Bayesian modeling
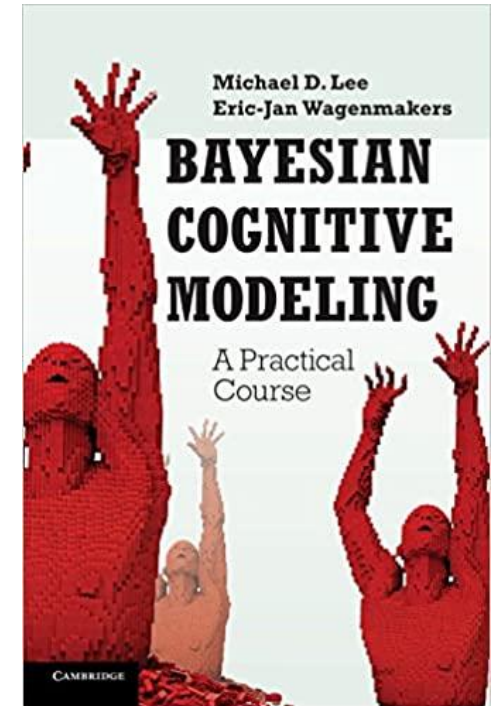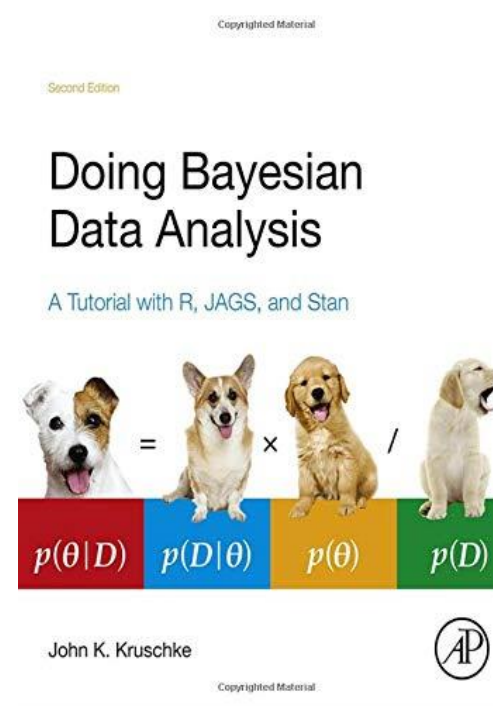
Thinking probalistically

Introduction to PyMC3
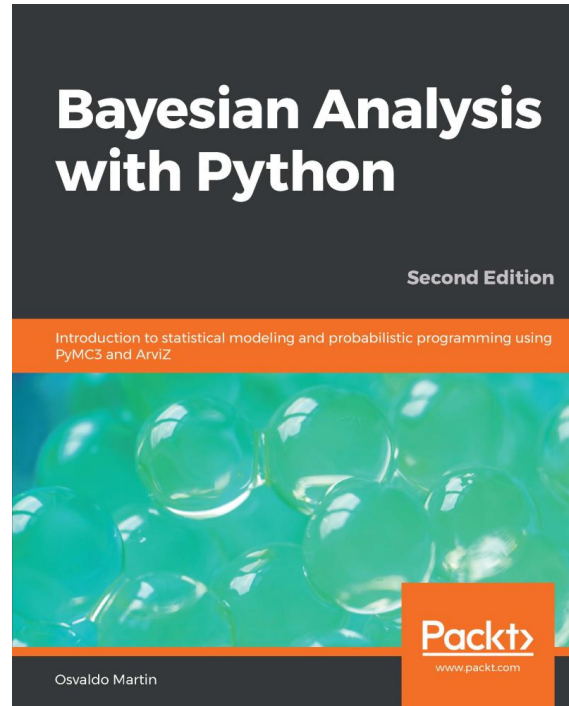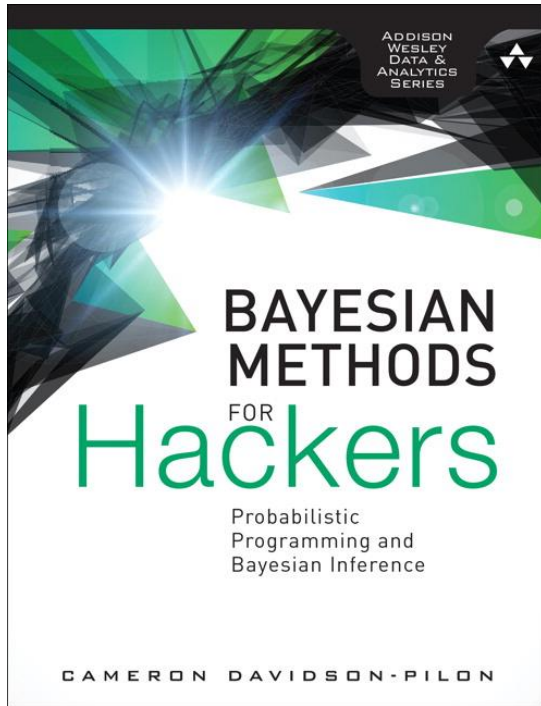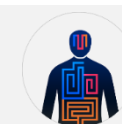
Thinking probabilistically

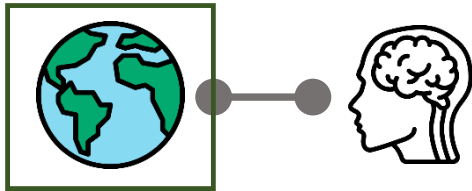# Thinking probabilistically

Frequentist ← 👍💲 → Bayesian

Probability is the long-run frequency of events.

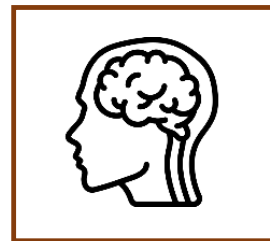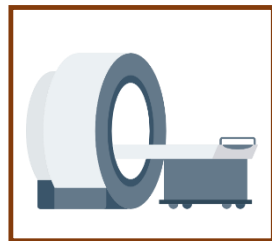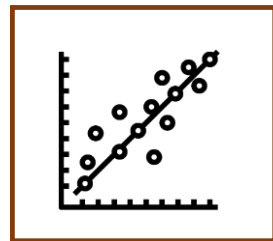**Probability** measure the *believability in an event*.

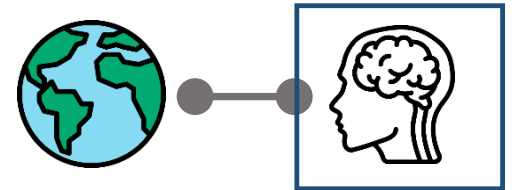$$f(y|\theta)$$

Fixed

$$p(\theta|y) = \frac{p(y|\theta)p(\theta)}{p(y)}$$

Fixed

Bayesian inference is simply updating your beliefs after considering new evidence.

MCMC samplers

- Approximation
  - Variational inference

- Stochastic sampling
  - MCMC methods
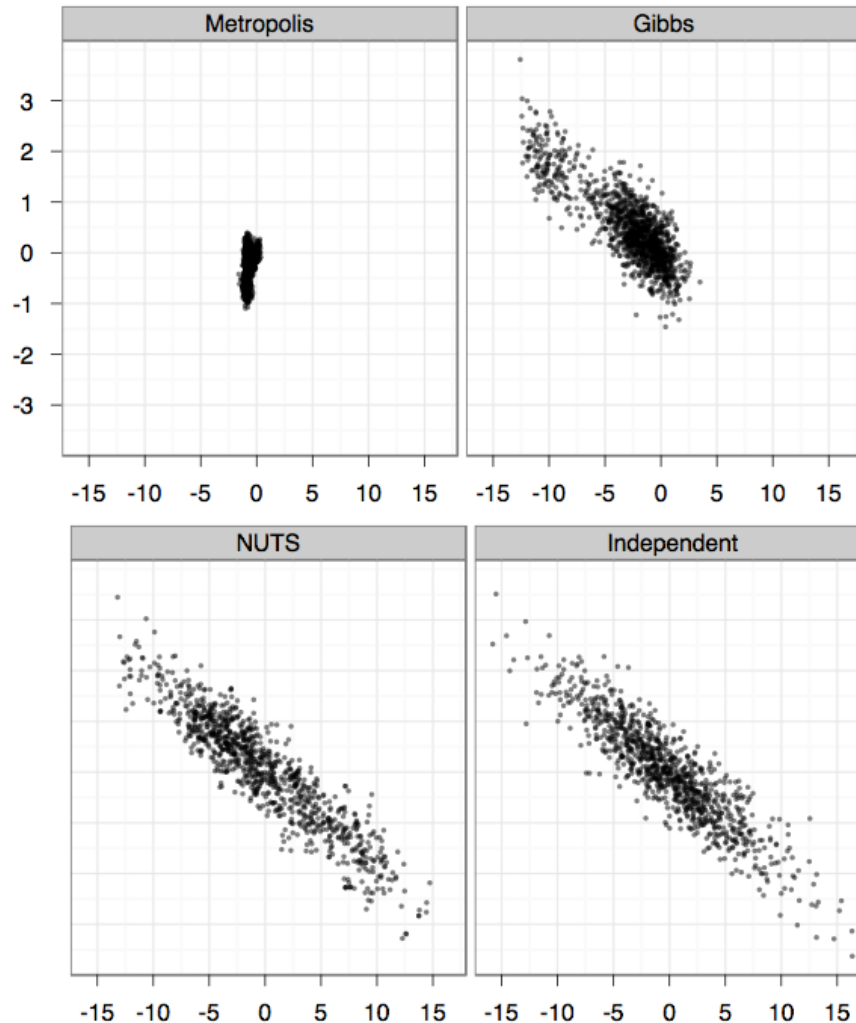
https://turing.ml/dev/docs/using-turing/sampler-viz

Probabilistic programming languages

JAGS

Stan

Turing.jl

Probabilistic programming languages

Graphical model
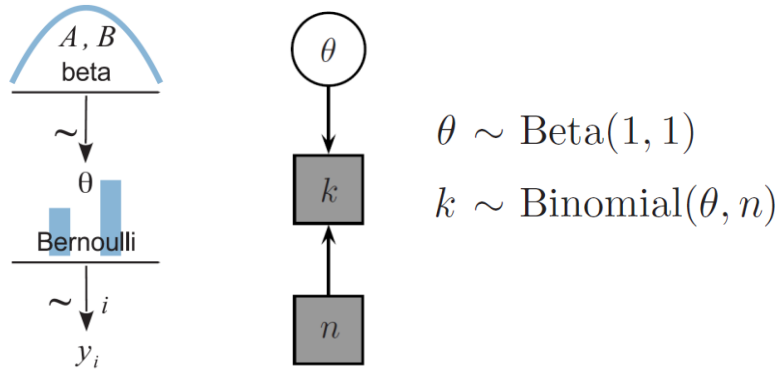
$$\theta \sim \text{Beta}(1,1)$$
$$k \sim \text{Binomial}(\theta, n)$$

Computational graph
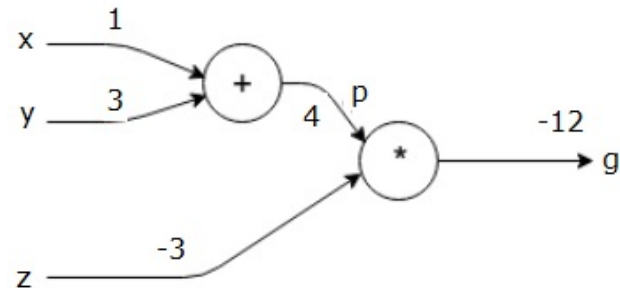
theano → C

- Automatic differentiation
- GPU computing
- Optimizations
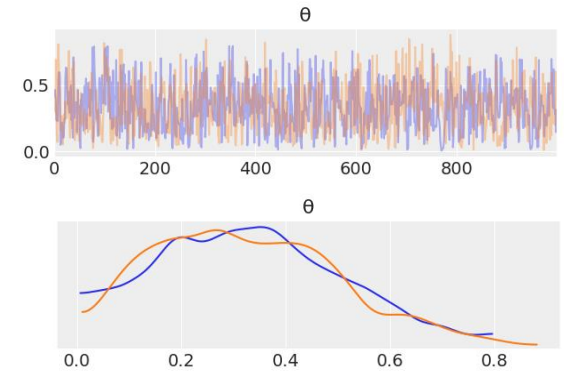
```
with pm.Model() as our_first_model:
    θ = pm.Beta('θ', alpha=1., beta=1.)
    y = pm.Bernoulli('y', p=θ, observed=data)
    trace = pm.sample(1000, random_seed=123)
```

Sampling

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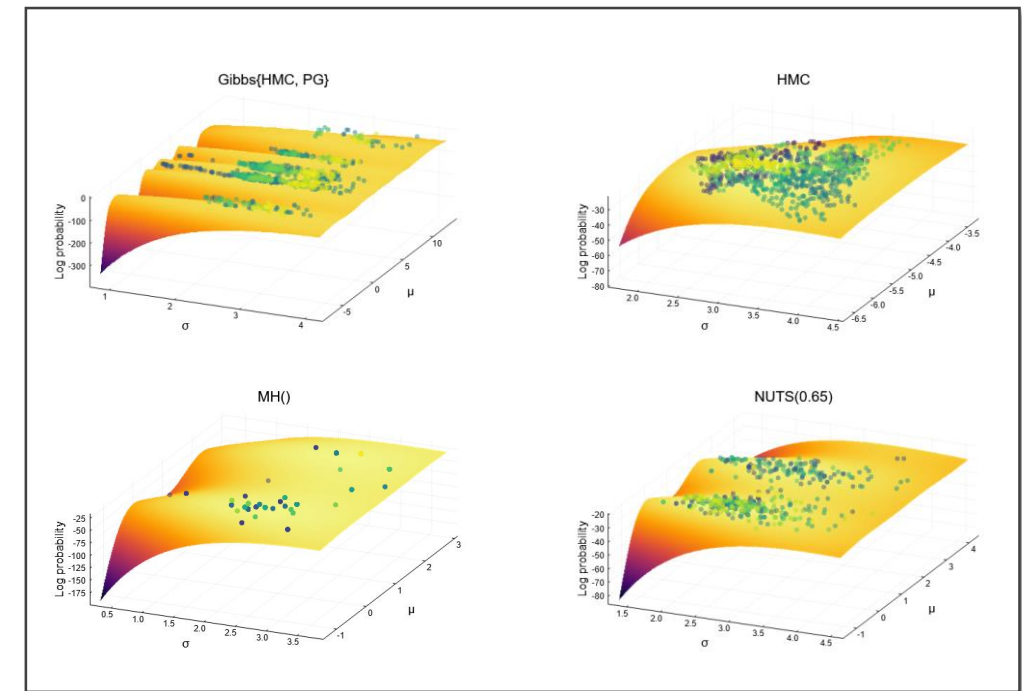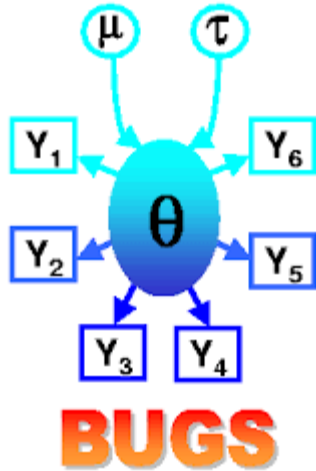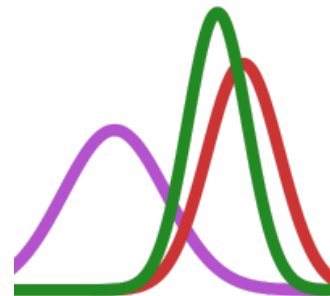group

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Hierarchical/multilevel models

$k_i \sim \text{Binomial}(\theta, n_i)$

$\theta \sim \text{Beta}(1, 1)$

Group 1	Group 2

$k_1 \sim \text{Binomial}(\theta, n_1)$

$k_2 \sim \text{Binomial}(\theta, n_2)$

$\theta \sim \text{Beta}(1, 1)$

- Hyperpriors

- Hyperparameters

Shrinkage

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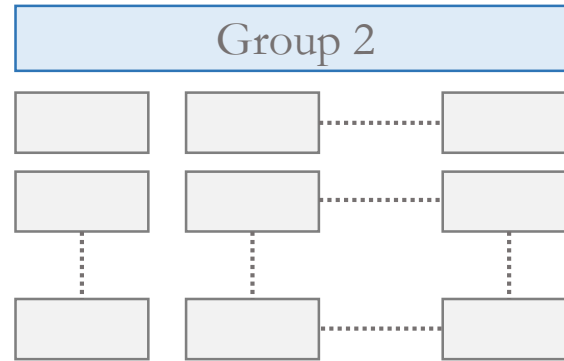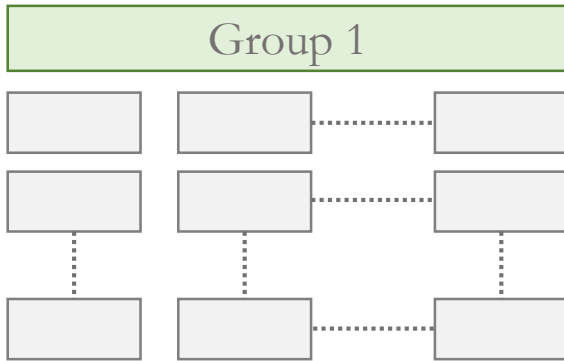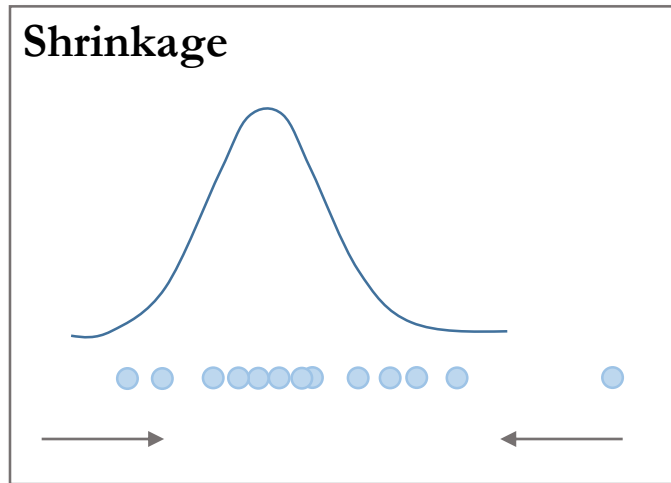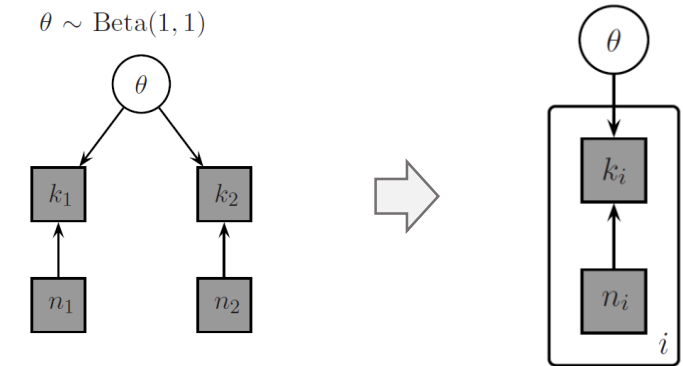
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Psychophysics

Psychophysics is concerned with measuring how external physical stimuli cause internal psychological sensations.

Hierarchial psychophysics

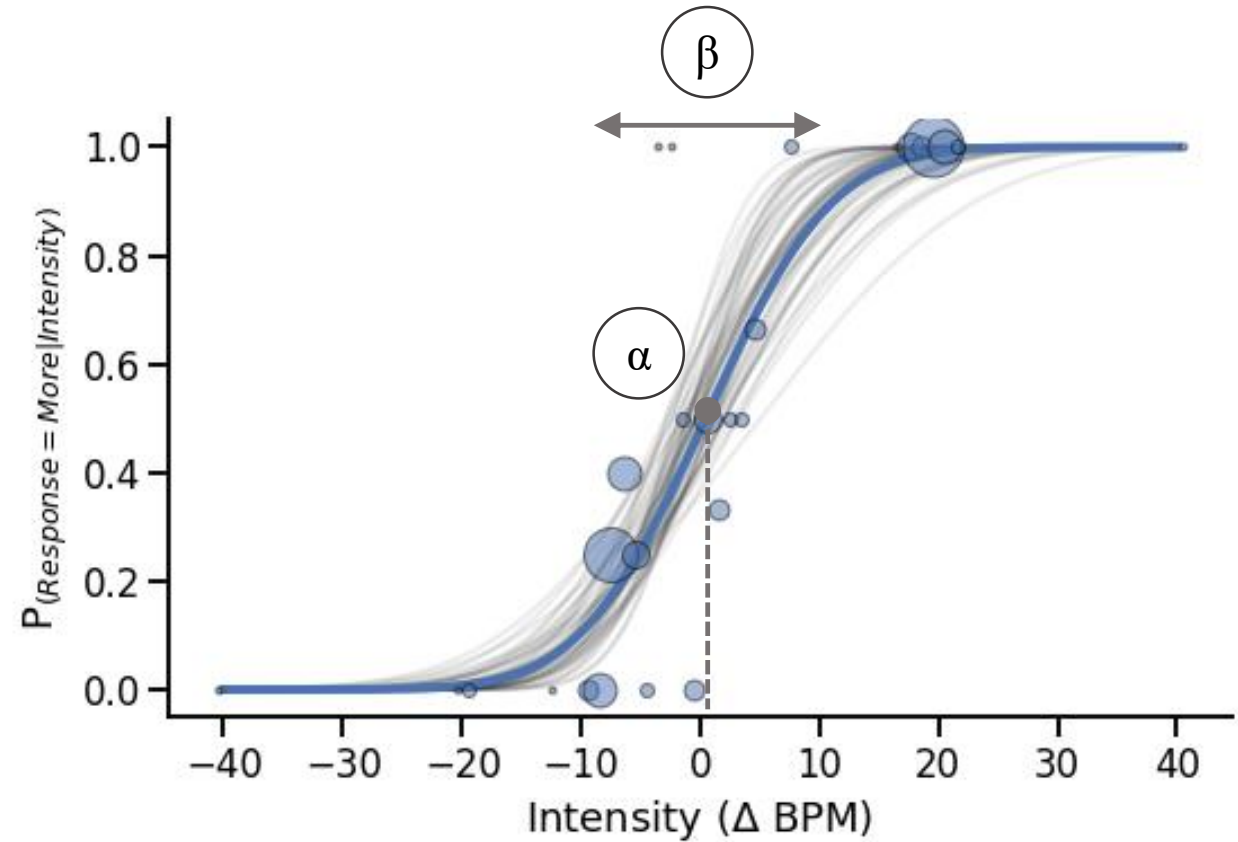Psychophysics is concerned with measuring how external physical stimuli cause internal psychological sensations.

Resources

Chris Fonnesbeck - An introduction to Markov Chain Monte Carlo using PyMC3 | PyData London 2019
https://www.youtube.com/watch?v=SS_pqgFziAg

van de Schoot, R., Depaoli, S., King, R., Kramer, B., Märtens, K., Tadesse, M. G., Vannucci, M., Gelman, A., Veen, D., Willemsen, J., & Yau, C. (2021). Bayesian statistics and modelling. Nature Reviews Methods Primers, 1(1). https://doi.org/10.1038/s43586-020-00001-2

Kruschke, J. (2015). Doing Bayesian data analysis : a tutorial with R, JAGS, and Stan. Boston: Academic Press.

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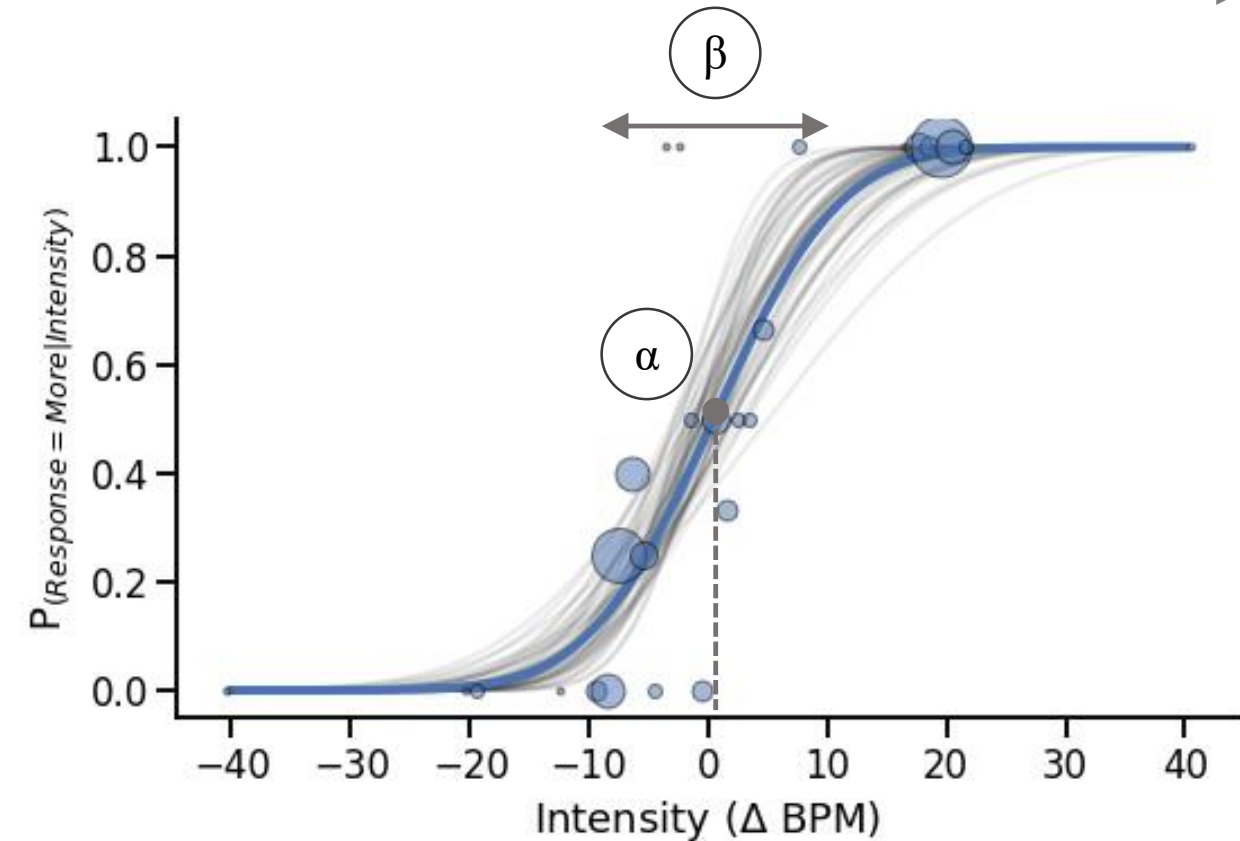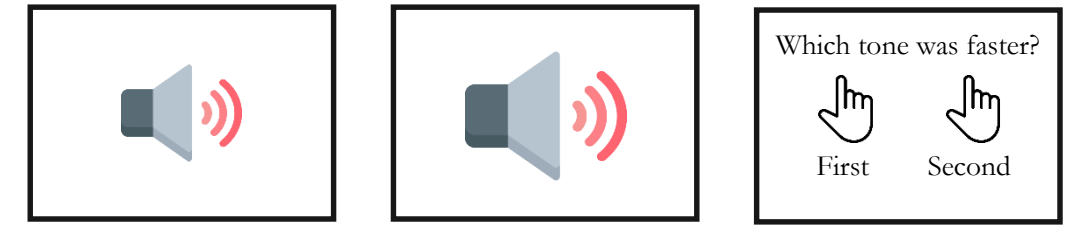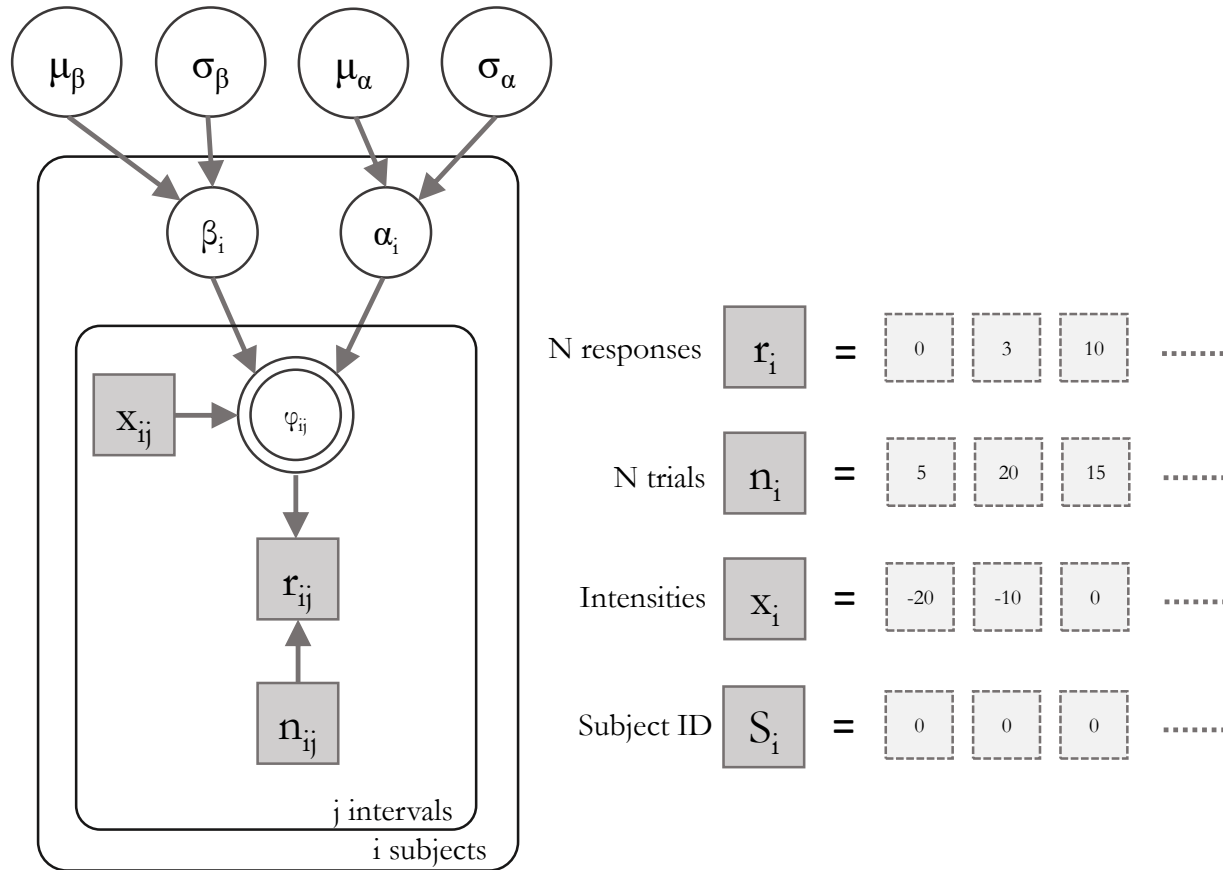group

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