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# Behavioral and EEG Indicators of True versus False Memory

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## Background

### False Memories, the Deese-Roediger-McDermott (DRM) Paradigm, and Psychophysiology

The Deese-Roediger-McDermott (DRM) paradigm [4] is one prominent approach to study the "false-memory" phenomenon. Here, the presence of schematic knowledge is crucial for the false recognition of unseen, schematically associated ("lure") items among several truly recognized control items.

The Fuzzy-Trace-Theory (FTT, [1]) explains these false memories by a different functioning of two different memory traces, "gist" and "verbatim", which are encoded in parallel but differ in precision and persistence.

Few studies investigated the DRM effect using visual scenes combined with a visual recognition phase [3]. Furthermore, previous studies were affected by single-item effects; a randomized categorical design was desirable.

A minority of DRM studies was combined with psychophysiological measurement. However, differences in event-related potentials (ERPs) between true and false memories have been found with other experimental paradigms [2], indicating different neurophysiological correlates of *recollection* and *familiarity*.

### Leading Questions:

1. Are true and false memories for details of visual scenes accompanied by different event-related potentials?

2. Is the DRM effect sensitive to a) the attentional ("gist" vs. "verbatim") instruction for the encoding phase, and b) the (photographic vs. virtual) type of the pictorial stimuli?

## Methods

### Subjects

44 students (31 f, 13 m, age 24.4 ± 2.9 y., various faculties)

### Stimuli and design

New scenic, pictorial stimuli (50% photographic, 50% by SceneCaster). 20 scenes; 1 lure and 3 controls plus 1 unrelated item per scene. Categorical design (randomized choice of the "lure" item out of 4 items within each scene, balanced over subjects). Within-subject manipulation of "gist" vs. "verbatim" attentional focus for encoding.

### Procedure

**Phase 1:** encoding phase (presentation of 20 scenes for 55 seconds each, see figure 1, with cover story and pseudo-task)

**Phase 2:** retention phase (Tellegen Absorption Scale and EEG preparation)

**Phase 3:** retrieval phase (serial presentation of 2 x all 100 items, see figure 2, duration: 4 sec., SOA 5.6-6.0 sec., yes-or-no answer)

**Phase 4:** level of confidence rating (self-paced serial presentation of all 100 items, 7-step rating scale)



Figure 1: scenic picture (encoding phase)

Figure 2: single item (retrieval phase)

### Recording and data analysis

**Behavioral:** memory accuracy; reaction time; level of confidence.

**Physiology:** 15-channel EEG; reference: linked mastoids; sampling: 500 Hz; filter: 0.15-30 Hz. 2-channel EOG.

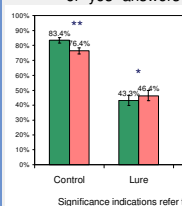
**Analysis:** ANOVA for behavioral data; t-test and bootstrapped amplitude difference [5] for ERPs.

## Results

### Behavioral data

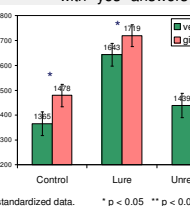
#### Memory accuracy

Figure 3: percentage of "yes" answers



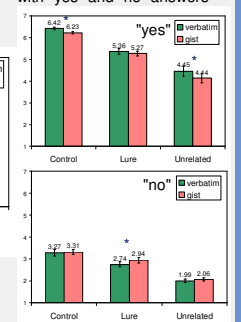
#### Reaction time

Figure 4: reaction time with "yes" answers



### Level of confidence

Figure 5+6: confidence ratings with "yes" and "no" answers



### Event-related potentials

#### Grand average of ERPs at Pz electrode site

Figure 7: rejected lures (red) vs. rejected unrelated items (black)

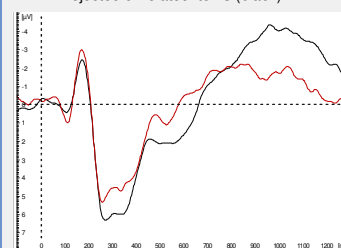
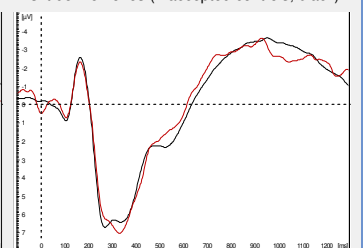


Figure 8: false memories (= accepted lures, red) vs. true memories (= accepted controls, black)



#### Significance tests:

**t-test** for P300 peak amplitude (300-600 ms):

- rejected lures vs. rejected unrelated items:  $T_{43} = 2.24$ ;  $p < 0.05$

- accepted lures vs. accepted controls:  $T_{43} = 0.83$ ;  $p > 0.1$

**bootstrapped amplitude difference** (on an individual basis, peak-to-peak method, [5])

- rejected lures vs. rejected unrelated items: significant ( $p < 0.05$ ) in 24 of 44 subjects

- accepted lures vs. accepted controls: random pattern, significant ( $p < 0.05$ ) in 2 of 44 subjects.

## Discussion

1. The DRM study used a categorical design with new, scenic pictorial stimuli. Recognition rates indicated a good performance of the item set and design. Level-of-confidence ratings suggest that the typical "yes"-or-"no" answers in the DRM retrieval phase provide a shortened view on false memories.

2. Higher memory accuracy, faster responses and higher levels of confidence in the "verbatim" than in the "gist" condition were found, which would be in line with the Fuzzy-Trace Theory. Furthermore, memories tended to be more accurate for stimuli composed of photographic elements than for virtual images, although the latter were less complex.

3. ERPs differed between the two different types of "correct rejections" (i.e. schematically associated lures or unrelated items), which reflects the processing of different tasks. Contrary to our expectation however, ERP differences between true and false memories were not significant. ERPs in this study did not allow for a differentiation between recollection and familiarity.

## References

1. Brainerd, C.J.; Reyna, V.F. (1990). Fuzzy Trace Theory. *Developmental Review*, 10, 3-47.
2. Curran, T.; Cleary, A.M. (2003). Using ERPs to dissociate recollection from familiarity in picture recognition. *Cognitive Brain Research*, 15(2), 191-205.
3. Miller, M. B.; Gazzaniga, M. S. (1988). Creating false memories for visual scenes. *Neuropsychologia*, 36(6), 513-520.
4. Roediger, H.L.; McDermott, K.B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21(4), 803-814.
5. Rosenfeld, J.P., Soskins, M., Bosh, G., Ryan, A. (2004). Simple, effective countermeasures to P300-based tests of detection of concealed information. *Psychophysiology*, 41(2), 205-219.