Working memory is robust to distractor interference but not changes in stimulus noise

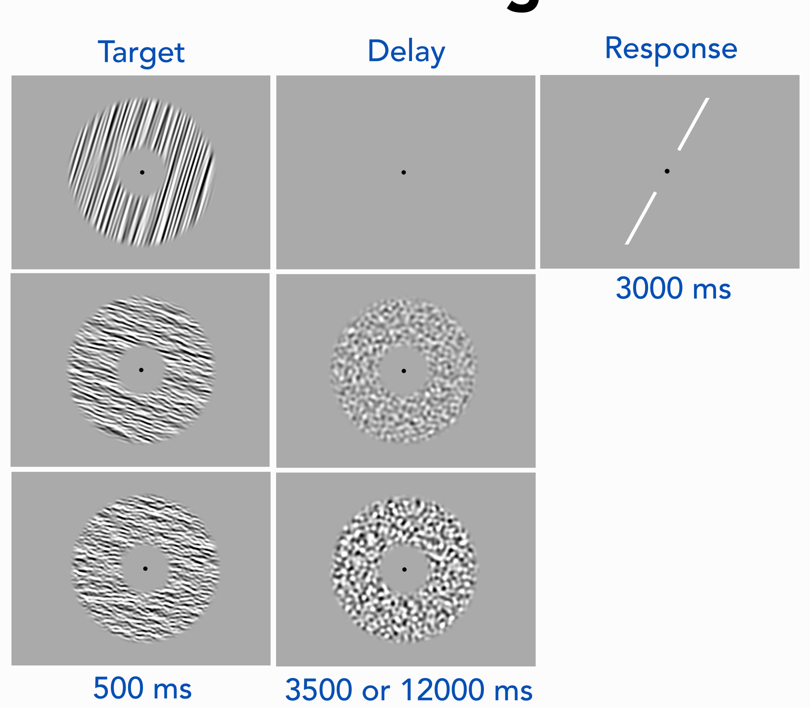
Holly E. Kular, Kirsten C.S. Adam, John T. Serences

Does stimulus noise at encoding influence distraction?

- WM is surprisingly resilient to visual distraction [1,2,3].
- However, most work has used high contrast or salient stimuli. This may mask interactions between stimulus strength & distractibility.
- Here, we simultaneously manipulated sensory noise & distractor strength.
- If noisier WM representations are more susceptible to interference from distractors, we would expect to see an interaction between sensory noise & distractor strength

Methods

Task Design



Versions

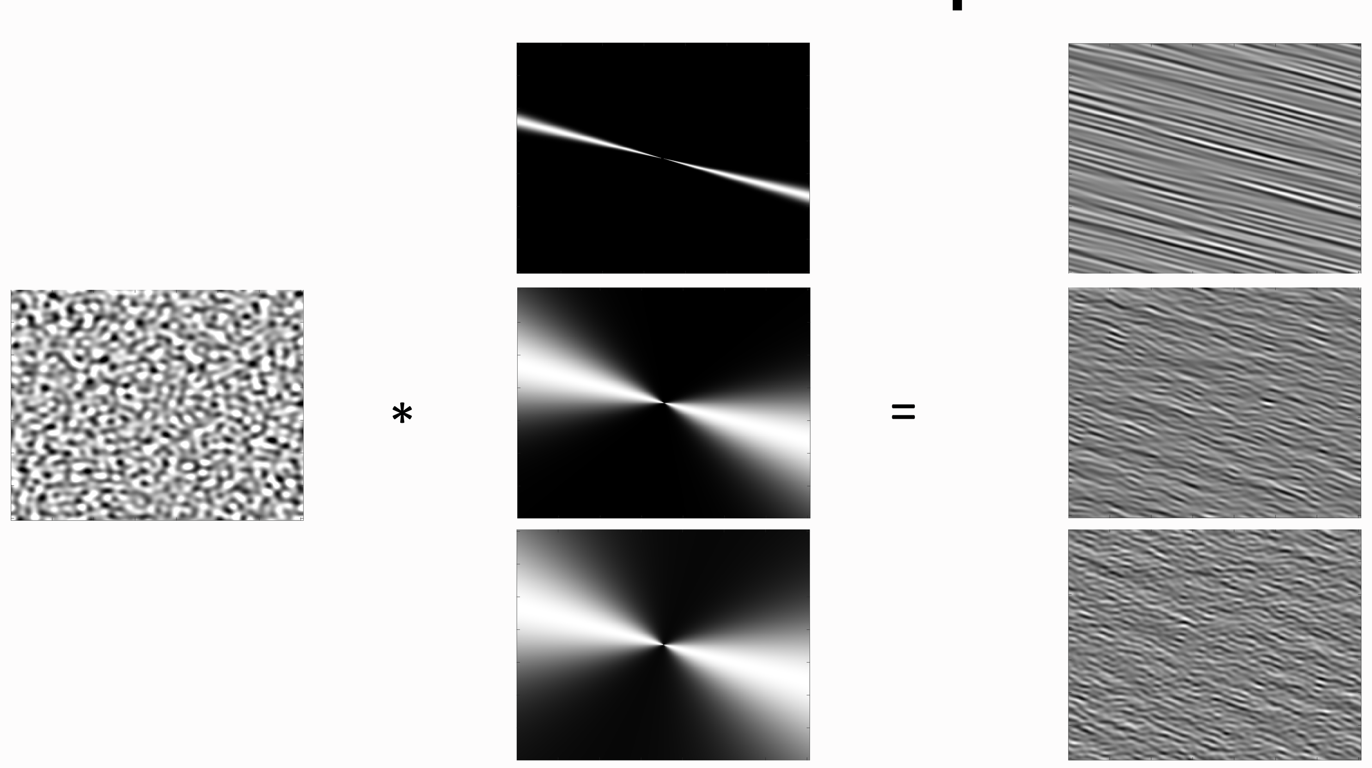
E1: short delay, 8 Hz distractor
27 participants, 360 trials per participant

E2: short delay, 25 Hz distractor
38 participants, 360 trials per participant

E3: long delay, 25 Hz distractor
14 participants, 168 trials per participant

E4: short delay, 25 Hz distractor, dual task
20 participants, 360 trials per participant

Stimulus Noise Manipulation



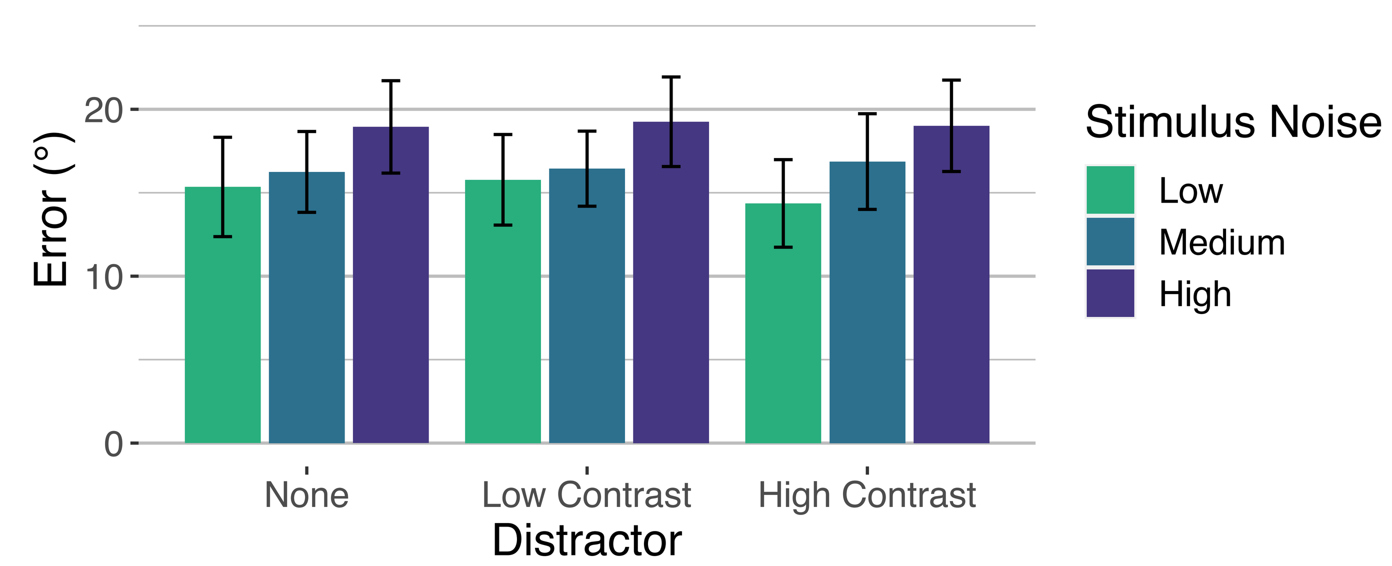
Step 1: Generate random white noise

Step 2: Circular von Mises PDF to filter orientation, adjustable bandwidth

Step 3: iFFT to bring back into spatial domain

Results

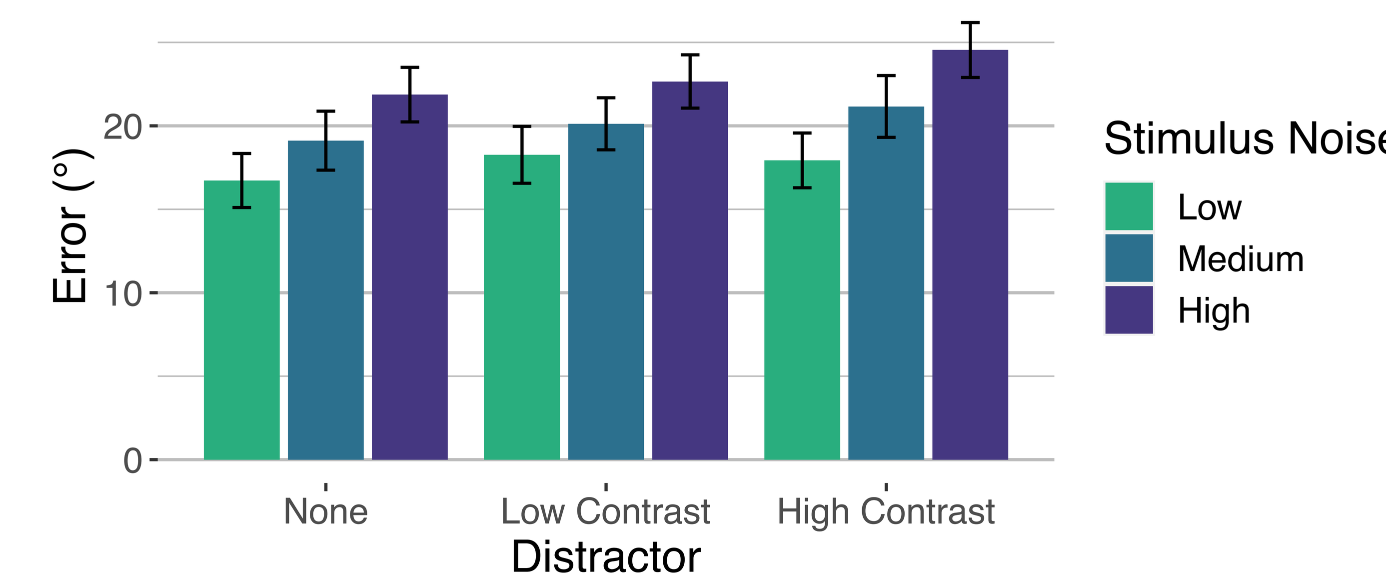
Expt 1 – short delay, slow distractor



Found effect of stimulus noise only:

- Main effect stimulus noise (BF_{01} = 7.15 x 10^7, η_p^2 = 0.23)
- No main effect of distractor (BF_{01} = 0.06, η_p^2 = 0.004)
- No interaction (BF_{01} = 0.06, η_p^2 = 0.01)

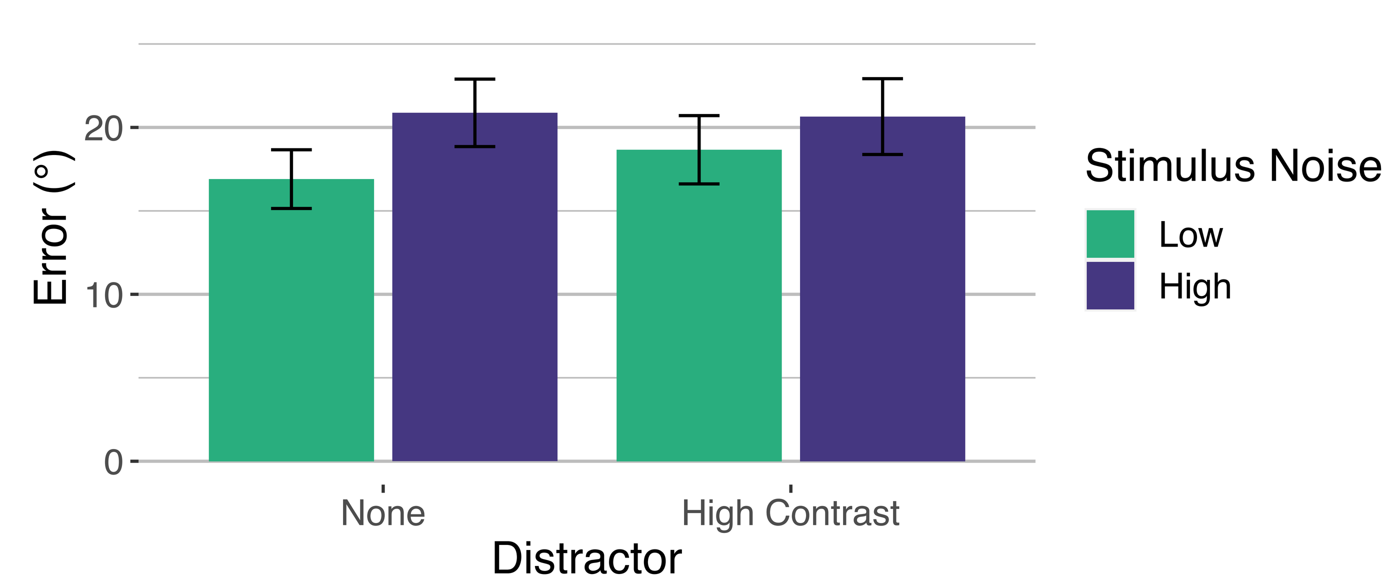
Expt 2 – short delay, fast distractor



Making the task harder with a more dynamic distractor revealed effect of stimulus noise and distractor:

- Main effect stimulus noise (BF_{01} = 9.16 x 10^{16}, η_p^2 = 0.27)
- Main effect of distractor contrast (BF_{01} = 4.30, η_p^2 = 0.05)
- No interaction (BF_{01} = 0.04, η_p^2 = 0.01)

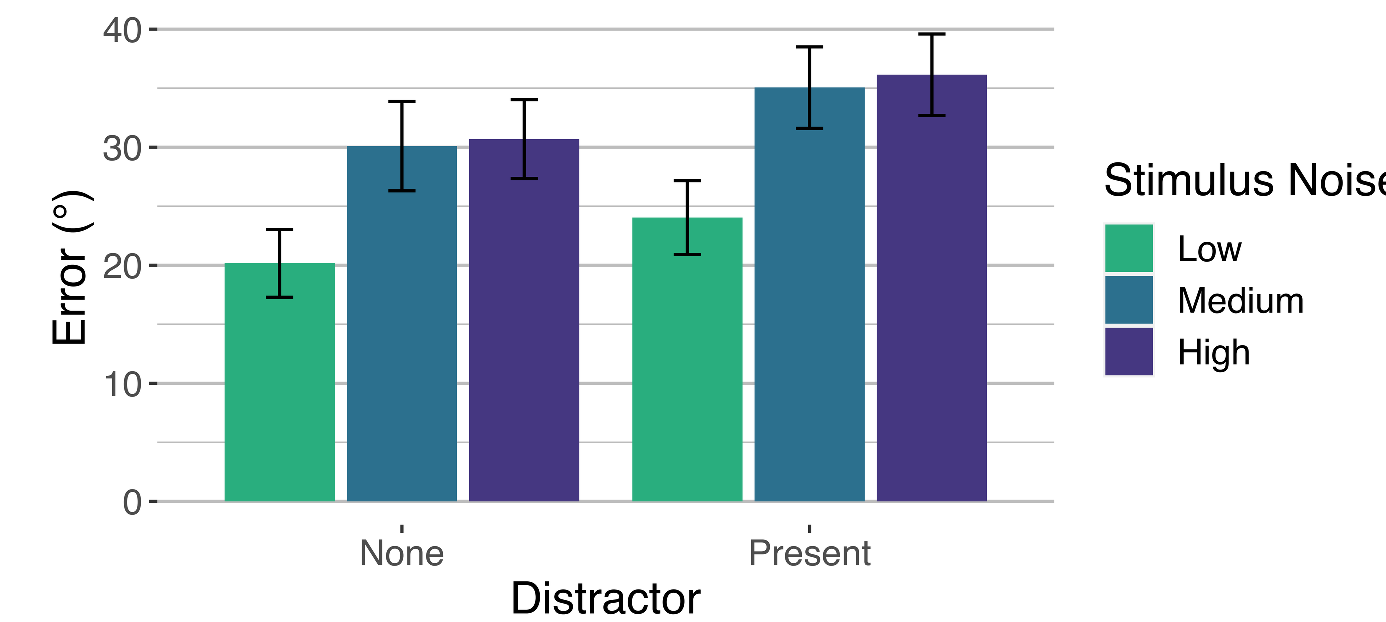
Expt 3 – long delay, fast distractor



Making the task harder with a longer delay, still only an effect of stimulus noise:

- Main effect stimulus strength (BF_{01} = 456, η_p^2 = 0.24)
- No main effect of distractor (BF_{01} = 0.35, η_p^2 = 0.02)
- No interaction (BF_{01} = 0.57, η_p^2 = 0.03)

Expt 4 – dual task, short delay, fast distractor



Making the task harder with a dual task revealed effect of stimulus noise and distractor:

- Main effect stimulus noise (BF_{01} = 1.38 x 10^6, η_p^2 = 0.34)
- Main effect of distractor presence (BF_{01} = 4.77, η_p^2 = 0.1)
- No interaction (BF_{01} = 0.14, η_p^2 = 0.002)

Conclusions

Even when we introduce noise to WM encoding, representations are quite robust to interference

- Representations of sensory stimuli and remembered stimuli compete.
- However, only main effect of distractors observed, suggesting that encoded information is largely insulated from new sensory inputs, irrespective of how 'fragile' the memory is.

Results Summary

	Stimulus noise	Distractor	Interaction
E1	✓	☒	☒
E2	✓	✓	☒
E3	✓	☒	☒
E4	✓	✓	☒

National Eye Institute
NATIONAL INSTITUTES OF HEALTH
RO1-EY025872

Serences Lab @ UCSD
hkular@ucsd.edu
@KularHolly

References

[1] Lorenc, Mallet, & Lewis-Peacock (2021) *Trends in Cognitive Sciences*
[2] Clapp, Rubens, & Gazzaley (2010) *Cerebral Cortex*
[3] Hakim, Feldman-Wüstfeld, Awh, & Vogel (2021) *Cerebral Cortex*

Acknowledgments: Thanks to Maggie Henderson for image filter code.