Between the single- and dual-process models of recognition memory: an alternative view

Olya Hakobyan (olya.hakobyan@rub.de)
Institute for Neural Computation, Ruhr University Bochum
Germany

Sen Cheng (sen.cheng@rub.de)
Institute for Neural Computation, Ruhr University Bochum
Germany

Abstract

According to the widely established dual-process model, the perirhinal cortex and hippocampus make distinct contributions to recognition memory in the form of familiarity and recollection. These two processes are associated with the curvilinearity and y-intercept of the ROC-curves, respectively. The evidence that hippocampal lesions affect the y-intercept more than the curvilinearity seems to support this view. Here, we argue that quantitative differences between generic memory modules are sufficient to account for this result. Thus, two qualitatively different memory systems are not required. Although similarities to single-process accounts exist, our model generates realistic ROC-curves based on distinct mechanisms.

Keywords: recognition memory; hippocampus; perirhinal cortex; computational modeling

Since recognition judgments involve decision making under uncertainty, signal detection theory has been widely utilized in research on recognition memory. However, in contrast to the predictions of signal detection theory, the recognition ROC-curves express a pronounced y-intercept. One of the most discussed findings in the recognition literature is the reduction of the y-intercept after hippocampal lesions. According to the dual-process account, this observation is evidence for a selective role of the hippocampus in one process, recollection, which is impaired after hippocampal lesion. The second process, familiarity, is associated with the curvilinearity of the ROC-curve and not affected as much by hippocampal lesions. By contrast, single-process accounts argue that the impairment after hippocampal lesions is due to the overall decrease in the memory strength (Yonelinas & Parks, 2007). We use an algorithmic model of recognition memory to account for this result. Our model differs in crucial ways from both the dual- and single-process computational models. The dual-process models implement different architectures and/or memory mechanisms for memory retrieval in the hippocampus and perirhinal cortex (Norman & O'Reilly, 2003), whereas the single-process models typically model a single system that uses global similarity as memory strength measure (Clark & Gronlund, 1996). While we agree that the y-intercept in recognition memory reflects memory strength rather than a qualitatively different process, the use of the global similarity is often associated with

the perirhinal cortex and cannot explain how the involvement of the hippocampus increases the memory strength.
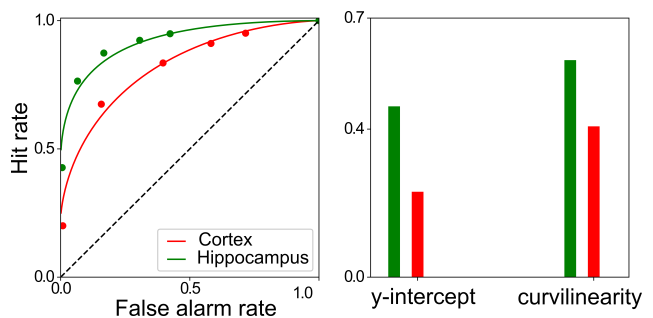

Figure 1: Due to quantitative differences in parameters, the hippocampus and perirhinal cortex appear to have different contributions although the underlying mechanism is the same.

We suggest that both memory modules engage in generic memory storage and retrieval, while recognition judgment is a decision process that evaluates the similarity between the retrieval cue and the retrieved pattern. Importantly, retrieval and recognition are based on the maximum similarity between the cue and *individual* stored items, in contrast to a global-match measure. Our results show that both features of the ROC-curve can be generated by a single simple memory module and the relative expression of the two features depends on the parameters of the memory module, such as pattern separation and robustness to noise. In its current form, the model accounts for the influence of multiple factors on recognition performance, such as input statistics, lesions, list length and retention time.

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