ONE STEP BACKWARD: A SYSTEMATIC LITERATURE REVIEW ON THE USE OF N-BACK TASKS TO INCREASE WORKING MEMORY FOR LEARNER IN SLA

Darline Joy Magtana
University of Southeastern Philippines, Philippines

Article Info	ABSTRACT
	This literature review examines the role of working memory capacity (WMC) in second language acquisition (SLA) and explores potential solutions for learners with low WMC. Research shows that students with higher WMC perform better in vocabulary learning, oral fluency, and grammar. However, few studies offer strategies to help learners with lower WMC. The review highlights N-back tasks as a promising tool for improving working memory. Studies show that N-back training can enhance memory capacity but requires consistent practice for visible results. The researcher suggests incorporating N-back tasks to help students with low WMC improve their language learning skills.

Corresponding Author:

Darline Joy Magtana,
University of Southeastern Philippines, Philippines
Email: djmagtana@usep.edu.ph

1. INTRODUCTION

One of the significant challenges that students encounter in learning a second language is their low working memory (Chow et al., 2021; Ruiz et al., 2021; Wiest et al., 2022; Teng & Cui, 2024). Most of them can easily comprehend and process information for the time being but forget it instantly the next day. This problem slows down their progress and negatively impacts their overall success (Fry et al., 2020; Ger & Roebers, 2023). Several studies underscored the importance of working memory capacity (WMC) in SLA (Hamidnia et al., 2024; Harvey, 2024; Chingchit, 2024). Moreover, Kargar Behbahani & Razmjoo (2023) highlighted the role of WMC in EFL students' language proficiency. Their study revealed that participants with higher WMC performed better than those with lower WMC. This result emphasizes the significance of learners' cognitive abilities, especially their working memory, in retaining and recalling vocabulary (Perez, 2020; Ruiz et al., 2021; Teng & Zhang, 2023).

In the same context, Vanek's (2024) research showed the impact of working memory on specific L2 performance "(namely new vocabulary learning and grammatical

inferencing)." He also suggests the successful integration of working memory tests into the educational process.

Furthermore, a study by Mateo (2024) reveals a significant relationship between working memory and second language acquisition in Filipino grade 10 students. His study revealed that various aspects of working memory—"such as planning, problem-solving, reasoning, and understanding the first language comprehension"—greatly affect how well language learners process a second language.

The research findings mentioned above discuss the impacts (both positive and negative) of working memory capacity on the second language acquisition of L2 learners. However, there was no mention of solutions to address the influence of low working memory capacity on second language acquisition (SLA). Thus, this review collates several studies on the low working memory of language learners and explores N-back tasks as a potential solution.

2.   METHOD

The researcher utilized a systematic literature review to examine the available literature on using N-back tasks to increase working memory in SLA for learners. A systematic literature review is a methodology for discovering, assessing, and synthesizing research to address a particular inquiry. Systematic literature reviews are autonomous academic investigations that employ a well-defined strategy to guarantee objectivity in the review process.

Steps in a systematic literature review in this research include Frame the question: Clearly state the research question, identify relevant publications: Search for studies that are relevant to the question. Assess study quality: Evaluate the risk of bias in the studies. Summarize the evidence: Extract data from the studies and interpret the findings: Draw conclusions about the question.

This research data analysis is evaluating previous research that is relevant to the research topic. We carry out this analysis by comparing, contrasting, and synthesizing the findings from these studies.

3.   RESULTS AND DISCUSSION

Working Memory

Working memory plays a crucial role in second language acquisition (Huang et al., 2022). Working memory as "*structures and processes that humans use to store and manipulate information*" (Baddeley et al., 2021; Ludyga et al., 2022). Unlike short-term memory, working memory does not just store information; it also processes and works it out.

Working memory capacity varies from person to person. These differences come from two main skills: being able to hold on to information in short-term memory and focus on getting it back from long-term memory (Forsberg, 2021; Naveh-Benjamin & Cowan, 2023; Lin et al., 2024). Individuals with a high capacity for working memory

usually achieve better results than those with a low capacity across different tasks (Thomassin et al., 2015; An et al., 2024). In solving mathematical problems, Anjariyah et al. (2022) found that students with high WMC performed better than those with low WMC.

A study by Vu et al. (2024) has strengthened the idea that there is a strong link between working memory capacity and oral fluency in a second language (L2). Additionally, it was discovered that various ways of measuring working memory capacity relate to L2 oral fluency (Gagné et al., 2022; Muhammadpour et al., 2023; Manchón et al., 2023; Saed & Awwad, 2024).

Regarding vocabulary skills, Teng & Cui (2024) study with 180 Chinese students revealed that working memory (WM) significantly predicts their vocabulary learning outcomes. The result showed that enhanced WM allows learners to engage more deeply with target words, giving them an edge in learning new vocabulary. Though WM is also a crucial cognitive device for sentence writing (Teng & Cui, 2024), Li's (2023) study suggested that working memory has no connection with writing performance.

This study by Durand-López (2024) looked into morphosyntax and found that working memory (WM) is a flexible system that could be used to improve morphosyntax in a second language (L2). Additionally, these studies prove that higher WM capacity results in greater success in SLA. Hence, the researcher reviewed studies on a particular strategy that would help improve L2 learners' WM capacity.

N-Back Training

In 1958, Kirchner developed the N-back task to assess working memory in cognitive neuroscience and understand how it works (Yaple & Arsalidou, 2018; Frost et al., 2021; Beukers et al., 2024). It was a visual test with four difficulty levels (from "0-back" to "3-back"). Mackworth added a version in 1959 for letters with up to six levels (Burgoyne et al., 2024). In N-back tasks, people see a series of items, like letters or pictures, and they must decide if each item matches the one shown n items earlier (Coulacoglou & Saklofske, 2017).

Figure 1 shows 1-back and 2-back examples. On the left side, the second presentation of the letter "L" is correct in this 1-back example, as "L" was just presented one trial previously. On the right side is a 2-back example where the second presentation of the letter "D" is correct.
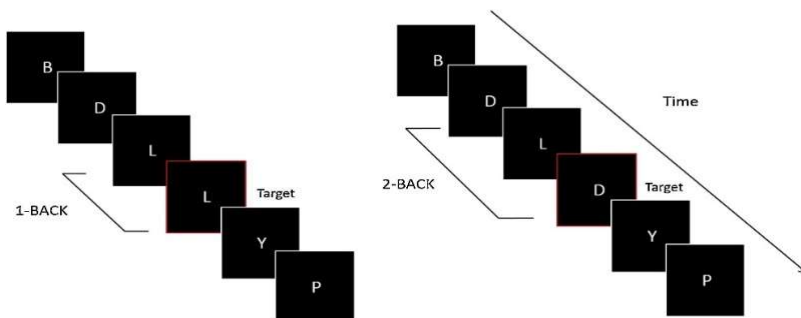

Figure 1. Basic Operation of the N-Back Test (Gilmour et al., 2019)

In the study by Salminen et al. (2016), they trained older and young adults using n-back tasks. The training results showed an improvement in the WM capacity of both groups. Dziura and Ślebarska (2024) yielded similar results in their study of young adults. Their WM capacity improved after n-back training, which involved using smartphones daily.

Also, Guo et al. (2023) looked at 37 healthy young adults from Hubei University and found that N-back training improves brain functions related to working memory. This shows that having higher cognitive abilities can have a positive effect on having lower cognitive abilities (Peng & Kievit, 2020; Tang, 2021; Mason et al., 2021).

A Zhang et al. (2023) study of 46 young men also found that N-back tasks, along with short bouts of aerobic exercise and 30 minutes of cognitive training, can improve the WM's executive function.

4. CONCLUSION

This review's collected studies highlighted the significance of working memory in SLA and demonstrated how N-back tasks can enhance it. Certainly, language learning is more challenging for adults than children, but both may have trouble doing the same task. With the advent of technology, students have become so reliant on the internet that they no longer try to think critically about their questions and quickly turn to online answers. This has affected them in many ways, especially their cognitive skills. Their retention skills decline, and they quickly forget information.

In SLA, they do not just need short-term memory to store rules about language; they need working memory that processes and applies those rules for effective and meaningful learning to happen. Employing memory training, such as N-back tasks, would be beneficial in addressing the issue of students' working memory. This training is not considered a perfect tool and still needs improvement to be more effective. It also does not provide immediate and instant results, but it would hopefully bring positive outcomes with constant and consistent practice. Ultimately, this tool is accessible, affordable, and interactive, allowing anyone using it to enjoy and improve their WM capacity simultaneously.

REFERENCES

An, H., & Li, S. (2024). The effects of planning type, working memory, and anxiety on L2 writing performance. *Individual differences and task-based language teaching*, 166-201.

Anjariyah, D., Juniati, D., & Siswono, T. Y. E. (2022). How Does Working Memory Capacity Affect Students' Mathematical Problem Solving?. *European Journal of Educational Research*, *11*(3), 1427-1439.

Baddeley, A. D., Hitch, G., & Allen, R. (2021). A multicomponent model of working memory. *Working memory: State of the science*, 10-43.

Beukers, A., Hamin, M., Norman, K. A., & Cohen, J. D. (2024). When working memory may be just working, not memory. *Psychological Review*, *131*(2), 563.

Burgoyne, A. P., Frank, D. J., & Macnamara, B. N. (2024). Which "working memory" are we talking about? Complex span tasks versus N-back. *Psychonomic Bulletin & Review*,

1-15.

Chingchit, O. (2024). The contribution of written corrective feedback and its association with working memory on the development of EFL learners' English plurals. *Language Teaching Research*, 13621688241246134.

Chow, B. W. Y., Mo, J., & Dong, Y. (2021). Roles of reading anxiety and working memory in reading comprehension in English as a second language. *Learning and Individual Differences*, *92*, 102092.

Coulacoglou, C., & Saklofske, D. H. (2017). Executive Function, Theory of Mind, and Adaptive Behavior. Psychometrics and Psychological Assessment.

Durand-López, E. M. (2024). Working memory training yields improvements in L2 morphosyntactic processing. *Language, Cognition and Neuroscience*, *39*(6), 757-772.

Dziura, N., & Ślebarska, K. (2024). Memory dual N-back training using mobile devices and its effect on working memory capacity. *Current Psychology*, 1-11.

Forsberg, A., Adams, E. J., & Cowan, N. (2021). The role of working memory in long-term learning: Implications for childhood development. In *Psychology of learning and motivation* (Vol. 74, pp. 1-45). Academic Press.

Frost, A., Moussaoui, S., Kaur, J., Aziz, S., Fukuda, K., & Niemeier, M. (2021). Is the n-back task a measure of unstructured working memory capacity? Towards understanding its connection to other working memory tasks. *Acta Psychologica*, *219*, 103398.

Fry, C. E., Langley, K., & Shelton, K. H. (2020). Executive functions in homeless young people: Working memory impacts on short-term housing outcomes. *Child Neuropsychology*, *26*(1), 27-53.

Ger, E., & Roebers, C. M. (2023). The relationship between executive functions, working memory, and intelligence in kindergarten children. *Journal of Intelligence*, *11*(4), 64.

Gagné, N., French, L. M., & Hummel, K. M. (2022). Investigating the contribution of L1 fluency, L2 initial fluency, working memory and phonological memory to L2 fluency development. *Language Teaching Research*, 13621688221076418.

Gilmour, G., Porcelli, S., Bertaina-Anglade, V., Arce, E., Dukart, J., Hayen, A., ... & Serretti, A. (2019). Relating constructs of attention and working memory to social withdrawal in Alzheimer's disease and schizophrenia: issues regarding paradigm selection. *Neuroscience & Biobehavioral Reviews*, *97*, 47-69.

Guo, A., Yang, W., Yang, X., Lin, J., Li, Z., Ren, Y., ... & Wu, J. (2023). Audiovisual n-back training alters the neural processes of working memory and audiovisual integration: Evidence of changes in ERPs. *Brain Sciences*, *13*(7), 992.

Hamidnia, H. R., Habibzadeh, H., & Gharaei, Z. (2024). Working Memory Capacity and Contextual Novel Linguistic Input: A Cross-Modal Priming Study on Persian English Subordinate Bilinguals. *Journal of Psycholinguistic Research*, *53*(5), 63.

Harvey, J. (2024). Exploring the Impact of Working Memory Capacity on Academic Reading and Achievement in South African Online Tertiary Students. *Reading Psychology*, 1-23.

Huang, T., Loerts, H., & Steinkrauss, R. (2022). The impact of second-and third-language learning on language aptitude and working memory. *International Journal of Bilingual Education and Bilingualism*, *25*(2), 522-538.

Kargar Behbahani, H., & Razmjoo, S. A. (2023). The contribution of working memory and language proficiency to lexical gain: Insights from the involvement load hypothesis. *Teaching English as a Second Language Quarterly (Formerly Journal of Teaching Language Skills)*, *42*(3), 117-146.

Li, S. (2023). Working memory and second language writing: A systematic review. *Studies in Second Language Acquisition*, *45*(3), 647-679.

Lin, W., Lv, C., Liao, J., Hu, Y., Liu, Y., & Lin, J. (2024). Feature versus object in

interpreting working memory capacity. *npj Science of Learning*, *9*(1), 67.

Ludyga, S., Gerber, M., & Kamijo, K. (2022). Exercise types and working memory components during development. *Trends in cognitive Sciences*, *26*(3), 191-203.

Manchón, R. M., McBride, S., Martínez, M. D. M., & Vasylets, O. (2023). Working memory, L2 proficiency, and task complexity: Independent and interactive effects on L2 written performance. *Studies in Second Language Acquisition*, *45*(3), 737-764.

Mason, G. M., Lokhandwala, S., Riggins, T., & Spencer, R. M. (2021). Sleep and human cognitive development. *Sleep medicine reviews*, *57*, 101472.

Mateo, S. R. (2023). The Influence of Working Memory on Second Language Processing Outcomes of Language Learners. *Psychology and Education: A Multidisciplinary Journal*, *16*(6), 1-1.

Muhammadpour, M., Hassanzadeh-Taleshi, M., & Salehi-Amiri, F. (2023). The effects of different task repetition schedules on oral narratives of L2 learners with high and low working memory capacity. *Acta Psychologica*, *236*, 103933.

Naveh-Benjamin, M., & Cowan, N. (2023). The roles of attention, executive function and knowledge in cognitive ageing of working memory. *Nature Reviews Psychology*, *2*(3), 151-165.

Peng, P., & Kievit, R. A. (2020). The development of academic achievement and cognitive abilities: A bidirectional perspective. *Child Development Perspectives*, *14*(1), 15-20.

Perez, M. M. (2020). Incidental vocabulary learning through viewing video: The role of vocabulary knowledge and working memory. *Studies in Second Language Acquisition*, *42*(4), 749-773.

Ruiz, S., Rebuschat, P., & Meurers, D. (2021). The effects of working memory and declarative memory on instructed second language vocabulary learning: Insights from intelligent CALL. *Language Teaching Research*, *25*(4), 510-539.

Ruiz, S., Rebuschat, P., & Meurers, D. (2021). The effects of working memory and declarative memory on instructed second language vocabulary learning: Insights from intelligent CALL. *Language Teaching Research*, *25*(4), 510-539.

Saed, N., & Awwad, A. (2024). L2 Proficiency and Working Memory As Predicted By Learners'implicit and Explicit Knowledge. *European Journal of Literature, Language and Linguistics Studies*, *8*(3).

Salminen, T., Frensch, P., Strobach, T., & Schubert, T. (2016). Age-specific differences of dual n-back training. *Aging, Neuropsychology, and Cognition*, *23*(1), 18-39.

Tang, N. (2021). Cognitive abilities, self-efficacy, and financial behavior. *Journal of Economic Psychology*, *87*, 102447.

Teng, M. F., & Zhang, D. (2023). The associations between working memory and the effects of multimedia input on L2 vocabulary learning. *International Review of Applied Linguistics in Language Teaching*, *61*(3), 1021-1049.

Teng, M. F., & Cui, Y. (2024). Comparing incidental learning of single words and collocations from different captioning conditions: The role of vocabulary knowledge and working memory. *Journal of Computer Assisted Learning*, *40*(3), 973-989.

Thomassin, N., Gonthier, C., Guerraz, M., & Roulin, J. L. (2015). The Hard Fall Effect. *Experimental Psychology*.

Vanek, N. (2024). Working Memory and English Language Learning: Implications for Classroom-Based Research. In *Cognitive and Educational Psychology for TESOL: A Guide for Practitioners* (pp. 17-37). Cham: Springer Nature Switzerland.

Vu, D. C., Nguyen, T. V., & Kitjaroonchai, N. (2024). Exploring the Relationship Between Working Memory Capacity and L2 Oral Fluency. *Theory and Practice in Language Studies*, *14*(7), 2002-2012.

Wiest, G. M., Rosales, K. P., Looney, L., Wong, E. H., & Wiest, D. J. (2022). Utilizing

cognitive training to improve working memory, attention, and impulsivity in school-aged children with ADHD and SLD. *Brain Sciences*, *12*(2), 141.

Yaple, Z., & Arsalidou, M. (2018). N-back working memory task: Meta-analysis of normative fMRI studies with children. *Child Development*, *89*(6), 2010-2022.

Zhang, W., Liu, H., & Zhang, T. (2023). Immediate and short-term effects of single-task and motor-cognitive dual-task on executive function. *Plos one*, *18*(8), e0290171.