

The effect of consensuality on metacognitive judgments in syllogistic reasoning

Igor Bajšanski^{1*}, Maja Močibob¹, Pavle Valerjev²

¹Department of psychology, Faculty of Humanities and Social Sciences, Rijeka, Croatia

²University of Zadar, Department of Psychology, Zadar, Croatia

*sibajsan@ffri.hr

Abstract

The aim of this study was to examine the relation of the consensuality of answers in syllogistic reasoning problems to metacognitive judgments and response times. In two experiments, participants (N=126) solved syllogistic problems and made metacognitive judgments (judgment of confidence in the correctness of the answer and judgment of task difficulty), after or before solving each problem. Intraindividual correlation coefficients (Goodman-Kruskal gamma coefficient) between reasoning accuracy and metacognitive judgments and between answer consensuality and metacognitive judgments were computed from the joint data of both experiments. Mean gamma coefficients were higher for consensuality than for reasoning accuracy both for judgments of confidence and judgments of task difficulty. Also, consensual answers were given more quickly than non-consensual answers. The results indicate that reasoners, instead of monitoring their actual performance, seem to rely on different type of cues while making metacognitive judgments in syllogistic reasoning. Both consensuality and its relation to metacognitive judgments could be the outcome of processes of the generation of possible answers while solving syllogistic reasoning problems.

Keywords: metacognition; syllogistic reasoning; judgment accuracy

Introduction

Metacognitive processes of monitoring and control have been extensively studied in the domain of memory (Dunlosky & Bjork, 2008). It has been recognized that it is important to expand the study of metacognition to other domains of cognition, in particular to the psychology of reasoning (Thompson, 2009; Thompson, Prowse Turner, & Pennycook, 2011).

According to a theoretical framework proposed by Nelson and Narens (1990), people make various metacognitive judgments when they attempt to monitor and control their own memory, such as judgments of learning and confidence judgments. The relationship between these judgments and performance can be determined in two ways (Koriat, 2007). Absolute accuracy (or calibration) is the degree to which the mean value of judgments corresponds to the mean actual performance, and relative accuracy is measured by the within-subject correlation between judgments and performance, typically measured by the Goodman-Kruskal gamma coefficient (Nelson, 1984). Accuracy of metacognitive judgments in the domain of reasoning can be determined in a similar way. Furthermore, research on metacognitive monitoring in reasoning should study problems such as whether confidence is correlated to performance, the accuracy of reasoners' metacognitive

judgments, the ability of reasoners to discriminate tasks which they solved correctly from those which they solved incorrectly, and the relation of the accuracy of their metacognitive judgments to reasoning ability.

Several studies have addressed the role of metacognition in syllogistic reasoning. In particular, these studies had examined the relationship between confidence judgments and reasoning accuracy (Prowse Turner & Thompson, 2009; Shynkaruk & Thompson, 2006). The results showed that reasoning accuracy and confidence were generally not correlated, and that confidence and accuracy were mediated by different variables.

In this paper we will present additional analyses of our previously published results (Bajšanski, Močibob & Valerjev, 2014, Experiments 2 and 3). In this study we analyzed the accuracy of metacognitive judgments in syllogistic reasoning. The most important result of our investigation was the low absolute and relative accuracy of these judgments. Participants were overconfident and metacognitive judgments generally were not correlated to reasoning accuracy. Therefore, reasoning accuracy and metacognitive judgments are influenced by different factors. What is under question here are the sources on which reasoners base their judgments, if the accuracy of responses is not the source.

According to cue utilization approach to metacognitive judgments in a domain of memory (Koriat, 1997), metacognitive judgments are based on various cues which differ in their validity, or relation to actual performance. Some of these cues are processing fluency, accessibility, familiarity of retrieval cues and ease of retrieval. To the extent to which the cues are related to actual memory performance, metacognitive judgments will also be accurate.

Thompson et al. (2011) identified three types of cues which can determine metacognitive judgments in reasoning tasks (feeling of rightness): answer fluency (the ease with which the initial conclusion comes to mind), conclusion acceptance and conflicting answers. Fluent answers, accepted answers and non-conflicting answers should be assigned higher confidence ratings.

Koriat (2008) reported correlation between consensuality and confidence in answering general-information questions. Consensuality is defined as the percentage of participants who endorse a particular answer. Consensual answers (answers endorsed by most participants) are assigned higher confidence ratings than non-consensual answers. Koriat proposed that two potential cues – decision time and self-

consistency – are related to both consensuality and confidence.

Data on the consensuality of answers in syllogistic reasoning problems (conclusions accepted by most participants for each syllogism) are available in a meta-analytic study on syllogistic reasoning by Khemlani & Johnson-Laird (2012). In line with this aforementioned analysis, we hypothesize that answer fluency should be related both to metacognitive judgments and the consensuality of answers in syllogistic reasoning. The first relationship is based on a large body of data indicating that fluency of processing is related to metacognitive judgments in various domains (Thompson, 2009). As for the second proposed relationship, it is based only on tentative evidence. First, Koriat (2008) found that in answering general-information questions, consensual answers are reached faster than non-consensual answers. Second, we compared one-model and multiple-model syllogisms (Bara, Bucciarelli, & Johnson-Laird, 1995) for percentages of consensual conclusions reported by Khemlani and Johnson-Laird, and it was revealed that these percentages were higher for one-model than for multiple-model syllogisms. One-model syllogisms are also processed more rapidly (more fluently) than multiple-model syllogisms (Bucciarelli & Johnson-Laird, 1999). However, the possible relationship between consensuality of conclusions and their response latencies should be studied more systematically.

The aim of the analyses presented here was to further explore the basis of metacognitive judgments in syllogistic reasoning, following the hypothesis that metacognitive judgments should be related to the consensuality of answers. Consensual answers are expected to be associated with higher metacognitive judgments than non consensual answers. They are also expected to be processed faster than non consensual answers.

Method

Participants and design

A total of 126 psychology students participated in two experiments. Participants solved syllogistic problems and made different metacognitive judgments. In Experiment 1 (N=64), participants made judgments after solving each reasoning problem and in Experiment 2 (N=62) participants made judgments after a quick overview of each problem before solving it. Half of the participants in each experiment rated their performance (E1: *how confident they are they solved the task correctly*; E2: *how confident they are they will provide the correct answer*) and the other half of the participants rated the perceived difficulty of the task. The ratings were given on a 7-point scale (1- not confident at all/not difficult at all, 7-extremely confident/very difficult).

Materials and procedure

Twenty four syllogistic problems (sixteen valid and eight invalid) were used in this study. Problems included

syllogisms of all four different figures and of different degrees of difficulty.

In each trial, participants were shown two premises containing professions as A, B and C terms. The premises were followed by five possible answers (four conclusion statements and a “no valid conclusion” option) and participants had to choose the answer that logically followed the given premises or to select a “no valid conclusion” option if they thought it was impossible to deduce a logically valid conclusion from the given premises.

The experiments were programmed and run using E-prime. Participants were tested individually. The instructions were presented on a computer screen and were followed by two practice problems. Each participant was then presented with 24 randomly ordered tasks. Participants were asked to make a metacognitive rating after solving each reasoning problem (E1) or before solving each problem (E2), and also by pressing the corresponding key. There was no set time limit for giving the answers and ratings.

Results and discussion

The data from both experiments were combined and analyzed jointly. In order to examine the basis of metacognitive judgments in syllogistic reasoning for each participant, we computed two intraindividual correlation coefficients. First, the Goodman-Kruskal gamma coefficient was computed between reasoning accuracy and metacognitive judgments. Second, the gamma coefficient was computed between answer consensuality and metacognitive judgments. Consensual answers were assigned a value of 1, and non-consensual a value of 0. This method of coding was implemented because it allowed us to compare gamma coefficients calculated for accuracy and consensuality.

Two two-way repeated measures ANOVAs were conducted, first for judgments of performance, and second, for judgments of difficulty. In both ANOVAs there were two independent variables: type of relation (gamma correlation between judgments and accuracy and gamma correlation between judgments and consensuality) and judgment phase (before or after answering).

First, for judgments of performance, a significant main effect of relation type was obtained ($F_{1,60} = 31.05, p < .001$): mean gamma coefficients were higher for consensuality ($M = .40, SEM = .05$) than for reasoning accuracy ($M = .10, SEM = .06$). The effect of judgment phase and interaction effect were not significant ($F_{1,60} = 0.08, F_{1,60} = 2.37$, respectively).

Second, for judgments of difficulty a significant main effect of relation type was obtained ($F_{1,60} = 22.61, p < .001$): mean gamma coefficients were higher for consensuality ($M = .32, SEM = .05$) than for reasoning accuracy ($M = .07, SEM = .05$). The effect of judgment phase was not significant ($F_{1,60} = 0.14$), and interaction effect was marginally significant ($F_{1,60} = 3.71, p = .06$).

Third, the response times differed for problems in which participants gave consensual answers and problems in which they gave non-consensual answers. Consensual answers were given more quickly than non-consensual, both in Experiment 1 ($t_{63} = 7.53, p < .001$; Consensual: $M = 23.88s, SD = 8.30$; Non-consensual: $M = 31.27s, SD = 13.06$) and Experiment 2 ($t_{60} = 6.95, p < .001$; Consensual $M = 15.35s, SD = 9.35$, Non-consensual $M = 21.00s, SD = 11.77$).

The results clearly point to the conclusion that while making metacognitive judgments reasoners do not monitor their actual reasoning performance, but they rely on different type of cues. However, they cannot base their judgments on consensuality itself, because they do not know what the typical answers given by other participants in the studies of syllogistic reasoning are. The consensuality of answers, as well as its relation to metacognitive judgments and to response times, is probably the outcome of the processes of the generation of possible answers during syllogistic reasoning. Problems that seem to the reasoner to have more than one possible solution will be perceived as more difficult and will be associated with lower confidence judgments. However, in such a situation it is probable that a greater number of different responses will be generated by different participants, therefore increasing the number of participants who choose a non-consensual answer. Problems that bring to mind a single solution will be perceived as easy, non-conflicting problems, and they will also lead a majority of participants to endorse a consensual answer. It is important to notice that these solutions are often not the correct ones in syllogistic tasks. Furthermore, we propose that consensual answers are the ones which come to mind first, even for syllogistic problems which elicit many different responses, and are therefore likely to be assigned higher metacognitive judgments. This hypothesis should be tested in further studies.

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