

Getting Insight by Talking to Others – Or Loosing Insight by Talking Too Much?

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Abstract

The purpose of the present study was to investigate the effects of addressee of verbalization, self or other, on insight problem solving. Thirty-five participants were assigned to one of the three conditions: toward-self verbalization, toward-other verbalization, or irrelevant verbalization (control). A 3-minute verbalization phase was inserted after 5 minutes of solving the T-puzzle. The participants were asked to write down their thoughts during the first 5 minutes as a record in the toward-self verbalization condition, and as an instruction for other participants in the toward-other verbalization condition. The participants in the control condition were required to write down their concerns. After that, they were asked to engage in the puzzle again for 10 minutes. The results showed a detrimental verbalization effect while allowed a wide range of effects for the self vs other distinction going in either direction. We are using this study as a basis for a pre-registered report.

Keywords: insight problem solving; verbalization; self vs other; metacognitive monitoring

Introduction

Collaboration is ubiquitous in our daily life. Previous studies have shown that collaboration facilitates problem solving (Miyake, 1986; Okada & Simon, 1997; Shirouzu, Miyake, & Masukawa, 2002). Specifically, collaboration is effective in solving problems when novel ideas or perspectives are needed. Insight problems are a typical example of this sort of problem. Since most studies have addressed whether or not collaboration can facilitate problem solving, little is known about why collaboration has facilitative effects on problem solving. By identifying the factors causing the facilitative effects of collaboration on problem solving, we may be able to collaborate with others more effectively.

Diversity of background knowledge is assumed to be one of the most important factors causing the facilitative effects of collaboration on problem solving (Surowiecki, 2005). This hypothesis posits that people can make use of more diverse knowledge when working together. If the diversity of background knowledge was the only factor, then the facilitative effects of collaboration on problem solving would not be obtained when members have the same knowledge bases. Collaboration, however, facilitates problem solving even when there is little diversity in background knowledge. Bahrami et al. (2010) showed that two people working

together to detect a subtle visual signal can do better than the best one working alone. Crucially, Kiyokawa (2002) showed that two people working together can solve a problem better than working alone even when one of the members was prohibited to express his/her ideas to solve the problem. Okada and Simon (1997) found that participants were able to reach the solution in a scientific discovery task when working together than when working alone but there was not a significant difference in diversity of hypotheses they entertained. It may be useful to consider factors other than diversity of background knowledge as contributing to the facilitative effects of collaboration on problem solving.

Metacognitive Monitoring in Insight Problem Solving

Facilitation of metacognitive monitoring during collaboration is another potential factor which may be responsible for the facilitative effects of collaboration on problem solving, especially insight problem solving. In other words, collaboration may facilitate insight problem solving because people can monitor their cognitive processes better when working together than when working alone. Previous studies have shown that metacognitive monitoring plays a critical role in problem solving. That is, the more appropriately one can monitor one's cognitive processes, the better one can solve the problem. However, previous studies have also shown that metacognitive monitoring does not always work in problem solving, and in particular not for insight problem solving, when working alone (Metcalf, 1986; Metcalfe & Wiebe, 1987). This phenomenon is interpreted as implying that the processes underlying insight problem solving when working alone is implicit and non-reportable. Indeed, this dysfunction of metacognitive monitoring is assumed to be one of the factors responsible for the difficulty of insight problem solving. Since people cannot know correctly where they are in the problem space when working alone, they cannot choose their moves so as to head in the right direction, and as a result, cannot readily reach the correct solution.

When working together, on the other hand, people have to communicate what they are thinking to their partners. Therefore, they have to change their thinking modes from

implicit and non-reportable to explicit and reportable ones during collaboration. These changes in thinking modes when working together may enhance metacognitive monitoring and, as a result, facilitate insight problem solving. Based on this hypothesis, the tendency to think about one's cognitive processes explicitly or verbally specifically in order to communicate them to a partner may be a key contribution to the facilitative effect of collaboration. Therefore, not only an actual collaborative setting but also a hypothesized one will be enough for people to change their thinking modes and facilitate their metacognitive monitoring and performance in insight problem solving. To reconcile the claim that verbalizing to others is helpful with the previous claim that people have poor metacognition of insight processes, we draw a distinction between verbalizing to oneself as a target and verbalizing to others, which we now consider.

Metacognitive Monitoring and Verbal Overshadowing Effect

There is evidence relevant to our hypothesis in a line of research on the verbal overshadowing effect. These studies have shown that verbalization directed toward oneself disrupts insight problem solving and verbalization directed toward others does not. Schooler, Ohlsson, and Brooks (1993) showed that verbalizing thoughts after each trial when attempting to solve insight problems can disrupt performance¹. This disruptive effect of verbalization on insight problem solving is called verbal overshadowing effect. The verbal overshadowing effect may originate from a dysfunction of metacognitive monitoring in insight problem solving. The hypothesized process is as follows. People cannot verbalize what they are actually thinking about because they cannot know where they are in the problem space. Therefore, they tend to verbalize what is easy to do so irrespective of their actual cognitive processes. As a consequence, they cannot make use of information other than what they verbalize and so find it hard to reach the correct solution (see also Kiyokawa and Nakazawa, 2006).

Kiyokawa and Nagayama (2008), on the other hand, have found that verbalizing thoughts toward others does not disrupt but rather facilitates insight problem solving. They examined the effects of failure-focused verbalization on insight problem solving using the same task as that used in Kiyokawa and Nakazawa (2006). Participants were randomly assigned to either of the failure-focused verbalization or the irrelevant verbalization (control) conditions. The participants in the failure-focused verbalization condition were asked to write down the ways they thought inappropriate for solving

the problem as advice toward other participants. The participants in the control condition were asked to describe in detail what they were studying and interested in. The results revealed that failure-focused verbalization facilitated insight problem solving. The study is consistent with, but was not designed to support the claim, that there is something beneficial about directing one's verbalization to someone else rather than oneself, in acquiring a metacognitive grasp on where one might be in a problem space. Bahrami et al (2012) argue that a key function of meta-cognition is social collaboration; if this is so, engaging socially, or trying to, may facilitate what seems a private process, metacognition. This is the claim we wish to test. The mechanism by which metacognition, an apparently private process, is maximally engaged may thus paradoxically rely on social cues.

Purpose of Present Study

The purpose of the present study is to clarify the effects of addressee of verbalization, self or other, on insight problem solving in terms of metacognitive monitoring by examining the verbal overshadowing effects. Our hypothesis is that verbalizing one's thought just as a record disrupts insight problem solving because metacognitive monitoring does not work well, whereas verbalizing one's thought for communicating with other facilitates insight problem solving because it helps metacognitive monitoring.

We will address this question by comparing each solution rate of the puzzle in the two experimental conditions and the control condition. The first experimental condition was the toward-self verbalization condition. In this condition, participants were asked to verbalize reflectively what they were thinking during struggling with the puzzle as a record for themselves. The second experimental condition was the toward-other verbalization condition, in which participants were asked to verbalize their thinking during the previous solving phase as advice for other participants. In the control condition, participants were asked to verbalize not their thinking about their problem solving but their recent concerns irrelevant to solving the puzzle. Thus, the theory that metacognition may not work in a solo setting but does best when engaged in a social context was tested by the following prediction: 1) less participants should solve the puzzle in the toward-self verbalization condition than in the toward-other condition. If in contrast there is just a general overshadowing effect, then there should be little difference shown in the previous contrast but 2) less participants should solve the puzzle in the verbalization conditions than in the control condition. We here investigate these predictions in an

¹ Schooler et al. (1993; Exp. 3) found verbalizing reduced percentage of problems solved in 6 minutes by 25% for insight problems and about 5% for non-insight problems, a difference of 20%. Gilhooly, Fioratou & Henretty (2010) tightened up the design and compared percentage of insight with non-insight problems solved in 4 minutes. Crucially, for them verbalizing versus silence did not significantly interact with problem type, $F = 1.63$. Does this fail to replicate Schooler et al? We need a Bayes factor to determine whether the data supported H0 over a reasonable H1. The raw

interaction effect would be expected to be 20% (i.e. Schooler et al.'s effect) $\times 4/6$ (correcting for time difference) = 13%. In fact, Gilhooly et al. found a sample overshadowing effect of 4% for insight problems (57 – 53%) and 0% for non-insight (48 vs 48%), i.e. a raw interaction effect of 4% (with $SE = 4\%/\sqrt{1.63} = 3.1\%$). Modelling H1 as a half-normal with $SD = 7\%$, gives a Bayes factor $B_{H(0,7)} = 0.92$, i.e. Gilhooly et al.'s interaction does not count against Schooler et al.

exploratory study, that is one that was not pre-registered, in order to have a firm basis for a pre-registered study. We will thus estimate the sort of effect sizes we find that are relevant to the predictions.

Method

Participants

Thirty-five participants were recruited from the participant pool of the School of Psychology at the University of Sussex. All were required to have UK or EU passports. They received 2 course credits or 3 pounds for taking part in the study. The participants granted their informed consent before participation and the Ethical Committees both of the University of Sussex and Nagoya University approved the study.

Design

We used a between-participants design. The independent variables had three levels: toward-self verbalization, toward-other verbalization, and irrelevant verbalization. The key dependent variable was the proportion of participants who solved the T-puzzle.

Procedures

The participants were randomly assigned to one of the following three conditions: toward-self verbalization, toward-other verbalization, or irrelevant verbalization (control). The experiment took place in a small room with the experimenter present and only one participant at a time. After providing their informed consent to the study, the participants engaged in a practice task for 3 minutes. Before the main task, as a practice task, they were asked to make a rectangle shape (see Figure 1 (b)) using the four pieces presented (see Figure 1 (a)) for three minutes in order to get accustomed to manipulating the pieces they would use in the main task. After that, they were asked to solve the main shape puzzle, called the T-puzzle on a display using a mouse for a total of 15 minutes. In the puzzle, they were asked to form a T shape (see Figure 1 (c)) using the same four pieces as the practice task.

They were asked to let the experimenter know when they think that they had reached the correct solution. Then the experimenter checked if they have reached the correct solution and if so, the solution phase was terminated at that time. If not, they continued the task.

A 3-minute verbalization phase was inserted after 5 minutes of solving the puzzle. In this phase, the participants were asked to enter their thoughts using a keyboard following the particular instructions in each condition. The first two sentences in the instructions both in the toward-self and other verbalization conditions were the same as those used in Schooler et al. (1993). Those in the toward-self verbalization condition were instructed to write down what they were thinking about in the first 5-minute solution phase, as a record to themselves. The instruction was as follows. "Please write down, in as much detail as possible, everything you can remember about how you have been trying to solve the problem. Give information about your approach, strategies, any solutions you tried, and so on. Write as a record to yourself, like a diary of how you tried to solve the problem in the last five minutes. Remember you are addressing yourself in making these notes; it should feel exactly like talking to yourself. Try to write about 100 words. You can check how many words you have written by looking here. You can take 3 minutes for this writing."

Those in the toward-other verbalization condition were asked to write down their thoughts in the first 5-minute solving phase as advice to other participants. The instruction was as follows. "Please write down, in as much detail as possible, everything you can remember about how you have been trying to solve the problem. Give information about your approach, strategies, any solutions you tried, and so on. Write instructions for other participants on how to solve the problem, based on what you found out in the last five minutes. Remember you are talking to someone else when making these notes; it should feel exactly like a conversation with someone else. Try to write about 100 words. You can check how many words you have written by looking here. You can take 3 minutes for this writing."

Those in the control condition are asked to write down their recent interests as an irrelevant topic to the puzzle. The



(a) Used pieces



(b) Solution of the practice



(c) Solution of the T-puzzle

Figure 1: Tasks.

instruction is as follows. "Please write down, in as much detail as possible, everything you can remember about what you have been interested in. Give information about your interests, hobbies, any things you want to do, and so on. Write about your interests that have nothing to do with the problem you have been trying to solve in the last five minutes. We want you to take a break from the problem. Remember to write about something other than the puzzle. Try to write about 100 words. You can check how many words you have written by looking here. You can take 3 minutes for this writing."

After the verbalization phase, the participants were required to solve the puzzle again for 10 minutes. They were given a hint to solve the puzzle. Specifically, they were asked to put the pentagon piece not vertically or horizontally but diagonally. This hint was shown to be effective in reaching the correct solution by Suzuki and Hiraki (1998).

After the main task, the participants were asked to fill in a question sheet. The following questions were included in the sheet: (1) "Have you ever tried to solve this puzzle before?" (2) "If you answer "yes" in the first question, when it was it?" (3) "Did you know the correct solution to the puzzle before the experiment?" (4) "To whom did you address your verbal description in the middle of doing the puzzle?" (5) "What was your description about?" (6) "What's your nationality?"

Results

Based on the answers to the questions (1) and (3), we made sure that none of the participants had experienced the T puzzle before the experiment or knew the correct solution. Based on the answers to the question (6), we also made sure that the nationalities of all the participants were UK or EU. A participant in the toward-other condition engaged in the practice task longer than 3 minutes and therefore the data of the participant was excluded from the analyses.

Manipulation Check

We checked whether the participants followed the instructions on the verbalization by the following two ways. First, we examined their recognized addressees based on the question (4) in the post-task questionnaire. Second, we examined what the participants wrote down in the verbalization session. We will report the 95% credibility intervals based on a uniform prior, which are numerically the same as 95% confidence intervals.

Recognized Addressees Table 1 shows frequency of each option the participants selected as their addressees in the post-task questionnaire in each condition. If the participants followed the instruction properly, the participants in the toward-self verbalization condition should have chosen "Self"

Table 1: Number of each option selection in each condition.

	Toward-self	Toward-other
Self	10	2
Other people	1	10
Total	11	12

Table 2: Number of participants who used or did not use "You" as a subject or imperative form at least once in their descriptions in each condition.

	Toward-self	Toward-other
Used	1	9
Did not use	10	3
Total	11	12

and those in the toward-other verbalization condition "Other People". Indeed, the selection rate of "Self" was considerably higher in the toward-self verbalization condition than the toward-other verbalization condition with odds ratio, OR = 50.00, 95% CI, [3.88, 643.90].

What the Participants Verbalized We examined the quantity and quality of the participants' verbalization in order to check whether they followed the instructions. First, we compared the number of words among these 3 conditions. Hopefully there would be only minor differences in the sheer quantity of their verbalization, as number of words, among these conditions (Toward-self verbalization: $M = 92.8$, $SD = 12.8$; Toward-other verbalization: $M = 80.6$, $SD = 16.3$; Control: $M = 82.5$, $SD = 19.5$, 95%CI, Toward-self verbalization vs Toward-other verbalization: [-18.43, 42.90], Toward-other verbalization vs Control: [-35.68, 39.42], Toward-self verbalization vs Control: [-23.56, 44.29]).

Second, we examined the subjects and predicates the participants used in their verbalization. Specifically, we counted the number of participants who used "you" as a subject or imperative form at least in their description. If the participants followed the instructions, more participants in the toward-other verbalization condition should use "you" or imperative form than in the toward-self verbalization condition. Indeed, as Table 2 shows, more participants used "You" as a subject or imperative form in their description in the toward-other verbalization condition than the toward-self verbalization condition with odds ratio, OR = 30.00, 95% CI, [2.63, 342.75].

Task Performance

The performance in each condition is shown in Table 3. First, we compared the solution rates between the toward-self and other verbalization conditions in order to test the effects of

the addressee of verbalization on insight problem solving. Plausible odds ratios spanned interesting effect sizes around the null value of 1 (OR = 1.90, 95% CI [0.33, 11.01]).

Next, we combined the data in the toward-self verbalization and in the toward-other verbalization conditions into the verbalization condition and compared the solution rates between the verbalization and control (non-verbalization) condition. The result showed that the solution rate could be higher in the control condition than the verbalization

Table 3: Performance in each condition.

	Toward- self	Toward- other	Control
Solved	3	5	8
Unsolved	8	7	3
Total	11	12	11

condition by a small to a considerable amount (OR = 5.00, 95% CI, [1.03, 24.29]).

In sum, while the evidence allowed a wide range of effects for the self vs other distinction going in either direction, the evidence favoured a detrimental verbalization effect rather than an overall positive effect of verbalization. In particular, the crucial theoretical distinction between verbalizing to self vs other had a 95% probability of lying in the interval 1/3 to an effect as high as OR = 11, that is higher than the estimated effect of verbalizing versus non-verbalizing, for which OR = 5 in our sample.

Based on these rough estimates, we can now determine the sort of effect sizes we would expect in a follow up study, for which this report constitutes its pre-registration. Specifically, using the identical procedure as for this exploratory study, for analyzing results we will use an odds ratio of 5 as a roughly predicted effect size for our pre-registered experiment for all effects. The function of this exploratory study was to check the procedure worked smoothly and determine plausible possible effect sizes (Considering the past literature using the same task, Kiyokawa & Nakazawa, 2006, an odds ratio of 3.11 was found for a verbal over-shadowing effect, which is in the same ballpark). We will use this estimate for Bayes factors to make existential claims of whether or not an effect exists. To get evidence for whether an effect does or does not exist, a rough idea of the scale of effect to be detected is needed. Following Dienes and Mclatchie (2018), we will model H1 by setting the *SD* of a half-normal to 5. We will collect participants until the contrast given as prediction 1) at the end of the introduction has a Bayes factor either greater than 3 or less than 1/3.

Discussion

In the present study, we investigated the effects of addressee of verbalization, self or other, on insight problem solving in terms of metacognitive monitoring by examining the verbal

overshadowing effects. Our hypothesis was that verbalizing one's thought just as a record disrupts insight problem solving because metacognitive monitoring does not work well, whereas verbalizing one's thought for communicating with other facilitates insight problem solving because it helps metacognitive monitoring. The results showed that the manipulation worked well in terms of participants obeying instructions. Further, the results were consistent with a small to large verbal overshadowing effect on insight problem solving. Crucially, the results allowed a wide range of effects for the self vs other distinction going in either direction. In the following section, we will discuss the necessity of re-examining the verbal overshadowing effect on insight problem by Bayes factors and another possible self vs other difference in metacognitive monitoring.

Verbal Overshadowing Effect Should Be Examined Using a Bayes Factor

There has been a debate between the special-process view and business-as-usual view of insight problem solving. The former posits that insight problem solving processes are implicit, unlike non-insight problem solving. The latter, on the other hand, assumes that the same processes used in non-insight problem solving are involved in insight problem solving. Since the prediction for the verbal overshadowing effect based on the special-process view is different from that based on the business-as-usual view, previous studies have addressed whether or not the verbal overshadowing effect is obtained in order to determine which view is valid (Ball et al., 2015; Fleck & Weisberg, 2004; Gilhooly et al., 2010; Schooler et al., 1993). Specifically, based on the special-process view, verbalization should disrupt only insight problem solving. Based on the business-as-usual view, on the other hand, verbalization should disrupt neither insight nor non-insight problem solving. The evidence from the present study supports the special-process view.

There is a methodological problem on how to determine whether or not the verbal overshadowing effect is obtained. Previous studies concluded that the verbal overshadowing effect was not obtained when there was a non-significant effect of verbalization on problem solving. But non-significance includes both the case where the data were insensitive and where there is evidence for no verbal overshadowing. In contrast, Bayes factors distinguish evidence for no effect relative to a model of the sizes of effect expected, from no evidence at all. In our follow up experiment, we will use Bayes factors.

Self vs Other Differences in Metacognitive Monitoring May Be Emerged Only by Attribution

The present study was motivated by the self vs other difference in metacognitive monitoring when asked to communicate one's thinking processes to others. If the function of metacognition is intrinsically social (Bahrami et al, 2012), the module or mechanism may be best engaged when social cues trigger it. But there may be other factors related to facilitation of metacognitive monitoring in insight

problem solving during collaboration. Specifically, the facilitation of metacognitive monitoring may be obtained only by regarding the processes to be monitored as generated by others. (For example, the thinking of others may be regarded with more skepticism than one's own thinking.) Several studies have supported this hypothesis.

Schunn and Klahr (1993) compared performance on an insight-like rule discovery task between self- or other-generated hypothesis conditions. The participants in the self-generated hypothesis condition were asked to generate their own initial hypotheses. The participants in the other-generated condition were given the most frequently generated hypothesis. The results showed that the hypothesis was investigated more thoroughly in the other-generated condition than in the self-generated condition and that the participants in the other-generated condition terminated with incorrect solutions less than those in the self-generated condition. Kiyokawa, Ueda, and Okada (2004) compared the performance of an insight-like rule discovery task between the self- or other-generated hypothesis conditions. The results showed that the participants in the other-generated hypothesis condition outperformed those in the self-generated hypothesis condition and that the plausibility dropped down after the participants in the other-generated hypothesis condition faced some counterevidence while that increased in the self-generated hypothesis condition.

Kiyokawa, Izawa, and Ueda (2007) investigated effects of swapping between doing and observing a partner or oneself on insight problem solving using the T-puzzle. The results showed that swapping between doing and observing a partner solving the puzzle facilitated insight problem solving, whereas swapping between doing and seeing one's past actions (i.e. within an individual) disrupted problem solving. Kotera et al. (2011) compared the performance of the T puzzle when they observed moves regarded as generated by oneself or by others. The results revealed that observation disrupted insight problem solving if one attributed the observed moves to oneself, but not if one attributed them to another person.

However, all these results may also be explained by our original hypothesis, in the introduction, that it is simply engaging in a social way that maximizes the efficacy of metacognition. Our replication of the current study (of which this paper constitutes its pre-registration) until we get evidence for or against the self versus other contrast being effective will help settle the matter: If other is more effective than self, then it may simply be a matter of engaging social cues.

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