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RESEARCH REPORT

Conflict and Bias in Heuristic Judgment

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Conflict has been hypothesized to play a key role in recruiting deliberative processing in reasoning and judgment tasks. This claim suggests that changing the task so as to add incorrect heuristic responses that conflict with existing heuristic responses can make individuals less likely to respond heuristically and can increase response accuracy. We tested this prediction in experiments involving judgments of argument strength and word frequency, and found that participants are more likely to avoid heuristic bias and respond correctly in settings with 2 incorrect heuristic response options compared with similar settings with only 1 heuristic response option. Our results provide strong evidence for conflict as a mechanism influencing the interaction between heuristic and deliberative thought, and illustrate how accuracy can be increased through simple changes to the response sets offered to participants.

Keywords: conflict, dual processes, judgment, reasoning

Heuristic (Type I) processes play a key role in reasoning and judgment (Epstein, 1994; Evans, 2006; Kahneman, 2003; Sloman, 1996; Stanovich & West, 2000). These processes are activated automatically, and engaged without considerable cognitive oversight, making them both easy to use and difficult to avoid. Although the use of Type I processes is often desirable, these processes can occasionally lead to logical fallacies, errors in probability judgment, and other types of biases. In these settings individuals need to rely on additional, deliberative reasoning strategies, which involve increased attention to task-relevant information, more detailed processing of this information, and, often, the suppression of automatic response tendencies. For this reason, this type of reasoning is often considered to be performed by a second set of (Type II) processes; processes that are slower to activate, and whose application is effortful and requires cognitive control (see Evans, 2003 and Evans & Frankish, 2009, for a review).

What are the contextual determinants of Type II engagement? When are individuals most likely to reason deliberatively, avoid bias, and respond accurately? It is here that scholars have suggested the importance of response conflict (De Neys, 2012; Evans, 2007; Pennycook et al., 2014; Pennycook, Fugelsang, & Koehler, 2015; Thompson, Prowse Turner, & Pennycook, 2011). Particularly, in reasoning and judgment tasks in which the components of the task generate multiple response tendencies, the conflict between these responses, and the subsequent detection of this conflict, has been hypothesized to trigger Type II processing. This type of processing, once engaged, attempts to resolve the conflict, and select one of the initially activated responses, or, in certain settings, selects an alternate nonactivated response.

Conflict is an important metacognitive variable, and has been shown to be involved in recruiting top-down control in low-level psychological domains. It is thus not unlikely that conflict plays a similar role in high-level reasoning and judgment. Indeed, there is growing evidence that suggests that Type II engagement is in fact more likely in tasks that are high in conflict. For example, judgments take longer in tasks involving conflicting responses (Bonner & Newell, 2010; De Neys & Glumicic, 2008; Pennycook, Fugelsang, & Koehler, 2012). These tasks also lead to the activation of brain areas associated with conflict detection (De Neys, Vartanian, & Goel, 2008) and stronger feelings of metacognitive difficulty (Thompson et al., 2011; Thompson & Johnson, 2014). Likewise, cognitive load has been shown to have a stronger influence on responses in settings with conflict compared with those without response conflict (De Neys, 2006a, 2006b). Similar results have also been established using eye-tracking, verbal protocols, recall, and postchoice confidence ratings (see, e.g., De Neys, 2012 and 2014 or Pennycook et al., 2015 for an overview).

The above tests rely on measures other than participant responses. However, the hypothesis that conflict triggers Type II processing also makes strong predictions regarding response accuracy. Particularly, in settings involving an incorrect heuristic response and a correct nonheuristic response, changing the response set so as to add an additional incorrect heuristic response option should lead to increased conflict and subsequently increased Type II processing. This should make the individual more likely to select the nonheuristic response, and thus solve the reasoning task correctly. In contrast, if the response set does not induce conflict, or if conflict does not trigger Type II processing, then the presence of additional heuristic responses should make the decision maker more likely to respond heuristically and incorrectly. We study this prediction in the following experiments.

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Study 1A

We test for the effect of conflict on response accuracy using the inclusion-similarity effect in an argument strength task. As an example, consider the following question, adapted from Sloman (1996):

> Which of the following arguments are the most convincing?
>
> A: All birds have an ulnary artery, therefore all robins have an ulnary artery.
>
> B: All birds have an ulnary artery, therefore all penguins have an ulnary artery.
>
> C: All birds have an ulnary artery, therefore all ostriches have an ulnary artery.

When given questions like this, individuals are more likely to choose A, as robins are more similar to the prototypical bird than penguins or ostriches. This is a product of Type I processing, which often operates based on similarity and association and ignores the fact that robins, penguins, and ostriches all belong to the category of birds, and that all arguments should be seen as being maximally, and thus equally, convincing (see Sloman, 1996).

Now consider replacing C with the following:

> D: All birds have an ulnary artery, therefore all sparrows have an ulnary artery.

When individuals are given Arguments A, B, and C, there is only one heuristic response (Argument A). Here there is little conflict. When given A, B, and D, however, there is much more conflict: Both robins and sparrows are highly similar to the prototypical bird, and both A and D are compelling heuristic responses. If conflict does play a role in recruiting Type II processing then we should expect individuals to be more likely to use Type II processing when offered A, B, and D. Subsequently, they should be able to recognize instances of category membership, and state that all arguments are equally convincing, thereby avoiding the inclusion-similarity effect.

Method

Participants (n = 153; mean age = 24.63, 53% female) performed the above mentioned argument strength task for monetary compensation in a university laboratory in the United States. There were two conditions of interest. The first offered participants arguments A, B, and C (control condition), whereas the latter offered participants arguments A, B, and D (conflict condition). After seeing these arguments, participants in both conditions were asked to choose whether: 1. A is the most convincing; 2. B is the most convincing; 3. C/D is the most convincing; 4. A and B are equally convincing and more convincing than C/D; 5. A and C/D are equally convincing and more convincing than B; 6. B and C/D are equally convincing and more convincing than A; or 7. All arguments are equally convincing.[1]

Participants in Study 1A were divided into three groups. The first group was given the control condition and the second group was given the conflict condition. The remaining group was not given a reasoning task. Instead participants in this group were merely required to rate the similarity of the each of the four bird species used in this study to the "typical bird", on a scale of 1 to 100.

Results and Discussion

We first examined the similarity ratings of the bird species with the typical bird to verify our assumptions about the arguments that are most likely to be supported by Type I processing. We found that the robins and sparrows were considered to be more similar to the typical bird than penguins and ostriches ($\beta = 41.36$, $t = 14.84$, 95% CI[35.89, 46.86], $p < .01$), with mean similarity ratings of 88.85, 90.79, 45.26, and 51.56 for robins, sparrows, penguins, and ostriches. Given these differences, the conflict-based account of Type II engagement predicts that we should expect to observe a lower incidence of the inclusion-similarity effect in the conflict condition, where there are two conflicting heuristic arguments, than in control condition, where there is only one such argument. We found that this is indeed the case. Particularly, 67% of participants in the conflict condition stated that all arguments are equally convincing, the correct response, compared with 45% of participants in the control condition. When tested with a logistic regression this is a statistically significant difference ($\beta = 0.93$, $z = 2.27$, 95% CI[1.12, 1.73], $p < .05$), with an odds ratio of $OR = 2.53$.

This result is further illustrated in Figure 1, which also shows that most participants who did not respond correctly responded heuristically, by selecting either one or both of the arguments involving typical birds as being stronger. There were very few participants who believed that the arguments involving the atypical birds were stronger (which would have been an incorrect non-heuristic response). Overall the results of this study provide strong support for claim that conflict in a reasoning task recruits Type II processing, leading to fewer reasoning biases.

Studies 1B Through 1D

Studies 1B through 1D attempt to expand on the results of Study 1A, with additional controls and measures. In Study 1B we use the paradigm of Study 1A while also collecting response time data to measure the extent of Type II engagement. This type of data is necessary to test process-level predictions of the proposed mechanism, and considerable prior work has relied on response times to make inferences regarding Type II engagement (see De Neys, 2012 for a discussion). Overall, if conflict does lead to increased Type II engagement then we would expect longer response times when decision makers are given response sets with multiple conflicting heuristic responses relative to response sets with only one heuristic response.

Study 1C tests whether the conflict condition generates the metacognitive experiences typically associated with conflict. It uses a variant of the paradigm of Thompson et al. (2011) who find that conflict in reasoning and judgment tasks leads to reduced

[1] Although the three arguments used in the conflict condition are referred to as A, B, and D in this paper, in the experiment, they were referred to as A, B, and C. Additionally, the specific argument that was presented as A, B, or C was randomized in both conditions.

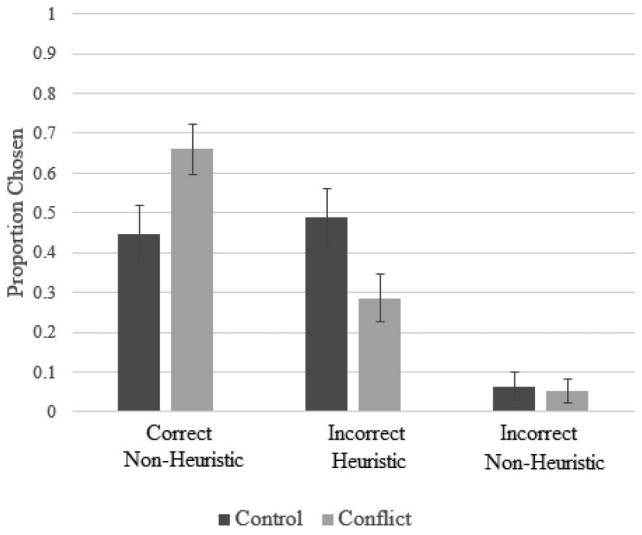

Figure 1. Proportion of participants who chose the correct response, the heuristic but incorrect responses, and the nonheuristic and incorrect responses in Study 1A. Error bars: ±1 *SE*.

self-reported "feeling of rightness" in the heuristic response (Thompson et al. hypothesize that this feeling of rightness is detected by a set of metacognitive processes involved in monitoring the decision, which then determine the allocation of attention, effort, and time, for the remainder of the decision). If increased Type II processing in Study 1A is attributable to increases in conflict, we would expect reductions in self-reported feelings of rightness for participants who select an incorrect heuristic response in the conflict condition, compared with those who select this response in the control condition.

Finally, Study 1D attempts to control for the effect of similarity on our results. The arguments that generate conflict in Study 1A are the ones in which the subordinate categories (robins and sparrows) are similar to the superordinate category (birds). However, we should expect these results to emerge even if Type I processing favors arguments in which subordinate categories are dissimilar to the superordinate categories. This would happen when individuals are asked to judge which of the available arguments are least convincing. In this setting, Type I processing would favor arguments involving penguins and ostriches (Arguments B and C), and conflict would be highest when participants are given the choice between Arguments A, B, and C, rather than A, B, and D. Examining this variant of the argument strength task would not only serve to replicate and extend the results of Study 1A, but would also check whether the results of this study only emerge because of judgments of similarity or are limited to the specific stimuli in Study 1A in some other sense.

Method

There were 151 participants (mean age = 22.11, 51% female) in Study 1B, 106 participants (mean age = 32.38, 37% female) in Study 1C, and 172 participants (mean age = 31.39, 31% female) in Study 1D. Participants in 1B were university students who took the test in a computer laboratory. Participants in 1C and 1D were recruited through Amazon Mechanical Turk and completed the study online. All participants were located in the United States, fluent in English, and given monetary compensation for participating.

All three studies were based on the design outlined in Study 1A.[2] Study 1B was based on a straightforward extension of Study 1A, with response time measures. Study 1C modified 1A with the design proposed by Thompson et al. (2011), in which participants in both the control condition (Arguments A, B, and C) and the conflict condition (Arguments A, B, and D) were asked to give their initial responses as quickly as possible. Because of the speed and primacy of heuristic processing, this response is likely to be the response favored by Type I processes; one that is not influenced by Type II control (Thompson et al., 2011). After providing this response, participants were asked to rate, on a scale of 1 to 100, how correct their response appeared to them (capturing the self-reported feeling of rightness studied in Thompson et al.'s work).

Study 1D also used the arguments in 1A, with half of the participants given Arguments A, B, and C, and half given Arguments A, B, and D. Participants were also however asked to either evaluate which of the arguments were the most convincing, or to evaluate which of the arguments were the least convincing. This is a 2 × 2 design (C vs. D and most vs. least), and the conflict-based account of Type II engagement would predict that participants who are given Argument D in the most condition (and thus have two typical birds in a setting where Type I processing supports typicality) or Argument C in the least condition (and thus have two atypial birds in a setting where Type I processing supports atypicality) should be more likely to recruit Type II processing and less likely to display the inclusion-similarity effect. Statistically, this amounts to an interaction.

Results

In Study 1B, 76% of participants in the conflict condition stated that all arguments are equally convincing, compared with 57% of participants in the control condition. This is a statistically significant ($\beta = 0.93$, $z = 2.27$, 95% CI[1.12, 1.73], $p < .05$) replication of Study 1A. Additionally, the mean response times were 27.42 seconds ($SD = 12.79$) in the conflict condition and 22.76 seconds ($SD = 15.32$) in the control condition. After taking a logarithmic transform of this data, to adjust for non-normality and outliers, we find that these differences are statistically significant ($\beta = 0.27$, $t = 3.24$, 95% CI[0.10, 0.44], $p < .01$). These differences also hold if participants giving correct responses and incorrect responses are analyzed separately ($p < .05$ for both subgroups). Additionally, a regression of log-response time on condition (conflict vs. control), accuracy (correct vs. incorrect), and the interaction between condition and accuracy, shows that there is a significant main effect of condition ($\beta = 0.39$, $t = 2.57$, 95% CI[0.09, 0.69], $p < .05$), but not accuracy ($p = .94$). The interaction is also nonsignificant ($p = .39$). These results are summarized in Figure 2.

As expected, participants in the conflict condition in Study 1C were not statistically more likely to give the correct response ($p = .30$) than participants in the control condition (however, they

[2] Except for the fact that they did not ask a third group of participants to rate bird similarities (i.e., all participants in these studies made judgments of argument strength).

did have a slightly higher response accuracy: 65% accuracy vs. 55% accuracy in the two conditions). Importantly, among the participants who selected one of the incorrect heuristic responses, we noted a significantly lower feeling of rightness if they were in the conflict condition ($M = 65.50$, $SD = 20.69$) compared with if they were in the control condition ($M = 78.79$, $SD = 19.48$) ($\beta = -13.29$, $z = -2.13$, 95% CI[−25.90, −1.68], $p < .05$). We also ran a variant of this analysis on the entirety of our dataset, with condition (conflict vs. control), accuracy (correct vs. incorrect), and the interaction between condition and accuracy, as independent variables. Again we found a significantly lower feeling of rightness in the conflict condition compared with the control condition ($\beta = -13.29$, $t = -2.38$, 95% CI[−24.36,-2.22], $p < .05$). There was no main effect of giving the correct response ($p = .24$), however there was a positive interaction between being in the conflict condition and giving the correct response ($\beta = 19.45$, $z = 2.27$, 95% CI[5.24,33.65], $p < .01$). The average feelings of rightness for the four types of participants in this study are summarized in Figure 3.

In Study 1D we found that a higher proportion of participants generated the correct response when they were provided with Argument D and asked to evaluate the most convincing argument (73%) compared with when they were provided with Argument C and asked to evaluate the most convincing argument (59%). In contrast, a higher proportion of participants generated the correct response when they were provided with Argument C and asked to evaluate the least convincing argument (86%) compared with when they were provided with Argument D and asked to evaluate the least convincing argument (69%). These results, shown in Figure 4, correspond to a statistically significant interaction effect ($\beta = 1.63$, $z = 2.25$, 95% CI[0.21, 3.04], $p < .05$).[3]

Discussion

Studies 1B through 1D replicate the finding of Study 1A, while also providing process-level evidence for the conflict-based account proposed in this paper. Particularly, Study 1B showed that decision makers take longer in the conflict condition, indicating that participants in this condition do experience increased Type II engagement. Additionally, Study 1C showed that the conflict condition leads to increased feelings of metacognitive difficulty in participants, suggesting that the Type II engagement observed in Study 1B can reasonably be attributed to increases in perceived conflict. Finally, Study 1D showed that the effect documented in Study 1A is robust to the framing of the task: Conflict leads to increased Type II processing and a higher probability of a correct response, both when it is generated by multiple typical categories in tasks asking participants to find the most convincing argument, and when it is generated by multiple atypical categories in tasks asking participants to find the least convincing argument.

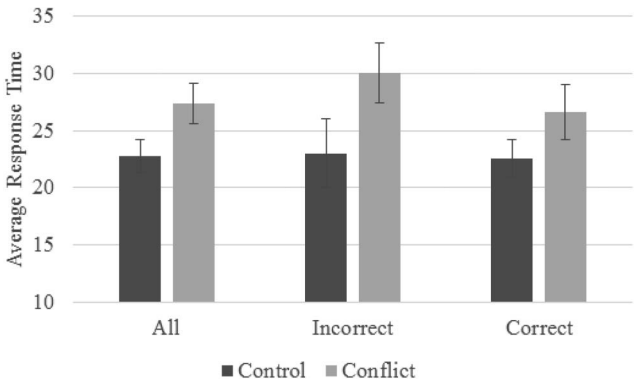

Figure 2. Average response times (seconds) in control and conflict conditions of Study 1B, for all participants, participants responding incorrectly, and participants responding correctly. Error bars: ±1 *SE*.

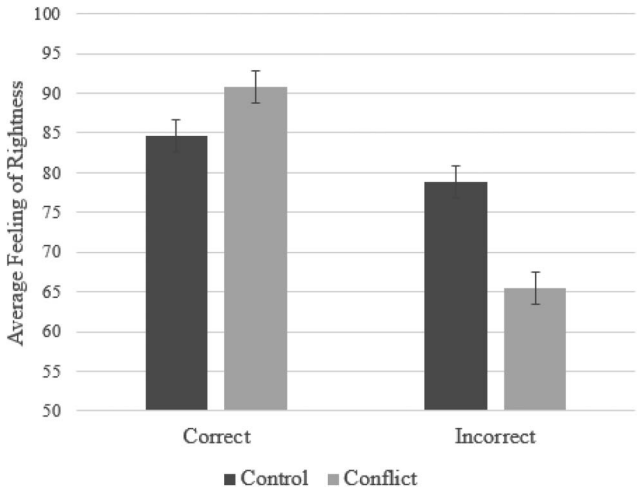

Figure 3. The average feeling of rightness in the control versus conflict condition when participants gave correct and incorrect responses, in Study 1C. Here participants were asked to respond as quickly as possible. Error bars: ±1 *SE*.

Study 2

Are the effects of conflict limited to the inclusion-similarity effect, or can conflict also influence accuracy in tasks other than those involving judgments of relative argument strength? Study 2 examines this by studying conflict in a fallacy involving judgments of frequency, associated with the availability heuristic (Tversky & Kahneman, 1973). Consider the following question:

> Which of the following is greater?
>
> A: The number of words in English whose third from last letter is "i."
>
> B: The number of words in English ending with "ive."
>
> C: The number of words in English ending with "ibe."

Any word that ends with "ive" or "ibe" must also have "i" as it's third from last letter. Thus regardless of the actual number of words in the English language with the endings listed here, quan-

[3] We also found that individuals were significantly more likely to give the correct response when they were asked to evaluate the least likely argument compared with the most likely argument ($\beta = -1.43$, $z = -2.73$, 95% CI[−2.46, −0.41], $p < .01$). This main effect of task framing suggests that the deliberative system is disproportionately more likely to be engaged when the heuristically compelling arguments involve dissimilar categories compared with similar categories.

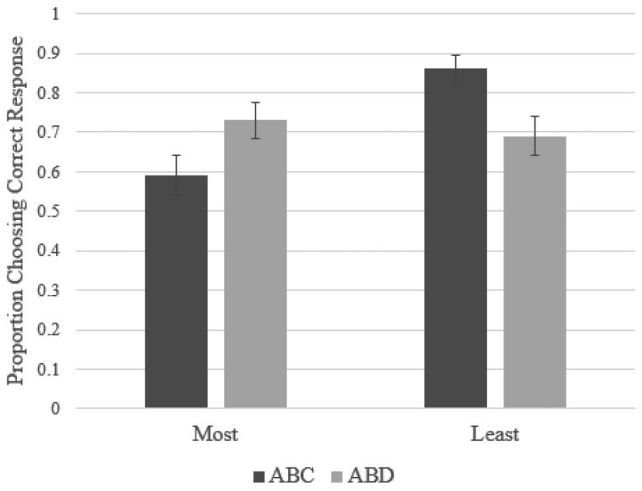

Figure 4. The interaction between the question ("which of the following is most/least convincing?") and the arguments (A, B, and C vs. A, B, and D) offered to the participants in Study 1D. Error bars: ±1 *SE*.

tity A must be the greatest. Previous work has however shown that individuals given similar questions often do not recognize this fact, and thus often fail to select A as their response. This is because examples of words that end with "ive" are highly accessible, and the use of the availability heuristic makes words with these endings appear more numerous to individuals than words with other endings (Tversky & Kahneman, 1973). Note that words ending with "ibe" are extremely rare, and the availability heuristic does not strongly support this response.

Now consider replacing response C with the following:

D: The number of words in English ending with "ize."

When individuals are given responses A, B, and C, only one response is supported by Type I processing (response B). When given A, B, and D, however, there is conflict, and both response B and response D are supported by Type I processing, as there are numerous examples of words that end with "ize" (as well as with "ive"). If conflict does play a role in recruiting Type II processing we would expect individuals to be more likely to choose the correct response when given quantity D compared with quantity C.

Method

Participants (n = 130; mean age = 33.31, 41% female) were recruited from Amazon Mechanical Turk. All participants were located in the United States and were fluent in English. Half of the participants in Study 2 were given responses A, B, and C (control condition), whereas the other half of participants were given responses A, B, and D (conflict condition). Participants in both conditions were asked to indicate which response was associated with the larger quantity.

Results and Discussion

Sixty-two percent of participants in the conflict condition were able to give the correct response, compared with only 39% of participants in the control condition. This is a statistically significant difference ($\beta = 0.94$, $z = 2.61$, 95% CI[0.24,1.64], $p < .01$), with an odds ratio of $OR = 2.56$. Additionally, as in previous studies, we found that most of the participants who responded incorrectly chose one of the heuristic responses. These response patterns are illustrated in Figure 5. Overall, Study 2 found that individuals are significantly more likely to recognize instances of category membership in the presence of multiple conflicting heuristic responses. This reduces their reliance on the availability heuristic, generating increased accuracy in Tversky and Kahneman's (1973) word frequency task. These results show that the phenomenon outlined in Studies 1A through 1D is extendable to novel tasks, and that it is not limited to the inclusion-similarity effect in judgments of relative argument strength.

General Discussion

A number of researchers have suggested that the presence of conflicting response tendencies signals the need for Type II processing (De Neys, 2012; Evans, 2007; Pennycook et al., 2014, 2015; Thompson et al., 2011). This claim makes simple but powerful predictions regarding response accuracy: Changing the reasoning task so as to add additional incorrect heuristic responses should trigger conflict, generating increased Type II processing, and making the individual more likely to response correctly and avoid bias. We tested this prediction and found that individuals are indeed more likely to be correct in argument strength tasks (Sloman, 1996) with two incorrect conflicting heuristic arguments compared with similar tasks with only one heuristic argument. Moreover, conflict conditions were associated with increases in response time and reduced feelings of rightness in the heuristic response. We also observed this effect in a different type of task, involving judgments of word frequencies (Tversky & Kahneman, 1973). These results provide strong support for conflict as a mechanism involved in recruiting Type II processing.

Most existing work has attempted to manipulate Type I/II processing using either explicit changes to the information in choice

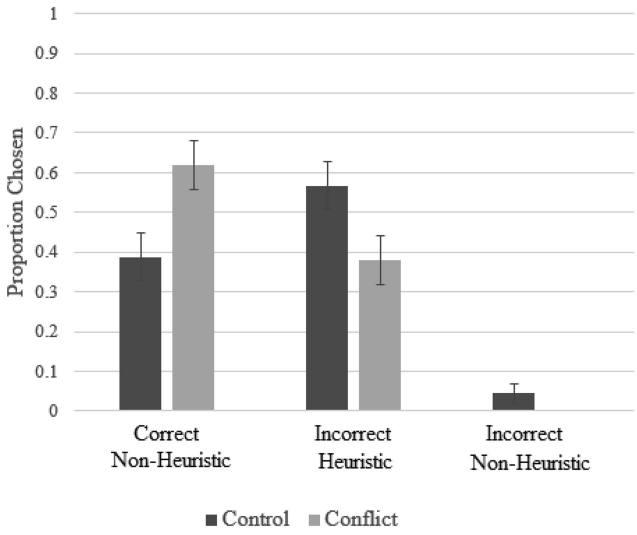

Figure 5. Proportion of participants who chose the correct response, the heuristic but incorrect response, and the nonheuristic and incorrect response in Study 2. Error bars: ±1 *SE*.

problem (e.g., base rates that are congruent or incongruent with descriptions), explicit changes to the presentation of the choice problem (e.g., problems in easy or hard to read fonts), or else explicit changes to incentives, instructions, working memory load or other features of the task. Our results, in contrast, show that Type II processing can be manipulated using just changes in the response set: Keeping all else constant, response sets with multiple heuristic responses generate increased conflict and thus increased Type II processing.

This result has a number of important theoretical implications. First, it illustrates the adaptive relationship between the content of the judgment and reasoning task and the mechanisms used by individuals to solve the task. In settings where heuristics cannot guarantee a correct response (that is, when multiple responses are supported by Type I processing), individuals are more likely think deliberatively and engage more sophisticated Type II processes. Similar findings have been documented in judgment and decision making research (e.g., Payne, Bettman, & Johnson, 1993). This result also suggests that accuracy is not necessarily reduced when additional, compelling but incorrect responses are offered to participants, as would be expected if Type II engagement was insensitive to the contents of the response set. The fact that it is possible to observe the opposite relationship—increased accuracy with more heuristic responses—suggests that the processes involved in judgment and reasoning interact in complex ways with the task at hand.

On a practical level, the results in this paper showcase a simple approach to debiasing individuals and improving the quality of reasoning and judgment processes. The dual process theories considered in this paper have already been used to develop psychological and behavioral interventions for improving accuracy, however much of this work involves heavy handed manipulations, such as explicit instructions to adopt a certain reasoning strategy, or even actual training in statistical reasoning (see Milkman, Chugh, & Bazerman, 2009 for a discussion). Our findings suggest that in some settings it could be possible to increase accuracy through more subtle changes to the decision task. For example, instead of explicitly asking decision makers to consider category-membership relations while evaluating arguments, it could be possible to increase the salience of these relations by adding additional responses with heuristically compelling categories. Of course there are many settings in which such manipulations are unlikely to be effective, and testing the bounds of this approach is an important topic of future work.

It is useful to note that a case has been made for correct nonheuristic responses being activated automatically at the start of the reasoning task (De Neys, 2012). Indeed, much of the existing work on conflict referenced in this paper studies conflict between correct nonheuristic responses and incorrect heuristic responses. This paper instead focuses on conflict between two incorrect heuristic responses. As heuristic responses are more salient, conflict between heuristic responses is likely more compelling, and a stronger signal for the need for Type II processing. Future work should however attempt to test whether the results documented in this paper extend to settings involving only conflict between a heuristic and a nonheuristic response. This would also shed light on the precise mechanisms involved in conflict detection in judgment and reasoning tasks, the ways in which these mechanisms signal the need for Type II processing, and settings in which Type II engagement can fail to correct the initial heuristic bias.

Relatedly, the argument strength and word frequency tasks used in this paper require the processing of category-membership relations. In contrast, most tasks used to study conflict involve probabilistic rules such as base-rates. Category-membership tasks are especially desirable for studying the engagement of Type II processing as there is a logically correct response whose justification is clear once category-membership relations have been recognized. This implies that the biases generated by Type I processing can be corrected with sufficient attention to the properties of the responses in question. Additionally, it is possible to add additional responses to the set of responses presented in these tasks, or to modify existing responses, without changing the correct response (e.g., that "all arguments are equally convincing"). This makes these tasks particularly useful for examining the effect of changes to the response set on the individual's beliefs and behavior, which, is the main goal of this paper. With that in mind, it may be possible to generate variants of other tasks, such as base-rate tasks, to rigorously test the effect of conflict on response accuracy. This should be attempted in future work.

Finally, although this paper has adopted a dual-process perspective on reasoning and judgment, many of the insights of this paper would apply even in the absence of a strict dichotomy between Type I and Type II processing. For example, conflict could lead to increased attention to task-relevant information even if the processes underlying this type of attention were conceptualized as being on a continuum with heuristic response tendencies, or else as being one of three or more distinct types of systems at play in judgment (see Evans & Stanovich, 2013). Regardless of these interpretations, it is clear that conflict plays an important role in increasing response accuracy through increased deliberation, and for this reason it is a key metacognitive variable with important consequences for judgment and reasoning accuracy.

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