible that although a participant shows a strong preference for a certain response option, they also evaluate other options positively.

In order to explore the role of Type 1 and 2 processes in people's judgments and in utilizing base rates and descriptions, we implemented an instruction manipulation (see e.g., Klaczynski, 2001). Half of the participants were asked to rely on their intuitions, whereas the rest of the participants were instructed to think logically. From a dual-process perspective, intuitive instructions should encourage Type 1 processing, whereas logical instructions should increase the influence of Type 2 processes. Indeed, previous research (e.g., Chiesi, Primi & Morsanyi 2011; Ferreira, Garcia- Marques, Sherman & Sherman, 2006) showed that instructions affected participants' susceptibility to reasoning biases. Thus, we expected that whereas in the intuitive condition participants would be strongly affected by descriptions, logical instructions should increase the tendency to rely on base rate information. Nevertheless, this should only happen if participants are consciously aware of the conflict, and if they judge that base rates are more relevant to making sound judgments than descriptions.

Another question that we wanted to investigate was whether heuristic responses are associated with higher liking ratings than non-heuristic responses. In a recent paper (Thompson & Morsanyi, 2012) we proposed that heuristic responses might be hard to resist, because of the positive affective valence that they carry. Specifically, we suggested that as heuristic responses are generated fluently and effortlessly, and fluent processing is associated with positive affect (see Topolinski & Reber, 2010 for a review), participants will prefer a heuristic mode of processing, because heuristic responses "feel right". In order to test the assumption that liking ratings are closely related to participants' actual choices, we presented the problems with an option, and they were asked to rate it according to how much they liked it. After performing a different task,

participants were (unexpectedly) presented with the problems once more, but this time they had to select a response from three options. Given the associations between heuristic (i.e., Type 1) processing, positive affect and confidence, we expected that initial liking ratings would be good predictors of subsequent choices.

In summary, the aim of the present study was to better understand the processes underlying performance on engineers and lawyers-type problems. Given the high rate of heuristic responses, we were particularly interested in whether participants experienced a conflict while solving the tasks. We employed a novel paradigm (i.e., asking for liking ratings) to investigate the effect of base rates and descriptions, and we combined it with an instruction manipulation, in order to explore the role of Type 1 and 2 processes in participants' judgments. Additionally, we wanted to test the assumption that heuristic responses are associated with positive affect. Finally, we also predicted that the affective valence of choice options would be closely related to how likely individuals will be to opt for a response when they are offered a choice between different responses.

Methods

Participants

The participants were 62 students (54 females, mean age 21 years 2 months) from the University of Plymouth, UK who participated in the study for ungraded course credit. Participants were randomly allocated either to the intuitive (n=32) or to the logical (n=30) instruction condition.

Materials

The participants were presented with 12 problems: 4 *conflict* problems (i.e., where the description of the person was incongruent with base rates), 4 *non-conflict* problems (where descriptions and base rates were congruent), and 4 *neutral* problems (with irrelevant descriptions). The problems were presented in two parts (using a "moving window" procedure – see de Neys & Glumicic, 2008, Experiment 2). The base rates were presented first (together with the information that the person was randomly selected from a large sample – marked as Part 1 in Table 1), then participants had to press the space bar, and this information disappeared, and the description of the person (Part 2) appeared together with the statement about the person and the rating scale for liking ratings. Participants could review base rate information by pressing a radio button on the computer screen. The problems were presented in a random order, which was different for each participant. The statement that participants had to rate either corresponded to the base rates or to the description (or both), or it simply said that the person was equally likely to belong to either category (see Table 1 for examples). In order to reduce content effects, we created two task sets, where for the same problem participants were either offered a heuristic (i.e., description-based), or a non-heuristic response (see Table 1 for illustrations). Finally, in the second part of the experiment, participants were presented with the same problems again, using the same presentation format as in the first part. However, instead of providing liking ratings for one response option, participants had to choose from three responses (i.e., 1. the person belonged to one category – e.g., engineers; 2. the person belonged to the other category – e.g., lawyers; or 3. it was equally likely that the person belonged to either one or to the other category).

Procedure

Participants solved the problems on the computer. First they were presented with instructions, and they were informed that they could review the first part of the problem. Additionally, in the intuitive condition participants were told: "*When you make your liking ratings, rely on your intuition and feelings. Give the first rating that comes to mind, without any conscious reflection, and do this as quickly as you can."* In the logical condition the instructions ended like this: "*When you make your liking ratings, take the point of view of a perfectly logical person. Think about your answer very carefully. Don't rush. You can take as much time as you want."* Subsequently, the participants were presented with a practice problem, and then they had to work through the 12 experimental problems. After this, they had to perform a different (unrelated) task for about 5 minutes. Finally, they were presented with the problems again. This time they had to choose from three options, rather than evaluating a response which was offered to them. In the second part of the experiment participants were instructed to consider the problems carefully, but they were not explicitly asked to reason intuitively or logically. This part also started with a practice problem.

Results

First, as a manipulation check, we compared the average time that participants spent solving each problem across the intuitive and logical conditions (collapsed across all tasks). As expected, participants in the intuitive condition responded more quickly (M=17820 ms, SD=4235 ms) than participants in the logical condition (M=23872 ms, SD=7223 ms; $t(60)=4.06$, $p<.001$).

We also wanted to see whether we could replicate the pattern reported by De Neys and Glumicic (2008) regarding participants' inspection of base rates. Specifically, these authors reported that participants were more likely to opt for reviewing base rate information if the base rates were in conflict with the description of the person, as opposed to when there was no such conflict. In our analyses we included not only conflict and non-conflict problems, but also problems with neutral descriptions, in order to see whether problems with base rate-incongruent and neutral descriptions are processed differently. Finally, we were also interested in whether the tendency to review base rates differed across the two instruction conditions.

Participants in the intuitive condition reviewed on average 11% (SD=.22) of the base rates in the case of

Table 2: Participants' liking ratings across the different types of task, and different statements.

	Incongruent		Congruent		Neutral	
	Heuristic	*Base rate*	*Heuristic/ base rate*	*Equally likely*	*Heuristic/ equally likely*	*Base rate*
intuitive	3.19 *(.74)*	2.66 *(.76)*	3.63 *(.61)*	3.14 *(.95)*	3.16 *(.83)*	3.27 *(.84)*
logical	3.47 *(.82)*	2.42 *(.97)*	3.60 *(.93)*	3.32 *(.92)*	3.68 *(1.03)*	3.22 *(.85)*

conflict, 8% (*SD*=.21) in the case of non-conflict, and 9% (*SD*=.21) in the case of neutral problems. The corresponding numbers in the logical group were 23% (*SD*=.24), 14% (*SD*=.18), and 28% (*SD*=.29), respectively. A 3x2 mixed ANOVA with problem type (conflict/non-conflict/neutral) as a within-subjects factor and condition (intuitive/logical) as a between-subjects factor indicated a significant effect of problem type ($F(2, 120)= 4.04$, $p=.020$, $\eta_p^2=.06$), and a significant effect of condition ($F(1, 60)= 6.77$, $p=.012$, $\eta_p^2=.10$). The problem type by condition interaction was not significant ($p=.114$). That is, in general participants in the logical condition were more inclined to review base rates. Follow-up analyses also showed that participants were more likely to review base rate information if descriptions were not in line with base rates, regardless of whether descriptions were conflicting or neutral. Indeed, the tendency to review base rates did not differ between conflict and neutral problems.

Next we analyzed participants' liking ratings (see Table 2). In order to gather further support for the claim that participants were sensitive to the conflict between the descriptions and base rates, we compared their liking ratings for description-based (i.e., heuristic) responses across problems where base rates and descriptions were congruent (non-conflict), and where these were incongruent (conflict). A 2x2 mixed ANOVA with condition (intuitive/logical) as a between-subjects, and problem type (congruent / incongruent) as a within-subjects factor indicated a significant effect of problem type ($F(1, 60)= 5.95$, $p=.018$, $\eta_p^2=.09$). The effect of condition, and the condition by problem type interaction were not significant. That is, participants, regardless of condition, liked description-based responses more if these were not in conflict with base rates.

Another issue that we were interested in was whether participants' liking ratings were higher for heuristic responses than for non-heuristic responses. To investigate this question, we first collapsed ratings across *conflict* and *neutral* problems. As we described in the introduction, in the case of both types of task there is a general tendency for participants to disregard base rates. This is assumed to be the consequence of an automatic (i.e., heuristic) tendency to generate responses that correspond to (or take into account) the descriptions (cf. Kahneman & Frederick, 2005).

The average ratings for heuristic and base rate responses in the intuitive condition were *M*=3.17 (*S*D=.51) and *M*=2.96 (*SD*=.63), respectively. The corresponding ratings in the logical condition were *M*=3.58 (*SD*=.60) for heuristic, and *M*=2.82 (*SD*=.78) for base rate responses. In line with our predictions, a 2x2 mixed ANOVA with response type (heuristic/base rate) as a within-subjects and condition (intuitive/logical) as a between-subjects factor indicated that participants liked heuristic responses more than base rate responses ($F(1, 60)= 19.80$, $p<.001$, $\eta_p^2=.25$). Additionally, there was a significant interaction between response type and condition ($F(1, 60)= 6.32$, $p=.015$, $\eta_p^2=.10$). Interestingly, this interaction showed that there was a greater difference between ratings for heuristic and base rate responses in the case of participants in the logical as compared to the intuitive condition. That is, participants who invested more time and effort into providing their liking ratings were more biased by the descriptions. Nevertheless, participants in both conditions provided higher liking ratings for responses which are supposed to be based on heuristic (i.e., Type 1) processing than for non-heuristic (i.e., Type 2) responses.

Finally, we wanted to investigate how closely the liking ratings were related to participants' actual response choices in the second part of the experiment (this analysis was conducted at the level of tasks; see Figure 1). The correlation between liking ratings and the probability that a participant selected a given response was significant both in the intuitive ($r(384)=.20$, $p<.001$) and in the logical condition ($r(360)=.38$, $p<.001$), and the association was significantly stronger in the logical condition, as indicated by a Fisher *r*-to-*z* transformation ($z=2.67$, $p=.008$).

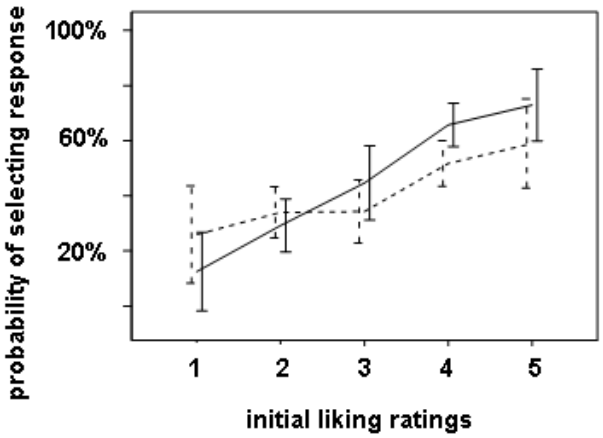


Figure 1: The probability of selecting a response as a function of liking ratings in the two conditions (broken line: intuitive condition).

Discussion

In the present study we employed a new method (asking for liking ratings) to investigate the cognitive underpinnings of performance on engineers and lawyers-type problems. Liking ratings can be used to investigate both conscious and unconscious preferences, and they are very sensitive to subtle changes in participants' judgments.

Arguably, the most interesting finding is that although participants' probability judgments were biased by the person's description both in the intuitive and in the logical condition, this bias was stronger in the logical group. This is in contrast with earlier studies which generally reported a decrease in biases as a result of logical instructions (e.g., Chiesi et al., 2011; Ferreira et al, 2006). This finding is also in contrast with the assumption that in heuristics and biases tasks people automatically generate an initial heuristic response, which is either accepted without modification, or it is suppressed by conscious and effortful reasoning (e.g., Evans, 2006). Instead, it seems that, at least in the case of the engineers and lawyers problem, although most people show an initial (weak) preference for heuristic responses, this preference becomes significantly stronger when they invest more time and effort in the evaluation of the response options.

Indeed, a similar pattern has been observed in the case of the Wason selection task, using eye tracking methods (Ball, Lucas, Miles & Gale, 2003). In the selection task people tend to focus on a response (usually the one, which is considered the intuitive response) almost immediately after they are presented with the options, but then they spend a longer period considering this response before making their eventual choice. This pattern has been cited as evidence that although Type 2 processes are employed in the selection task, they are merely used to rationalize an initial, Type 1 response (Evans, 2006). Nevertheless, there is evidence that people do engage in a conscious reasoning process when they make their choices in the selection task, although this does not necessarily result in finding the normative solution (cf., Handley, Newstead & Neilens, 2011). Indeed, spending more time on evaluating a compelling response option might increase reasoners' confidence in the correctness of the response (see e.g., Thompson & Morsanyi, 2012).

The increased bias in the logical condition suggests that conscious reasoning processes play an active role in the engineers and lawyers problem. Instead of just approving intuitive response tendencies, they magnify the initial bias. Indeed, this process might involve the active rejection of base rates as a potential basis of judgment. In fact, participants not only rated the responses which corresponded to base rates lower than the responses which were in line with the descriptions, but their ratings for base rate responses were also slightly negative.

With regard to conflict detection, our results support earlier findings (e.g., de Neys & Glumicic, 2008) which suggested that participants experience a conflict when base rates and the description of the person cue different responses. However, we should note that providing a neutral description resulted in similar levels of base rate-inspection as providing base rate-incongruent descriptions. Thus, base rate inspection could be taken as a sign of uncertainty or decreased processing fluency, rather than of "conflict detection". As we found no evidence for a difference between the intuitive and logical groups in "conflict detection" (as indexed by reviewing base rates, and the difference between liking ratings for description-based responses in conflict and non-conflict problems), it remains unclear if participants are conscious of the conflict. We could expect that offering a response which corresponds to the base rates in a conflict task makes base rate information more salient. Nevertheless, participants' evaluations of these options were slightly negative, which indicates that even if they were aware of the potential significance of base rates (and the conflict between base rates and descriptions), they still preferred to base their judgments on the descriptions. Thus, it is unlikely that the reason that only a small minority of participants give normative responses to the engineers and lawyers problem is that participants only detect the conflict unconsciously, and, as a result, their conscious responses remain unaffected by this.

As expected (cf., Thompson & Morsanyi, 2012), heuristic responses were liked more than probability-based responses. This corresponds to the general pattern that most participants select or generate a heuristic response when they are presented with the engineers and lawyers problem (see e.g., De Neys & Glumicic, 2008; Kahneman & Tversky, 1973). This pattern is also in line with the idea that heuristic processing is associated with positive affect, and this affective component might contribute to participants' tendency to accept these responses. Indeed, initial liking ratings were significantly related to participants' response choices. The finding that this relationship was stronger in the logical group suggests that these participants indeed considered the options more carefully than participants in the intuitive condition (given that response choices in the second part of the study were based on careful consideration).

Although affective reactions might contribute to both liking ratings and response choices, it is also possible that the liking ratings were unrelated to participants' affective states, and participants simply indicated with their liking ratings the extent to which they found a particular response correct or appropriate. Other studies (e.g., Topolinski & Strack, 2009b: Morsanyi & Handley, 2012) demonstrated through effective priming and emotion-misattribution manipulations that liking ratings are sensitive to participants' affective states. Nevertheless, future studies should seek to provide more direct evidence for the link between affect, liking ratings, and heuristic responses. One method which seems particularly suitable would be to measure the activation of facial muscles which are associated with smiling and frowning, using electromyography (see Topolinski, Likowski, Weyers, & Strack, 2009), while participants evaluate heuristic and non-heuristic response options.

In summary, our findings provide new insight into the cognitive processes involved in the engineers and lawyers problem. Most importantly, these results indicate that conscious thinking might contribute to the biases often observed in judgment and reasoning. Indeed, there is a growing body of evidence to indicate that responses which are assumed to be based on heuristic or automatic (i.e., Type 1) processing often require cognitive effort. Generating these responses might even be more effortful than producing other responses, which traditional dual-process approaches associated with effortful, Type 2 processing (see e.g., Handley, Newstead & Trippas, 2011; Morsanyi & Handley, 2008). These findings, together with criticism which is based on more theoretical considerations (e.g., Keren & Schul, 2009; Osman & Stavy, 2006), pose a challenge to dual-process theories of reasoning.

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