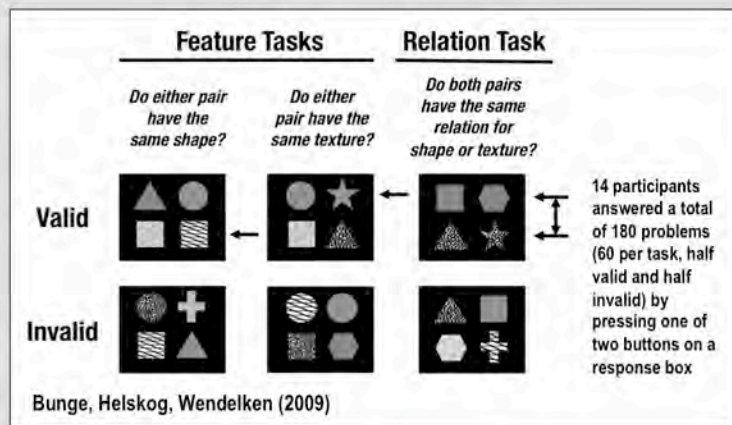




Introduction

- Analogical reasoning requires 1) the explicit representation of abstract relations and 2) mapping of those relations between source and target
- Analogical reasoning is critically dependent on prefrontal cortex (PFC; Morrison et al., 2004; Krawczyk et al., 2008) and neuroimaging studies have suggested that rostralateral PFC is important for both of these core cognitive processes (Christoff et al., 2003; Bunge et al., 2005)
- Using fMRI to study a visual analogy task, Bunge, Helskog, and Wendelken (2009) found left RL PFC activation when they subtracted activation from a simpler task which just required judging the features from pairs of object
- In the present study we used Bunge et al.'s task in an Event-Related Potential (ERP) study to begin to evaluate the time course of analogical reasoning

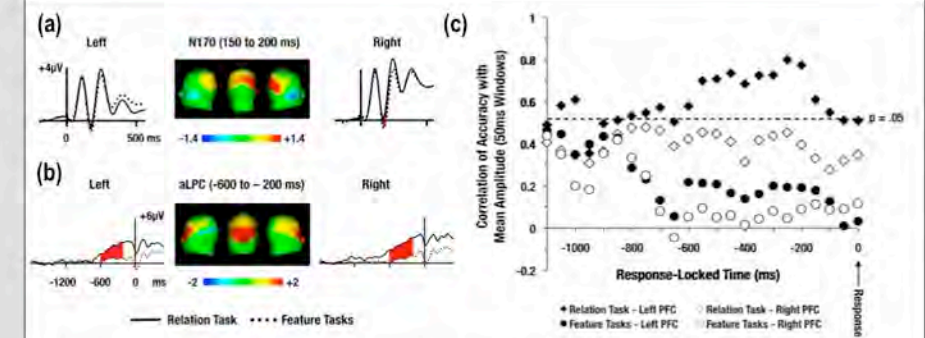
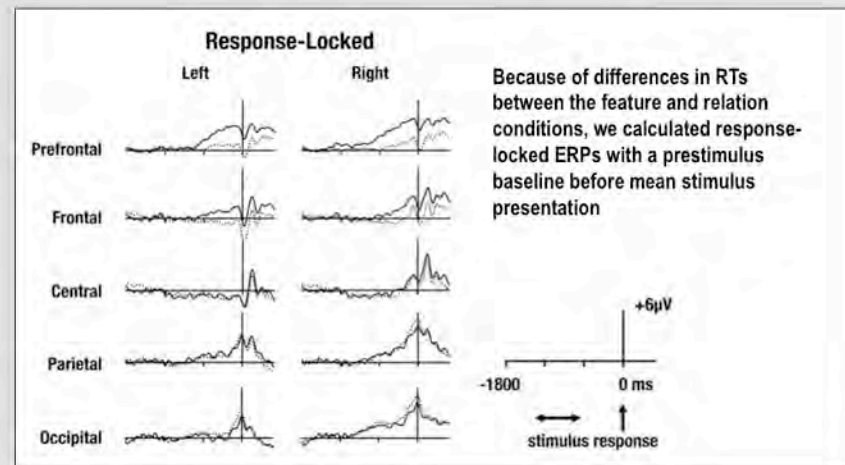
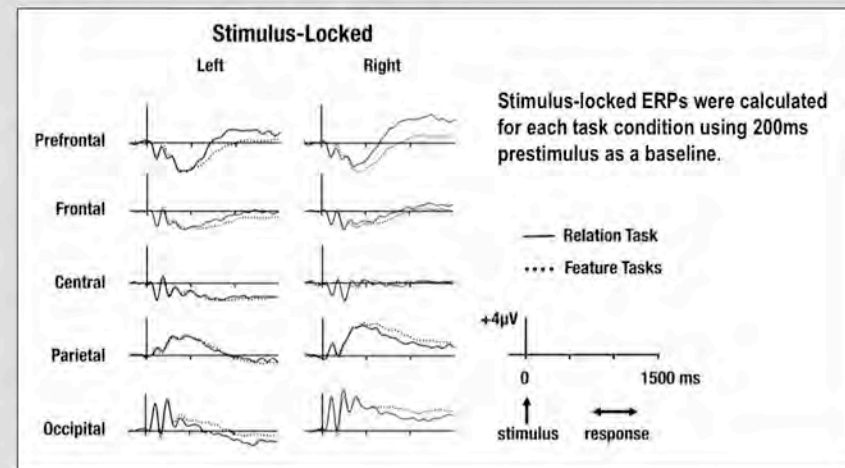


Methods

- Six shapes and six textures were used to construct 60 stimuli reused for three tasks. In feature tasks participants had to decide whether top or bottom pair matched across a specified condition while in relation task they had to perform an analogy between top and bottom pair
- EEG data were collected for 38 channels using Biosemi Active2 electrodes. Data were mastoid re-referenced and filtered offline and all channels were corrected for ocular artifacts using a PCA-based algorithm in EMSE

Results

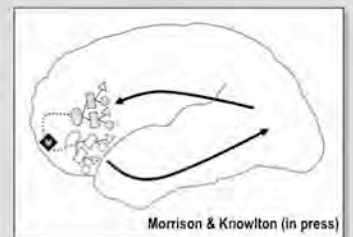
- 18 undergraduate students were paid \$20 for participation in the one hour testing session. Results from four participants were eliminated because their accuracy on the relation task was below 70%.
- Participants were more accurate and faster in the feature tasks ($M_r = .95$; $SD_r = .01$; $M_f = 872$; $SD_f = 39$) than in the relation task tasks ($M_r = .88$; $SD_r = .02$; $M_f = 1081$; $SD_f = 60$).
- Feature tasks yielded a more negative stimulus-locked N170 ERP than the relation task, suggesting that participants used a more holistic strategy to consider relations in the feature task than they did in the relation task.
- We found greater bilateral prefrontal activation in response-locked relation- task ERPs than in feature-task ERPs from around 600 ms to 200ms before the response.



(a) Feature tasks yielded a more negative stimulus-locked N170 ERP than the relation task, suggesting that participants used a more holistic strategy to consider relations in the feature task than they did in the relation task. (b) While mean amplitude from -600 to -200ms was reliably different for feature and relation tasks in both hemispheres, (c) mean amplitude showed an increase in correlation with performance only in the left hemisphere in a time window consistent with analogical mapping.

Summary

- We found evidence that bilateral anterior PFC is likely important for the processing of abstract relations in analogical reasoning.
- In contrast, it appears that left anterior PFC is involved in the processing necessary for analogical mapping.
- Recent attempts to provide an algorithmic account of what the brain (Hummel & Holyoak, 2005; Morrison & Knowlton, in press) must do to process analogies suggests that left anterior PFC may be necessary for tracking firing patterns of relational structures, a necessary function in analogical mapping as well as many other examples of complex relational reasoning.



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