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Dissociating short- and long-term recency

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In this paper, we contrast two approaches to recency effects in free recall. The first is the Hebbian dual trace view, which holds that the contents of short-term store is based on the activation of consolidated memory representations and that episodic memory is related to synaptic weight changes that occur when representations remain active for long enough time. In accordance with this view, recency effects in immediate free recall are due to easy read-out from the activation-based short-term store. This is compared to the second view which holds that there exists only a single memory system and that recency effects in free recall are due to a recency-based retrieval process that is sensitive to the temporal discriminability of items (cf. Crowder, 1976). This second view accounts for recency effects in both the immediate free recall and the *continuous distractor task*. Whereas in the former, participants are presented with a sequence of words after which they are required to recall all the words in any order, in the continuous distractor task, participants are also required to perform a distractor task before and after each word, which should wipe-out the contents of the short-term store. Even so, a *long-term recency effect* is obtained in this task (Bjork & Whitten, 1974), rendering it difficult to maintain a view that all recency effects are a signature of a short-term store.

However, in this paper, we argue against a retrieval-only view of recency and show by developing and applying a new neurocomputational model of free recall, that a more detailed dual-trace approach forms a parsimonious explanation for recency effects in immediate and continuous distractor free recall. In addition, we present data that suggest that the *temporal scale-invariance* principle, i.e. when the ratio between the inter-presentation and the retention interval is kept constant a similar recency slope should be observed (Glenberg, et. al, 1983), is not always found.

Model explanations of recency

The neurocomputational process model of free recall has an activation-based short-term memory component (cf. Davelaar & Usher, 2002; Haarmann & Usher, 2001) and a contextual episodic memory system. The model accounts for short- and long-term recency effects (see figure 1) in different ways.

Short-term recency is due to easy read-out from the activation-based memory component and to a limited extent to contextual processes (as there is a negative recency gradient in the episodic traces, see for discussion Davelaar & Usher, 2002). In the model, the competition between activated representations underlies the capacity limitation and the displacement type of forgetting.

Long-term recency is due to the contextual retrieval process. In the model, context units are activated sequentially according to a random walk with drift, which ensures that temporally close items are more likely to be associated with the same context unit than temporally distant items. The context keeps changing during the retrieval phase and drives the sequential recall.

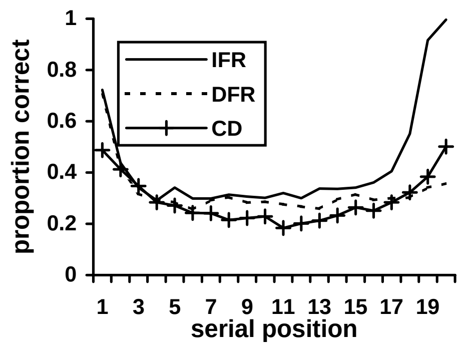

Figure 1. Model application to list memory. The model accounts for serial position functions in immediate (IFR), delayed (DFR) and continuous distractor (CD) free recall. The ability to account for short- and long-term recency allows a consideration of dissociations between them.

The model predicts that semantic similarity has a differential effect on short- and long-term recency and that the serial position curve reveals a shift from recency to primacy as function of presentation rate, a prediction that other dual-store models (e.g. SAM; Raaijmakers & Shiffrin, 1981) do not make.

Semantic similarity

As discussed in a previous paper (Haarmann & Usher, 2001), our model predicts that semantic associates that are presented in close temporal proximity, support each other in the activation-based memory system. When pairs of associates are presented (e.g. scissors steel light candle), the model predicts that a *zigzag* pattern (better recall for words for the first that second word in a pair of related words) would be present in immediate free recall at recency positions. This is explained as follows. The first member of a pair is relatively spared from being displaced when the second member is presented and therefore stays longer in active state. As the displacement process is asymmetric (first-in-first-out), a relative advantage for

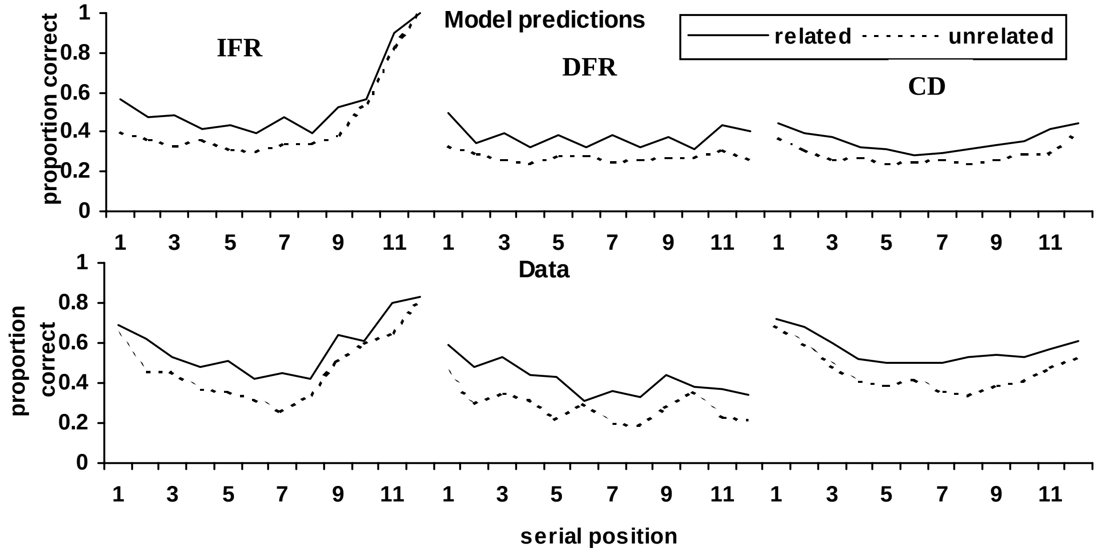

Figure 2. Model predictions (top) and data (bottom) for the effect of semantic similarity (pairs of associates) in immediate (IFR), delayed (DFR) and continuous distractor (CD) free recall. Note the presence of a zigzag pattern in immediate and delayed free recall, which is absent in the continuous distractor task.

odd over even positions is present. The model predicts that at pre-recency positions a zigzag pattern could be observed, but that this is of a smaller magnitude. The zigzag pattern at these positions is due to stronger episodic trace strength for the first that the second pair member. It therefore predicts a zigzag pattern in delayed free recall. As in the continuous distractor task members of a pair are assumed not to occupy the short-term buffer simultaneously, no zigzag pattern is expected.

Presentation rate effects

The forgetting mechanism need not be of a first-in-first-out nature. The activation levels that representations reach, depend strongly on the duration that a representation is allowed to accumulate activation in the face of other competing representations. The model predicts an effect of presentation rate on the recency function even when the ratio is kept constant. In fact, the model predicts a shift from recency to primacy with increase in presentation rate (results are in figure 3). This shift in gradient is due to the inhibitory influence that already activated representations have on subsequent activation of other representations. Under slow presentation rate conditions, the activation accumulates to such a level that it can counter the inhibitory influence, leading to a first-in-first-out displacement process. Under fast presentation rates, the activation does not reach this critical level and as a result subsequent items are less likely to activate their corresponding representations, thus leading to a primacy gradient.

Conclusion

The data supports a dual trace view of human memory, where short- and long-term recency effects are due to different processes. The temporal scale-invariance is shown not to hold for situations where our model predicts greater involvement of the activation-based short-term buffer to recall performance.

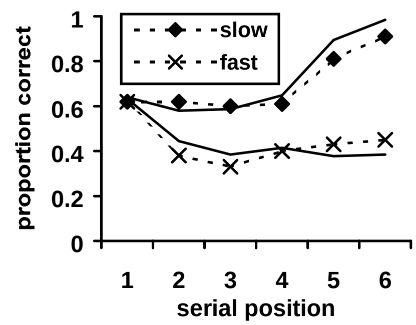

Figure 3. Model prediction (solid lines without symbols) and data (dashed lines with symbols) on presentation rate effects in category cued recall. Note that the recency gradient that is present at slow presentation rate (800 ms) has made way for a primacy gradient with fast presentation rates (100 ms), which is not explained by the scale invariance principle postulated by the temporal discriminability account of recency effects.

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