Evidence for chunking of global and local representations in working memory

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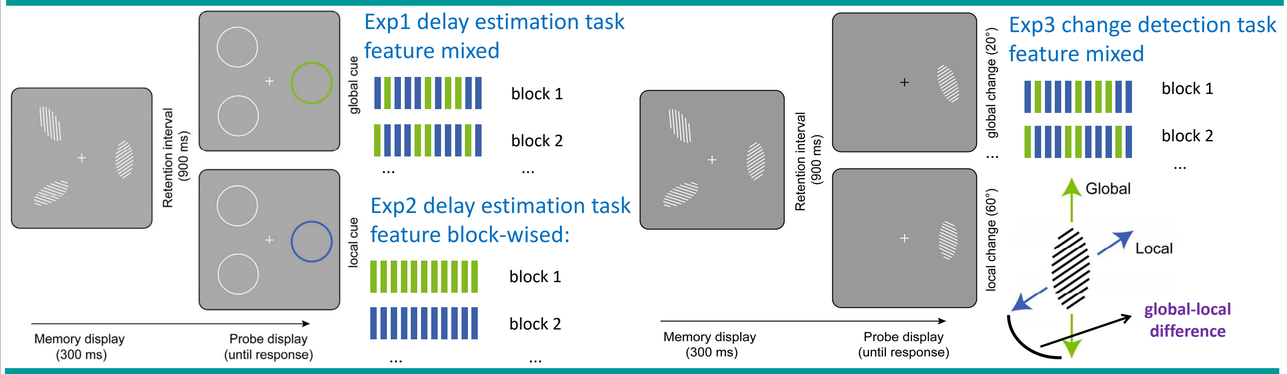
Introduction:

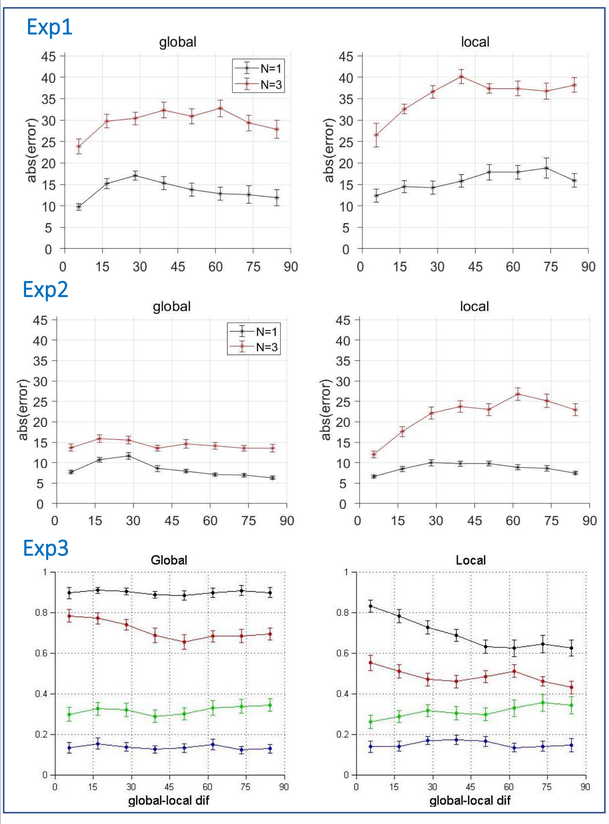
- Objects stored in visual working memory often have a hierarchical structure, containing global and local representations.
- Previous work about hierarchical stimulus mainly focused on whether the global or local representation is processed with higher priority.
- Here, we investigated whether and how people store global and local representations jointly or independently in WM using newly devised stimulus with global and local features in continuous feature space.
- We proposed four cognitive factors that might account for our data: precision variability, swapping, bias, and chunking. Then we conducted a factorial model comparison analysis to compare each factor's contribution in hierarchical WM.

Method:



Results:

In all three experiments we found an obvious trend: along with the increase of global-local difference the WM error first increase and then keep constant.



This can be regarded as an interaction between global and local representations. We proposed three hypotheses to account for this interaction: bias, swapping and chunking. Besides, we compared the models assume variable vs equal WM precision.

VP:

$$p(r|O_g,\ O_l, \kappa_{g3}) = \int_0^{\infty} VM(Og, \kappa_{g3})\, d\kappa_{g3}$$

$$p(\kappa|J_{g3}, \tau) = Gamma(\kappa; J_{g3}, \tau)$$

Bias:

$$p(r|O_g,\ O_l, \kappa_{g3}, bias_g) = VM(Og + bias\_g * (Ol - Og), \kappa_{g3})$$

Swapping:

$$p(r|O_g,\ O_l, \kappa_{g3}, p\_swap) = VM(O_g, \kappa_{g3}) * (1\text{-}p\_swap) + VM(O_l, \kappa_{g3}) * p\_swap$$

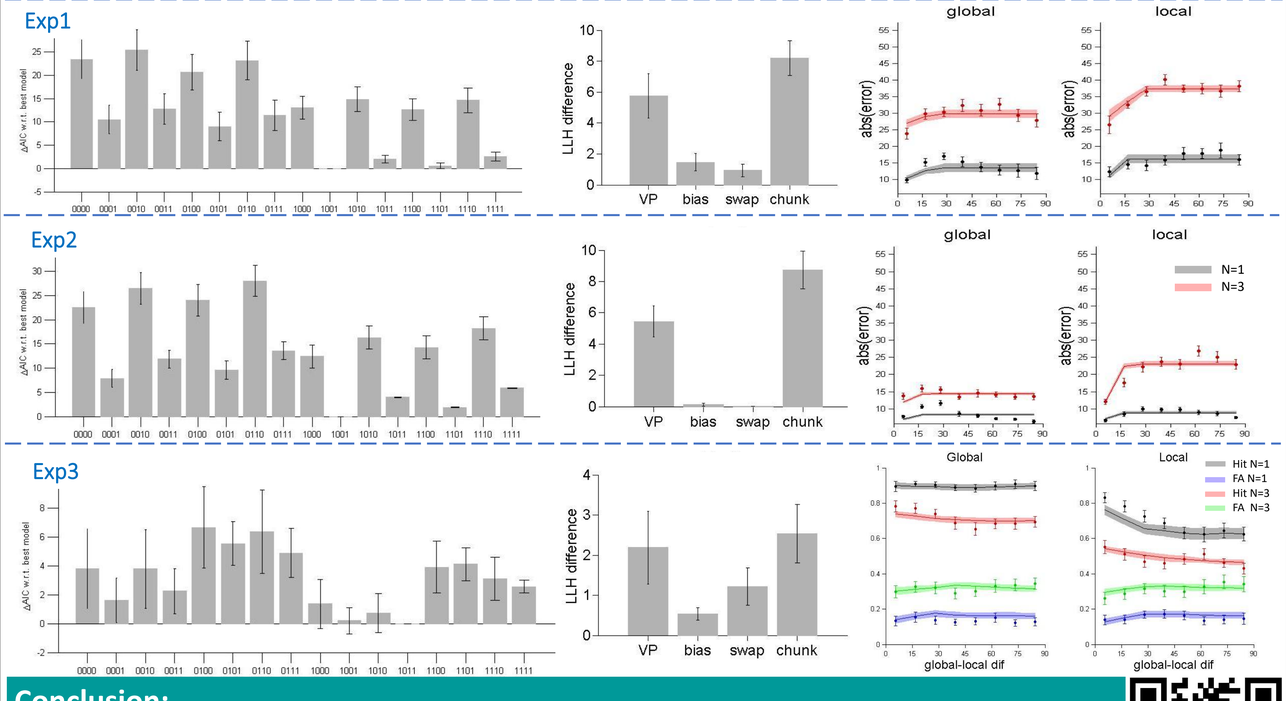
Chunking:

$$p(r|Og,\ O_l, \kappa_{g3}) = \begin{cases} VM\left(\frac{O_g + Ol}{2}, \kappa_{g3} + \kappa_{l3}\right) & if\ abs(O_g - Ol) < c\_3 \\ VM(O_g, \kappa_g) & if\ abs(O_g - Ol) \geq c\_3 \end{cases}$$

Four factors were analyzed in all potential models: VP vs EP, bias vs no bias, swapping vs no swapping, chunking vs no chunking, consisting of a 2*2*2*2 factor space. We compared the group AIC for all 16 models to investigate the contribution of each factor.

model	VP	bias	swapping	chunking
1	1	1	1	1
2	1	1	1	0
3	1	1	0	1
4	1	1	0	0
5	1	0	1	1
6	1	0	1	0
7	1	0	0	1
8	1	0	0	0

model	VP	bias	swapping	chunking
9	0	1	1	1
10	0	1	1	0
11	0	1	0	1
12	0	1	0	0
13	0	0	1	1
14	0	0	1	0
15	0	0	0	1
16	0	0	0	0



Conclusion:

- We found the difference between global and local representations can influence working memory precision.
- Our factorial model comparison analysis shows that chunking is the best explanation of this effect rather than bias and swapping.