Towards Multimodal Atlases for Object Recognition

Neuroimaging and Informatics Team

Beijing Normal University,China

May 21, 2012

Concept

Image

An image is something which represents brain properties of brain in picture format;

Concept

Image

An image is something which represents brain properties of brain in picture format;

Map

A spatial representation of the specific brain properties.

Concept

Image

An image is something which represents brain properties of brain in picture format;

Map

A spatial representation of the specific brain properties.

Atlas

A structural framework in which individual brain maps can integrated.

Concept

Image

An image is something which represents brain properties of brain in picture format;

Map

A spatial representation of the specific brain properties.

Atlas

A structural framework in which individual brain maps can integrated.

Database

A system to archive and manage brain atlas and individual brain maps.

Diversity of Atlas

Modality

1. Structural atlas: AAL, HO, TG, Brodmann, Julich CYTO,...
2. Functional atlas:...
3. Connectional atlas:....
4. Chemoarchitectural atlas: Julch, Allen,...

Diversity of Atlas

Modality

1. Structural atlas: AAL, HO, TG, Brodmann, Julich CYTO,...
2. Functional atlas:...
3. Connectional atlas:....
4. Chemoarchitectural atlas: Julch, Allen,...

Method

1. Deterministic atlas: Talariach, AAL, TG,...
2. Probabilistic atlas: HO, Julich CYTO,...

Diversity of Atlas

Modality

1. Structural atlas: AAL, HO, TG, Brodmann, Julich CYTO,...
2. Functional atlas:...
3. Connectional atlas:....
4. Chemoarchitectural atlas: Julch, Allen,...

Method

1. Deterministic atlas: Talariach, AAL, TG,...
2. Probabilistic atlas: HO, Julich CYTO,...

Representation

1. Volume: Talariach, AAL, Julich CYTO,...
2. Surface: TG,...

Multimodal Object Atlas

Objective

1. Construct the first multimodal atlases(morphology,function,connectivity,behavior)for object recognition;
2. Develop a set of tools and establish a pipeline to process all localizer data in NSP.

Multimodal Object Atlas

Objective

1. Construct the first multimodal atlases(morphology,function,connectivity,behavior)for object recognition;
2. Develop a set of tools and establish a pipeline to process all localizer data in NSP.

Strategy

1. Volume $\rightarrow$ Surface
2. Region $\rightarrow$ Connectivity
3. Probabilistic atlas

Data

Object localizer

1. Face, Scene, Object, Scramble object

Subjects

1. Cohort 2006: 202 college students

Contrast

Face ROI

1. face-object
2. face-objscn
3. face-scram
4. face-fix

Object ROI

1. object-scram
2. object-facescn
3. object-fix
4. scram-fix

Place ROI

1. scene-object
2. scene-faceobj
3. scene-scram
4. scene-fix

Activation analysis

GLM

1. FILM from Feat(volume), fsfast from freesurfer(surface)
2. A gamma HRF and its temporal derivative

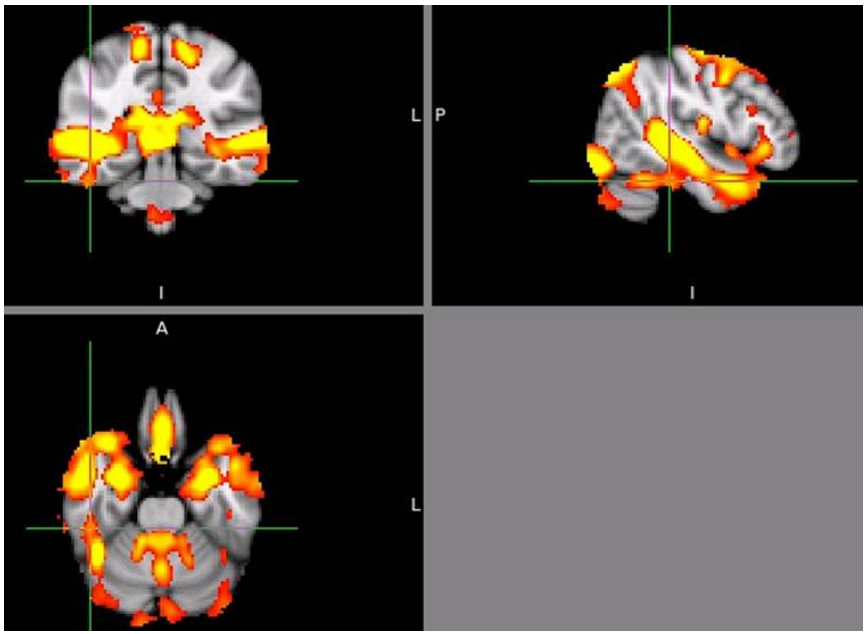
Normalization

1. Volume: Linear registration(FLIRT) + Nonlinear registration(FNIRT)
2. Surface: Curvature based nonlinear registration

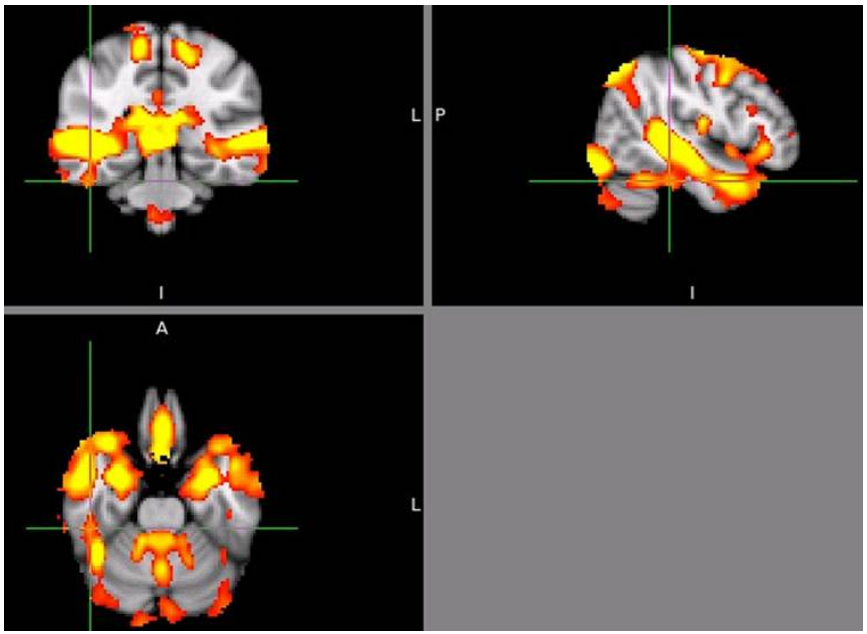
Threshold

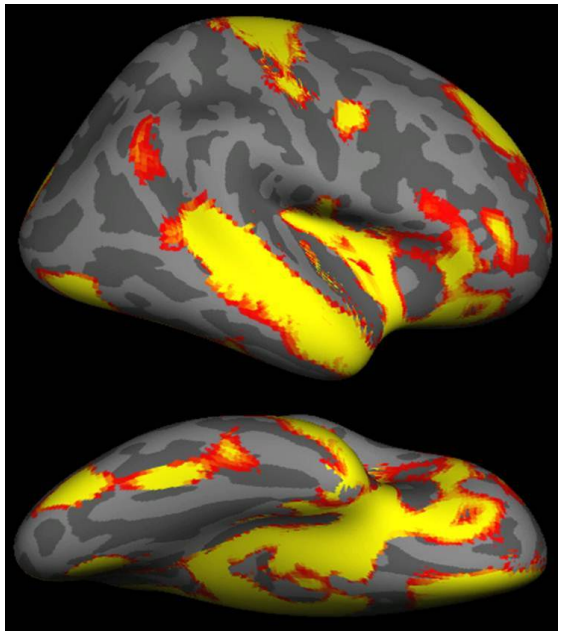
1. Right-tailed test, uncorrected $p < 0.05, 0.01, 0.001$

RFX Group analysis



RFX Group analysis

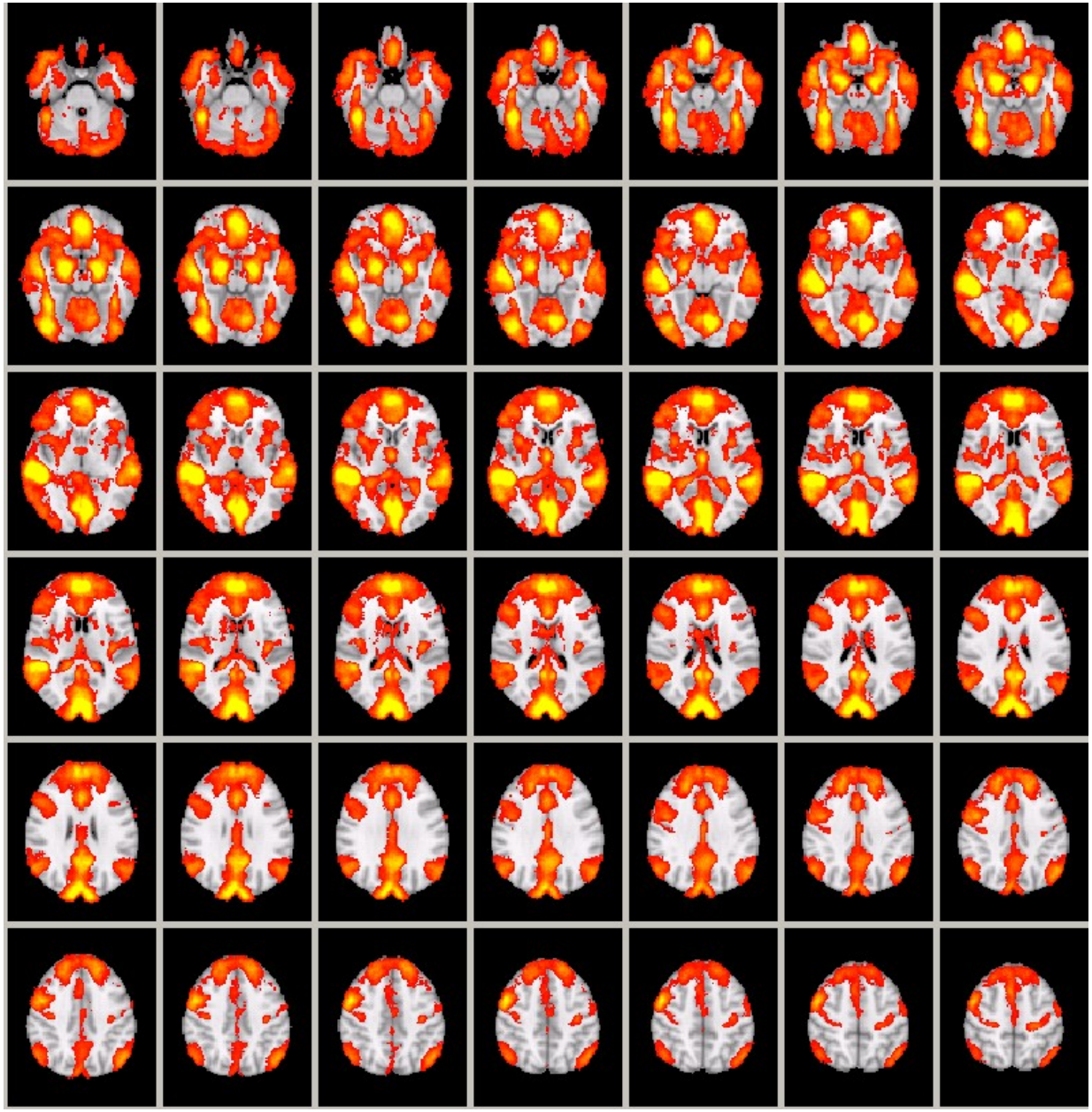




Workflow

1. Construct contrast probabilistic map;
2. Parcellation of contrast probabilistic map;
3. Determine subject specific ROI with hand,semiautomatic or automatic method;
4. Construct ROI probabilistic atlas.

Probabilistic map



Landmark

1. Anatomical MRI：macroanatomical landmark and extents
2. Group level parcellation for contrast map：group activation landmarks and extent
3. Probabilistic map：group activation magnitude
4. subject-specific activation map：subject-specific activation magnitude and extent

Landmark-FFA

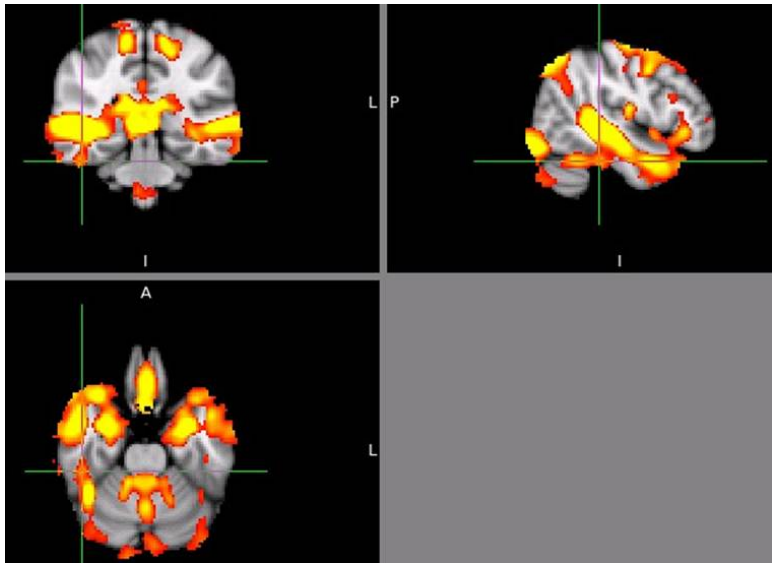
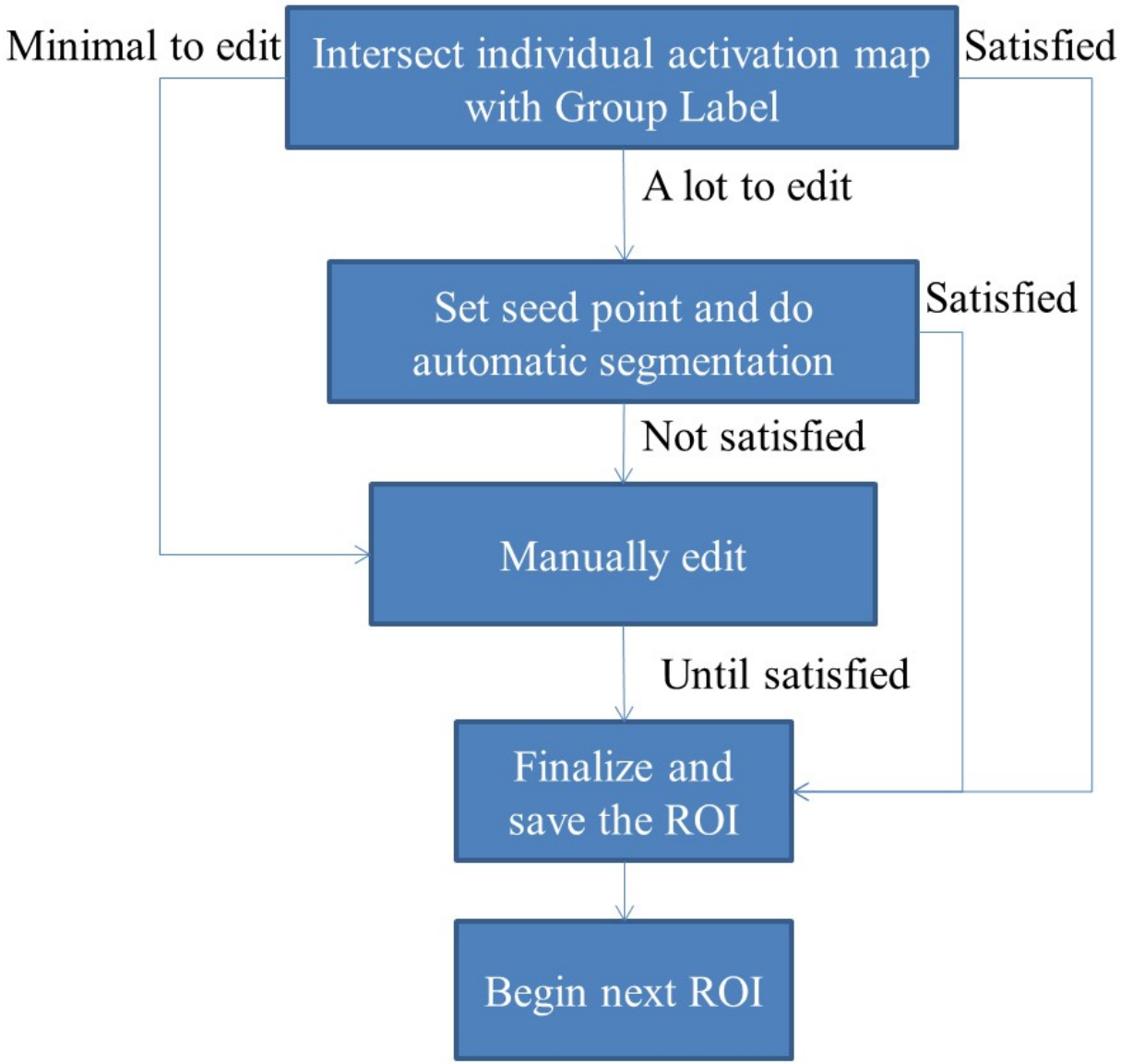


Figure: XXX

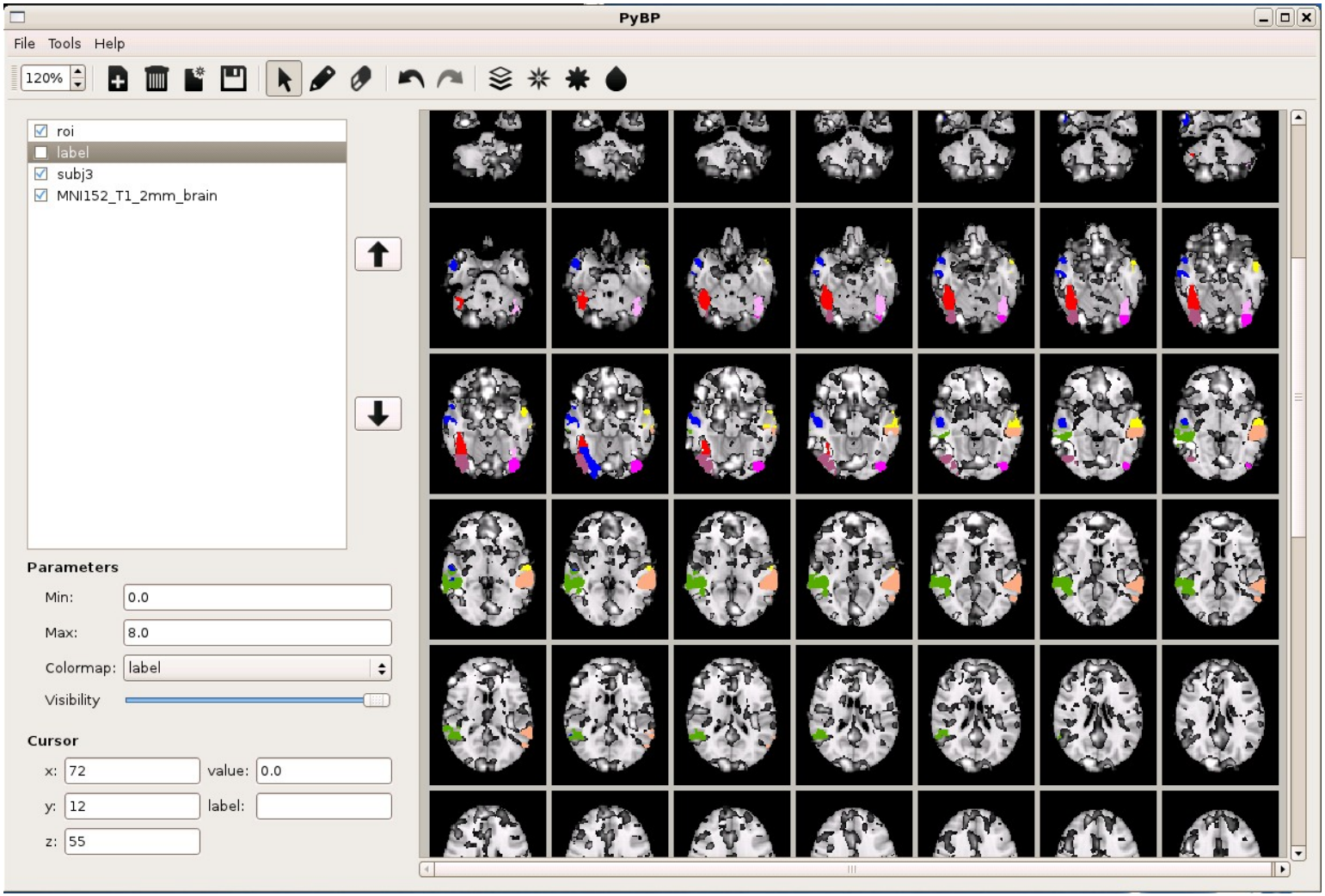
Pick subject-specific ROI



PyBP

1. MRI结构像gray显示，激活图gray显示，设阈限为2.3-6；
2. 首先使用group parcellation label和被试激活图做交集；
3. 基于交集产生的New volume依照label editor中label的顺序手动编辑ROI:凡label没覆盖且认为属于label的激活voxel，都涂上Label 颜色；
4. 编辑完全部ROI后，再和被试激活图进行交集。

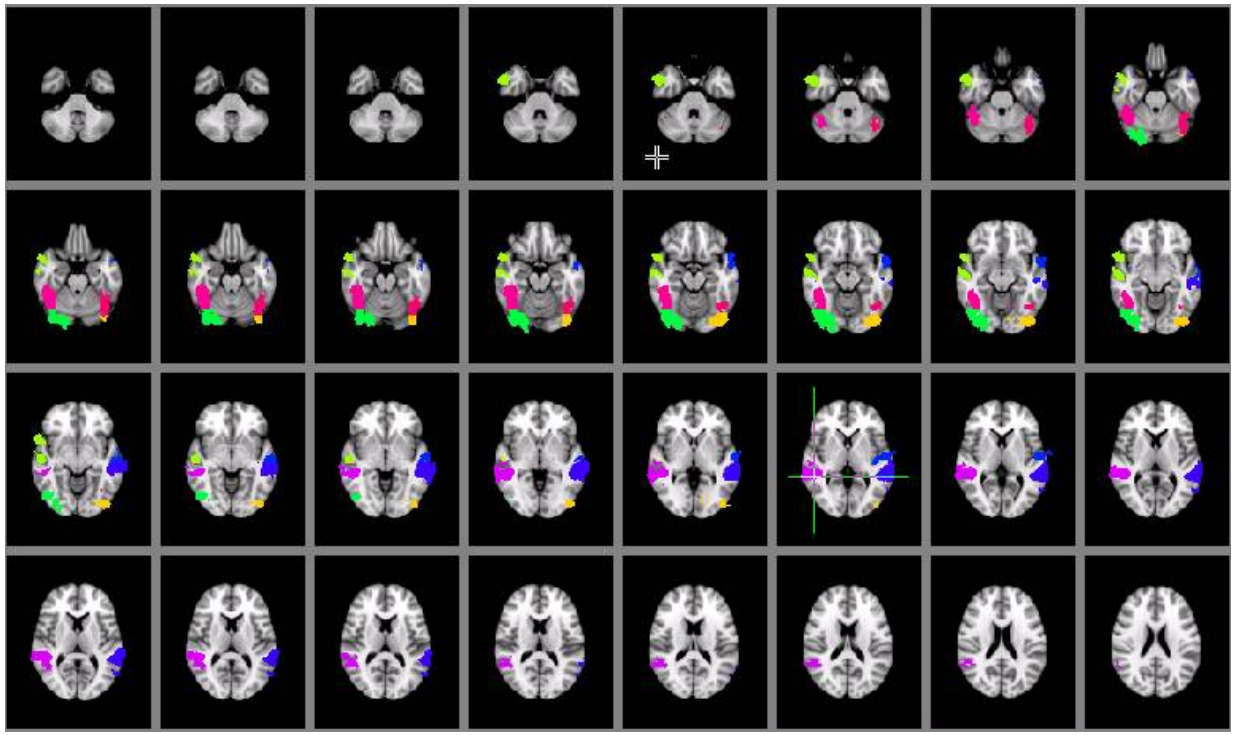
PyBP



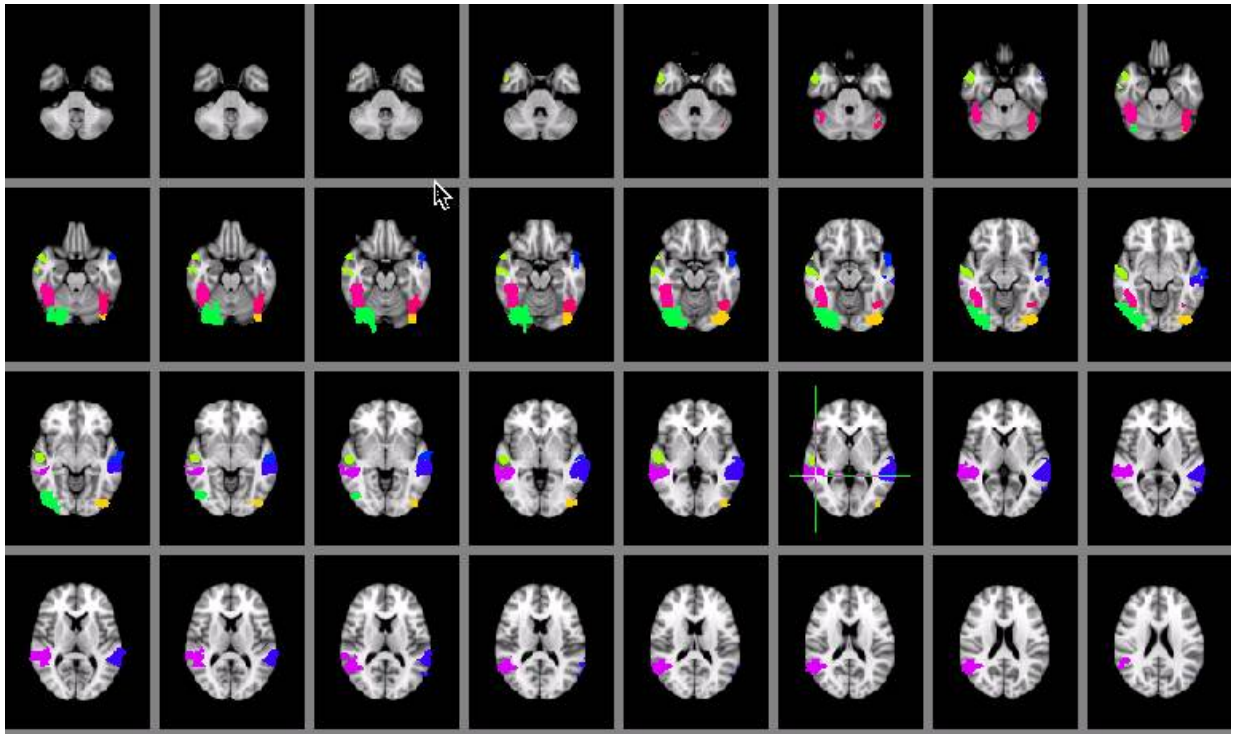
Criteria

1. 依据被试激活cluster和解剖结构，group level parcellation 的相对位置；
2. 依据被试激活cluster间的相对位置；
3. 确保每个被试的激活阈限统一；
4. 连续的cluster 是必要条件，若在一个group label 中，有两个连续的cluster，则选择一个更可能的；
5. 范围在group level parcellation 边缘或只有部分相交，依据和其它脑区的相对判定，该cluster是否入选；
6. 可以通过调整被试激活图阈限，从最有把握的cluster中心开始选择，然后降低阈限递增添加，直至最终阈限；

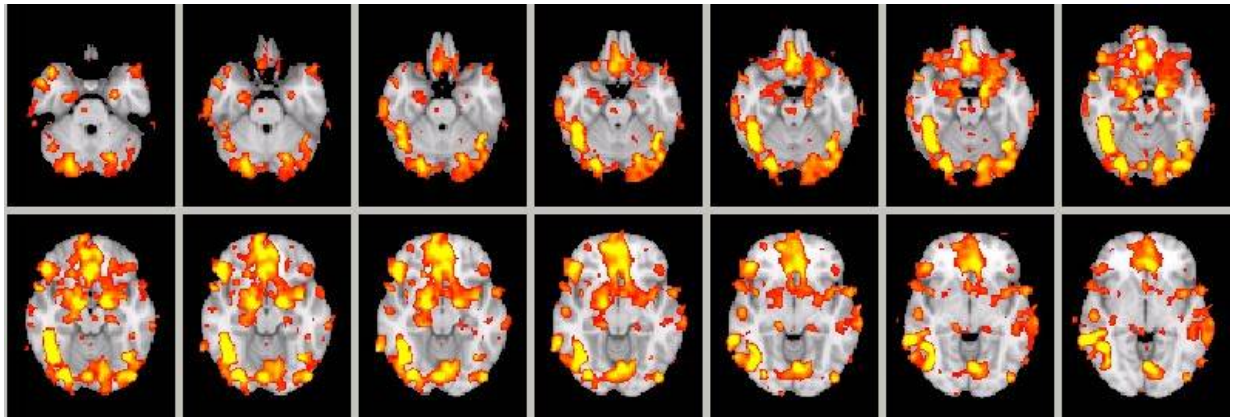
Test



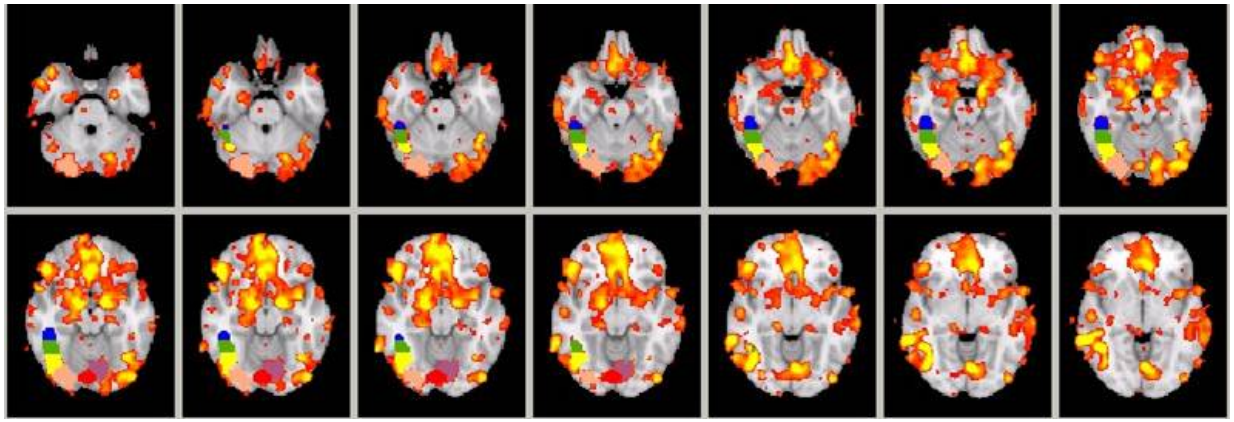
Retest



Semiautomatic parcellation



Semiautomatic parcellation



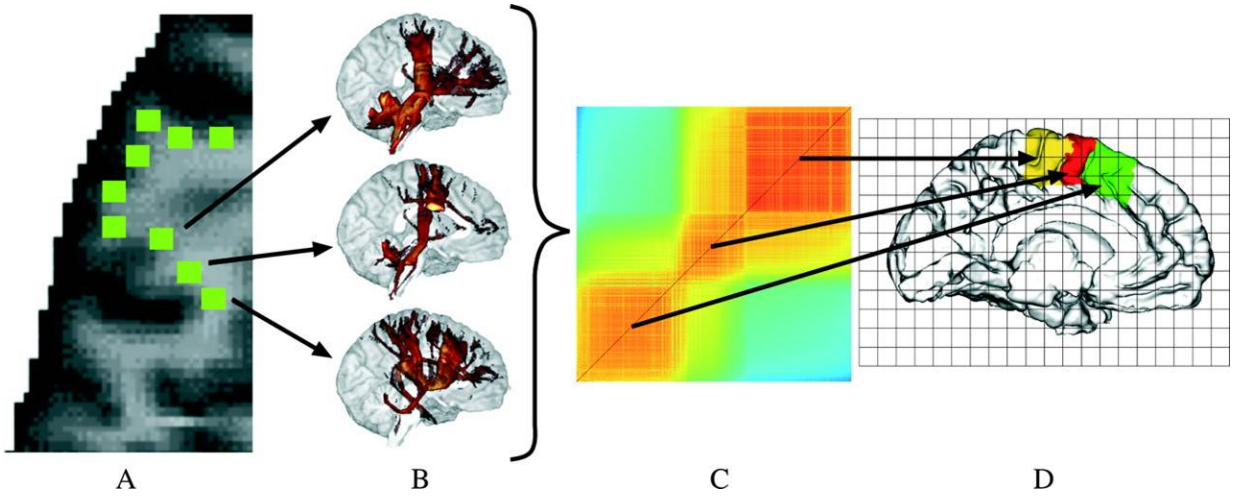
Scientific questions

1. Measure individual variability(location and response);
2. Measure the spatial relation between fROI and aROI;
3. Measure the spatial relation between fROI from different contrast;
4. Asymmetry of ROI(location,response,connectivity);
5. Trend of ROI in hierarchy;
6. Male vs. female(gender x lobe);
7. Behavior correlation analysis.

Connectivity Atlas

1. rfMRI functional connectivity atlas;
2. DTI anatomical connectivity atlas;
3. Behavior significance.

Connectivity based parcellation



1. rfMRI functional connectivity based brain parcellation;
2. DTI anatomical connectivity based brain parcellation.

Structure and Connectivity based fROI predicting

1. MRI morphology;
2. Resting state functional connectivity;
3. DTI anatomical connectivity;

Way station

Dividing the brain is more art than science; there is long way to go, we should attack it in phase-wise manner. Where is our way station ?

1. Large population of object localizer group results;
2. Group parces guided region parcellation;
3. Contrast probabilistic map
4. Region atlas: face selective region atlas, ventral visual region atlas, whole brain region atlas;
5. Connectivity atlas: ...
6. ...

ROI

Face

1. lOG,pFG,aFG,pSTS,mSTS,aSTS
2. dTP,lTP,vTP,aIT

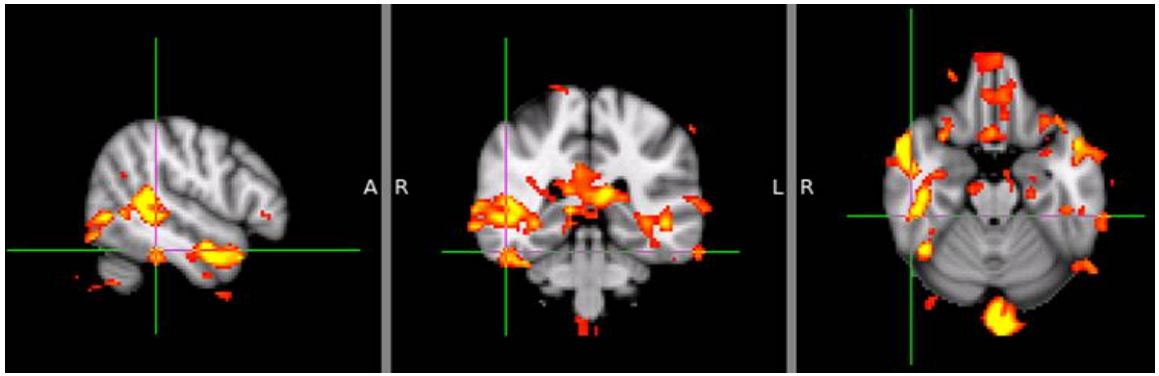
Object

1. LO,pFS,ITS

Scene

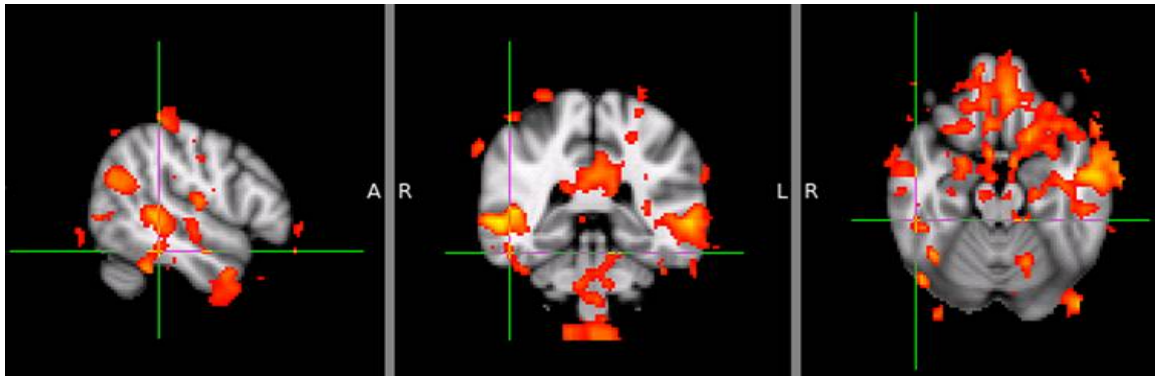
1. PPA,TOS,RSC

FFA



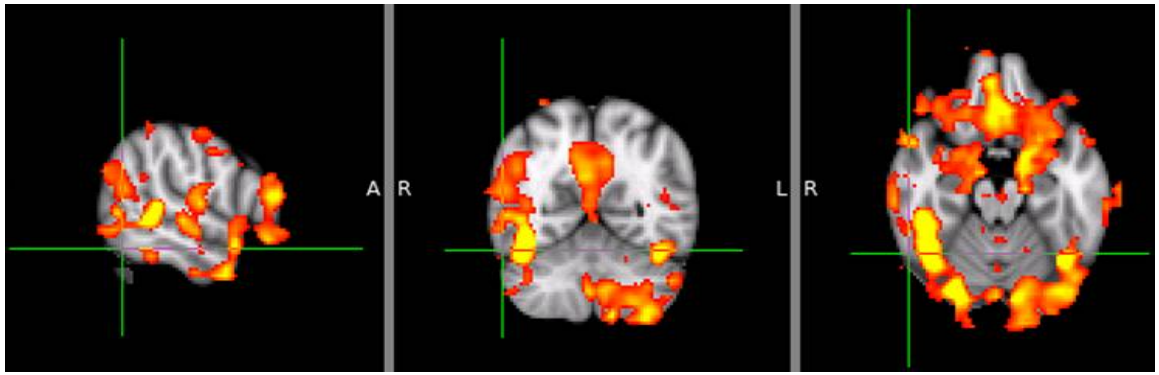
MRI	梭状回中部
Label	ID=5,OFA前，pSTS下
Zstat	pFus,aFus，对称，右优

IPL



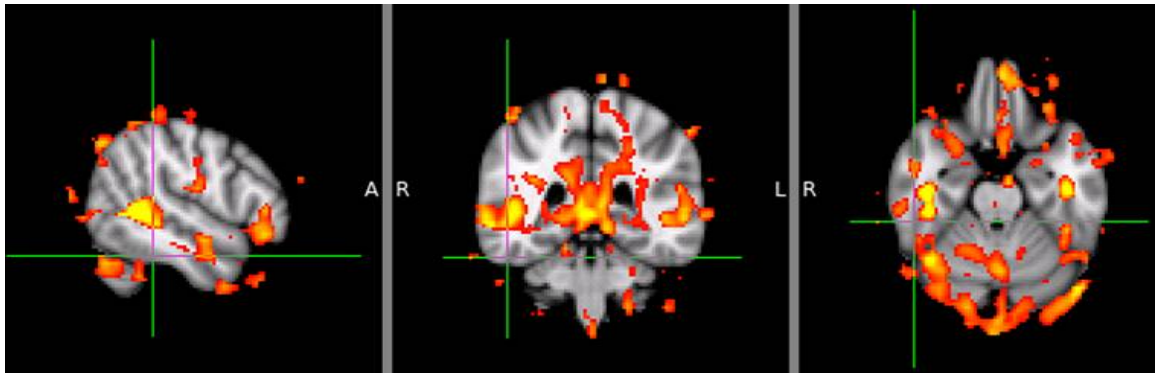
MRI	颞上沟后部，颞顶交互处
Label	ID=X,OFA前上，pSTS后上
Zstat	IPL, pSTS, aSTS, aIT, sagittal向沿STS间隔排列

pSTS



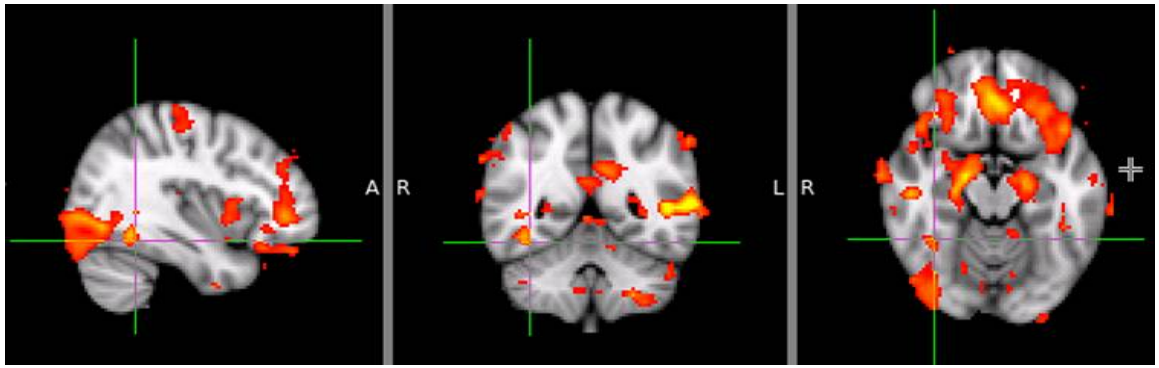
MRI	颞上沟后部
Label	ID=X,FFA侧上，mSTS后上
Zstat	IPL, pSTS, aSTS, aIT, sagittal向沿STS间隔排列

aSTS



MRI	颞上沟前部
Label	ID=X,pSTS 前下
Zstat	IPL, pSTS, aSTS, aIT, 沿STS间隔排列

aIT



MRI	颞上沟，颞极交互处，外侧
Label	ID=X, aFus 前部
Zstat	IPL, pSTS, aSTS, aIT, sagittal向沿STS间隔排列