Exogenous attention improves perception through facilitation, not suppression

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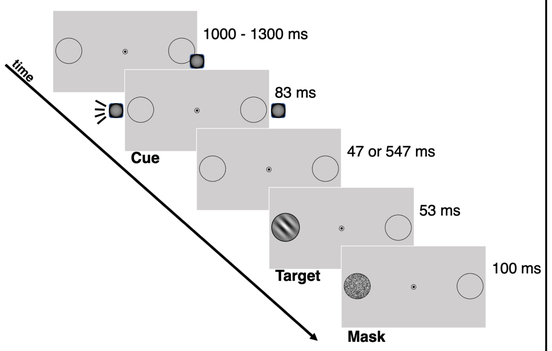
Research Question

How does exogenous attention improve visual perception?

Facilitation? Suppression? Both?

Experimental Design



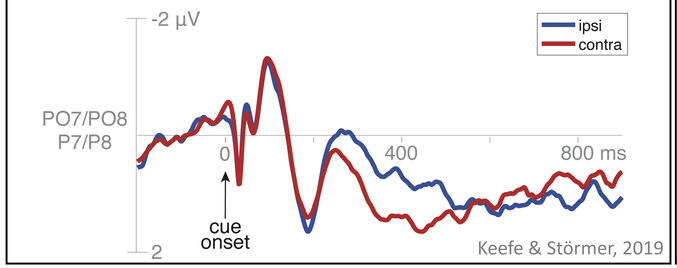
- **Task:** judge the orientation of a Gabor patch target (clockwise or counterclockwise).
- **Cue:** pink noise burst played randomly from the right, left, or center of the screen either 130ms (short-SOA) or 630ms (long-SOA) before target.
- **Behavioral analysis**: accuracy was evaluated for short-SOA trials for valid, invalid, and neutral cues
- **ERP analysis:** visual-cortical activity was analyzed on long-SOA and no-target trials (1/3 of trials) to avoid contamination of target-evoked activity.
  - **Auditory-evoked Contralateral Occipital Positivity (ACOP)**, an ERP component linked to the deployment of attention to peripheral cues[1], was evaluated to investigate these changes.

Experiment 1: behavior only, N = 21.

Experiment 2: EEG and behavior, N = 19

The ACOP

- ERP positivity over visual cortex contralateral vs. ipsilateral to a salient peripheral cue, indexing exogenous attention
- May be the result of enhanced activity at the cued location (contra) or suppressed activity at uncued locations (ipsi)



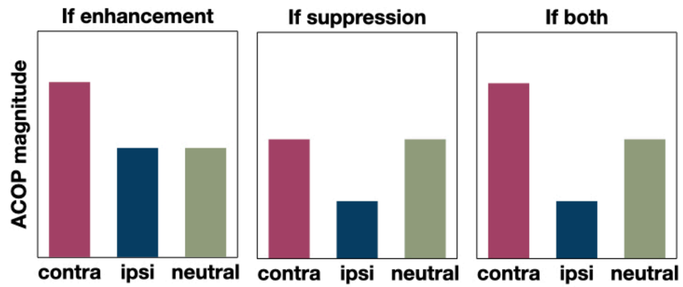
Keefe & Störmer, 2019

Logic and Predictions

The central cue serves as a 'neutral' baseline condition in which participants do not shift their attention to a peripheral location but are still generally alerted the same way as for peripheral cues.

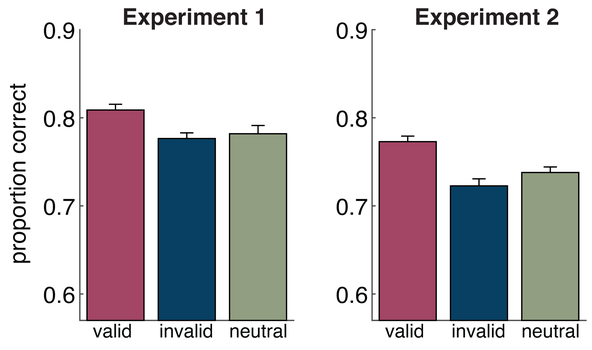
Relative to the 'neutral' no-shift cue condition:

1) Does performance improve at the cued location, worsen at the uncued location, or both?
2) Is visual cortical activity enhanced with respect to the cued location (contralateral increase), suppressed with respect to the uncued location (ipsilateral decrease), or both?

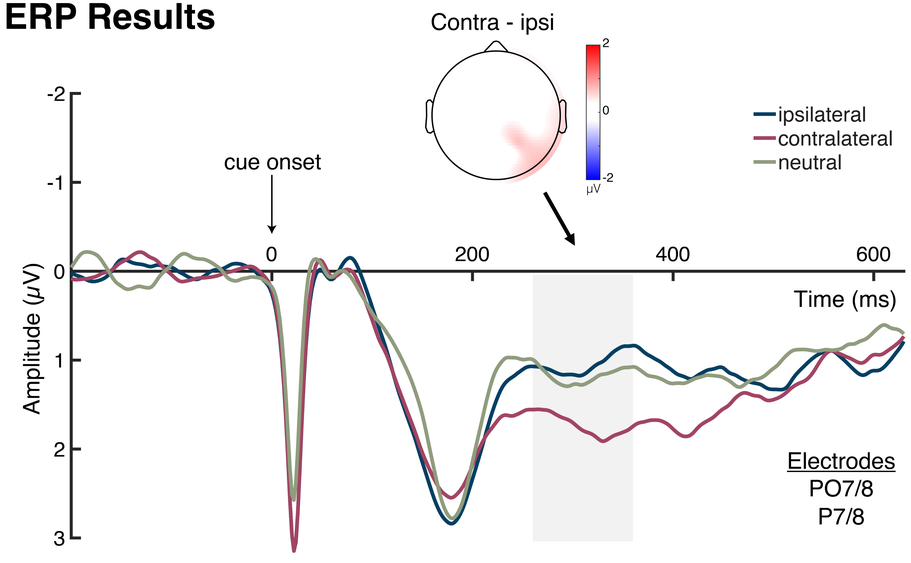


Behavioral Results

- Across both experiments, performance was significantly better when the target was presented at the same location as the cue (valid) vs. the opposite location (invalid) or the central location (neutral).
- Critically, performance did not differ following invalid and neutral cues.
- **This is broadly consistent with a facilitation account, because a valid cue improved performance relative to the neutral cue, but an invalid cue did not decrease performance relative to the neutral cue.**

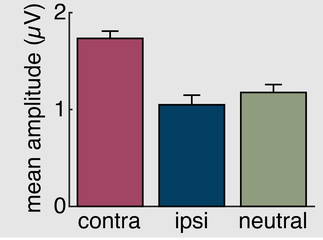


ERP Results



- Activity over contralateral visual cortex was significantly more positive than either the ipsilateral activity or activity elicited by the neutral cue.
- There was no difference in amplitude between the ipsilateral and neutral waveforms.
- **Thus, visual activity contralateral to the cued location was enhanced, with no hint of activity being suppressed with respect to the uncued location (ipsilateral waveform).**

Mean ERP amplitude during ACOP window (260 – 360 ms)



Conclusion

Relative to a 'no-shift' cue, behavior and ERPs were affected only at the location of the cue, leading to enhanced processing/activity at the attended location/hemisphere.

This demonstrates that exogenous attention improves perception by facilitating processing at a cued location and does not suppress processing at uncued locations.

References

1. Hillyard, S. A., Störmer, V. S., Feng, W., Martinez, A., & McDonald, J. J. (2016). Cross-modal orienting of visual attention. *Neuropsychologia*, *83*, 170-178.
2. Keefe, J. M., & Störmer, V. S. (2020). Alpha-band oscillations and slow potentials shifts over visual cortex track the time course of both endogenous and exogenous orienting of attention. *bioRxiv*, 2019-12.

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