An Experiential Basis for Posterior Middle Temporal Gyrus Body Part Concept Representation

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Introduction

Body part concepts are implicated in category related semantic deficits

- Autotopagnosia indicates a potentially special representation of body part concepts[1]
  - Patients cannot point to their own body parts on verbal command, but can recognize body parts when touched
- "Category-specific comprehension deficit restricted to body parts" [2] – 1997
- "The Selective Sparing of Body Part Knowledge: A Case Study" [3] – 1998
- "Evidence for Multiple, Distinct Representations of the Human Body" [4] – 2005
- Most literature on body part concepts use pictographic stimuli, little known about lexically accessed representations

Can experiential models explain semantic representations of body part concepts?

Methods

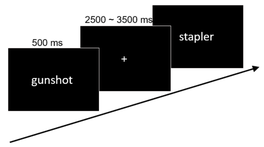
Participants & Stimuli

- 25 healthy, right-handed, adult native speakers of English
- 300 nouns belonging to 6 categories of concepts

Scanning Parameters

- 18 runs of 311 volumes each across 3 scanning days
- GE 3T scanner: TR = 1500 ms, TE = 33 ms, 68 axial slices, 1.625 x 1.625 x 2 mm voxels

Design & Preprocessing



Task: How often have you experienced the concept?
Response: 1 → rarely; 2 → sometimes; 3 → often

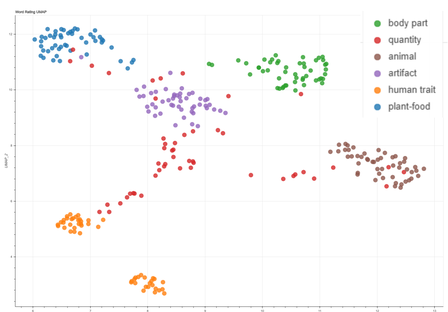
- Fast event-related design, jittered inter-stimulus interval, pseudo-randomized trial sequence
- Each stimulus word repeated 6 times across three scanning sessions on separate days.
- Slice timing correction, distortion correction with SEmap, data preprocessed and project to HCP 32k surface using containerized version of fMRIprep

Experiential Model

- Ratings of 65 experiential (sensory, motor, affective, temporal, spatial, quantity, cognitive, social) attributes were collected for each word using a 0-6 Likert scale [5]

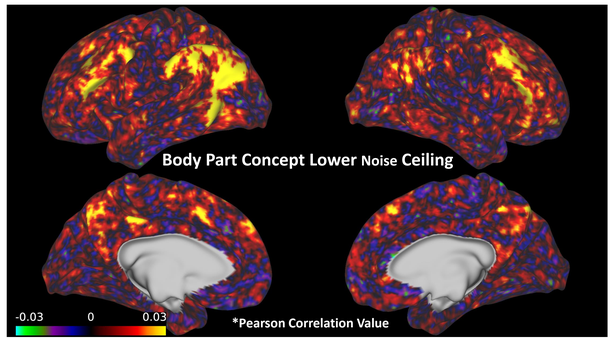
Body Part Concepts		
instep	spine	torso
eyebrow	muscle	heel
pancreas	waist	toenail
leg	cheek	earlobe
trachea	skeleton	retina
abdomen	liver	thigh
ligament	cartilage	fingernail
clavicle	knuckle	lip
kidney	navel	intestines
testicle	thumb	armpit
forearm	eyelid	belly
nipple	elbow	bladder
stomach	diaphragm	ankle
finger	shoulder	mustache
beard	tooth	nose
skull	wrist	forehead
nostril	pelvis	

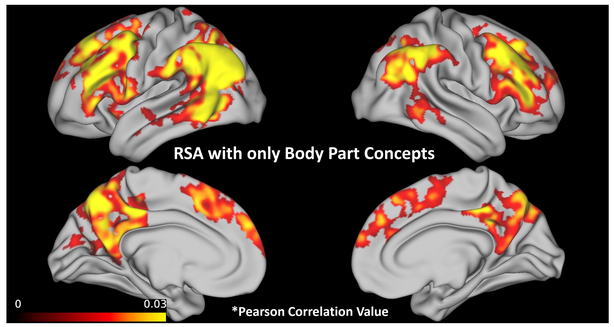
UMAP of Experiential Ratings



RSA with 50 Body Part Concepts

Where are body part concepts represented?



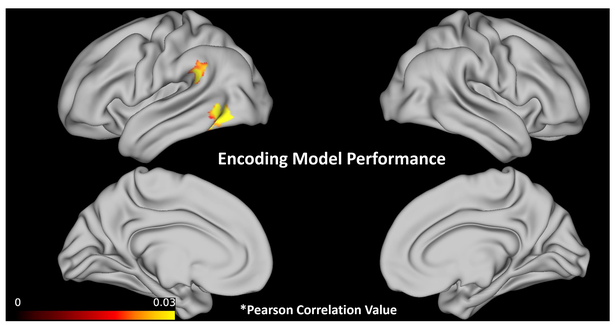


- All Representational Dissimilarity Matrices (RDMs) generated from Pearson correlation distance
- 5mm radius searchlight results were smoothed with 4mm FWHM kernel
- Family-Wise Error Corrected with Cluster forming threshold at p < .01, and cluster-level significance α < .01

✓ **Experiential model accounts for dissimilarities between lexically presented body part concepts**

Vertex Wise Encoding Analysis

Can we train a vertex-wise encoding model to predict dissimilarity patterns of an unseen category of objects?



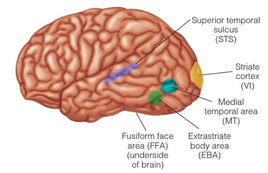
* Same statistical thresholds as above

- Predicted neural RDMs were correlated with the observed RDMs and the resulting correlations were assessed for significance

✓ **Experiential encoding model can be used to predict body part dissimilarities in using non body part concepts in <u>supra marginal gyrus</u> and <u>Posterior middle/inferior temporal gyrus</u>**

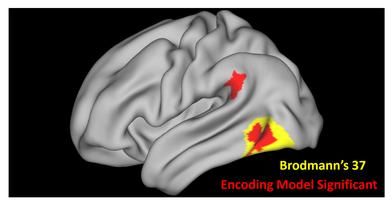
Related Prior Work / Speculation

- Body part concept representation close to **Extrastriata Body Area** [6]

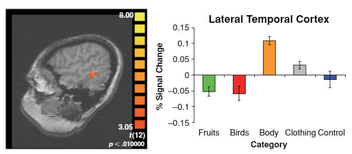


- Brodmann's 37 implicated in body part concept representation [4]

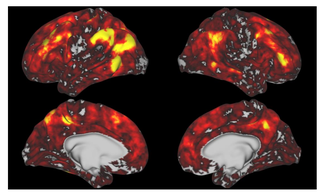
"All three subjects with body image lesions had suffered temporal lesions [..] the lesion involved portions of Brodmann's area 37"



- Lateral Temporal Cortex Previously implicated in univariate analysis of body part concepts [7]

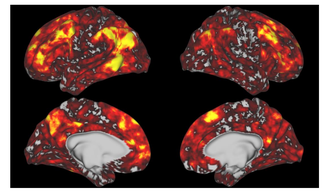


- RSA Regression with non-negative least squares implicates a few experiential features that distinguish body part concepts from other categories of concepts



"often physically near to you (within easy reach) in everyday life"

Near



"someone or something that would be hard for you to live without"

Needs

Conclusions / Future Directions

- Both single category RSA and encoding analysis indicate that our experiential model captures much of the shared variance in multivariate analysis
- Although much of the generally recognized semantic network contains some decodable information about body part concepts, the supramarginal gyrus and posterior middle / inferior temporal gyrus appear to be particularly important in body part concept representation
- In the future, we will predict body part *specific* activations using feature maps derived from an independent dataset

References

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