Working Memory Load and Lexical-Semantic Processing under Dual-Task Demands

Nilanjana Chowdhury(n.chowdhury@iitg.ac.in)[1], Bidisha Som[2], Sukumar Nandi[3]
[1]Centre for Linguistic Science and Technology, [2]Department of Humanities and Social Sciences, [3]Department of Computer Science and Engineering, [1 2 3]Indian Institute of Technology Guwahati

Working memory supports language processing by maintaining and updating verbal information during ongoing task performance. Although higher working-memory load is often assumed to reduce resources for concurrent linguistic processing, it remains unclear whether the dual-task cost appears in lexical-semantic verification itself or in the concurrent memory-updating task. [1], [2]. The present study investigated whether increasing the load of verbal working-memory interferes with lexical semantic processing in dual-task conditions. **Participants and Methods:** 57 participants completed Experiment 1and Experiment 2. Experiment 1 established the working-memory manipulation using digit-based 2-back and 3-back tasks across 3-, 5-, and 7-digit sequences. Participants judged whether the current digit sequence matched the sequence presented two or three trials earlier. Experiment 2 combined the same load manipulation with a primary picture-word matching task and a secondary digit-recall task. In the primary task, participants judged whether a written word matched a preceding picture; in the secondary task, they responded to embedded digit sequences. Secondary-task response times were compared between 2-back and 3-back conditions within each sequence length. Accuracy was analyzed using participant-clustered binomial models, and response times were analyzed using linear mixed-effects models on log-transformed response time (RT). **Result:** Experiment 1 confirmed a strong working-memory load effect. Accuracy declined significantly from 2-back to 3-back for 3-digit sequences, 81.48% vs. 74.44%, ($z = -3.21$, $p = .001$); 5-digit sequences, 89.44% vs. 77.61%, ($z = -6.34$, $p < .001$); and 7-digit sequences, 87.61% vs. 0.92%, ($z = -8.56$, $p < .001$). Response Time (RT) were faster in 3-back than 2-back across the same comparisons: 3-digit sequences, $p < .001$, 6.69% faster; 5-digit sequences, $p < .001$, 11.46% were faster; and 7-digit sequences, $p < .001$, 18.88% faster. This indicated a speed–accuracy trade-off under increased load. In Experiment 2, primary-task picture–word matching showed no reliable 2-back/3-back difference in accuracy, ($z = 1.64$, $p = .101$, or RT, $\beta = -0.003$, $SE = 0.039$, $z = -0.07$, $p = .942$). However, secondary-task comparisons showed dual-task costs in higher-load conditions, especially 3-back/5-digit RT, ($\beta = 0.274$, $p < .001$), and 3-back/7-digit RT, ($\beta = 0.372$, $p < .001$). **Discussion:** These findings suggest asymmetric dual-task costs: lexical-semantic matching remained robust under concurrent verbal load, whereas memory updating became slower alongside language processing. Thus, verbal load did not directly impair lexical-semantic verification, but increased the cost of maintaining and updating information under high-load conditions.

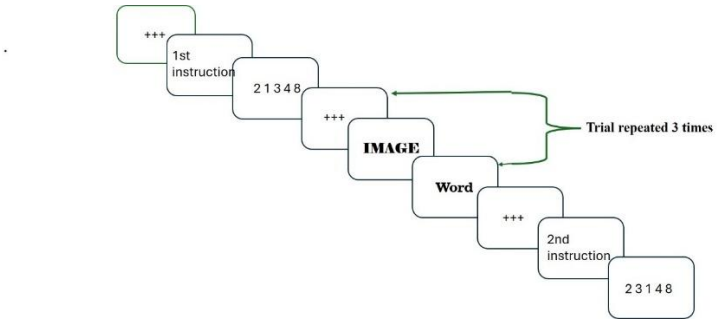

Fig1. Experimental design of Dual Task Paradigm

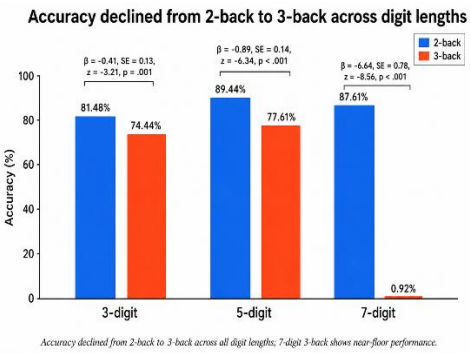

Fig2. Declining Accuracy

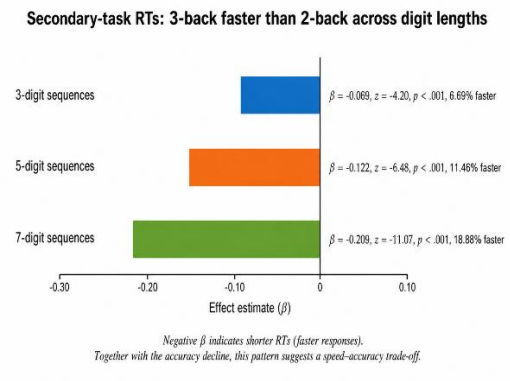

Fig3. RT of 3-back faster than 2-back

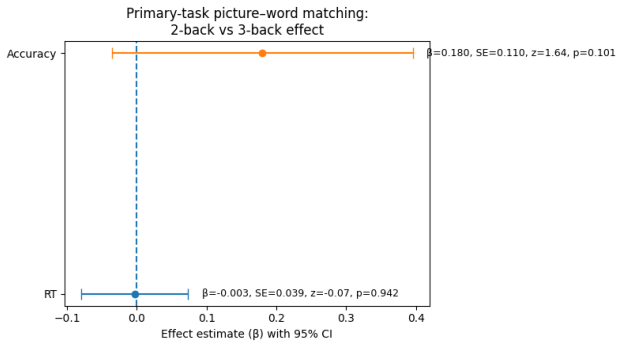

Fig4. Comparison of 2-back & 3-back in Picture-Word Matching

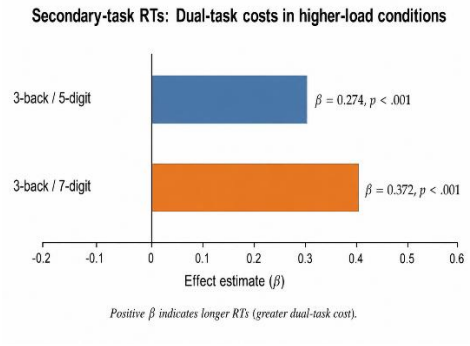

Fig5. Secondary-task RT: Dual-task

References

[1] J. Sweller, “Cognitive load during problem solving: Effects on learning,” *Cogn. Sci.*, vol. 12, no. 2, 1988, doi: 10.1016/0364-0213(88)90023-7.

[2] A. Baddeley, “Working memory: Theories, models, and controversies,” *Annu. Rev. Psychol.*, vol. 63, 2012, doi: 10.1146/annurev-psych-120710-100422.