The role of working memory in simple-arithmetic strategies

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Introduction

Solving simple-arithmetic problems (e.g., 8 + 5; 6 x 7) relies on working-memory resources (*DeStefano & LeFevre, 2004*) and on multiple strategy use (e.g., *Hecht, 1999; LeFevre et al., 1996a, 1996b*). Until now, the combination of both research topics (working memory *and* strategy use) has not received much attention, though. The present study was designed to test the role of executive and phonological working-memory components across several simple-arithmetic strategies. The influence of individual differences was tested as well.

Method

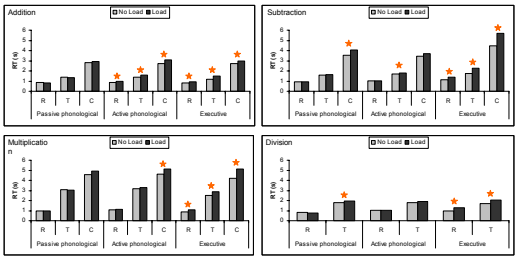
Participants had to solve simple addition, subtraction, multiplication, or division problems.

Choice/no-choice method: There was 1 choice condition, in which participants were free to choose any strategy they wanted (retrieval, transformation, and counting) and 2 to 3 no-choice conditions in which participants were requested to solve all problems with one single strategy.

Selective interference paradigm: The passive phonological store was loaded by means of irrelevant speech, the active phonological rehearsal process was loaded by means of letter strings which had to be maintained, and the central executive was loaded by means of a continuous choice reaction time task. Each subject participated in a no-load and a load condition.

Results

Analysis of percentages strategy use in choice conditions showed no effects of working-memory load on strategy selection. The frequency with which each strategy was chosen was equal in load and no-load conditions.



As can be seen in the figures above, the analysis of reaction times in no-choice conditions showed significant effects of working-memory load on strategy efficiency. The retrieval strategy relied on executive resources only. Transformation and counting strategies relied on executive and phonological resources.

The influence of individual differences was tested in the multiplication and division experiments only. The variables tested were: arithmetic skill (French kit), math experience (math classes in high school), math anxiety, the frequency of calculator use, and gender.

Multiplication	Skill	Experience	Anxiety	Calculator	Gender
Retrieval RT	-.415*	-.006	.009	.294*	-.210*
Transform RT	-.208*	.002	-.051	.093	-.047
Count RT	-.284*	.006	-.112	.109	.012
Retrieval use (%)	.190*	.256*	-.202*	-.205*	.270*

Division	Skill	Experience	Anxiety	Calculator	Gender
Retrieval RT	-.264*	-.047	.195*	.019	-.130
Multiplication RT	-.328*	-.230*	.233*	.083	-.105
Retrieval use (%)	.003	.150	-.006	-.063	.062

Execution speed (strategy efficiency) and percentages retrieval use (strategy selection) increased as participants were more skilled, more experienced, less math anxious, and less frequent calculator users. Both dependent variables were also higher in boys than in girls. Yet, the results differed greatly across operations.

Discussion

Strategy selection did not depend on working-memory resources. Strategy efficiency did depend on working-memory resources, although the role of the central executive was much more important than the role of the phonological loop. Procedural strategies also relied more heavily on working memory than did retrieval strategies.

References

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