Schema effects on learning and memory

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INTRODUCTION

Background: Schema theory predicts that learning and remembering new information is enhanced when the to-be-learned information can be assimilated with prior knowledge or "schemas". Experiments in rats have shown that schemas enable rapid learning and consolidation, whereby new memories sooner become independent of the hippocampus. fMRI studies in humans suggest that the medial prefrontal cortex becomes increasingly important during encoding and retrieval of schema-congruent information.

Aims:
1) Develop a human analogue of the item-location memory task that was used to study schema effects in rats.
2) Use this task to assess schema effects on behavioral performance and brain activation during memory encoding and retrieval in humans.

METHOD

Subjects: n=23 males, 19-29 yrs, all right-handed

Paradigm: Subjects use a computer program to learn the location of artworks in a museum. The museum has a permanent and a temporary collection, each with 10 unique artworks on display. In the permanent collection, both the artworks and their locations are fixed across days. In the temporary collection, artworks are fixed but have new locations each day.

Training (days 1-4): Subjects learn to associate the artworks with their specific locations. Each day there are four trials with each artwork, and subjects receive feedback on their performance on each trial.

New learning (day 4): Subjects learn the location of 20 new artworks (10 in each collection), in a similar manner as during training.

Recall (days 6 and 20): Recall of the new artworks is tested 48 hrs and 2 weeks later. There are four trials with each artwork. No feedback is provided in this phase.

fMRI scanning:
- Siemens Skyra 3 Tesla
- Whole-brain gradient-echo EPI
- Field of view: 257.2 x 257.2 x 5 mm
- TR/TE: 2.63 s

Data analysis:
- Mixed-effects GLM in FEAT (FSL)
- Shown here: preliminary group results from the analyses of task blocks
- All shown activations are significant at z>2.3, cluster p<0.05 corr.

FMRI RESULTS

SESSION-DEPENDENT ACTIVATIONS

BEHAVIORAL RESULTS

SUMMARY AND CONCLUSIONS

As a result of repeated training, knowledge of item-locations accumulated in the permanent condition but not in the temporary condition. This indicates that subjects developed a stable mental schema of item-locations in the permanent condition, and that the temporary condition can serve as a valid control condition.

During learning of new item-locations on day 4, performance was better in the permanent than in the temporary condition. This is in line with other observations that the availability of a schema enhances new learning.

Recall performance was initially (48 hrs) similar in the two conditions but decreased more over time (2 weeks) in the permanent condition. Thus, we find no evidence that schemas facilitate long-term recall. This is contrary to theoretical predictions and past research, but may have a plausible explanation: Subjects reported higher interference among new items in the permanent condition (day 4) vs. that of normal conditions (day 4), than among new items in the temporary condition.

Our preliminary fMRI results show that the manipulation of schema knowledge is reflected in activation differences both between conditions and over time. New learning with a prior schema yields greater activation in PFC and in visuo-spatial processing regions incl. the retrosplenial cortex and precuneus, compared to new learning without a schema. This activation may reflect integration of new information with existing knowledge represented in neocortical networks.

These results are still preliminary and additional fMRI analyses (e.g., individual trials and performance effects) will reveal more of the intricate details of schema learning and memory.

REFERENCES

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