

Introduction into fMRI analysis. PsyMsc4 (Goethe 2021).

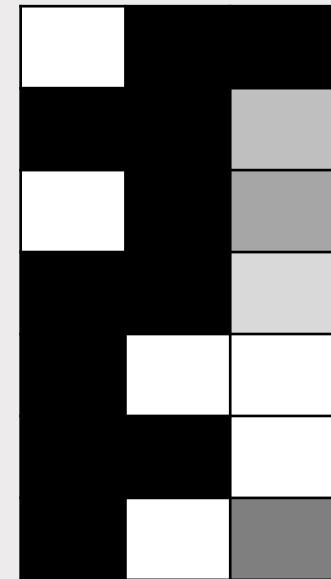
Session-3

Javier Ortiz-Tudela and Francesco Pupillo

Recap of last week

General recap.

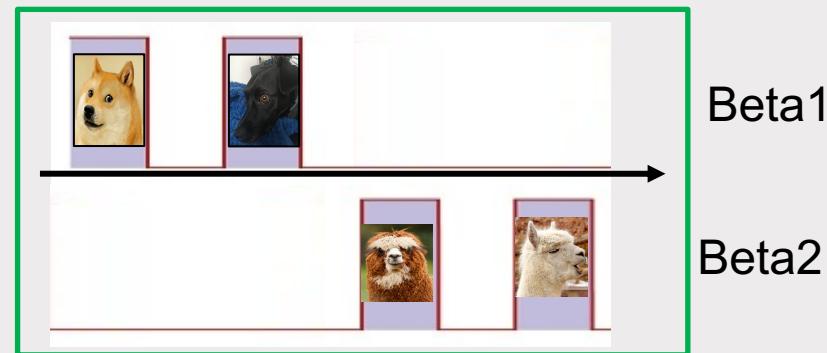
- fMRI sequences measure BOLD signal.
- Regression is the usual approach to analyze BOLD signal change.
- We use the condition (or stimulus) time course to model BOLD time course in each voxel.
- Regression will give us beta estimates for each voxel.
- The number (and meaning) of each beta estimates depends on the task model that we use.
- Nuisance regressors can help “cleaning” our signal.
- Estimations on head motions are the most common nuisance regressors used.



Functional MRI. Inference.

Our GLM (linear regression) outputs beta estimates for each one of our regressors.

How should we interpret them?



Functional MRI. Inference.

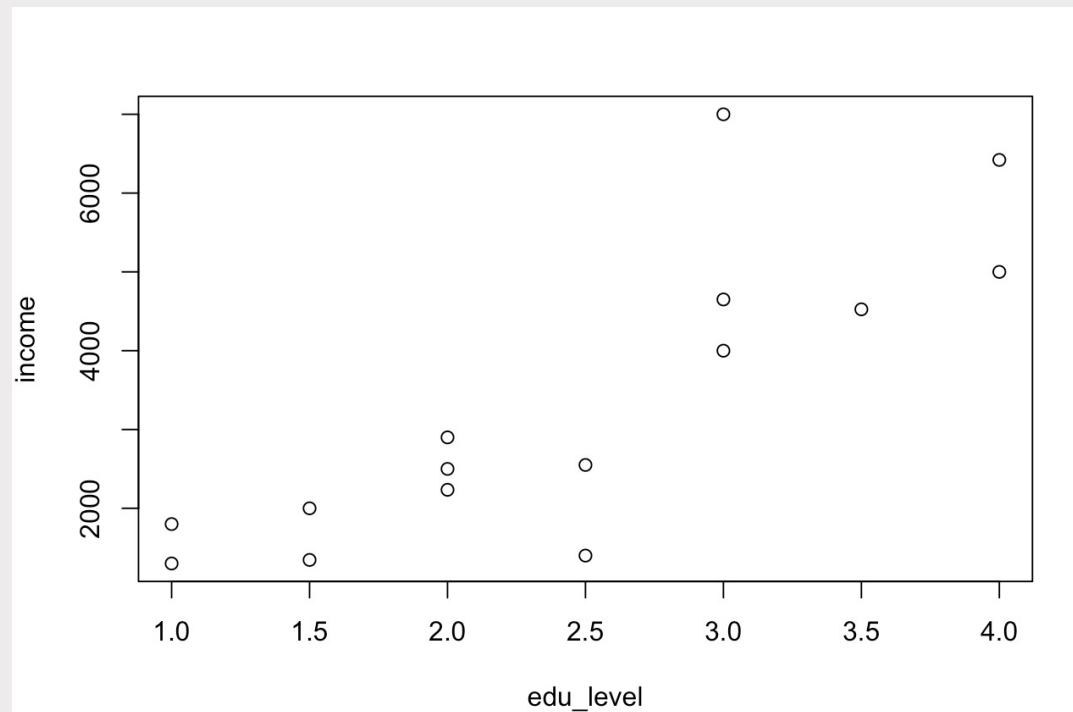
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However, we cannot draw inferences directly from betas. Why?

A “real life” example: Let’s predict **income** from **education level**.

Income in USD and education level from 1 (High school) to 4 (PhD)

beta = 1561.6



Functional MRI. Inference.

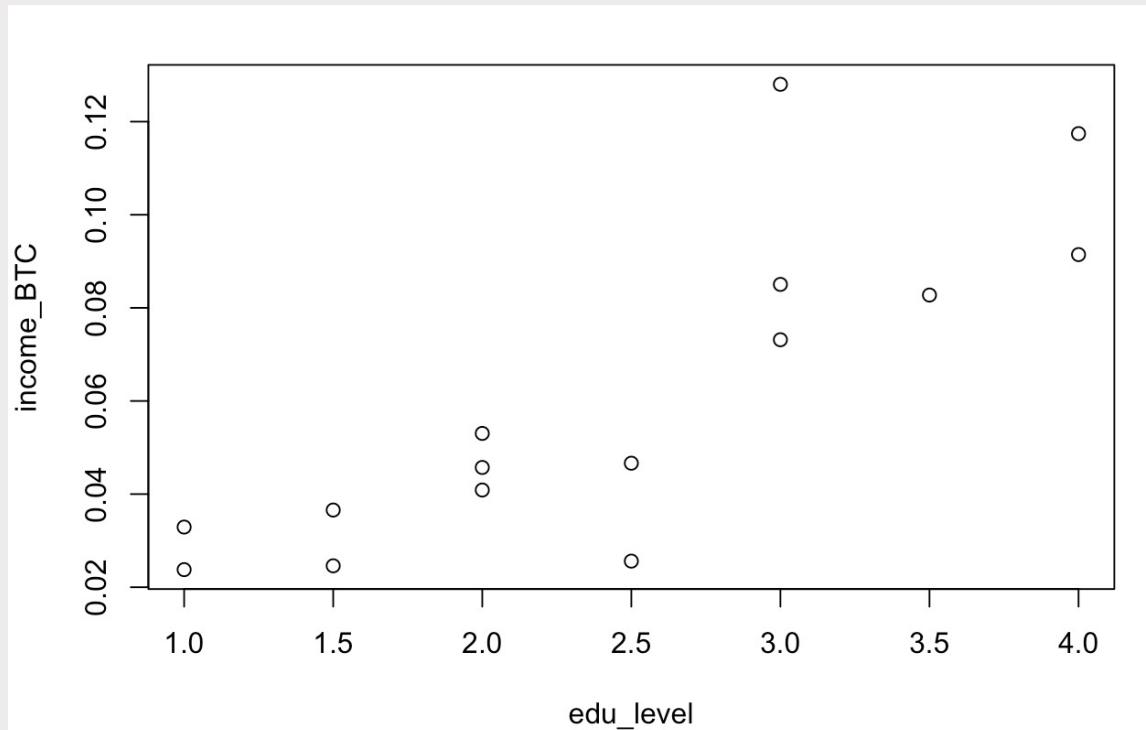
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A “real life” example: Let’s predict **income** from **education level**.

Income in BTC and education level from 1 (High school) to 4 (PhD)

beta = 0.0286



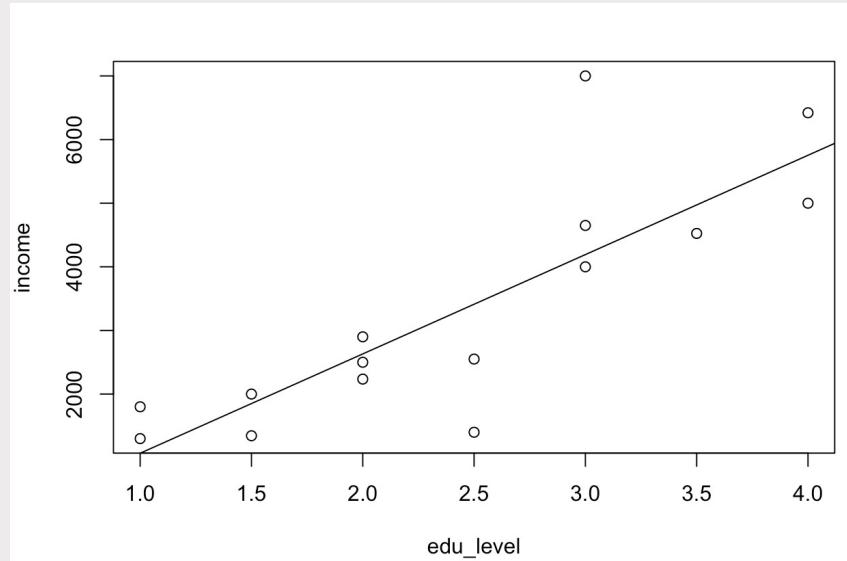
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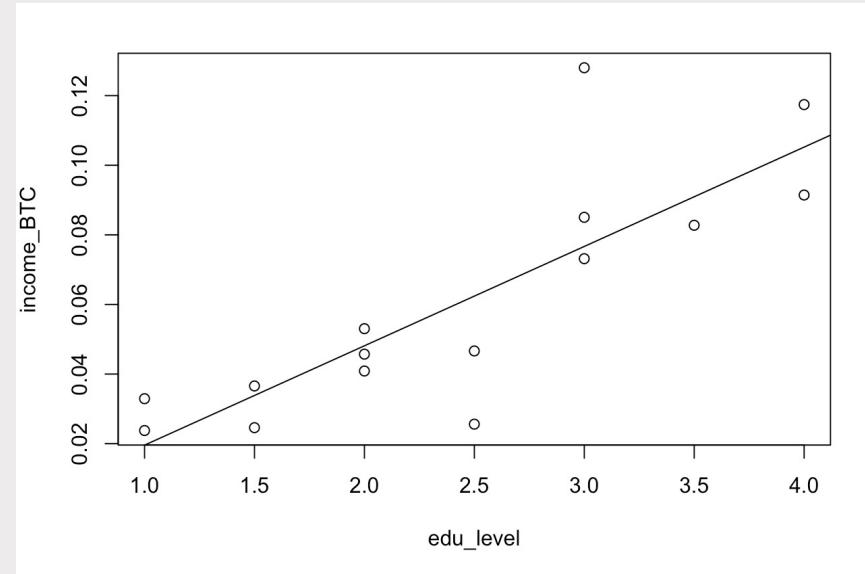
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A “real life” example: Let’s predict **income** from **education level**.

Income in USD -> beta = 1561.6



Income in BTC -> beta = 0.0286



Functional MRI. Inference.

We need to convert them to something meaningful.

Enter the t-statistic!



Functional MRI. Inference.

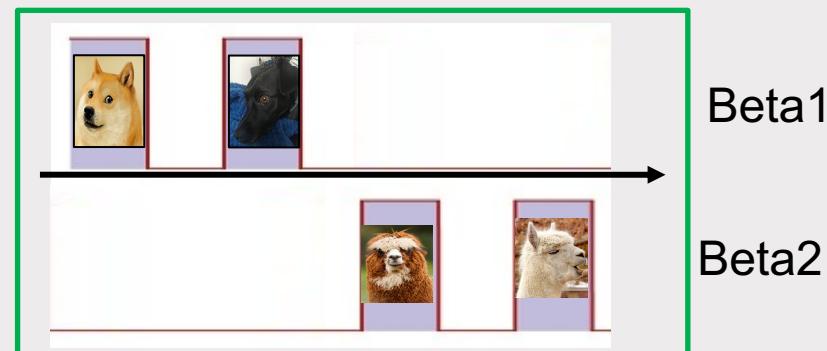
A critical concept in fMRI research: contrast.

Different types of contrasts:

T-tests

- Against baseline.
- Between regressors.

F-tests



Functional MRI. Inference.

A critical concept in fMRI research: contrasts.

T-test against (implicit) baseline.

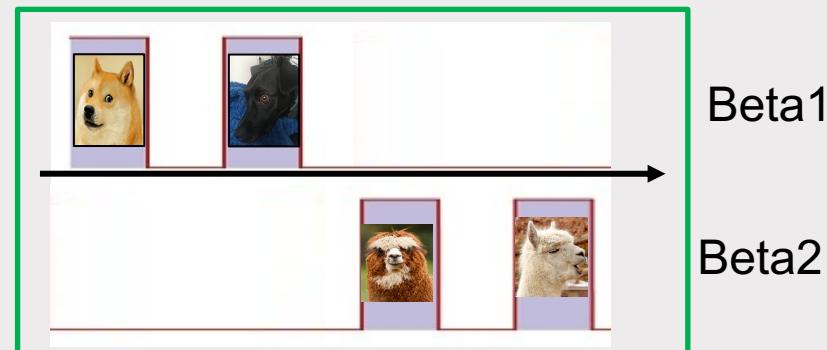


Functional MRI. Inference.

A critical concept in fMRI research: contrasts.

T-test against (implicit) baseline.

Enter **contrast vectors**.



Functional MRI. Inference.

A critical concept in fMRI research: contrasts.

T-test against (implicit) baseline.

Enter **contrast vectors**. A set of values (a.k.a., weights) representing the comparison that we want to make.

We can use them to *select* the betas that we will contrast by defining a weight for each beta.

With contrast vectors we can easily define:

- Simple comparisons for multiple conditions.
- Complex sets of comparisons across conditions.
- They are used in most fMRI analysis packages.



Functional MRI. Inference.

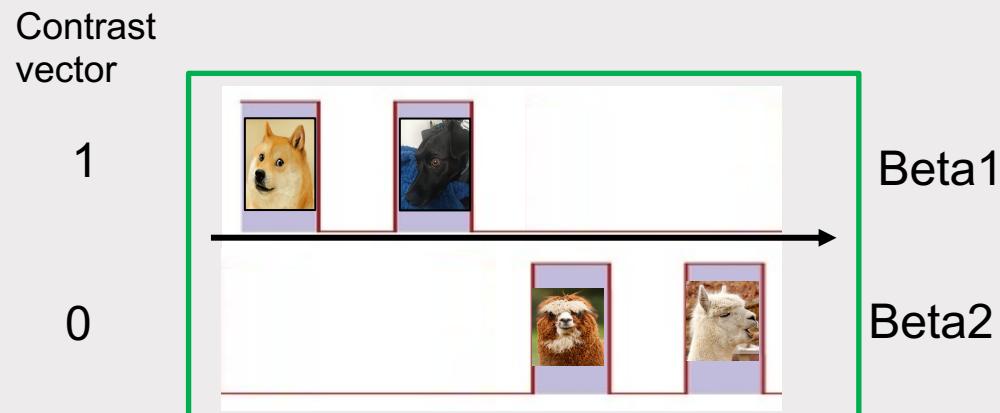
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T-test against (implicit) baseline.

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We can use them to *select* the betas that we will contrast by defining a weight for each beta.

Example: Let's *select* only the beta for DOG FACES.



Functional MRI. Inference.

A critical concept in fMRI research: contrasts.

What if we want to have a finer question? Which voxels are **more** active for DOG FACES **than** for ALPACA FACES?

QUESTION:
How should we set the contrast vector?

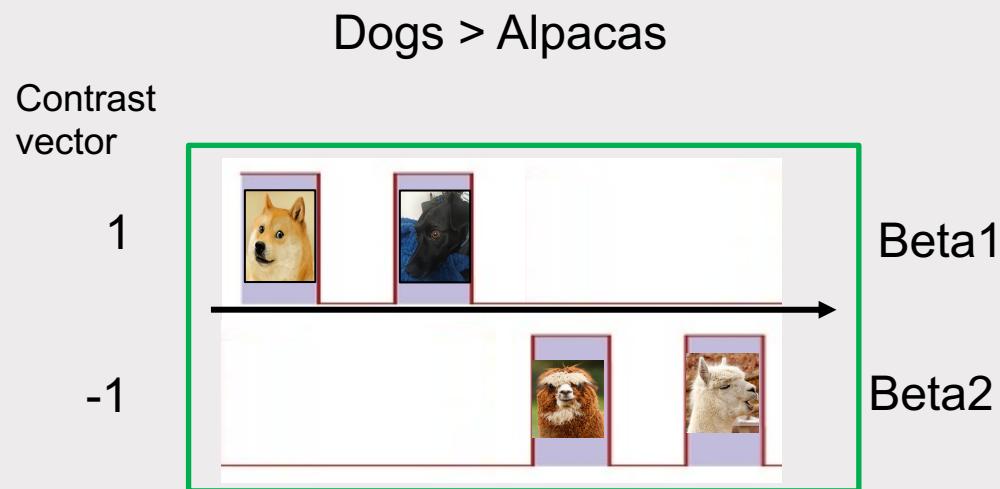
Contrast
vector



Functional MRI. Inference.

A critical concept in fMRI research: contrasts.

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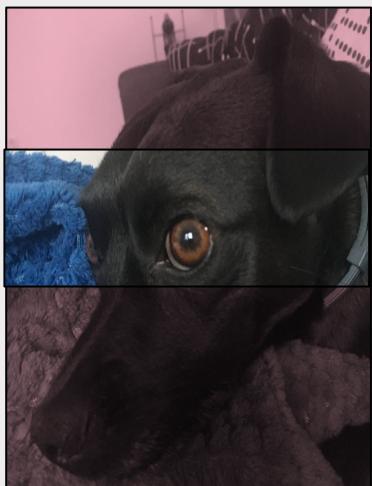
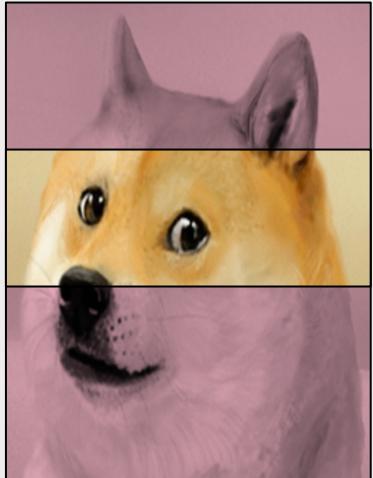
Functional MRI. Inference.

A critical concept in fMRI research: contrasts.

What if our question is more complex?

Does the brain response to staring differ between dog faces and alpaca faces?

F-tests



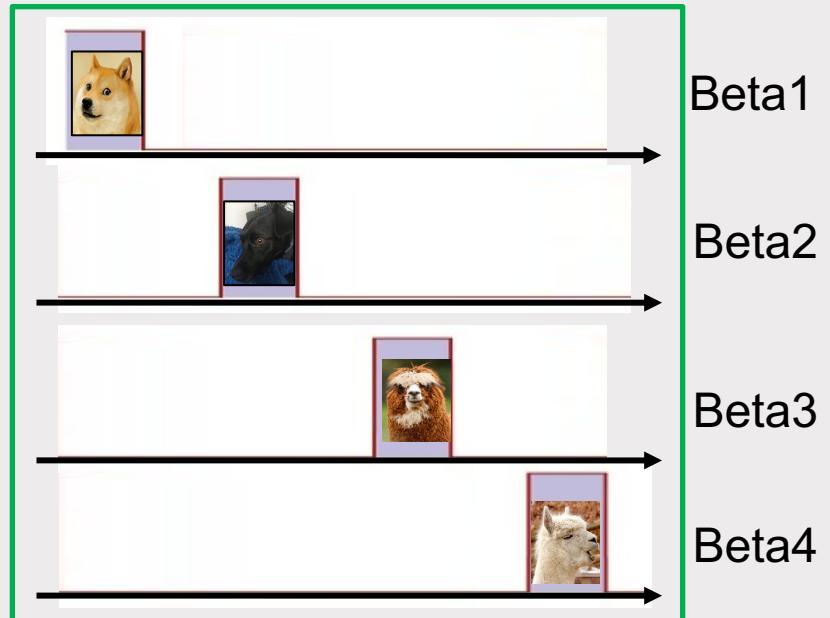
Functional MRI. Inference.

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“One beta per trials is estimated”

Functional MRI. Inference.

A critical concept in fMRI research: contrasts.

What if our question is more complex?

Does the brain response to staring differ between dog faces and alpaca faces?

F-tests

Dogs > Alpacas

Staring > Side-ways

1

1

1

-1

-1

1

-1

-1



“One beta per trials is estimated”

Functional MRI. Inference.

IMPORTANT NOTE:

Your fMRI experiment is only as good as your baseline.

- Can we find the love brain region?
- Can we find brain areas related to political affiliation?
- Can we find voxels for Jennifer Aniston?

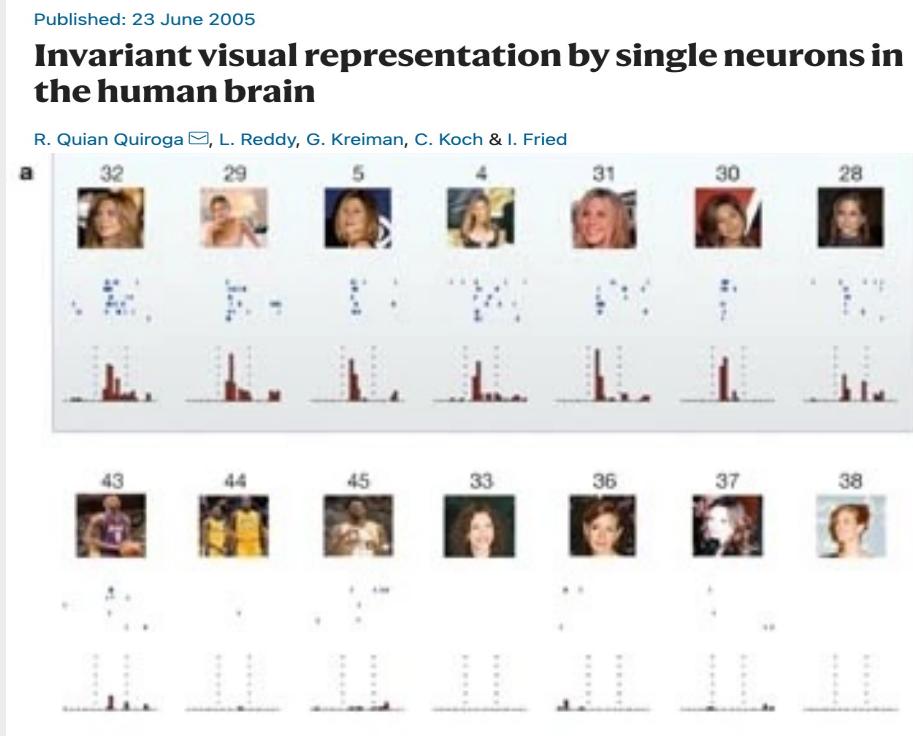
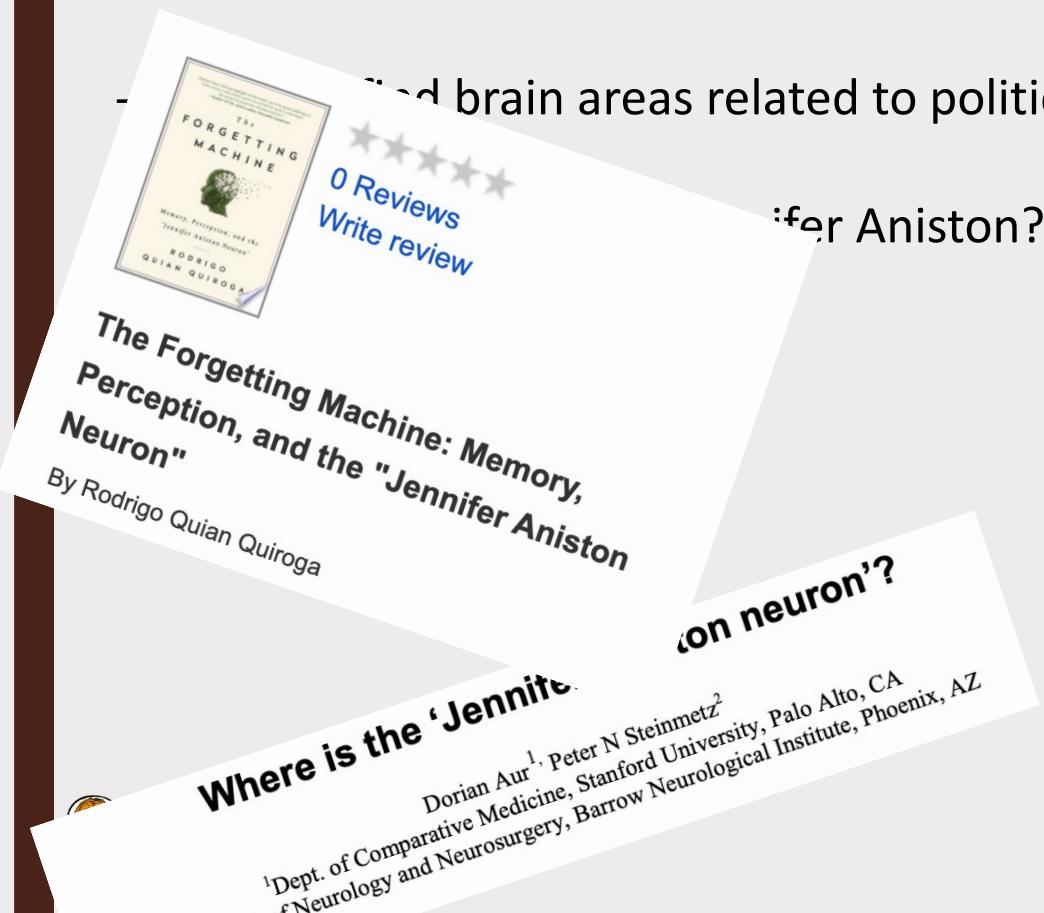


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GLM

General recap.

- Beta estimates cannot be interpreted directly.
- T and F contrasts can be used to compare conditions.
- Beware of contrasts against implicit baseline.
- Contrast vectors are widely used and powerful.
- When designing an experiment, always chose an appropriate baseline.

