**Cognitive and Electrophysiological Mechanisms of**

**Visual Short-Term Memory Updating**

Most of our everyday activities require holding visual information in our minds and using it to guide our actions. Visual short-term memory (VSTM) is the system that provides this ability. Importantly, the information in VSTM should be continuously updated, in order to accommodate task-relevant input from the environment and remove irrelevant and outdated information. Previous work from my laboratory on *verbal* short-term memory updating revealed two component processes of updating. The first, *local updating* is responsible for the actual modification process of the information. The second, *global updating* is carried out after the information modification takes place, and is responsible for the creation of a unitary compound representation out of the new and old items in VSTM. The aim of the present project was to examine whether similar processes take place in VSTM, and uncover the mechanisms by which VSTM updating is carried out.

As part of *Aim 1* of this project, a VSTM updating task was developed in which several arrays of visual information are presented one after the other. The participants in this task were required to update their memory with the new information that appears in each screen, and then to perform a recognition test based on the most recent information. Performance in the recognition test was examined, as a function of the previous update condition. Specifically, we found that change detection performance was sensitive to the number of items that were updated in the second memory array, compared to the first array. Such a difference is predicted by local updating, but not expected if global updating takes place. Based on these results, we moved to examining the event-related potential (ERP) correlates of VSTM updating (*Aim 3)*. The behavioral paradigm was modified to enable examining the electrophysiological brain correlates of VSTM updating. In addition to replicating the behavioral results, we identified two independent ERP components that correspond to local and global updating, respectively. Specifically, ERP activity over frontal electrodes was sensitive to the number of changed items within a memory set, around 300ms from stimulus onset. This effect is compatible with the predictions of local updating. In addition, the activity in lateral-posterior electrodes was different in the no-update conditions compared to all updating conditions, but no effect was observed for the number of updated items. This pattern is compatible with the predictions of global updating. The results of this work published in *Journal of Vision* (Kessler et al., 2015).

Given the lack of behavioral evidence in the visual paradigm for global updating, we turned to investigate the phenomenon of global updating in verbal working memory (WM), in a greater detail. This step was essential in order to assess whether the different results for verbal WM and VSTM reflects differential updating mechanisms in the two systems, or stem from procedural differences. Together with Prof. Klaus Oberauer from the University of Zurich, we examined the contribution of the exact sequence of repeated and updated items within a memory set, as opposed to merely the number of updated items (as done before). This investigation revealed a new mechanism that is involved in WM updating, namely update-switching. We demonstrated that updating information in verbal WM is done in a sequential manner, and that RTs in updating tasks reflect two components: local updating, and the operation of switching between updated and repeated items. These processes explained the data, as well as previously published data, better than the predictions of the global updating hypothesis. This study was published in *Journal of Experimental Psychology: Learning, Memory and Cognition* (Kessler & Oberauer, 2014). A follow up study that further confirmed the sequential scanning hypothesis is now *in press* in *Psychonomic Bulletin & Review* (Kessler & Oberauer, in press).

The finding of a cost of switching between updating and maintenance in WM is a first and important behavioral evidence that confirms the prediction of computational models, which suggest a flexible gating mechanism that controls the input into WM. Based on this finding, we turned to investigate the role of update switching in the n-back task, a classical WM updating paradigm (Rac-Lubashevsky & Kessler, in press), and in procedural WM, namely WM for procedural tasks rather than declarative information (Kessler et al., in press). In both these domains, update-switching was found to be a crucial determinant of performance.

References:

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