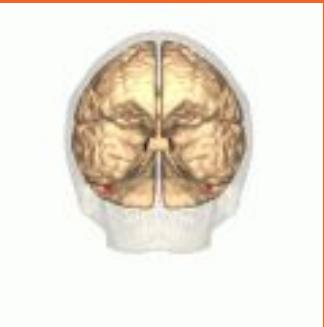


Bill and Ted's Excellent Final Project



Presented clip



Clip reconstructed
from brain activity



MakeAGIF.com

Hannah, Jake, Elisa, Rob

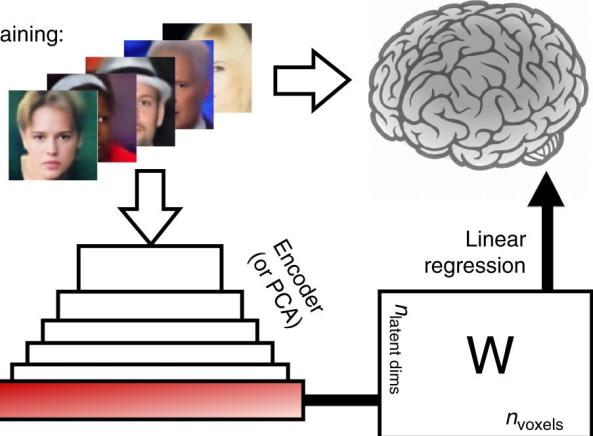
Data Set/Study Description

- Title: Reconstructing Faces from fMRI Patterns using Deep Generative Neural Networks (VanRullen & Reddy 2019) (“Mind reading”???)
- 4 subs, 8 sessions, 11-14 runs
- Determine a ROI based on observed activity pattern
- Run both PCA and Neural Network to reconstruct faces
- Advantages of Neural Network

Math used in NN

a

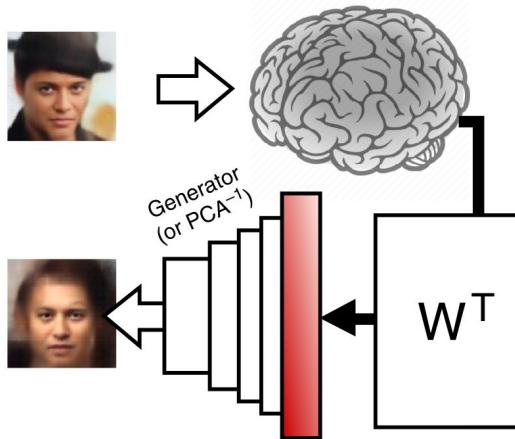
Training:



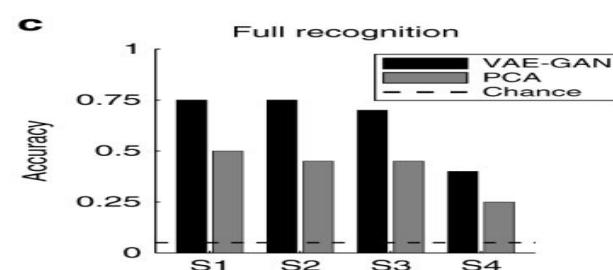
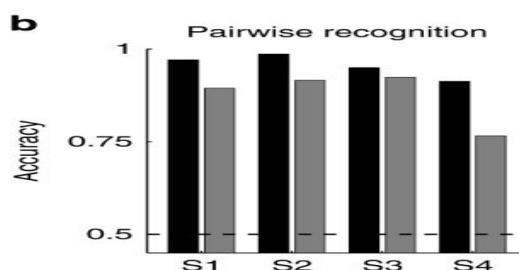
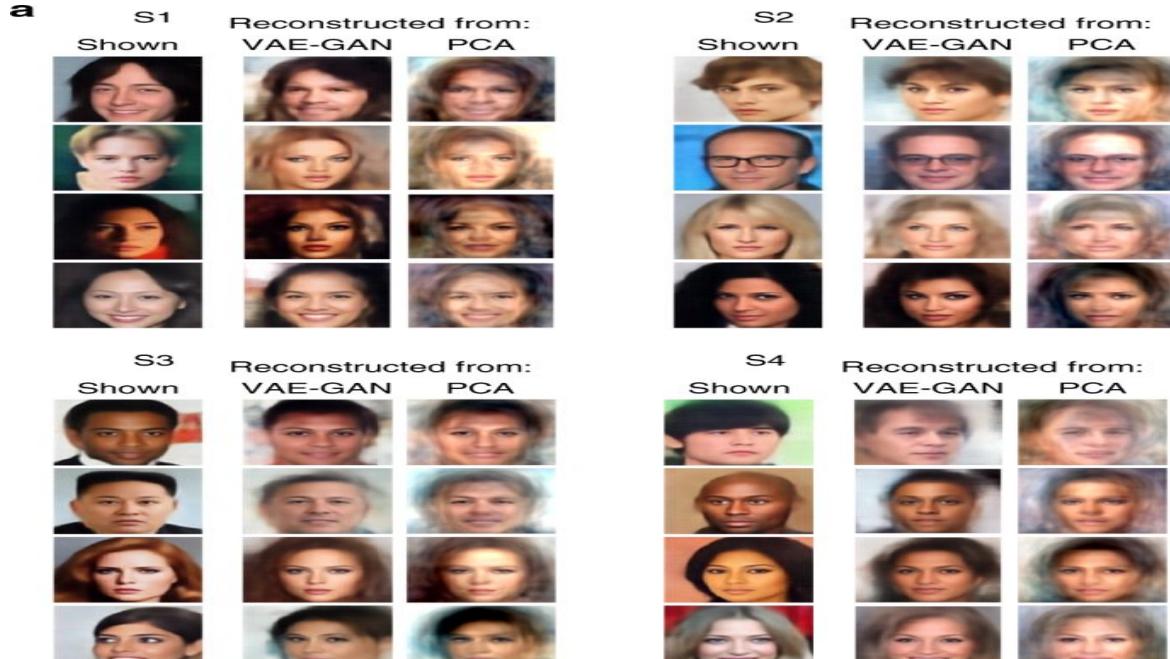
- Y - activation pattern
- X - vector of facial features
- W - mapping from X to Y
- Train based on original activity: solve for W
- Test based on new activity and weights: solve for X
- Train/test measures/ensures accuracy of model

b

Testing:



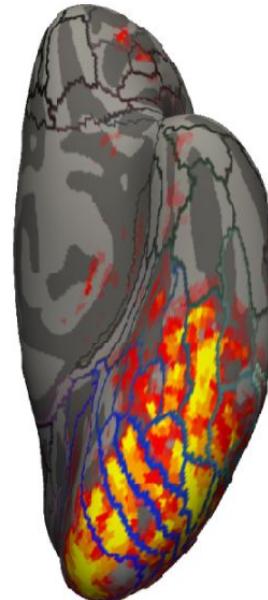
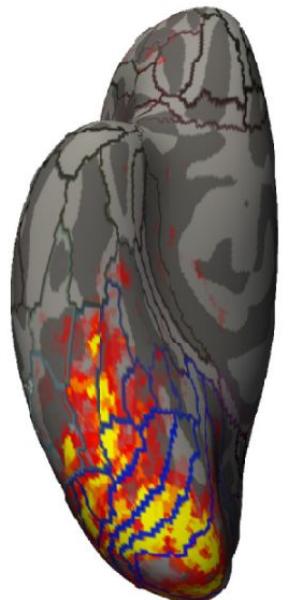
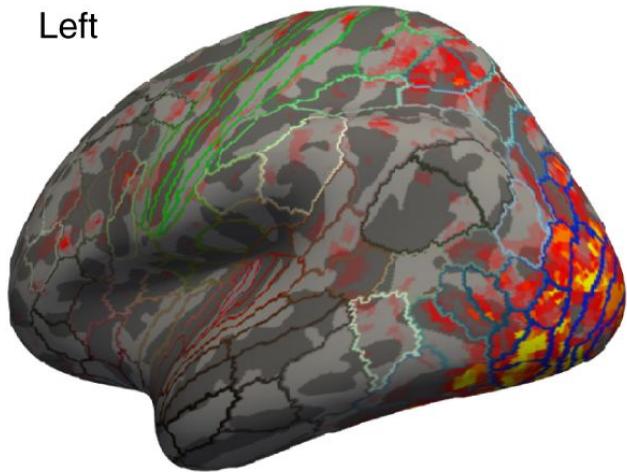
PCA vs. NN



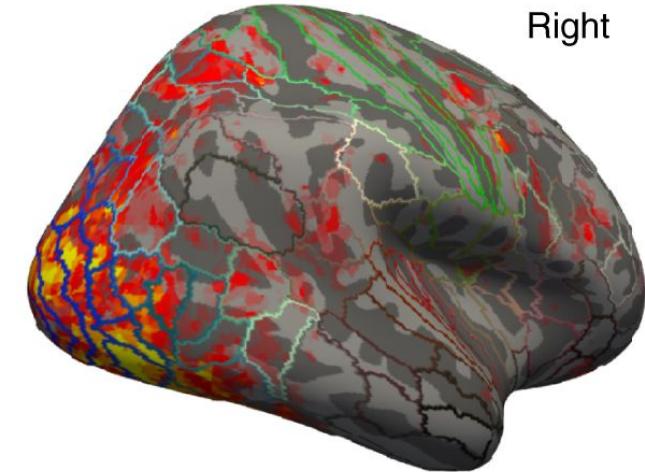
Description of Tasks

- Face and Fixation Events
- Localization Events
- Imagery Tasks

Left



Right



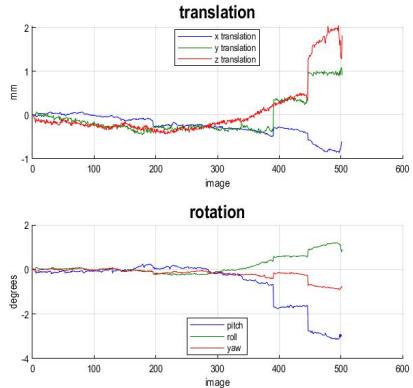
$n = 0$

4

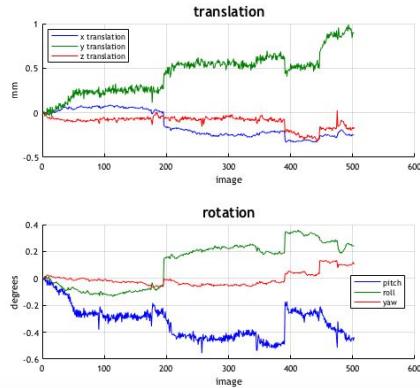


Realignment Checks

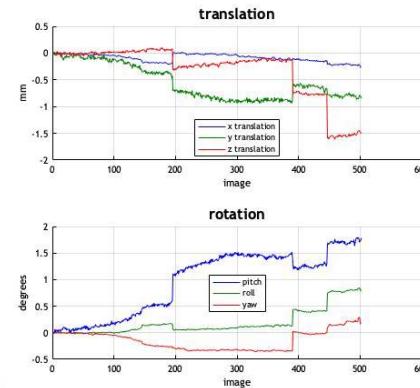
Sub-01



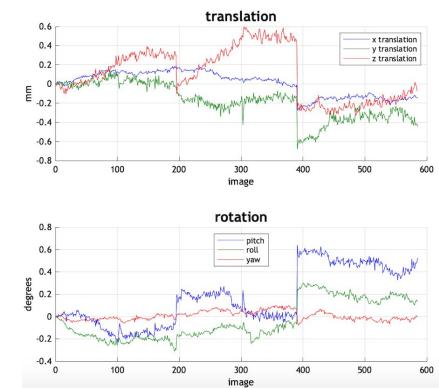
Sub-02



Sub-03

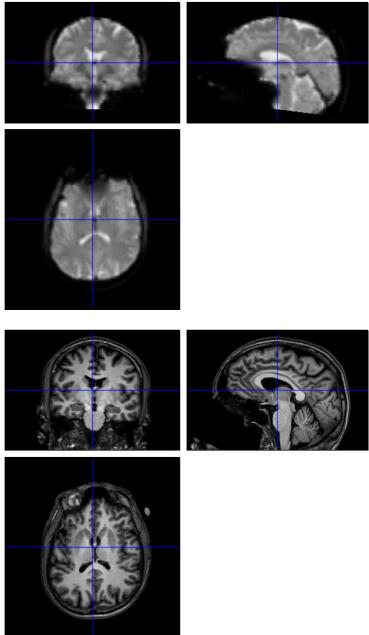


Sub-04

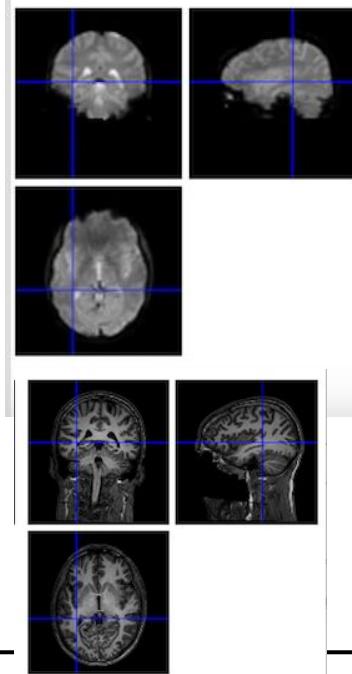


Co-Registration Checks

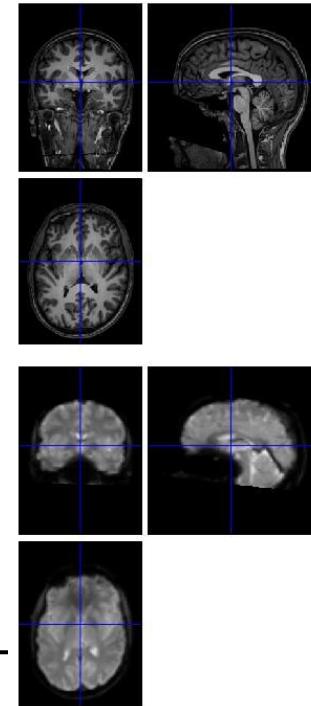
Sub-01



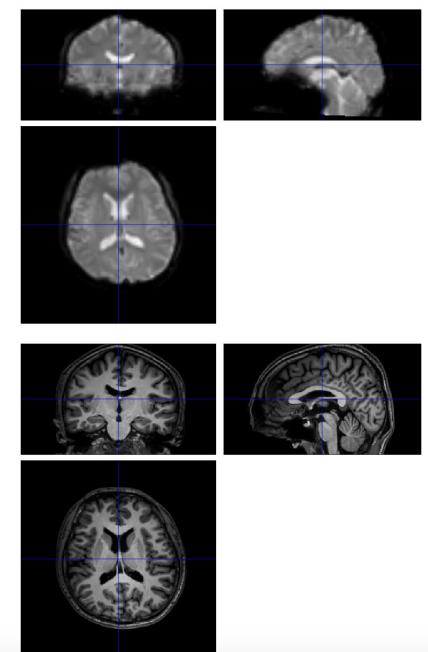
Sub-02



Sub-03

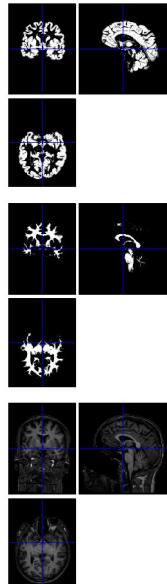


Sub-04

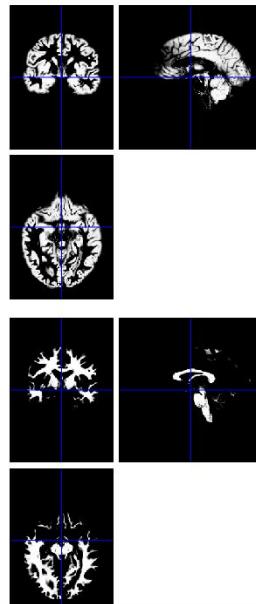


Segmentation Checks

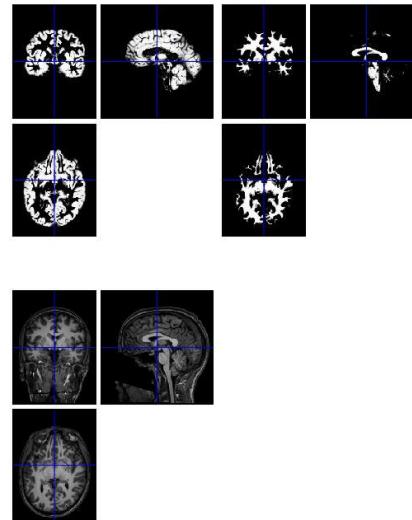
Sub-01



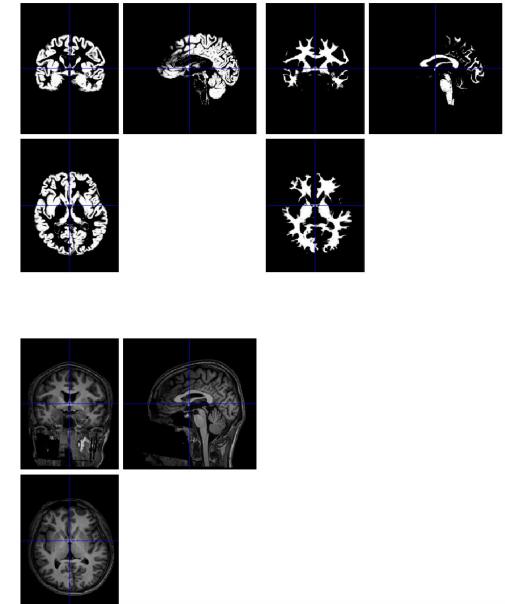
Sub-02



Sub-03

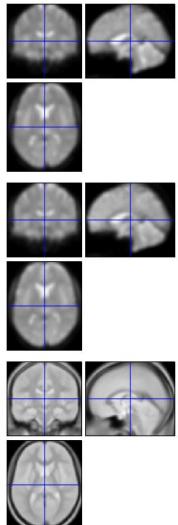


Sub-04

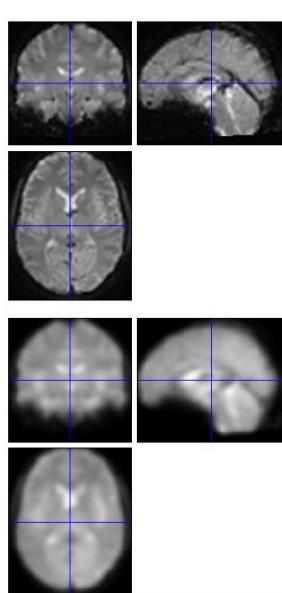


Normalization Checks

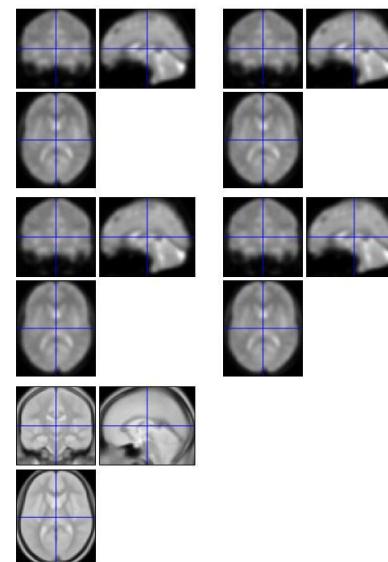
Sub-01



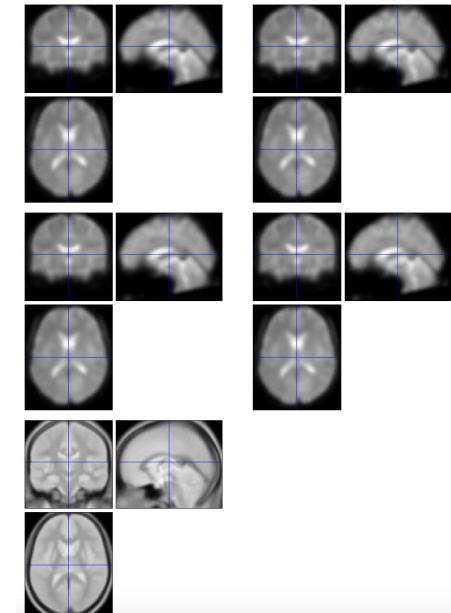
Sub-02



Sub-03



Sub-04



Contrasts & Hypotheses

Faces

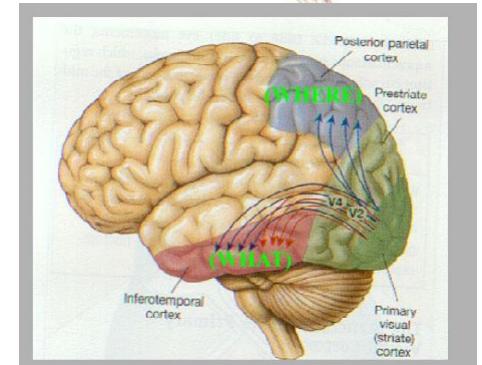
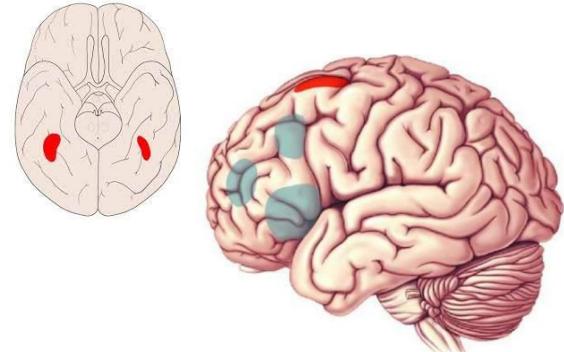
- We hypothesize activation in the occipital lobe and specifically in the FFA

Attention- no attention

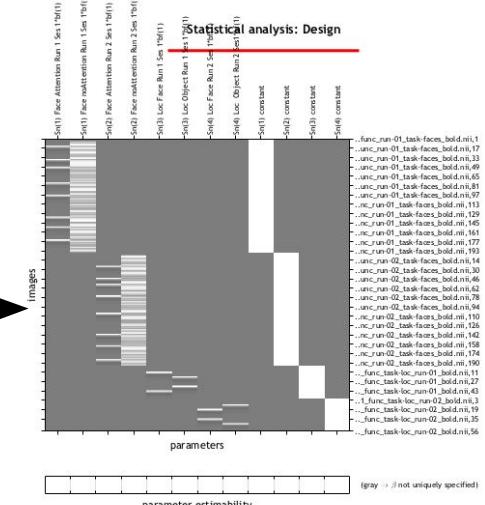
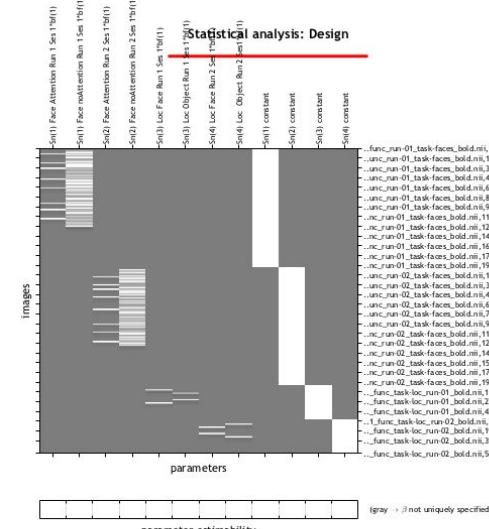
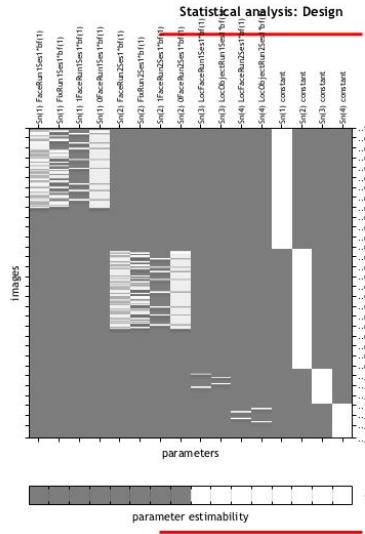
- We hypothesize activation in the occipital lobe and inferior prefrontal cortex

Object-face

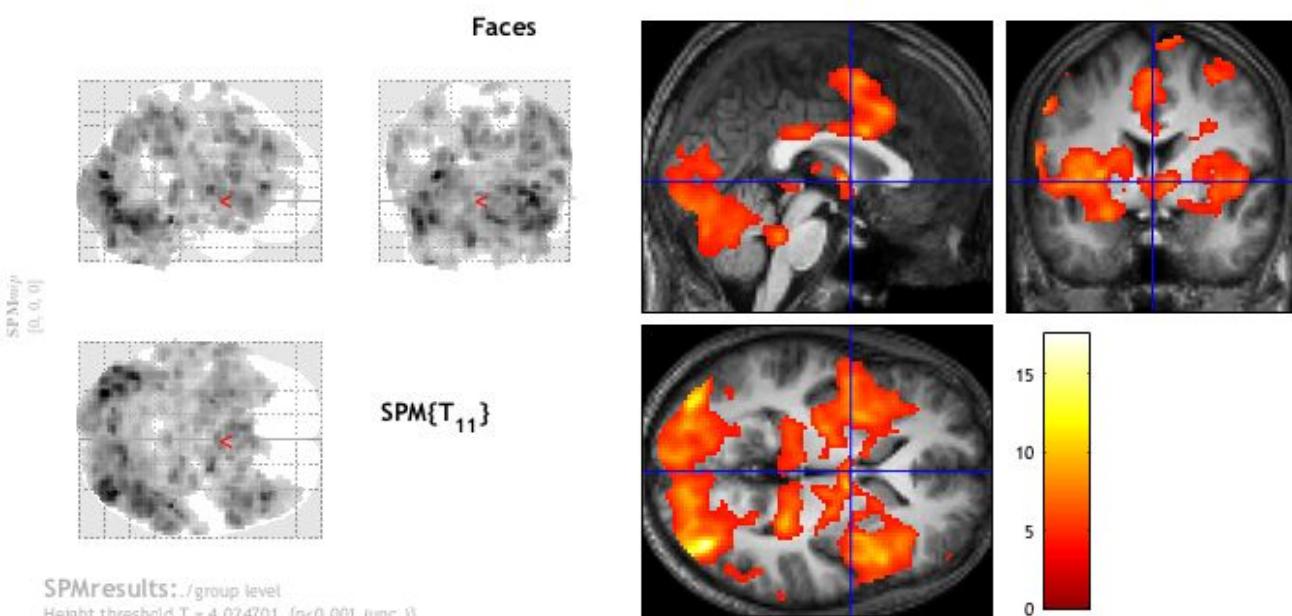
- We hypothesize a lot of activation in the occipital lobe and inferior temporal cortex



First-Level Chronicles



Faces



SPMresults: ./group level
Height threshold T = 4.024701 [p<0.001 (unc.)]
Extent threshold k = 69 voxels

cluster-level				peak-level					mm mm mm		
$p_{\text{FWE-corr}}$	$q_{\text{FDR-corr}}$	k_E	p_{uncorr}	$p_{\text{FWE-corr}}$	$q_{\text{FDR-corr}}$	T	(Z_E)	p_{uncorr}			
0.000	0.000	47903	0.000	0.000	0.013	17.58	5.99	0.000	-30	-84	14
				0.000	0.013	16.68	5.90	0.000	38	-76	-2
				0.001	0.013	15.82	5.80	0.000	-40	-62	-18

— 1st Peak —



The interface displays three brain slices: Sagittal (SAG), Coronal (COR), and Transverse (TRA). A blue highlighted region is visible in all three slices, indicating the location of the 'Superior Occipital Gyrus'.

Superior Occipital Gyrus

- 1. Nomenclature, Parts.**
- 2. Location.**
 - upper part of the lateral surface of the occipital lobe
- 3. Function, Connectivity.**
 - visual functions

Talairach coordinates

x: -30 y: -84 z: 14

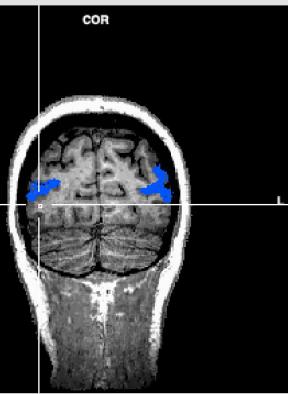
Tips

- Explore different visualizations of the brain switching between 3D orthographic slice view and 3D mesh models. The icons in the tool bar provide different views on the rendered brain models.
- Click the right mouse button on a background region. The appearing context menu provides additional display options.

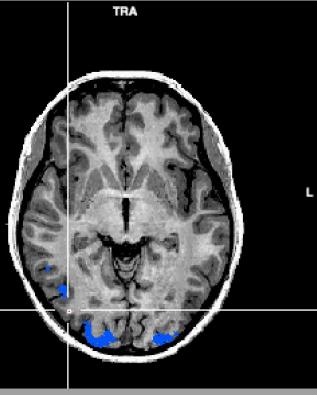
Instructions

- Click with the left mouse button in the main window.
- Move the mouse up and down as well as left and right while keeping the mouse button pressed.
- Release the mouse button. Click at any region-of-interest.
- Selection:** Click at various regions of the brain while holding down the Command key.

— 2nd Peak —



COR



TRA

Middle Occipital Gyrus

- Nomenclature, Parts.**
 - lateral occipital gyrus
- Location.**
 - between superior occipital gyrus and inferior occipital gyrus
- Function, Connectivity.**
 - visual functions

Talairach coordinates

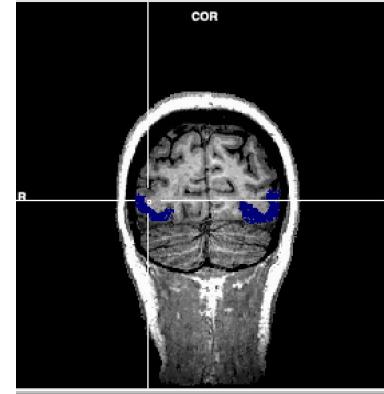
x: 38 y: -76 z: -2

Tips

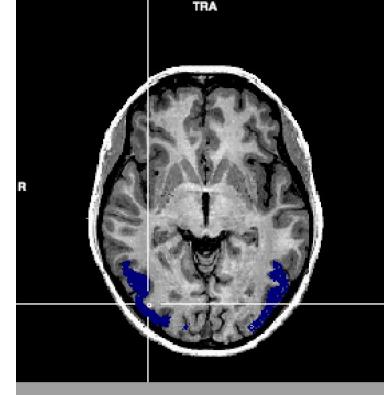
- Explore different visualizations of the brain switching between 3D orthographic slice view and 3D mesh models. The icons in the tool bar provide different views on the rendered brain models.
- Click the right mouse button on a background region. The appearing context menu provides additional display options.

Instructions

- Click with the left mouse button in the main window.
- Move the mouse up and down as well as left and right while keeping the mouse button pressed.
- Release the mouse button. Click at any region-of-interest in another slice sub-window.
- Selection:** Click at various regions of the brain while holding down the Command key.



COR



TRA

Inferior Occipital Gyrus

- Nomenclature, Parts.**
- Location.**
 - inferior lateral surface of the occipital lobe
- Function, Connectivity.**
 - higher order processing of visual information

Talairach coordinates

x: 38 y: -76 z: -2

Tips

- Explore different visualizations of the brain switching between 3D orthographic slice view and 3D mesh models. The icons in the tool bar provide different views on the rendered brain models.
- Click the right mouse button on a background region. The appearing context menu provides additional display options.

Instructions

- Click with the left mouse button in the main window.
- Move the mouse up and down as well as left and right while keeping the mouse button pressed.
- Release the mouse button. Click at any region-of-interest in another slice sub-window.
- Selection:** Click at various regions of the brain while holding down the Command key.

— 3rd Peak —

COR

TRA

BrainVoyager Brain Tutor invites you to learn about the structure and function of the human brain, especially the cerebral cortex. Follow the suggestions in the "Instructions" window as well as the short messages in the status bar.

The head and brain visualizations presented here are based on magnetic resonance imaging (MRI) scans. For more information about the background of this program, select "User's Guide" in the "Help" menu.

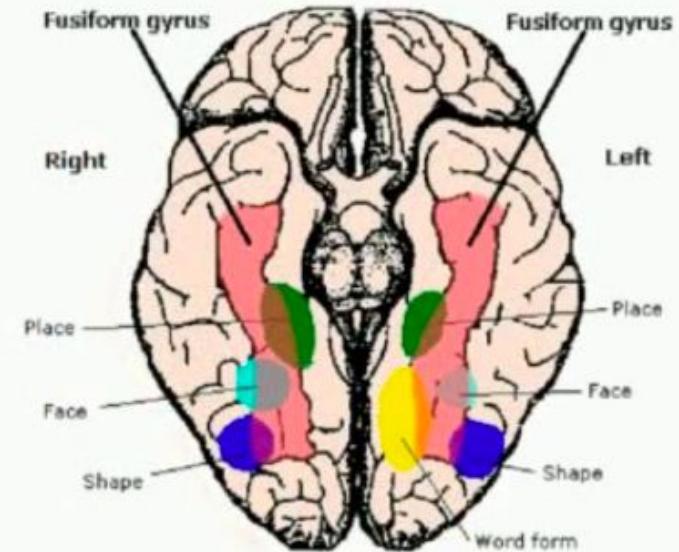
Talairach coordinates
x: -40 y: -62 z: -18

Tips

- Explore different visualizations of the brain switching between 3D orthographic slice view and 3D mesh models. The icons in the tool bar provide different views on the rendered brain models.
- Click the right mouse button on a background region. The appearing context menu provides additional display options.

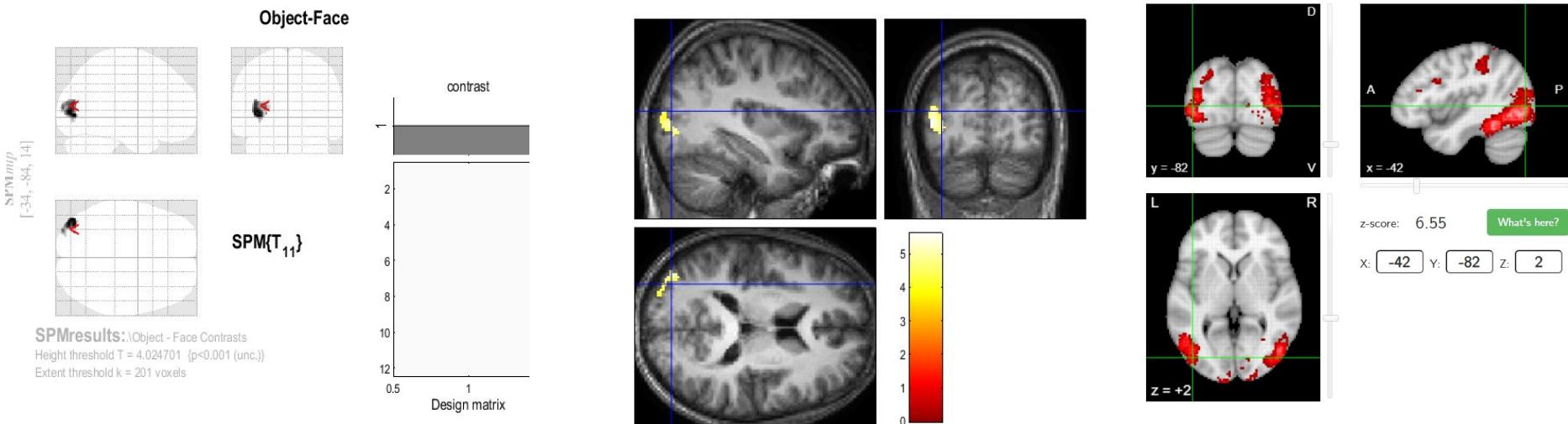
Instructions

- Click with the left mouse button in the main window.
- Move the mouse up and down as well as left and right while keeping the mouse button pressed.
- Release the mouse button. Click at any region-of-interest in another slice sub-window.
- Selection:** Click at various regions of the brain while holding down the Command key.



Object-Faces

Automated Meta-Analysis for Object Recognition



Statistics: *p*-values adj.

cluster-level				peak-level					mm mm mm		
$p_{\text{FWE-corr}}$	$q_{\text{FDR-corr}}$	k_E	p_{uncorr}	$p_{\text{FWE-corr}}$	$q_{\text{FDR-corr}}$	T	(Z_E)	p_{uncorr}	-42	-82	2
0.005	0.003	255	0.000	0.952	0.625	5.60	3.78	0.000	-42	-82	2
				0.989	0.677	5.20	3.62	0.000	-42	-82	14
				0.998	0.677	4.88	3.49	0.000	-30	-94	10

1st Peak

SAG COR TRA

Middle Occipital Gyrus

- Nomenclature, Parts.**
 - lateral occipital gyrus
- Location.**
 - between superior occipital gyrus and inferior occipital gyrus
- Function, Connectivity.**
 - visual functions

Talairach coordinates
x: -42 y: -82 z: 2

Tips

- Explore different visualizations of the brain switching between 3D orthographic slice view and 3D mesh models. The icons in the tool bar provide different views on the rendered brain models.
- Click the right mouse button on a background region. The appearing context menu provides additional display options.

Instructions

- Click with the left mouse button in the main window.
- Move the mouse up and down as well as left and right while keeping the mouse button pressed.
- Release the mouse button. Click at any region-of-interest in another slice sub-window.
- Selection:** Click at various regions of the brain while holding down the Command key.

SAG COR TRA

Inferior Occipital Gyrus

- Nomenclature, Parts.**
- Location.**
 - inferior lateral surface of the occipital lobe
- Function, Connectivity.**
 - higher order processing of visual information

Talairach coordinates
x: -42 y: -82 z: 2

Tips

- Explore different visualizations of the brain switching between 3D orthographic slice view and 3D mesh models. The icons in the tool bar provide different views on the rendered brain models.
- Click the right mouse button on a background region. The appearing context menu provides additional display options.

Instructions

- Click with the left mouse button in the main window.
- Move the mouse up and down as well as left and right while keeping the mouse button pressed.
- Release the mouse button. Click at any region-of-interest in another slice sub-window.
- Selection:** Click at various regions of the brain while holding down the Command key.

2nd Peak

Middle Occipital Gyrus

- Nomenclature, Parts.**
 - lateral occipital gyrus
- Location.**
 - between superior occipital gyrus and inferior occipital gyrus
- Function, Connectivity.**
 - visual functions

Talairach coordinates

x: -42 y: -82 z: 14

Tips

- Explore different visualizations of the brain switching between 3D orthographic slice view and 3D mesh models. The icons in the tool bar provide different views on the rendered brain models.
- Click the right mouse button on a background region. The appearing context menu provides additional display options.

Instructions

- Click with the left mouse button in the main window.
- Move the mouse up and down as well as left and right while keeping the mouse button pressed.
- Release the mouse button. Click at any region-of-interest in another slice sub-window.
- Selection:** Click at various regions of the brain while holding down the Command key.

3rd Peak

The image shows a brain visualization interface with three orthogonal slices: Sagittal (SAG), Coronal (COR), and Transverse (TRA). A specific region of interest is highlighted in blue on the SAG and COR slices. The TRA slice shows the full brain structure.

Superior Occipital Gyrus

- 1. Nomenclature, Parts.**
- 2. Location.**
 - upper part of the lateral surface of the occipital lobe
- 3. Function, Connectivity.**
 - visual functions

Talairach coordinates:
x: -30 y: -94 z: 10

Tips

- Explore different visualizations of the brain switching between 3D orthographic slice view and 3D mesh models. The icons in the tool bar provide different views on the rendered brain models.
- Click the right mouse button on a background region. The appearing context menu provides additional display options.

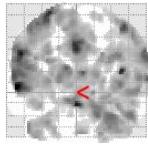
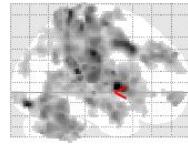
Instructions

- Click with the left mouse button in the main window.
- Move the mouse up and down as well as left and right while keeping the mouse button pressed.
- Release the mouse button. Click at any region-of-interest in another slice sub-window.
- Selection:** Click at various regions of the brain while holding down the Command key.

Attention-No Attention

Automated Meta-Analysis
for Attention

Attention-No Attention



1

2

4

6

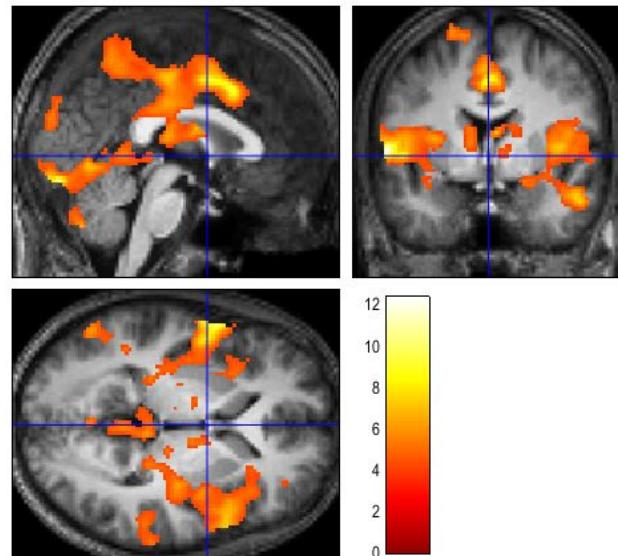
8

10

12

C

SPM{T₁₁}



SPM results: Attention - NonAttention Contrasts

Height threshold T = 4.024701 (p<0.001 (unc.))

Extent threshold k = 205 voxels

Statistics: *p*-values adjusted for

set-level

cluster-level

p

*p*_{FWE-corr}

c

*q*_{FDR-corr}

0.000

197370.000

6

0.009

0.196

12.31

5.35

0.000

-60

2

4

0.024

0.196

11.15

5.16

0.000

-56

-22

34

0.026

0.196

11.04

5.14

0.000

-2

-86

-14

0.000

0.000

7418.000

0.038

0.196

10.64

5.07

0.000

42

-38

18

0.109

0.274

9.32

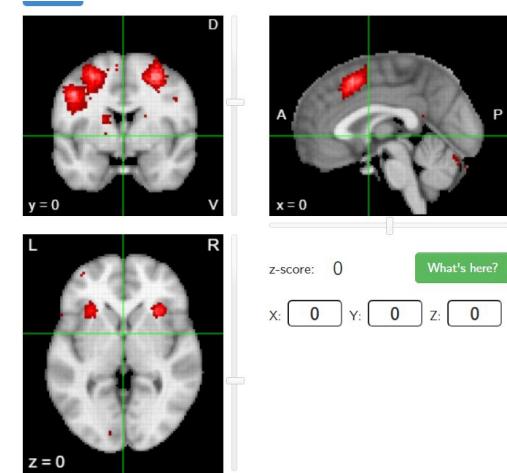
4.81

0.000

44

-34

58



First Peak

The image shows a brain visualization interface with three orthogonal slices: Sagittal (SAG), Coronal (COR), and Transverse (TRA). A green highlighted region is visible in the Superior Temporal Sulcus across all three slices. The interface includes a coordinate system with A (Anterior), P (Posterior), R (Right), L (Left) markers, and Talairach coordinates (x: -60, y: 2, z: 4).

Superior Temporal Sulcus

- 1. Nomenclature, Parts.**
- 2. Location.**
 - temporal lobe
 - separates medial temporal gyrus from superior temporal gyrus
 - surrounded at posterior end by angular gyrus
- 3. Function, Connectivity.**
 - cross-modal integration, i.e. of visual and auditory information
 - receives input from sensory areas

Talairach coordinates
x: -60 y: 2 z: 4

Tips

- Explore different visualizations of the brain switching between 3D orthographic slice view and 3D mesh models. The icons in the tool bar provide different views on the rendered brain models.
- Click the right mouse button on a background region. The appearing context menu provides additional display options.

Instructions

- Click with the left mouse button in the main window.
- Move the mouse up and down as well as left and right while keeping the mouse button pressed.
- Release the mouse button. Click at any region-of-interest in another slice sub-window.
- **Selection:** Click at various regions of the brain while holding down the Command key.

Second Peak

The image shows a 3D brain visualization interface with three orthogonal slices: Sagittal (SAG), Coronal (COR), and Transverse (TRA). A yellow region of interest is highlighted in all three slices, indicating a specific brain area. The interface includes a callout box with the following information:

Supramarginal Gyrus

- 1. Nomenclature, Parts.**
- 2. Location.**
 - inferior part of the lateral parietal surface
 - surrounds the end of lateral sulcus
- 3. Function, Connectivity.**
 - includes Wernicke's area

Talairach coordinates: X: -56, Y: -22, Z: 34

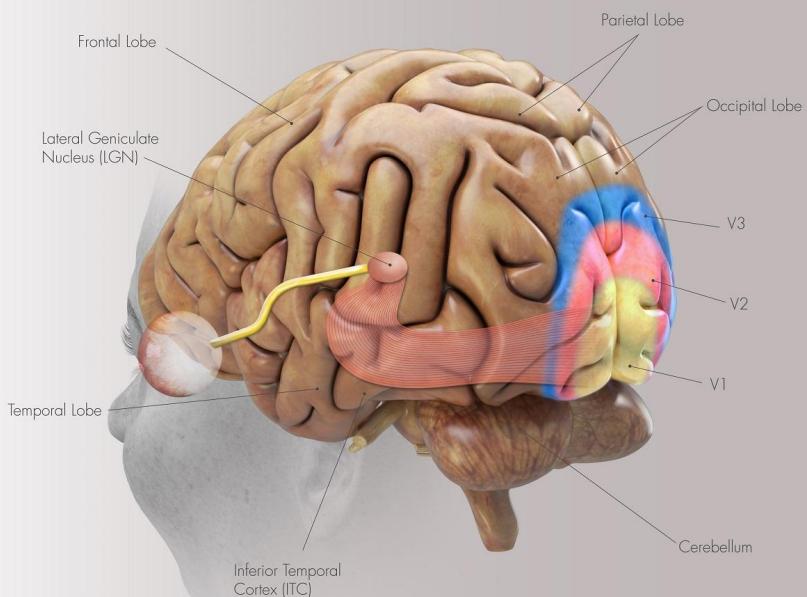
Tips

- Explore different visualizations of the brain switching between 3D orthographic slice view and 3D mesh models. The icons in the tool bar provide different views on the rendered brain models.
- Click the right mouse button on a background region. The appearing context menu provides additional display options.

Instructions

- Click with the left mouse button in the main window.
- Move the mouse up and down as well as left and right while keeping the mouse button pressed.
- Release the mouse button. Click at any region-of-interest in another slice sub-window.
- Selection:** Click at various regions of the brain while holding down the Command key.

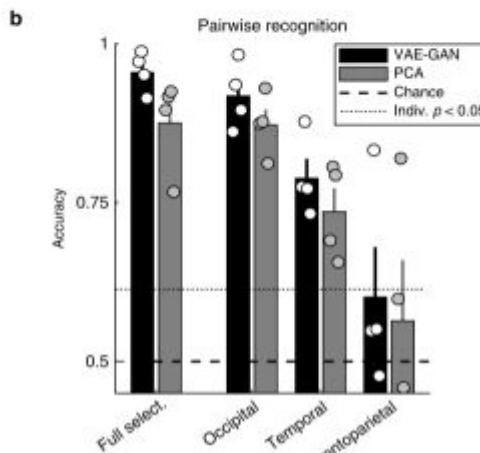
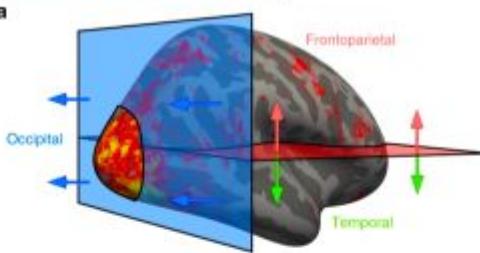
Third Peak



Connections to Paper

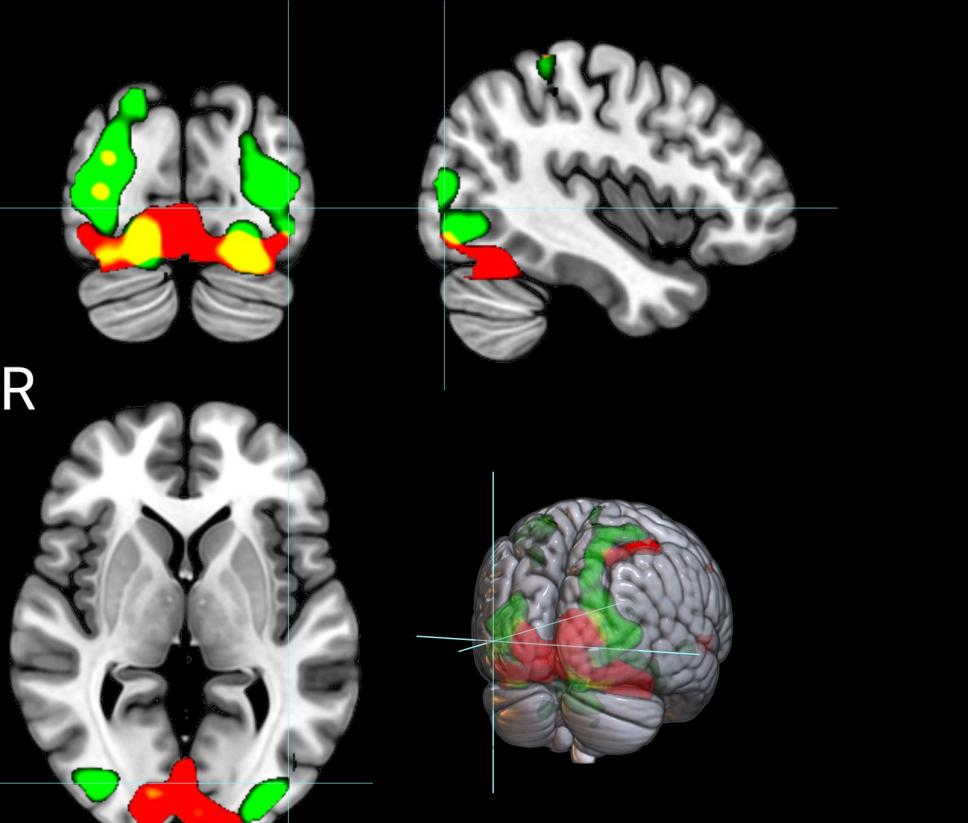
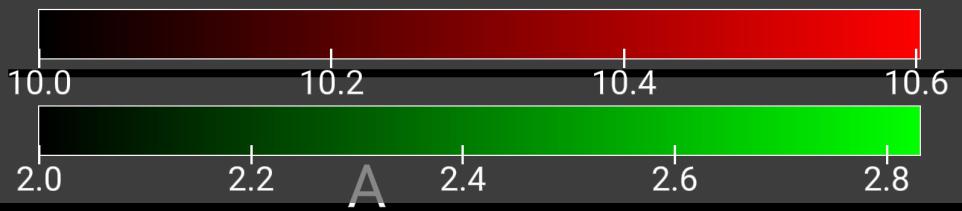
Fig. 5

From: Reconstructing faces from fMRI patterns using deep generative neural networks



- The paper evaluated brain regions as a function of how important they were to the ability of reconstructing the faces
 - Mirrors the areas that are most activated
 - Occipital voxels and to lesser extent temporal voxels
- The paper attributes the fusiform gyrus as being important in recognizing gender
 - Notable bc/ there was no mention of the FFA specifically

Extra Content!



Crosshair Position		
m	-30.0 -84.0 14.0	0
vx	67.0 49.0 93.0	

<input type="checkbox"/> Hide Crosshair
<input type="checkbox"/> BBox (nonzero)
<input type="checkbox"/> Colormap "hot"

Cytoarchitecture

23.9% Area hOc4lp
2.1% Area hIP4 (IPS)

<input type="checkbox"/> Add SPM
<input type="checkbox"/> Add Image
<input type="checkbox"/> Remove

SPM: Face Activation [p<0.001 (unc.), k=156]

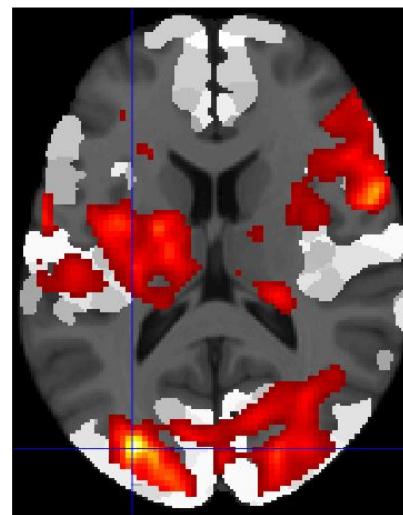
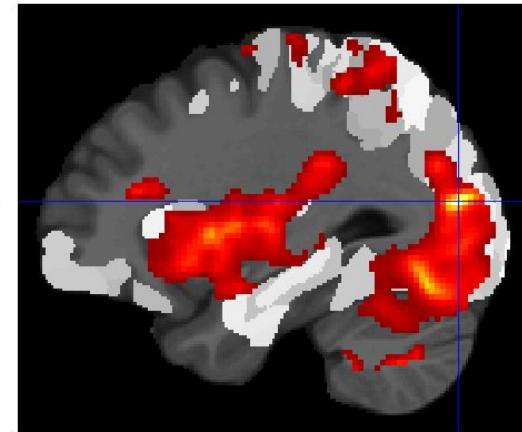
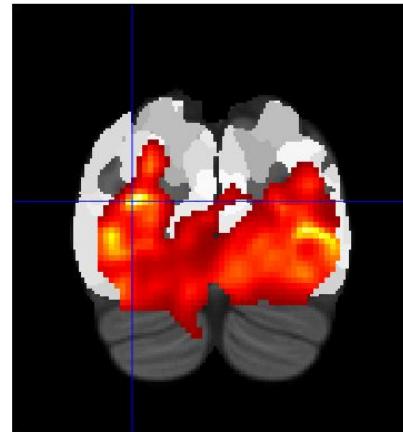
Cluster 1 (47903 vox): -3... (17.6): -30 / -84 / +... ▾

Assignment based on Maximum Probability Map
4.1% in Area hOc1 [V1] [57.4 activated]

Probability exceedance (under cluster vs. entire map)
1.13 [1.12; 1.15] for Area hOc1 [V1]

Top probabilities at peak voxels (union)

0.95 for Area hOc4la
0.87 for Area hOc4lp
0.80 for Area FG2
0.77 for Area FG1
0.48 for Area FG4



<input type="checkbox"/> Print Window	<input type="checkbox"/> Print All Clus...	+
<input type="checkbox"/> Save Table	<input type="checkbox"/> Exit	-

Macroanatomy:
43.0% Lateral Occipital Cortex, superior division
4.0% Lateral Occipital Cortex, inferior division
Assignment based on Maximum Probability Map
3.4% in Lateral Occipital Cortex, superior division [22.0 activated]
3.3% in Occipital Fusiform Gyrus [98.2 activated]
Probability exceedance (under cluster vs. entire map)
1.21 [1.19; 1.22] for Occipital Fusiform Gyrus
0.93 [0.92; 0.93] for Lateral Occipital Cortex

Crosshair Position		
m	-42.0 -82.0 2.0	0
vx	55.0 51.0 81.0	

<input type="checkbox"/> Hide Crosshair
<input type="button"/> BBox (nonzero)
<input type="button"/> Colormap "hot"

Cytoarchitecture

Area hOc4la

74.4% Area hOc4la

3.2% Area hOc5 [V5/MT]

<input type="button"/> Add SPM
<input type="button"/> Add Image
<input type="button"/> Remove

SPM: Object-Face [$p < 0.001$ (unc.), $k=124$]

Cluster 1 (255 vox): -42/-... (5.6): -42 / -82 / +2

Assignment based on Maximum Probability Map

58.1% in Area hOc4lp [11.2 activated]

25.8% in Area hOc4la [4.6 activated]

Probability exceedance (under cluster vs. entire map)

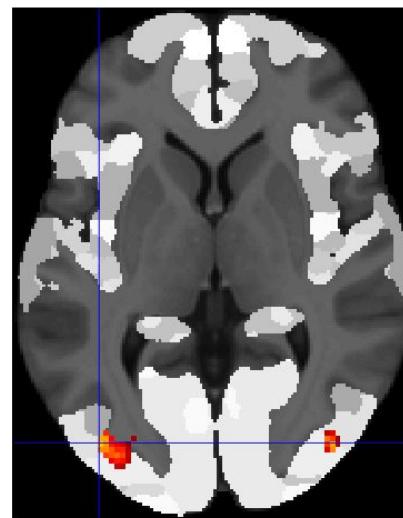
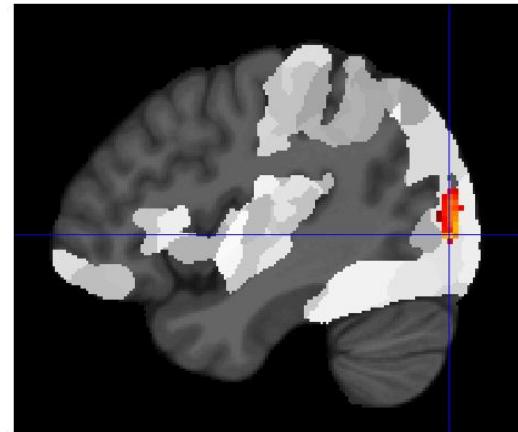
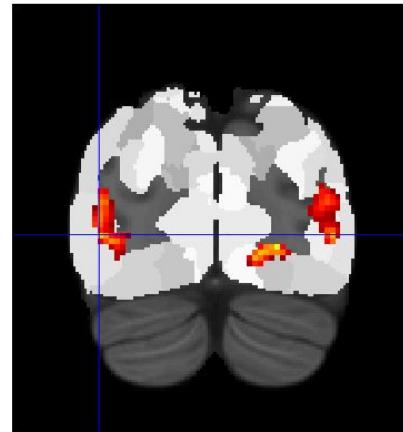
1.90 [1.85; 1.95] for Area hOc4lp

1.08 [1.04; 1.11] for Area hOc4la

Top probabilities at peak voxels (union)

0.99 for Area hOc4lp

0.96 for Area hOc4la



<input type="button"/> Print Window	<input type="button"/> Print All Clus...	<input type="button"/> +
<input type="button"/> Save Table	<input type="button"/> Exit	<input type="button"/> -

Macroanatomy:
50.0% Lateral Occipital Cortex, inferior division
Assignment based on Maximum Probability Map
37.8% in Lateral Occipital Cortex, inferior division
[2.9 activated]
22.1% in Lateral Occipital Cortex, superior division
[0.8 activated]
Probability exceedance (under cluster vs. entire map)
1.49 [1.45; 1.53] for Lateral Occipital Cortex, inferior division

Crosshair Position			
m	-60.0	2.0	4.0
vx	37.0	135.0	83.0
	0		

<input type="checkbox"/> Hide Crosshair
<input type="button"/> BBox (nonzero)
<input type="button"/> Colormap "hot"

Cytoarchitecture

17.1% Area TE 3
7.1% Area 44

<input type="button"/> Add SPM
<input type="button"/> Add Image
<input type="button"/> Remove

SPM: Attention-No Attention [p<0.001 (unc.)],
Cluster 1 (19737 vox): -6... (12.3): -60 / +2 / +4

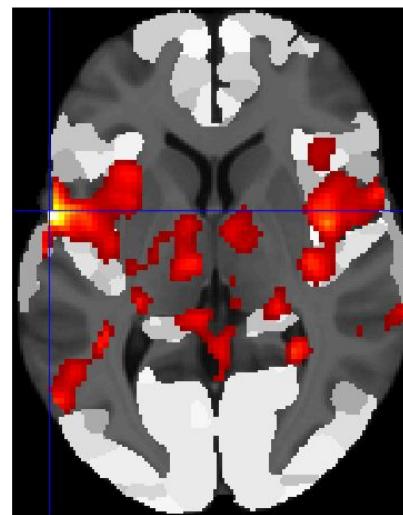
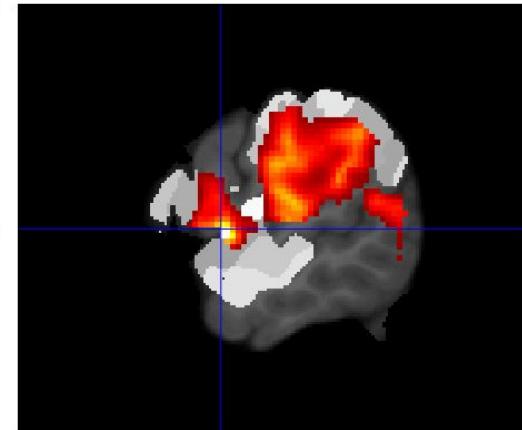
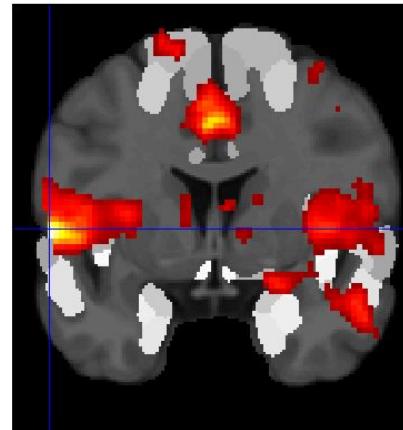
Assignment based on Maximum Probability Map

Probability exceedance (under cluster vs. entire map)

Top probabilities at peak voxels (union)

0.84 for Area PFT (IPL)

0.59 for Area 4a



<input type="button"/> Print Window	<input type="button"/> Print All Clus...	<input type="button"/> +
<input type="button"/> Save Table	<input type="button"/> Exit	<input type="button"/> -

Macroanatomy:
41.0% Precentral Gyrus
15.0% Central Opercular Cortex
Assignment based on Maximum Probability Map
7.4% in Postcentral Gyrus [27.0 activated]
5.8% in Precuneous Cortex [24.8 activated]

Probability exceedance (under cluster vs. entire map)
1.50 [1.48; 1.52] for Precuneous Cortex
1.10 [1.09; 1.11] for Postcentral Gyrus

Top probabilities at peak voxels (union)