Detecting 3D location change in the presence of grouping cues

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Introduction

Task: Detect movement of one sphere (Fig. 3 & 4). Result: Remarkably poor performance [1], especially when **task-irrelevant connecting lines (dipoles)** change (Fig. 1).

Is this caused by
- image change?
- grouping change?

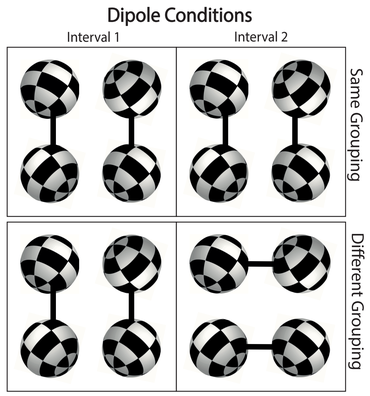

Figure 1: "Static dipoles" and "switching dipoles" conditions.

Power Analysis

How many participants are needed to detect an effect of a similar size?

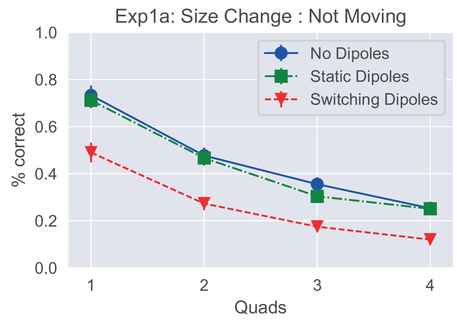

Figure 2: Performance for localization in the previous experiment.

Effect	DFn	DFd	F	$\Delta\eta^2$	p-value
dipoles	2	24	38.20	.761	$< .001$***

Table 1: Group level effect of dipoles for 2 quads (8 spheres).

Recommended sample size to achieve 95% power is 3.

Test	Effect size (w)	df	sample size	α	power
χ^2	.3 (medium)	2	300	.0166(.05/3)	.993

Table 2: Power analysis for individual tests.

Methods

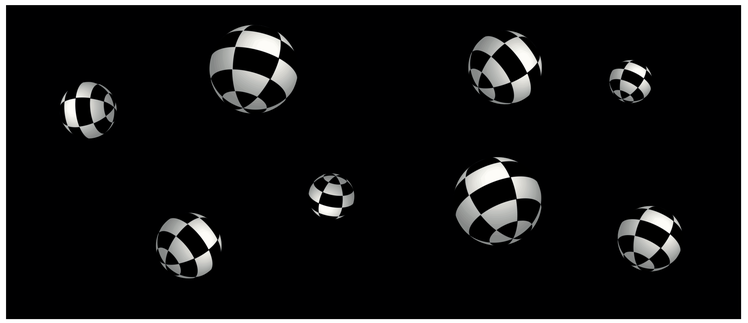

Figure 3: Sphere distances from participant's starting location were 2.5-7.5m.

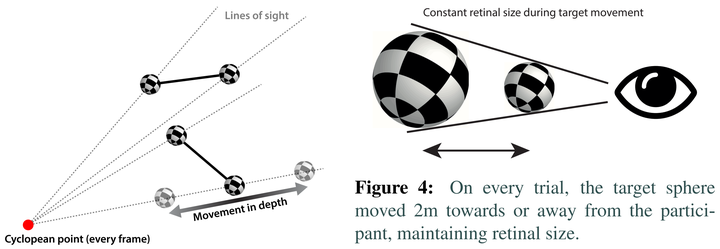

Figure 4: On every trial, the target sphere moved 2m towards or away from the participant, maintaining retinal size.

Results

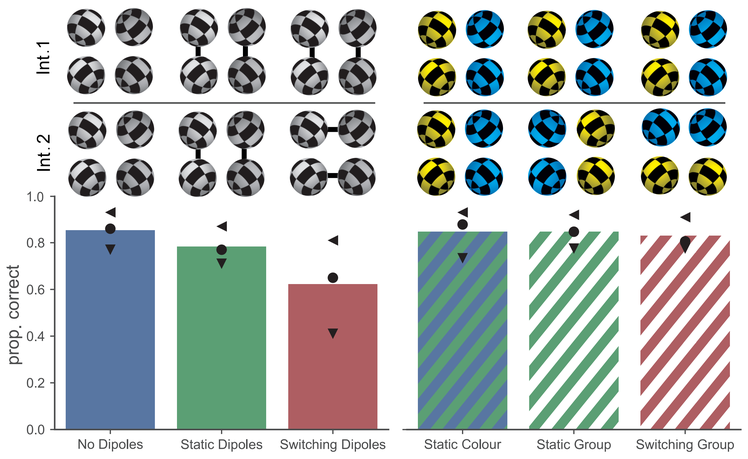

Figure 5: Performance of 3 participants for dipoles and 2-colour conditions (100 trials per participant per condition).

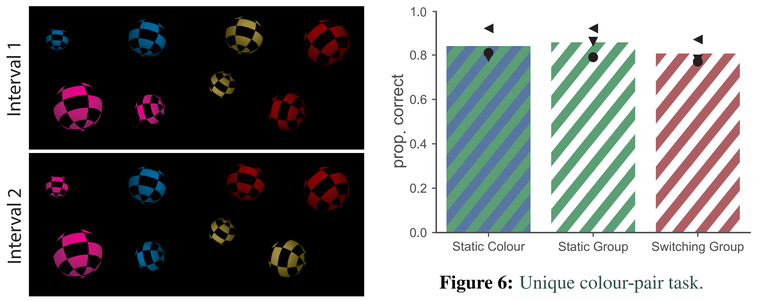

Figure 6: Unique colour-pair task.

At the individual participant level, all Holm-Bonferroni corrected χ^2 tests (n=300) were significant for the dipole conditions and non-significant across both sets of color conditions.

Effect	DFn	DFd	F	$\Delta\eta^2$	p-value
dipoles	2	4	8.18	.8	.039*
colour (2 groups)	2	4	0.35	.14	.725 (n.s.)
colour (paired spheres)	2	4	3.27	.62	.144 (n.s.)

Table 3: Group level effects.

Conclusions

- Replication of the original effect of lower performance on trials where connecting lines between objects switched position ("switching dipoles").
- Image change alone does not cause disruption similar to the switching dipoles effect.
- The same is true for grouping change.
- Findings for colour grouping in 3D scenes are compatible with the 2D literature [2, 3].

References

[1] Peter Scarfe and Andrew Glennerster. Sensory cues used to determine 3d world stability. *Journal of Vision*, 16(12):285–285, 2016.

[2] Yuhong Jiang, Ingrid R Olson, and Marvin M Chun. Organization of visual short-term memory. *Journal of Experimental Psychology: Learning, memory, and cognition*, 26(3):683, 2000.

[3] Yuhong Jiang, Marvin M Chun, and Ingrid R Olson. Perceptual grouping in change detection. *Perception & Psychophysics*, 66(3):446–453, 2004.