Working Memory related to different subtasks can be maintained in separate non-interfering stores.

Aida Rezaei*, Tamer Gezici, İpek Çiftçi, Ausaf Farooqui

Bilkent University Neuroscience Department , Ankara, Türkiye , National Magnetic Resonance Research Center (UMRAM) , Ankara, Türkiye , Aysel Sabuncu Brain Research Center , Ankara, Türkiye

INTRODUCTION

1. Working memory is the capacity to maintain goal-relevant information from long-term memory or the external environment in a highly available state and to modify it flexibly to support the goal at hand.[1]

2. The amount of data that can be kept and processed in working memory at one time, working memory capacity (WMC), is limited. Many studies suggest that we can maintain up to four items in our WM at a time.[2]

3. Most of the time, however, we are maintaining more than four pieces of information. One means for this is chunking. The process by which the mind divides large pieces of information into smaller units is named chunks so that they are easier to be memorized.[3]

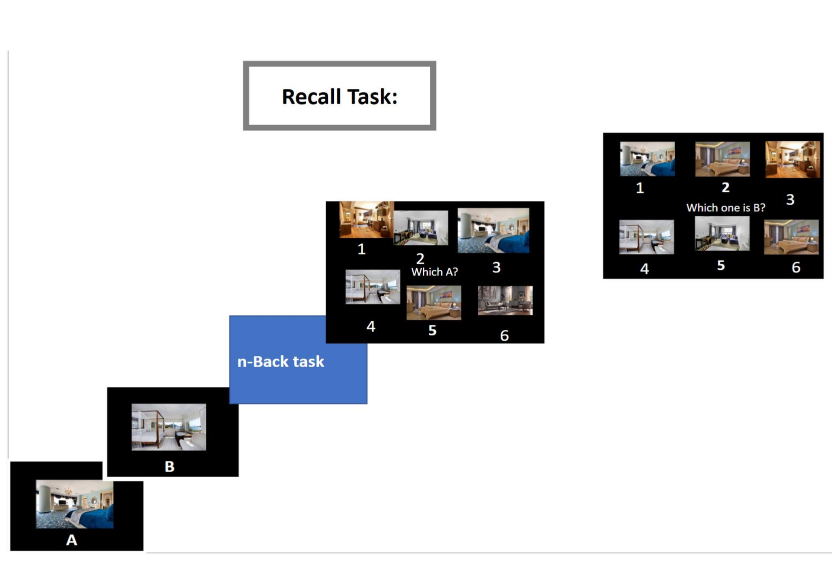
4. Here, we ask if, in multitasking situations, we are able to go beyond the WMC of four items.[2]

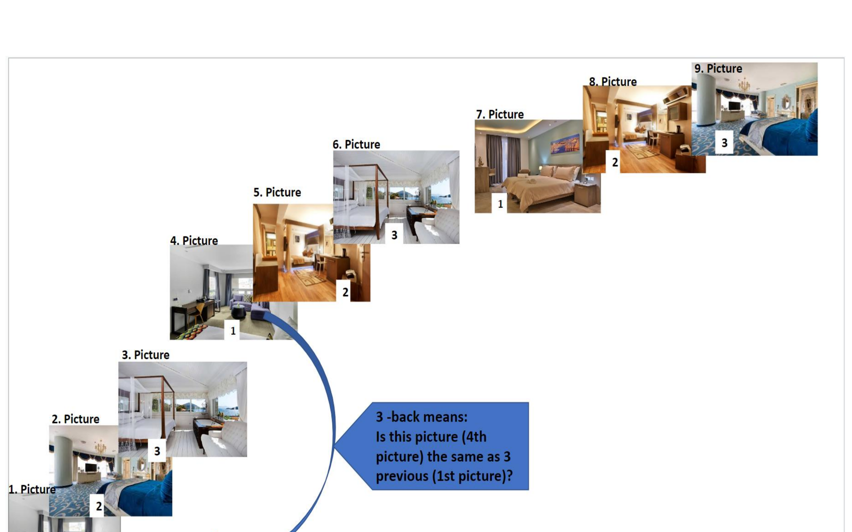
5. Some studies have suggested that WM information is maintained as part of the larger task-related program. Information related to different tasks or subtasks may be maintained as part of different programs. [2]

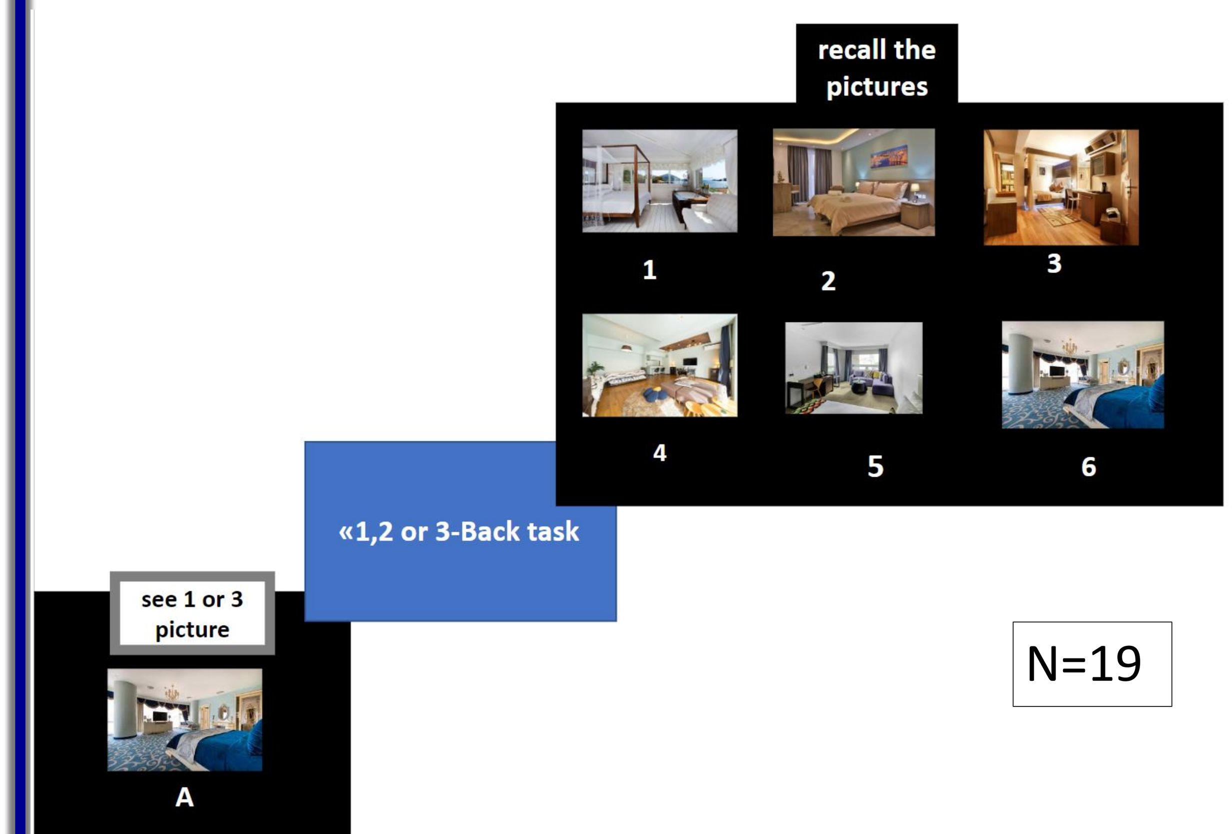
6. If different task-related programs were maintained separately, it may be possible that WM information related to different tasks doesn't interfere with each other. In this study, we investigated this issue.[3]

Experiment 1:

- Participants executed a number of extended trials. Each trial consisted of two subtasks –A and B.
- Participants first saw 1 or 3 pictures to be recalled later as part of subtask B.
- They then did a separate subtask A while maintaining subtask B pictures. Subtask A was an n-back task that required maintaining and updating pictures drawn from the same pool as subtask B pictures.
- After finishing subtask A, they completed task B using the initial subtask B pictures.
- WM loads of subtasks A and B were independently manipulated.
- We examined whether increased WM load related to subtask B impacted the concurrent execution of subtask A.
- If WM items related to subtasks A and B were maintained as parts of different non-interfering programs, then increasing the WM load of one would not impair performance on the other subtask.

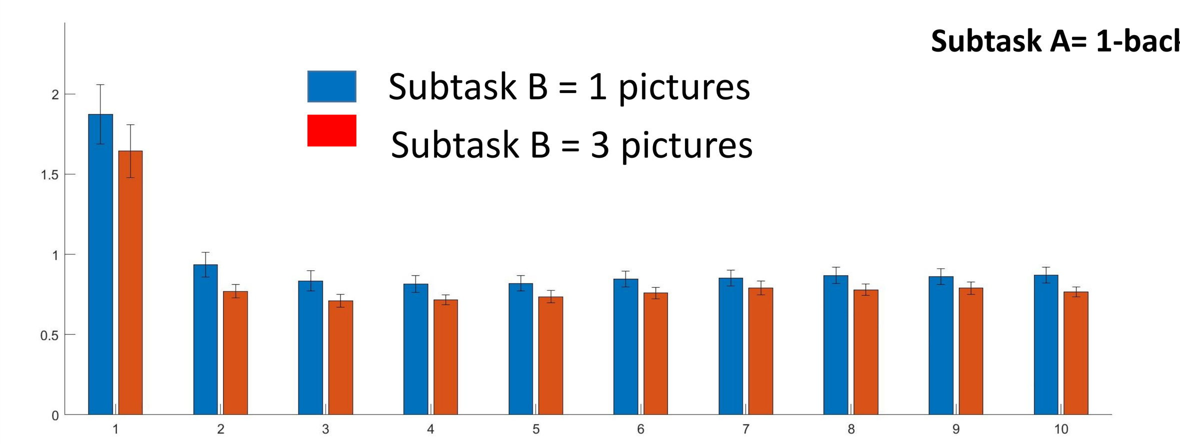


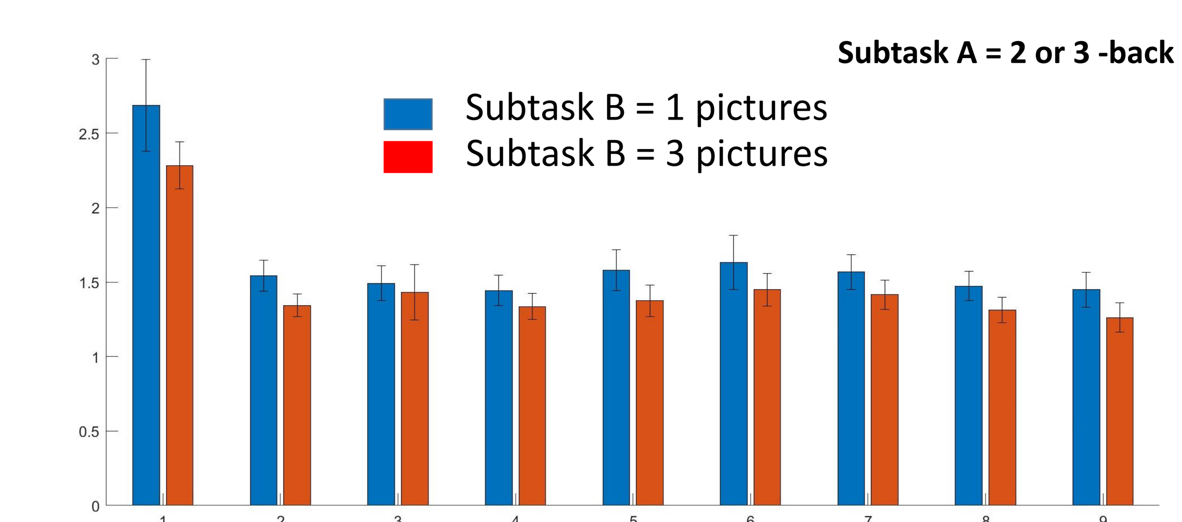




N=19

RESULTS



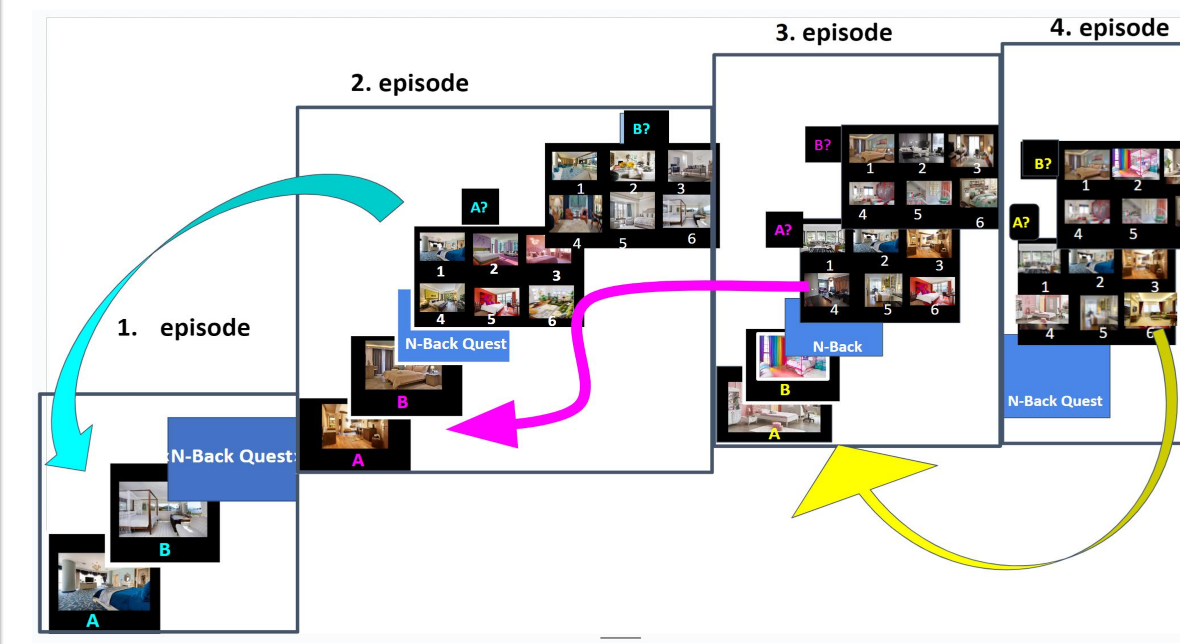


(Errorbars are representing 95% confidence intervals.)

Performance on n-back, i.e. subtask A, did not decrease when more subtask B pictures were to be kept in mind.

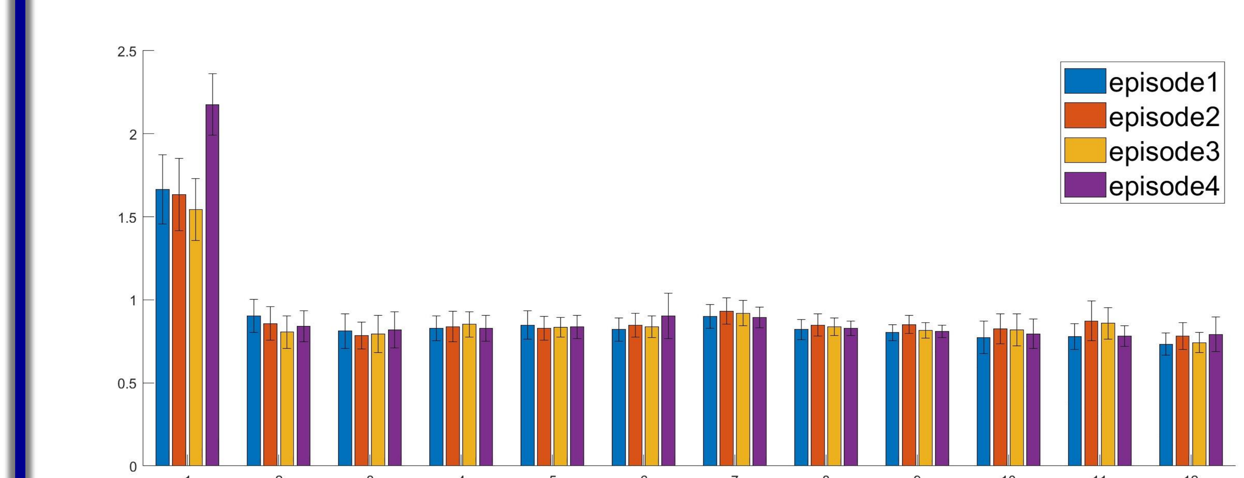
Experiment 2:

- An objection may be that in experiment 1, subtask B pictures were not maintained in a goal-directed WM store but were passively maintained as part of (e.g.) activated long-term memory. To rule this out, we did experiment 2.
- In experiment 2, participants executed even longer trial episodes made of *four* sequential task episodes. Each episode was again made of subtasks A and B, and involved the same maintenance of subtask B pictures while executing subtask A. But crucially, the B pictures kept in WM in one task-episode were to be recalled not in that episode but in the next, e.g., B pictures from episode 1 (or mB1) were recalled not after subtask A of the episode (i.e. A1) but after A2. The overall structure thus was:
  mB1-A1 – mB2-A2-rB1 – mB3-A3-rB2 – A4-rB3
- This forced the participant to keep two sets of B pictures in mind and recall not the immediately preceding B pictures but the one before. This can only be done if B pictures were goal-directedly and not passively, maintained. This also meant that during subtasks A2 and A3, participants were maintaining two sets of B pictures (B1 & B2 and B2 & B3, respectively). But during A1 and A4, they only maintained one set of B pictures (B1 and B3, respectively).
- We again investigated if increased WM load related to one subtask affected performance on the other subtask.



N=40

RESULTS



(Errorbars are representing 95% confidence intervals.)

Performance on n-back, i.e., subtask A, across the four episodes was not different even though they required different numbers of subtask B pictures to be concomitantly kept in mind.

CONCLUSION

- WM capacity limits may be task or subtask specific. It is possible that WM items related to different tasks or subtasks in certain multitasking situations don't interfere with each other, plausibly because of their maintenance in separate stores.

References

[1] Postle, B. R., & Oberauer, K. (2022). Chapter to appear in M.J. Kahana and A.D. Wagner (Eds.), The Oxford Handbook of Human Memory

[2] Velichkovsky, B. B. (2017). Consciousness and working memory: Current trends and research perspectives. Consciousness and Cognition, 55, 35-45.

[3] Adams, E. J., Nguyen, A. T., & Cowan, N. (2018). Theories of working memory: Differences in definition, degree of modularity, role of attention, and purpose. Language, speech, and hearing services in schools, 49(3), 340-355.