



Individual Development
and Adaptive Education

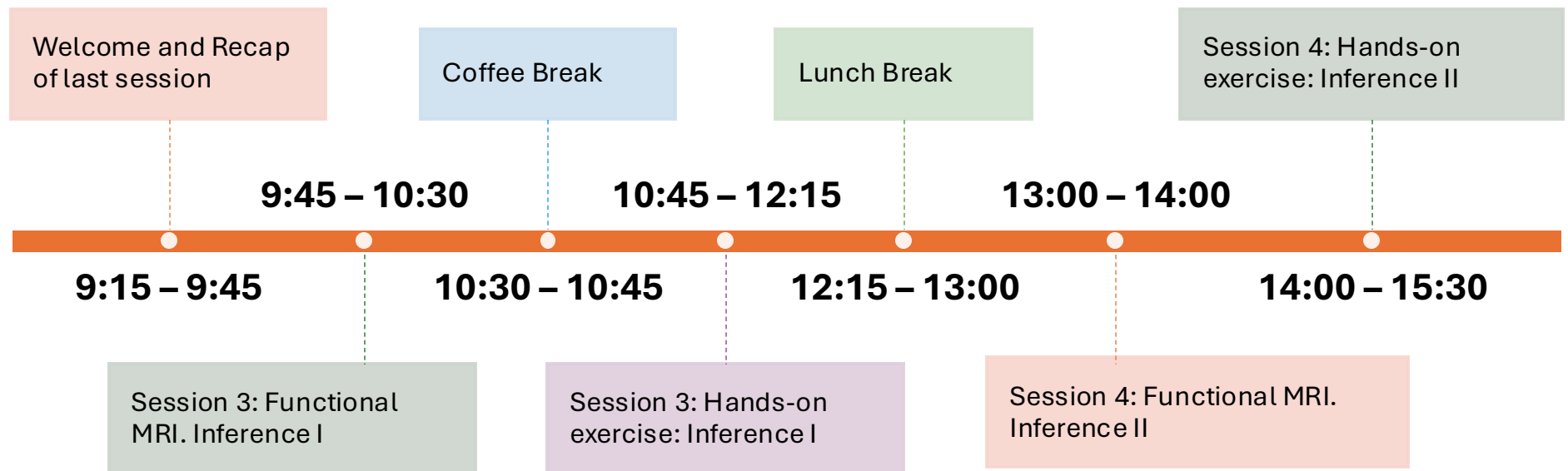


Leibniz-Institut für Bildungsforschung
und Bildungsinformation

Session 3: Functional MRI. Inference

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- Education and Human Development & Individualized Learning Laboratory, DIPF | Leibniz Institute for Research and Information in Education

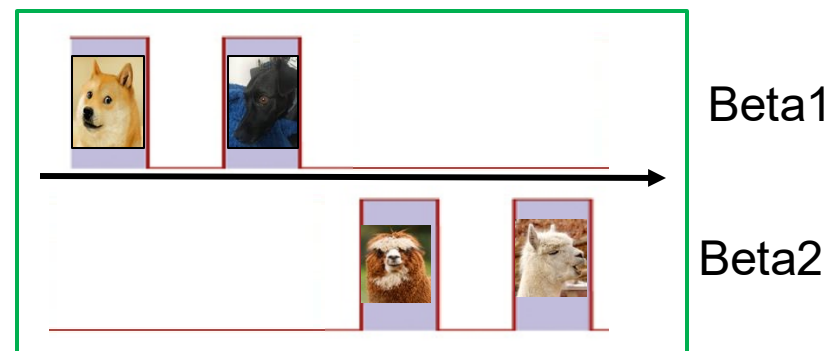
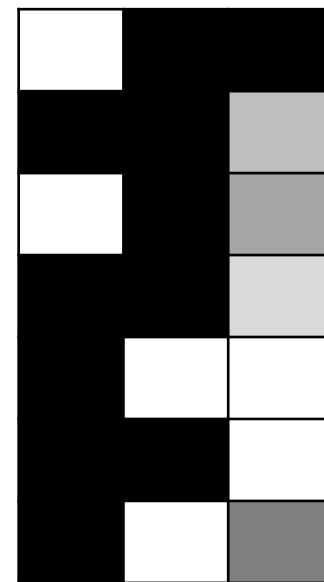
Agenda Day 2



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.



A large orange circle on the left side of the slide, partially cut off by the edge.

"Story Behind the Object"

Take 1 minute to pick an object from your bag, pocket, or desk that represents something about you, your learning style, or your daily life.

One by one, show your object to the group and briefly share:

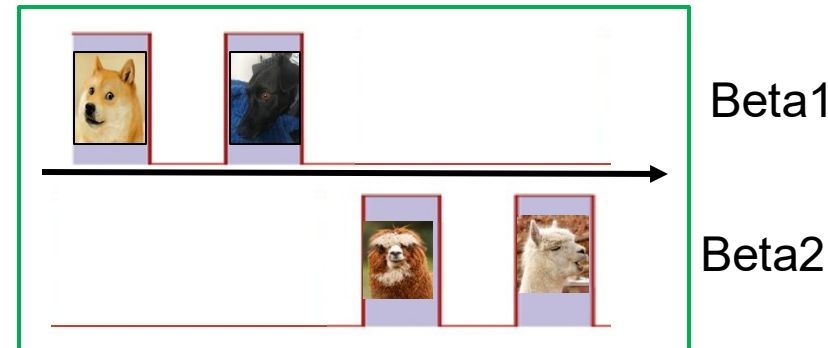
- What it is
- Why it is meaningful to you
- A short story related to it



Functional MRI. Inference.

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

How should we interpret them?



Functional MRI. Inference.

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

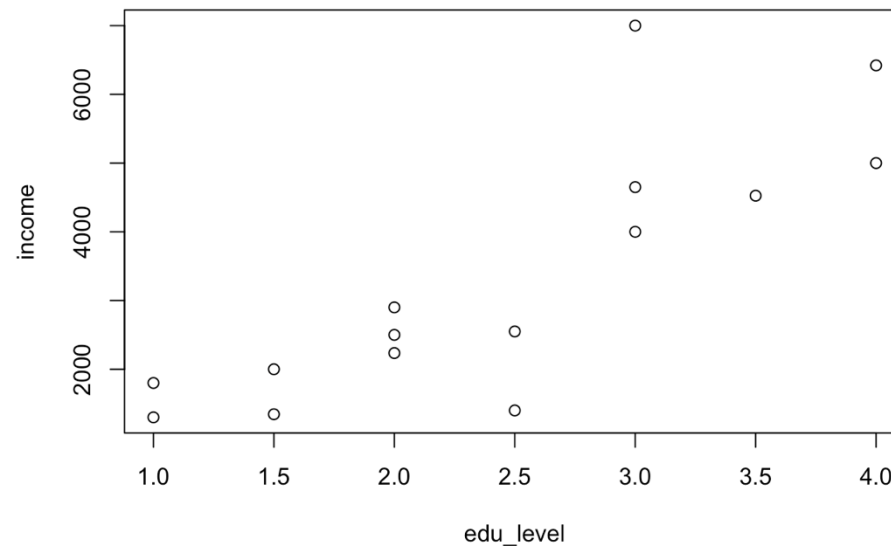
However, we cannot draw inferences directly from betas.

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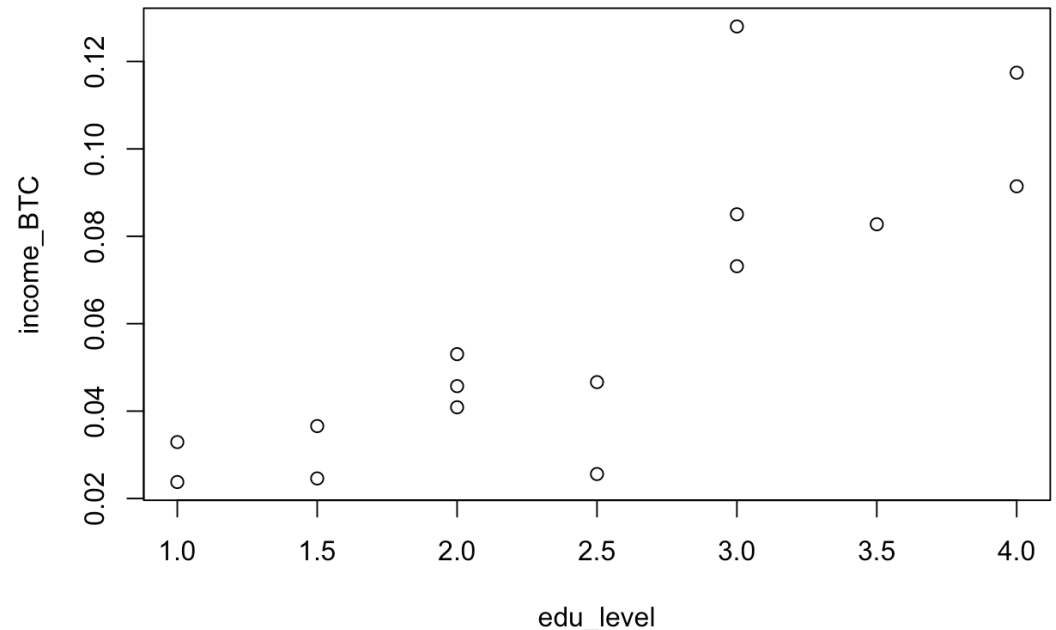
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A “real life” example: Let’s predict income from education level.

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

beta = 0.0286



Functional MRI. Inference.

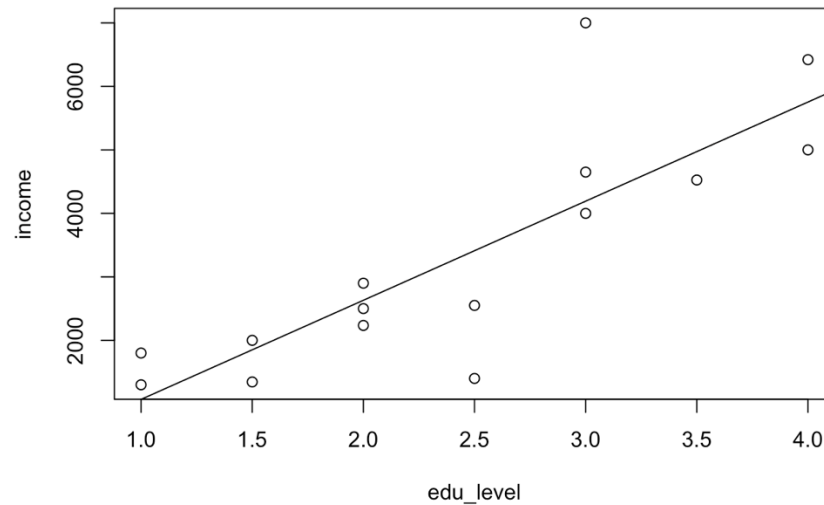
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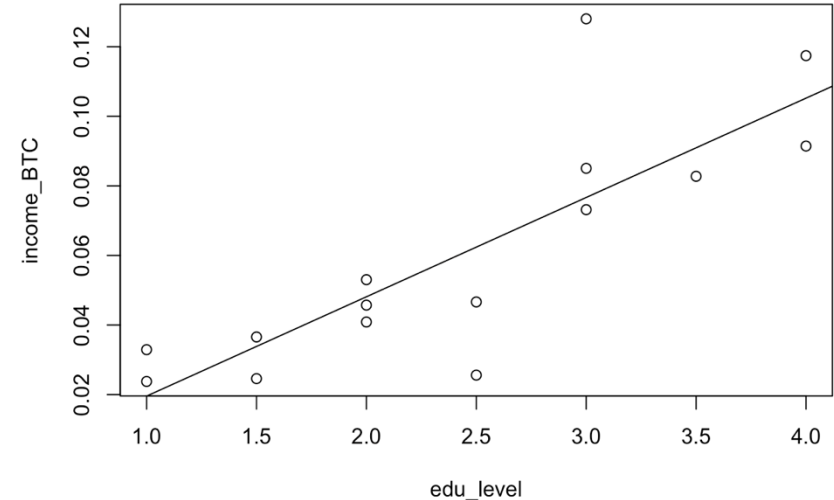
Why?

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

Income in USD -> beta = 1561.6



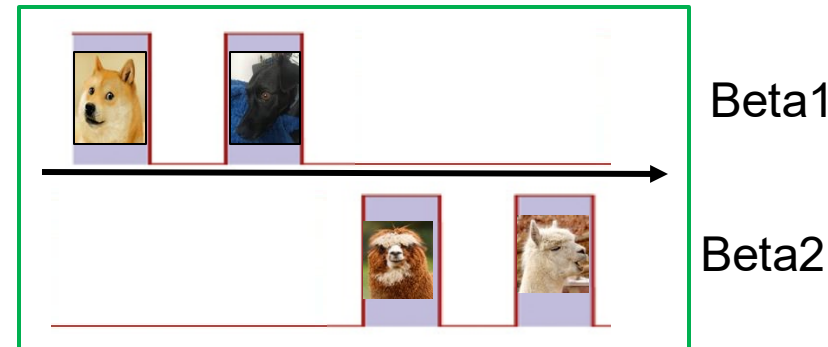
Income in BTC -> beta = 0.0286



Functional MRI. Inference.

We need to convert them to something meaningful.

Enter the t-statistic!



Functional MRI. Inference.

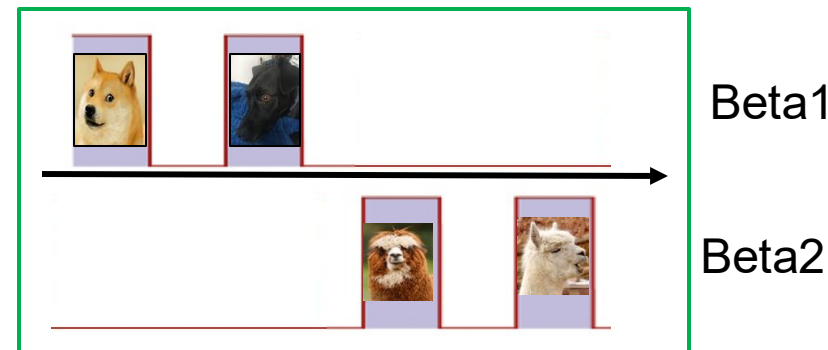
A critical concept in fMRI research: contrast.

Different types of contrasts:

T-tests

- Against baseline.
- Between regressors.

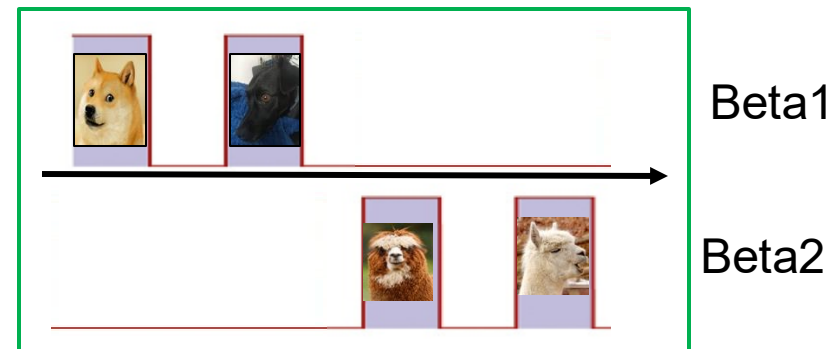
F-tests



Functional MRI. Inference.

A critical concept in fMRI research: contrasts.

T-test against (implicit) baseline.

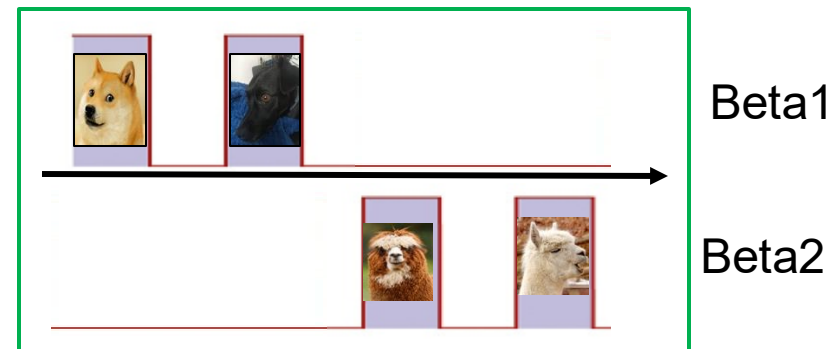


Functional MRI. Inference.

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T-test against (implicit) baseline.

Enter contrast vectors.



Functional MRI. Inference.

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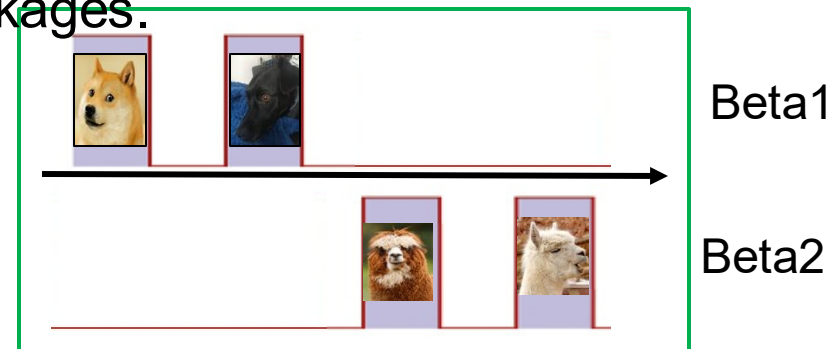
T-test against (implicit) baseline.

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.

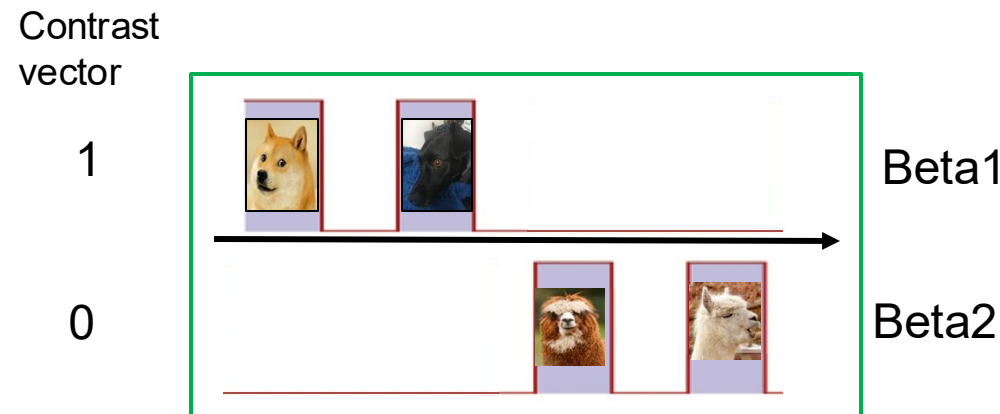
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Example: Let's select only the beta for DOG FACES.



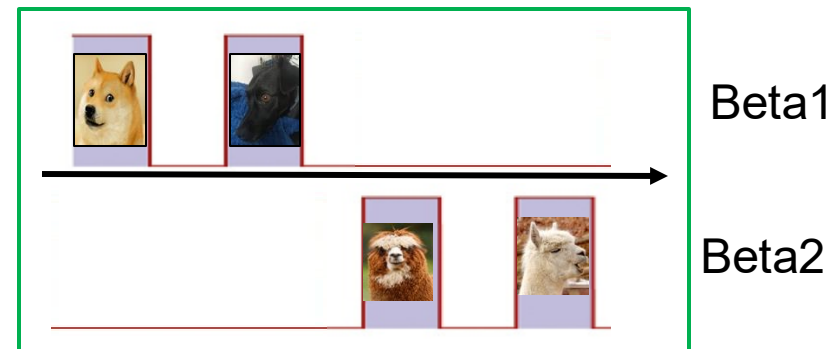
Functional MRI. Inference.

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?

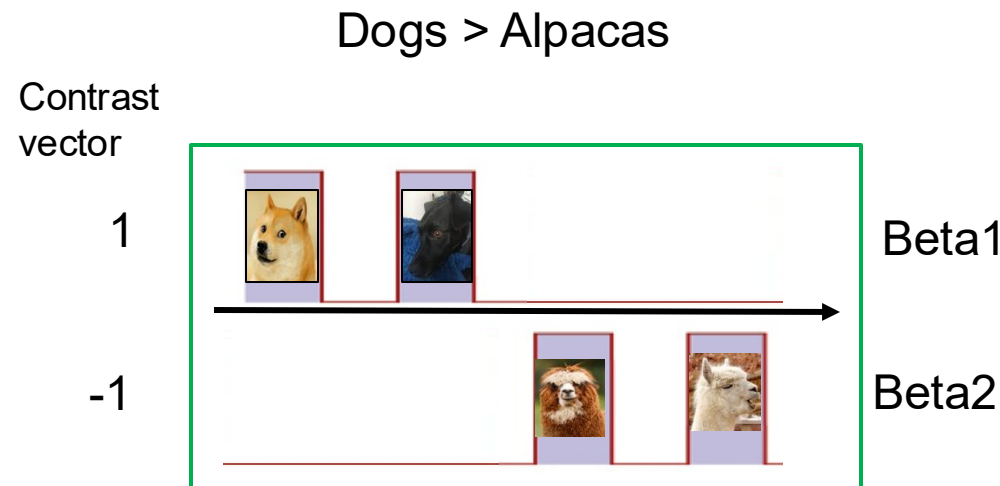
Contrast
vector



Functional MRI. Inference.

A critical concept in fMRI research: contrasts.

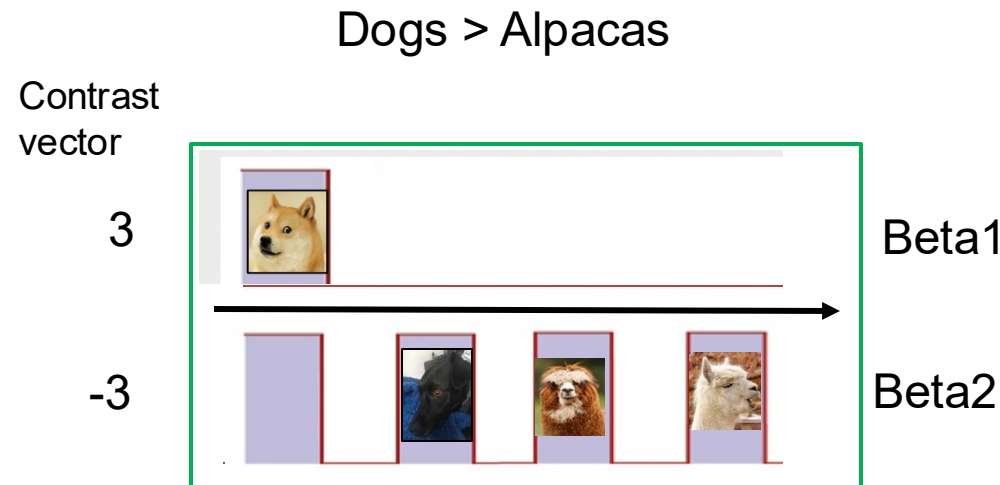
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Functional MRI. Inference.

A critical concept in fMRI research: contrasts.

What would this contrast vector give us?



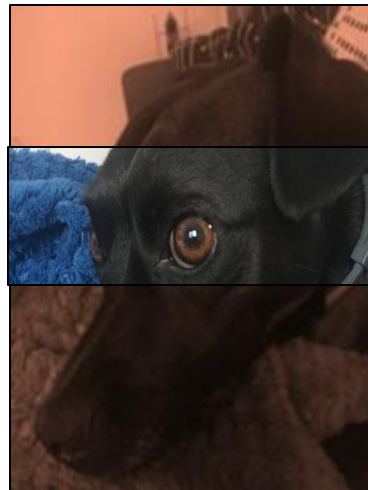
Functional MRI. Inference.

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



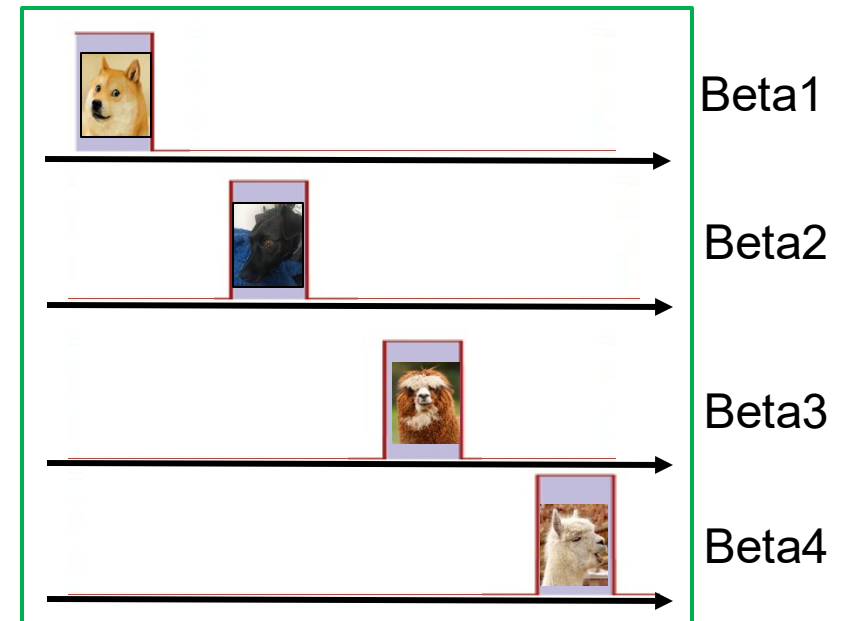
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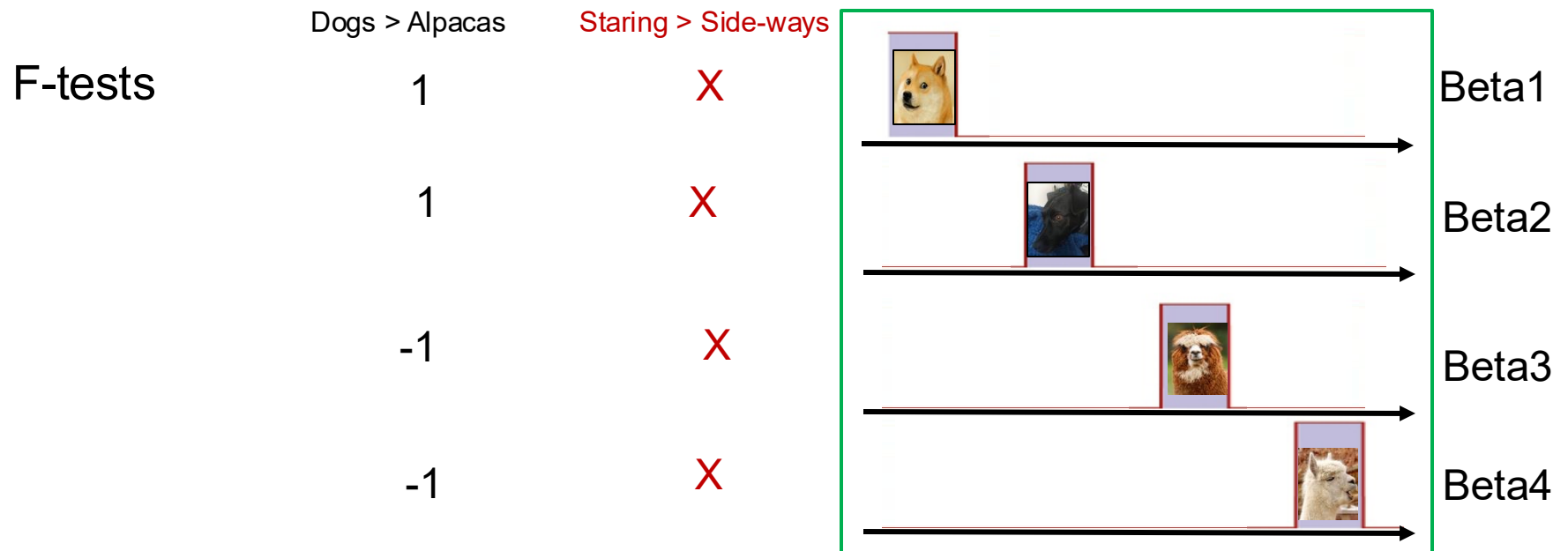
“One beta per trials is estimated”

Functional MRI. Inference.

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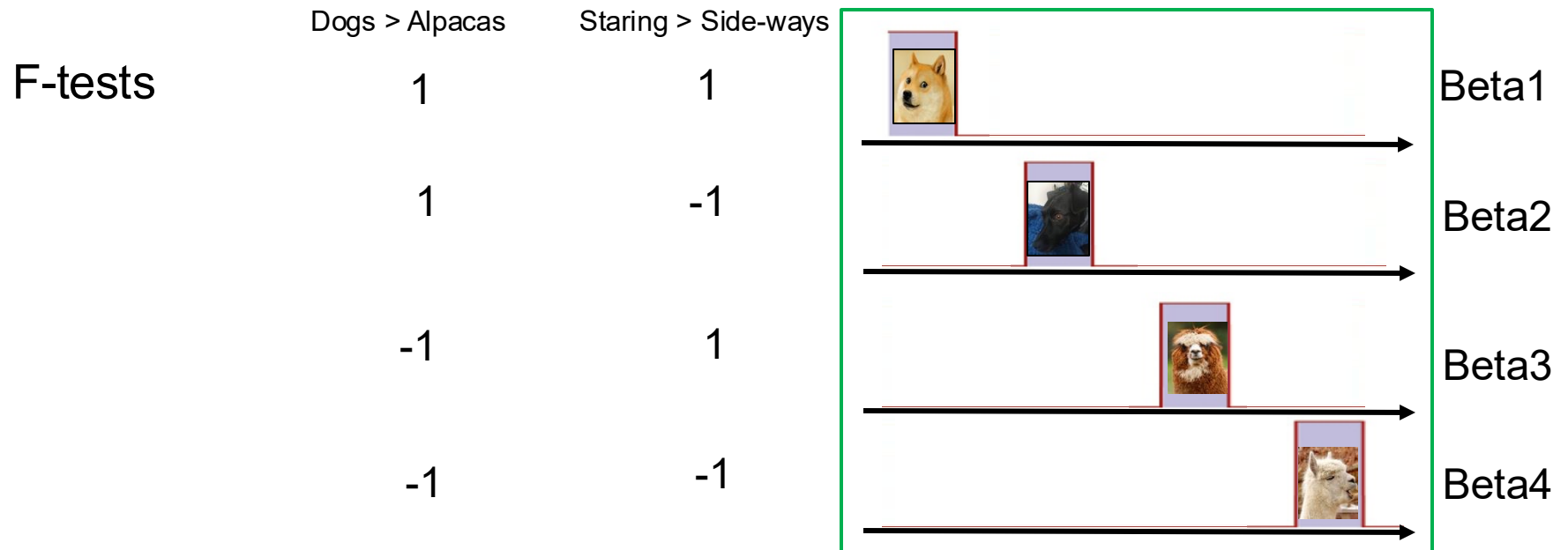
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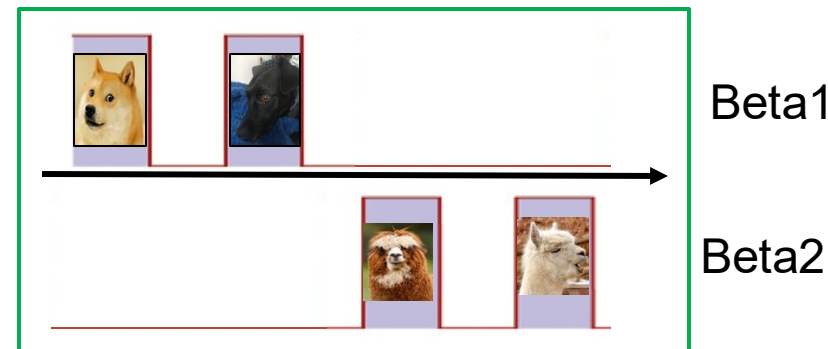


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Functional MRI. Inference.

IMPORTANT NOTE:

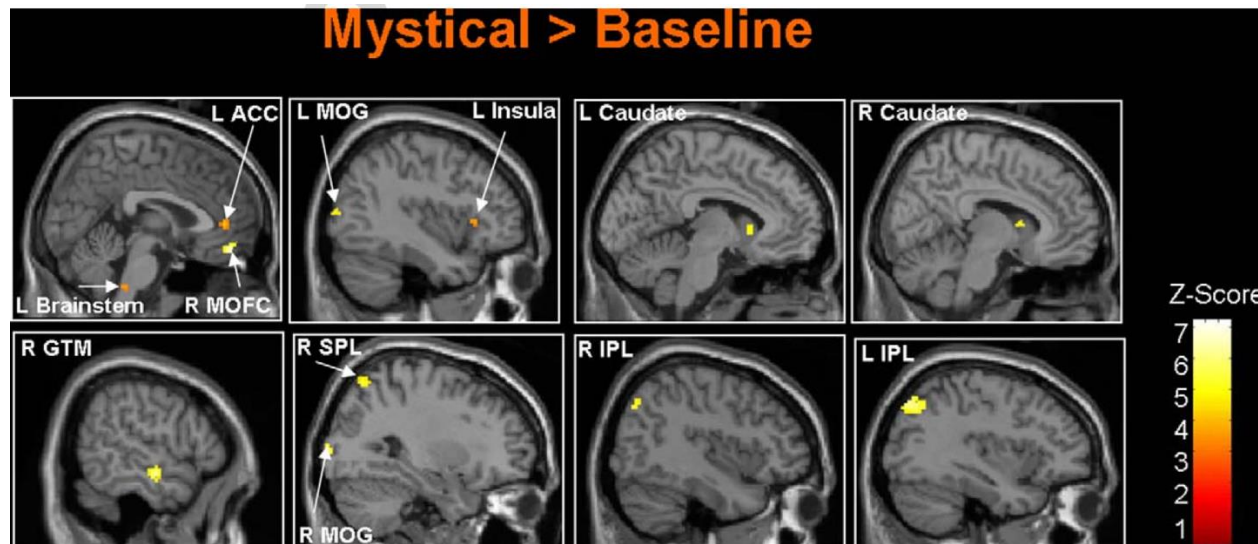
Your fMRI experiment is only as good as your baseline.



Functional MRI. Inference.

IMPORTANT NOTE:

Your fMRI experiment is only as good as your baseline.



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.

