

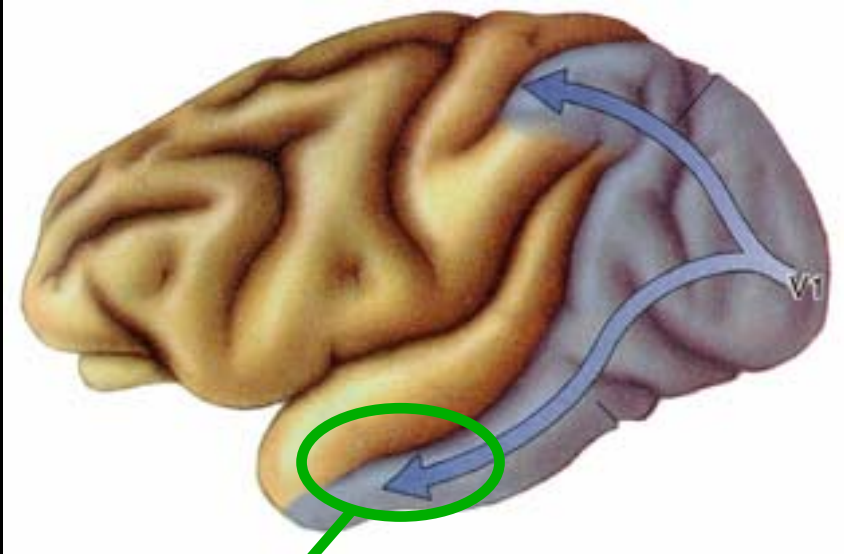
Neural Systems for Visual Scene Recognition

Russell Epstein

University of Pennsylvania



“Where” (dorsal)

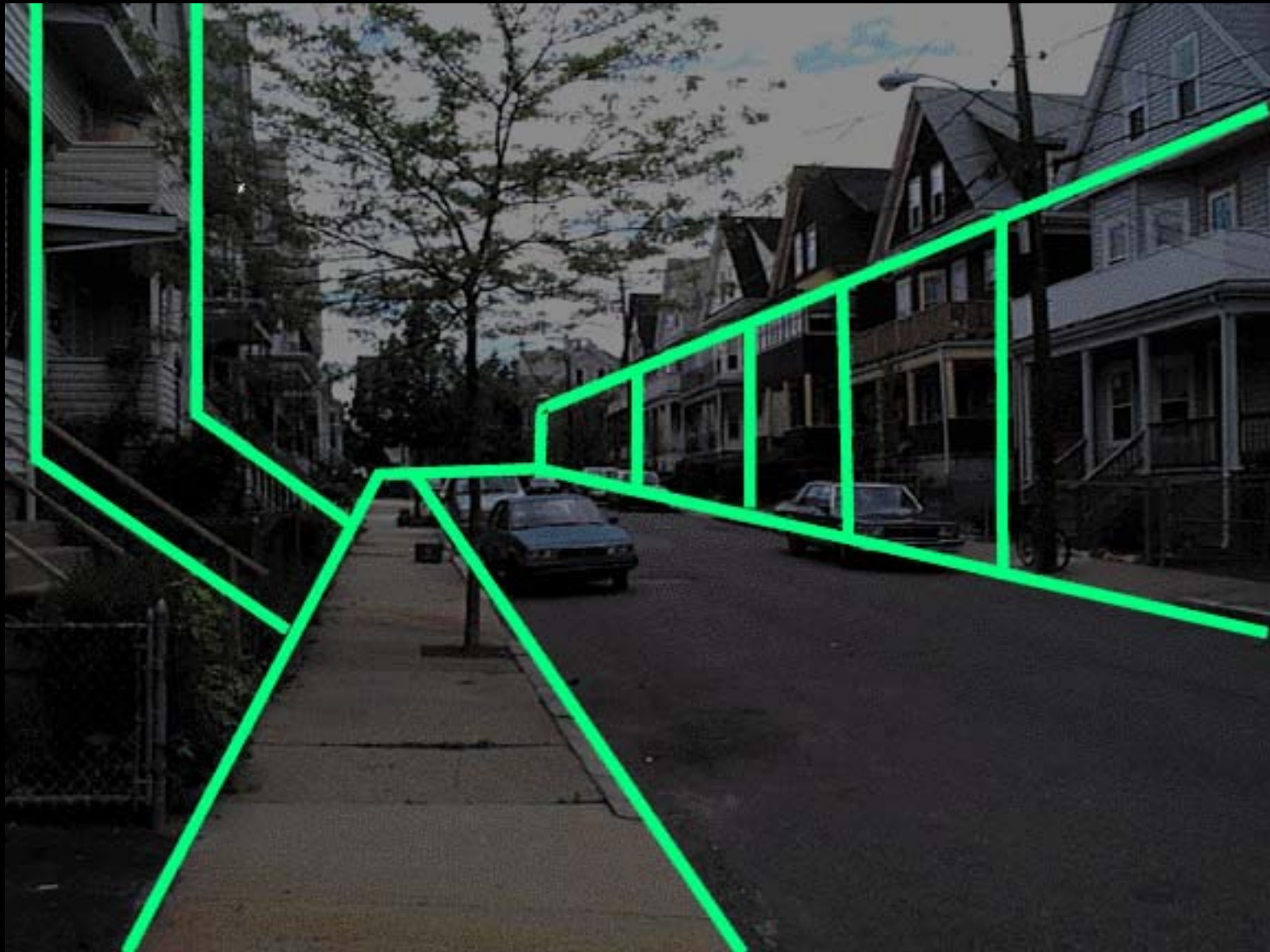


“What” (ventral)

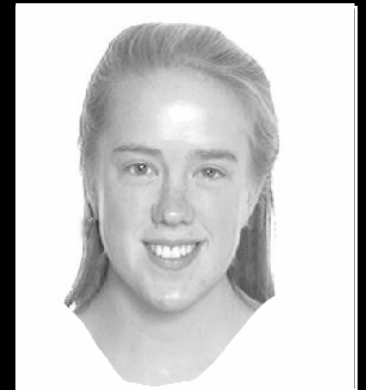






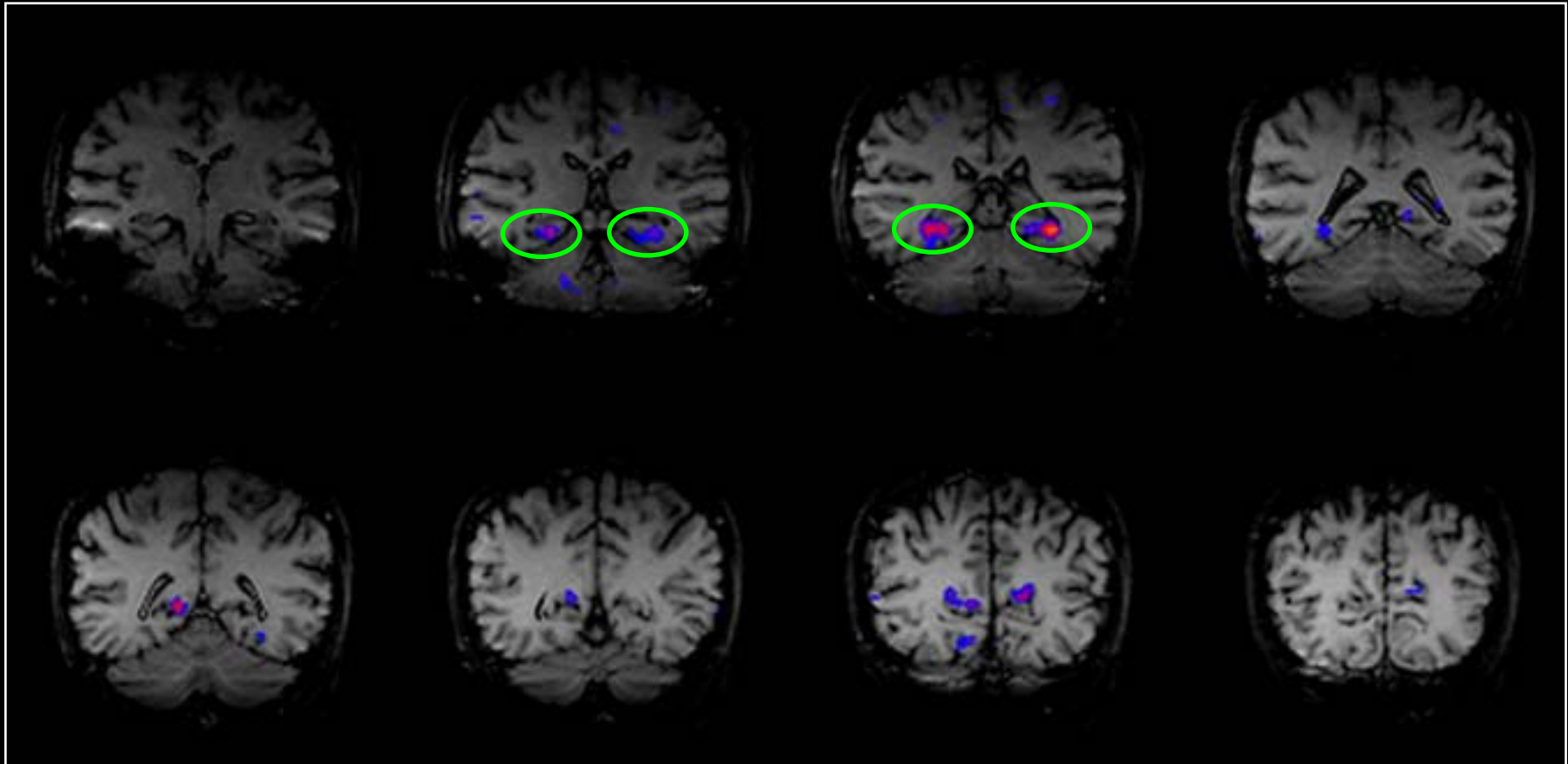


Cortical specialization for scenes?



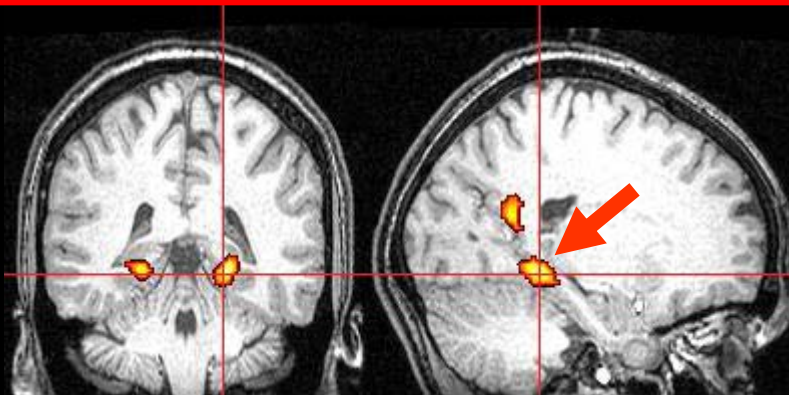
Scenes > Faces & Objects

(1 Subject)



“Parahippocampal Place Area” (PPA)

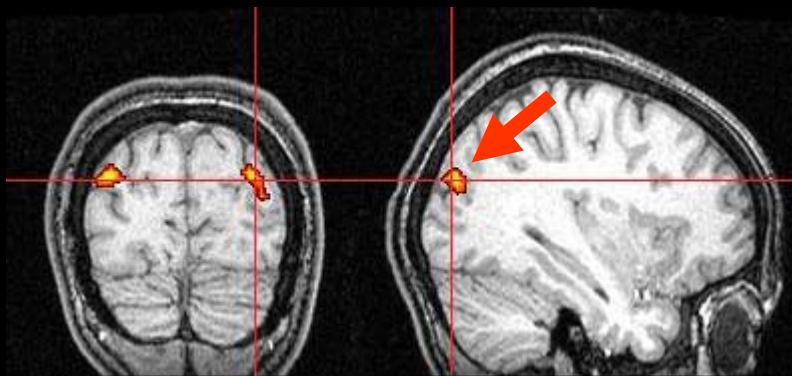
**Parahippocampal
Place Area (PPA)**



**Retrosplenial
Cortex (RSC)**

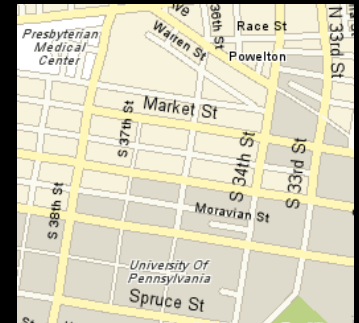


**Transverse
Occipital
Sulcus (TOS)**



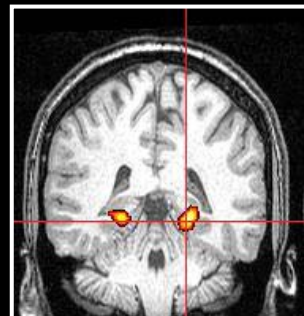
(scenes>objects at
 $p < 0.05$ corrected)
1 subject

What kind of scene recognition?



Category ID:
“storefront on a
city street”

Location ID:
“Penn Bookstore
36th & Walnut”



PLACE



Category Recognition:
"Storefront"

Exemplar Recognition:
"Penn Bookstore
...at 36th & Walnut St"

SITUATION/EVENT



Category Recognition:
"Party"

Exemplar Recognition:
"The birthday party of a
random six year old
whose name I don't
know"

Examples of Stimuli

LOCATION IDENTIFICATION



Penn Bookstore

CATEGORY IDENTIFICATION



Classroom



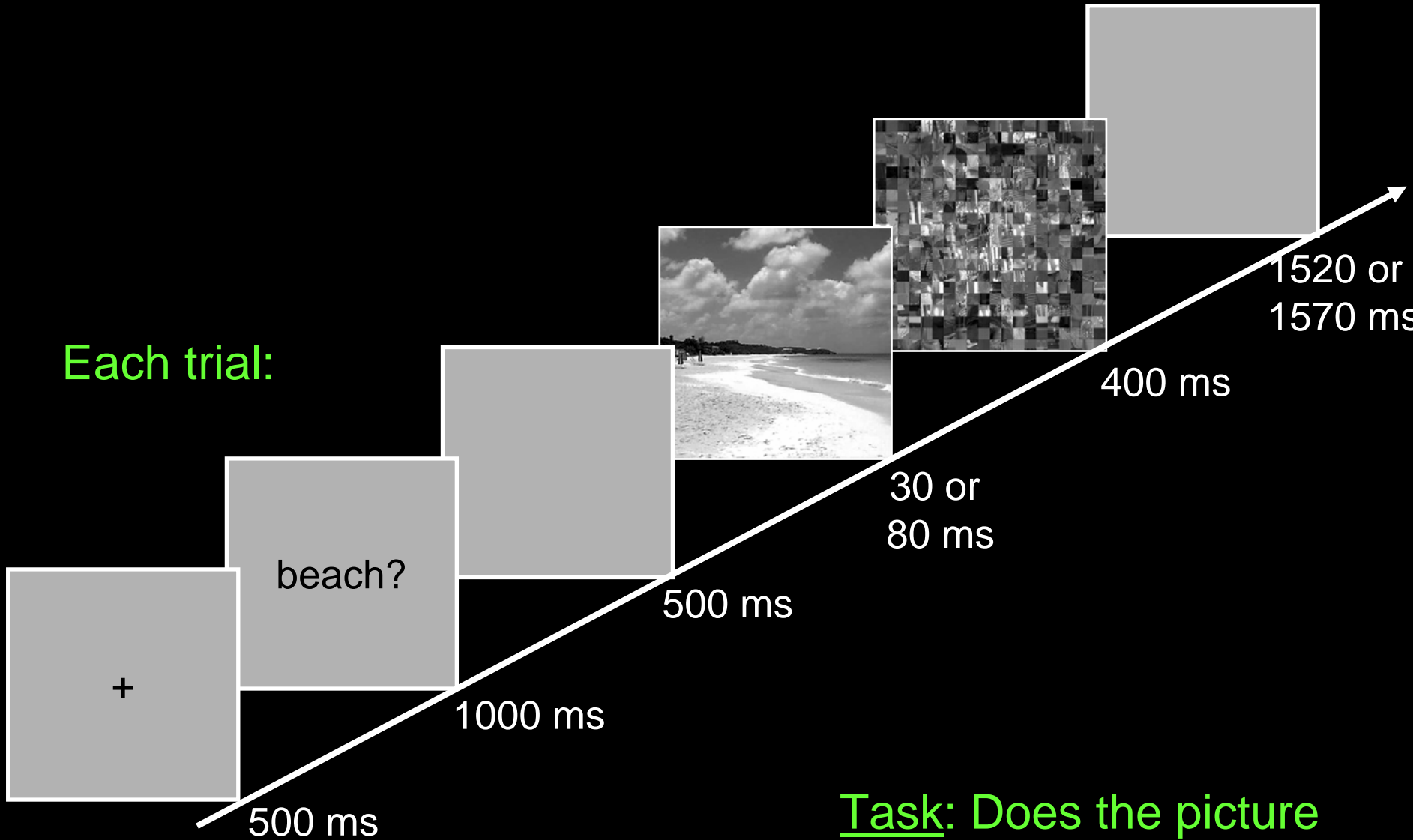
Houston Hall



Dining Room

Experimental Paradigm

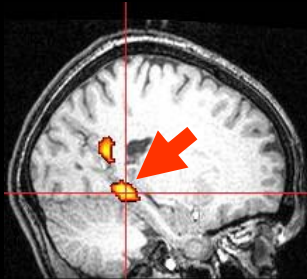
Each trial:



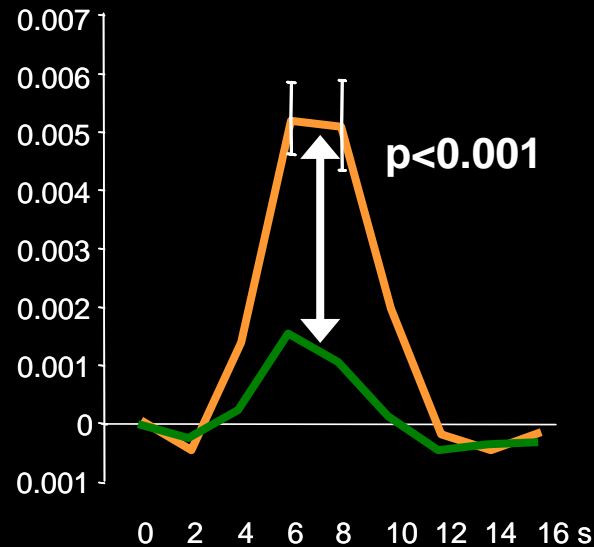
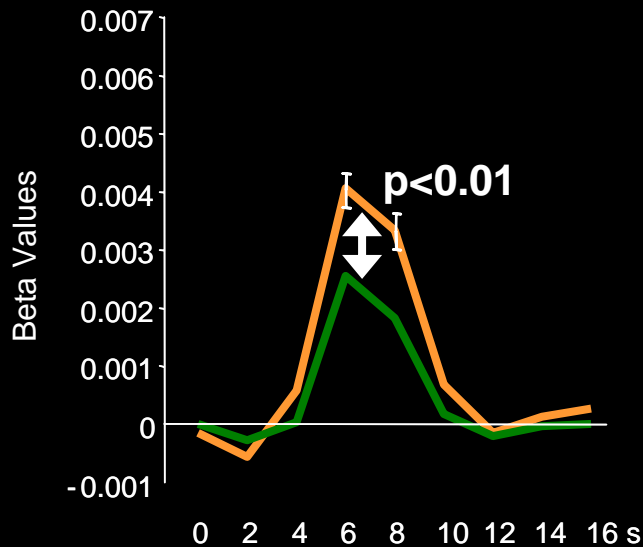
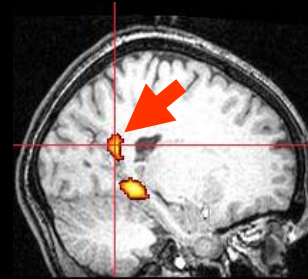
Task: Does the picture match the label (yes/no)?

Results

PPA



RSC

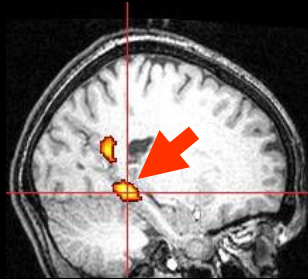


— Location ID
— Category ID
(N=5)

→ PPA & RSC may be more critically involved in location identification than in category identification

PPA vs. RSC

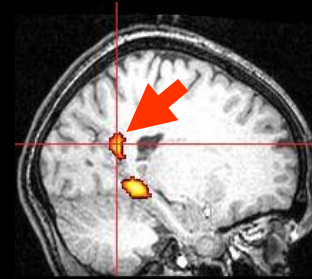
PPA



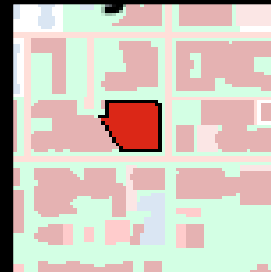
Represents the geometric structure of specific, individual scenes.



RSC



Represents the spatial relationship between scenes and their surrounding environments.



→ Both kinds of representations are necessary for location identification (but may be less important for category identification)

Location recognition, or just exemplar recognition?



Where is this?

- Penn Bookstore
- 36th and Walnut St.
- Facing North

Condition 1: Location: “West or East of 36th Street?”



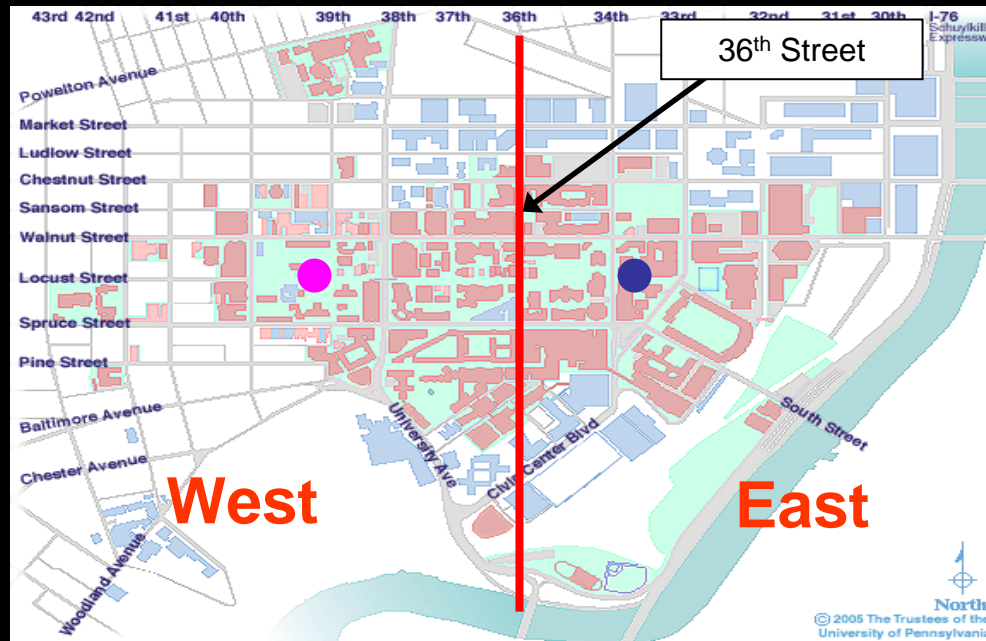
Response Choices:

1 = West

2 = East



“1”



“2”

(Epstein, Parker & Feiler, J. Neurosci, in press)

Condition 2: Orientation: “Facing West or East?”



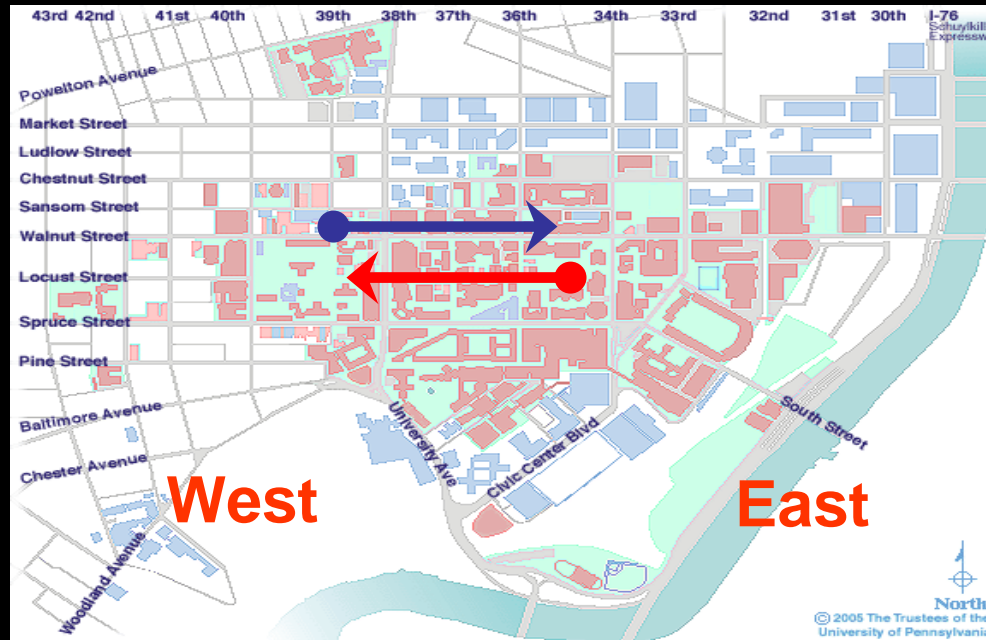
Response Choices:

1 = Facing West

2 = Facing East



“1”



“2”

Condition 3: Familiar Scene Control: “Penn or Not Penn?”



“1”



“2”

Response Choices:

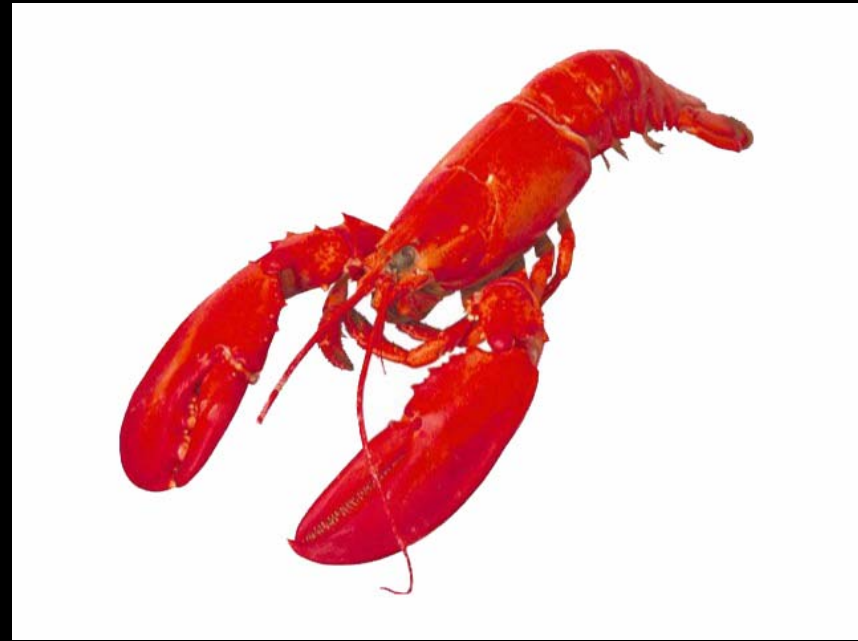
1 = Penn

2 = Not Penn

Condition 4: Object Control: “Vehicle or Not Vehicle?”



“1”



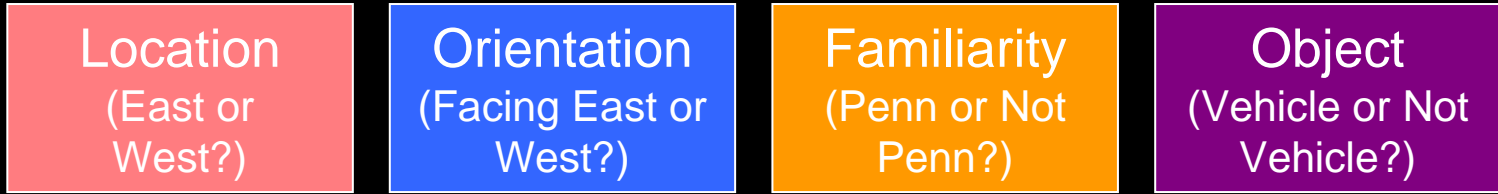
“2”

Response Choices:

1 = Vehicle

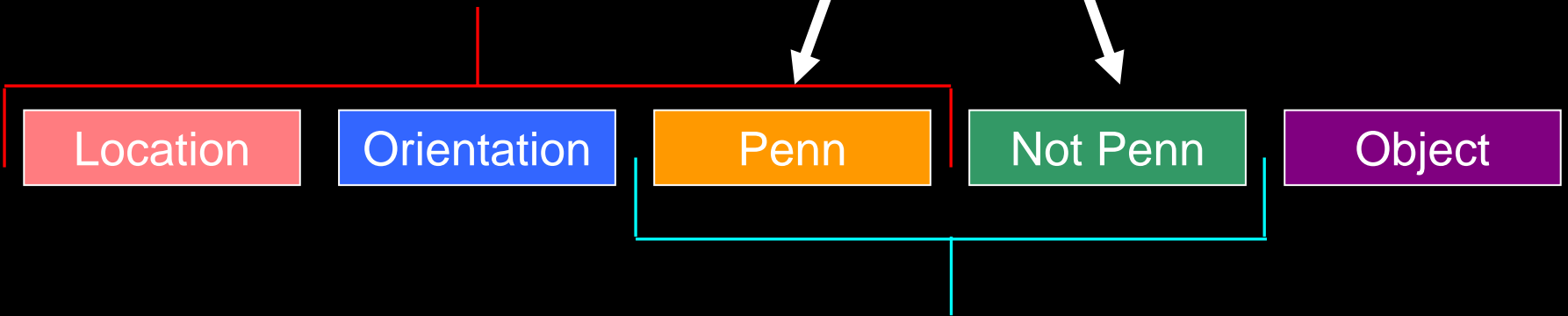
2 = Not Vehicle

4 tasks:



5 conditions:

Same Stimuli, Different Tasks



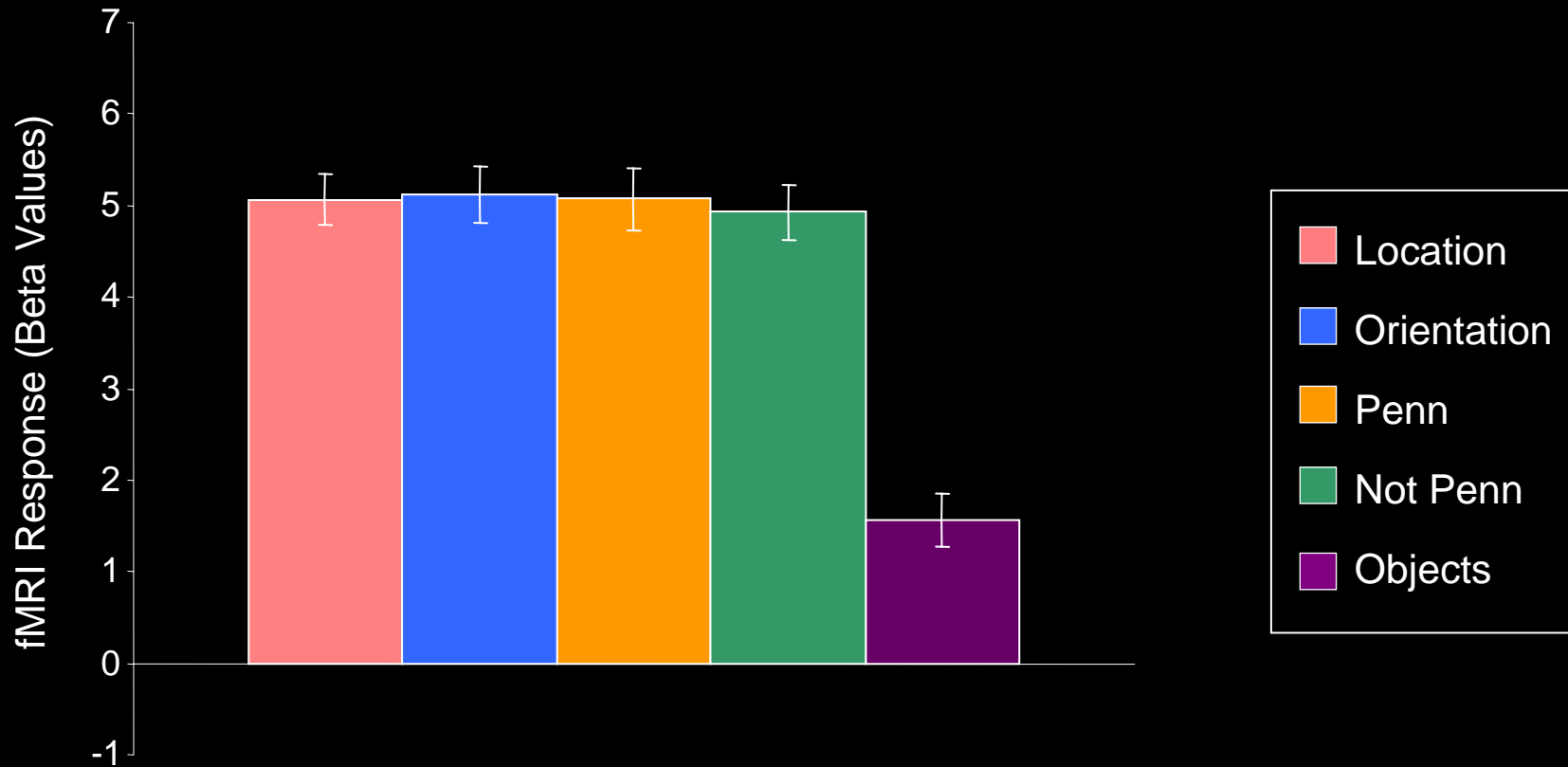
Same Task, Different Stimuli

Results: Behavioral

	Location	Orientation	Penn	Not Penn	Object
<i>Accuracy (% correct)</i>	88.6 ± 1.5	84.5 ± 2.3	97.4 ± 0.9	97.6 ± 1.1	99.0 ± 0.3
<i>Reaction Time (ms)</i>	1782 ± 113	1944 ± 94	1029 ± 51	1138 ± 77	750 ± 33

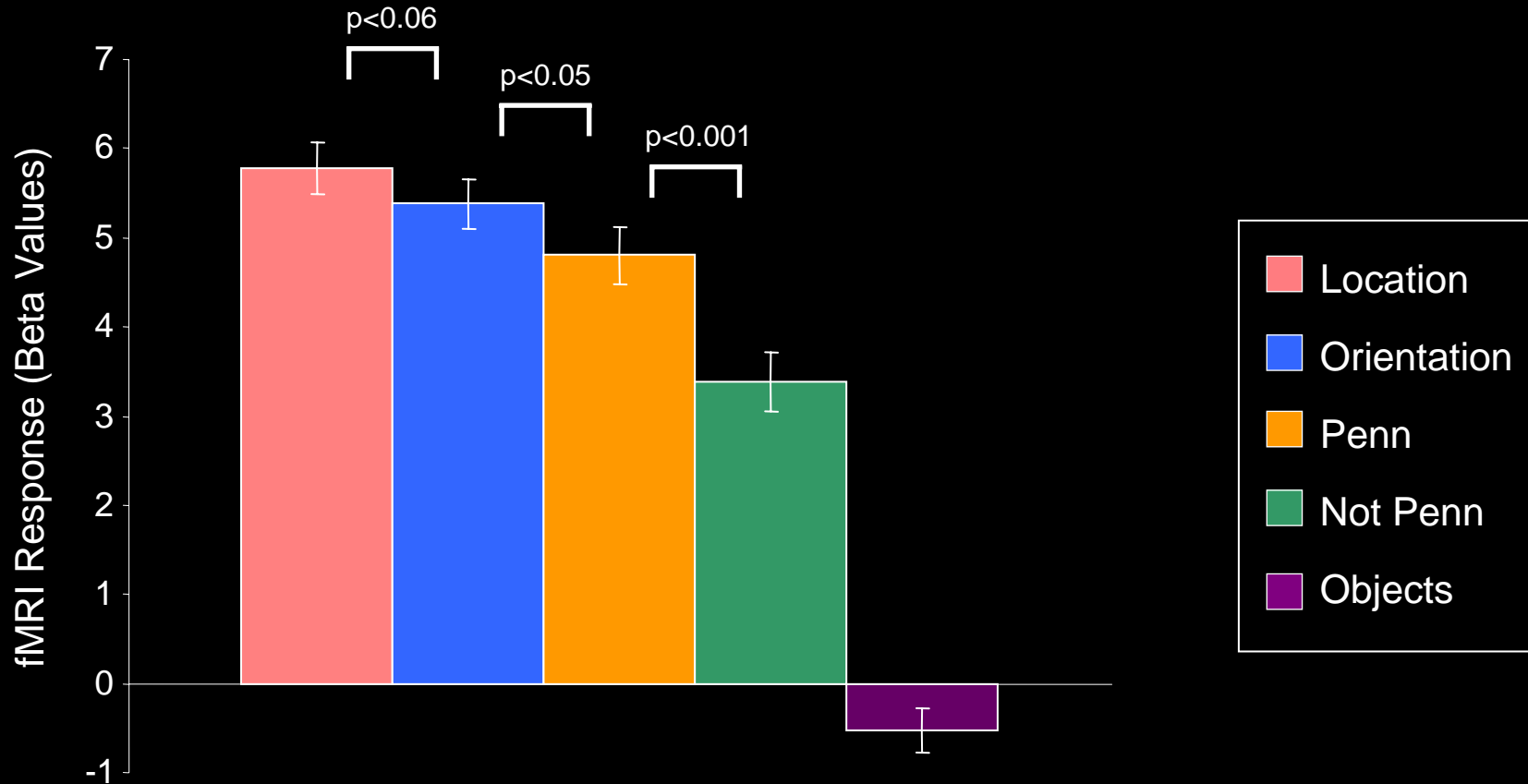
→ *Location and Orientation judgments are more difficult (lower accuracy, longer RT) than Familiarity or Object judgments*

Results: PPA



→ *PPA responds equally strongly in all scene conditions, consistent with a PPA role in scene perception*

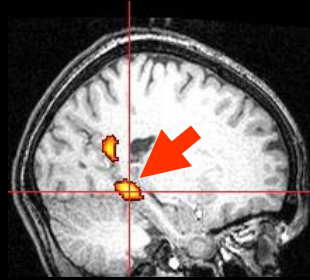
Results: RSC



→ RSC response is affected by both task (Location > Orientation > Penn) and familiarity (Penn > Not Penn).

PPA vs. RSC

PPA

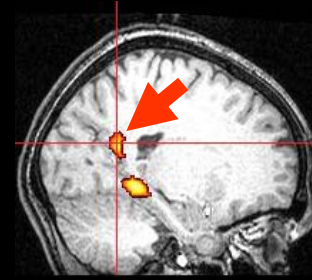


Represents the geometric structure of specific, individual scenes.

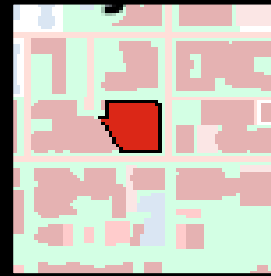


Active when a scene is viewed (or imagined)

RSC



Represents the spatial relationship between scenes and their surrounding environments.



More active when location information

- (1) Can be retrieved (familiar > unfamiliar)
- (2) Is intentionally retrieved

Conclusions (but not quite the end)

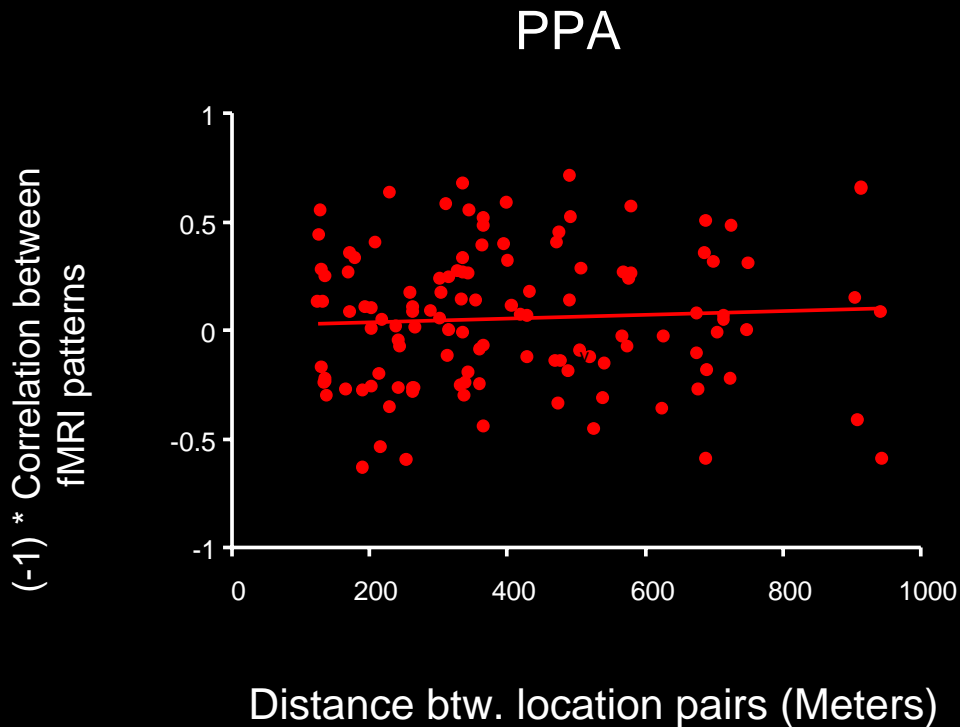
- The human brain contains specialized regions involved in scene processing (PPA & RSC).
- PPA and RSC are more critically involved in location identification than other scene recognition tasks
- PPA and RSC play distinct but complementary roles in location identification:
 - » PPA: represents local scene geometry, as defined primarily by fixed background elements
 - » RSC: represents the relationship btw. the local scene and wider space (“Where am I?”).
- Next step: use fMRI adaptation/pattern analysis studies to more fully determine the representational space in these regions

fMRI Pattern Analysis study



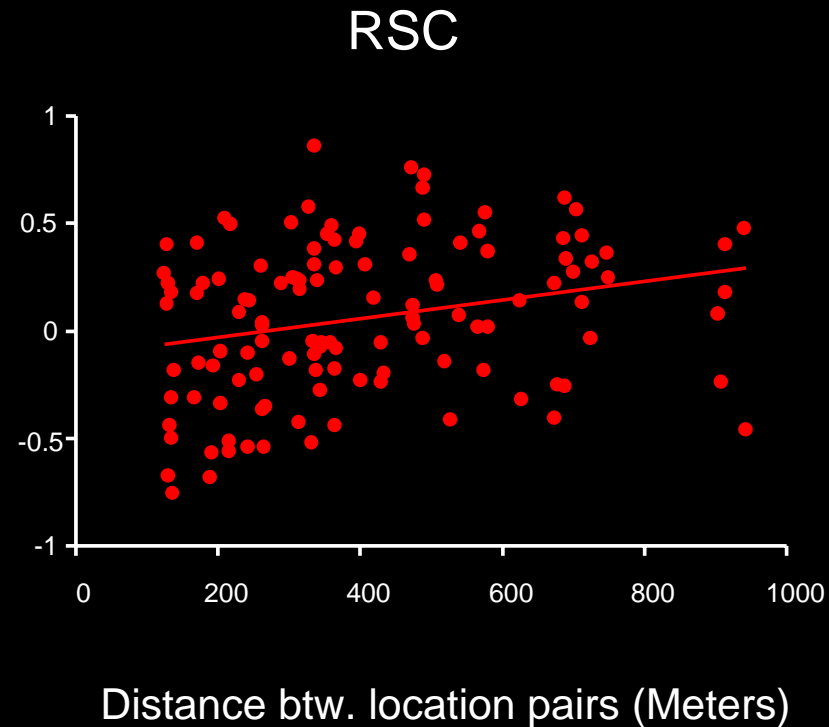
(Feiler, Epstein & Aguirre, VSS 2007, Poster 1148)

Results from subject 1



$r = 0.05$, n.s.

*No relationship btw. physical distance
and neural distance*



$r = 0.27$, $p < 0.01$

*Closer locations have
more similar fMRI patterns*

Please come to the Wednesday Morning Poster Session!

(#1146) Position-Invariant fMRI Adaptation Effects in Scene-Selective Regions

Sean MacEvoy, Russell Epstein

(#1147) Two kinds of fMRI repetition suppression?

Whitney Parker, J. Stephen Higgins, Alana Feiler, Russell Epstein

(#1148) The map in the brain: Distributed cortical representations of large-scale space

Alana Feiler, Russell Epstein, Geoffrey Aguirre

Thanks!

Geoff Aguirre

Alana Feiler

J. Stephen Higgins

Karen Jablonski

Nancy Kanwisher

Sean MacEvoy

Whitney Parker

Whitehall Foundation

National Eye Institute