The Role of Action Information in Thematic Relations between Objects

Ruthie E. Wittenberg[1], Christine E. Watson[2], Laurel J. Buxbaum[2], & Sharon L. Thompson-Schill[1]

[1]University of Pennsylvania, [2]Moss Rehabilitation Research Institute

Does action information play a role in the processing of thematic relationships between objects?

Introduction

- Object concepts: organized both taxonomically (categorically) and thematically (in terms of associated roles in events)
- Thematic information: 1. Critical for determining relationships between manipulable objects; 2. Activates a bilateral temporo-parietal network including inferior parietal lobules and middle temporal gyrus
- Left temporo-parietal cortex: plays an important role in action-based object relationships
- Stroke patients with left temporo-parietal lesions less sensitive to the action element of thematically-related manipulable objects than healthy controls or patients with other lesion loci

Hypotheses

- Left Angular Gyrus: more active when thinking about event/thematic similarity compared to category/taxonomic similarity
- Left Angular Gyrus: not differentially activated for taxonomic judgments made with action compared to taxonomic judgments made without action
- Precuneus: more activation for taxonomic judgments compared to thematic judgments
- Taxonomic relationships between objects will show greater activation in anterior temporal lobe than thematic relationships

Methods

Participants

- 14 participants from the University of Pennsylvania (5 females), mean: 21.8 years, range: 18-30

Stimuli

- Task and stimuli based on Tsagkaridis et al. 2014
- 36 groups of objects, 2 triads formed from each group=72 unique triads; 36 scrambled trials

Action Ref-Tax-ThA (72) | **No Action Ref-Tax-ThNoA (72)** | **Scrambled (36)**

- Both kinds of judgments made on all 36 Ref-Tax-ThA triads and all 36 Ref-Tax-ThNoA Triads.

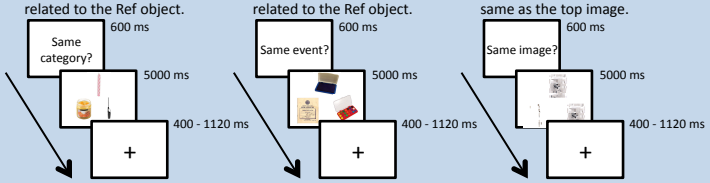
Design

- Event-related, 4 runs of 45 trials each (7 min 39 sec total per run), 3 second TRs
- Data collected on a 3-T Siemens Trio system and 32-channel array head coil; echo-planar fMRI performed in 42 axial slices and 3 mm isotropic voxels
- Correct trials only, RT regressed as no interest in fMRI analysis

Category Trials (n=72): Select the object that is taxonomically related to the Ref object.

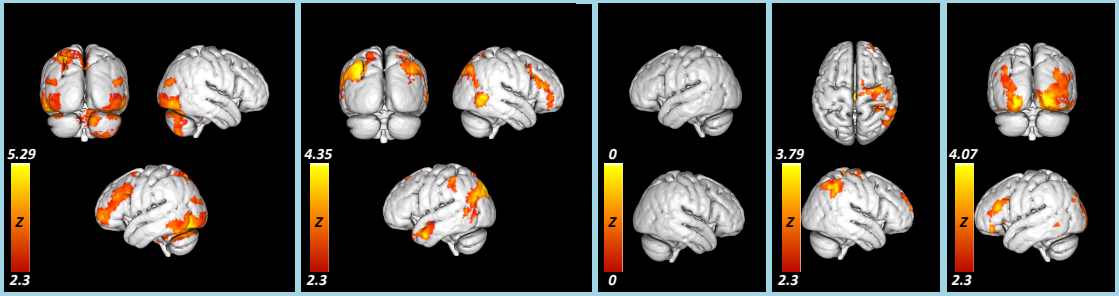
Event(n=72): Select the object that is thematically related to the Ref object.

Scrambled(n=36): Select the image at the bottom that is the same as the top image.



Results

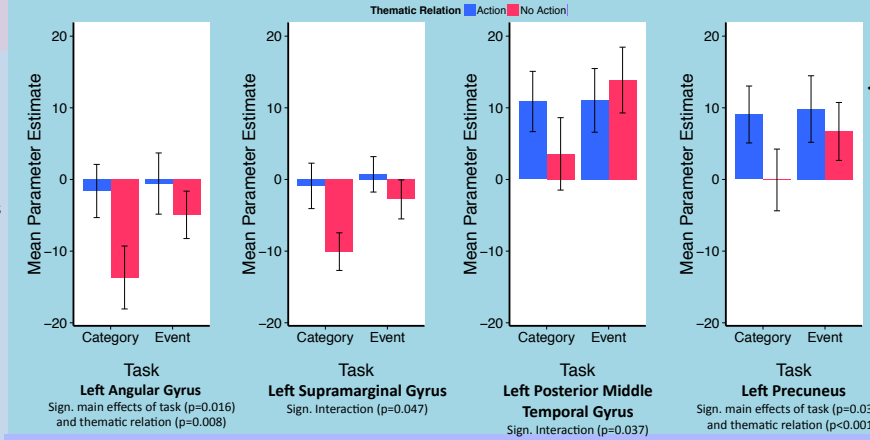
Whole Brain



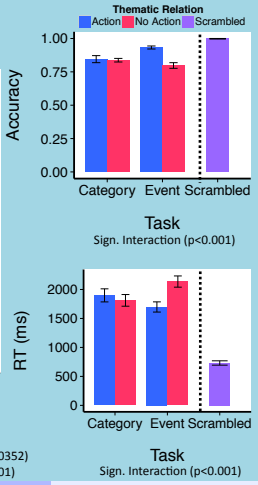
All trials > Baseline | **Event (all trials) > Category (all trials)** | **Category (all trials) > Event (all trials)** (n.s.) | **Event(Th+A) > Event (Th-A)** | **Event(Th-A) > Event(Th+A)**

Anatomical Regions of Interest (ROIs)

Anatomical regions defined from Harvard Oxford Cortical atlas, thresholded at 25%
ROI analyses show each condition > scrambled



Behavioral



Conclusions

Event vs. Categorical Similarity

- Whole brain analyses: thinking about event similarity activates bilateral temporoparietal areas
- ROI analyses: stronger activation for Event vs. Category in left AG, but not strongly active for either task
- Contrary to hypothesis, left precuneus was more active for Event vs. Category
- Whole brain analyses showed Event > Category in left anterior temporal cortex
- No areas more active for Category > Event judgments

Events Based on Common Action (Th+A) vs. Co-occurrence in Space and Time (Th-A)

- Whole-brain analyses showed more activation in right AG for Th+A, among other areas
- ROI analysis in left pMTG showed not just Th+A > Th-A, but also that Event or Category (Th+A) activates pMTG
- Areas predicted to be more active for Th+A during Event trials were actually more active for Th-A

Future Analyses

1. Collected motor imagery localizer; can use to create functional ROIs in which to examine Th+A/Th-A differences
2. Have continuous ratings of similarity between target and correct answer, e.g. action similarity, thematic similarity, taxonomic similarity. Can use to find regions whose activations vary with similarities.

References

[1] Buxbaum & Kalenine (2010)
[2] Jackson et al. (2015)
[3] Kalenine et al. (2009)
[4] Pluciennicka et al. (2015)
[5] Sass et al. (2009)
[6] Tsagkaridis et al. (2014)

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Contact

wittenb@sas.upenn.edu