

Counterfactual imagination as a source of memory distortion: cognitive and brain mechanisms

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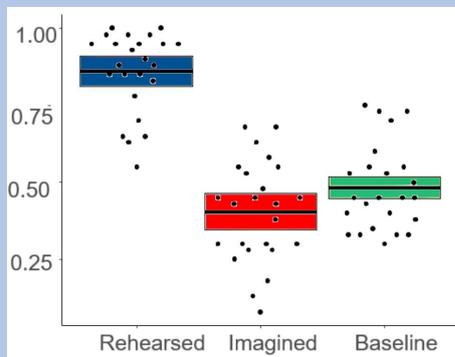
Background:

It can be difficult to differentiate between imagined and perceived events within our long-term memory^{1,2,3}. Researchers have developed lab-based paradigms in which participants perform or imagine actions with everyday objects, to replicate how we interact with the world. In these studies participants often make source-confusion errors, by mistakenly reporting they had performed actions that they only imagined^{4,5}. However, these studies don't tell us how imagination can distort *existing* memories. Here, we investigated whether counterfactual imagination would impair memories for previously performed actions.

Participants performed actions with 120 everyday objects and later either mentally **rehearsed** the same action or **imagined** a counterfactual action when shown pictures of the objects. Objects that did not appear in this task were treated as the **baseline** condition. We then tested participants memory for the performed actions. We also recorded EEG activity while participants attempted to recall to investigate the brain mechanisms associated with imagination-induced memory distortions. We predicted that true memories for performed actions would be more difficult to recall after counterfactual imagination.

Cued recall performance:

Proportion of accurate responses during the cued recall test. Accuracy for the imagination condition was significantly lower than the baseline condition. Therefore, counterfactual imagination impairs or distorts the original memory trace beyond simple forgetting over time.

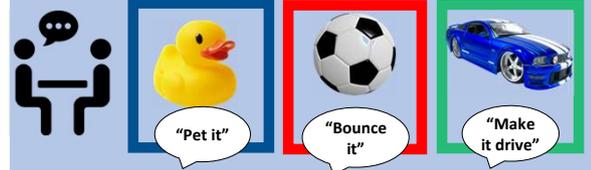


Stimuli, procedure and design:

24 participants, 20.4 years, $SD_{age} = 1.93$ years

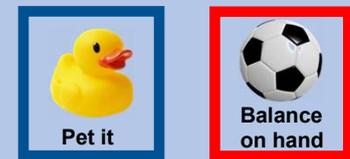
Encoding phase

120 real objects handed to participants with instructions to perform actions



Manipulation phase

80 object picture -action sentence pairs shown with 3 repetitions (240 trials). Participants imagined performing the described action



Cued recall

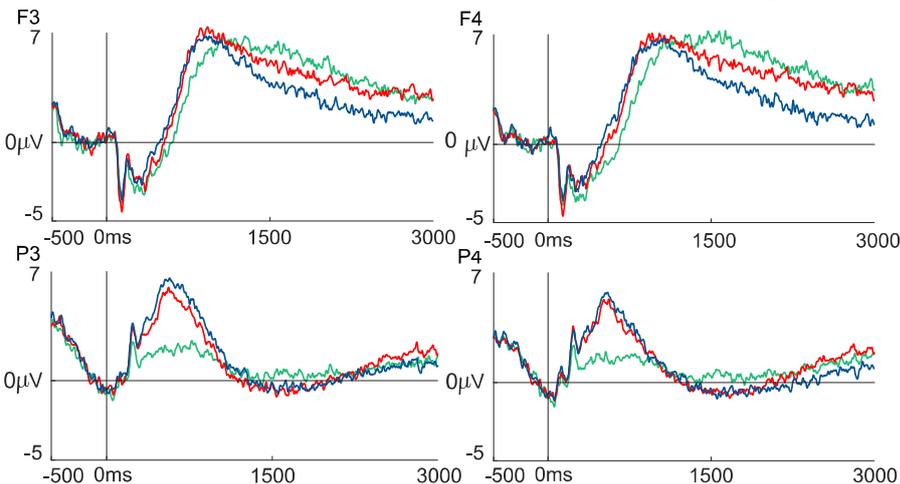
Participants asked to recall the action performed for each object in the encoding phase



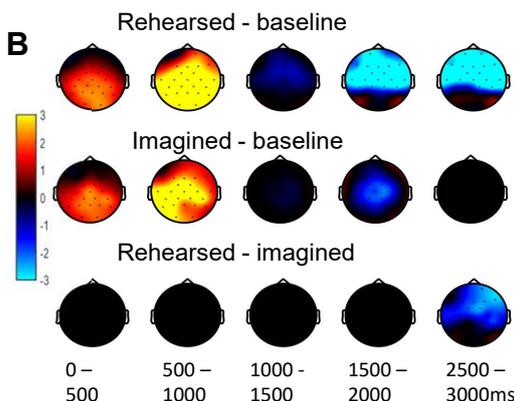
A

Cued recall ERPs

– Rehearsed
– Imagined
– Baseline



B



- A. Grand-average ERPs from the cued recall test, showing left-frontal (F3), right-frontal (F4), left-parietal (P3) and right-parietal (P4) electrodes.
- B. Pairwise differences between ERP conditions. Coloured regions show significant ERP differences as assessed with cluster-based permutation tests.

Discussion of ERP results:

Early ERPs (0-1000ms) were sensitive to whether the image cue had been previously seen, so are in line with typically old-new effects⁶.

Later Frontal ERP slow drifts (1500-3000ms) were more positive when recall was difficult (baseline > imagined > rehearsed), in line with literature associating frontal slow drifts with executive control functions during remembering, such as retrieval monitoring⁷ These findings therefore suggest similar retrieval control processes were involved when recall was difficult due to a lack of rehearsal (baseline) and when recall was difficult due to the impairing effects of counterfactual imagination.

Future directions:

We plan to perform time-frequency analysis for this experiment, to test for relationships between ERP slow drifts and oscillations.

Conclusions:

We found novel evidence that counterfactual imagination can distort true memories of self-performed actions, despite their sensorimotor rich nature. ERPs suggested that remembering true actions after counterfactual imagination recruited control processes at a late stage of retrieval.

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