### THE CORTICAL INTERFACE BETWEEN VISION AND LANGUAGE



### HOW DO WE UNDERSTAND LANGUAGE?

"Close your eyes and let the word paint a thousand pictures..."



### NATURAL LANGUAGE EXPERIMENT



Huth, de Heer, Griffiths, Theunissen, & Gallant. Nature (2016)



### **FURL RESPONSES**

Low Resp.

High Resp.



ramadan and all pagan festivals of that season of winter



Kay et al. *Nature* (2008), Nishimoto et al. *Current Biology* (2011), Huth et al. *Neuron* (2012), Huth et al. *Nature* (2016), etc.





#### SIMPLEST MODEL:



### WORD MODEL PERFORMANCE: MEDIOCRE



#### **IMPROVED MODEL:**

similar responses to words with similar meanings



Distributional hypothesis:

"You shall know a word by the company it keeps" J. R. Firth (1954)



Transforms analogies into vectors!

Captures structure of the world!



#### **IMPROVED MODEL:**

similar responses to words with similar meanings



### SEMANTING POR **IMPROVED MODEL:** REPRESENTATIONAL SHALLARIT B ANA & SSprior stay tuned:

Nuñez, Huth, Oliver, & Gallant (2018?)

### SEMANTIC MODEL PERFORMANCE: EXCELLENT



### WORD MODEL PERFORMANCE: MEDIOCRE



### SEMANTIC MODEL IS BETTER EVERYWHERE



Word

### SEMANTIC MODEL IS BETTER EVERYWHERE

## These brain areas

### MODEL INTERPRETATION

### What information is represented in each voxel?

### MODEL INTERPRETATION

emotions politician taught community advicecounselor intellectualsir reasoned humor<sup>scientist</sup>kindly opinion political discussionspeakingaback genuinely remarks reading politicsreligious anger biology dislikepeople's discussed fellow appreciated culture educated arrogant rightly pope encourage chaplain response colleagues offended politemoral recognize argue enthusiasm remark

Lower response

twice square stacked below each two dozen resulting nearestyards nearly mileseight dozen resulting nearestyards nearly mileseight finishes circular month thirty-five single total metres mounted wreckage days excess steep block passengers eleven pair mm dome placed highest

#### **Higher response**





### MAPS ARE CONSISTENT ACROSS SUBJECTS



### LANGUAGE VS. VISION







### EXPERIMENTS

month

month week hou parl building location

woman

child

#### Visual fMRI data

2h natural movies from Hollywood movie trailers



ocean cliff

#### Language fMRI data

2.5h narrative stories from The Moth Radio Hour

"...she was removing photographs from the walls and placing them in little piles around the house..."



### CORRELATION BETWEEN LANGUAGE AND VISION



0.5

### CORRELATION BETWEEN LANGUAGE AND VISION

### BORING

0.5



0.0



### gallantlab.org/huth2016

### **ONE CATEGORY: PLACES**



### **ONE CATEGORY: PLACES**



Subject 2

Subject 6

Subject 3

### LANGUAGE VS VISION

\* what about other categories?

Subject 2
BODIES

Subject 2 FACES





### **GENERAL PROPERTY!**



Sara Popham



# Do visual & language cortex form a *single, contiguous cortical map?*

Could this explain **why** language cortex is organized the way it is?

### QUESTIONS

- \* Which came first? Does the organization of one follow the other?
  - \* Studying language maps in congenitally blind subjects could help answer this!

#### OUESTIONS 51H

voxel [20,67,66] left model performance: 0.269 (p=0.000) Not b

000) Not bad, pretty reliable

IPS

IPS

**IPSs** 

M1H

М

51M

PrinS

### \* What about other modalities? Somatosensation?

brittle<br/>smooth<br/>tightly crushed<br/>heavier<br/>blades flesh thing<br/>trengt sking<br/>bare limbs sking<br/>bladejaggedbely<br/>ibaggedbelge<br/>baggedbelge<br/>baggedbelge

### **CASEFORGE** with James Gao



caseforge.com

### PYCORTEX

#### with James Gao & Mark Lescroart



\* Fast geodesic distances!\* WebGL!

\* Flatmaps!

pycortex.org



### CREDITS

Wendy de Heer Sara Popham Anwar Nuñez Shinji Nishimoto

Frédéric Theunissen Tom Griffiths Jack Gallant THANKS!