An eye movement-defined hierarchy of visual stimuli

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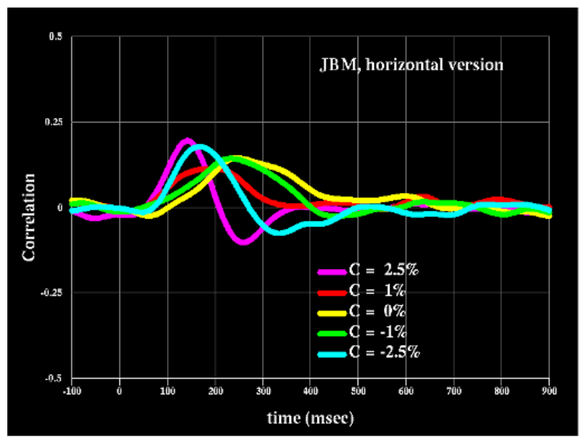
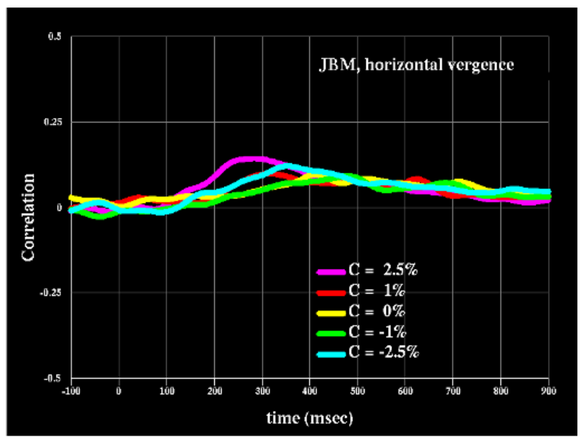
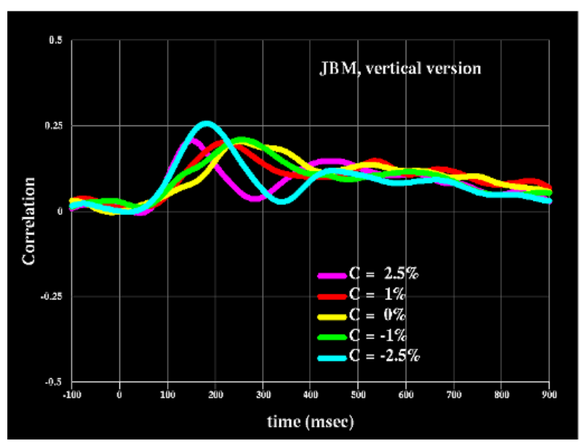
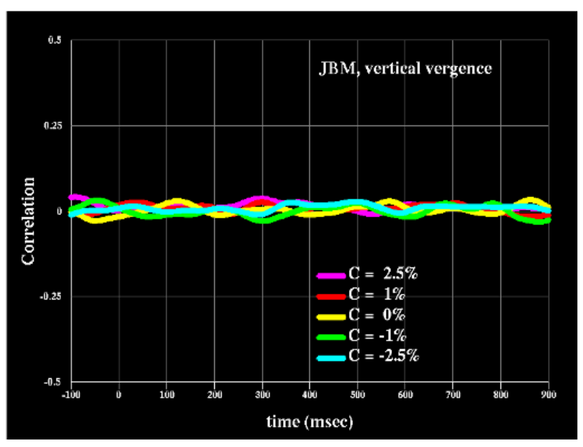
1. 2nd-order motion does not drive vertical vergence



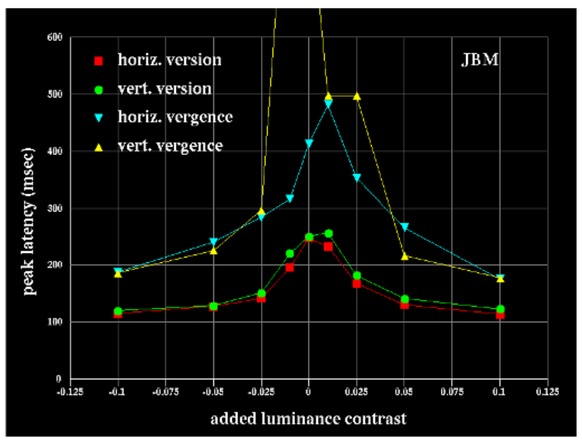


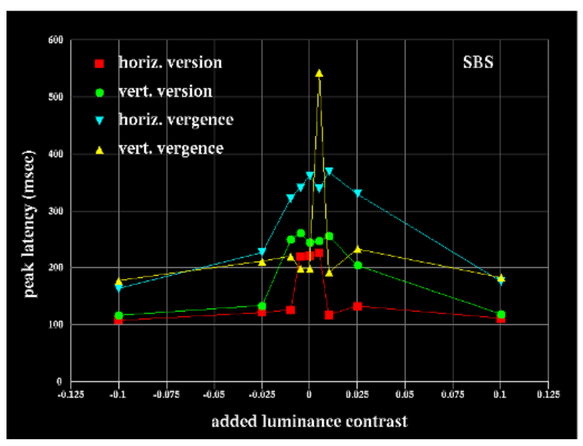


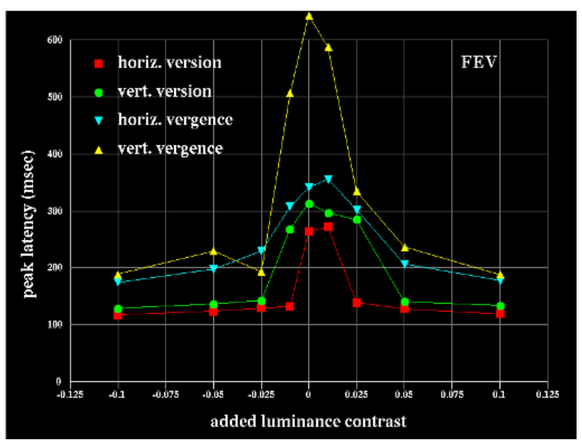


To the left we show eye movement correlograms generated in response to independent pseudorandom motion in each eye. The stimulus was a bull's eye target defined by contrast modulation; the different curves show different amounts of added luminance modulation used to null small amounts of first-order motion energy generated by the visual system's compressive nonlinearity. Isolation of the second-order mechanism increases the latency of the correlogram peak by approximately 100 msec.

On the right are plotted peak latencies as a function of added luminance contrast, and all four types of eye movement for three subjects. The already weak vertical version response is abolished at the null point.



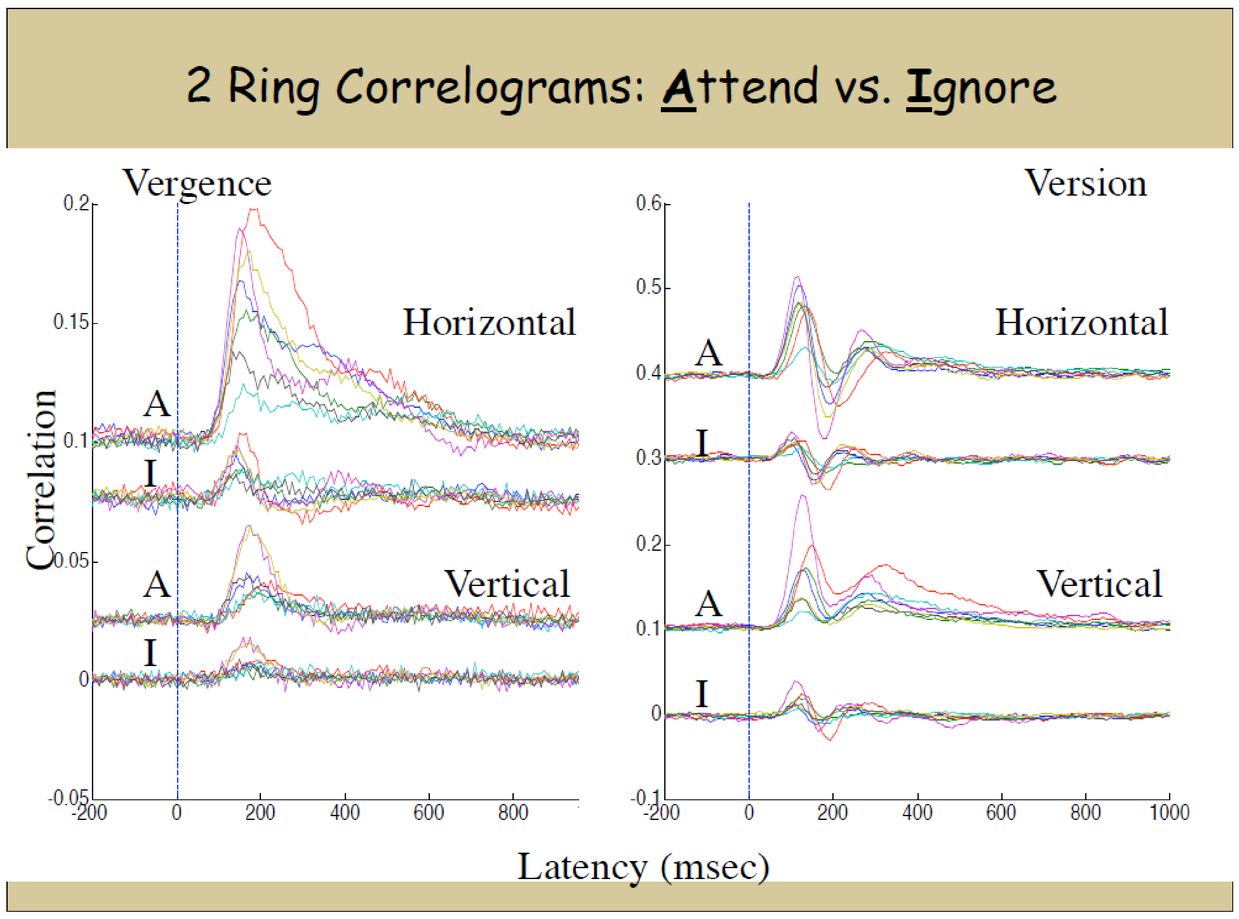




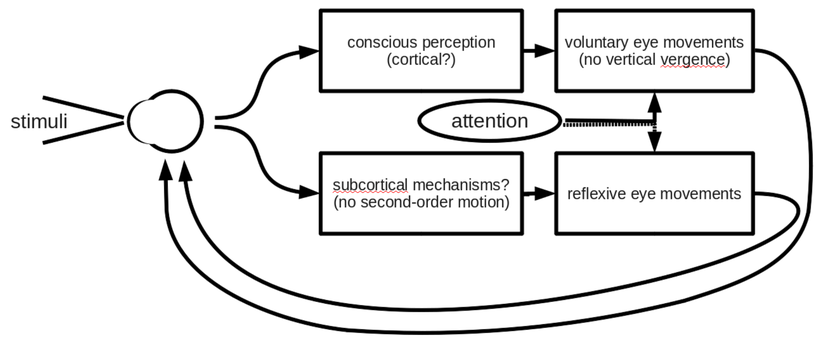
2. Attention adds a long-latency component ***except*** for vertical vergence

Eye movement responses were measured in response to independent motion of two, initially concentric rings. Subjects were instructed to track the center of one or the other; responses were identical for the inner and outer rings under the same attention conditions. The panel at right shows superimposed data for seven subjects.

The response to the ignored target is generally over by 300 milliseconds, while the response to the attended target often persists as long as 600 milliseconds – except in the case of vertical version, where the response to the unattended target appears to be an attenuated copy of the attended response.



3. Theory



Our results can be explained by a model consisting of a fast reflexive system that controls all types of eye movement (including vertical vergence), which is only sensitive to a subset of visual stimuli (excluding second-order motion). Voluntary eye movements are generated with longer latencies by a separate system, which can target any perceived object selected by attention. Attention modulates the strength of the reflexive system (possibly at the level of the sensory representation of the stimulus?), but does not change the time course of the response.

4. Predictions

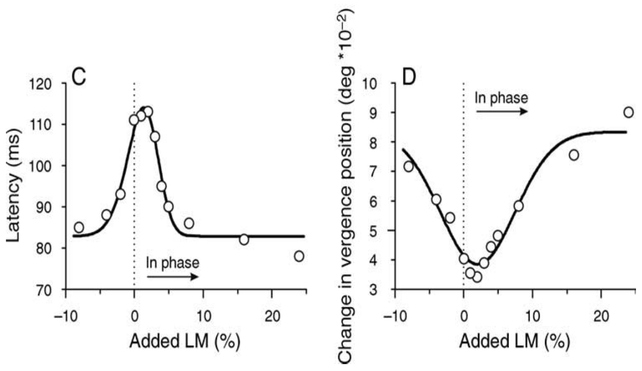
No response of any kind to unattended second-order stimuli in dual-ring task?

Ditto for cyclopean stimuli?

Diffeent period-versus-delay slopes for second order stimuli in delayed feedback paradigm?

5. A conflict?

Rambold et al. (2010) have demonstrated vertical vergence responses to second-order contrast modulated stimuli, with only a small increase in latency. One difference between our experiments and theirs are that they employed a stimulus subtending a much larger field-of-view (approx. 50 deg. diagonal) than ours (10 degree circular field). It is possible that optical aberrations in the periphery made it impossible to null the distortion products over the entire visual field with a single amplitude of luminance modulation.



Figures from Rambold et al. (2011).

6. References

Rambold, H. A., Sheliga, B. M., and Miles, F. A. (2011). Evidence from vergence eye movements that disparities defined by luminance and contrast are sensed by independent mechanisms. Journal of Vision, 10(14):31, pp. 1-34.

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