

DECISION-MAKING

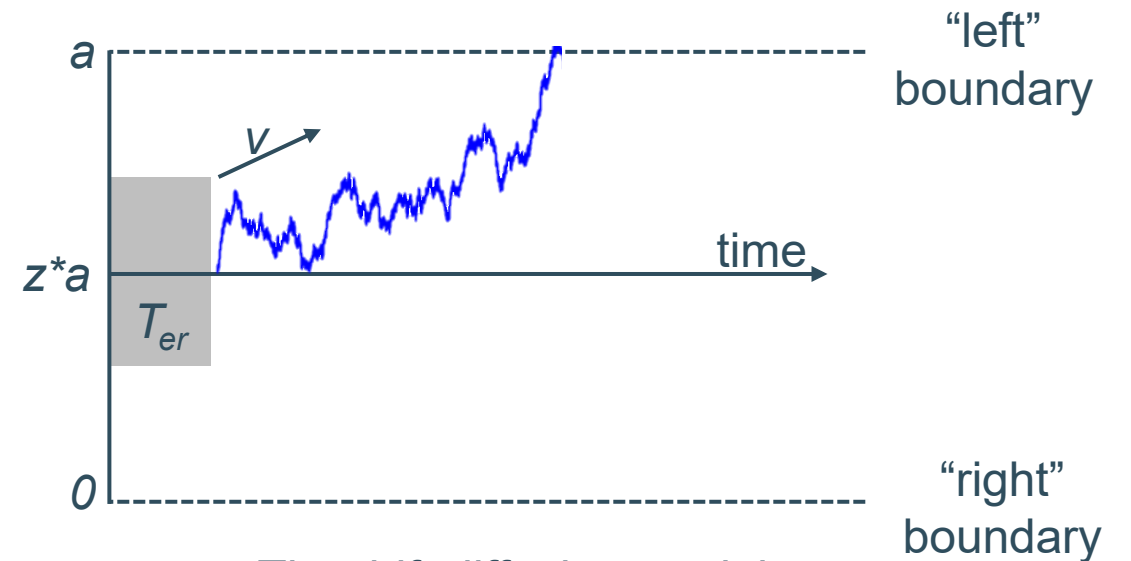
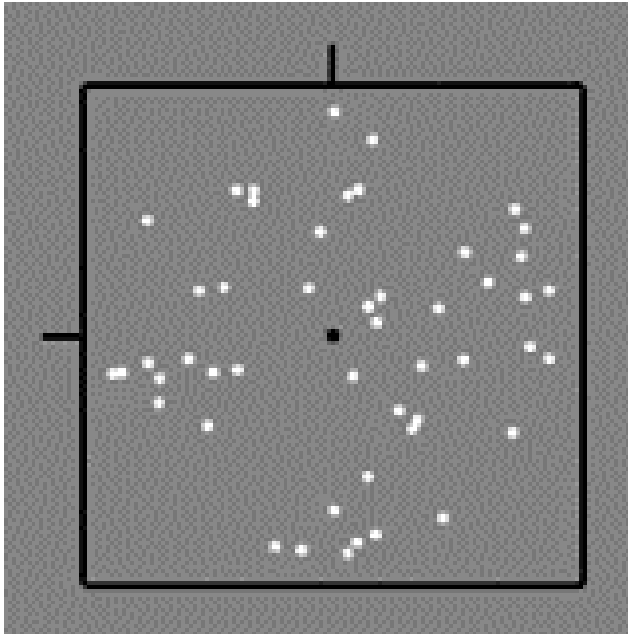
Kobe Desender



Decision making

- Decision making as noisy evidence accumulation

e.g. are these dots moving left or right?

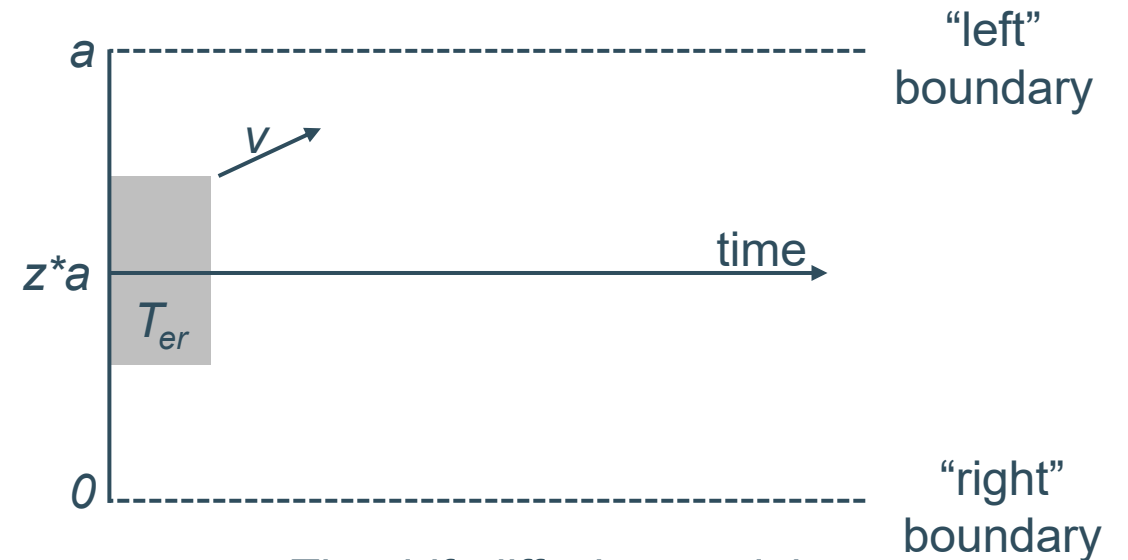
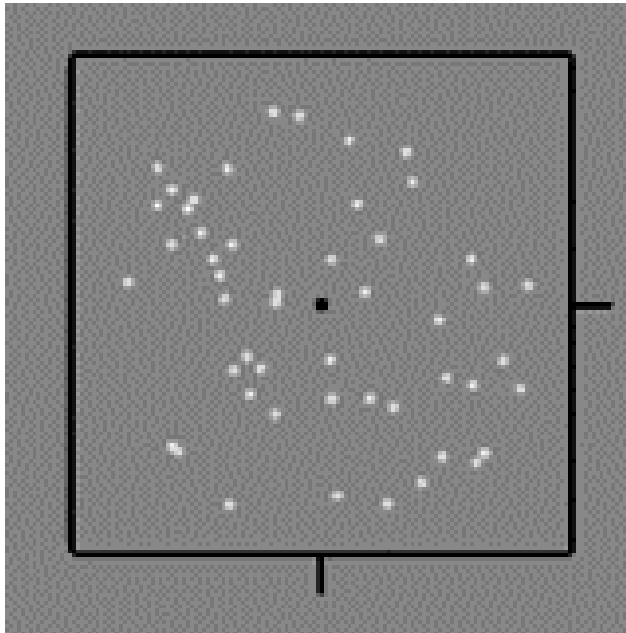


The drift diffusion model
(Ratcliff & Tuerlinckx, 2002, *Psychon Bull Rev*)

Decision making

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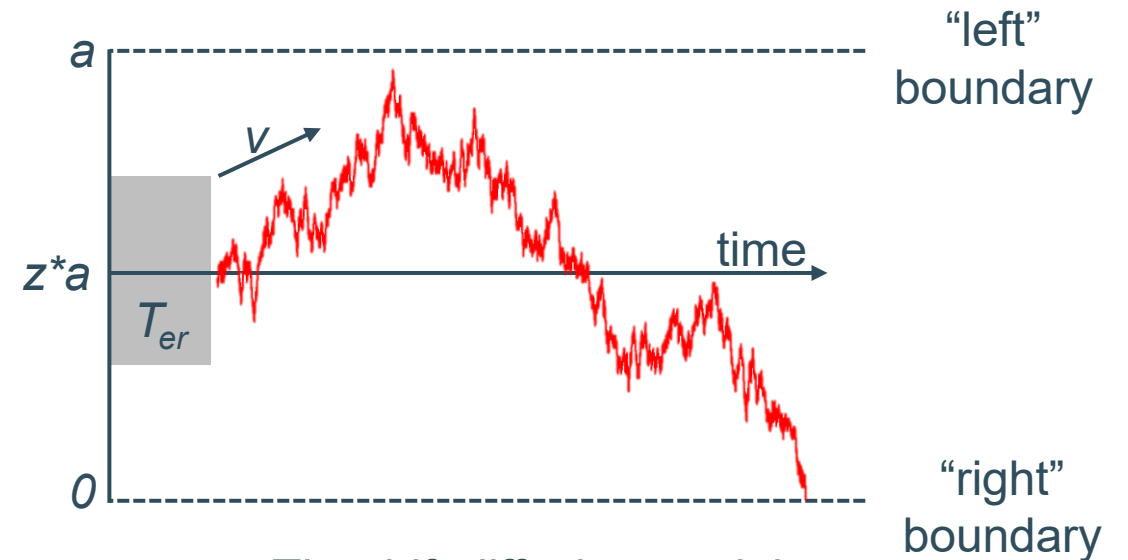
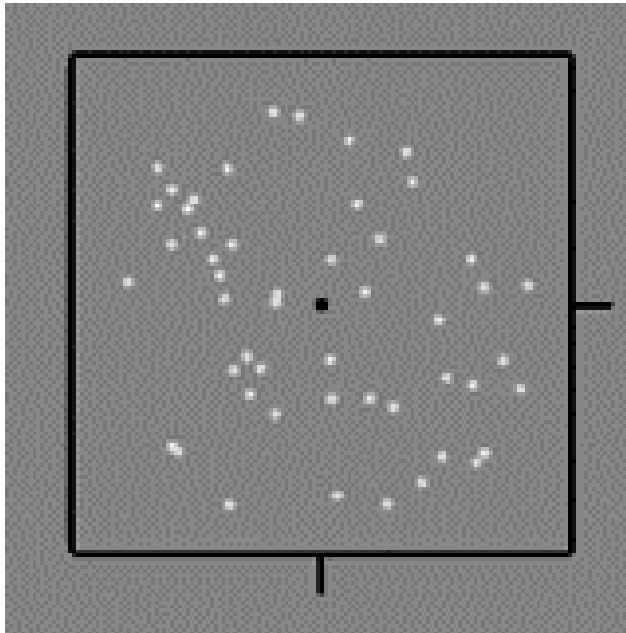


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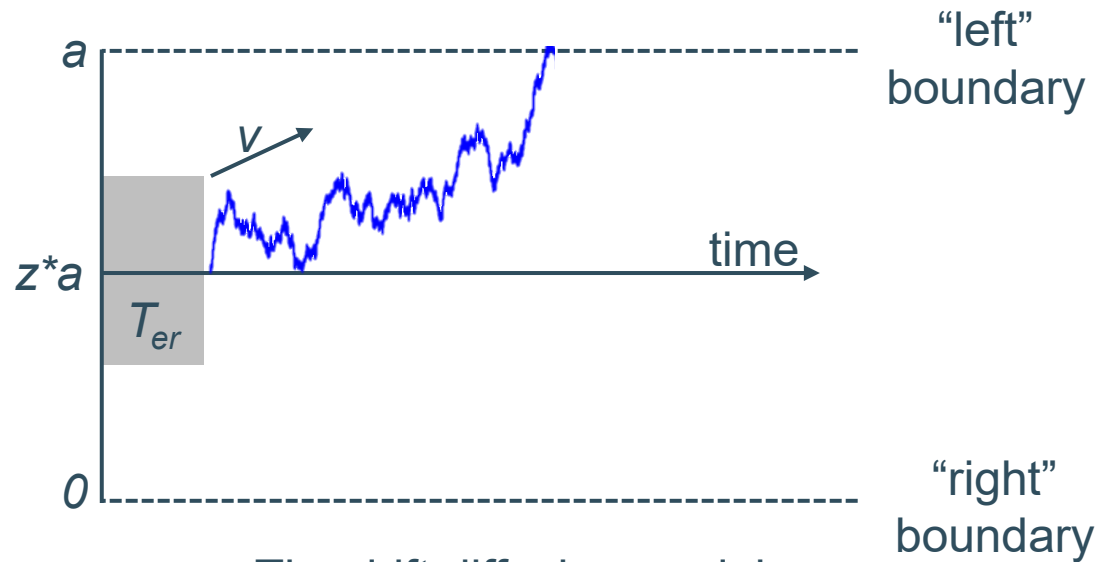
- Decision making as noisy evidence accumulation

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The drift diffusion model
(Ratcliff & Tuerlinckx, 2002, *Psychon Bull Rev*)

Decision making



The drift diffusion model
(Gold & Shadlen, 2007)

v = drift rate: efficiency of information accumulation (i.e., task difficulty, mental focus,...)

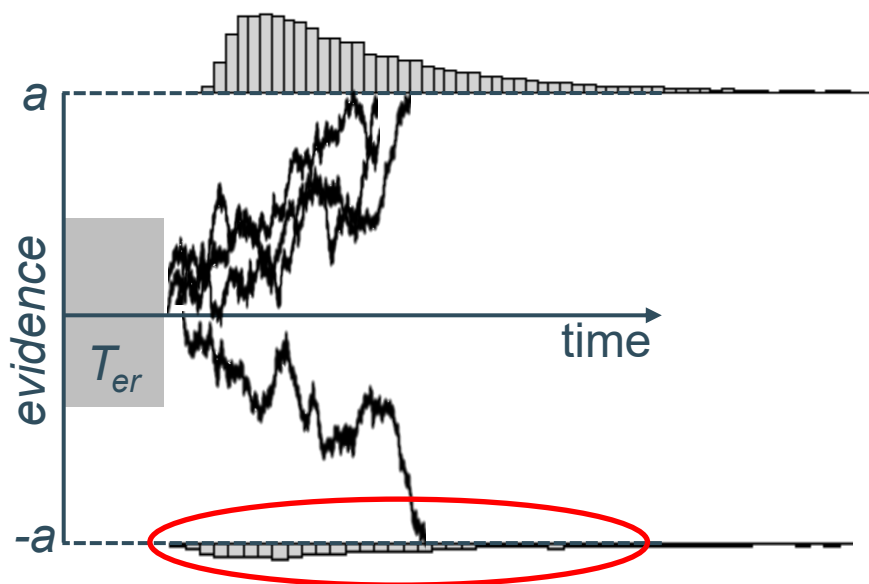
a = decision bound: amount of evidence required before a decision is made (i.e., control the speed-accuracy trade-off)

z = starting point: implements a bias for left or right responses

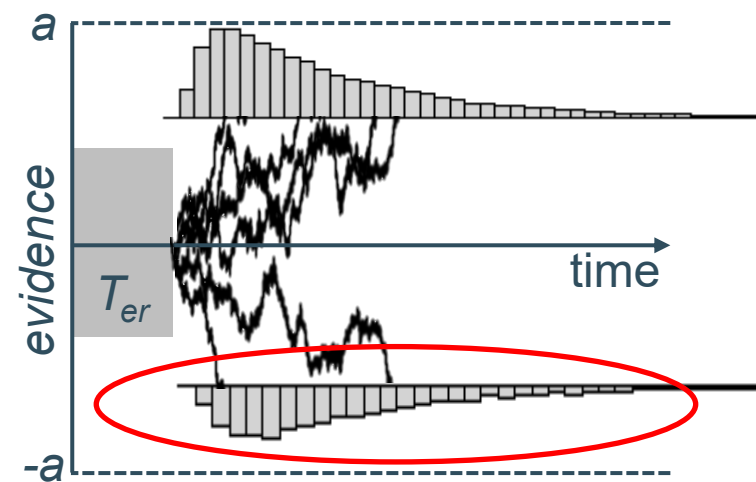
T_{er} = non-decision time: captures stimulus encoding, response execution,...

Decision making

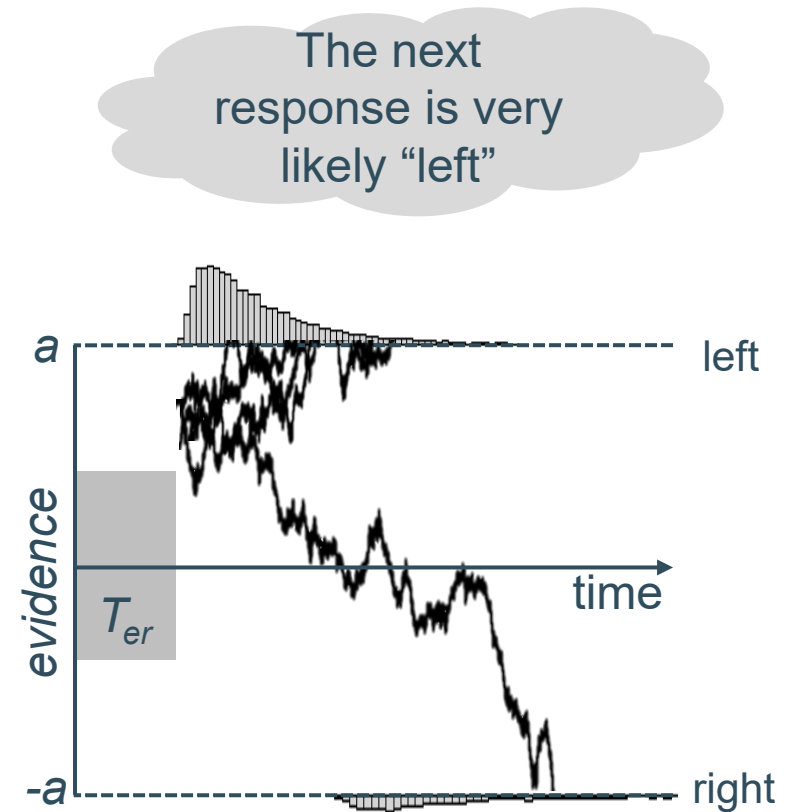
“Try to be accurate”



“Try to be fast”



Decision making



Decision making

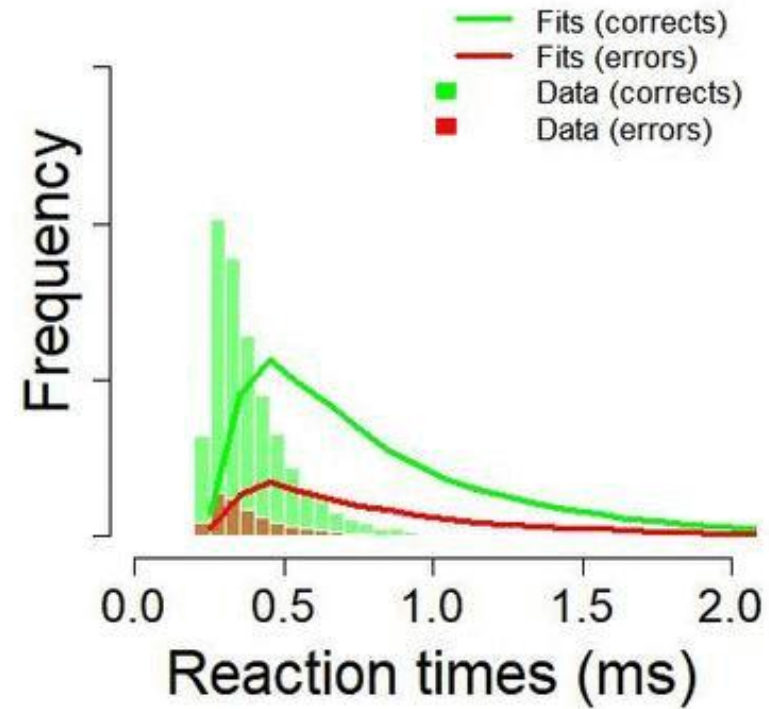
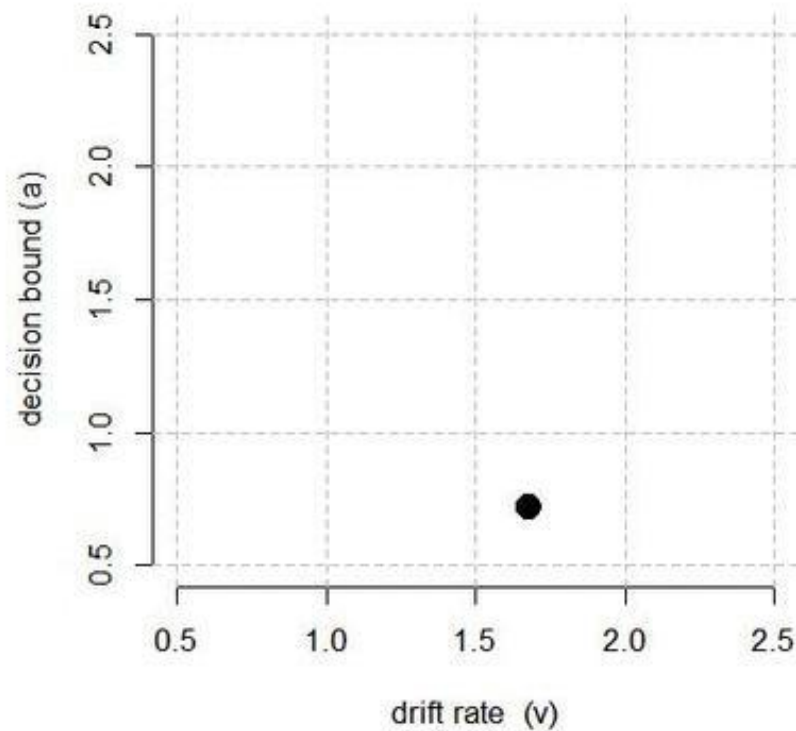
- Some thoughts:
 - Only suitable for (speeded) binary choice tasks
 - Precise RT measurements
 - Widely used in perceptual DM, but also value-based DM, social DM, etc.

Estimating the DDM parameters

- Imagine you have run an experiment, and now want to estimate the DDM parameters
- Estimating the parameters of the DDM is rather tricky because the likelihood function contains an infinite sum (Wald, 1947):

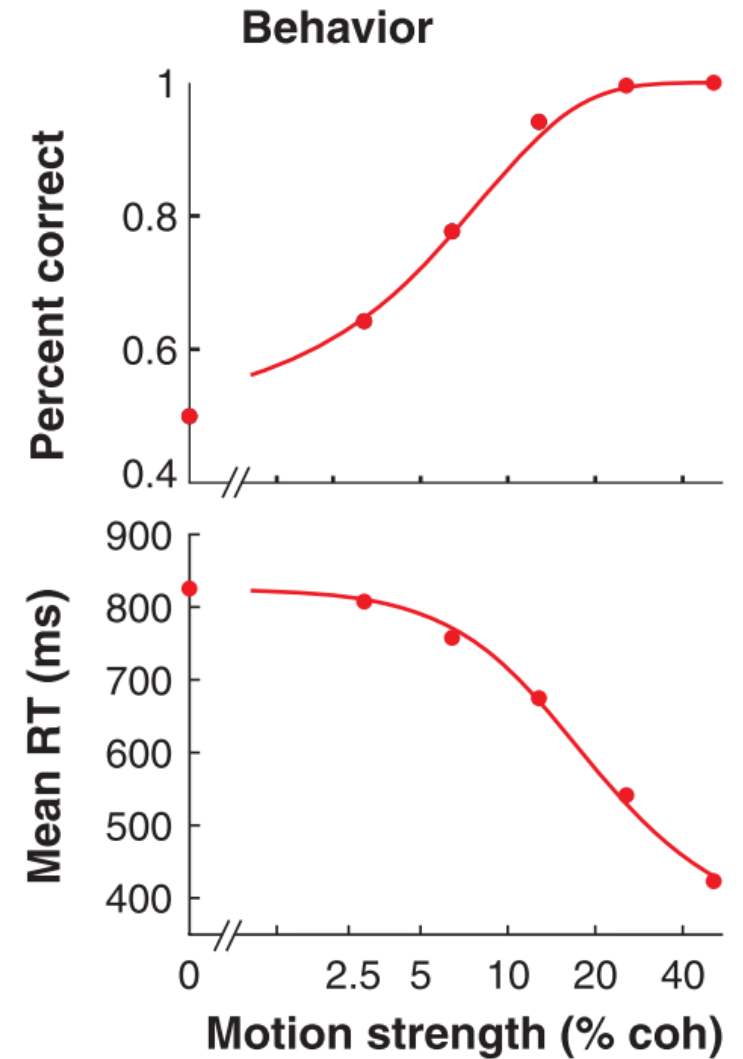
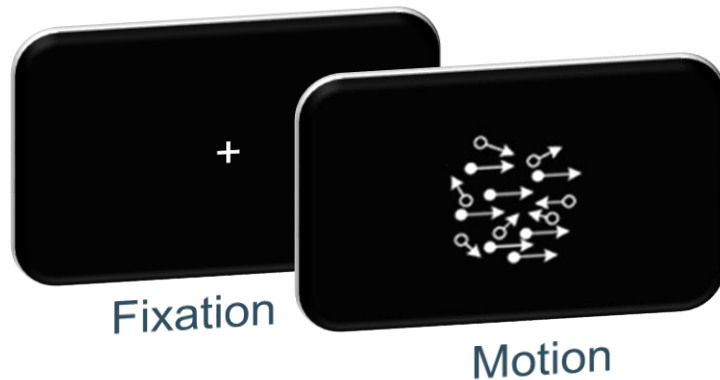
$$f(x|v, a, z) = \frac{\pi}{a^2} \exp\left(-vaz - \frac{v^2 x}{2}\right) \times \sum_{k=1}^{\infty} k \exp\left(-\frac{k^2 \pi^2 x}{2a^2}\right) \sin(k\pi z)$$

Estimating the DDM parameters

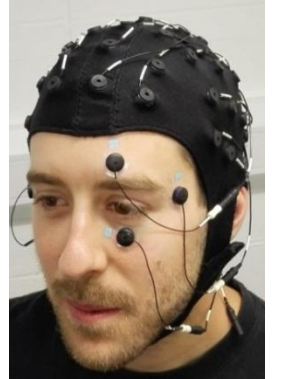


Decision making

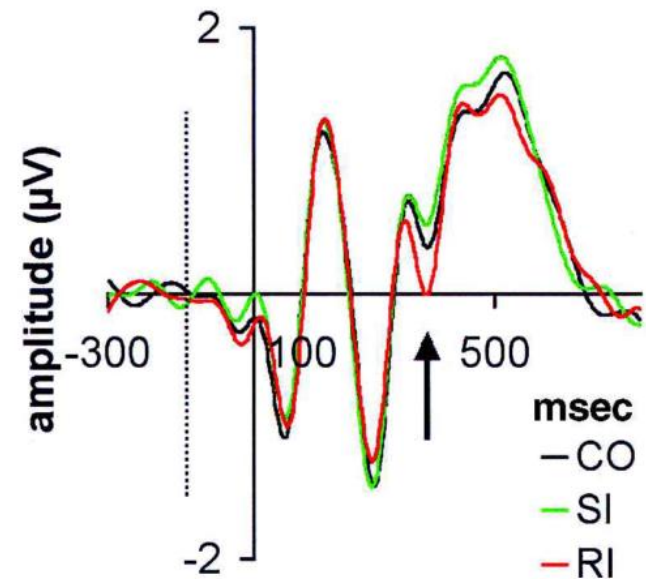
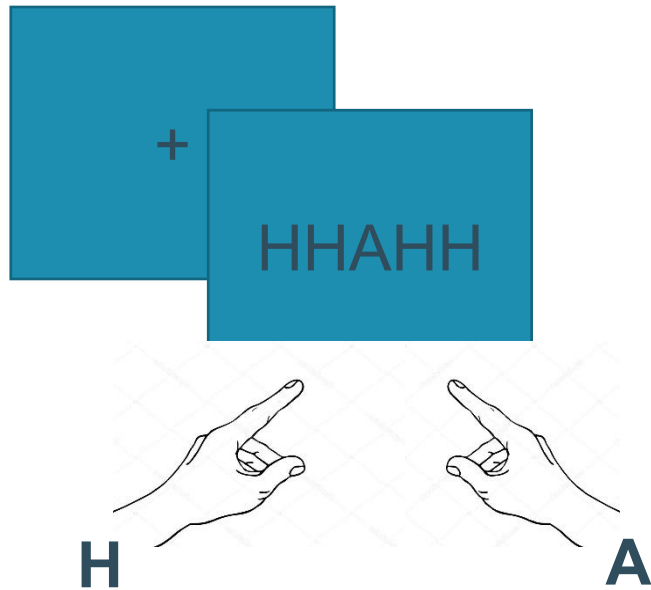
- Decision making as noisy evidence accumulation



Decision making

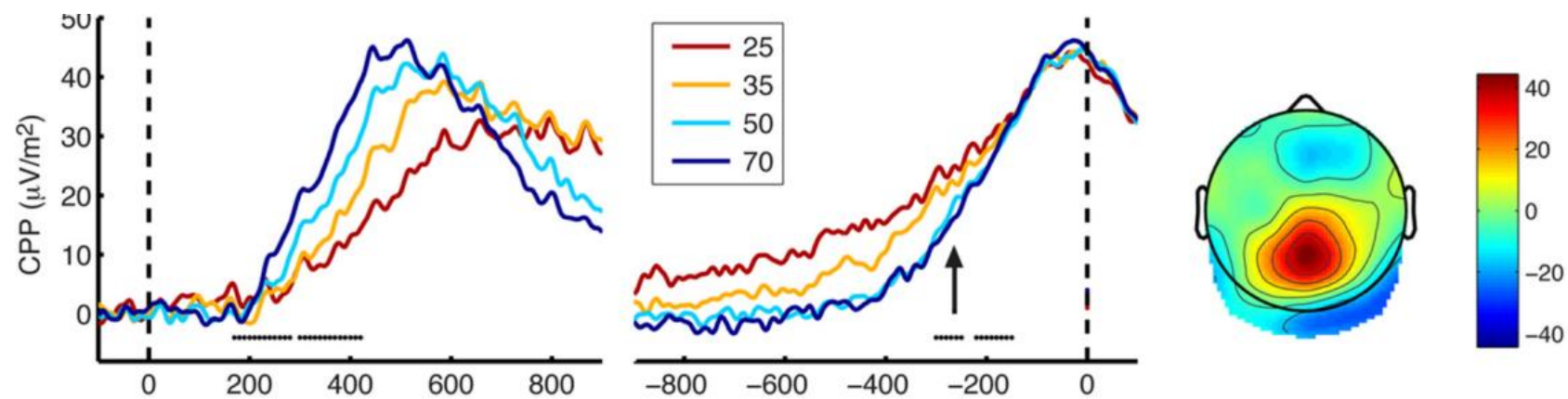
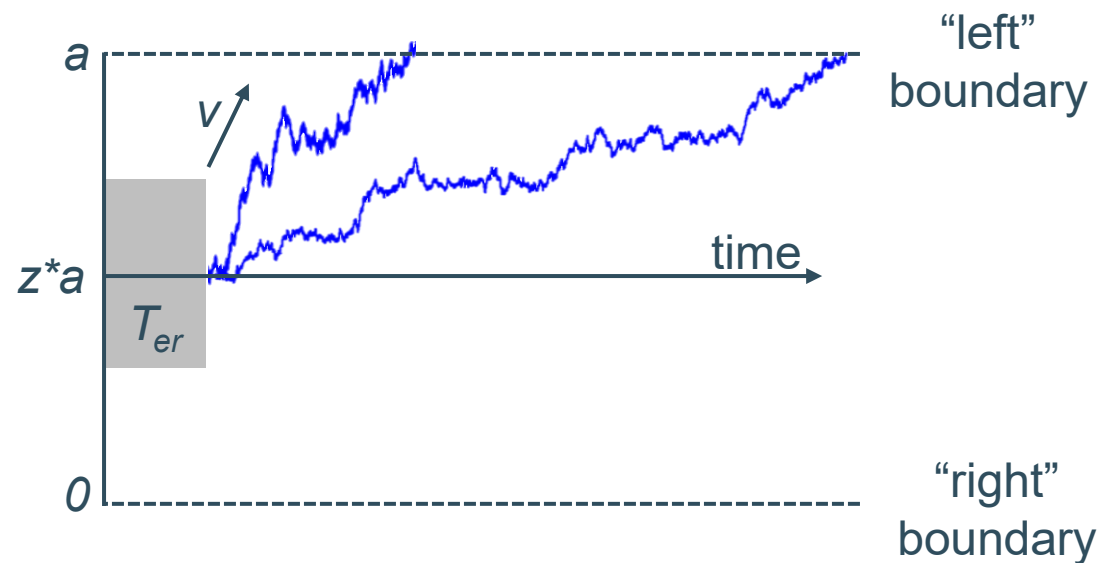
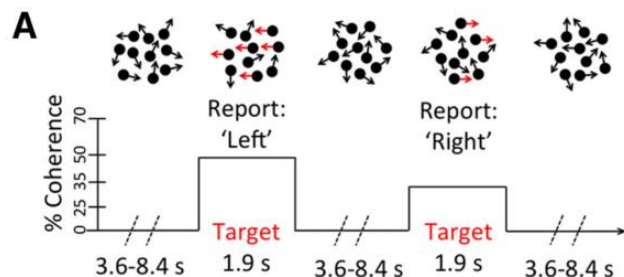


- O'Connell et al. (2012): sudden onset of a stimulus triggers a rapid cascade of neural events that may obscure this evidence accumulation signal



van Veen & Carter (2002)

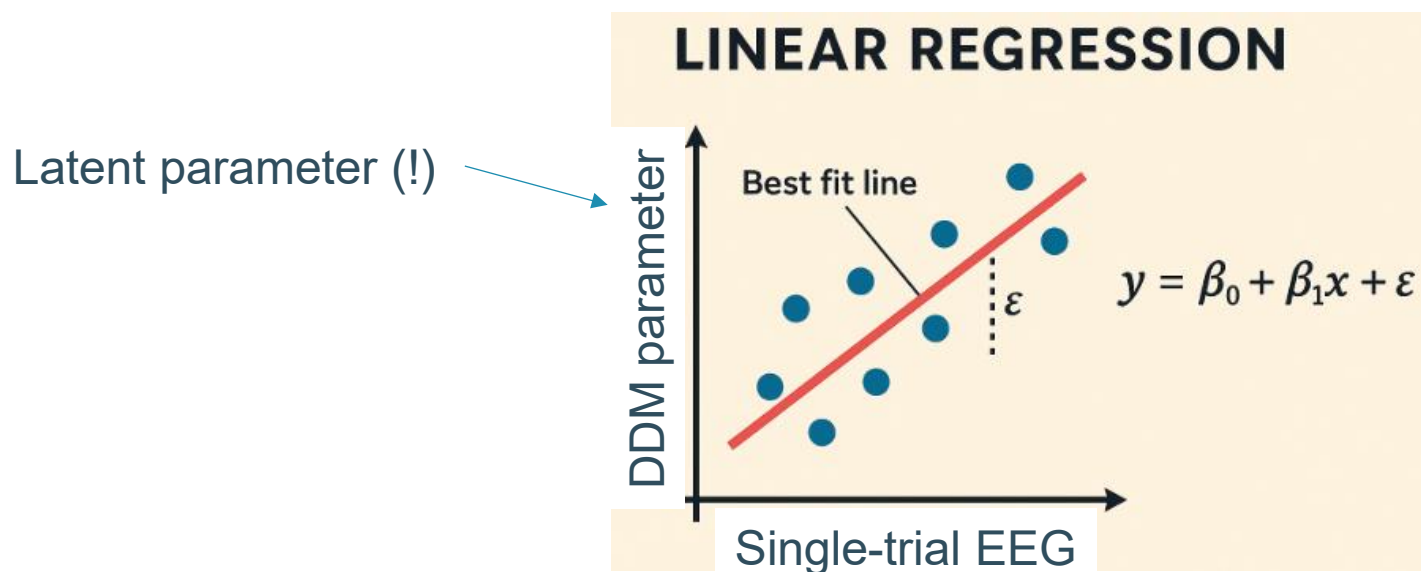
Decision making



(Kelly & O’Connell, 2013)

Decision making

- But this is just visual inspection, based on grand averages. Can we provide more direct evidence?
- Regression to the rescue



Traditional DDM

$$y = b_0$$

e.g. drift = 1

Regression-style DDM

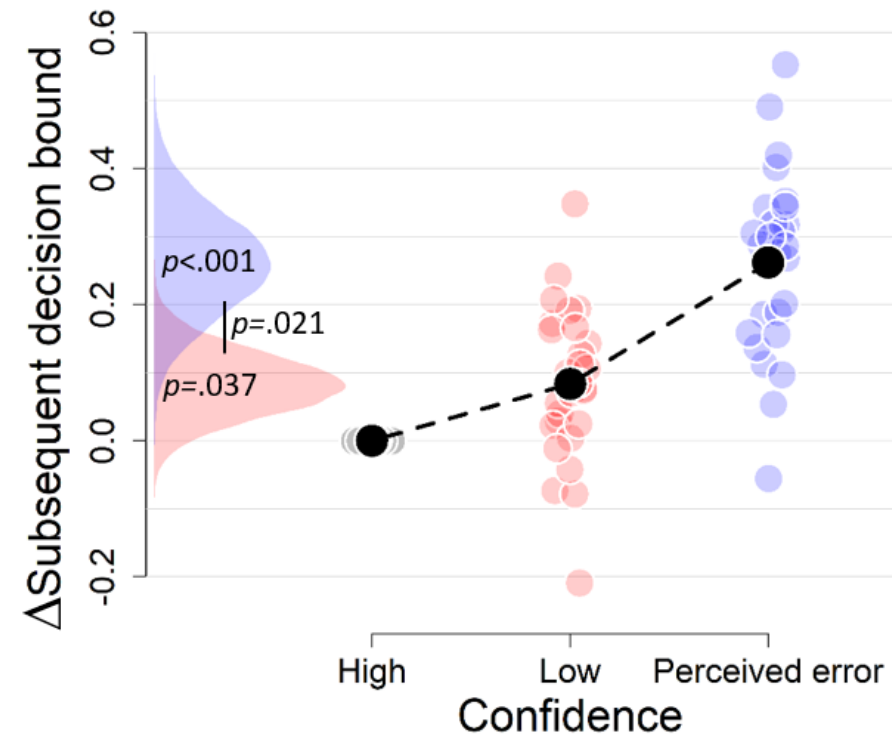
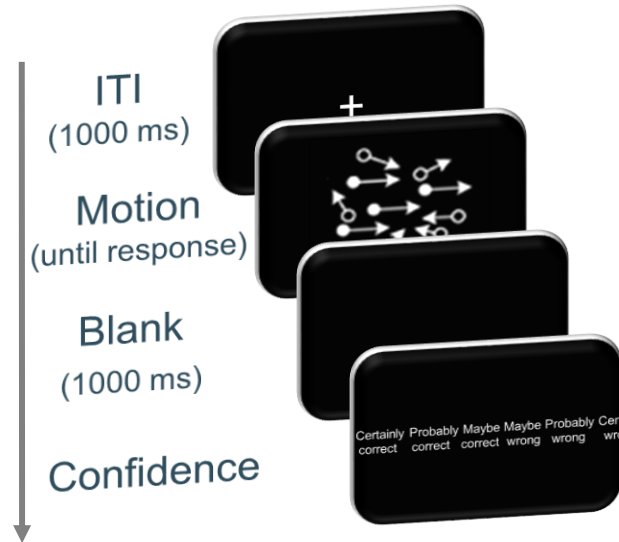
$$y = b_0 + b_1 * X$$

e.g. drift_{trial1} = 1 + b₁*EEG_{trial1}

Decision making

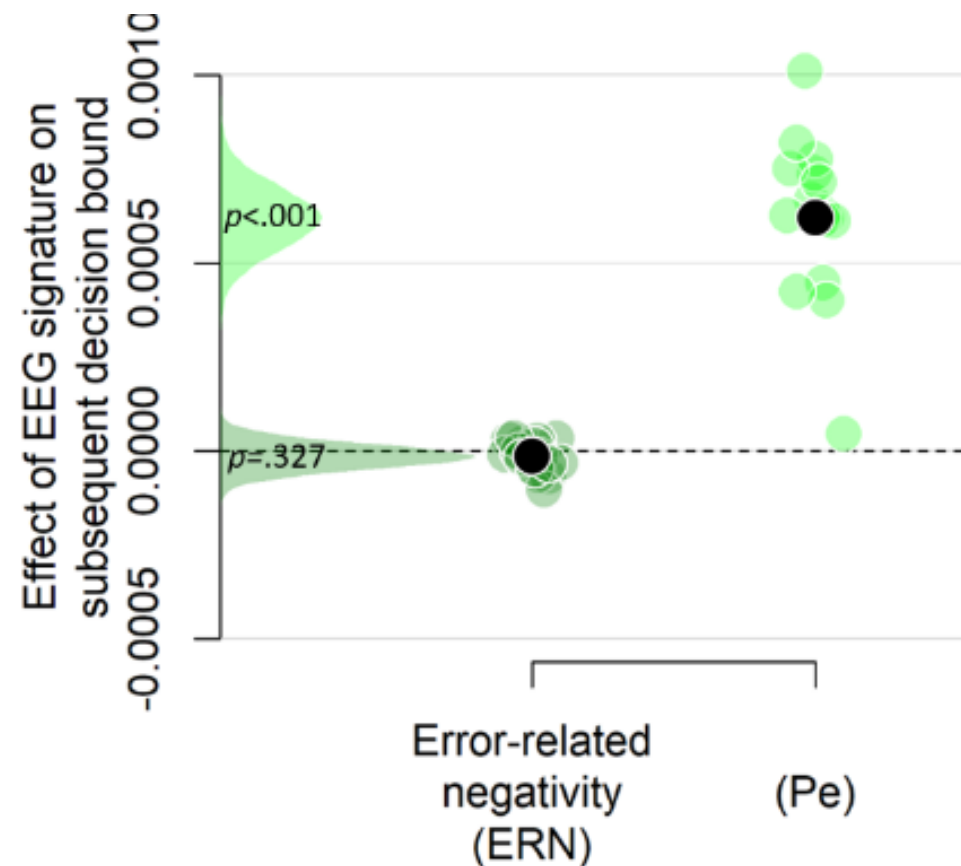
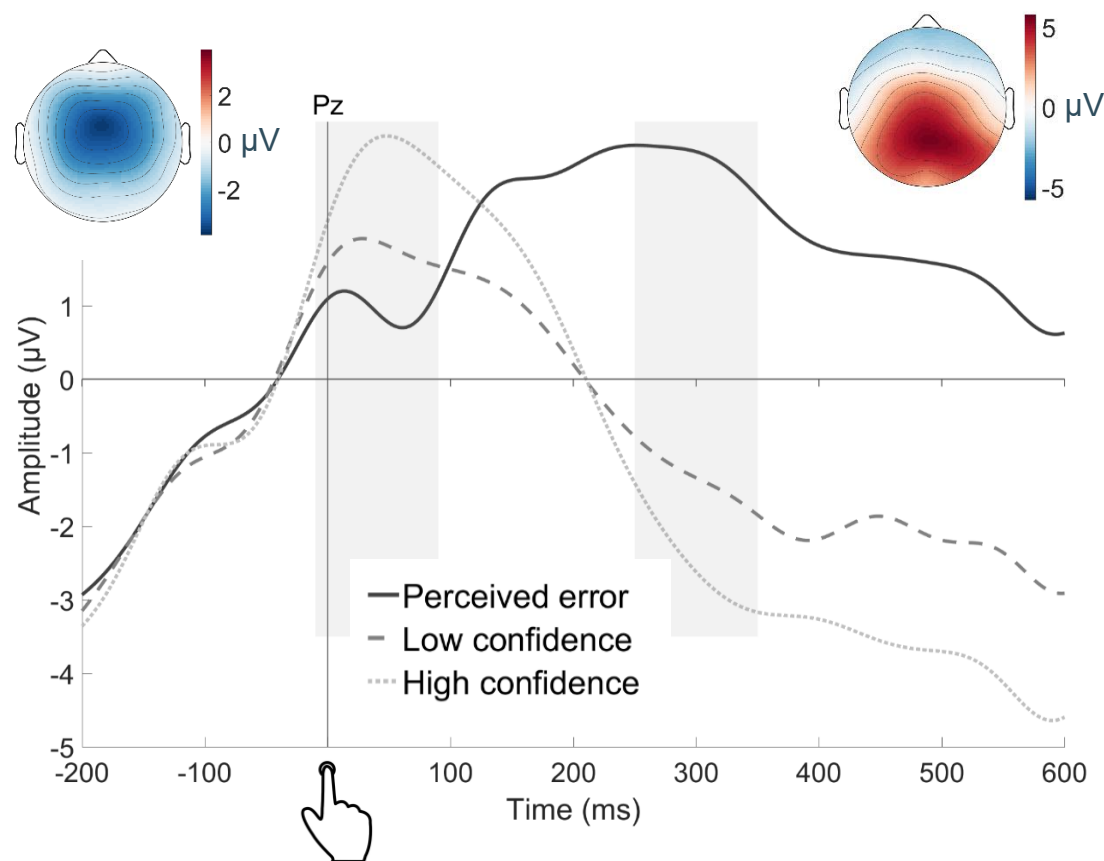
- What questions can we answer
 - 1. Which signals in the brain reflect decision-making?
=> Today (!)
 - 2. How does variable x affect the decision-making process?
 - Confidence (Desender et al., 2019)
 - Caution ratings (Visser et al., *in prep*)

Confidence



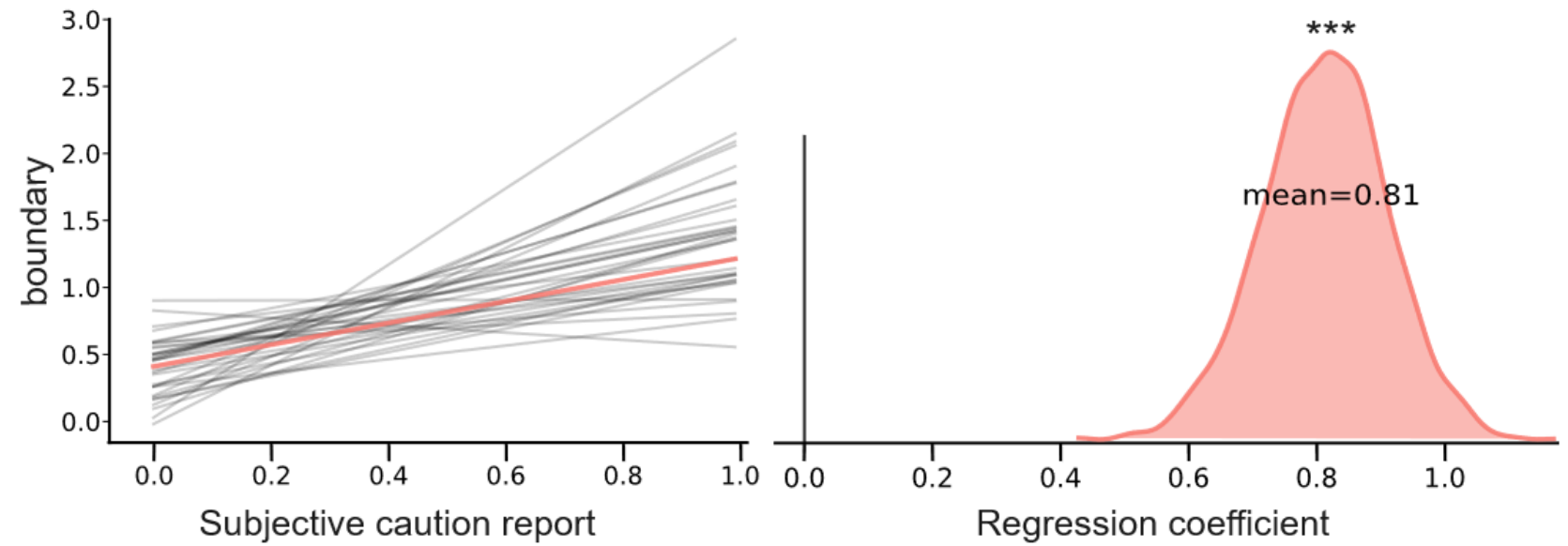
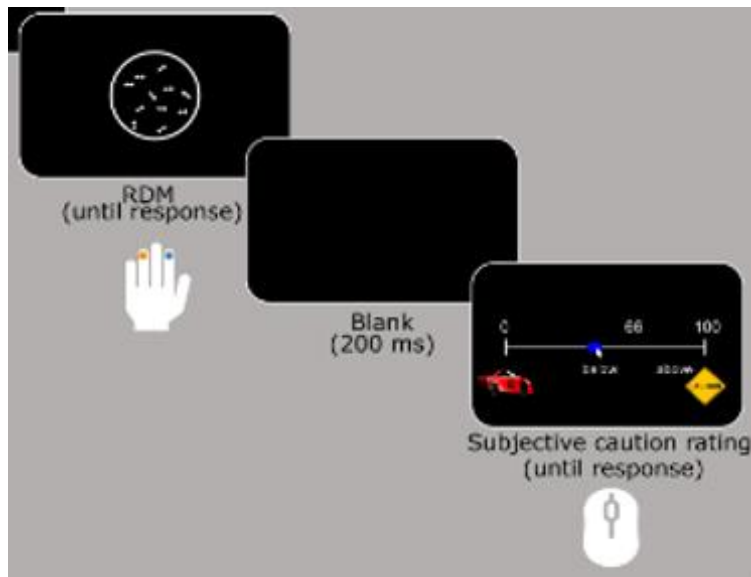
Desender et al., 2019, *eLife*

Confidence



Desender et al., 2019, *eLife*

Caution ratings



Visser et al., *in prep*

Decision making

- Cool! How can I do this?
 - If you have lots of time and like coding
 - Implement your own rstan model (get in touch if you want a headstart!)
 - If you have exactly 1h30 minutes
 - Use a toolbox (e.g. hssm) which has the regression module implemented

www.desenderlab.com

or

https://colab.research.google.com/drive/1Ul9azKmvXRRReiH-WjBYia_7wgL3punt1?usp=sharing



DesenderLab.com



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