

Meta-Analysis in Neuroimaging

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Neuroimaging Methods Workshop

6/30/2011

Meta-Analysis

What is it?

Why use it?

How does it work?

Demonstration

Meta-Analysis

What is it?

Why use it?

How does it work?

Demonstration

What is a meta-analysis?



“... the analysis of analyses...”

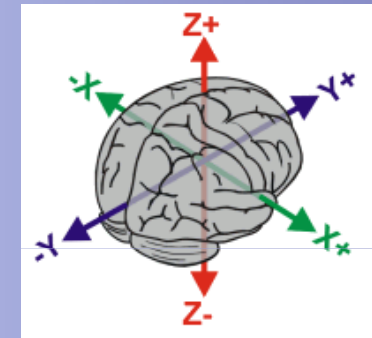
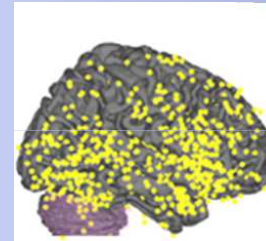
(Glass, 1976)

What is it?

	fMRI			
	x	y	z	Z score
L Precent G (4/6)	-46	-8	32	7.18
R Precent G (6)	48	-3	24	7.31
R Sup Temp S (22/21)	55	-23	5	5.65
R Med Sup Fr G (6)	4	11	55	5.84

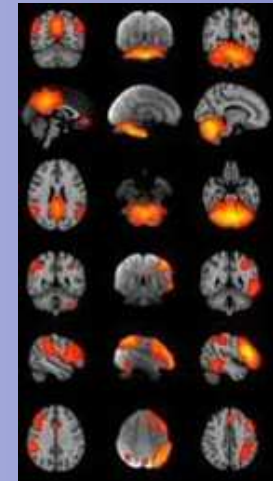
- Coordinate-based meta-analysis (CBMA)

- coordinates (Lazar et al., 2002)



- Image-based meta-analysis (IBMA)

- volumes (Salimi-Khorshidi et al., 2009)



Meta-Analysis

What is it?

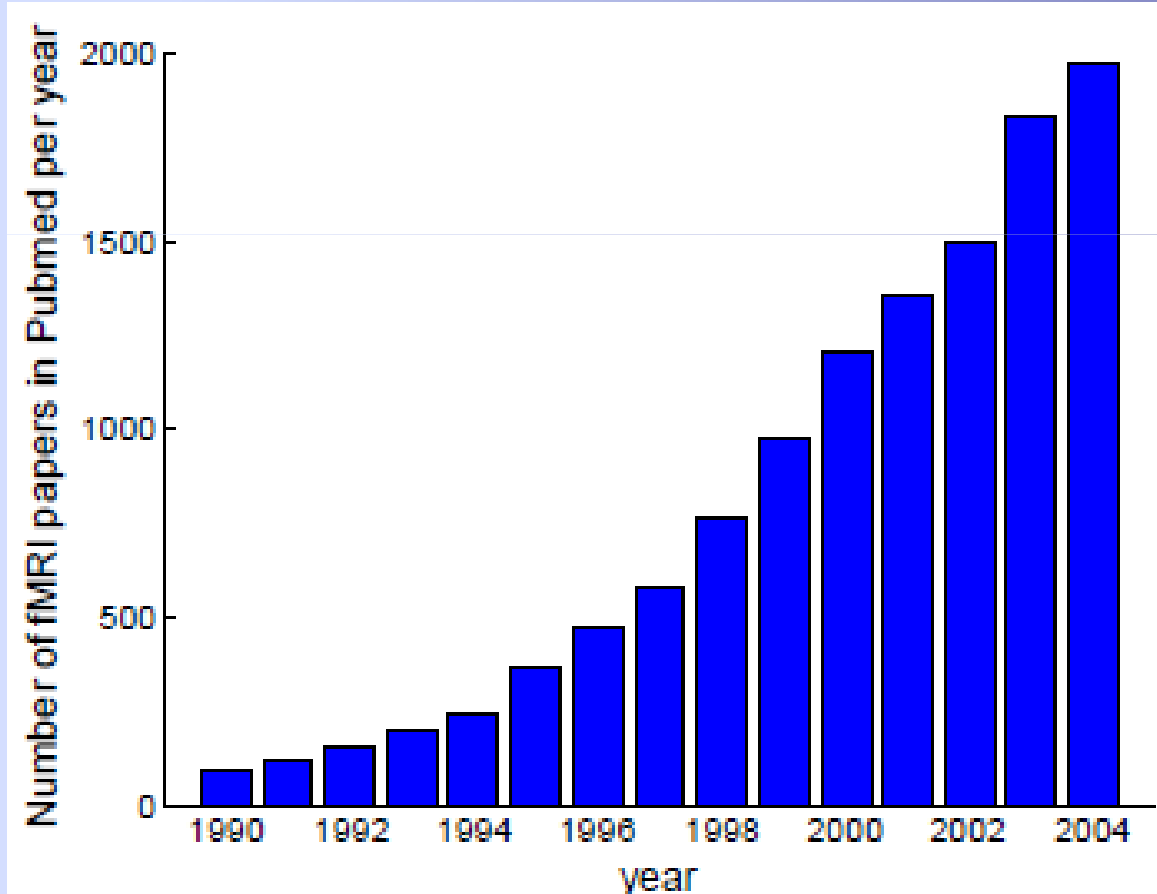
Why use it?

How does it work?

Demonstration

Why use it?

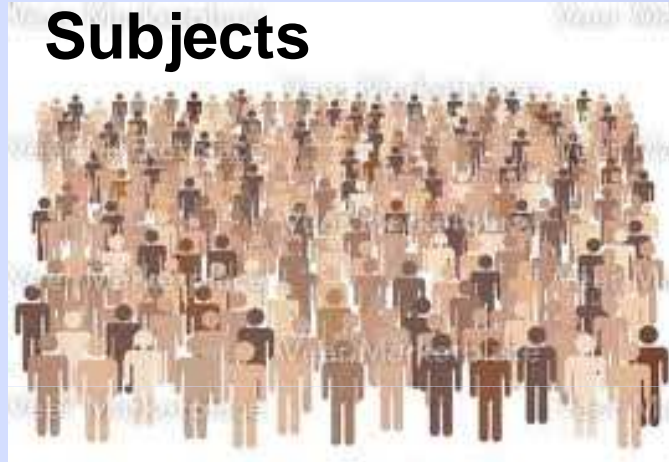
- Overwhelming amount of neuroimaging studies out there!



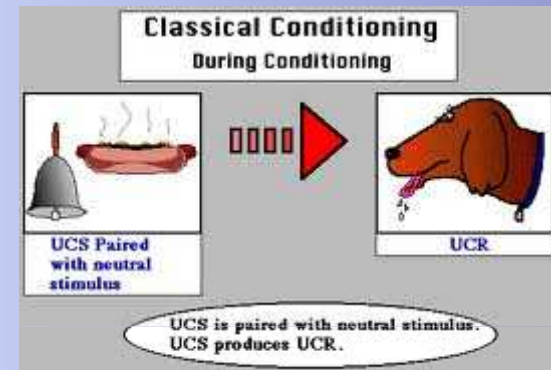
Why use it?

Variability across studies

Subjects



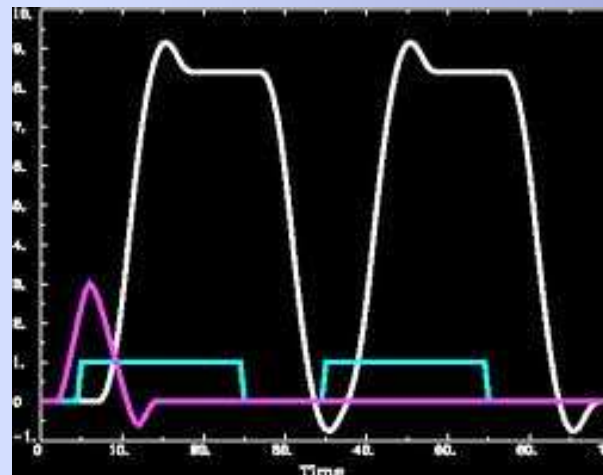
Stimuli



Scanner Strength



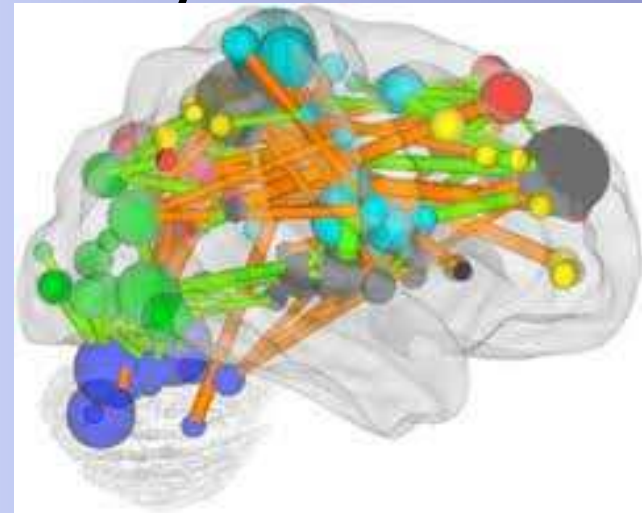
Analysis



<http://afni.nimh.nih.gov/afni/doc/misc/ERPFMRlanalysis>

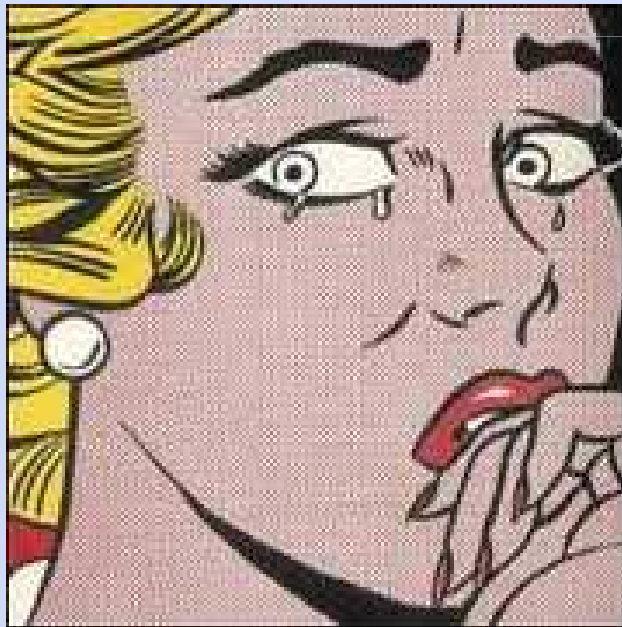
Why use it?

- Which regions most consistently activated across studies
 - Small sample sizes, high false positive rates
- Which regions most consistently *co-activated*
 - Functional connectivity



Why use it?

- Functional specificity
 - e.g. Amygdala and emotion: emotional and non-emotional tasks



Meta-Analysis

What is it?

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Demonstration

Meta-Analysis Tools

- GingerALE (Activation Likelihood Estimate; ALE)
(Turkeltaub, 2002; Eickhoff, 2009)
- NeuroSynth
- Multi-level Kernel Density Analysis (MKDA)
- AMAT
(Wager, 2007)
- fMRI Data Center
- SumsDB (Van Essen Lab)
- NIDAG

Meta-Analysis Tools

- GingerALE
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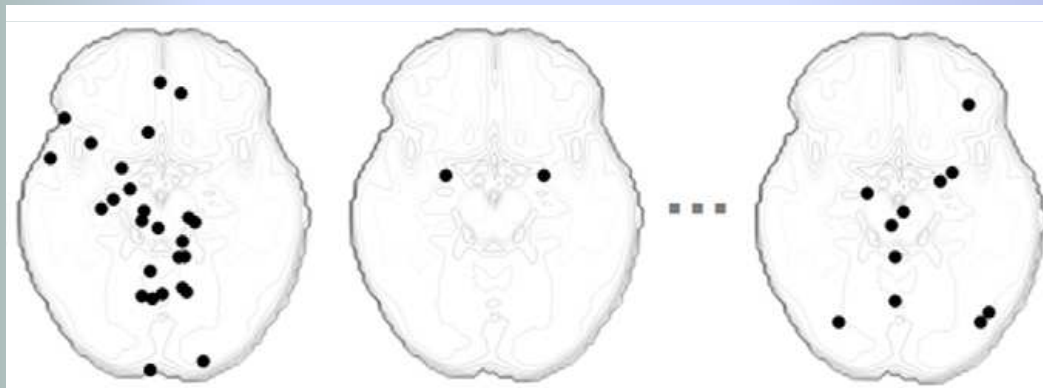
How does it work?

ALE

**Coordinates of peak activation
for each study**

Word reading > cross fixation

	fMRI		
	x	y	z
L Precent G (4/6)	-46	-8	32
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R Med Sup Fr G (6)	4	11	55

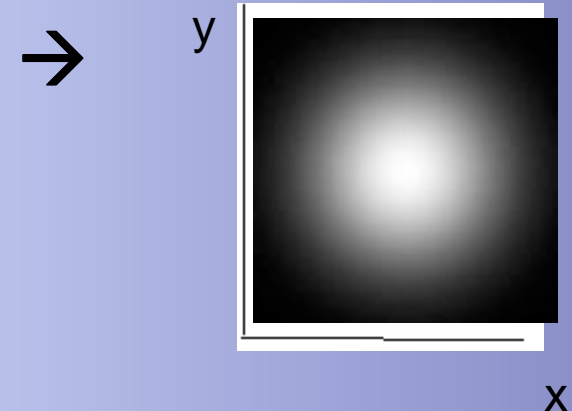


Study 1

Study 2

Study n

**Distribution of Foci become fixed
for each study**



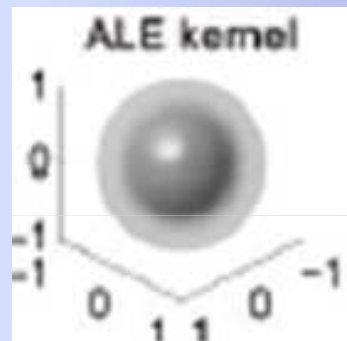
How does it work?



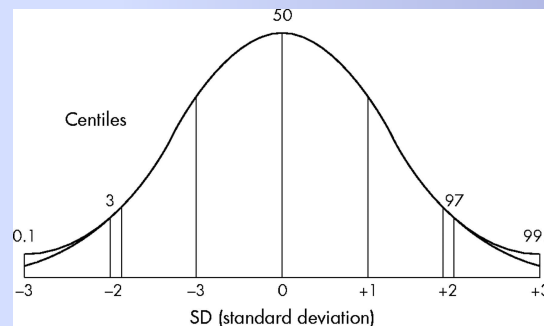
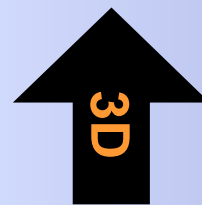
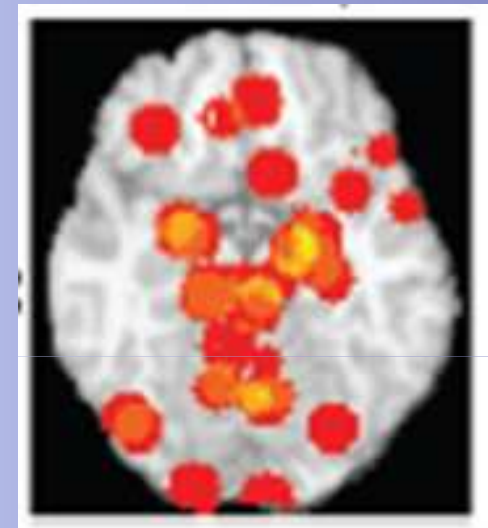
**“Modeled Activation”
(MA) map**

Kernel Convolution

For each voxel



=



How does it work?

Significant??

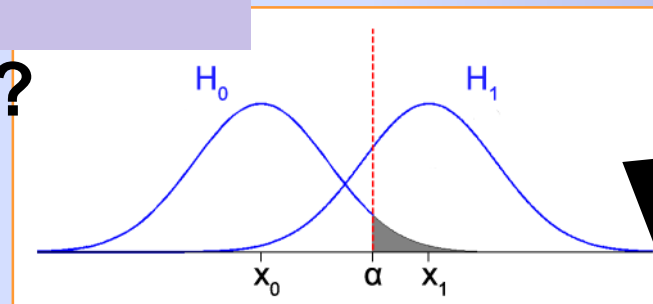
?

How to tell
if it is significant?

H_0 What is the
null hypothesis?

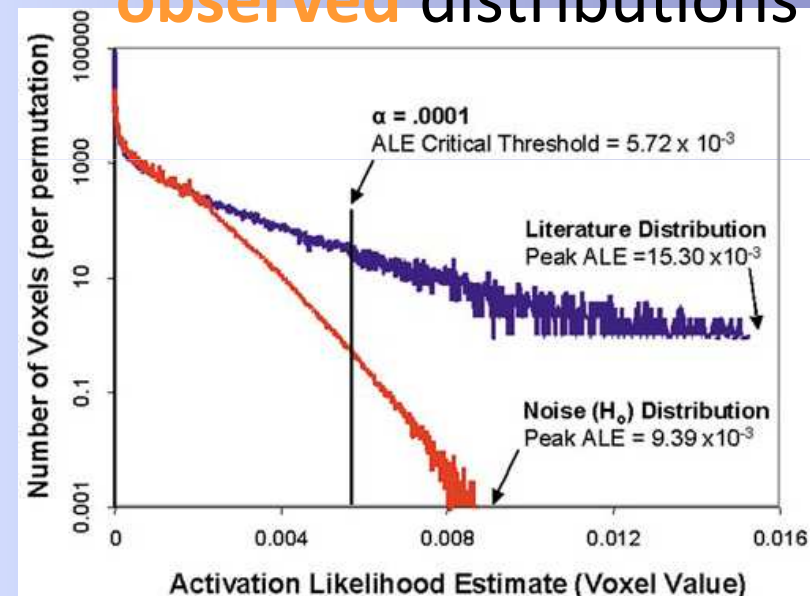
A **random** distribution
of ALE scores if no true
convergence exists

simulation repeated
 10^{11} times
(e.g. Monte Carlo)



As if

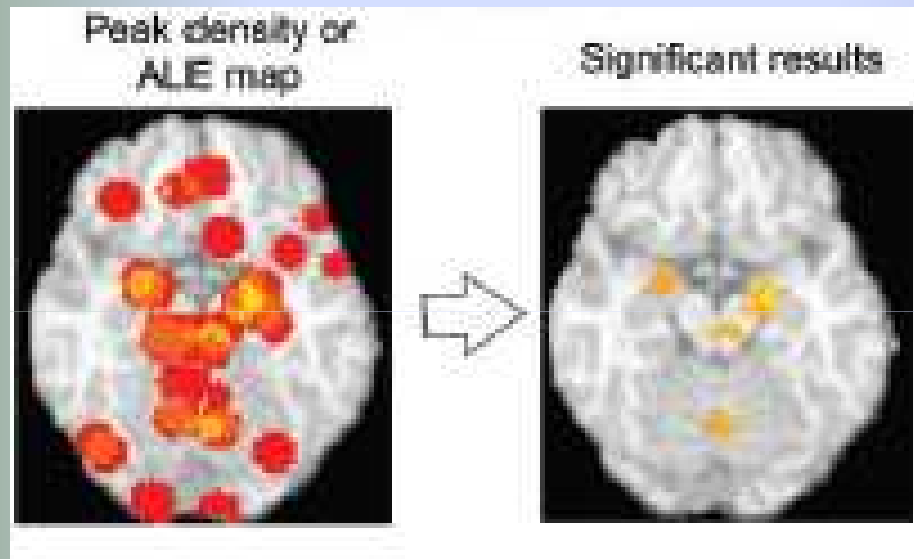
Compare the **random** and
observed distributions



Choose a **threshold** (α)
(corrected for multiple comparisons or false discovery rate)
to determine the **p-value**
of each voxel

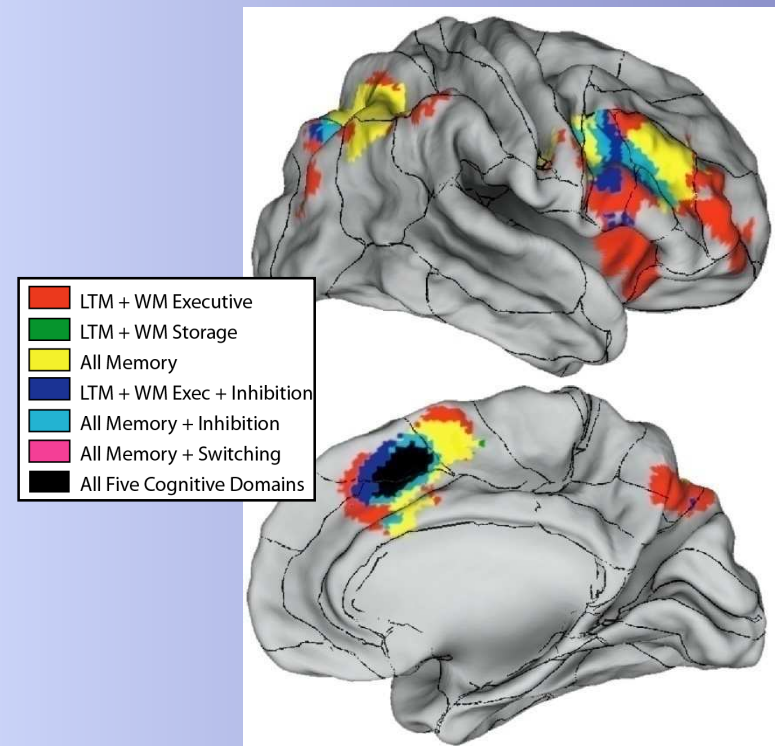
How does it work?

Apply Significance Threshold



Then, **clusterize** and apply a **cluster size threshold** (e.g. 50 mm³)

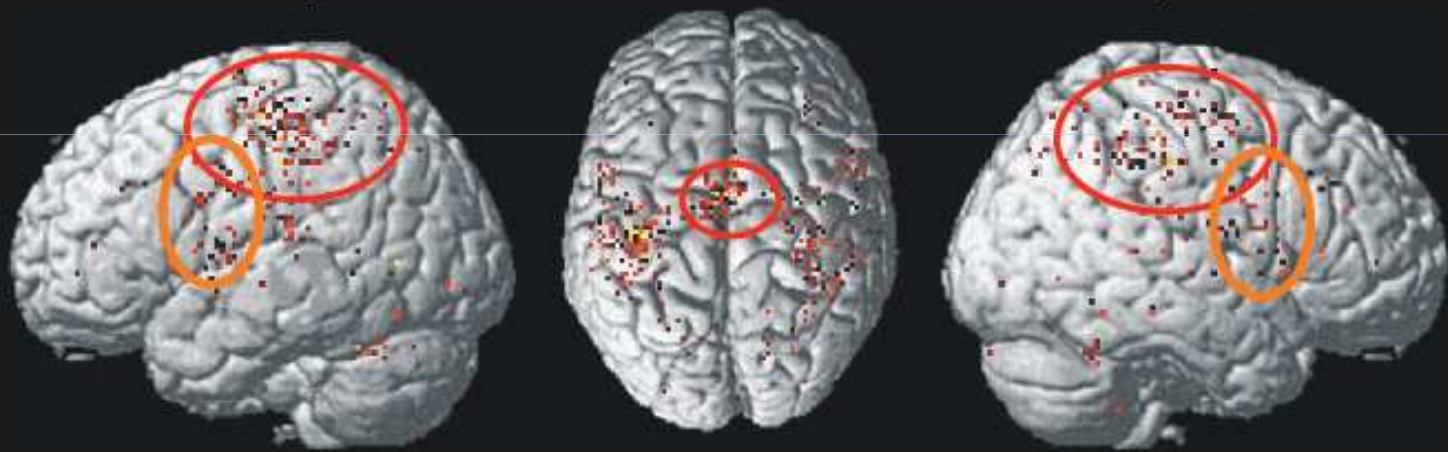
This process can be **repeated** for each functional group of coordinates



How does it work?

Meta-Analysis on Finger Tapping

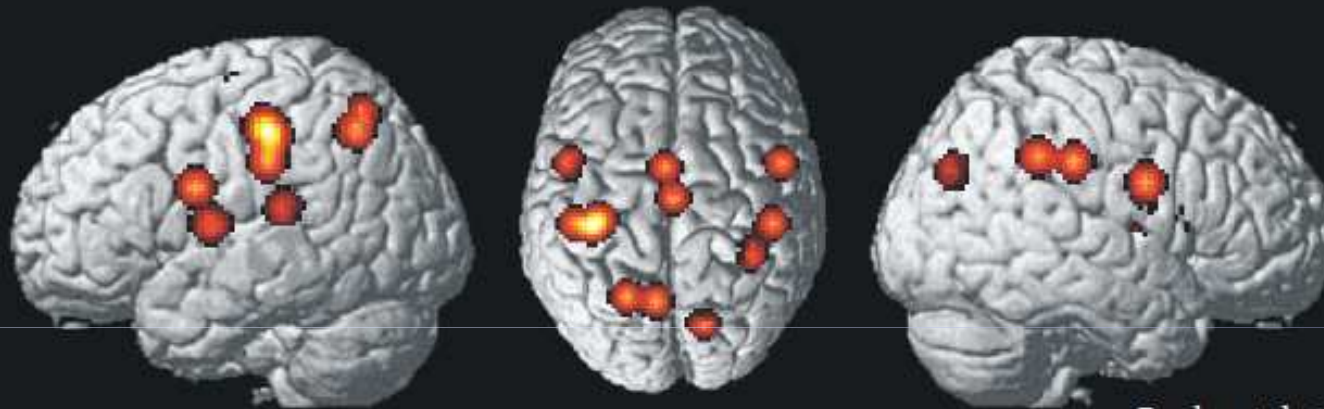
Location of activation foci



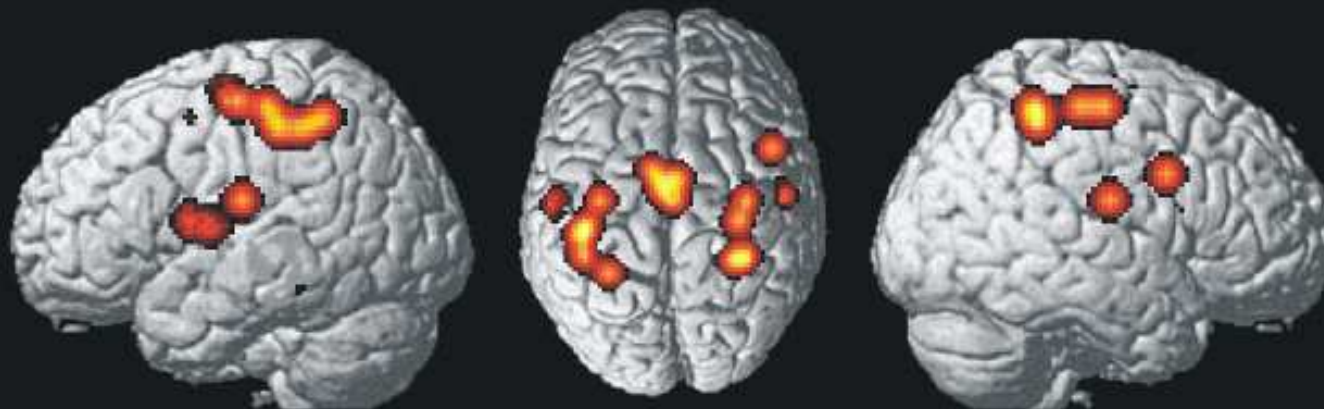
Where do the reported foci
converge ?

How does it work?

Gaussian Representation of Activations



Boecker et al., 1998

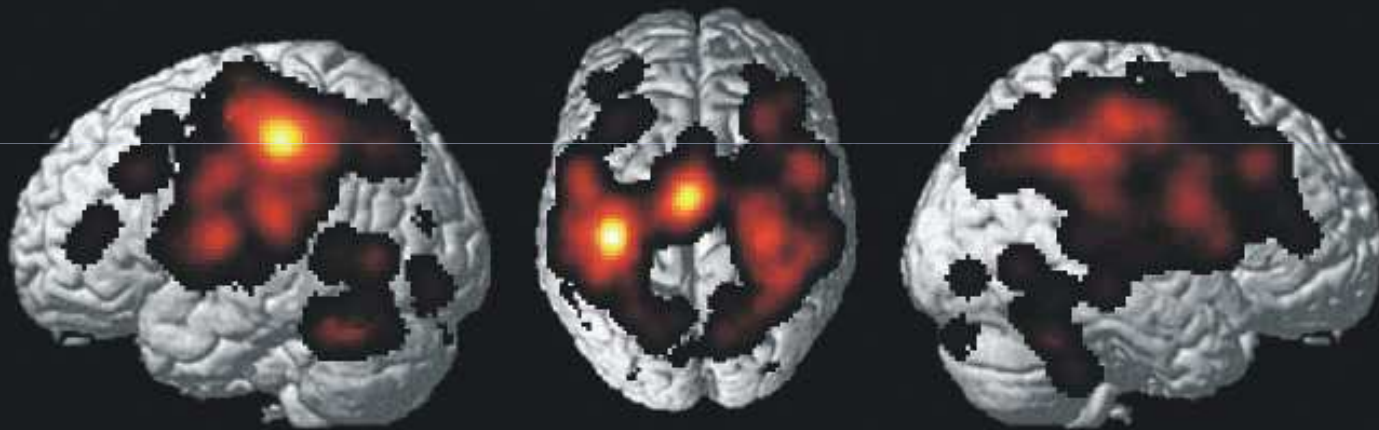


Gerardin et al., 2000

How does it work?

Activation Likelihood Estimates

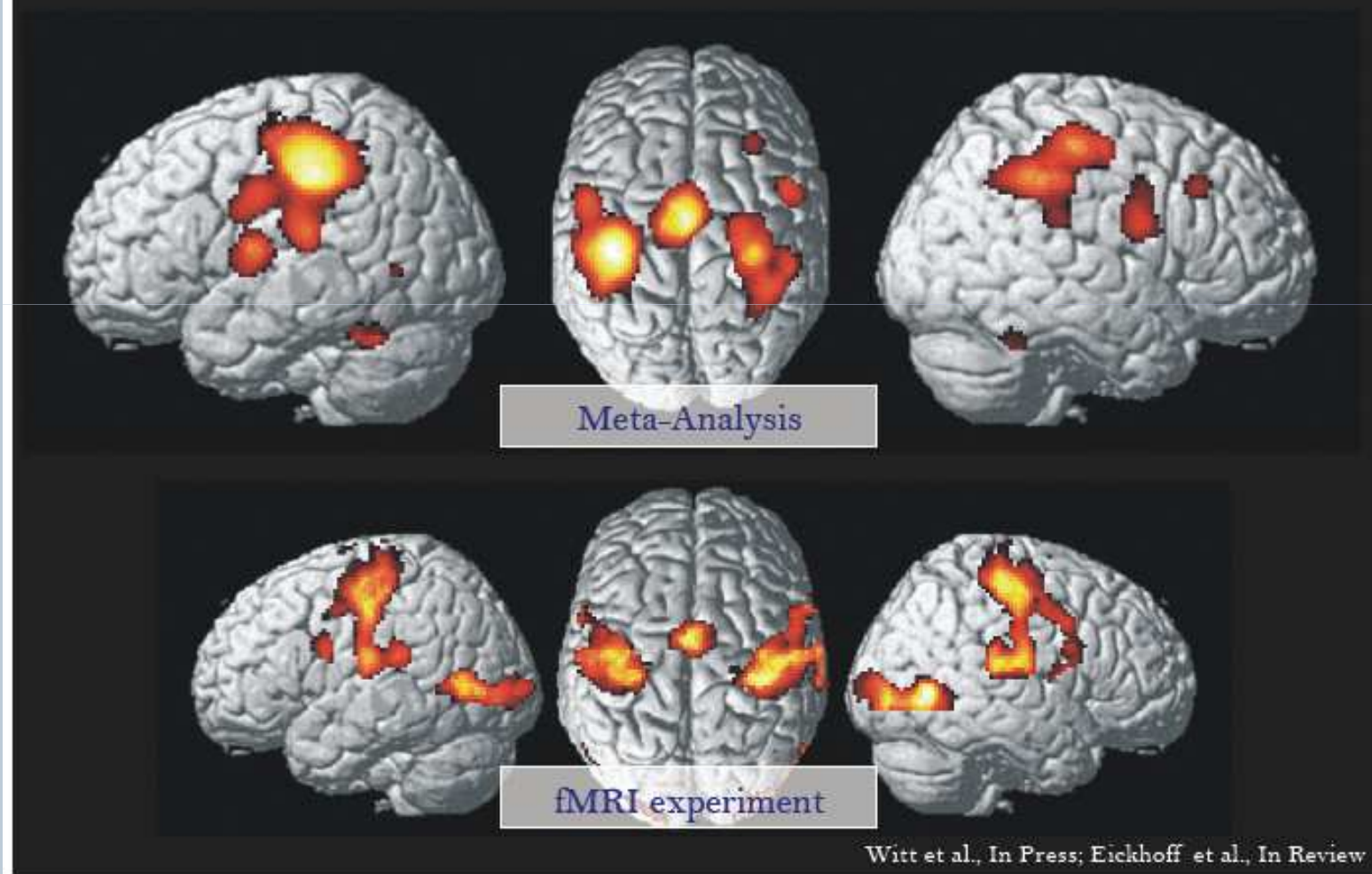
Defined as the union over all experiments



Which of these values are significant?

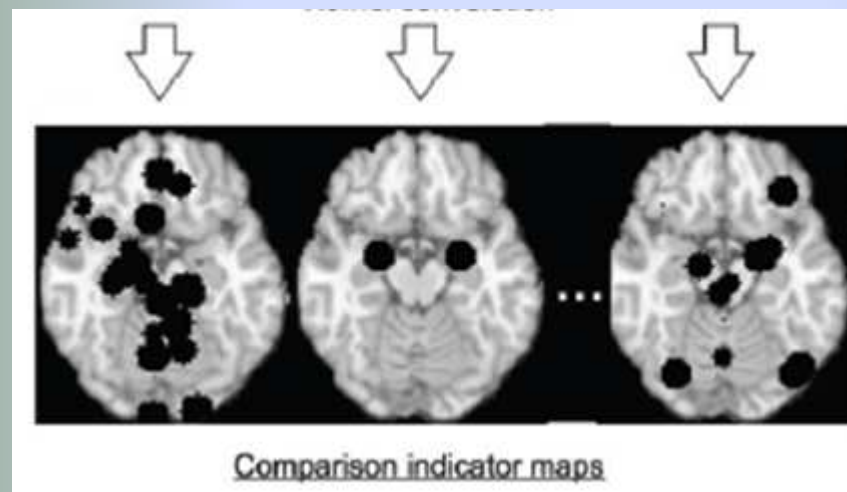
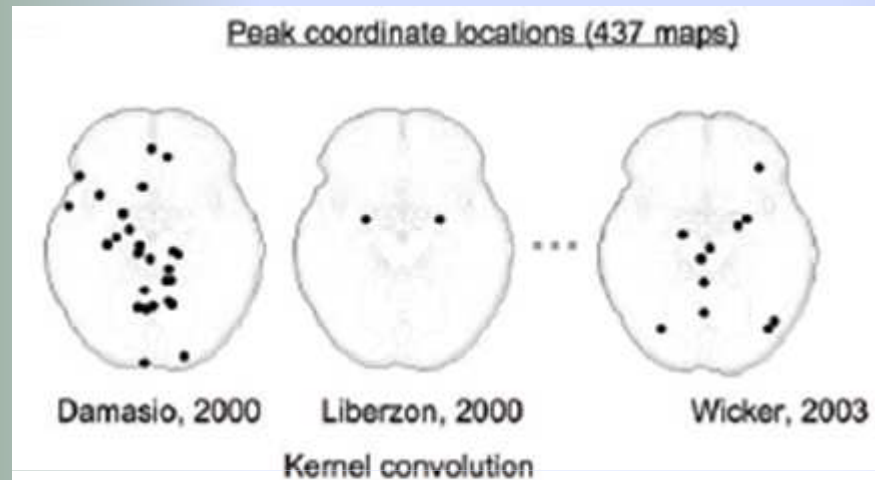
How does it work?

Meta-Analysis on Finger Tapping

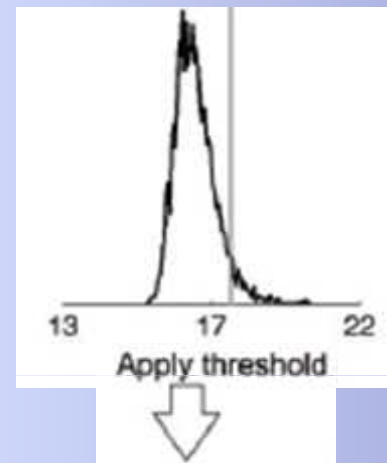


How does it work?

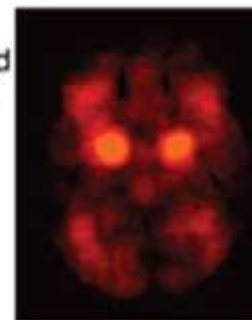
MKDA



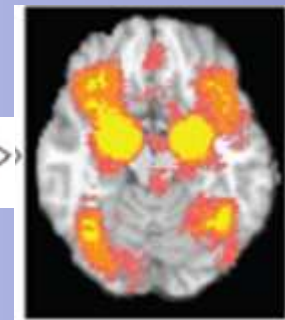
Expected maximum proportion
Under the null hypothesis



Weighted
average



Significant regions



Proportion of activated
Comparisons map
(from 437 comparisons)

How does it work?

Neurosynth

neurosynth.org *beta*

Home

Images

Data

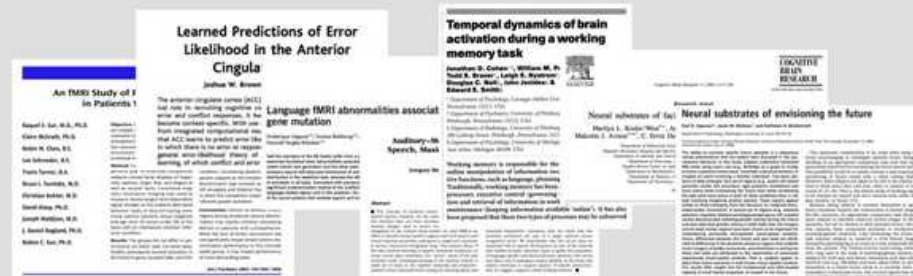
Resources

Blog

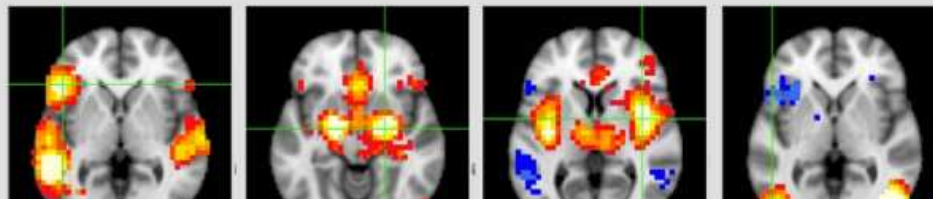
FAQ

NeuroSynth is a platform for large-scale, automated synthesis of functional magnetic resonance imaging (fMRI) data extracted from published articles.

Our goal is to turn this:



Into this:



Database contents

2,047 terms

4,393 studies

147,493 activations

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Demonstration

Brainmap.org



The screenshot shows the Brainmap.org website. At the top, there's a navigation bar with links: Home, About, Metadata, Publications, Results, Contact. Below this, a section titled "Announcements - October 2, 2019" contains text about the release of Version 1.1 of the software (Slauth, GingeALE, and SynMap). It mentions that users need to re-run their analyses and that the database has been updated. To the right of the text is a search bar with a "Search" button. Below the search bar, there's a section titled "Download Software" with three icons: Slauth v.1.1, GingeALE v.1.1, and SynMap v.1.1. The bottom section is titled "BrainMap Web Application" and describes the online application for searching the database.

brainmap.org

Home About Metadata Publications Results Contact

Announcements - October 2, 2019

BrainMap has released Version 1.1 of its software (Slauth, GingeALE, and SynMap). With the release of this version, we require that you manually log in Slauth with your username and password, even if you previously ran the software to remember these fields. This is a required action, since we are moving from an old version of the Oracle Database to an improved database, under the new database structure, it is now possible to perform all ALE and DR searches at the Experiment level. This facilitates faster processing in obtaining search results.

Also in Version 1.1, we have released a new **SLAUTH** interface, used for viewing ALE results. This interface displays a small detail in the previous interface and offers a better representation of Talairach space. We also updated the results in GingeALE to match the revised template. GingeALE automatically changes the mask to match ALE results. Thus, if you were viewing ALE files that were created prior to this release, GingeALE will update the mask that was previously implemented. Nevertheless, to ensure that your images are as accurate as possible, we suggest that re-run your meta-analysis using the new mask templates.

What is BrainMap?

BrainMap is an online database of published functional neuroimaging (fMRI and PET) experiments with coordinate-based (x,y,z) activation locations in Talairach space. The goal of BrainMap is to provide a vehicle to share metadata and results of studies in specific research domains, such as language, memory, attention, emotion, and perception. BrainMap can also be used to perform meta-analyses of similar research studies.

BrainMap was created and developed at the Research Imaging Center of the University of Texas Health Science Center San Antonio (UTHSCSA).

BrainMap Software

There are 3 different applications in the BrainMap software suite:

1. **Slauth**: Application interface and Talairach coordinate pooling (this application requires a username and password)
2. **GingeALE**: performs meta-analyses via the activation likelihood combination (ALE) method, also converts coordinates between MNI and Talairach space using [vbovbo](#)
3. **SynMap**: database entry of published functional neuroimaging papers with coordinate results

BrainMap Web Application

A web application accessing the full set of database search criteria is also available, called **BrainMapWeb**. After a login, a list of statistics

Slauth v.1.1

GingeALE v.1.1

SynMap v.1.1

- a database of functional neuroimaging results
- a comprehensive tool for ALE meta-analyses
- Has coordinate data from studies

www.brainmap.org

Sleuth

**brainmap.org**

home forum icbm2tal publications credits contact

Sleuth Version 1.2

Sleuth is the BrainMap application that is used to search for papers of interest, read their corresponding meta-data, and plot their results as coordinates on a standard glass brain in Talairach space.

**Sleuth**

Sleuth is broken into four main panels: Search, Search Results, Workspace, and Plot.

Downloads (Updated 20.Aug.2009)

 [Download Mac](#)

 [Download PC](#)

 [Download Other](#)

Username and Passwords

To use Sleuth, please [apply for an account](#) to BrainMap. Your information will be kept confidential and you will not receive any unsolicited email.

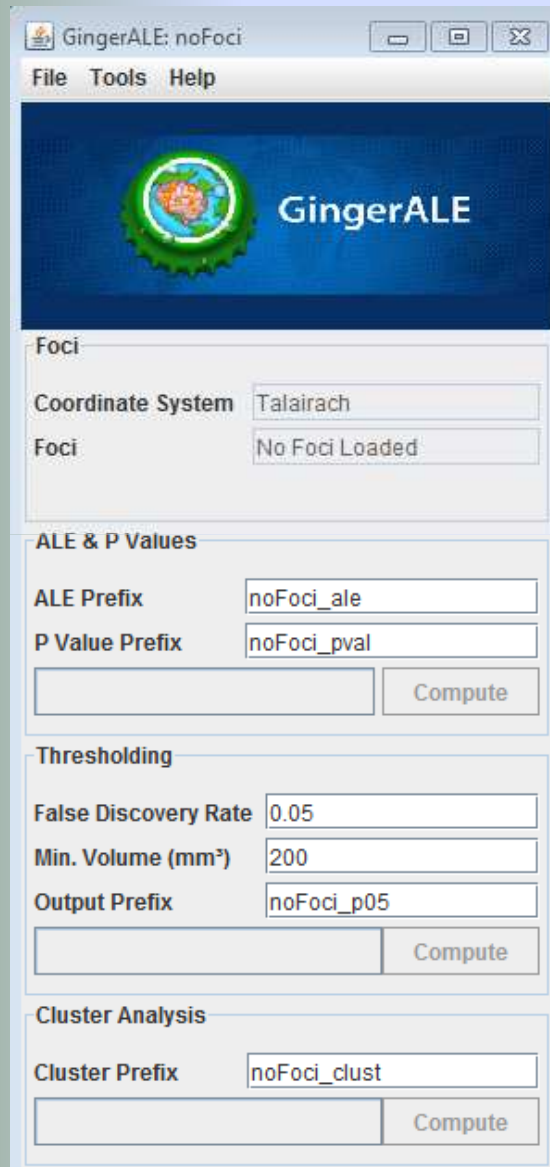
After receiving your account information, you may [change your password](#).

Forgot your password? [Tell us](#) and we will email it to you.

Documentation

<http://brainmap.org/sleuth/index.html>

GingerALE



- Definition of inclusion/exclusion criteria
 - Stereotaxic space (Talairach or MNI)
- Literature search
- Create a text file with all published coordinates
- GingerALE performs analysis for you!

<http://brainmap.org/ale/index.html>