Texture information processing in the Parahippocampal Place Area (PPA)

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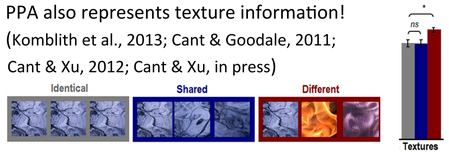
INTRODUCTION

- Traditional view of the PPA
  - Parahippocampal "Place" Area
  - Specific module for "scene" processing
- More Recent view
  - PPA represents spatial layout (Epstein & Kanwisher, 1998; Park et al., 2011), scene category (Walther et al., 2009; Epstein & Morgan 2011), line drawings (Walther et al., 2011), big objects (Konkle & Oliva, 2011; Troiani et al., 2012), etc.
  - PPA also represents texture information! (Komblith et al., 2013; Cant & Goodale, 2011; Cant & Xu, 2012; Cant & Xu, in press)



- However, not much is known about how the PPA represents texture in the context of a scene
  - The stimuli used in previous studies were patches (Cant & Xu, 2012)
  - Or surfaces of objects (Cant & Goodale, 2011)

- It has been suggested that the texture information might provide a cue to identifying a scene

Figure from Epstein & Julian (2013)

Research Question

How does the PPA represent texture within a scene?

Hypothesis 1

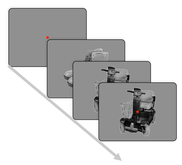
The PPA represents the "ensemble" of texture (e.g., what *kind* of texture)

Hypothesis 2

The PPA represents the texture as a cue to the identity of a scene ("*placeness*")

Localizer

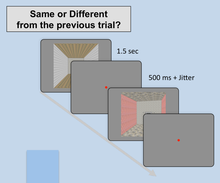
- One-back repetition detection task
- 4 Blocks of 4 conditions / Run
  - ✓ Face, Scene, Object, and Scrambled object
  - ✓ Stimulus duration: 800ms
  - ✓ 20 Stimuli / Block
- PPA localization: **Scene - Face** ($p < .0001$)



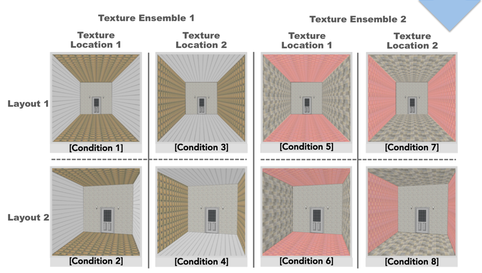
EXPERIMENT 1

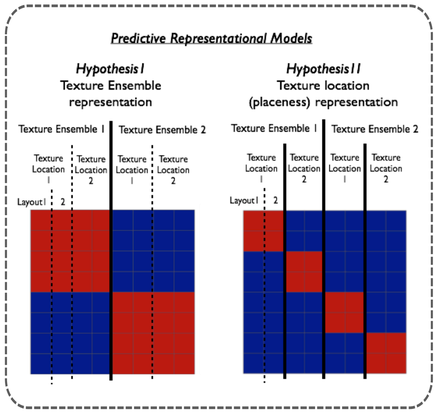
Methods

- Stimuli
  - ✓ 8 Different images were repeated
  - ✓ TextureEnsemble(2) x TextureLocation(2) x Layout(2)
  - ✓ Presented in a random order

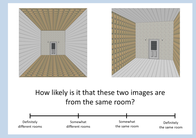


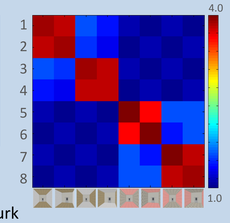
- Task: Placeness judgment (1: same, 2: different)
- Fast-Event Related
  - ✓ 1 Trial: 2 sec
  - ✓ 1 Run: 40 trials ; 6 runs
  - ✓ 160 TR (TR = 2 sec)





Behavioral Results

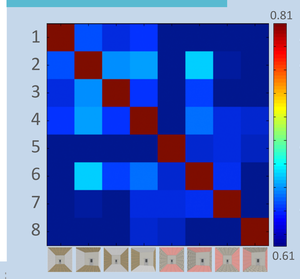




- Placeness Judgment Task
- Amazon Mechanical Turk
  - ✓ N = 26
  - ✓ 1 (Definitely different) ~ 4 (Definitely the same)

MVPA Results

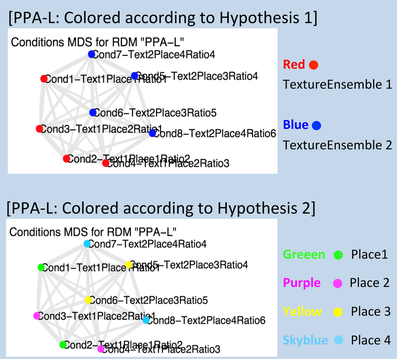
Similarity Matrix



- ✓ Based on *t*-map
- ✓ Extract the *t* values of each condition for every voxel within ROI
- ✓ Get correlation (Pearson *r*) between conditions
- ✓ Analysis done for each participant, then averaged

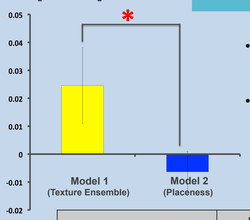
- Measurement of representational similarity between activation patterns of each condition pair

MDS Plot



- Only grouping by the same Texture Ensemble shows systematic structure in Multidimensional Scaling

Multiple Regression



- Two hypothetical models as predictors
- Only Model 1 (Texture Ensemble) could significantly explained the fMRI data

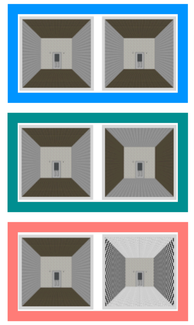
	beta	*p*
Model 1 (Texture Ensemble)	0.3692	0.0149 *
Model 2 (Placeness)	-0.0911	0.5371

→ **Hypothesis 1 supported !**

EXPERIMENT 2

Methods

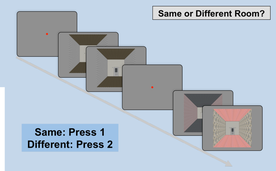
- Fast-Event Related Adaptation Design
  - ✓ 1 Trial: 4 sec (Jittered ITI: average 3 sec)
  - ✓ 1 Run: 48 Trials ; 4 Runs
  - ✓ 174 TR (TR = 2 sec)
  - ✓ 2 images were shown in one trial



[Condition 1: **Identical**]

[Condition 2: **Same Texture Different Placeness**]

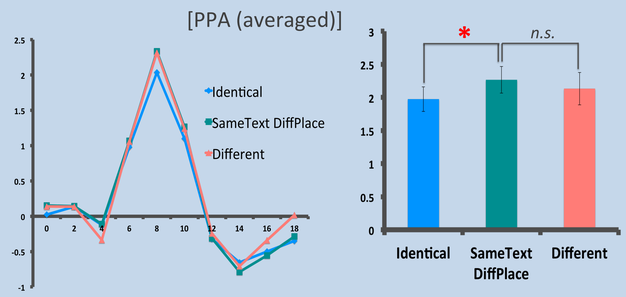
[Condition 3: **Different**]



- Task: Placeness judgment (1: same, 2: different)
- Stimuli
  - ✓ 3 Conditions
  - ✓ Image presentation order was counterbalanced across subjects
  - ✓ 256 different images (never repeated)

Neural Adaptation Results

- Peak activation (beta weights) in the PPA
- No difference between left and right PPA → Averaged results reported
- Significant difference between Condition 1 (Identical) and Cond 2 (Same TextureEnsemble, Different Placeness)



→ **Hypothesis 2 supported !**

DISCUSSION

- Different results from Experiment 1 & 2!
- Texture information in the PPA might be represented hierarchically
  - At coarser level: texture ensemble information (the kind of texture) is represented
  - At finer level: placeness information of a texture (e.g. specific texture location) is represented
- MVPA and Adaptation methods allow us to observe different levels of representation (Epstein & Morgan, 2011)
  - MVPA: coarser categorical representation
  - Neural Adaptation: finer grained exemplar representation; closely related to the representational distinctions revealed by behavior (e.g., placeness judgment)