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Research report

How do our brain hemispheres cooperate to avoid false memories?

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ABSTRACT

Memories are not always as reliable as they may appear. The occurrence of false memories can be reduced, however, by enhancing the cooperation between the two brain hemispheres. Yet is the communication from left to right hemisphere as helpful as the information transfer from right to left? To address this question, 72 participants were asked to learn 16 word lists. Applying the Deese–Roediger–McDermott paradigm, the words in each list were associated with an unpresented prototype word. In the test condition, learned words and corresponding prototypes were presented along with non-associated new words, and participants were asked to indicate which of the words they recognized. Crucially, both study and test words were projected to only one hemisphere in order to stimulate each hemisphere separately. It was found that false recognitions occurred significantly less often when the right hemisphere studied and the left hemisphere recognized the stimuli. Moreover, only the right-to-left direction of interhemispheric communication reduced false memories significantly, whereas left-to-right exchange did not. Further analyses revealed that the observed reduction of false memories was not due to an enhanced discrimination sensitivity, but to a stricter response bias. Hence, the data suggest that interhemispheric cooperation does not improve the ability to tell old and new apart, but rather evokes a conservative response tendency. Future studies may narrow down in which cognitive processing steps interhemispheric interaction can change the response criterion.

1. Introduction

Retrieving experiences means reconstructing events based on present knowledge. Like any other cognitive process, this reconstruction sometimes fails, thereby occasionally giving rise to memories for events that never took place. Neuropsychological (Curran et al., 1997; Delbecq-Derouesné et al., 1990; Parkin et al., 1996; Schacter et al., 1996a) and imaging studies (Cabeza et al., 2001; Schacter et al., 1996b, 1997a; Slotnick and Schacter, 2004) have shown that the occurrence of such false memories depends on the functioning of prefrontal, temporal and occipital areas of both brain hemispheres.

Behavioural measurements have also revealed that the communication between the two brain hemispheres matters for the incidence of false memories. The number of falsely

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recalled items sinks considerably when a task enforcing interhemispheric interaction is performed between encoding and retrieval (Christman et al., 2004): while a mere watching task without eye movements does not improve recollection, a task stimulating the interhemispheric exchange through bilateral saccadic eye movements leads to significantly less false recalls in subsequent memory testing. By the same token, the number of falsely recalled items is significantly lower for mixed-handers, who generally rely strongly on interhemispheric communication, than for right-handers, who employ less interhemispheric interaction (Christman, 1993, 2001; Christman et al., 2004). Moreover, the finding that the number of false memories increases after both left-hemispheric (Parkin et al., 1996) and right-hemispheric lesions (Curran et al., 1997; Schacter et al., 1996a) suggests that interhemispheric cooperation may play an important role in the avoidance of false memories. While the reasons for this benefit of interhemispheric crosstalk are not yet known, one might speculate that the requirement to engage both brain hemispheres may strengthen the memory traces, improve the accessibility of contralateral engrams, or allow the different processing strategies of the two hemispheres to positively complement each other.

The latter seems especially likely, since not only the interplay between the hemispheres matters for the frequency of false memories, it is also relevant which brain hemisphere encodes and retrieves stimuli (Fabiani et al., 2000; Loring et al., 1989; Westerberg and Marsolek, 2003). When the left hemisphere is the retrieving one, false memories arise less often than when the right hemisphere carries out the retrieval (Westerberg and Marsolek, 2003). In addition, there may also be a hemispheric difference for encoding. However, here the evidence is rather contradictory. While one study finds less false memories when the left hemisphere encodes stimuli (Loring et al., 1989), another study finds no performance difference (Fabiani et al., 2000). Moreover, event-related brain potentials suggest that it is the right hemisphere which differentiates between stimuli that were actually seen and stimuli that were not. Whereas event-related brain potentials differ for true and false recognitions when the right hemisphere encodes stimuli, they do not when the left hemisphere does the encoding (Fabiani et al., 2000). Taken together, this evidence points to possible hemispheric differences for encoding along with a left-hemispheric advantage for retrieval.

This raises the question as to whether the two directions of interhemispheric communication, from left to right and from right to left hemisphere, are similarly effective in reducing false memories. This point remained open in the previous studies, because there either only the encoding (Fabiani et al., 2000; Loring et al., 1989) or only the retrieval (Westerberg and Marsolek, 2003) of the items was lateralized. The present study investigated the issue by lateralizing both the encoding and the retrieval of stimuli: both learning and test items were presented in the visual periphery, so that they stimulated only one brain hemisphere. The information transfer between the two hemispheres was tested by presenting learning and test stimuli to opposite hemispheres.

To elicit a noticeable amount of false memories, the Deese–Roediger–McDermott paradigm was employed (Deese, 1959a, 1959b; Roediger and McDermott, 1995), as was done in the original study by Christman et al. (2004). In the Deese–Roediger–McDermott paradigm, all learning words are semantically connected to lure words which are not presented during the learning episode. At test, however, these lures as well as semantically unconnected new words are randomly intermixed with the previously studied words and typically elicit a high number of false remembrances (Deese, 1959a; Roediger and McDermott, 1995; Stadler et al., 1999).

Given the previously observed effect of interhemispheric interaction on the incidence of false memories (Christman et al., 2004), such false remembrances should occur less often with interhemispheric communication than without. However, since this effect was demonstrated only once so far (Christman et al., 2004), the present study attempted to replicate it here. In addition, this study addressed whether the two directions of interhemispheric transmission are similarly efficient in reducing false memories. This should be the case if a left-hemispheric superiority for encoding accompanies the left-hemispheric superiority for retrieval. In this case, an encoding advantage for left-to-right-hemispheric transfer would be balanced by a retrieval advantage for right-to-left-hemispheric exchange. By contrast, false recognitions should arise less frequently for right-to-left-hemispheric communication if no hemispheric difference for encoding occurs with the left-hemispheric superiority for retrieval. In that case, the transfer from right to left hemisphere should outperform the other way of interhemispheric communication at the retrieval stage. Likewise, right-to-left-hemispheric transmission should also be superior if a right-hemispheric superiority for encoding accompanies the left-hemispheric superiority for retrieval. In this last case, right-to-left-hemispheric transfer would be advantaged both at encoding and at retrieval.

2. Methods

2.1. *Participants*

Seventy-two participants were tested. Two subjects were discarded from the sample because they made none or exactly one button press. The remaining 70 participants (29 of them male) had a median handedness score of 100.00 as measured by the Edinburgh Handedness Inventory (Oldfield, 1971; standard deviation (SD) = 29.12; two lefthanders[1]) and a median age of 23.50 years (SD = 19.30, range from 12 to 73 years). The broad age span of the participants was chosen for two reasons. First, false memories tend to occur more often in older subjects (Isingrini et al., 1995; Koutstaal and Schacter, 1997; Multhaup, 1995; Norman and Schacter, 1997). Second, interhemispheric transfer might be age-modulated, and may be at its best between the ages of 20 and 60, when the corpus callosum is already fully matured, but not yet affected by age-related fiber degradation (Bastin et al., 2010; Bennett et al., 2010; Burgmans et al., 2010; Chen et al., 2009;

[1] Both lefthanders were in the nontransfer groups, however, so that the difference between right-to-left and left-to-right transfer cannot result from their influence.