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# Towards Multimodal Atlases for Object Recognition

Neuroimaging and Informatics Team

Beijing Normal University, China

May 17, 2012

## Image

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

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## Image

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

## Map

A spatial representation of the specific brain properties.

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## 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 be integrated.

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## 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 be integrated.

## Database

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

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# 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,...

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## Method

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

## Representation

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

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## 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.

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## Objective

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## Strategy

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

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## Object localizer

1. Face, Scene, Object, Scramble object

## Subjects

1. Cohort 2006: 202 college students

## 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

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# 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  $p < 0.05, 0.01, 0.001$

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# RFX Group analysis

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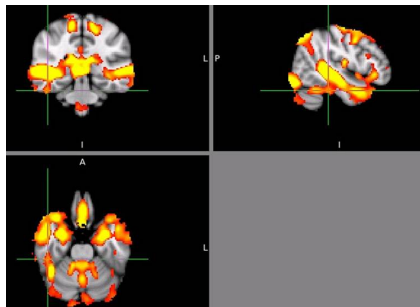
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# RFX Group analysis

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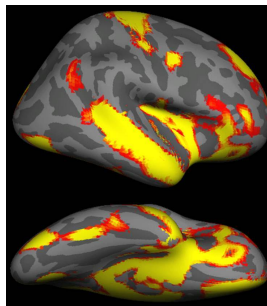
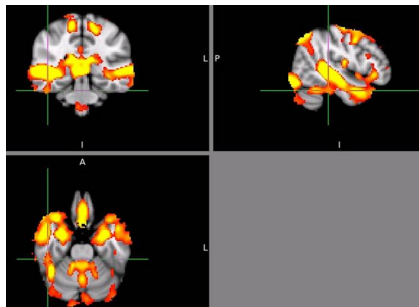
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1. Construct contrast probabilistic map;
2. Parcellation of contrast probabilistic map;
3. Determine subject specific ROI with hand, semiautomatic or automatic method;
4. Construct ROI probabilistic atlas.

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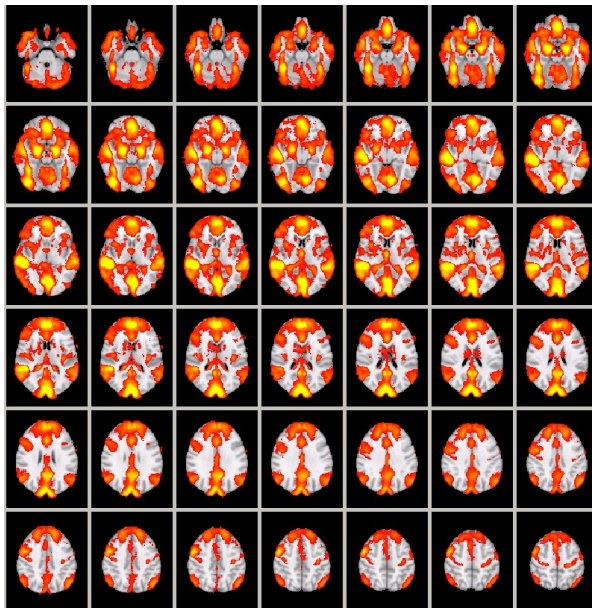
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# Probabilistic map



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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

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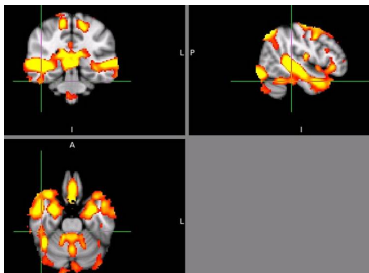
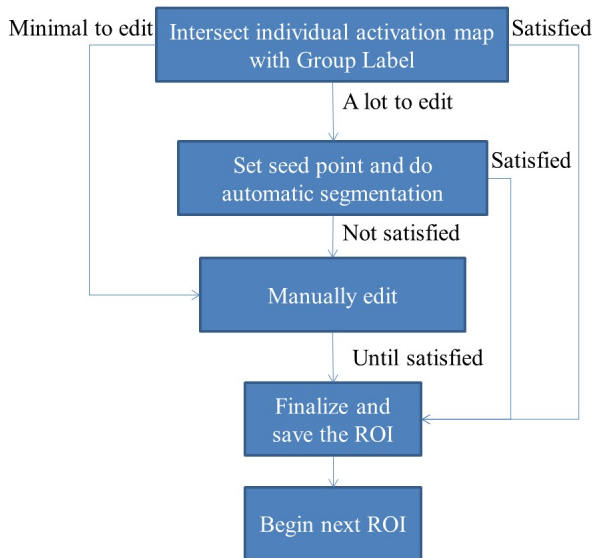


Figure: XXX

# Pick subject-specific ROI



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。

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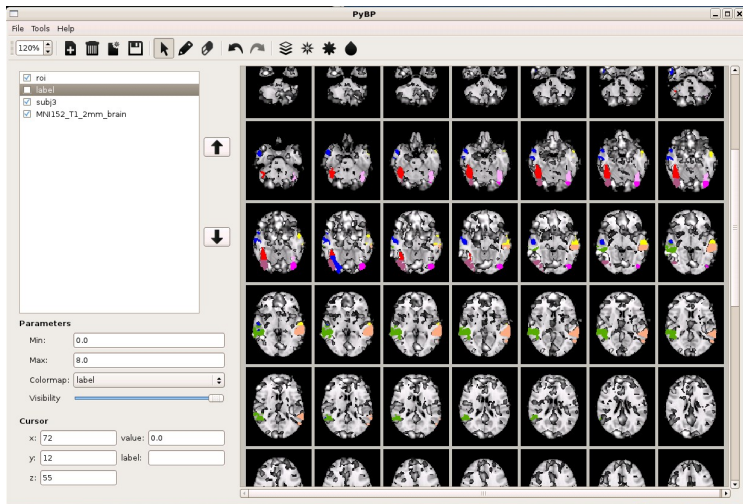
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1. 依据被试激活**cluster**和解剖结构，**group level parcellation** 的相对位置；
2. 依据被试激活**cluster**间的相对位置；
3. 连续的**cluster** 是必要条件，若在一个**group label** 中，有两个连续的**cluster**，则选择一个更可能的；
4. 范围在**group level parcellation** 边缘或只有部分相交，依据和其它脑区的相对判定，该**cluster**是否入选；
5. 可以调整阈限观察**cluster**变化情况，但画图和做交集时，必须确保采用统一固定阈限；

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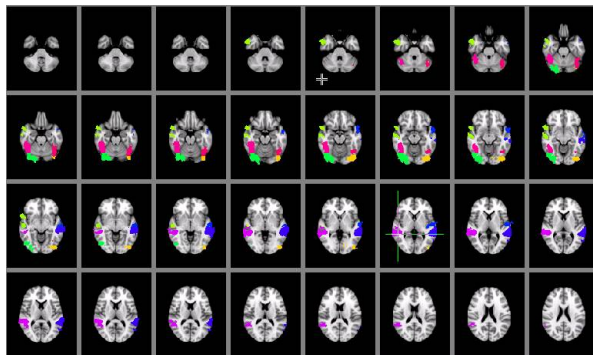
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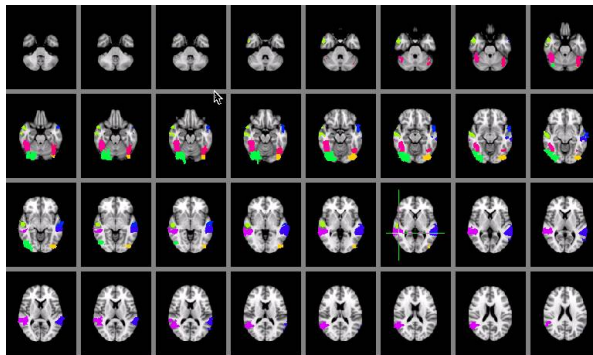
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# Retest



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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.

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

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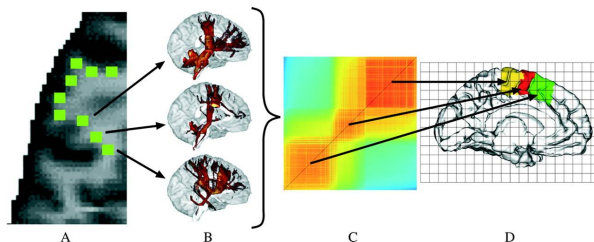
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# Connectivity based parcellation



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

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# Structure and Connectivity based fROI predicting

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

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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. ...

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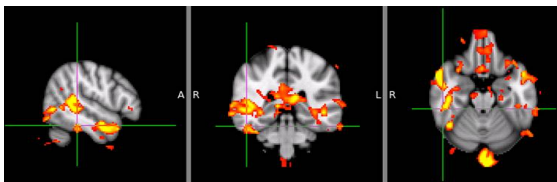
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MRI	梭状回中部
Label	ID=5,OFA前, pSTS下
Zstat	pFus,aFus, 对称, 右优

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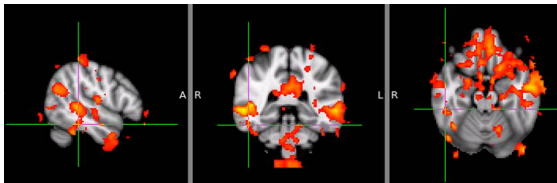
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MRI	颞上沟后部，颞顶交互处
Label	ID=X,OFA前上，pSTS后上
Zstat	IPL, pSTS, aSTS, aIT, sagittal向沿STS间隔排列

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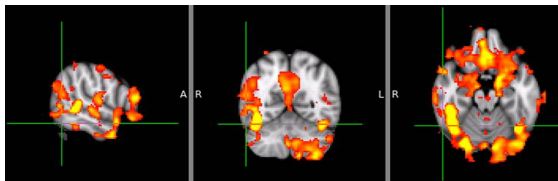
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MRI 颞上沟后部

Label ID=X, FFA侧上, mSTS后上

Zstat IPL, pSTS, aSTS, aIT, sagittal向沿STS间隔排列

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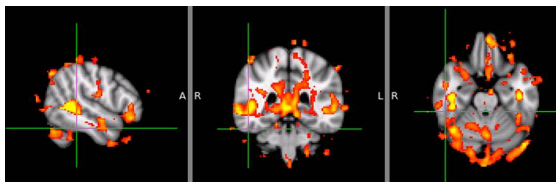
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MRI 颞上沟前部

Label ID=X,pSTS 前下

Zstat IPL, pSTS, aSTS, aIT, 沿STS间隔排列

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Label ID=X, aFus 前部

Zstat IPL, pSTS, aSTS, aIT, sagittal向沿STS间隔排列