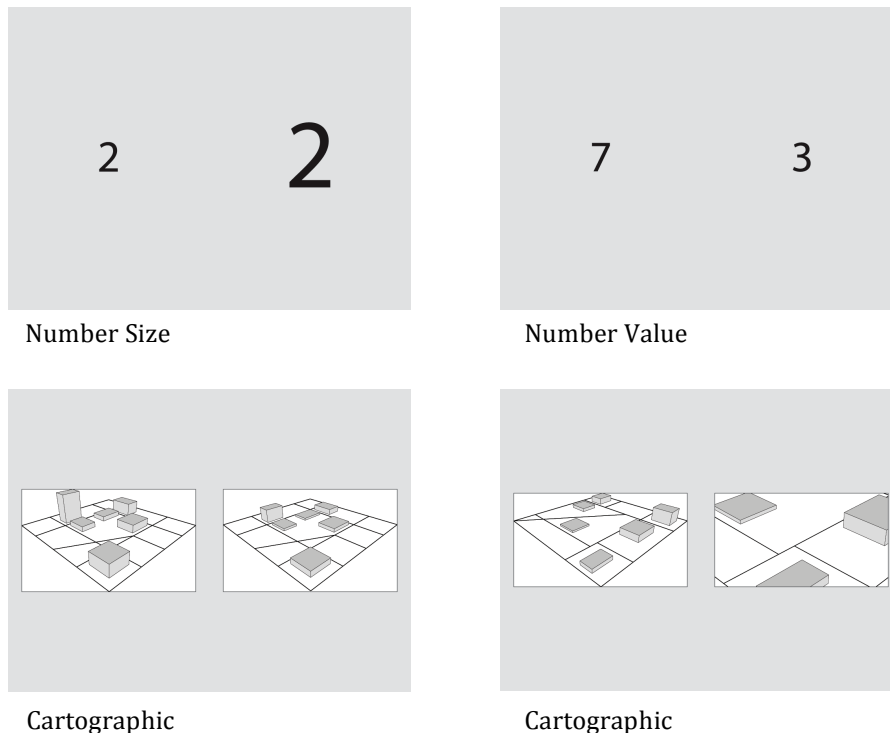


Neural Correlates in Numerical and Cartographic Scale and Magnitude

We present both behavioral and neurological results from a study designed to investigate scale and magnitude in map reading. Our overall objective was to uncover the relationships between these two primitives of geospatial thinking and how they compare with related numeric magnitude tasks. Participants were asked to determine which graphic in each pair was the largest (fig. 1). Each task was presented in three levels of difficulty to examine the *distance effect*, where the larger the difference between two stimuli the easier the decision (Moyer & Landauer, 1967).

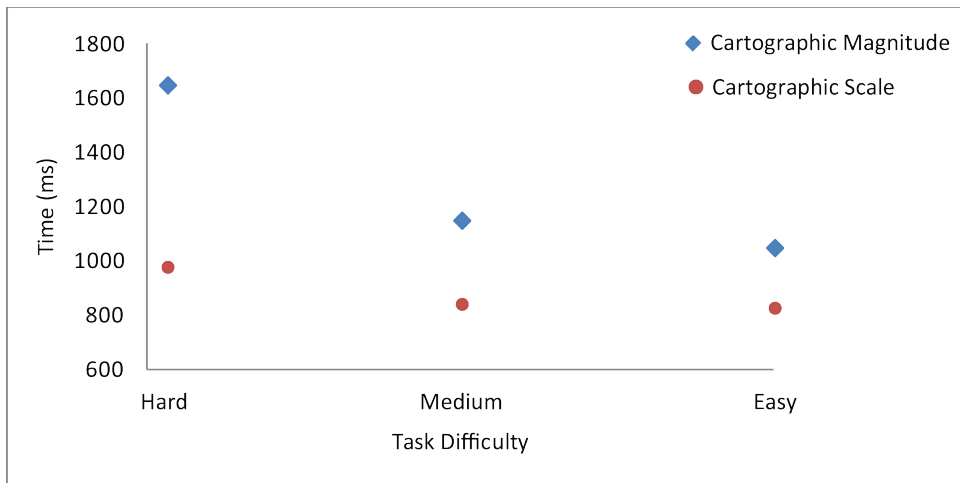
The experiment was conducted in two stages. In the behavioral stage, participants (n = 20) viewed a total of 400 trials over 2 sessions on a desktop computer and were asked to respond as quickly as possible while maintaining accuracy.

Figure 1 - Experimental Tasks



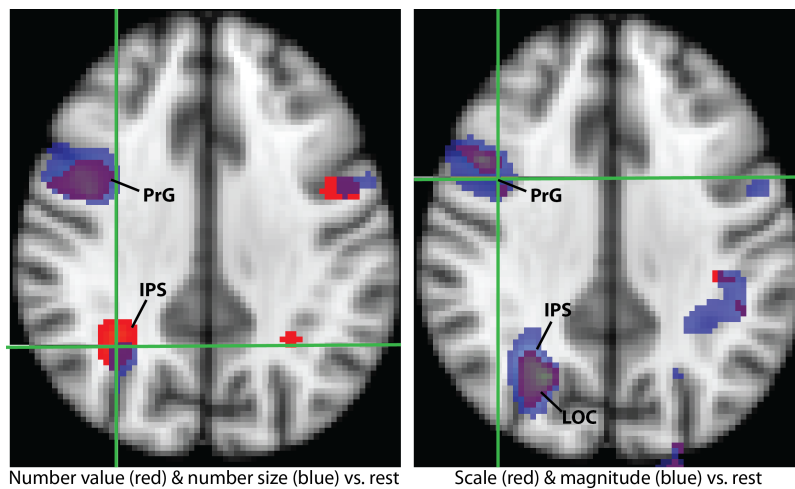
Analyses of the behavioral data revealed reaction time differences by difficulty level within tasks (scale $p < 0.001$; magnitude $p < 0.001$) as well as mean response time differences between tasks ($p < 0.001$). Participants responded more quickly when differences in the numeric and cartographic scale were larger. These results are consistent with previous research that identified task and difficulty level differences in numeric comparisons (Kadosh et al. 2005). Our research extends these results by applying the same construct to map graphics and cartographic scale. Figure 2 shows reaction time results by task (cartographic magnitude and cartographic scale) across the three difficulty levels.

Figure 2 - Response time by Difficulty



The second stage of the experiment focused on the neural correlates of these tasks with participants ($n = 10$) who performed the same experiment in the MRI scanner. fMRI data revealed similar patterns of activation for scale and magnitude tasks including the intraparietal sulcus (IPS), lateral occipital sulcus (LOC) and the precentral gyrus (PrG). Interestingly, these are the same areas that are commonly activated during numeric magnitude tasks. Together these results suggest that judgment of numeric and cartographic magnitude are neurologically similar.

Figure 3 - Neural activation by task



References

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