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Using metacognitive cues to infer others' thinking

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Abstract

Three studies tested whether people use cues about the way other people think—for example, whether others respond fast vs. slow—to infer what responses other people might give to reasoning problems. People who solve reasoning problems using deliberative thinking have better insight than intuitive problem-solvers into the responses that other people might give to the same problems. Presumably because deliberative responders think of intuitive responses before they think of deliberative responses, they are aware that others might respond intuitively, particularly in circumstances that hinder deliberative thinking (e.g., fast responding). Intuitive responders, on the other hand, are less aware of alternative responses to theirs, so they infer that other people respond as they do, regardless of the way others respond.

Keywords: deliberation, intuition, dual-process models, metacognition, projection.

1 Introduction

Dual-process models propose that two different modes of thinking—intuitive vs. deliberative—govern our reasoning, judgment and decision-making (e.g., Evans, 2006; Kahneman & Frederick, 2002; Stanovich, 1999). Intuition is thought to be fast, effortless, and largely automatic, whereas deliberation operates in a slower, more effortful, and controlled fashion. Because deliberation is slower than intuition, the deliberative response might only come to mind after one has already contemplated the intuitive response. This creates an asymmetry between deliberative and intuitive responders: as the deliberative solution might come to mind only after one has already considered the intuitive solution, deliberative responders are likely to be aware of both solutions, whereas intuitive responders should be less aware of other response alternatives. Mata, Ferreira, and Sherman (2013) demonstrated this metacognitive asymmetry. In their studies, subjects solved reasoning and judgment problems where deliberative reasoning and intuition were in conflict, that is, they suggested different solutions. Here is an example taken from the Cognitive Reflection Test (CRT; Frederick, 2005):

> A bat and a ball together cost 110 cents. The bat costs 100 cents more than the ball. How much does the ball cost?

The answer "10 cents" often comes to mind. This initial intuition is, however, incorrect. The correct answer is 5 cents, but coming up with that answer requires second-guessing one's initial intuition and engaging in additional deliberative reasoning. Mata et al. (2013) found that people who give the correct answer often consider the intuitive solution before coming to the deliberative solution. Therefore, they are aware that there are two possible solutions: an intuitive but incorrect solution, and a correct one that demands deliberation. Those who give the incorrect response, however, are generally not aware that there is an alternative response. Therefore, deliberative responders have a metacognitive advantage over their intuitive peers.

In this paper, we explore whether deliberative responders put this metacognitive advantage to use in social inference. More specifically, we tested whether deliberative responders pick up on cues that signal deliberative thinking (or lack thereof) in the way other people respond to infer what those people might respond to reasoning problems. If they themselves needed some time to come up with their response and did not respond with the first thing that came to their mind, and presumably if this took some effort, then deliberative responders might infer that others also respond deliberatively/correctly vs. intuitively/incorrectly 1) if others respond slowly vs. quickly; 2) if they know that others have first considered giving one response but then changed their minds and opted for a different response, instead of responding with the first thing that came to their mind; 3) if others are under conditions that make it possible for them to think carefully about a problem, as opposed to being mentally busy doing another task; or 4) if those other people usually like to think carefully about things, instead of trusting their gut feelings. All these variables—response time, cogni-

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tive load, second-guessing one's responses, and thinking disposition (i.e., need for cognition vs. faith in intuition)—are known to affect performance in reasoning tasks where deliberation and intuition are in conflict (e.g., De Neys, 2006; Shiloh, Salton, & Sharabi, 2002).

This research adds to what Mata et al. (2013) showed in several respects. First, the research by Mata et al. focused on people's confidence in their reasoning abilities. This research tests social inference, that is, how people infer what other people think at a given moment. Note that it is one thing to be aware of alternative, possible responses, as observed by Mata et al., and a different thing to infer whether a specific other person would give those responses or not in a specific situation. The latter calls for the ability to assess the other person and how she responded, and then use this assessment to select which of the response alternatives she might give. It could be that deliberative thinkers always infer that others will give the incorrect alternative responses, regardless of the way others respond, especially if they think that they are better than others (Alicke & Govorun, 2005), or that others are usually flawed in their thinking (Mata, Fiedler, Ferreira, & Almeida, 2013; Pronin, Lin, & Ross, 2002). Indeed, in previous research where no cues were given about other people's thinking (Mata et al., 2013), deliberative responders in general expected others to respond incorrectly. Would deliberative responders have the same pessimistic expectations about others if they saw signs of deliberation in others' thinking? Another contribution of this research consists of establishing the role of people's own reasoning in their metacognition about others' reasoning. Even though the metacognitive advantage shown in the original confidence studies of Mata et al. was presumed to result from deliberative responders having considered the intuitive solution first and only then coming up with a different solution, this link was not tested in that research. The present research tests whether people's abilities to infer what others think relates to how much they themselves experienced the same intuition as others.

We expected deliberative responders to use those cues to infer what others might respond. Intuitive responders, on the other hand, are less likely to be explicitly aware of alternative responses (but see De Neys, 2012, in press, for evidence that they might nonetheless be sensitive to the existence of alternative responses at an implicit level). They tend to respond with the first thing that comes to mind and are less likely to consider other response alternatives (Mata et al., 2013). Therefore, we expected that cues that signal deliberation or conflict in thinking would be less informative for them. As they themselves tend to consider only one response (at least at an explicit level; see De Neys, 2012, in press), we expected that, when asked to make inferences about how other people might respond, they would simply project their responses onto others, a common strategy in social inference (Nickerson, 1999).

These predictions also follow from other recent research on metacognition. Alter, Oppenheimer, Epley, and Eyre (2007), as well as Thompson, Prowse Turner, Pennycook, and colleagues (Thompson, Prowse Turner, & Pennycook, 2011; Thompson et al., 2013) showed that the fluency of the intuitive response, that is, the ease and speed with which it comes to mind, influences one's feeling of rightness in one's initial intuition and, therefore, the need that one feels to engage in further deliberation and revise that initial answer. Indeed, if the intuitive response comes to their mind very quickly and with a strong feeling of rightness associated with it, then intuitive responders should not expect it to take a long time or a great amount of effort to respond correctly to the problem. As for deliberative responders, they too think of the intuitive solution first (Mata et al., 2013; Thompson et al., 2011, 2013). However, they manage to override their initial, potentially flawed intuition, and through slower and more effortful deliberative thinking, they then come to the alternative correct response. Therefore, they should be more attuned to the different conditions under which one is likely to respond correctly or incorrectly.

Recent research by Kupor, Tormala, Norton, and Rucker (2014) investigated the inferences that people make about the quality of other people's decisions depending on whether those others make their decisions in a thoughtful manner (i.e., thinking slowly and carefully vs. quickly) or not. That research showed that people consider other people's decisions to be better when the degree of thoughtfulness that goes into their decisions is aligned with the perceived difficulty of the task at hand (e.g., they judge others' decisions to be better when other people are thoughtful and the task is perceived to be difficult). There are several important differences between that research and the present one. First, in the studies by Kupor et al., similar predictions were made for all subjects. Our hypothesis, on the other hand, relates the inferences that people make about others' thinking to *their own* thinking, such that deliberative responders and intuitive responders are expected to make different inferences. The calibration hypothesis of Kupor et al. and our hypothesis are compatible in the sense that, if people perceive the task to be demanding, they think that thoughtful reasoning is more appropriate. However, according to our hypothesis, perceived difficulty is not just a function of the task, but it is also related to perceivers' own thinking, such that deliberative perceivers might be more sensitive to the difficulty of conflict problems, whereas intuitive perceivers might not so easily realize that those problems are difficult and, therefore, that thoughtful deliberation is required to solve them. One more difference is that, in the present studies, subjects were asked to infer the responses that other people might give, whereas in the studies by Kupor et al.

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subjects were asked to assess the quality of others' decisions, not guess what those decisions were. Therefore, people's social-inference skills were truly put to the test in the present research.

In order to test whether deliberative responders discriminate between deliberative and intuitive responders, subjects in Studies 1 and 2 made guesses about other people and we varied within subjects whether the cues about the way those other people responded suggested the deliberative or the intuitive responses.

It is important to note that, even though we have been referring to deliberative vs. intuitive responders, we are not necessarily referring to individual differences, but rather to whether someone responds intuitively or deliberatively to a certain problem. The same person might respond intuitively to one problem and deliberatively to another problem. To test whether the metacognitive asymmetry really depends on the mode of thinking that one uses at a certain time, rather than on individual differences whereby some people are consistently better at both reasoning and social inference, we tested whether *the same* subjects were more or less likely to consider alternative responses (Study 1), and were better or worse at guessing others' responses (Studies 1 and 2), as a function of whether they solved some problems deliberatively or intuitively.

Finally, Study 3 provided a different test of how sensitive deliberative and intuitive responders are to metacognitive cues: subjects were asked to infer the conditions under which another person is likely to come up with correct responses. Specifically, whereas in Studies 1 and 2 subjects were asked to infer, for instance, whether someone who had responded quickly or slowly would respond correctly or incorrectly, in Study 3 they were asked to infer whether someone would respond quickly or slowly in order to respond correctly.

2 Study 1

In the first study, subjects were given descriptions of other people's thinking that varied in the dimensions discussed in the introduction—response time, cognitive load, second-guessing one's responses, and thinking disposition—and they were asked to guess what those people would respond to reasoning problems. We expected deliberative responders to be better than intuitive responders at using those cues to infer what others might respond.

Furthermore, we expected this asymmetry in inferential ability to relate to subjects' consideration of alternative responses when trying to come up with their own response. The metacognitive advantage investigated by Mata et al. (2013) was hypothesized to originate in the fact that deliberative responders experience the same intuition as others. Study 1 directly tested this hypothesis. In order to assess whether considering the alternative response has an effect on subjects' ability to infer others' responses, we asked them whether they had answered with the first thing that came to their mind or whether they had considered a different answer before coming up with their final answer. Moreover, we manipulated the likelihood of subjects considering alternative responses by having subjects solve problems where the deliberative and intuitive solutions were different (conflict problems), as well as problems where these solutions were the same (no-conflict problems). First, we expected consideration of alternative responses to be higher for deliberative responders than for intuitive responders in conflict problems, but not in no-conflict problems. Second, if consideration of alternative responses is related to the ability to infer others' responses, we expected deliberative responders to show better inferential skills than intuitive responders in conflict problems, but not in no-conflict problems.

2.1 Method

Subjects. Eighty subjects were recruited through Amazon's Mechanical Turk; eighty-one ended up participating.[1] Subjects were located in the United States and were required to have an approval rate in previous assignments of at least 95%. Subjects received 0.4 US dollars.

Procedure. Subjects were informed that they would see four questions and that they were to predict the answer of a different person to each of them based on some information that they would receive about these other people.

There were four CRT-type problems (three problems adapted[2] from Frederick, 2005, and a new one of the same kind; see Appendix). For each of them, subjects were asked to guess how a specific person, identified by a frequent American first name (an equal number of male and female names were used), might respond. To avoid transfer of inferences about specific other people across problems, a different name was used for each problem. Each problem was presented together with a description of how the person had thought about the response or what his or her usual thinking style is. These cues could either indicate that it was more likely that that specific person would give the intuitive response (e.g. "*Emily is a person who usually follows her gut feelings and does not like to think things through. How did Emily respond?*"), or the deliberative one (e.g. "*John did not respond immediately. He took quite some time to think about his answer before he*

[1] One subject did not sign up for compensation and was therefore not registered on Mechanical Turk as having taken part in the study.

[2] The contents of the CRT problems were changed so that subjects would not be able to look up the answers on the Internet (see Goodman, Cryder, & Cheema, 2013).

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Table 1: Means (and SDs) for correct cue usage by type of problem (conflict or no-conflict), type of cue and number of correct responses given to the conflict problems in Study 1.

		N of correct responses		
Type of problem	Type of cue	0	1	2
Conflict	Deliberative	0.00 (0.00)	0.34 (0.48)	0.77 (0.43)
	Intuitive	0.79 (0.42)	0.78 (0.42)	0.73 (0.45)
No-conflict	Deliberative	0.89 (0.32)	0.88 (0.34)	0.87 (0.35)
	Intuitive	0.74 (0.45)	0.75 (0.44)	0.80 (0.41)

responded. How did John respond?"). The question implied that subjects shoud enter the actual answer (rather than characterize it).

There were four types of cues, one for each problem (each specific problem in the CRT was always paired with the same type of cue for all subjects, but this pairing was determined in a random manner), pertaining to the following variables: response time; cognitive load; responding with the first solution that comes to mind versus second-guessing that first solution and considering alternatives; and whether the other person's thinking disposition is higher in need for cognition or in faith in intuition (see Appendix). Of the four cues that were used for the four problems, two suggested that the other person would give the deliberative response and the other two suggested the intuitive response. Whether for a certain problem the cue suggested the deliberative or intuitive response was counterbalanced between subjects, such that, for instance, some subjects read that the other person had responded quickly to a problem, whereas other subjects read that this other person had responded slowly to that same problem.

For each problem, after inferring the other person's response, subjects were asked to provide their own response. The two tasks—inferring the other person's response and providing one's own response—were completed on separate pages. Instructions made it clear that their response could be the same as the one they guessed the other person might give, or different.

After providing their guess and their own response to a problem, subjects were asked whether or not they had considered an alternative response. Specifically, they were asked to what extent they agreed (from 1: *not at all*, to 9: *very much*) with the sentences "*I answered with the first thing that came to my mind and didn't think of another answer*" and "*I considered a different answer before coming up with my final answer*". They were also asked: "*If you did consider another answer, which was it?*" and "*Can you think of an answer, different from the one you gave, that you think other people might give?*"

Of the four problems, two were presented in a conflict version where the intuitive and the deliberative solutions were different, and the other two were presented in a no-conflict version where those solutions coincided. The version of the problems was counterbalanced between subjects. The order in which the four problems were presented was randomized for each subject.

2.2 Results

For conflict problems, reasoning performance (i.e., the number of subjects' own correct responses) was positively correlated with the use of the cues provided to make correct guesses about others' responses (i.e., the number of problems for which subjects made guesses about others' responses in the theoretically expected direction,[3]) r = .40,[4] $p < .001$. However, this was the case only when the cues suggested deliberation, $r = .60$, $p < .001$, not when they suggested intuition, $r = -.05$, $p = .63$. A measure of discrimination was computed by subtracting the number of conflict problems for which subjects predicted that others would respond correctly when the cues suggested that others had used deliberative reasoning from the number of problems for which subjects predicted that others would respond correctly when the cues pointed to intuition. Reasoning performance was positively correlated with this discrimination score, $r = .52$, $p < .001$. In the no-conflict problems, reasoning performance (i.e., the CRT score for conflict problems) was unrelated to use of either type of cue, rs < .06, ps > .594. This pattern of results (see Table 1) yields a three-way interaction of performance,

[3] In line with what previous research (e.g., De Neys, 2006; Shiloh et al, 2002) shows about how the presented cue variables influence performance on conflict reasoning problems, inferences for conflict problems were scored as correct when they predicted incorrect responses from intuitive cues (responding quickly, being mentally busy with another task and therefore not being able to devote one's full attention to the problem, only considering one response and not second-guessing it, and following one's gut feelings instead of thinking things through) and correct responses from deliberative cues (taking some time to respond, being able to devote one's full attention to the problem, second-guessing one's first response and considering alternative responses, and thinking things through instead of following one's gut feelings).

[4] Subjects were the unit of analysis in all correlations.

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type of problem and type of cue, $F(2, 78) = 10.64$, $p < .001$.

Reasoning performance (i.e., conflict CRT score) correlates positively with the degree to which subjects considered alternative responses (aggregating the scores on the two scales asking whether subjects had considered another solution before responding or whether they had responded with the first solution that came to their mind) for conflict problems, $r = .40$, $p < .001$, but not for no-conflict problems, $r = -.08$, $p = .500$. For instance, subjects who responded correctly to both conflict problems were more likely to consider alternative responses than subjects who were consistently incorrect for conflict problems, $M = 4.96$, $SD = 2.56$ vs. $M = 2.25$, $SD = 1.47$, $t(46.69) = 4.69$, $p < .001$, but not for no-conflict problems, $M = 2.21$, $SD = 1.87$ vs. $M = 2.43$, $SD = 1.53$, $t < 1$. In conflict problems, most correct responders (52%–78% across problems) indicated 1) that they had considered an alternative solution before coming to their final response, and 2) that they could think of an answer, different from the one that they gave, which other people might give (62%–100%). For both questions, the alternative that most correct responders indicated was the intuitive response. Most incorrect responders, however, did not indicate alternative responses for either question 1 (0%–25%) or 2 (0%–28%).

The previous analyses involved between-subjects differences. To test whether the same subjects showed different inferential skills and were more or less likely to consider alternative responses as a function of whether they responded correctly or incorrectly to those problems, we considered those subjects who responded correctly to one of the conflict problems and incorrectly to the other. These subjects were better at using cues to infer others' responses to conflict problems when their own response was correct, $M = 0.75$, $SD = 0.44$, than when their response was incorrect, $M = 0.38$, $SD = 0.49$, paired $t(31) = 3.48$, $p = .002$, $d = 1.25$. And they were more likely to consider an alternative response (the aggregated scores mentioned in the previous paragraph) when responding correctly than when they responded incorrectly to conflict problems, $M = 5.73$, $SD = 2.92$ vs. $M = 3.17$, $SD = 2.46$, paired $t(31) = 4.95$, $p < .001$, $d = 1.78$.

To test whether, for conflict problems, considering the alternative response mediated the effect of performance (the accuracy of one's own responses) on the use of cues to infer others' responses (all three variables correlate with each other, rs > .339, ps < . 002), a mediation analysis was conducted following the guidelines of Preacher and Hayes (2008). Using the bootstrapping SPSS syntax provided by those authors (5000 resamples), the 95% confidence interval was [0.005, 0.198], consistent with mediation.[5]

[5]The four relevant coefficients are: $\beta_{X\to Y} = .40$, $p < .001$; $\beta_{X\to M} = .40$, $p < .001$; $\beta_{M(X)\to Y} = .21$, $p = .058$; $\beta_{X(M)\to Y} = .31$, $p = .006$. (Y is the dependent variable, X is the predictor, M is the mediator, and parentheses indicate that a variable is included in the regression model.)

2.3 Discussion

Deliberative responders[6] to a given problem were better than intuitive responders at predicting when other people might respond correctly, as they themselves did, and when others might respond incorrectly, differently from them. Critically, this insight into others' thinking was related to how much they themselves considered giving the alternative response before they came to their final solution. In this regard, Study 1 establishes the role of people's own reasoning in their metacognition about others' reasoning.

3 Study 2

In Study 1, subjects were asked to make specific predictions about the responses that other people might give to reasoning problems. That study showed that when subjects themselves give deliberative responses, but not intuitive ones, to those same reasoning problems, they use cues about the way others respond to successfully infer intuitive or deliberative responses that are in line with those cues. However, because intuitive responders do not know the correct response, it is impossible for them to predict that someone would give that response rather than the one they gave when given the deliberative cues. But this does not necessarily mean that intuitive responders would not be sensitive to the cues and that they would not be able to discriminate whether someone would respond correctly or incorrectly based on those cues. To address this question, in Study 2, instead of predicting the actual answers that other people would give, subjects were simply asked to predict whether other people would respond correctly or incorrectly. If intuitive responders are sensitive to cues about others' thinking, then they should be able to use those cues to predict whether others respond correctly or incorrectly, even if they do not know what the correct response is.

Another potential limitation of Study 1 concerns the way in which cue information was presented. It is possible that pragmatic demands played a role in subjects' interpretation of the task (Hilton, 1995). Specifically, as cues were presented as a contrast between two ways of responding (e.g., "*John responded very quickly, almost immediately, instead of taking the time to think about his answer*"), due to conversational norms (Grice, 1975), subjects may assume that they should make use of that information. Would subjects pick up on the cues and make good use of them if the cues simply designated the way

[6]Supporting the assumption that correct responding in the CRT is associated with deliberative thinking, Cokely and Kelley (2009) found that CRT performance is positively related, for instance, to the number of considerations made during an independent decision-making task.

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Table 2: Mean (and SD) number of guesses that others would respond correctly by type of cue and number of correct responses given in Study 2.

Type of cue	N of correct responses				
	0	1	2	3	4
Deliberative	1.58 (0.52)	1.55 (0.69)	1.42 (0.67)	1.75 (0.50)	1.82 (0.41)
Intuitive	1.50 (0.67)	1.27 (0.65)	1.17 (0.84)	0.50 (1.00)	0.64 (0.51)

in which the other person thought about the problem and responded to it, without the benefit of the counterfactual about how he or she could have done so differently (e.g., simply indicating that "*John responded very quickly, almost immediately",* without adding "*instead of taking the time to think about his answer*")? In Study 2, we minimized these potential demand characteristics in the cue-descriptive sentences.

3.1 Method

Subjects. Fifty subjects were recruited through Amazon's Mechanical Turk using the same criteria as in Study 1.

Procedure. As in Study 1, subjects were asked to predict how others would respond to reasoning problems and then they were asked to provide their own answers. However, unlike Study 1, subjects were simply asked to guess if the others responded correctly or incorrectly, instead of predicting the actual response that they thought the others would give. Furthermore, the cue information provided only deliberative- or intuitive-suggestive information instead of a contrast between the two (e.g. "*Emily is a person who usually follows her gut feelings. How did Emily respond?*" or "*John took quite some time to think about his answer before he responded. How did John respond?*"; see Appendix).

All 4 problems were presented in their conflict versions. Presentation order was randomized. The pairings of CRT problems and types of cues were the same as those used in Study 1. Two problems were paired with intuitive cues and the other two with deliberative cues, counterbalanced between subjects.

3.2 Results

A measure of discrimination was computed by subtracting the number of problems for which subjects predicted that others would respond correctly when the cues suggested that others deliberated from the number of problems for which subjects predicted that others would respond correctly when the cues suggested that others had relied on intuition. Reasoning performance (i.e., CRT score) is positively correlated with this discrimination score, $r = .41$, $p = .003$. Subjects who responded incorrectly to most problems tended to judge that other people would respond correctly regardless of whether the cues pointed to deliberation or intuition (for subjects who responded incorrectly to all problems, $t < 1$). On the other hand, subjects who responded correctly to most problems judged that others would respond correctly when the cues suggested deliberation, but they predicted that others would respond incorrectly when the cues suggested intuition (for subjects who responded correctly to all problems, $t(10) = 5.22$, $p < .001$, $d = 1.58$; see Table 2).

In the within-subjects analysis for subjects who gave both correct and incorrect answers, when these subjects were given cues suggesting intuition, they tended to make more accurate predictions about the other person's response when they themselves responded correctly to the same problem than when they responded incorrectly, $M = 0.67$, $SD = 0.49$ vs. $M = 0.33$, $SD = 0.49$, paired $t(14) = 2.09$, $p = .055$, $d = 0.54$. When cues pointed to deliberation, no such difference was found, $M = 0.28$, $SD = 0.46$ vs. $M = 0.11$, $SD = 0.32$, paired $t(14) = 1.37$, $p = .187$, $d = 0.33$.

3.3 Discussion

Study 2 showed that the metacognitive asymmetry that was found in Study 1—the fact that deliberative responders were better than intuitive responders at using metacognitive cues to infer others' thinking—was not a result of subjects being asked to predict *what* (i.e., concrete responses) other people might respond. Indeed, when in Study 2 subjects were asked to predict *how* (i.e., correctly or incorrectly) other people might respond, intuitive responders again proved to be unskilled at inferring others' reasoning performance. They were as likely to predict that others would respond correctly regardless of whether the way in which the other person responded suggested intuitive or deliberative thinking.

Study 2 also showed that deliberative responders are able to make use of simpler, more impoverished cues than those used in Study 1. They were able to pick up on the fact that, if someone responded in a certain way, for instance quickly, then it is likely that his response was incor-

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rect. They did not need to be made aware of the contrast between the way the other person responded and how they could have responded (e.g., quickly vs. slowly).

4 Study 3

Studies 1 and 2 tested whether people infer whether other people respond correctly or incorrectly on the basis of information about the conditions in which those other people respond. Inverting the logic of the previous studies, Study 3 tests whether subjects infer the conditions in which those other people responded (i.e., the information that served as cues in the previous studies) when provided with information about the correctness of the responses given by those other people. Specifically, subjects were asked to judge how much time someone would need in order to respond correctly to the same problems that were used in Studies 1 and 2. Thus, this third study provided yet another test of whether deliberative responders are more sensitive than intuitive responders to metacognitive cues—this time by asking them to predict the cues from the responses, rather than the other way around.

Furthermore, just as in Study 1, both conflict and no-conflict versions of the problems were used. This enabled us to further test whether intuitive responders are insensitive to the different demands of conflict and no-conflict problems, which would help explain the results of Studies 1 and 2. Indeed, one reason why intuitive responders might be less able to use metacognitive cues that suggest deliberative vs. intuitive solutions to conflict problems is that they may not be as sensitive as deliberative responders to the conflict in the problems, and therefore to the difference between conflict and no-conflict problems. That is, if a tricky conflict problem is not interpreted as being especially tricky or hard, then why should a person think that it would take time for someone else to respond correctly to that problem? Thus, the different sensitivity of deliberative and intuitive responders to metacognitive cues about others' thinking might be related to the difference between these different kinds of responders in how much they are able to discriminate between conflict and no-conflict versions of the problems. We predicted that intuitive responders would be less sensitive than deliberative responders to the time demand differences between conflict and no-conflict problems.

4.1 Method

Subjects. Fifty subjects were recruited through Amazon's Mechanical Turk using the same criteria as in Studies 1 and 2.

Procedure. Subjects were informed that they would see four questions and that they were to judge how much time a person would need to correctly answer those questions.

The same four CRT-type problems used in the previous studies were used in Study 3. Subjects saw one problem at a time. For each problem, after reading the premises, subjects were asked: "*How much time does a person need to answer this question correctly?*", to which they responded on a scale from 1 ("Very little time") to 9 ("A considerable amount of time"). For each problem, after judging the time that is necessary to answer it correctly, subjects were asked to provide their own response.

Of the four problems, two were presented in their conflict version and the other two were presented in their no-conflict version, counterbalanced between subjects. The order in which the four problems were presented was randomized for each subject.

Table 3: Mean (and SD) estimated time required for others to respond correctly by type of problem (conflict or no-conflict) and number of correct responses given to the conflict problems in Study 3.

	N of correct responses		
Type of problem	0	1	2
Conflict	3.14 (1.72)	3.00 (1.90)	3.93 (1.31)
No-Conflict	2.62 (1.82)	2.25 (1.33)	1.86 (0.99)

4.2 Results

To test the hypothesis that incorrect responders are less sensitive than correct responders to the time demand differences between conflict and no-conflict problems, a discrimination measure was computed by subtracting the average time that subjects estimated the other person would take in order to respond correctly to no-conflict problems from the average time that they estimated the other person would take in order to respond correctly to conflict problems. Subjects with better performance on conflict problems were also better at discriminating between the demands of conflict and no-conflict problems, $r = .33$, $p = .020$ (see Table 3). Whereas subjects who responded correctly to all conflict problems estimated that significantly more time was necessary to respond correctly to conflict problems than to respond correctly to no-conflict problems, paired $t(6) = 3.77$, $p = .009$, $d = 2.13$, this difference was smaller and not quite significant for those who responded incorrectly to all conflict problems, paired $t(24) = 1.82$, $p = .081$, $d = 0.37$.

In the within-subjects analysis for subjects who responded correctly to one of the conflict problems and incorrectly to the other, there were no differences in their predictions of the time necessary to respond correctly to

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conflict problems as a function of whether they gave correct versus incorrect responses to those problems, $t < 1$.

4.3 Discussion

Compared to responders who solve conflict problems correctly, incorrect responders are less aware of the difference in how demanding conflict and no-conflict problems are. These results help explain the advantage that correct responders had over incorrect responders in the previous studies with regard to their use of cues to infer other people's reasoning. If incorrect responders are less sensitive to the difference in demands between conflict and no-conflict problems, then they should be less able to discriminate between different responses (correct vs. incorrect) that someone else might give as a function of whether that someone's thinking met the demands of a specific problem or not.

5 General discussion

For problems where intuition and deliberation are in conflict, deliberative responders have a better insight than intuitive responders about the reasoning of other people. Previous research had already shown that deliberative responders are aware of alternative intuitive responses (Mata et al., 2013), but it did not test whether they infer whether others respond deliberatively or intuitively from the way others respond. These results indicate that they do.

The hypotheses were, first, that deliberative responders would share other people's intuition and consider the alternative response before thinking of the deliberative response; and second, that this would help them infer what other people might respond to reasoning conflict problems depending on whether others' thought process showed signs of also having considered alternative responses, or certain attributes that are favorable to deliberation (e.g., considerable time to think) that their own thought process had.

With regard to the first hypothesis, deliberative responders in general proved to be aware of the intuitive response alternatives when asked to estimate what other people might respond under circumstances that do not favor deliberation, and they often indicated that they themselves had considered the intuitive solution before coming to the deliberative response (Study 1).

Second, deliberative responders were generally able to infer whether others might respond deliberatively/correctly or intuitively/incorrectly depending on whether the way those other people had thought about the problem showed characteristics of deliberation or intuition (Studies 1 and 2). Likewise, they were able to infer whether other people's thinking might have shown characteristics of deliberation or intuition (e.g., slow vs. fast responding) when informed about the accuracy of those other people's responses (Study 3). The inferences that deliberative responders made about others were in line with what previous research shows about how the cue variables that were used—response time, cognitive load, second-guessing the solutions that first come to mind, thinking disposition—influence performance on conflict reasoning problems (e.g., De Neys, 2006; Shiloh et al, 2002).

In Study 1, intuitive responders might appear to have been skilled at using cues to infer others' responses when those cues suggested intuition, but note that mere projection of one's responses onto others (see Nickerson, 1999) would lead to the same seemingly sound inferences. Indeed, when the cues pointed to the deliberative responses, they also expected that others would respond intuitively as they did. Deliberative responders, on the other hand, adjusted their inferences depending on the kinds of cues they were given about others' thinking. Critically, they did not project their responses when the cues suggested that others might respond intuitively.

There is no reason to believe that deliberative responders have some special social inference ability that intuitive responders lack. Presumably, it is simply that intuitive responders base their inferences on wrong assumptions about the problems, failing to recognize their tricky nature (Study 3). Indeed, if they perceive a problem to be easy, then why would they estimate that others would need a long time to solve it? Consistent with the notion that there is no special inferential skill differentiating deliberative and intuitive responders, we found differences in inferential ability in the same individuals across different problems as a function of whether they succeeded or failed to solve the problems (in Studies 1 and 2, although not in Study 3). Thus, intuitive responders probably do not lack metacognition, but rather make misinformed inferences. However, further research exploring the relations between judgment and decision making skills and metacognition is needed (but see Ghazal, Cokely, & Garcia-Retamero, 2014).

The fact that intuitive responders do not believe that deliberative thinking is important (at least, not as much as deliberative responders do) is consistent with Stanovich and West's demonstration that people's own thinking agrees with their beliefs about how they ought to think, as measured by the Actively Open-Minded Thinking Scale (Stanovich & West, 1997; West, Toplak, & Stanovich, 2008; see also Baron, 1995). Moreover, the link between thinking in a deliberative manner and being able to infer others' thinking ties nicely with the hypothesis that people exert epistemic vigilance toward others' thinking (Sperber et al., 2010). People who are more prone to deliberate could have an advantage over people who do so less be-

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cause they can better predict how others will respond in different situations and whether or not others' reasoning is biased. One might even speculate about the reverse causality, whereby the ability to deliberate and think carefully might be fostered by one's experience in thinking about other's thinking and exercising vigilance towards potential biases of others (Mata, Fiedler, Ferreira, & Almeida, 2013).

Our results seem to suggest that only deliberative responders are sensitive to the conflict in classic reasoning problems and to the existence of alternative responses to these problems. In Study 1, for instance, when asked whether they had considered alternative responses, consistently correct responders discriminated between conflict and for no-conflict problems, indicating more awareness of alternative responses for conflict than for no-conflict problems, paired $t(29) = 5.90$, $p < .001$, whereas consistently incorrect responders did not discriminate between the different kinds of problems, $t < 1$. However, research by De Neys and colleagues (see De Neys, 2012, in press, for reviews) shows that intuitive responders might nonetheless be sensitive to the existence of alternative responses to the ones they give and to the intuitive/deliberative conflict in reasoning problems. This discrepancy might be due to the explicit nature of the measures used in our studies, which differs from the implicit measures used in De Neys' research. It might be that only deliberative responders are able to explicitly identify the alternatives, but intuitive responders are nonetheless sensitive to their existence, even though they cannot name them (see De Neys & Glumicic, 2008). Still, the results of the present studies concerning inferences about others' responses also seem to argue against the possibility of intuitive responders being sensitive to the conflict posed by the problems in those studies, as they were equally likely to infer that other people would respond correctly to a problem regardless of whether those other people responded quickly, a condition that hinders accurate responding to conflict problems, or slowly, a condition that fosters accurate responding to conflict problems (note that Study 2 did not require intuitive responders to explicitly mention alternative responses; simply that they estimated whether a correct or incorrect solution was likely to follow from, for instance, fast vs. slow responding to conflict problems); and in Study 3, intuitive responders were again somewhat insensitive to differences between conflict and no-conflict problems, when they were asked to estimate how much time was necessary for people to respond correctly to them. However, one should distinguish between social and intra-individual metacognition. Those measures referred to inferences about others' thinking. Even though intuitive responders have less explicit insight about other people's reasoning, as shown in the present studies, that does not necessarily imply that they have no insight into their own reasoning. We also note that our failure to find significant discrimination in intuitive responders might just have resulted from insufficient power to detect a small effect. Still, our findings have potential implications concerning people's ability to learn and how they manage their thinking efforts when trying to solve problems. Even if they have been taught, and know how to use, the reasoning rules that are necessary to solve certain problems correctly, people may nonetheless fail to apply those rules if they do not recognize that the problems call for deliberative reasoning (what Kahneman & Tversky, 1982, called errors of application).

Finally, one of the key predictions of the metacognitive asymmetry model (Mata et al., 2013) is that deliberative responders' ability to infer what goes on in the minds of others relates to what goes on inside their own minds. Specifically, deliberative responders' inferences about how other people might respond are presumably influenced by how much they themselves considered giving the intuitive responses. This link between one's own thinking and *social metacognition* (i.e., thinking about others' thinking; see Jost, Kruglanski, & Nelson, 1998) was, however, not directly established in previous research. Study 1 tested this hypothesis by measuring subjects' awareness of alternative responses and to what extent they themselves considered giving those responses at first, as well as by manipulating whether or not the problems posed a conflict between intuition and deliberation. As expected, the sound inferences made by deliberative responders were related to their having considered the alternative intuitive response. The asymmetry in inferential performance between intuitive and deliberative responders was observed only for conflict problems, for which intuitive and deliberative responders experienced different levels of considering alternative responses. Furthermore, subjects' consideration of alternative responses mediated the effect that their reasoning had on their inferences about others' responses. Therefore, Study 1 adds to our understanding of the metacognitive advantage investigated by Mata et al. by showing that the sound inferences made by deliberative responders are at least partly based on the very same thought process that they go through when trying to come up with their own responses. It is presumably because they themselves first experience the same intuition as others but then override it and come up with a different answer, that they are able to infer what others might respond. Therefore, we think that the good inferential skills of deliberative thinkers are not a result of their deliberative thinking mode alone, but of the fact that they are aware of two solutions that were suggested by two different modes of thinking. In this sense, one potential implication of these results is that accurate social metacognition requires both intuition and deliberation.

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Appendix: Problems used in all studies and cues used in Studies 1 and 2

Bat and ball problem / Cue: Response time

Conflict version: A TV and a DVD together cost 88 dollars. The TV costs 80 dollars more than the DVD. How much does the DVD cost?

No-conflict version: A TV and a DVD together cost 88 dollars. The TV costs 80 dollars. How much does the DVD cost?

Deliberative cue / Study 1: John did not respond immediately. He took quite some time to think about his answer before he responded. How did John respond?

Deliberative cue / Study 2: John took quite some time to think about his answer before he responded. How did John respond?

Intuitive cue / Study 1: John responded very quickly, almost immediately, instead of taking the time to think about his answer. How did John respond?

Intuitive cue / Study 2: John responded very quickly, almost immediately. How did John respond?

Widgets problem / Cue: Cognitive load

Conflict version: If it takes 10 hens 10 days to lay 10 eggs, how long would it take 100 hens to lay 100 eggs?

No-conflict version: If 5 hens lay 5 eggs in one day, how many eggs would 100 hens lay in one day?

Deliberative cue / Study 1: As Mary was answering this, there was nothing else on her mind distracting her or preventing her from devoting her full attention and thinking to answering this problem. How did the Mary respond?

Deliberative cue / Study 2: As Mary was answering this, she devoted her full attention and thinking to answering this problem. How did the Mary respond?

Intuitive cue / Study 1: At the time Mary was answering this, she was mentally busy with another task and therefore she could not devote all of her attention and thinking to answering this problem. How did Mary respond?

Intuitive cue / Study 2: At the time Mary was answering this, she was mentally busy with another task. How did Mary respond?

Lake problem / Cue: Second-guessing one's first solution and considering alternatives

Conflict version: A computer virus is spreading through the system of a computer. Every minute, the number of infected files doubles. If it takes 100 minutes for the virus to infect all of the system, how long would it take for the virus to infect half of the system?

No-conflict version: A computer virus is spreading through the system of a computer. Every minute, one file gets infected. If it takes 100 minutes for the virus to infect all of the system, how long would it take for the virus to infect half of the system?

Deliberative cue / Study 1: James at first thought of answering one thing, but then changed his mind and ended up giving another answer, instead of saying the first thing that came to his mind. What was the answer that he ended up giving?

Deliberative cue / Study 2: James at first thought of answering one thing, but then changed his mind and ended up giving another answer. How did James respond?

Intuitive cue / Study 1: James only considered giving one answer. At no time did he change his mind or even thought of giving another answer. What was his response?

Intuitive cue / Study 2: James only considered giving one answer to this problem. How did James respond?

Divide problem / Cue: Need for cognition vs. faith in intuition

Conflict version: Divide 40 by 1/2 and add 5. What is the end result?

No-conflict version: Divide 40 by 2 and add 5. What is the end result?

Deliberative cue / Study 1: Emily is a person who usually likes to think things through instead of following her gut feelings. How did Emily respond?

Deliberative cue / Study 2: Emily is a person who usually likes to think things through. How did Emily respond?

Intuitive cue / Study 1: Emily is a person who usually follows her gut feelings and does not like to think things through. How did Emily respond?

Intuitive cue / Study 2: Emily is a person who usually follows her gut feelings. How did Emily respond?