fMRI activity during a spontaneous dialogue task

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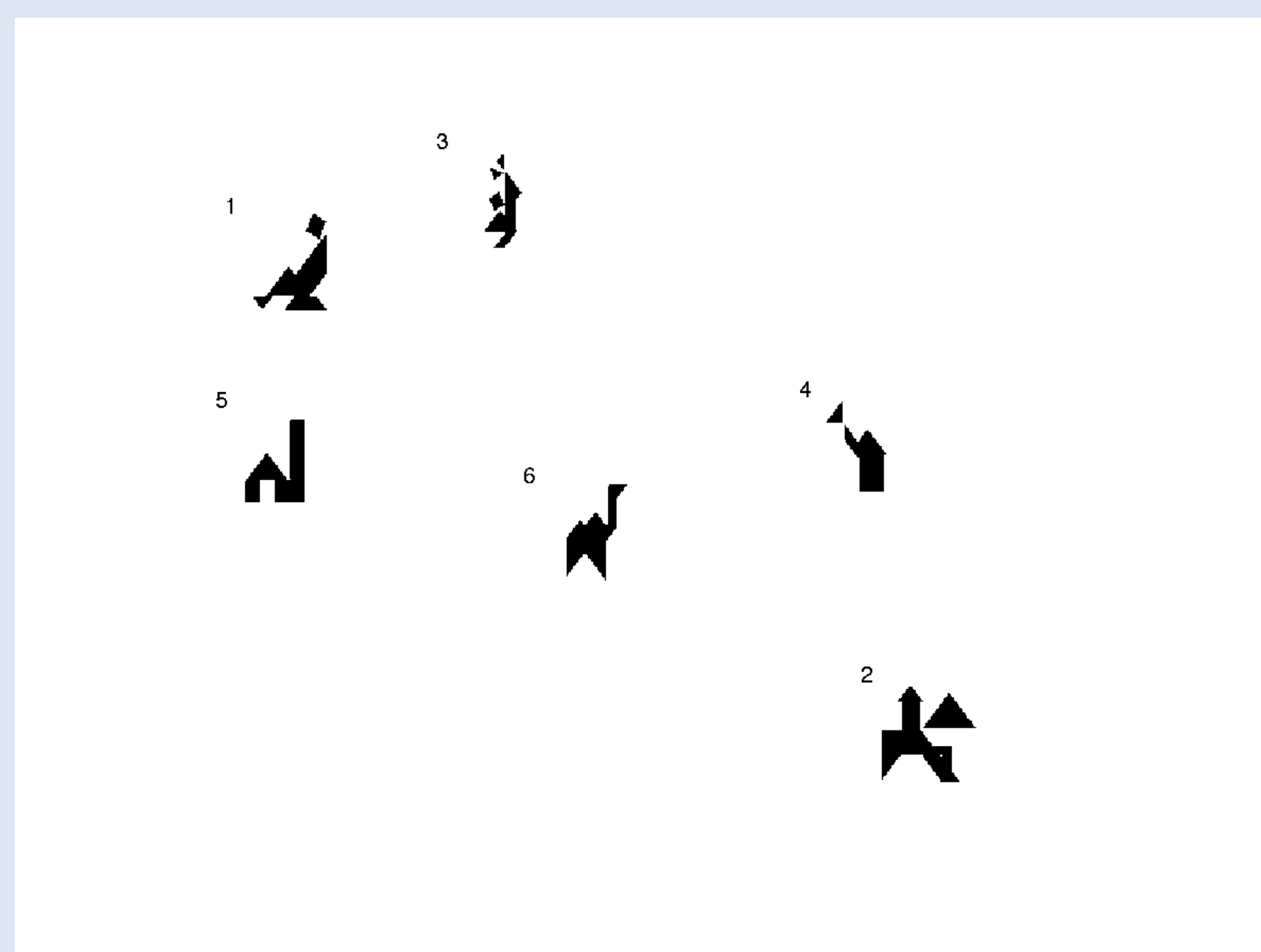
Motivations

o fMRI studies typically rely on event-related designs to isolate specific aspects of language[1]
o Recent studies have underlined the need for naturalistic paradigms (e.g. spontaneous language[2,3], movies[5])
o Such paradigms are a necessary next step; they allow us to:
  1) Evaluate the ecological validity of previous findings[2]
  2) Investigate cognition more naturally[4]
o The goals of this project:
  1) Develop a paradigm that encourages spontaneous dialogue, such as a game
  2) Test conventional analyses on imaging data from spontaneous language study

Methods

o Subjects: n=17, mean age =24.8 (18, 35), 65% female
o Scanning: Siemens 3T Trio with 32 channel head coil
o 2mm isotropic voxels
o MPRAGE + 5 runs @ 5-10min each; 40s baseline per run
o Audio: fMRI compatible noise cancelling microphone and headphones. Dialogue recorded on solid state recorder
o Audio transcript was annotated to determine timing of events
o Whole-brain, univariate glm analysis as first pass

Task in Scanner

o Game adopted from previously used paradigms[2,6]
o Instruction to participant:
  1) Describe each shape so that the experimenter (E) can pick it out from a list of similar shapes. Decide on a name for shape once E finds it (i.e. establish reference)
  2) Next, guide E to place the shape so that their screen looks like yours in the end
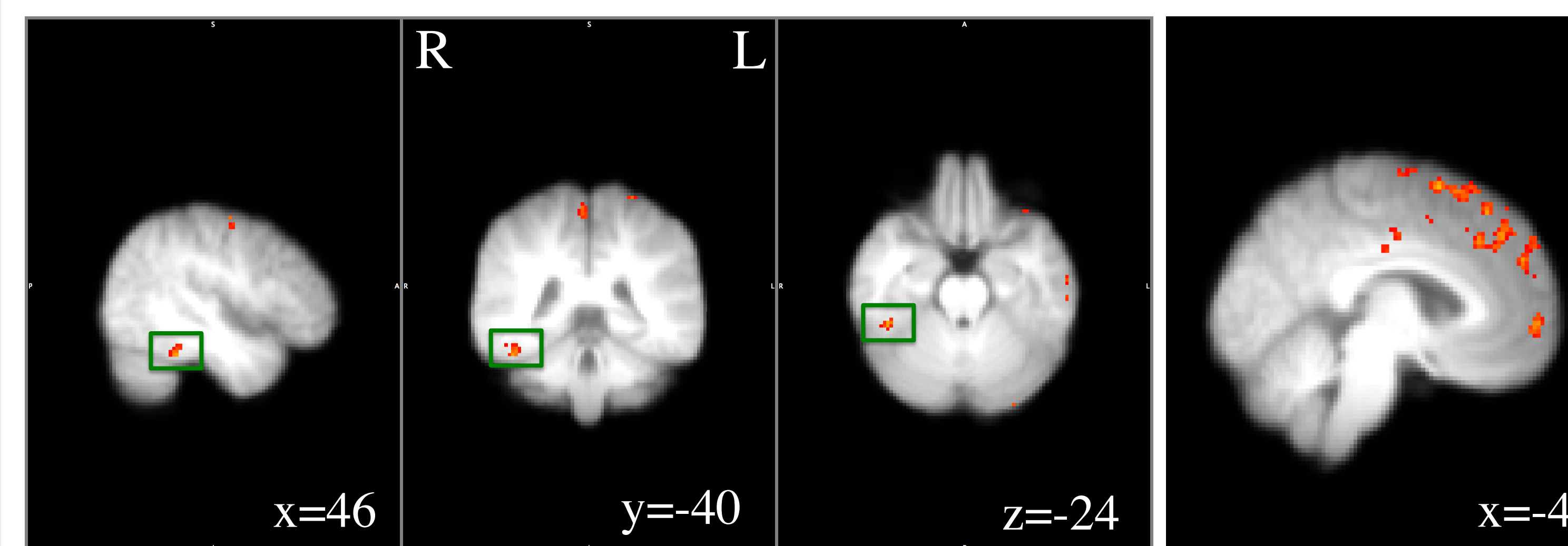o Instruction to E: ask questions, facilitate dialogue, complete task

Example stimulus set for a single run:

Annotation of Example Transcript

Establishing Reference	Can you describe [his] feet and legs?
	... He's got a triangle for the feet and a larger triangle for the legs, and they are laid out like he's... they're not straight up and down, so it looks like he has his legs spread out
	Ok, I have a couple that this might be. Can you see his arms?
	No, no arms.
	Ok, I think I found this one... We can call it the sitting guy?
Placing Shape	Ok, yeah. The sitting guy is in the second quadrant, 25% to the right and 25% down.
	25% of the whole page or of the quadrant?
	Whole page, but 25% of the quadrant to the right.
	Perfect, I think I have him in the right place. Do you want to move on to the next shape?
	Ok! So this one…

Goal	Subject	Experimenter	Animate/Inanimate

Animate vs Inanimate References

x=46   y=-40   z=-24   x=-4

o Every time an object is referenced, the reference was coded as either animate or inanimate (see annotation example above)
o **Contrast**: Animate - Inanimate (speaking and listening)
o **What we see**: Ventral temporal, fusiform activity (left panes); z>2.3, no cluster p threshold
o **Similar results:** Animate>Inanimate in event related design[7]
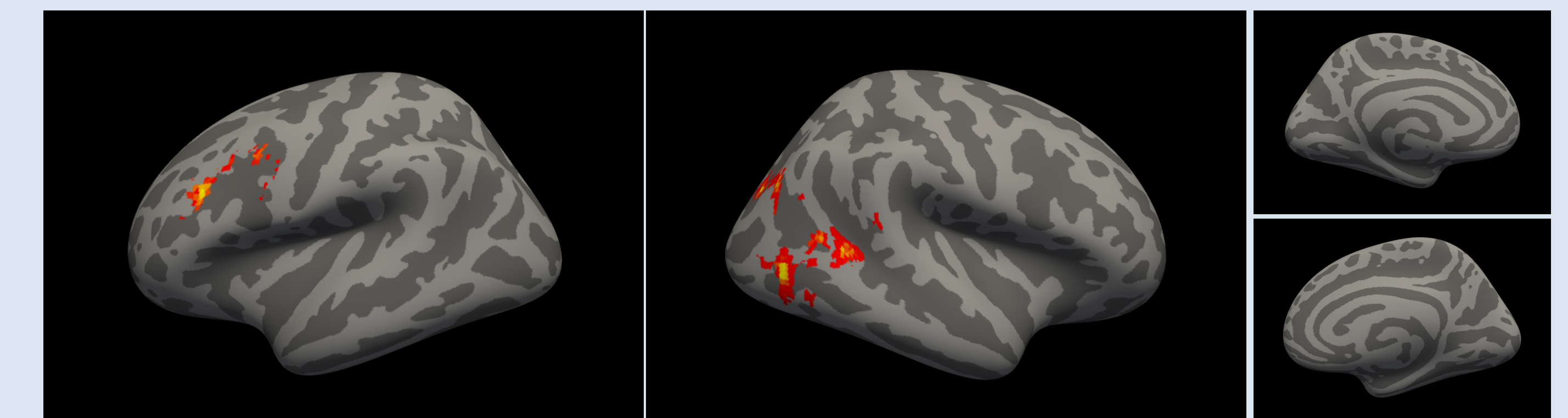o **Also:** Medial frontal (right pane); z>2.0, no cluster p threshold

Differential Activity Patterns Depending on Goal of Utterances

o **Contrast**: Subject describing shape characteristics > general speech
o **What they're doing**: Attempting to establish reference
o **What we see**: Left frontal cortex, right posterior middle temporal; z>2.3, cluster threshold p<0.05
o **Similar results seen in:** Self and other judgment tasks[8]

o **Contrast**: Subject describing shape location > general speech
o **What they're doing**: Describing spatial locations, conveying distance judgments
o **What we see**: Medial occipital (may be due to increased visual attention/eye movements), right posterior middle temporal, supramarginal gyrus; z>2.3, cluster threshold p<0.05
o **Similar results seen in:** Object-/landmark-centered spatial coding in a distance judgment task[9]

Conclusions

o Simple univariate contrasts reveal familiar activity patterns
o Spontaneous language paradigms such as these can:
  1) Validate previous research
  2) Fill in knowledge about brain activity during natural language use
  3) Inform hypotheses about natural language use that cannot be studied under controlled experiments

References

(1) Andric & Small, 2015
(2) Brown-Schmidt & Tannenhaus, 2008
(3) Hasson & Egidi, 2015
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(5) Hasson, Malach, & Heeger, 2009
(6) Duff, Hengst, Tranel, & Cohen, 2005
(7) Chao, Haxby, & Martin, 1999
(8) Denny, et al, 2012
(9) Committeri, et al, 2004

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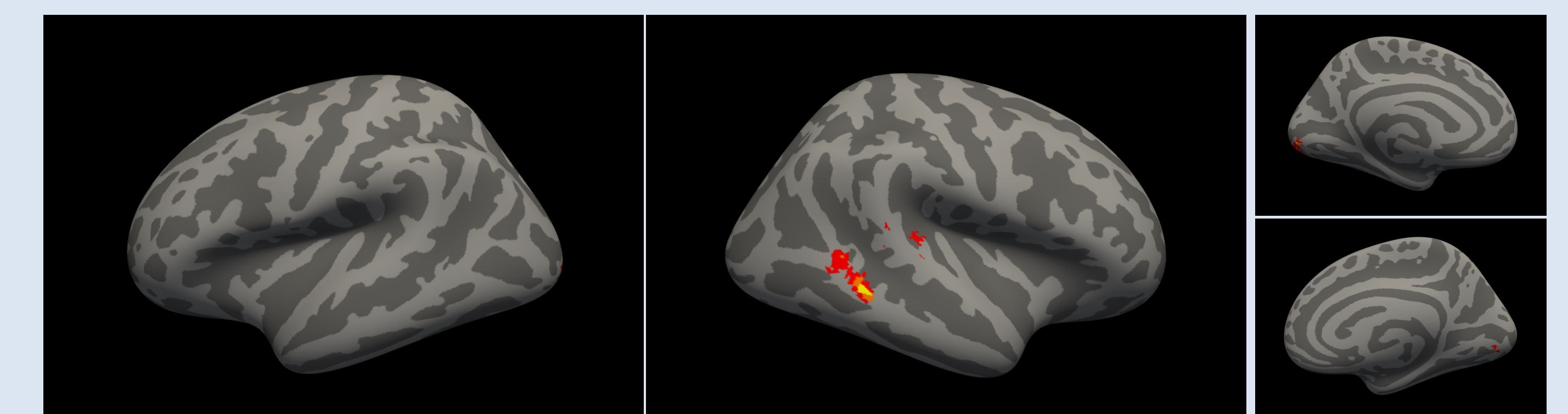Emilio Tamez: temilio@sas.upenn.edu
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