Modelling effects of object naming on long-term object recognition memory

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Lupyan (2008) demonstrated that overtly naming objects leads to impaired long-term recognition memory compared to objects rated for preference (naming effect). Critically, this effect was reflected in a reduction in hit rates for named objects with no differences in false alarm rates. Participants failed to recognize previously named objects but were not biased to falsely recognize lures matched to named objects.

Lupyan proposed a representational shift account of this naming effect whereby overtly naming an object activates top-down information of the object's category that then augments the bottom-up object representation. This top-down categorical information thus distorts the representation for the named object creating a mismatch between the memory representation of the object and the perceptual representation of the object when it is presented again later during a memory test. This mismatch leads to a lower hit rate for named objects. A central tenet of the representational shift account is that the memory distortion for named objects arises from a dynamic interaction between top-down category information and bottom-up perceptual representations. This account tacitly assumes that naming objects and rating their preference produces representations of otherwise equivalent memory strength, and that any difference in memory strength would not predict the naming effect.

More recent work argues that differences in recognition memory between named objects and preference rated objects are more likely a consequence of stronger memory following a preference rating (Richler, Gauthier, & Palmeri, 2010). Rating preference of objects leads to better memory than naming because rating preference is a more effortful task that leads to stronger representations (e.g., Craik & Lockhart, 1972).

Unfortunately, both the representational shift and depth of processing accounts are merely verbal theories. The current work investigates the plausibility of both accounts within the framework of the REM model, a

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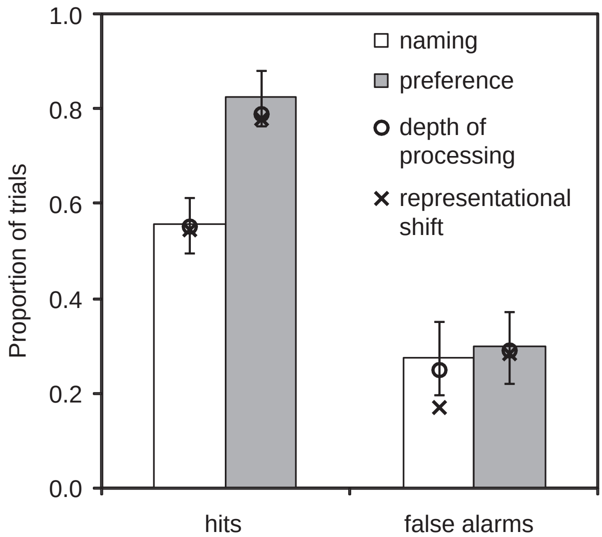

Figure 1. Model simulation results with behavioural data from Richler et al. (2010). Behavioural data shown in columns plot the proportion of hits and false alarms for objects named at study (white bars) and rated for preference (grey bars); error bars represent 95% confidence intervals. Model predictions are plotted as data points for the depth of processing model (circles) and representational shift model (crosses).

leading computational model of human recognition memory (Shiffrin & Steyvers, 1997). REM represents objects as a vector of features, with parameters that determine the value, strength, and probability of feature encoding. At test, the representation of a test object is compared to each trace in memory through calculation of a likelihood ratio. If the average of these likelihood ratios is greater than a criterion, the test object is labelled "old"; otherwise it is labelled "new".

Both the representational shift and depth of processing hypotheses can be modelled by manipulations of different mechanisms within REM. The representational shift is implemented as a postencoding shift of memory traces for named objects towards the prototypical object. The depth of processing account is modelled as a difference in the strength of encoding of feature values, with lower strength for preference versus named objects. This results in memory traces with more encoded values for rated objects than named objects.

Each of these two hypotheses was instantiated by a single parameter difference in REM between naming and preference, with all other parameters between the two encoding tasks held constant. One simulated experiment consisted of 40 study objects (20 in the naming condition, 20 in the preference condition) and 40 matched lures, just like the human experiments. Model performance was based on the average hit rates for the study objects and false alarm rates for the lures from 1000 experiment simulations. Best-fitting parameters for both models were found with the simplex method by minimizing the summed squared error between the model and behavioural data from Richler et al. (2010).

Results of the model simulations are shown in Figure 1 along with the Richler et al. (2010) behavioural results. To briefly summarize the behavioural data, the naming effect is reflected by the lower hit rate for objects named at study (white bars) relative to objects rated for preference (grey bars), with no difference between naming and preference in false alarms to matched lures. This pattern of results is accounted for by the depth of processing hypothesis (circles in Figure 1), but not by the representational shift model (crosses in Figure 1). The representational shift model predicts a lower hit rate for objects named at study; but, critically, the model also predicts fewer false alarms for lures matched to named objects.

Evaluating the two accounts of the naming effect offered by Lupyan (2008) and Richler et al. (2010) within a computational framework provides two critical results. First, the representational shift account does not predict the behavioural naming effect. Second, predictions from the depth of processing account are consistent with the behavioural naming effect. These results coupled with Richler et al. provide converging evidence that the naming effect can be explained using general principles of recognition memory, where memory differences are the result of differences in the strength of initial encoding.

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