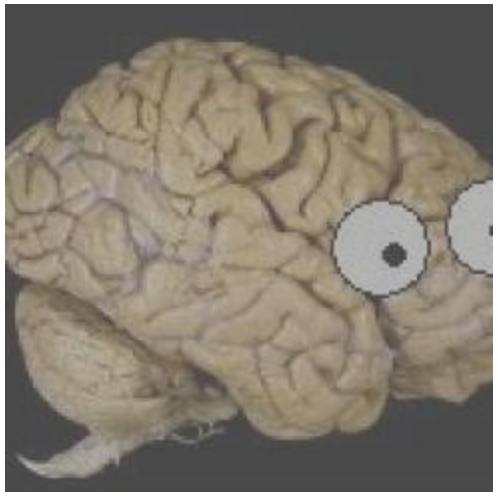

Neuroskeptic

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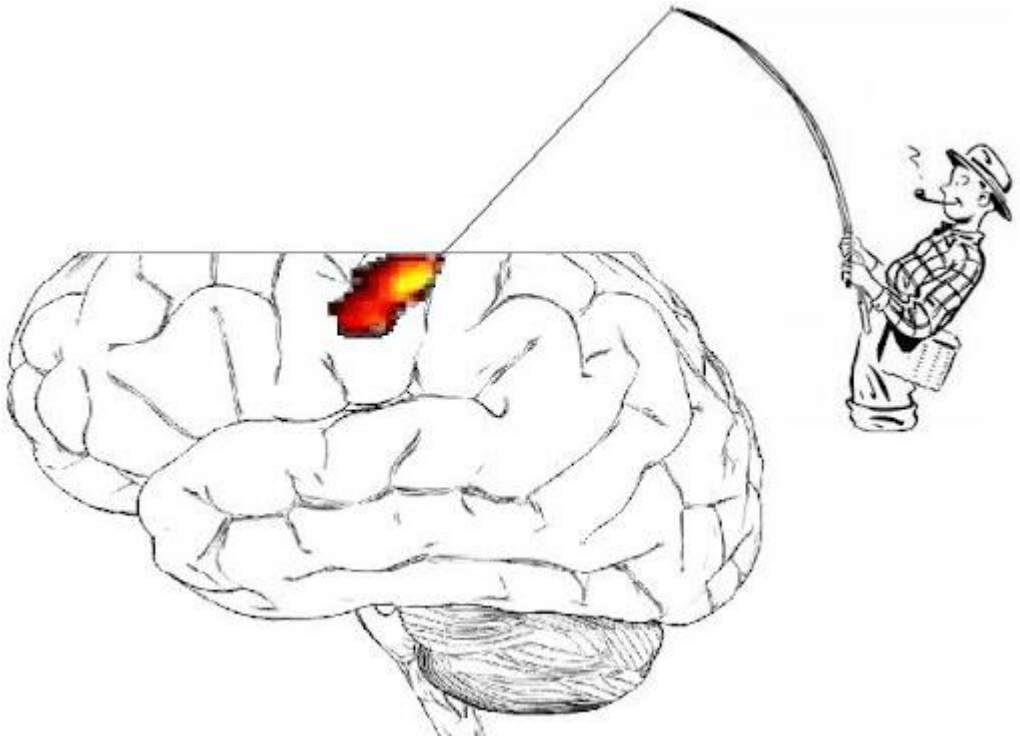
Ban The Blob?

Common pitfalls in interpreting neuroimaging data

Neuroscientists – Fishers of Blobs?



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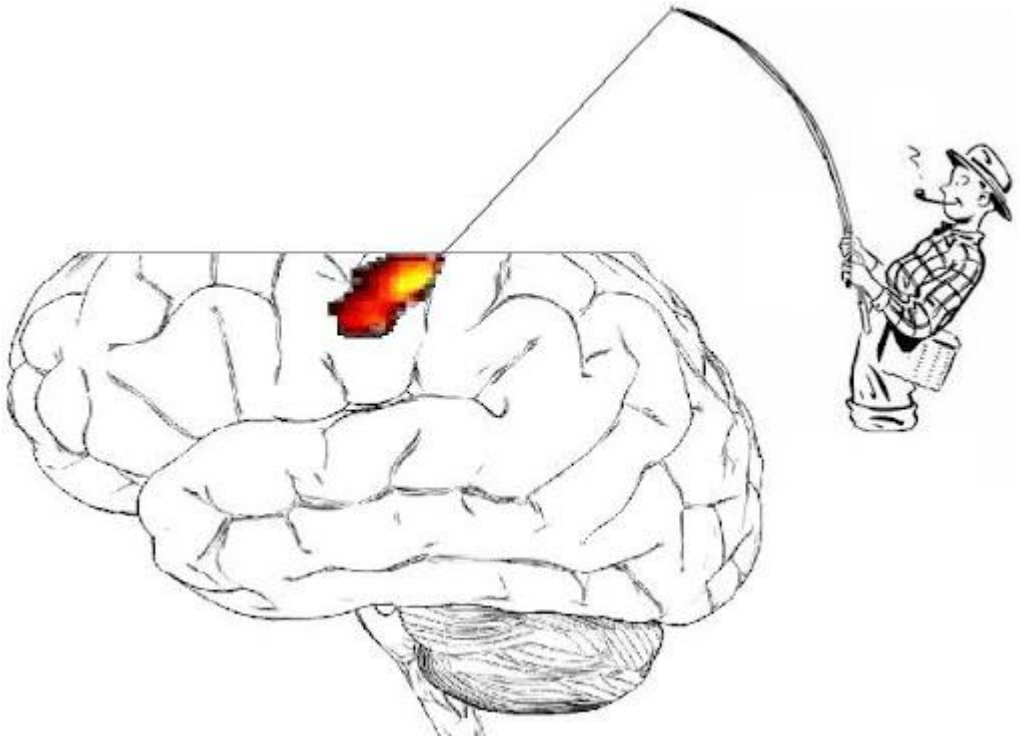

- A blob is a “result” that you can publish

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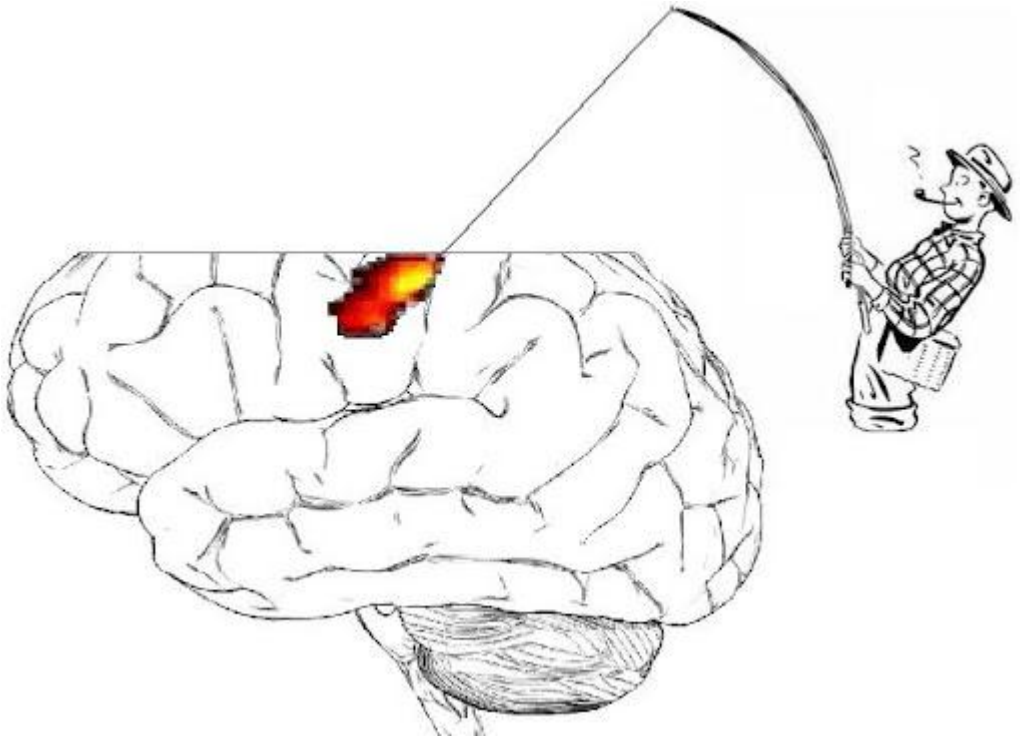

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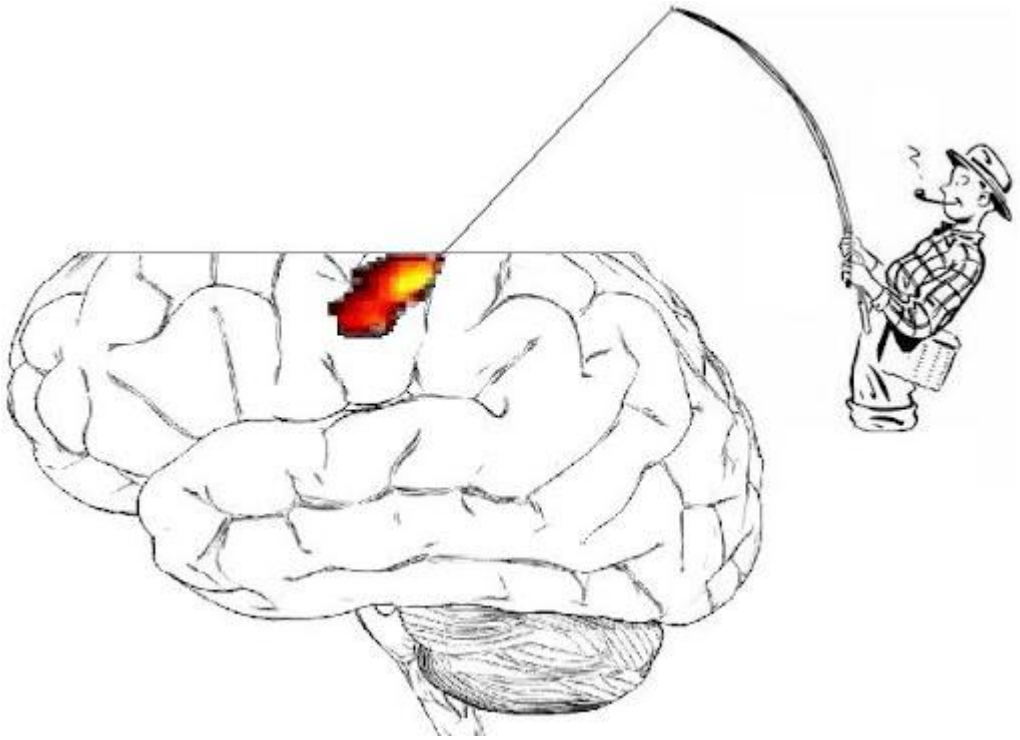
- You should be able to interpret (in terms of localized function) blobs.

Neuroscientists – Fishers of Blobs?



- A blob = a “result” that you can publish.
- You should be able to interpret (in terms of localized function) blobs.
- Blobs are the *first* thing you should look for, and the *final* goal of your analysis

What is an (fMRI) “Blob”?

- An area activated by a task?

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- An area where task-related activity fits a model?

What is a “Blob”?

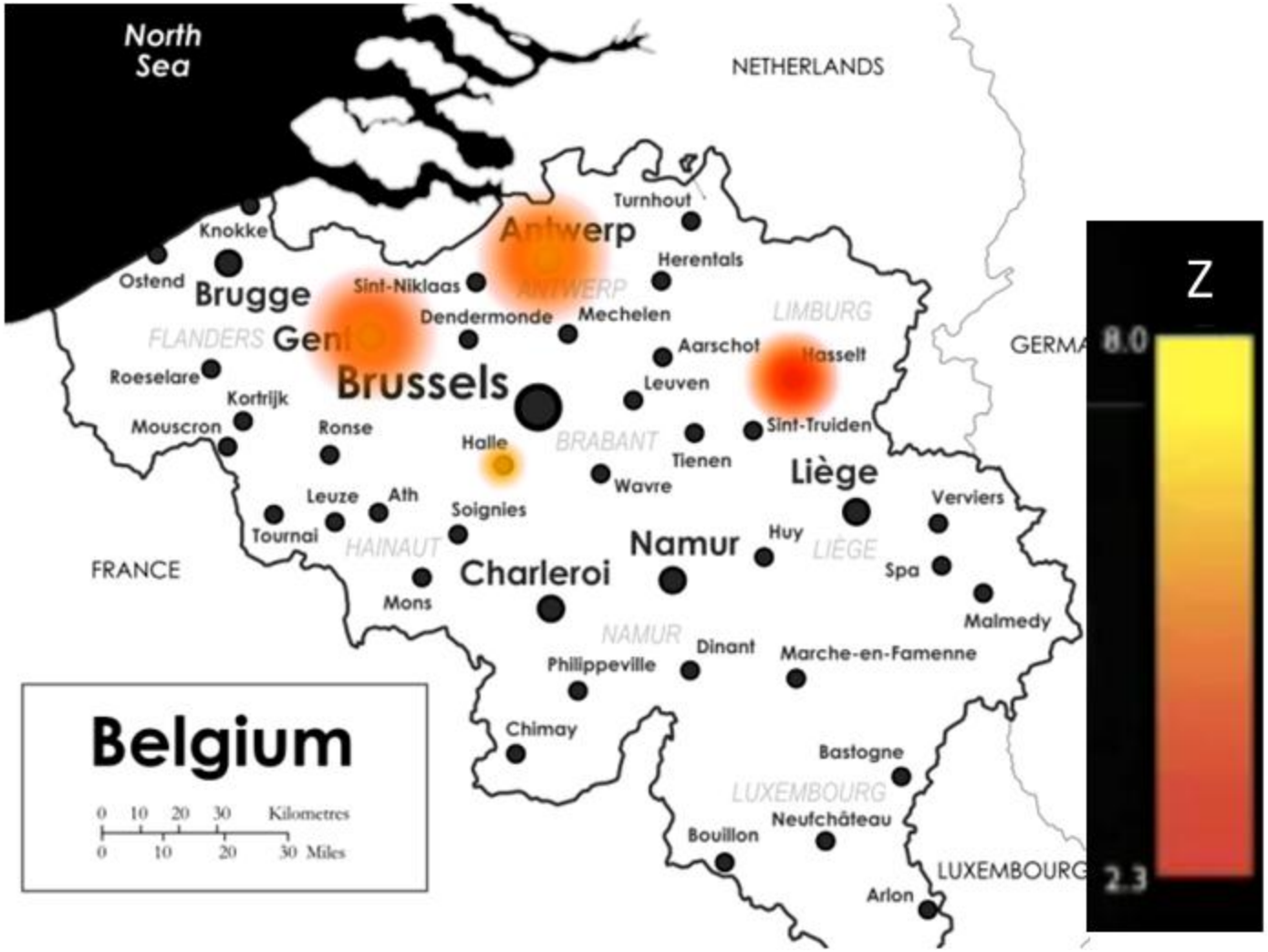
- An area activated by a task?
- An area where task-related activity fits a model?
- An area where task-related activity fits a model well enough to pass an arbitrary threshold.

Belgian Beer Lakes

Imagine A Study...

- We sample 100 people in each of various cities around Belgium: 50 men and 50 women.
- Each person completes an alcoholism questionnaire: “BLoB” (Belgian Liking of Beer) scale.
- We want to know:
  - Do Belgian men like drinking beer more or less than women?
  - If so, where in Belgium this difference is seen?

Would this be the **first way** you'd inspect those results?



Why not?

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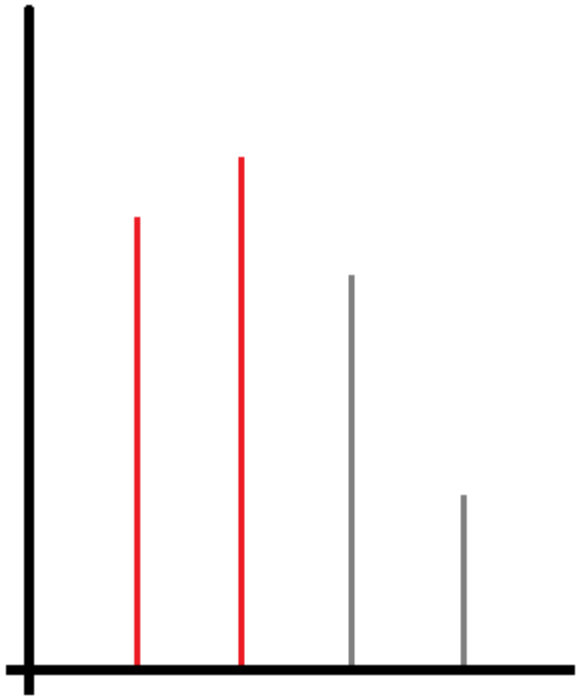
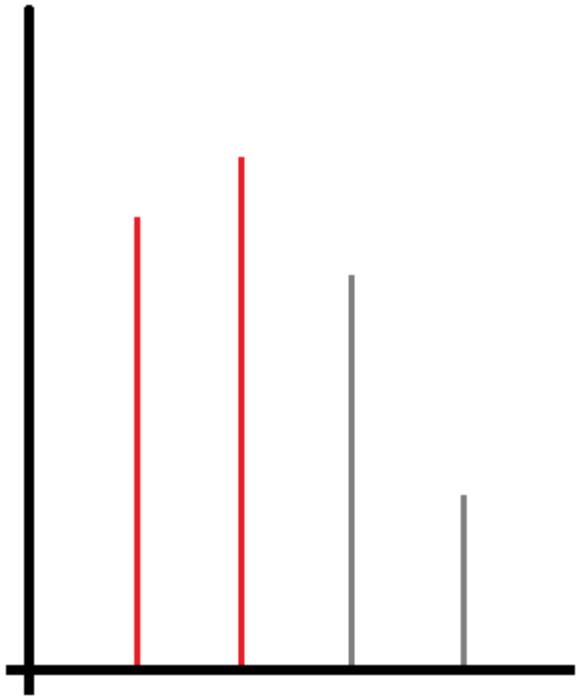
- It conceals the raw data – you only see (effectively) p-values.
- It imposes the arbitrary $p < 0.05$ cutoff and censors all nonsignificant points (even if they are $p = 0.051$).
- We know that blobs are significantly different to some null hypothesis, but we don't know whether each blob is *significantly more significant* than any non-blob point.

Erroneous Analysis of Interaction

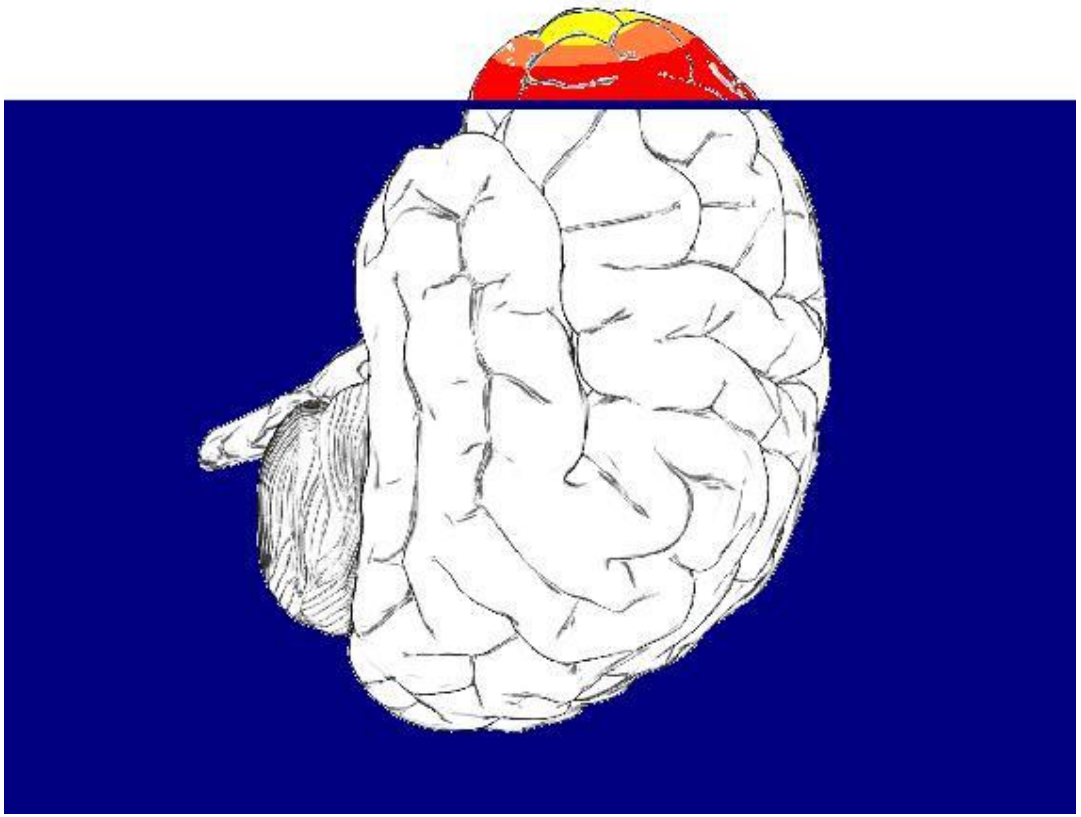


Erroneous Analysis of Interaction



- Nieuwenhuis, Forstmann & Wagenmakers (2011) Nat Neurosci 14 (9) Erroneous analysis of interactions in neuroscience

What About The Rest of the Brain?



- Thyreau et al 2012 *Neuroimage*
- N=1326 fMRI study of a face processing task (emotional faces vs. grey circles)
- Multicenter IMAGEN consortium.
- Results:

With Enough Subjects, The Whole Brain is A Blob

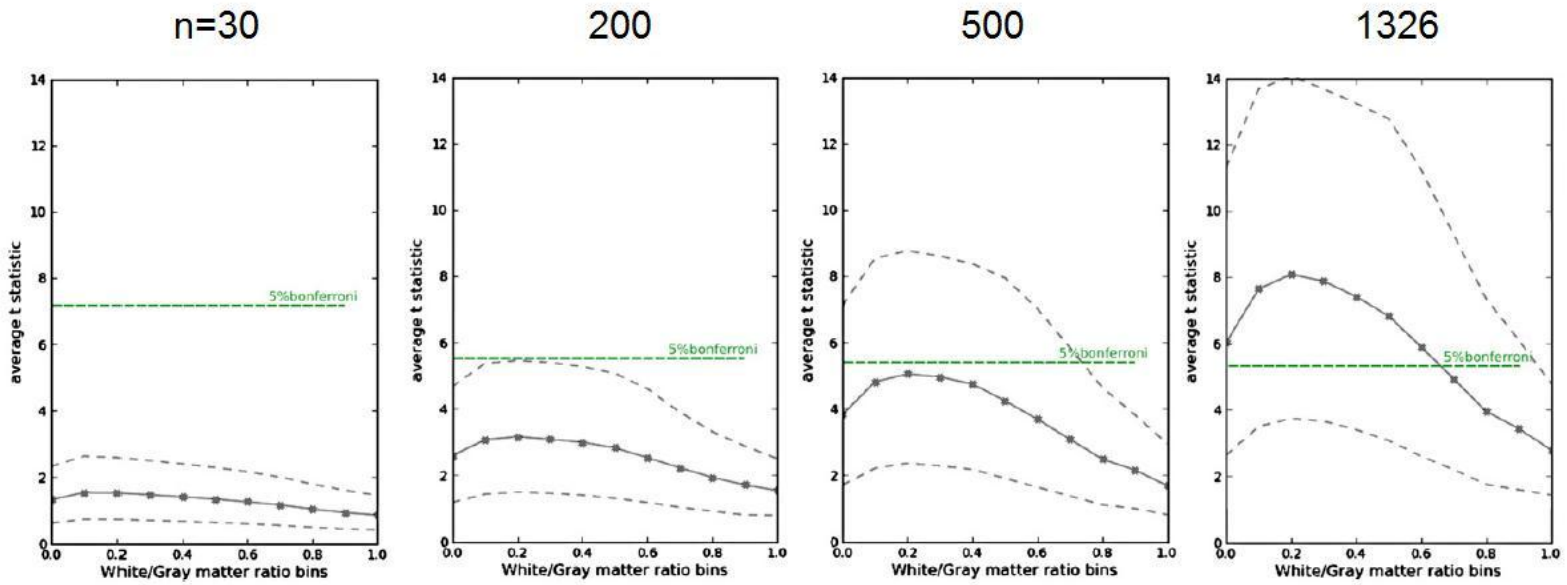
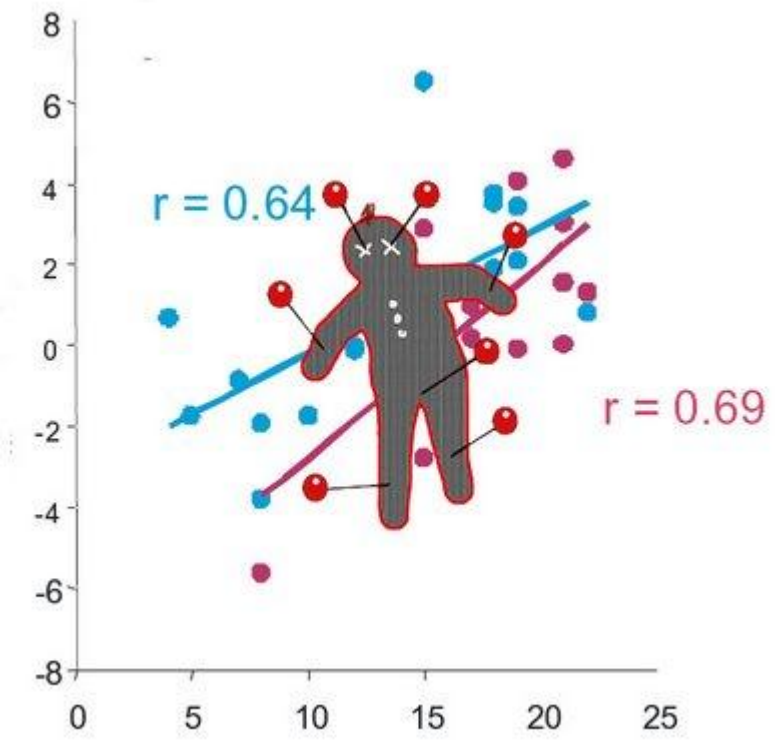


Fig. 2. Relationship between the effect statistics and the anatomical structure, for different group sizes (100, 200, 500, 1326). Top: Tissue probability as a function of the *t*-statistic. Red is gray-matter, blue is white-matter. Plain color lines are the averages over the ROIs, dashed lines are their 25–75% quantiles. Bottom: Average effect *t*-value as a function of the white/gray probability ratio.

So What?

- This is not a *surprising* result – it is elementary that t-scores / p-values are dependent on sample size.
- But this means that in using t/p-score based thresholding, we are applying a threshold based on our sample size.
- Should the practical limitation of sample size determine *which areas we think are activated*?
- But also...

Blobs are not Representative

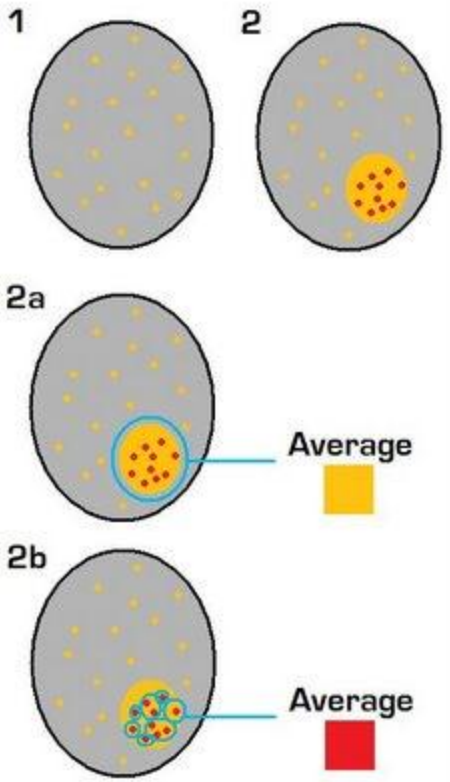


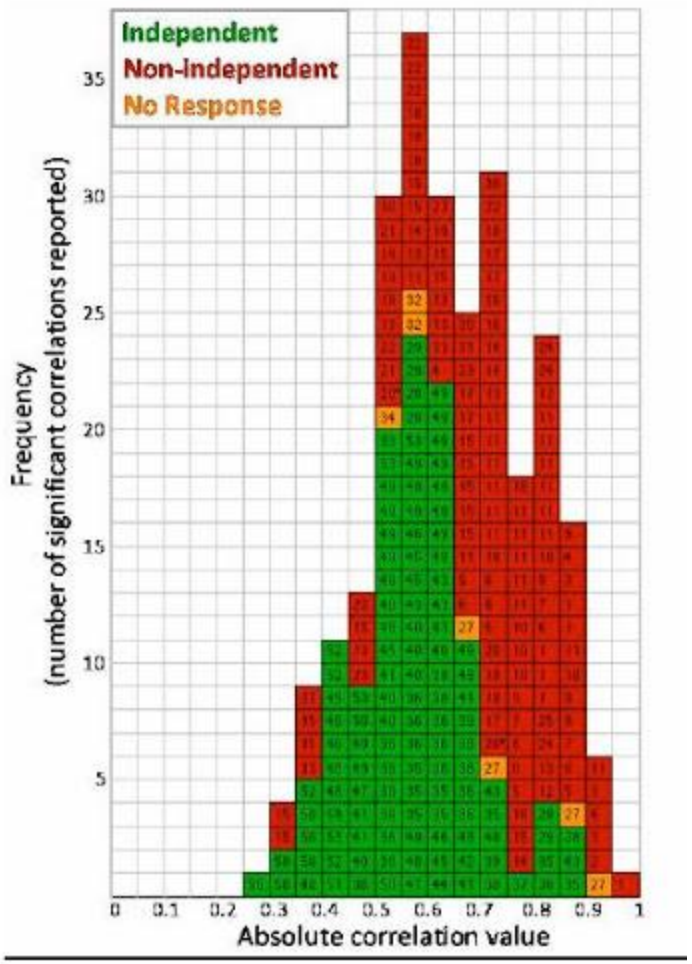
- The **“voodoo correlations”** problem – aka circularity, double dipping, non-independence

Blobs are not Representative

- Blobs did not create this problem, but they exacerbate it.
- Vul et al showed the error of treating significantly activated blobs (or, worse, peaks within blobs) as representative of anything (they’re not).
- Note that blobs might get more representative as the sample size increases.

Avoid Voodoo Blobs

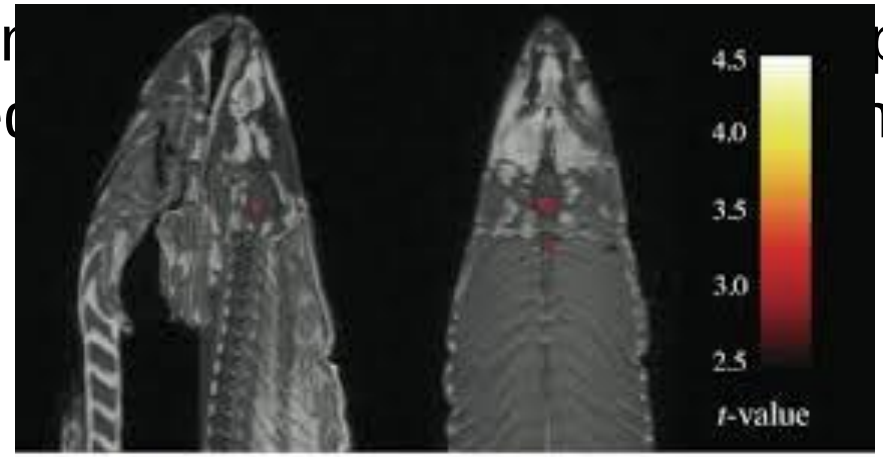




Vul et al 2009 *Perspect Psychol Sci*

On the other hand...

- Blobs (thresholding) serve a very important purpose.
- Whole-brain corrected blobs (FDR or FWE corrected) are evidence that ‘something is going on’.
- To adopt ar… p < 0.001 uncorrecte… mon (Bennet et …

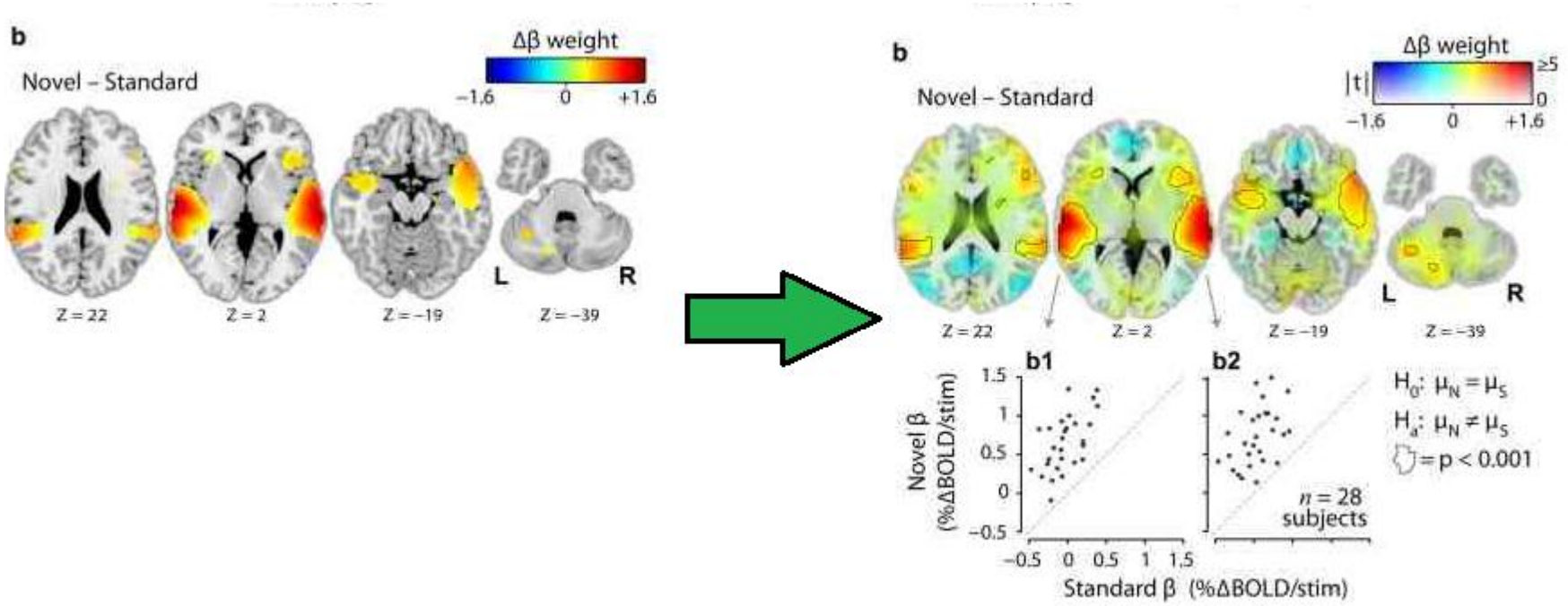


The fish that launched a thousand 'skeptics'

What we need is Diversity

- Blobs should not be the Alpha and the Omega of neuroimaging analysis. They should be one part of a comprehensive approach.
- Look at the unthresholded statistical parametric maps *alongside* the thresholded ones.
- E.g. In FSL you can find these in the *stats/* directory of FEAT output for fMRI.

Post-Blob Visualization? Or not quite?



- Allen, Erhardt, Calhoun (2012) Neuron *Data visualization in the neurosciences: overcoming the curse of dimensionality*