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LIMITATIONS IN REASONING ABOUT FALSE BELIEFS IN ADULTS: THE EFFECT OF PRIMING OR THE CURSE OF KNOWLEDGE?

Birch & Bloom (2007) suggest that adults' reasoning about other people's mental states is influenced by their privileged knowledge about reality. When asked where a person described in a story would search for a missing object, participants tend to judge with higher probability that the person would search in a particular box when they know that the object is indeed in that box. However, the results of that experiment could be an effect of unintended priming in the experimental materials. The increased attention towards the box might be caused by reading about it in the task instructions. In a new version of the experiment, we controlled for this factor by priming different locations in the instructions. The results show that it is unlikely that priming is the source of Birch and Bloom's observations: only knowledge about reality changed the participants' strategies in reasoning about the actions of others.

Key words: curse of knowledge, mental contamination, theory of mind

Introduction

Taking part in social interactions requires the ability to reason about other people's beliefs, goals and intentions. Although even infants have basic abilities to recognize intentional patterns in the behaviors of others, the capacity to interpret actions in terms of different beliefs becomes apparent at the age of 4-5 years. This development is considered to be caused by sudden conceptual growth (e.g. Gopnik, 1993), and to be the result of a gradual increase in the sophistication of cognitive processes such as memory, executive functions and language (e.g. Baillargeon et al., 2010). A plethora of cognitive resources is needed for

social thinking; hence, even adults sometimes have problems with an egocentric tendency to rely on their own cognitive perspective and to some extent ignore other people's points of view. Adults' egocentric problems with reasoning about others' beliefs are sometimes explained by their limited cognitive resources, such as working memory or attention, leading to an inability to conduct a fast revision of the initial interpretation (Keysar, Lin & Barr, 2003; Epley, Morewedge & Keysar, 2003). It was shown that in sufficiently complicated circumstances adults can have problems with tracking others' beliefs and distinguishing them from their actual knowledge about reality. This phenomenon is called "hindsight bias" (Fishhoff, 1975), "mental contamination" (Wilson & Brekke, 1994), "realist bias" (Mitchell et al., 1996), or finally the "curse of knowledge" (Birch & Bloom, 2007). For example, Mitchell et al. (1996) discovered that adults tend to assess that a character described in a story will more often ignore a false message and believe in a true message than vice versa (only the subjects, but not the character from the story, knew which of the contradictory pieces of information was true and which was false). The authors argued that knowledge about reality contaminates reasoning about another person's hypothetical beliefs.

Testing egocentric tendencies in adults usually requires more sophisticated and sensitive measures than those used with children. The experimental paradigms are based on tracking eye movements (e.g. Keysar et al., 2000) or measuring reaction time (Apperly et al., 2008). These methods allow researchers to capture the earliest moments of the interpretation process. On the other hand, the results obtained by Birch and Bloom (2007) show that the *curse of knowledge* might be demonstrated in a simple type of false belief task that includes a specific impediment to the interpretation process.

The curse of knowledge

In their experiment, Birch and Bloom (2007) used a modified version of a displacement task. Participants were given two pictures showing a sofa and four boxes of different colors, accompanied by a short narration. The story was about Vicki, who put her violin into a blue container and left the room. During her absence, her sister Denise moved the violin to another container and rearranged the containers in the room. In the first of three experimental conditions, participants would not be informed into which container the violin was moved (*ignorance condition*). In the second, they would be told that the violin was moved to the red container. The red container was placed where the blue container used to be. That means it could be considered as plausible that Vicki would actually look for her violin in there first (*knowledge-plausible condition*). In the third condition, the participants would be informed that Denise moved the violin to the purple container. That container, being not only of a different color, but also located in a different place in the room, would be an unlikely place for Vicki to look for her violin (*knowledge-improbable condition*).

One of the most important differences between this experiment and a standard displacement task was that the participants were not asked to say in which container Vicki would search for her violin, but to assess the probability that she would look into each of the containers. Another difference was that there were four boxes with different plausibility with which Vicki would look for her violin in each of them. The rearrangement of the room made it plausible that Vicki would look for her violin either in the box of the same color or in the box in the same place as the original box in which the violin had been. As to the other two boxes, there was no reason for Vicki to start searching for her violin in them.

The results of the experiment showed that in the *knowledge-plausible* condition the participants assessed looking for the violin in the red container as significantly more possible than in the other conditions. In the *knowledge-implausible* condition (violin in the purple box) the participants' judgments about Vicki's probable behavior were no different than in the case of the participants' ignorance on the matter of the violin's location.

The authors of the paper concluded that adults' knowledge might influence their reasoning about other people's beliefs or behavior. However, unlike in the case of young children, that knowledge would become a "curse" only if there were a plausible explanation for why the person in question would behave according to facts of which they couldn't be aware. If there were no plausible explanation for behaving according to the knowledge possessed only by the participant of the experiment (like looking for the violin in the purple box), the knowledge would not affect adults' judgment.

The present experiment

As Birch and Bloom's experiment showed, only plausible scenarios are affected by participants' knowledge. There are two plausible strategies that can be ascribed to Vicki in looking for her violin. One of them is checking in the same box (i.e. remembering its color and shape). The other is looking for the violin in the same place in which she put it (i.e. in the box that is situated by the sofa in the same place as was the box in which Vicki put her violin). However, the way in which the task in the experiment was formulated may raise some doubts about whether it was indeed knowledge that influenced the participants' judgment or rather simple priming of the red container.

Priming is an unconscious activation of knowledge or behavior caused by the context of a close previous experience. As has been widely observed, perceptual and conceptual priming might facilitate faster recognition of words, semantic categories or verbal reactions (see: Traxler, 2012, p. 84-87). In one of the typical examples, the *Word Stem Completion task*, participants are presented with different words in a neutral context. The exposure activates representations of these words. As a result, in a subsequent part of the experiment, when they are asked to complete words which begin with given letters, they are more likely

to use words which they encountered in the first part of the experiment (Graf & Mandler, 1984). However, the effect of priming might also occur in different modalities. In the experiment conducted by Bargh et al. (1996) the list of words related to rudeness or politeness primed participants' polite or impolite behavior in social interactions. In this case the semantic material presented to participants influenced the way in which they chose to behave.

Similarly, it is possible that in Birch and Bloom's experiment the participants' attention was drawn more strongly to the red box because it was mentioned explicitly in the task instructions and activated an explanation for looking for the violin in the red box. It is crucial to notice that this explanation is based on the reasonable premise that the red box is in the location where Vicki left her violin earlier (*knowledge-plausible condition*).

If priming was to have an influence on the task, there are two ways in which it could affect participants' performance. It could prime a particular box mentioned in the instruction and/or it could prime a particular location, pointing to the fact that a particular box is placed in the same location as the box in which Vicki's violin was originally. In order to answer this assumption we designed a new experiment in which we controlled for different priming factors in the instruction task.

If explicitly pointing to the box of a particular color or the fact that it is in the same place as the box where the violin used to be, but without giving information that it actually contains the violin, would cause the participants to assign a higher probability of looking in it for the violin, it could be concluded that the results observed by Birch and Bloom were in fact an effect of priming. However, if the *priming* conditions would show results statistically not different from the *ignorance condition* and only instructions giving the participants knowledge about the violin's new location (in the *knowledge condition*) would influence their choices, it could be considered that the "curse of knowledge" is indeed the best explanation of these results.

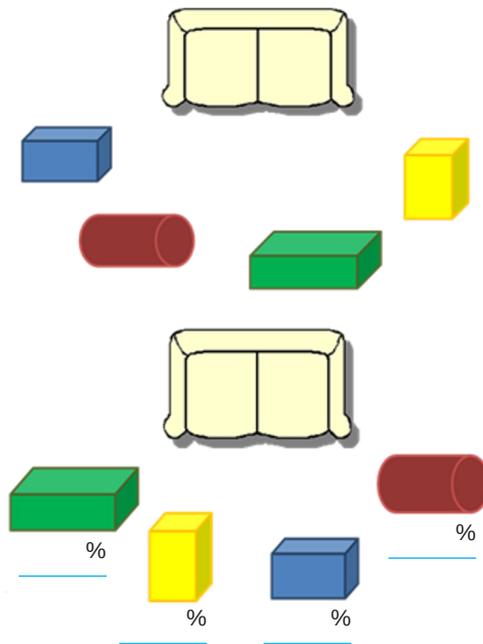
Method and experimental design

Our experiment used five different conditions to assess whether each of those types of priming as well as the "curse of knowledge" – as described by Birch and Bloom (2007) – could influence adults' judgments about other people's beliefs and actions.

One hundred and fifty-one participants were tested (104 female, 47 male), with a mean age of 22.5 years ($SD = 4.13$). We aimed for a similar number and demographic characteristics of participants in each condition to the ones presented in Birch and Bloom (2007).

All the participants were presented with a short narrative story accompanied by two pictures. The story was adapted from Birch and Bloom's (2007) experiment.

Picture 1. Maria's room before and after rearrangement (part of the experimental sheet)



“This is Maria’s room. Maria finished playing her violin, put it into the blue box, and left the room. During her absence, her younger sister Joanna came into the room and ...”

Then, five different conditions were used:

Ignorance condition: “... moved the violin to another box and rearranged the boxes in the room as shown in the picture.”

Color priming condition: “... moved the violin to another box and rearranged the boxes in the room as shown in the picture, leaving the green box empty.”

Color and location priming condition: “... moved the violin to another box and rearranged the boxes in the room as shown in the picture, putting the green box in place of the blue one.”

Knowledge condition: “... moved the violin to the green box and rearranged the boxes in the room as shown in the picture.”

Knowledge and location priming condition: “... moved the violin to the green box and rearranged the boxes in the room as shown in the picture, putting the green box in place of the blue one.”

Participants then had to answer the question:

“Into which box will Maria look first when looking for her violin? Write the probability as a percentage under each of the boxes. Remember that the percentages should add up to 100.”

In the second picture the green box was always in the place of the blue one.

In the *color priming* conditions the instruction points specifically to the green box – the box which is a plausible place to look for the violin, as it is in the same place as the blue one used to be. However, it does not describe the green box as the box with the violin in it.

In the *knowledge* conditions the instruction points to the green box by stating that it is the box into which the violin has been moved.

In Birch and Bloom’s experiment it was observed that participants were influenced by their own knowledge only if there was a plausible explanation for it – namely that the box which they knew contained the violin was in the same location as the box which used to contain it.

To assess whether the results of the experiment could be altered by indicating the box that is in the same location as the box that originally contained the violin, we used *location priming* conditions. In these the instructions explicitly pointed out that a particular box was now in the same location as the box where the violin used to be, therefore making it clear that it was a “plausible” answer.

Results

Similarly to the original experiment by Birch & Bloom (2007), participants in our replica of the *ignorance* condition assigned higher probability ratings to the blue container (54%) than to any other container, including the green one (33%). Therefore, they showed a basic preference for the strategy of searching for the same color and shape of the box. In two priming conditions, the *color priming* and the *color and location priming* conditions, in which the green container and its location were explicitly mentioned, participants gave nearly the same probability ratings as in the *ignorance* condition (respectively: 54% and 52% for the blue container, 30% and 34% for the green container). However, in the two *knowledge* conditions, where the location of the violin was explicitly mentioned, the probability rating for the green container was significantly higher (50% for *knowledge* and 50% for *knowledge and location priming*) than in the *ignorance* condition (*knowledge*: Mann-Whitney *U* test, $U = 293$, $p = 0.02$; *knowledge and location priming*: $U = 288$, $p = 0.02$). Also, the mean probability rating for the blue container was significantly lower in the *knowledge and method priming* condition than in the *ignorance* condition (Mann-Whitney *U* test, $U = 300$, $p = 0.02$). There was no significant difference between the probability of looking into the green

Table 1. Mean probability judgments that Maria would look in each of the containers

Conditions	Containers			
	blue (where the violin was initially)	green (in the former location of the violin)	yellow (different location)	red (different location)
Ignorance	54%	33%	7%	5%
Color priming	54%	30%	8%	8%
Color and location priming	52%	34%	7%	7%
Knowledge	42%	50%	4%	4%
Knowledge and location priming	37%	50%	8%	5%

and blue container comparing the *knowledge* and *knowledge and location priming* conditions (for blue: $U = 400$, $p = 0.5$; for green: $U = 430$, $p = 0.8$). See Table 1 for a summary of the participants' judgments for all the conditions.

Discussion

The results show that the additional manipulation of the instruction task was not enough to cause the effect of choosing a *location but not color strategy*, and consequently to assign higher ratings to the green container. Additional priming in the *knowledge and location priming* condition did not provoke growth in ratings for the green box, which implies that it was not an essential clue for subjects in formulating their judgments. Only the actual knowledge about the object's location seemed to influence participants' assessments. Furthermore, as found by Birch and Bloom (2007), participants did not focus on the less probable containers, even in the *color priming* condition where one of these containers (yellow or red) was in fact the actual location of the violin. In the light of our experiment, where different forms of priming did not play an important role in the participants' choices, it seems that the "curse of knowledge" described by Birch and Bloom is the most probable reason for this pattern of results. Pointing specifically at the fact that one of the boxes was in the same place as the box in which the object was originally held did not affect participants' judgments. Only knowledge about the facts, not prompting other answers, influenced the participants' assessments of other people's behavior.

One of the characteristic features of studies on social reasoning is that they often use very simplified narrative stories, in which a lot of information is given

implicitly. Because of that, it is not always possible to isolate many rules of reasoning that might influence participants' final answers. That is why different factors should be controlled more strictly than in the more ambiguous tasks that are often used in testing children's social thinking. Nevertheless, experiments like these play an important role in the search for the limits of mature paths of reasoning about the minds of others. They can stand as a base for further investigation into the circumstances in which adults are prone to mental contamination. There are two especially interesting fields of investigation.

First, there is the question of what factors moderate the tendency of an agent to overestimate a privileged cognitive perspective. Birch and Bloom's (2007) and our results show that the "curse of knowledge" can occur only when an agent can formulate a plausible, rational explanation of another person's behavior. The plausible explanation should be in line with the character's knowledge and within the scope of rationality that the agent ascribes to the character. That's why the possibility that Vicki would look for her violin in the other two "irrelevant" containers was rejected by participants even when they knew that the violin was in fact in one of them.

Second, it is worth exploring further which individual cognitive mechanisms participate in perspective taking and mind reading in adulthood. Recent studies show the significance of executive functions, in particular inhibition control and working memory (e.g. Apperly et al. 2009, German & Hehman, 2006). It seems that the capacity for belief reasoning is based not only on mature conceptual resources, but it also needs effective processes of keeping different cognitive perspectives in memory, selecting the perspective relevant for a given task and inhibiting any privileged, dominant point of view. Limitations in adults' theory of mind, like the "curse of knowledge," might be caused by insufficient executive resources (Samson, 2005). However, the role of these mechanisms in the way adults and children reconstruct and switch different cognitive perspectives is yet to be established.

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