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The neurodynamical basis of multi-item working memory capacity: sequential vs simultaneous stimulation paradigms

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When investigating multi-item WM, and in contrast to single item experiments, a decision must be made regarding a key aspect of the stimulation protocol: how the memory set is presented to the subject *simultaneously* or *sequentially*. It is worth noting that most studies investigating multi-item WM do not address this issue and focus either in simultaneous stimulation protocols (e.g. [1,2]) or in sequential stimulation protocols (e.g. [3]) without confronting the two situations. This is nevertheless an aspect which provides a benchmark to probe and compare the different theories regarding how resources are allocated among the different items of a memory set [4,5]. In this study, we explore a biophysically-realistic attractor model of visual working memory (VWM) endowed with synaptic facilitation and investigate what are the effects of varying the dynamics of the facilitation process. We find that: 1) it is possible to reproduce experimentally observed effects such as the *recency* effect in sequential stimulation protocols (i.e. items presented in the final positions of a sequence are more likely to be retained in WM), and 2) WM capacity is boosted in both sequential and stimulation protocols when endowing the attractor network with synaptic facilitation.

Conclusions

In agreement with our previous results [2], synaptic facilitation boosts the WM capacity limit by effectively increasing the synaptic strengths just for those pools to which a cue is applied, and then maintaining the synaptic facilitation by the continuing neuronal firing in only these pools when the cue is removed. In this study, the time constant τ_F of the synaptic facilitation process has been found to play an important role in modulating this effect with large τ_F values leading to larger capacity limits in both sequential and simultaneous stimulation protocols. However, too large τ_F values lead to neuronal dynamics which are not compatible with the *recency* effect, thus constraining the range of values that τ_F may take.

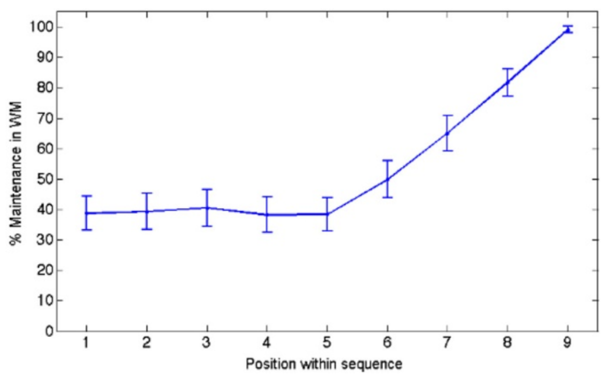

Figure 1 Maintenance of an item in WM memory as a function of its position within a sequence. The results are derived from computational simulations (100 blocks of 100 trials) of a delayed match-to-sample task (same stimulation protocol as in [3] and test item assimilated to a delayed match-to-sample task) with 9 selective neural assemblies sequentially stimulated. Maintenance in WM is estimated by assuming that an item is held in memory when its associated selective pool shows a mean persistent activity $\nu \geq 30$ Hz during a period of 500 ms 2 s after the end of the last stimulation. The network parameters can be found in [2] and τ_F=750 ms in this example.

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