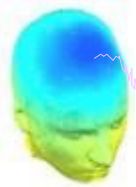
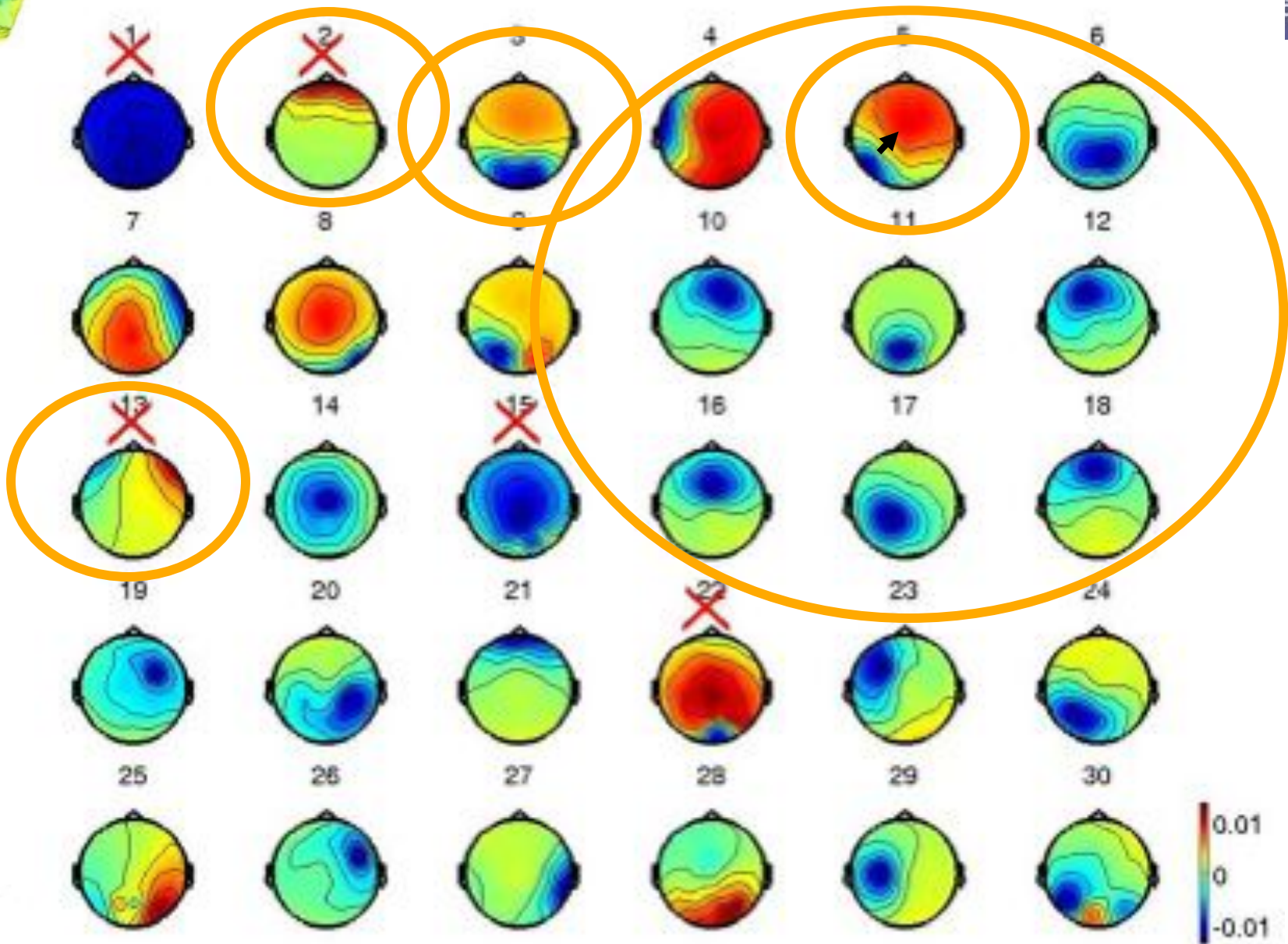


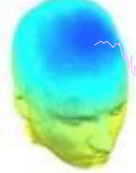
Effective Source Clustering





Largest 30 ICs (single subject)

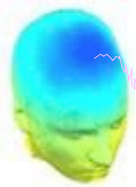




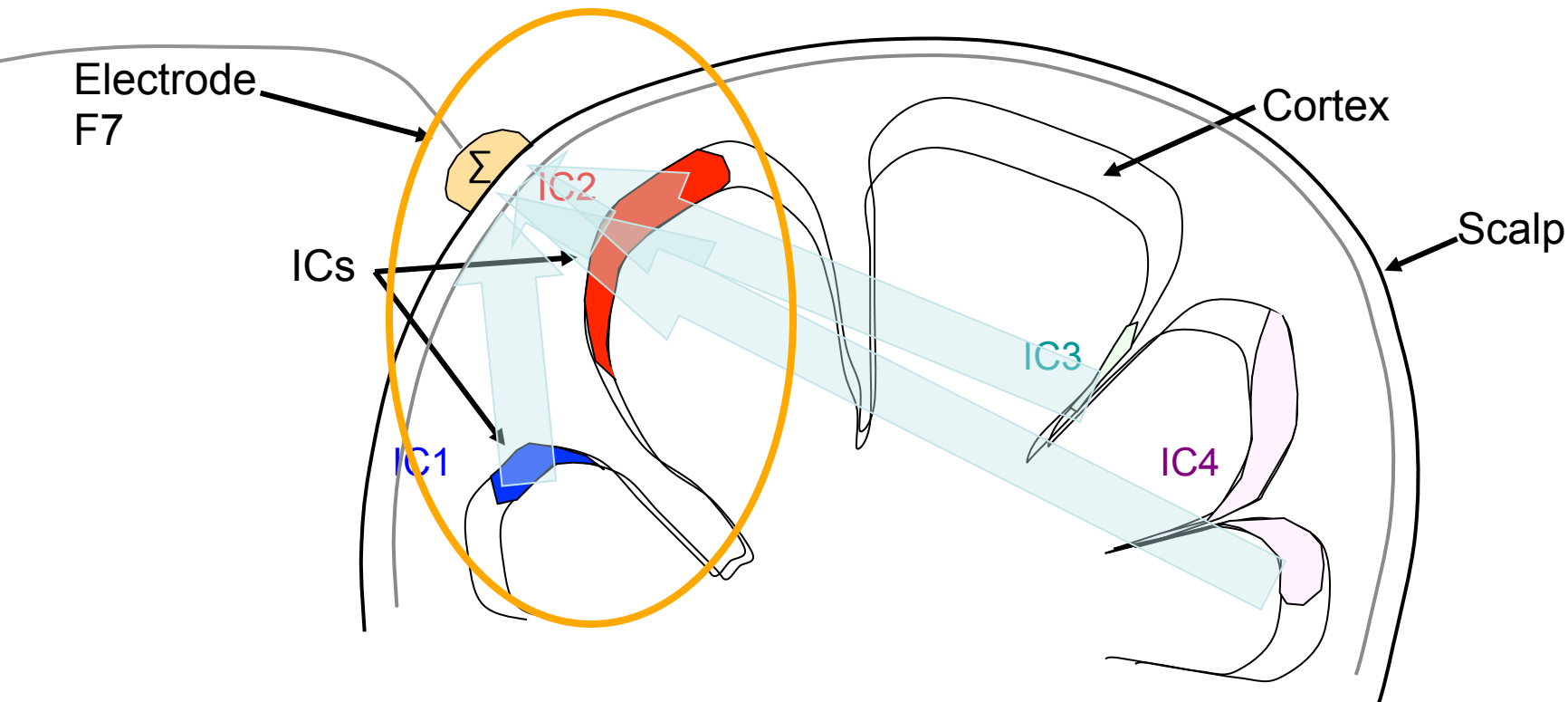
Why cluster independent components across subjects or sessions?

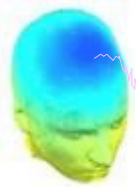


- ICA transforms the data from a channel basis (activity recorded at each channel)
- to a component basis (activity computed at each IC).
- Normally, EEG researchers assume that electrode, say channel F7 == F7 == F7 ... in each subject and then 'cluster' their data [***“Your Cz = My Cz.”***]
- But this is only ***roughly*** correct!

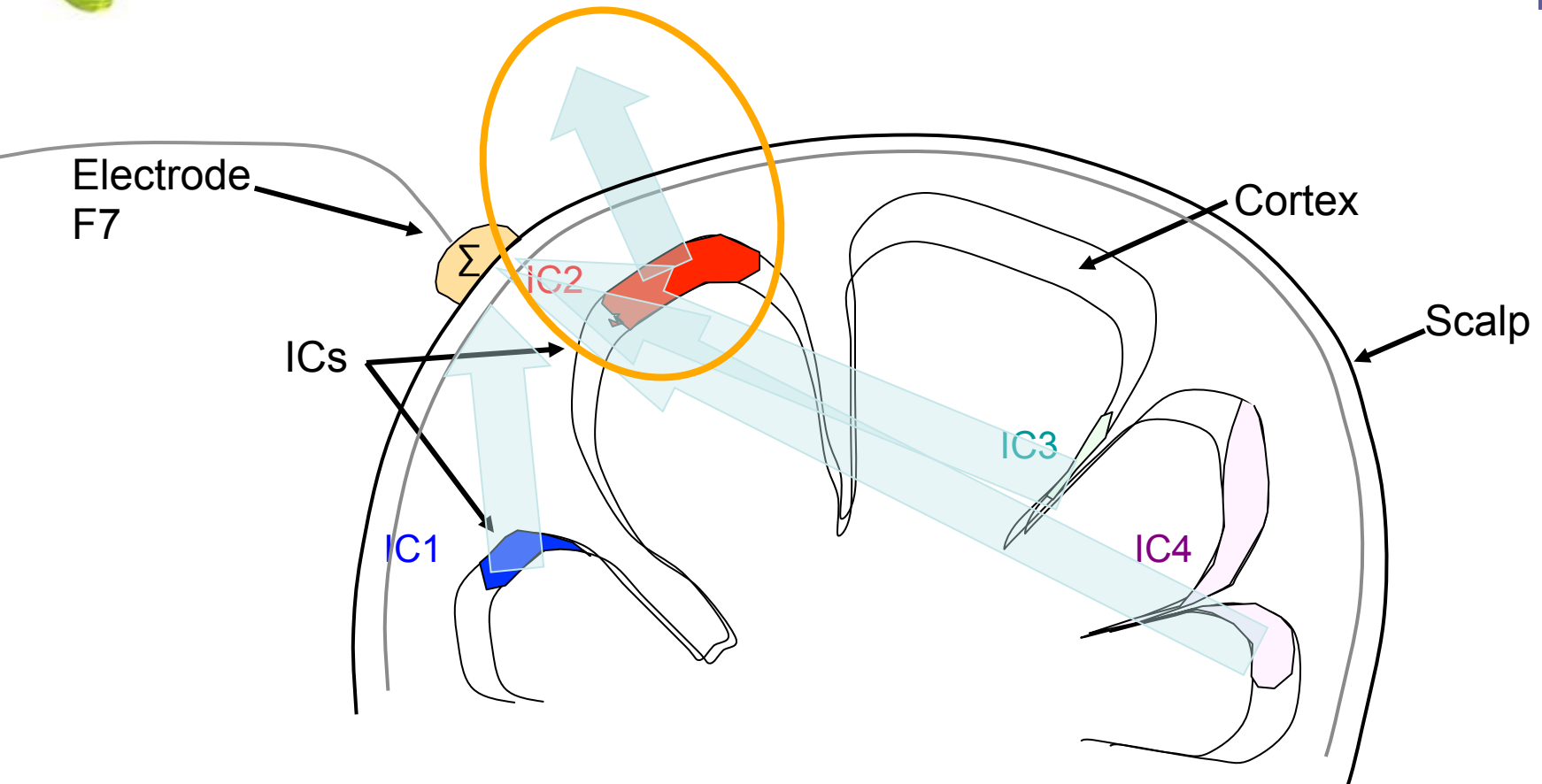


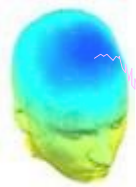
Example: First Subject



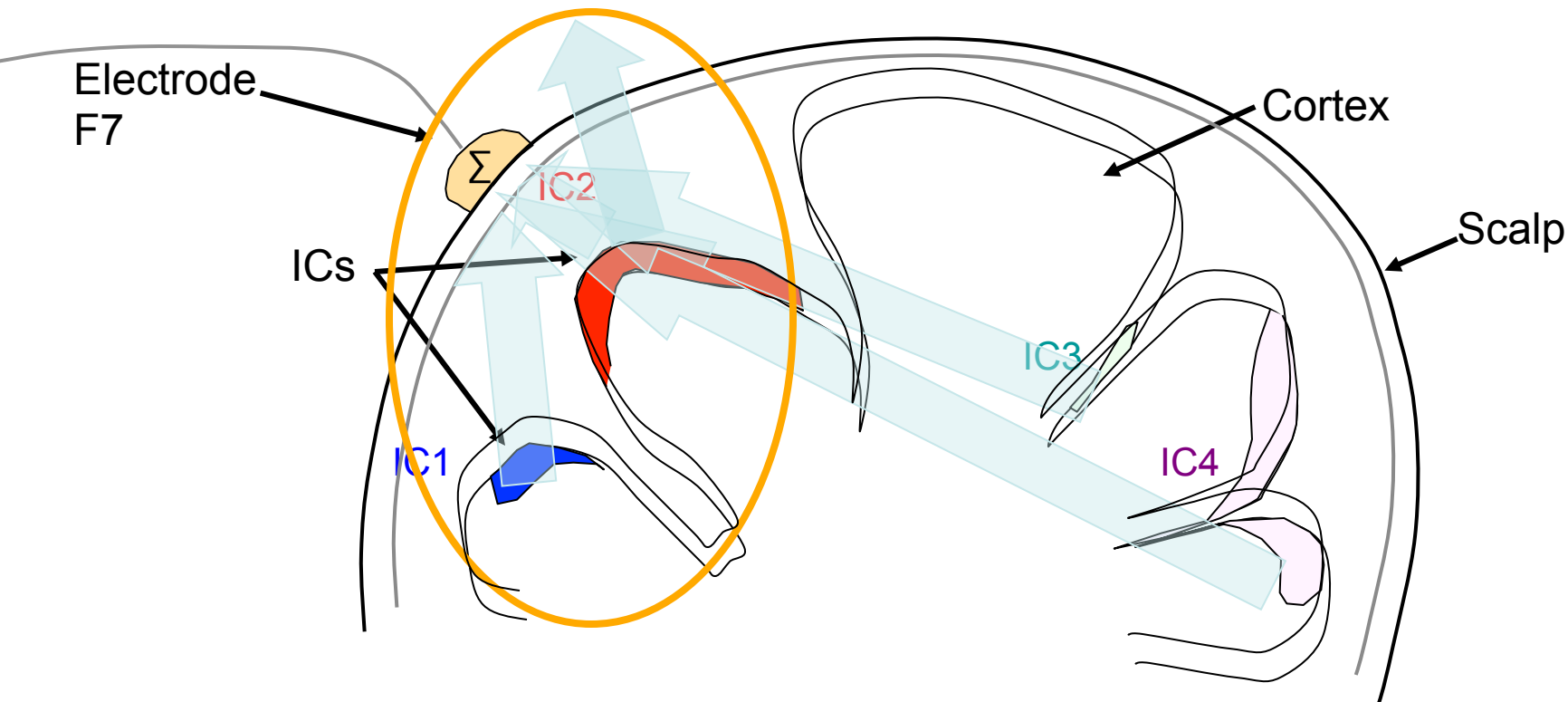
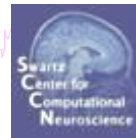


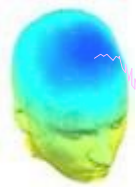
Seond Subject



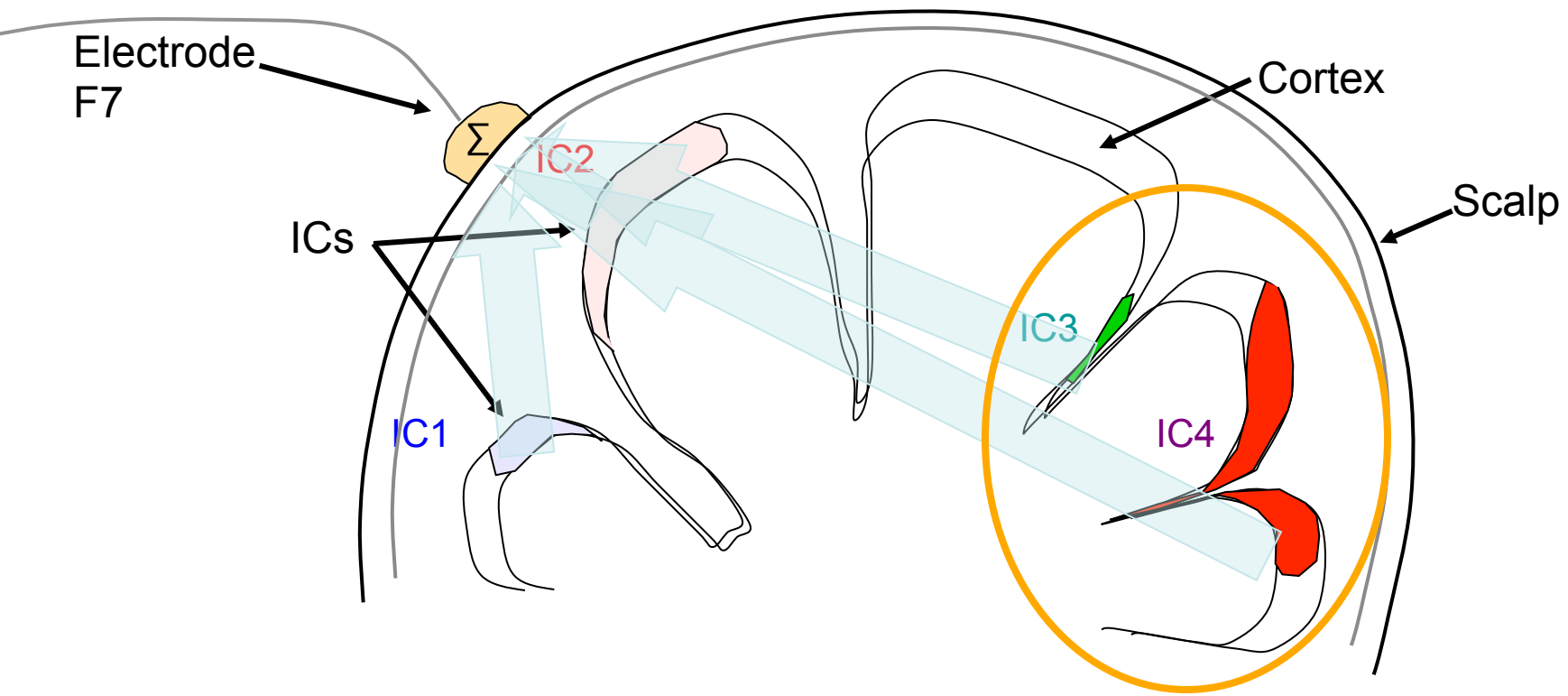
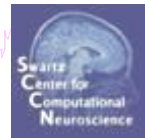


Third Subject





Fourth Subject

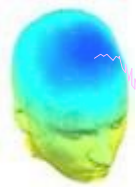


No more than
~30% of any
scalp channel
variance is
produced by any
one brain source!



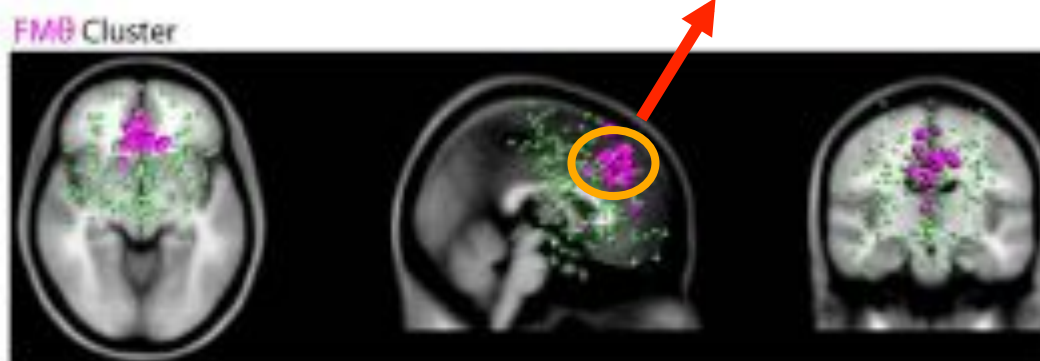
Scalp EEG signals are strong brain
source mixtures.

In this sense channel signals are
epiphenomena,
& source signals are the EEG
phenomena of interest.

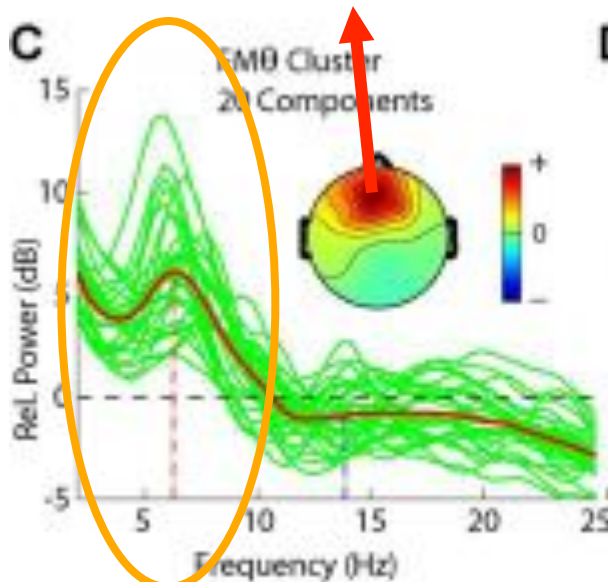


An FM-theta cluster In a working memory task

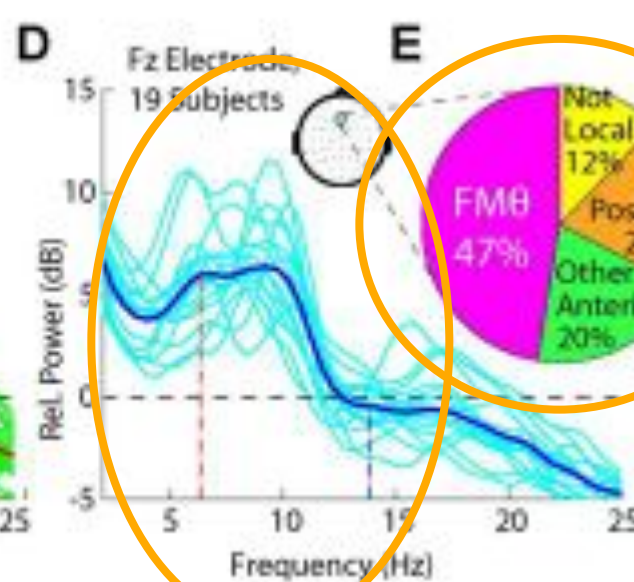
B



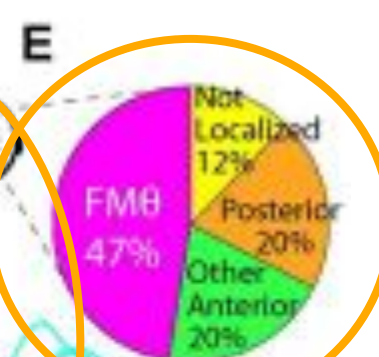
C



D



E



**Arthur Tsai –
Topological
source clustering**

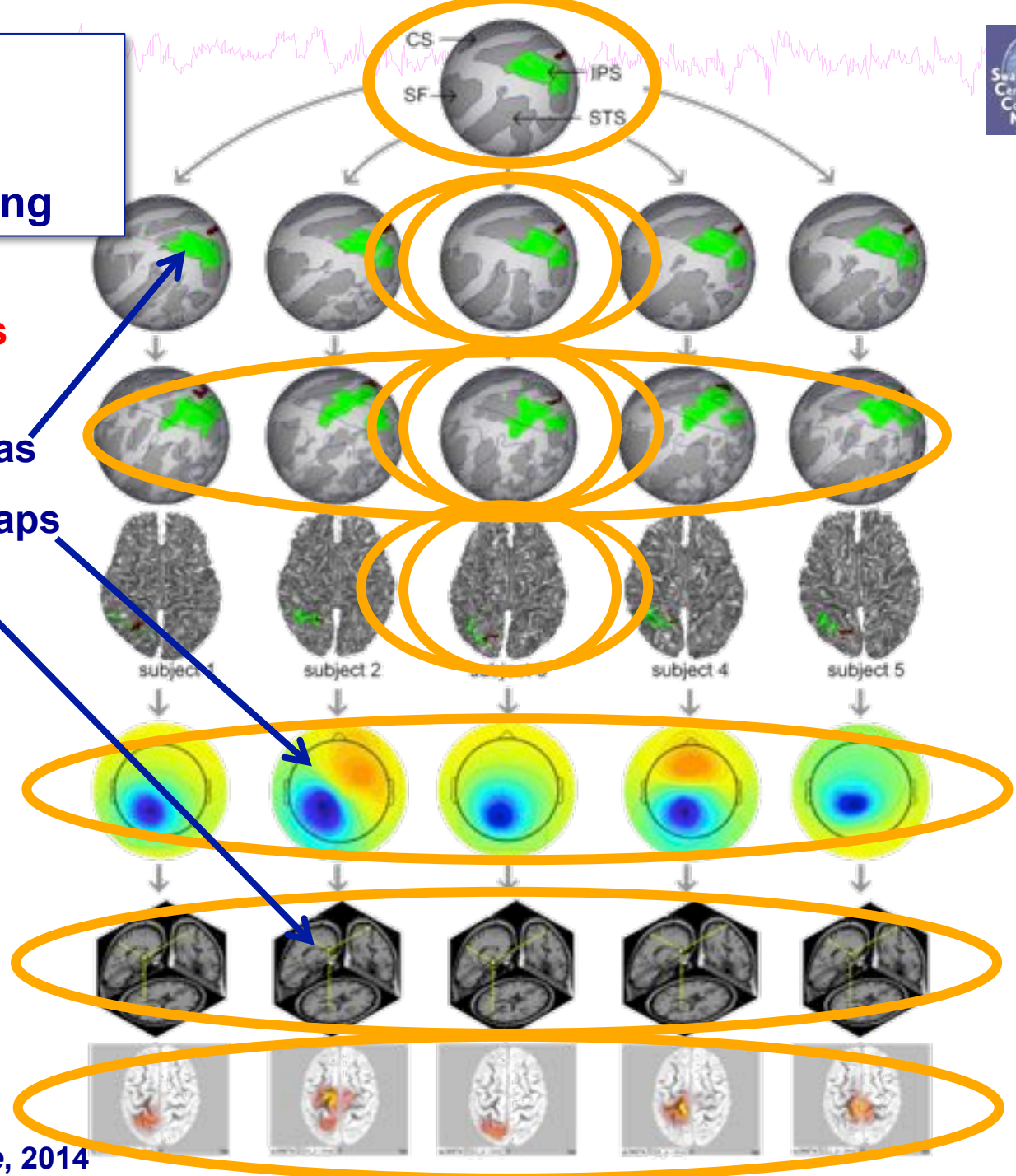


**Why should IC clusters
have width?**

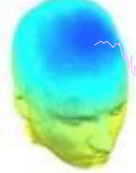
Equivalent cortical areas

Have different scalp maps

And dipole locations!

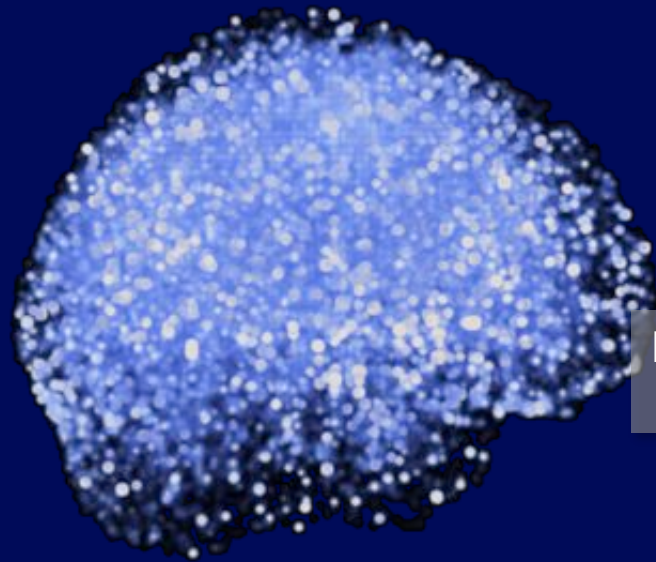


Arthur Tsai et al., *NeuroImage*, 2014

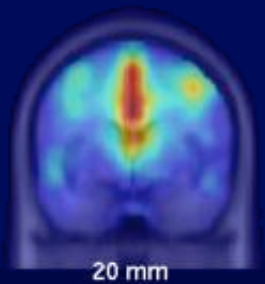
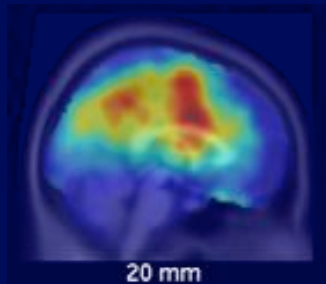


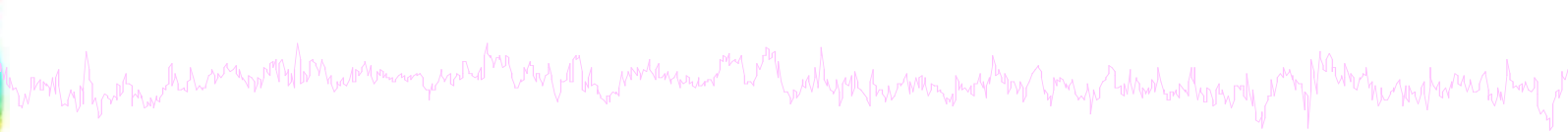
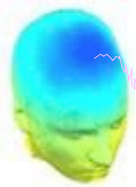
EEG IC Source Locations

(135,794 IC equivalent dipoles)



NB: Width of these hotspots gives a lower bound on source localization accuracy!



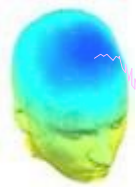


**Does the spatial distribution of IC
equivalent dipole source locations
depend on the task the subject
performs?**

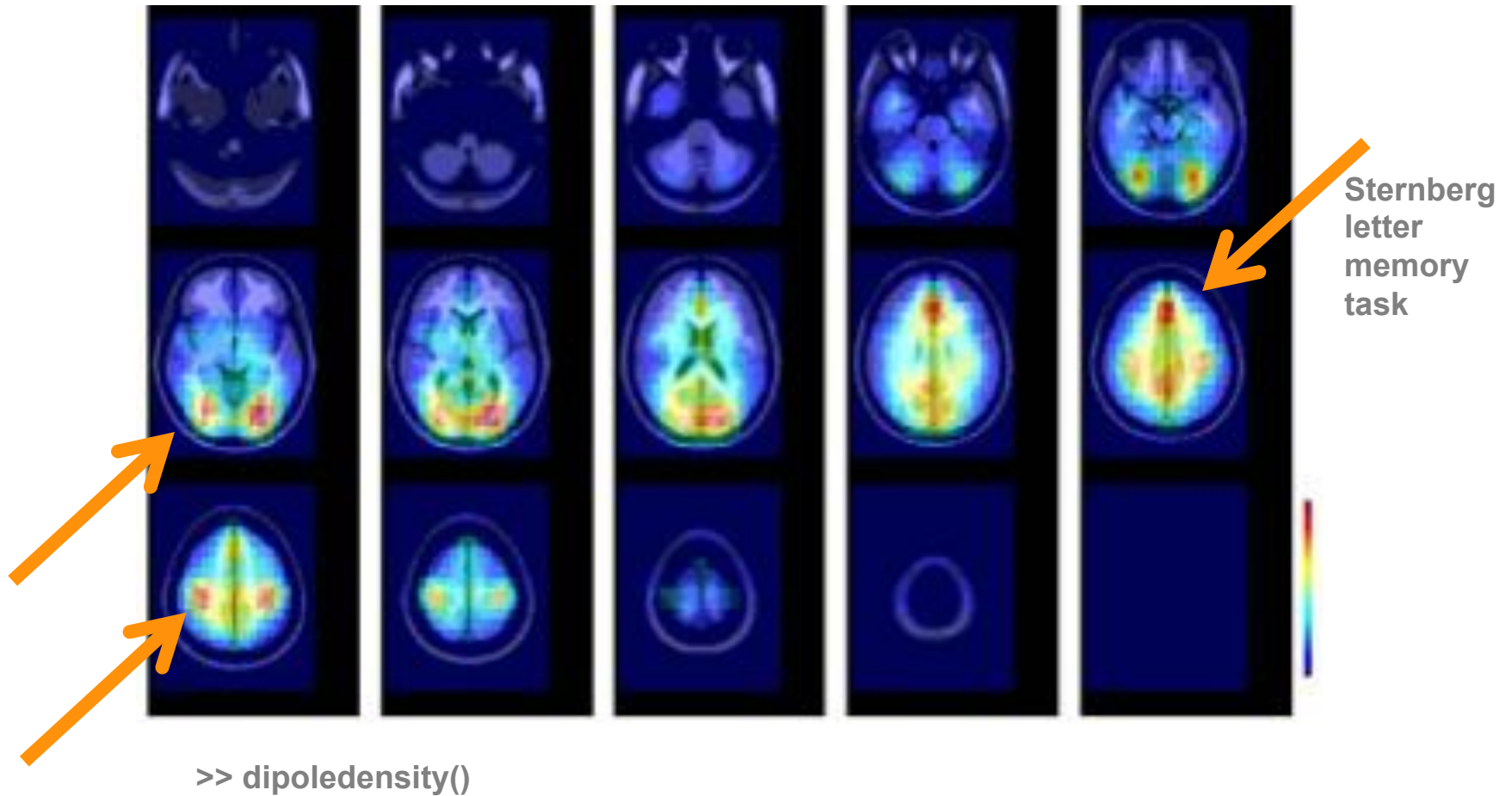
i.e.

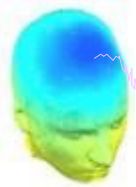
**Do “the same” ICs (& IC clusters)
appear for every task?**



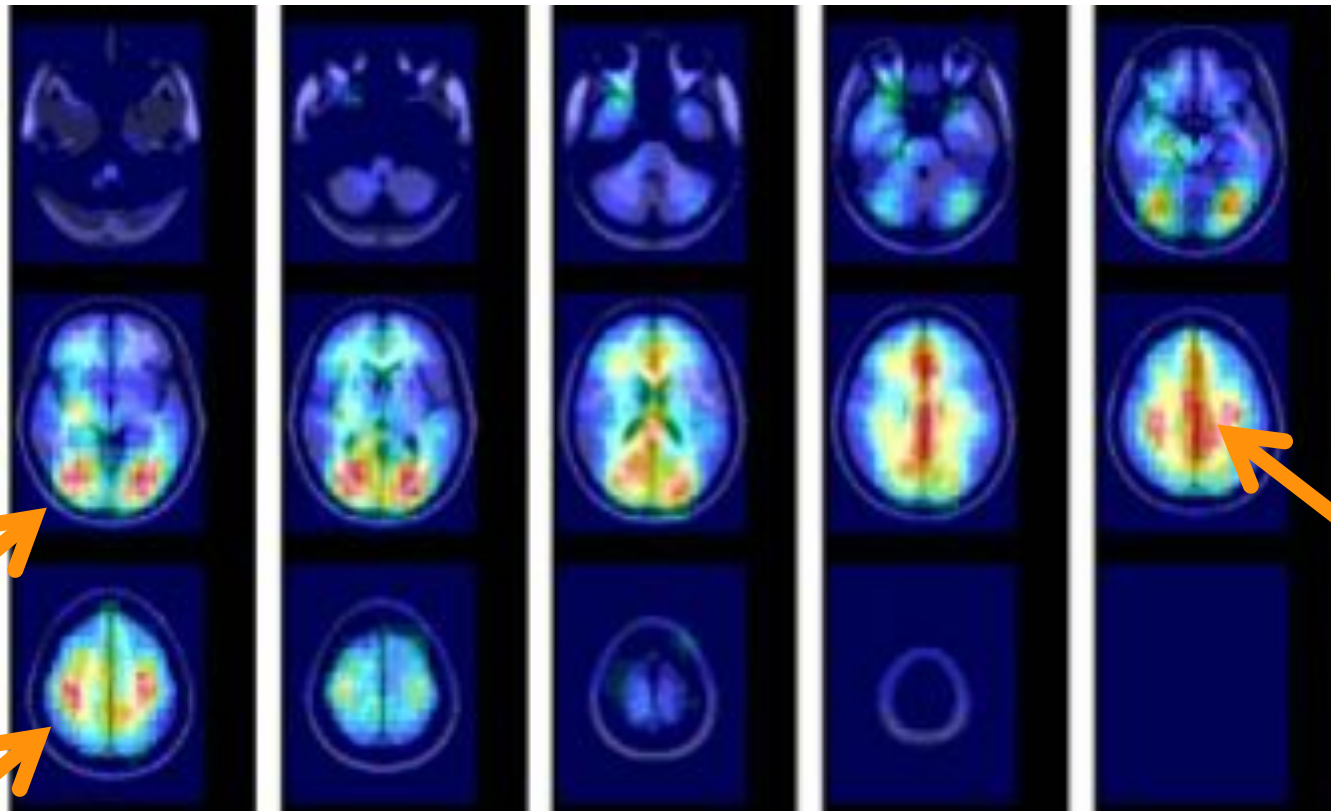


Equivalent dipole density



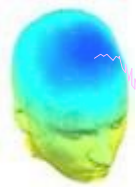


Equivalent dipole density

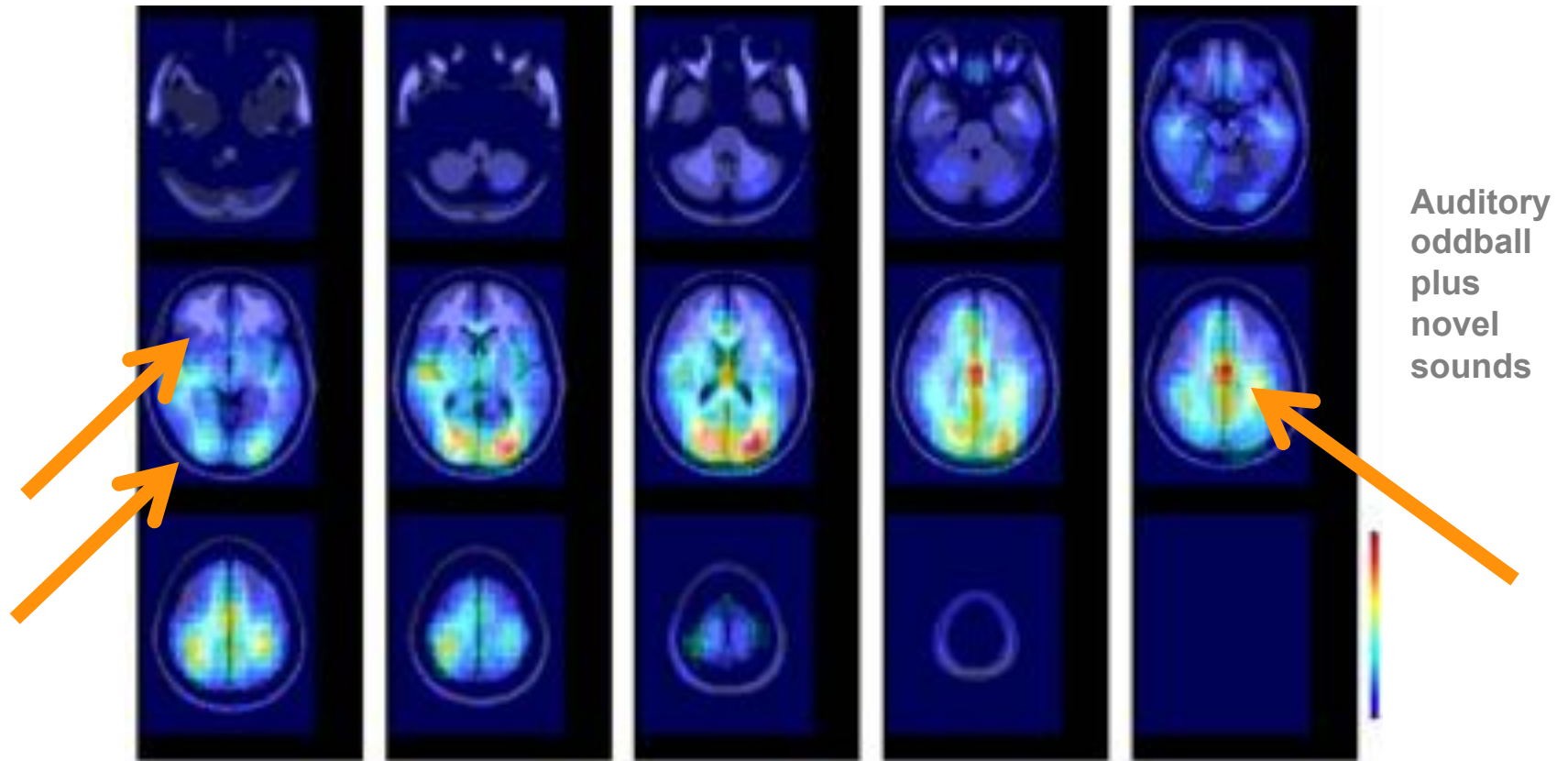


Letter
two-back
with
feedback

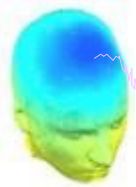
>> dipoledensity()



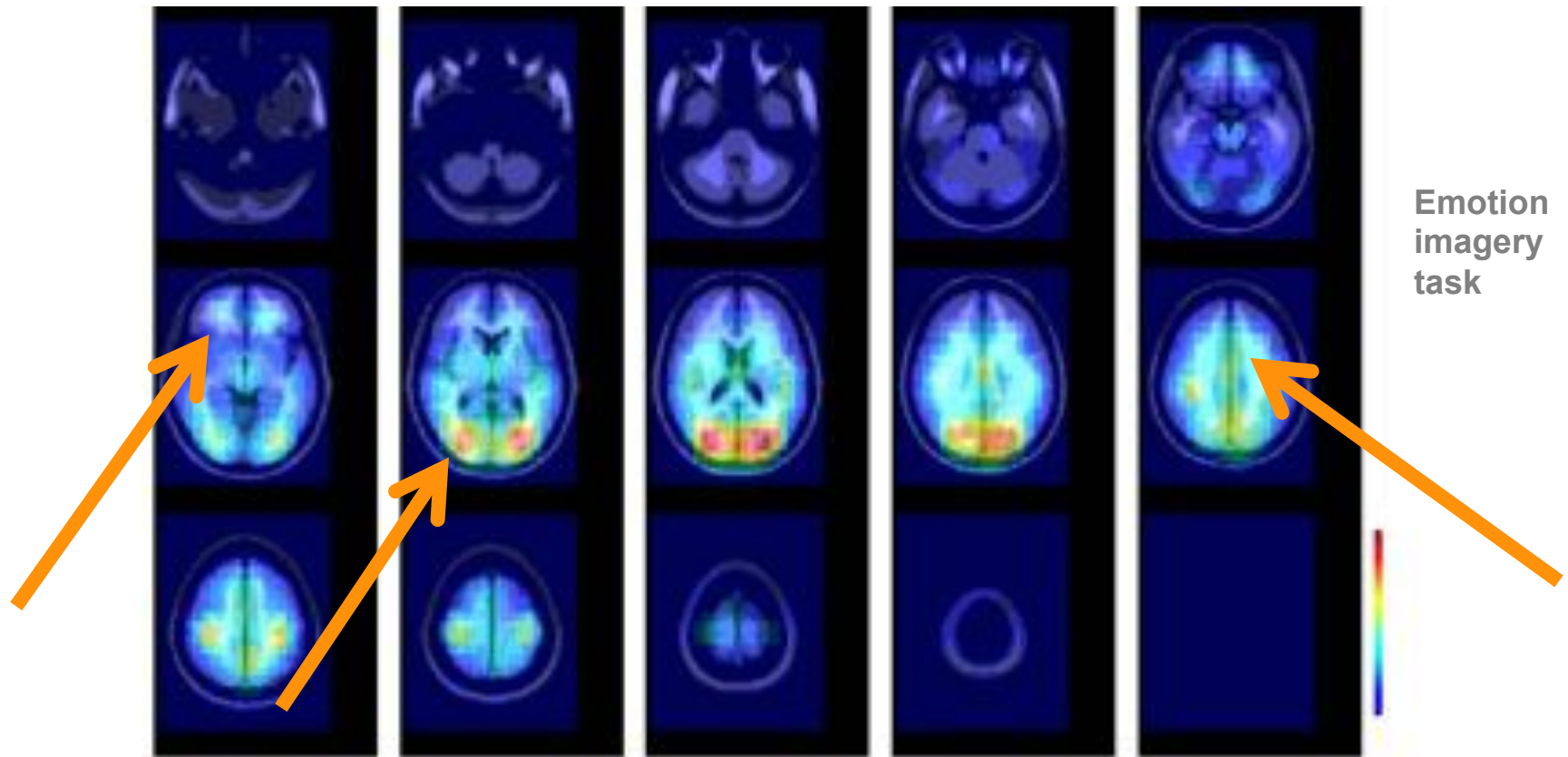
Equivalent dipole density



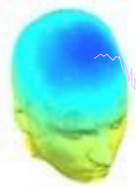
>> dipoledensity()



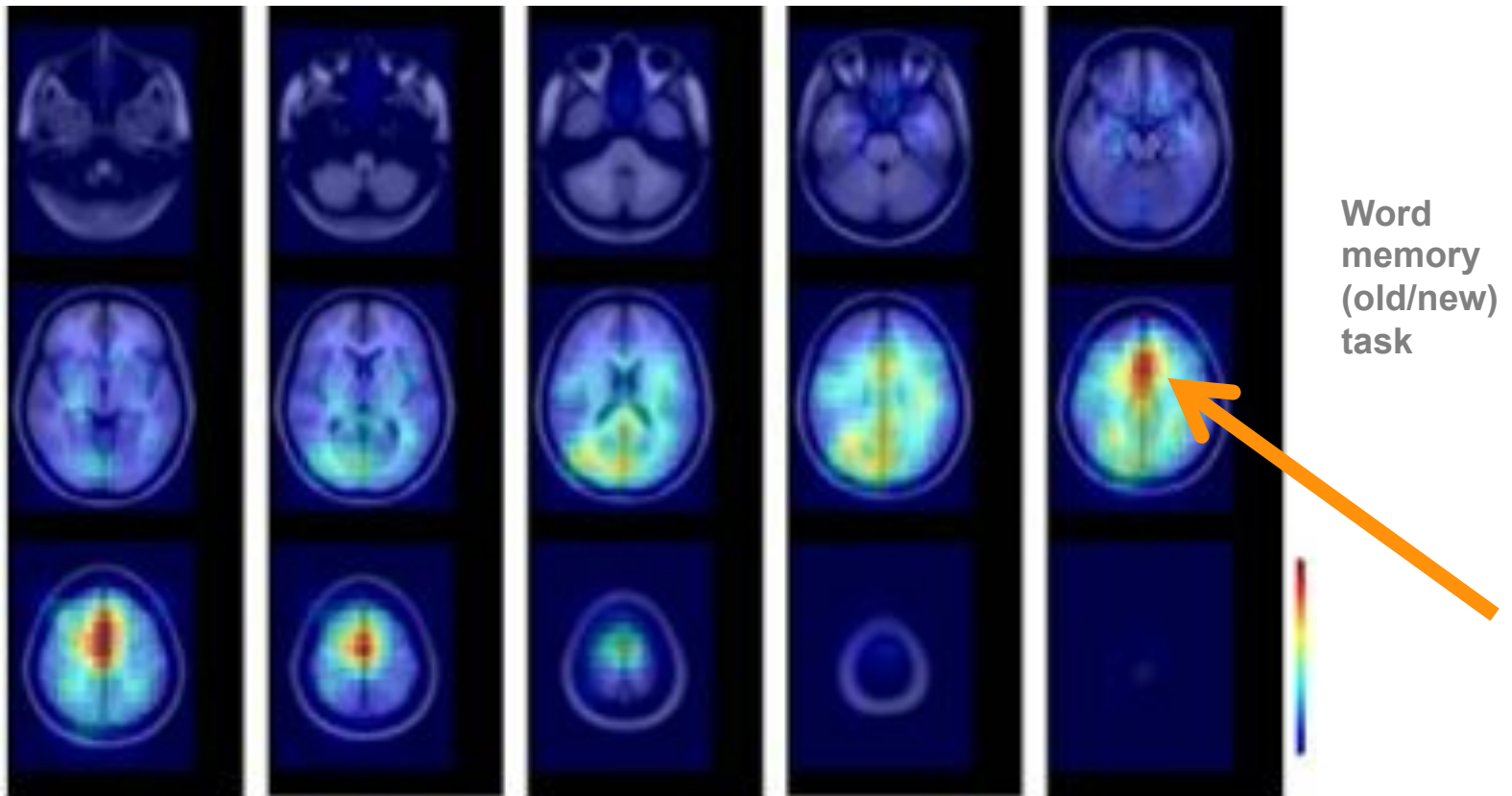
Equivalent dipole density



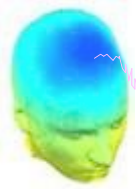
>> dipoledensity()



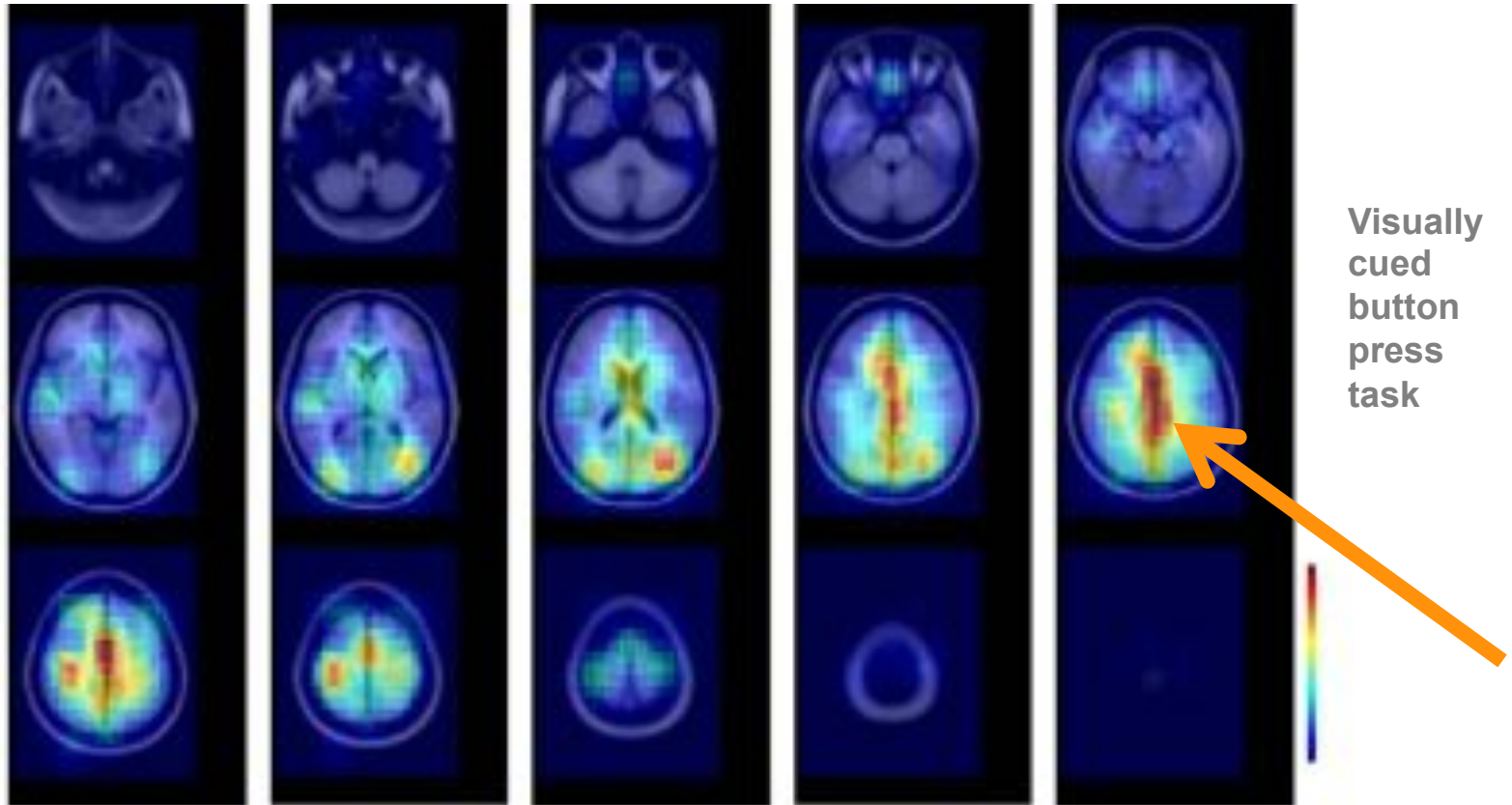
Equivalent dipole density Exp I



>> dipoledensity()



Equivalent dipole density Exp II



>> dipoledensity()



So how to cluster components?

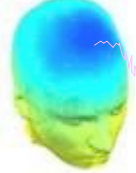


The same problems hold for clustering independent components

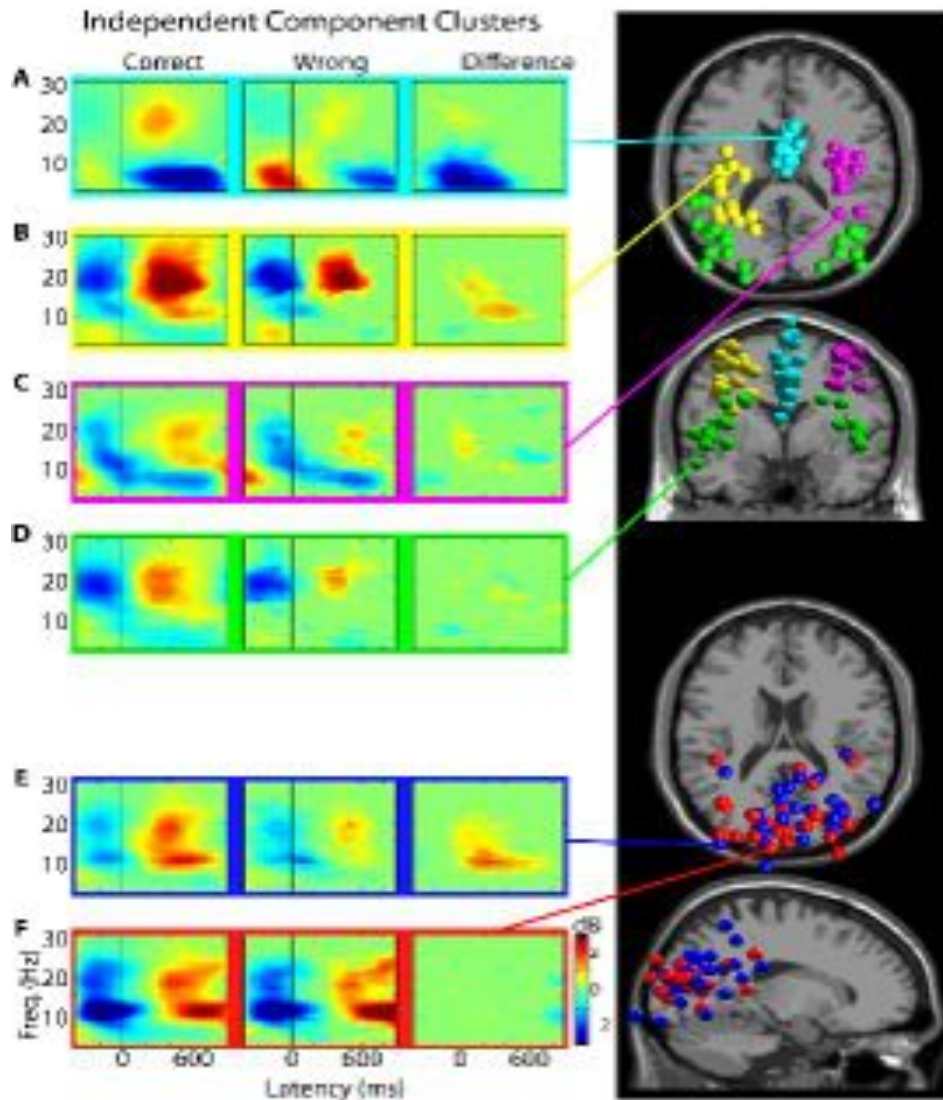
Across Ss, components don't even have “the same” scalp maps!

→ Are “the same” components found across subjects?

- What should define “the same” (i.e., “component equivalence”)?
 - Similar scalp maps?
 - Similar cortical or 3-D equivalent dipole locations?
 - Similar activity power spectra?
 - Similar ERPs?
 - Similar ERSPs?
 - Similar ITCs?
 - Or similar ***combinations*** of the above?? ...

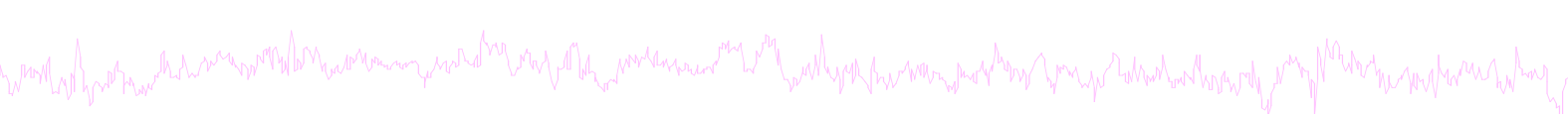


Study IC Clustering



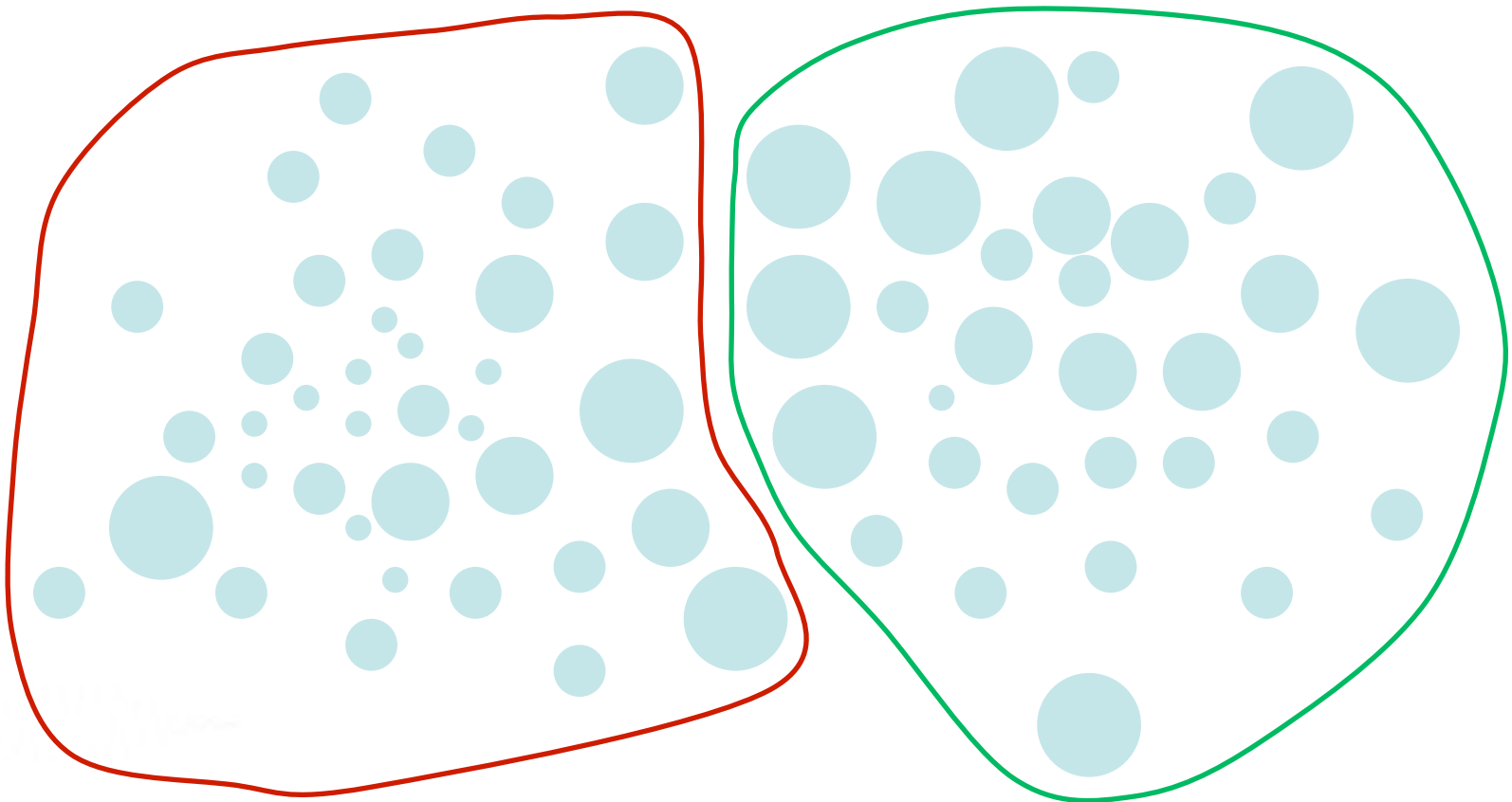
Sometime
clusters are
spatially separate
AND have distinct
responses.

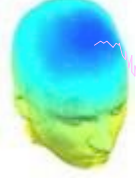
In other cases, they
may have similar
responses or may
overlap spatially.



Problems with multi-measure clustering

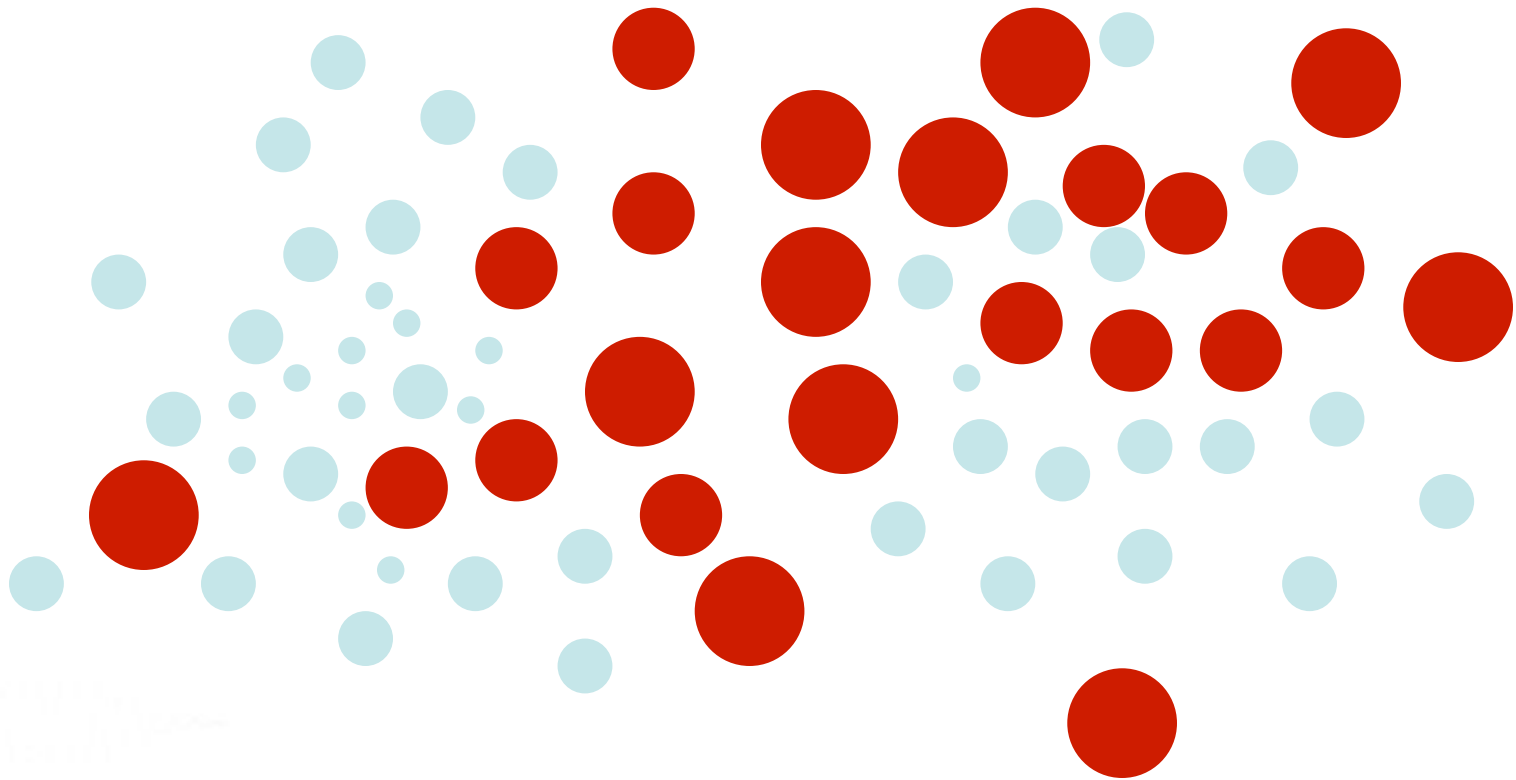
What are the clusters according to location?





Problems with multi-measure clustering

What are the clusters according to size ?

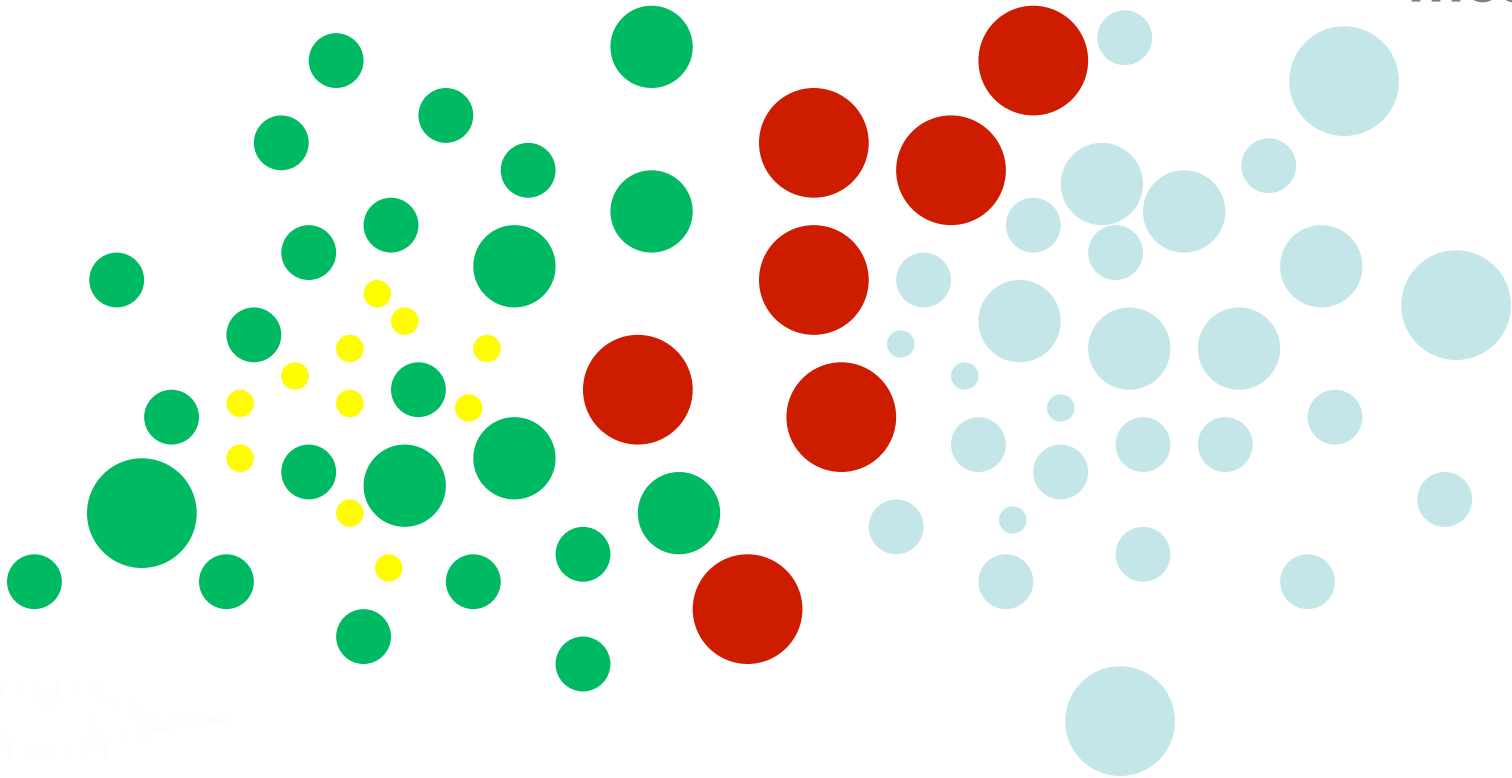


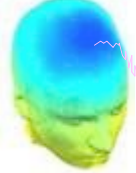


Problems with multi-measure clustering

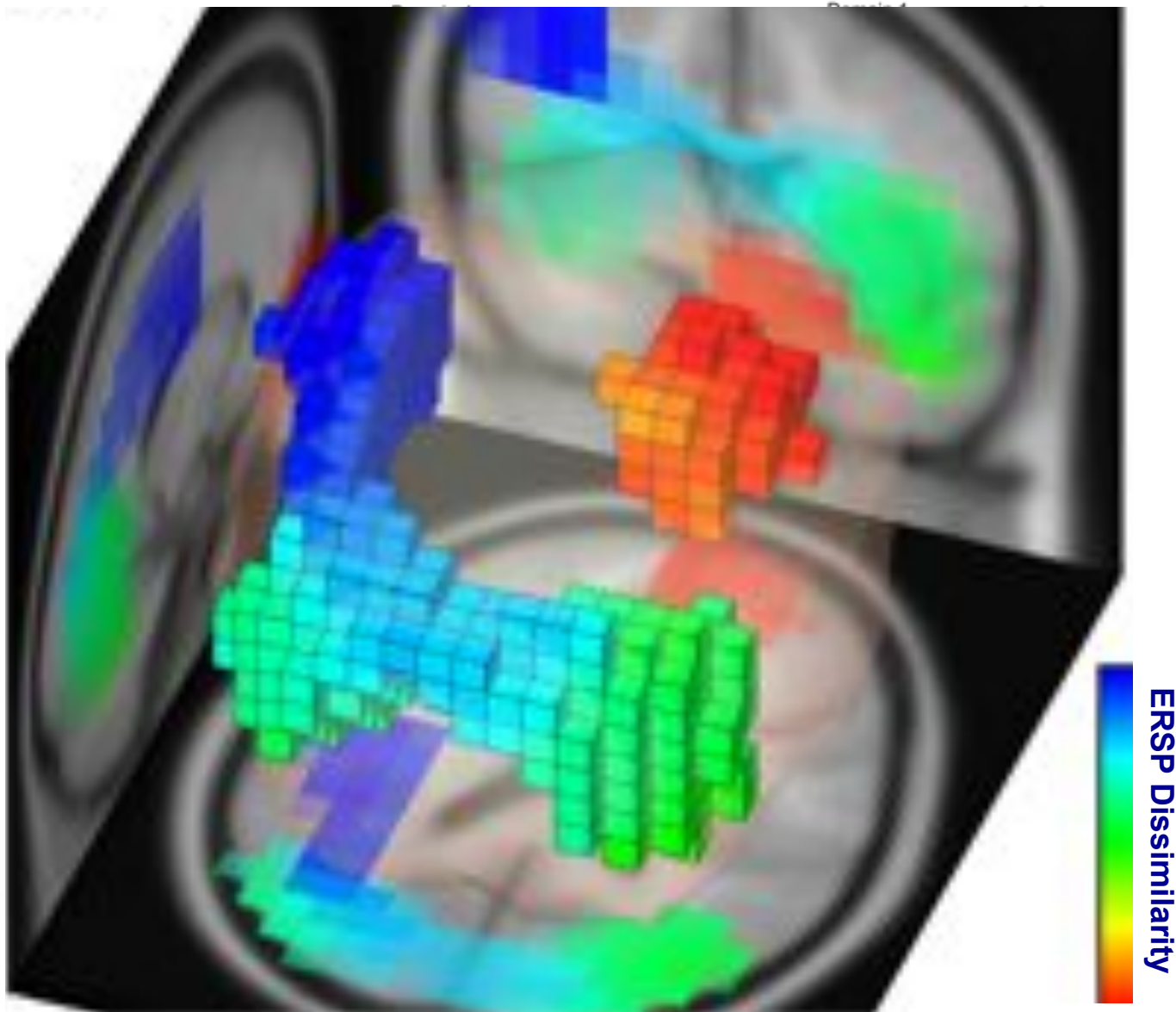
What are the clusters according to location and size?

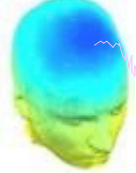
Well, it depends on how much weight we give each measure...





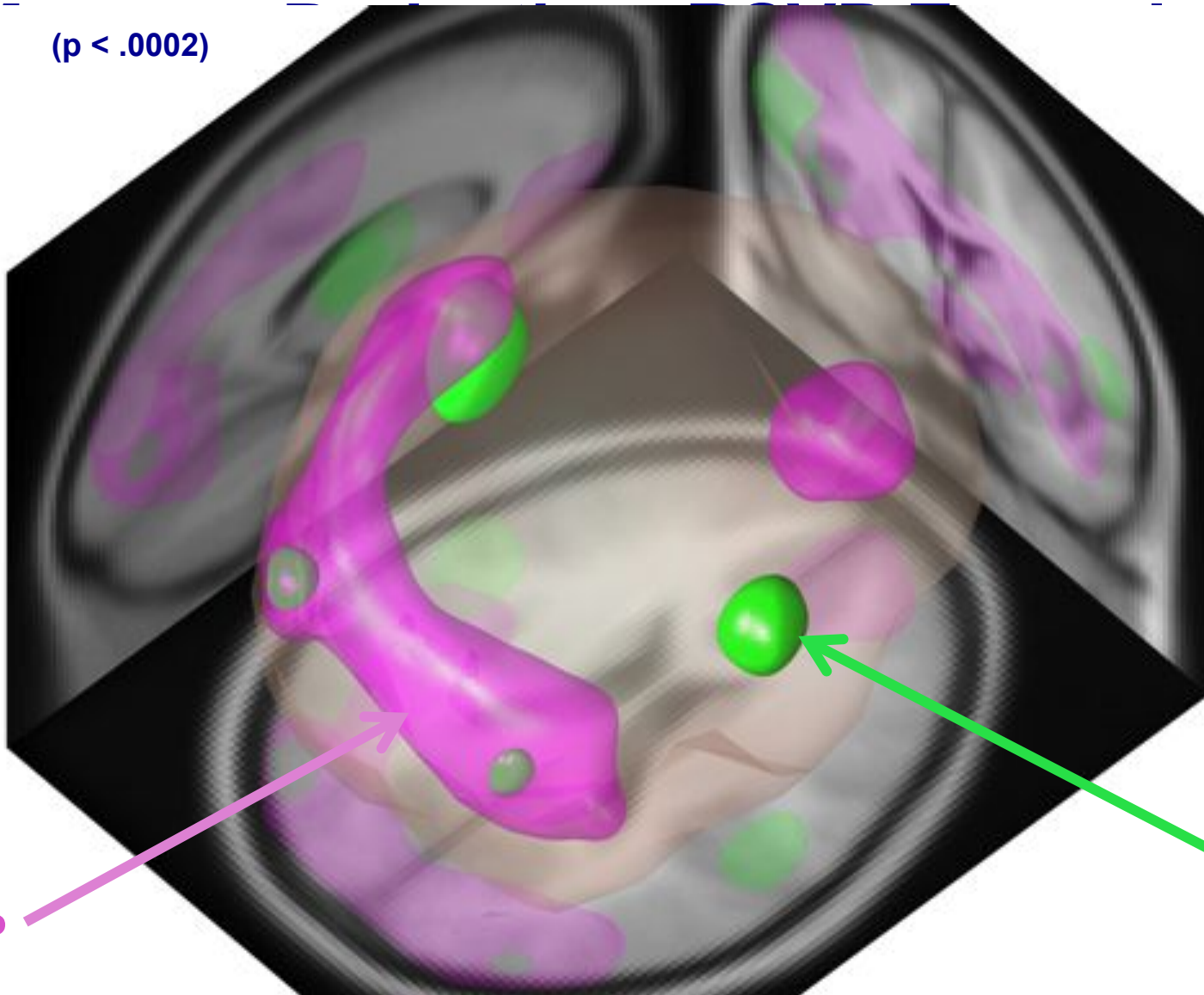
Measure Projection: RSVP Task Example





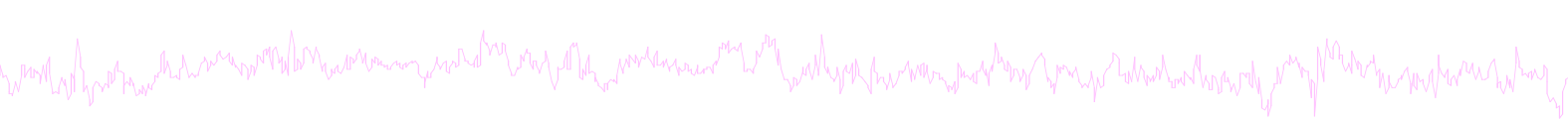
Measure Projection: RSVP Task Example

($p < .0002$)



ERSP

ERP



Questions?





High-Resolution Source Localization

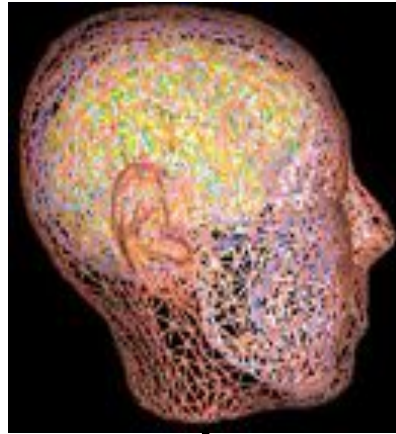


Electromagnetic source localization using realistic head models



NFT

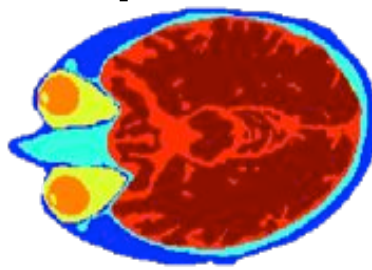
Solve the forward problem using realistic head models (BEM)



Mesh generation



MRI



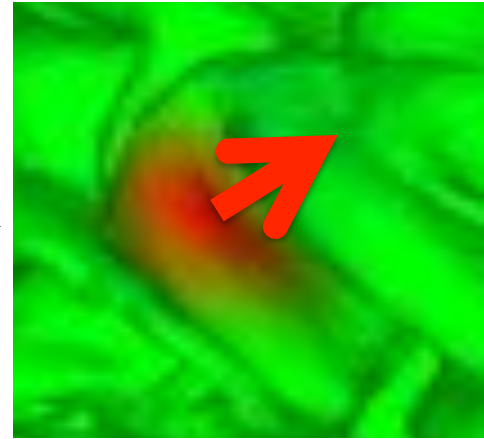
Segmentation

Sensor Localization

Signal Processing

Simple Map

Source Estimate



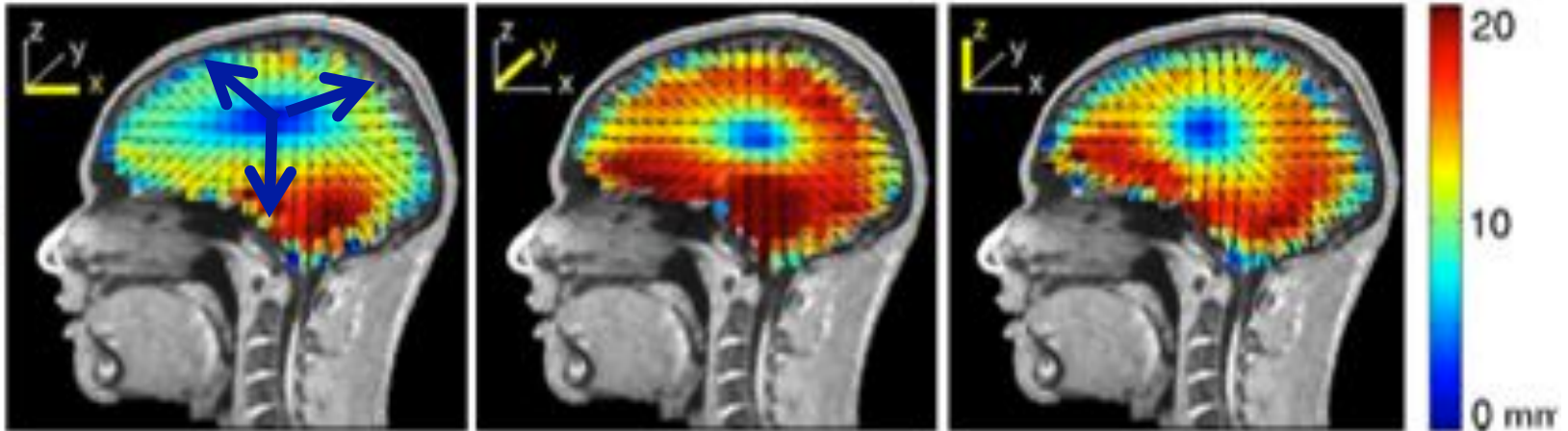
EEG/MEG

Effects of skull conductivity mis-estimation

Simulate 25

$\uparrow \text{RLS}_{25-4}$
 $\downarrow \text{RLS}_{80-4}$

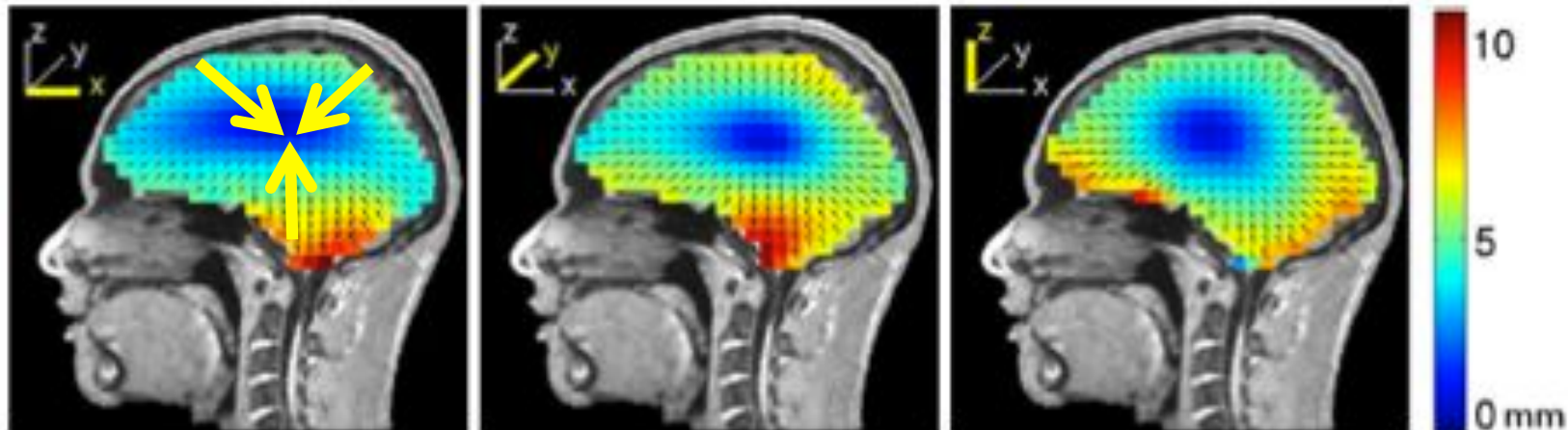
Assume 80

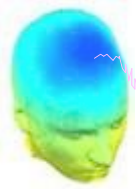


Simulate 25

$\uparrow \text{RLS}_{25-4}$
 $\downarrow \text{RLS}_{15-4}$

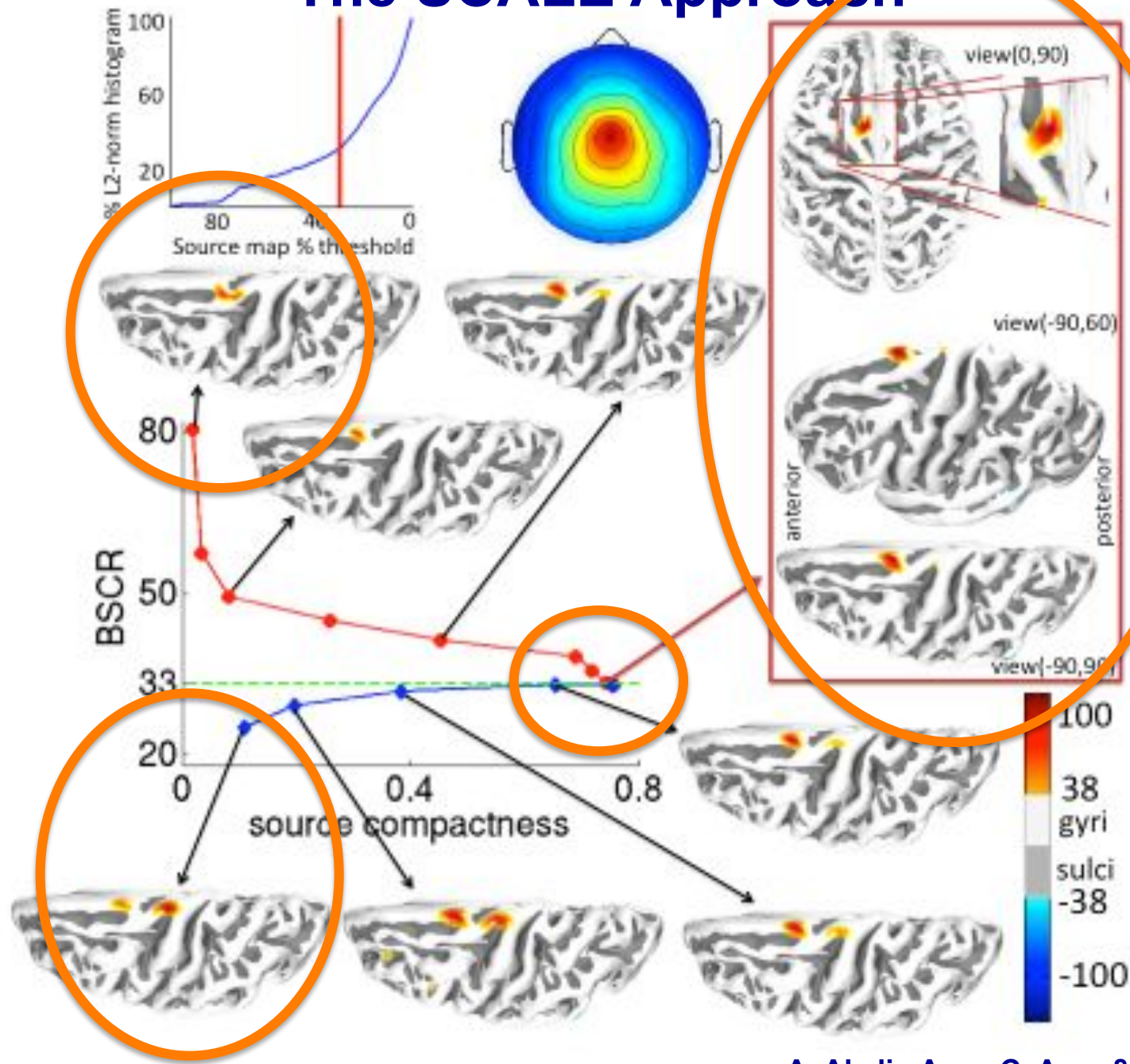
Assume 15



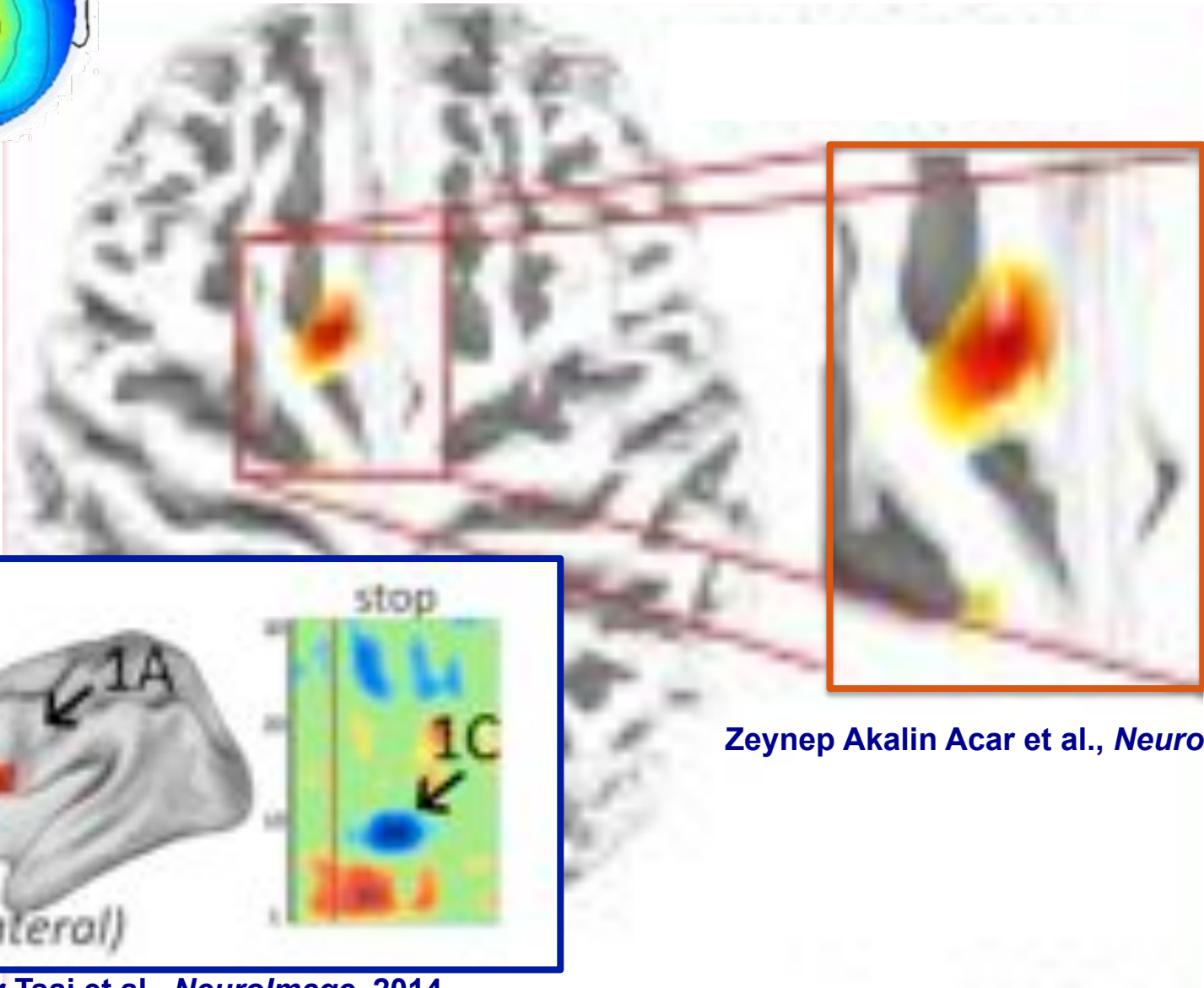


Simultaneous Conductivity And Location Estimation (SCALE)

The SCALE Approach

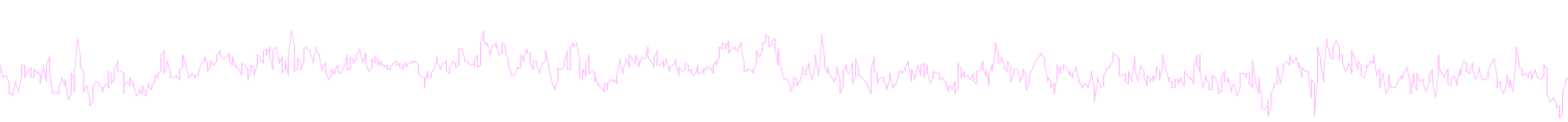


High-resolution source localization



Zeynep Akalin Acar et al., *NeuroImage*, 2016

Arthur Tsai et al., *NeuroImage*, 2014



Questions?

