Is the executive component of our working memory needed in all simple-arithmetic strategies?

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Intro

The executive component of our working memory (WM) is needed in both simple additions and simple subtractions (DeStefano & LeFevre, 2004). Although it has been shown that people use several strategies to solve simple-arithmetic tasks (LeFevre et al., 1996), it is not clear yet in *which* simple-arithmetic strategies the executive WM component plays a role.

Method

The Choice/No-Choice method was used to obtain unbiased estimates of strategy selection and strategy execution.
Twenty participants solved simple additions or subtractions in 4 conditions:
1 choice condition in which they were allowed to use the strategy they wanted (retrieval, transform, count)
-> *strategy selection*.
3 no-choice conditions in which they had to use one single strategy
-> *stratey execution*.
A choice reaction time task was used to inferfere with executive WM functions.

Results

The role of the executive in strategy execution (Figure 1)

Significant interaction between WM load (no load or executive load) and Strategy (retrieval, transform, or count) on no-choice latencies.
Although *each* strategy was executed significantly slower under WM load, this effect of WM load was larger on count than on transform and retrieval.
The effect was also larger on transform than on retrieval.

Figure 1

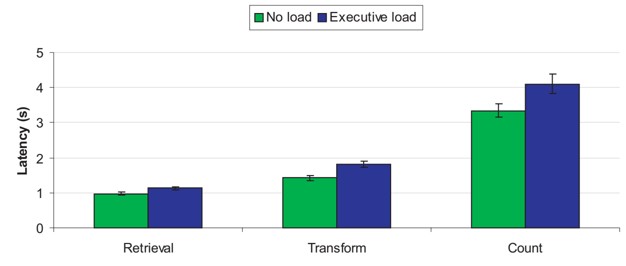
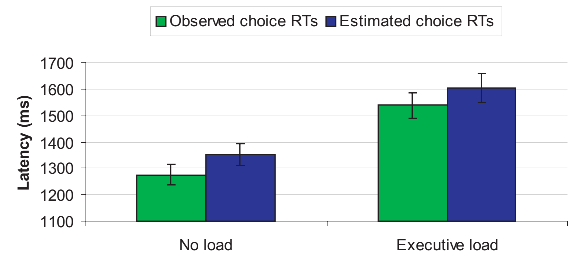


Figure 2



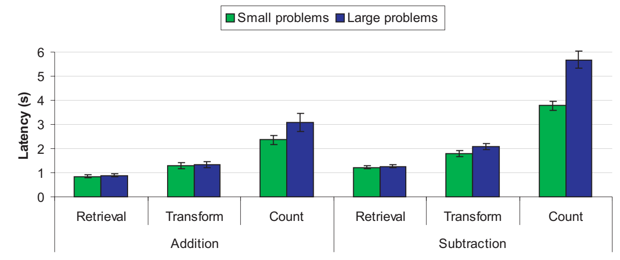
The role of the executive in strategy selection (Figure 2)

Estimated choice RTs are an estimation of what the choice RTs would have been when applying each strategy with the same frequency as in the choice condition, but *without* an optimal allocation of the strategies to particular problems. Estimated choice RTs are thus based on no-choice RTs; and are calculated with the following formula : (% choice of strategy *i* in session *j*) x (no-choice RT of strategy *i* in session *j*).
Observed choice RTs were significantly smaller than estimated choice RTs in the no-load condition but not in the load condition.
This indicates that participants were less adaptive under WM load.

The problem-size effect in strategy execution (Figure 3)

Significant interaction between Strategy (retrieval, transform, or count) and Problem size (small or large) on no-choice latencies.
The problem-size effect was absent in retrieval but significantly present in count and transform.
This effect was even more pronounced in subtractions than in additions (i.e., Strategy x Problem size x Operation interaction).

Figure 3



Conclusions

The present study investigated whether the executive WM component plays a role in simple-arithmetic strategy execution and strategy selection.

Strategy execution

All strategies relied on the executive WM component. However, as strategies became more demanding, more executive resources were needed.

Strategy selection

Having a choice among different strategies resulted in faster performance in no-load conditions but not in load conditions.
The executive WM component was thus needed to select the strategies in an adaptive manner.

References

DeStefano, D., & LeFevre, J. A. (2004). The role of working memory in mental arithmetic. *European Journal of Cognitive Psychology, 16, 353-386.*
LeFevre, J. A., Sadesky, G.S.,& Bisanz, J. (1996). Selection of procedures in mental addition: Reassessing the problem size effect in adults. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 22, 216-230.*