Working Memory Processes During Abductive Reasoning

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Introduction

Abductive reasoning is the process of finding a best explanation for a given set of observations. It is an essential feature of many real world tasks like medical diagnosis, discourse comprehension, and scientific discovery. Such problems often need the processing of an amount of information far beyond the capacity limits of working memory (WM). But on the other hand, working memory is expected to play a central role in human reasoning. On the basis of a computational model of abductive reasoning (Johnson & Krems, 2000) and of theories of text comprehension we propose a mechanism that reduces WM load during abductive reasoning. It suggests that only unexplained symptoms are kept in working memory with explained symptoms are transferred to long-term memory reducing WM load.

From this model it follows that unexplained observations should be more available in a recognition or recall task during abductive reasoning than explained ones. We tested this prediction in three experiments each using a different memory task to test the availability of observations.

Experimental Studies

The Experimental Task

In all experiments a task (BBX) was used where participants had to discover the hidden state of a system through indirect observations. The observations were presented sequentially to the participants. Only the current observation was visible. In each trial, after a variable amount of observations, the participants had to perform a memory task testing the availability of a given observation. The major manipulation in all experiments was whether this observation was already explained at the time of the memory task or not. That is, whether the participant had received the neccessary additional information to explain the observation and actually generated a hypothesis explaining this observation.

Results and Discussion

In the first experiment we used a recognition test as memory task to test the availability of the relevant observation. In the second experiment the recognition test was replaced with an implicit memory task. The mental availability of explained and unexplained observations were tested here by presenting a probe hypothesis that had to be judged with regard to its compatibility with observations presented until then.

The results of the first experiment showed that unexplained observations are recognised significantly faster than explained ones, consistent with model predictions. Regarding the recognition accuracy there was no significant effect of interval or explanation status. We also found that maintaining an unexplained observation in WM slows down the recognition and reduces the recognition accuracy for other observations.

The second experiment showed contrary to the model's predictions a tendency of explained observations being forgotten more often with increasing number of intervening observations than unexplained ones. This result suggested that observations are held actively in WM until they are explained. After an explanation was generated they are lost from WM. The result also indicates that explained observations are not integrated in a representation in long-term memory. This interpretation was confirmed in a third experiment showing that participants memory for explained and unexplained observations in an unexpected recall test after the interruption of the reasoning task was equally low.

General Discussion

The results confirmed the hypothesis that unexplained observations are actively hold in WM during abductive reasoning until a causal explanation can be generated. Contrary to the predictions of the model these explained observations seem not to become integrated into a representation in long-term memory, but are simply forgotten. But this could be due to the structure of the reasoning task we used, which makes the construction of an integrated representation rather difficult. Therefore in future investigations we need to use a task providing a richer structure, more comparable to real world tasks like medical diagnosis.

References

Johnson, T.R., & Krems, J.F. (2000). *Use of Current Explanations in Multicausal Abductive Reasoning.* Manuscript submitted for publication.