DEPARTMENT OF PSYCHOLOGY
NEUROPSYCHOLOGY LAB

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How stress modulates intention tremor | first project ideas

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TREMOR | what is it?

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Tremor is defined as rhythmic oscillatory activity of body parts

1. Mechanical oscillations
2. Oscillations based on reflexes
3. Oscillations due to central neuronal pacemakers
4. Oscillations because of disturbed feedforward or feedback loops

Deuschl ea., *Muscle Nerve*, 2001

Tremor | in the brain

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1. Primary motor cortex (MC) is involved in the tremor-generating network

2. MC oscillations are coherent with oscillations in the thalamus, basal ganglia and the cerebellum

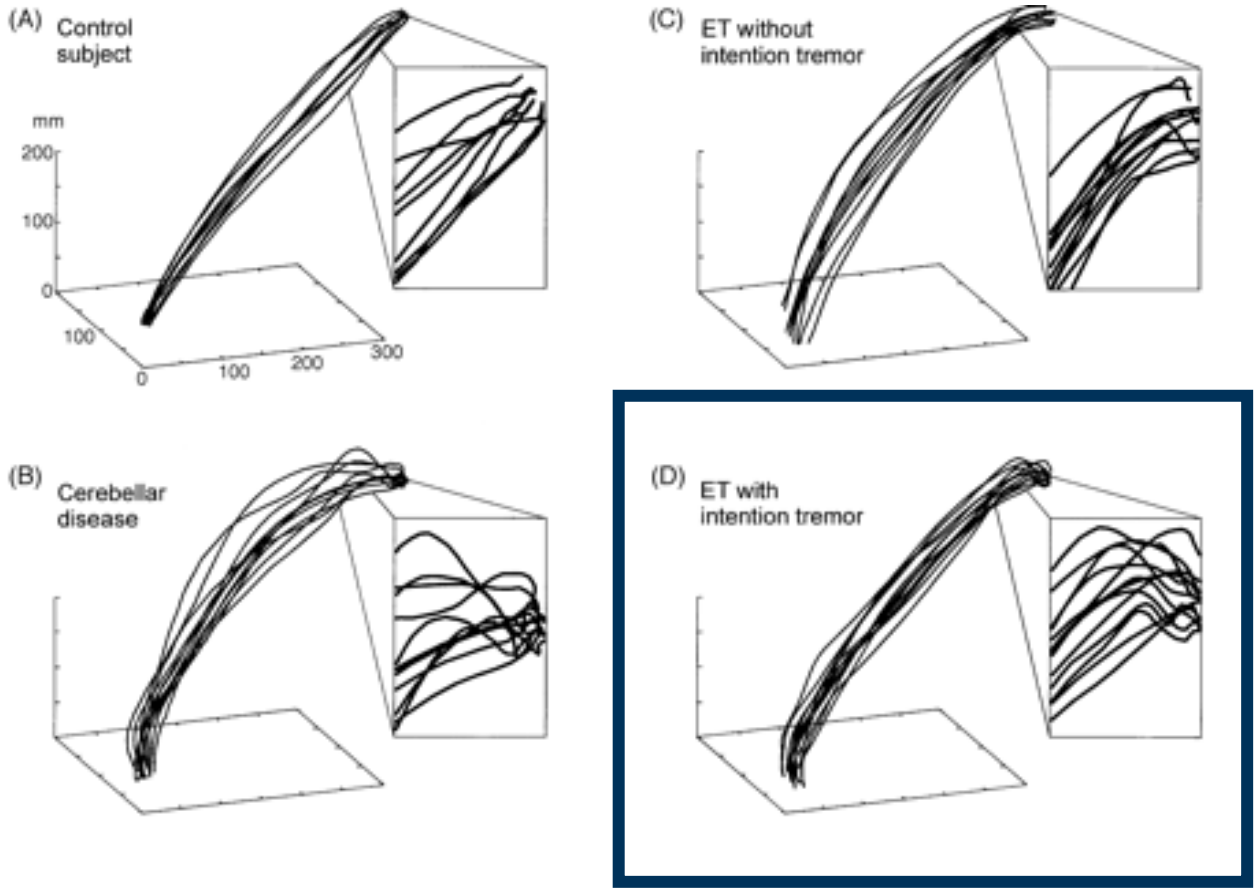
3. Rhythmic cortical activity has been shown to be transmitted to the STN and STN–GPi network

Schnitzler & Gross, *Nature Reviews Neuroscience*, 2005

Subtypes of tremor

- Parksinons tremor
- Physiological tremor
- Essential tremor
- Orthostatic tremor
- Cerebellar tremor
- …

- Intentions tremor



Deuschl ea., *Brain*, 2000

intention tremor

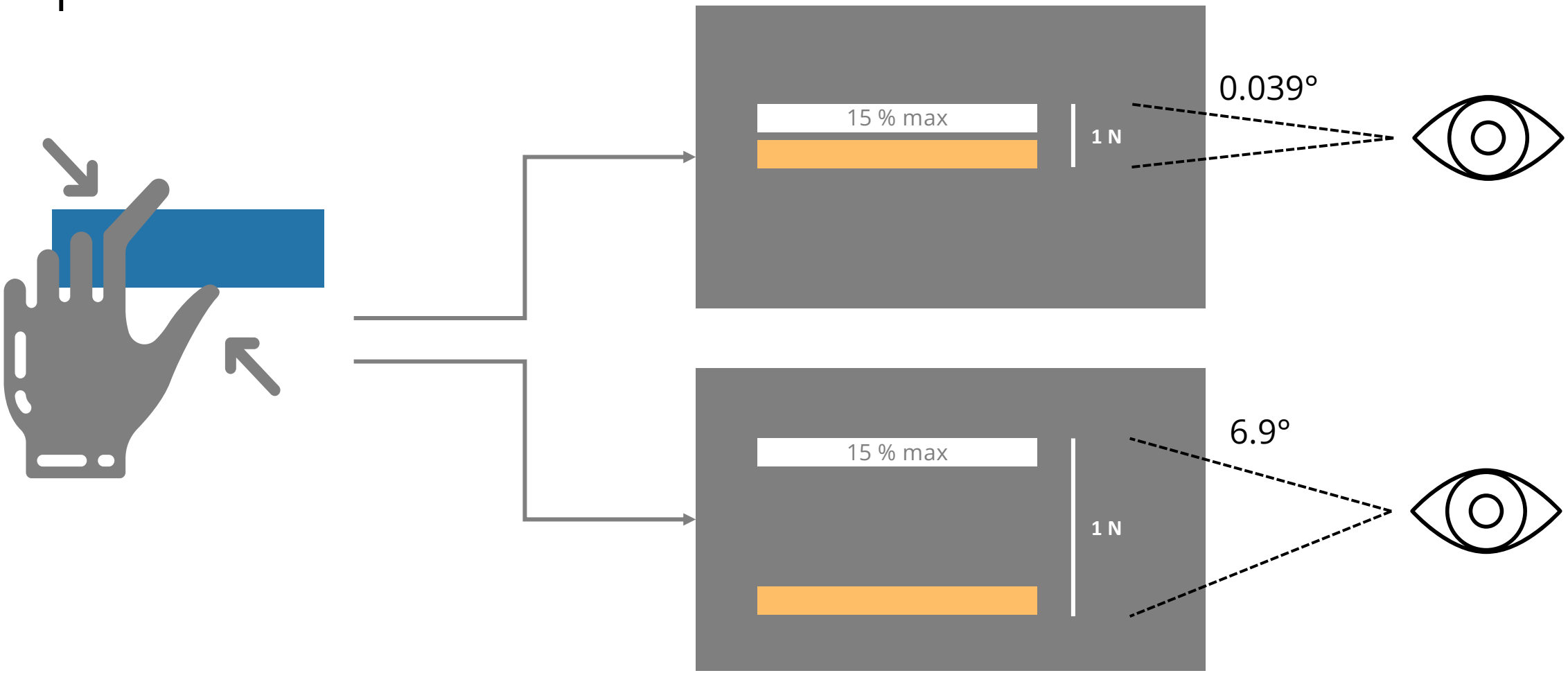
- The underlying cause of the tremor could lie within or outside the core network

- Visual input?:
  i. an increase in visual feedback exacerbates tremor
  ii. this will be related to an altered BOLD response in the cerebellum, thalamus, and motor cortex, as well as in parietal and visual areas

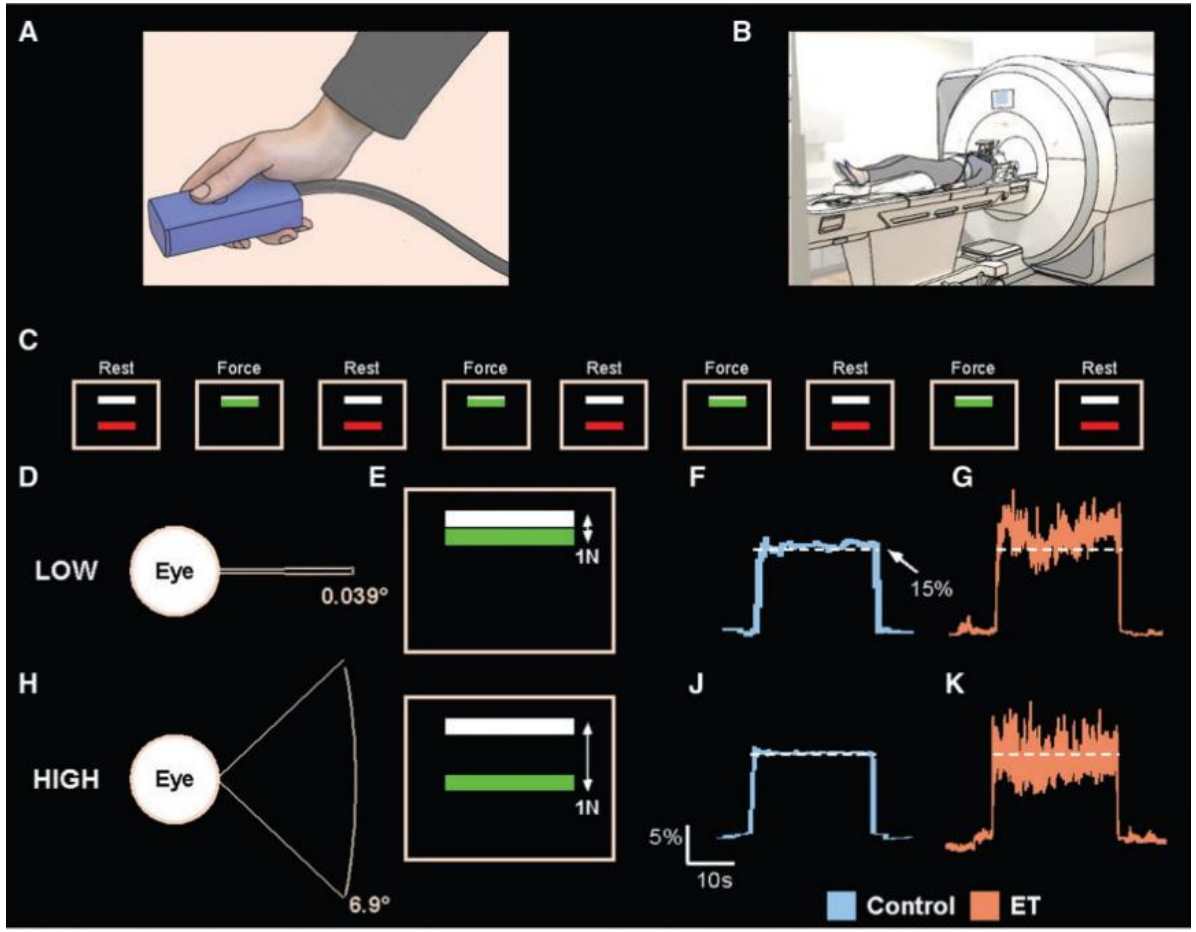
Schnitzler ea., *Movement Disorders*, 2009, Archer ea., *Brain*, 2017

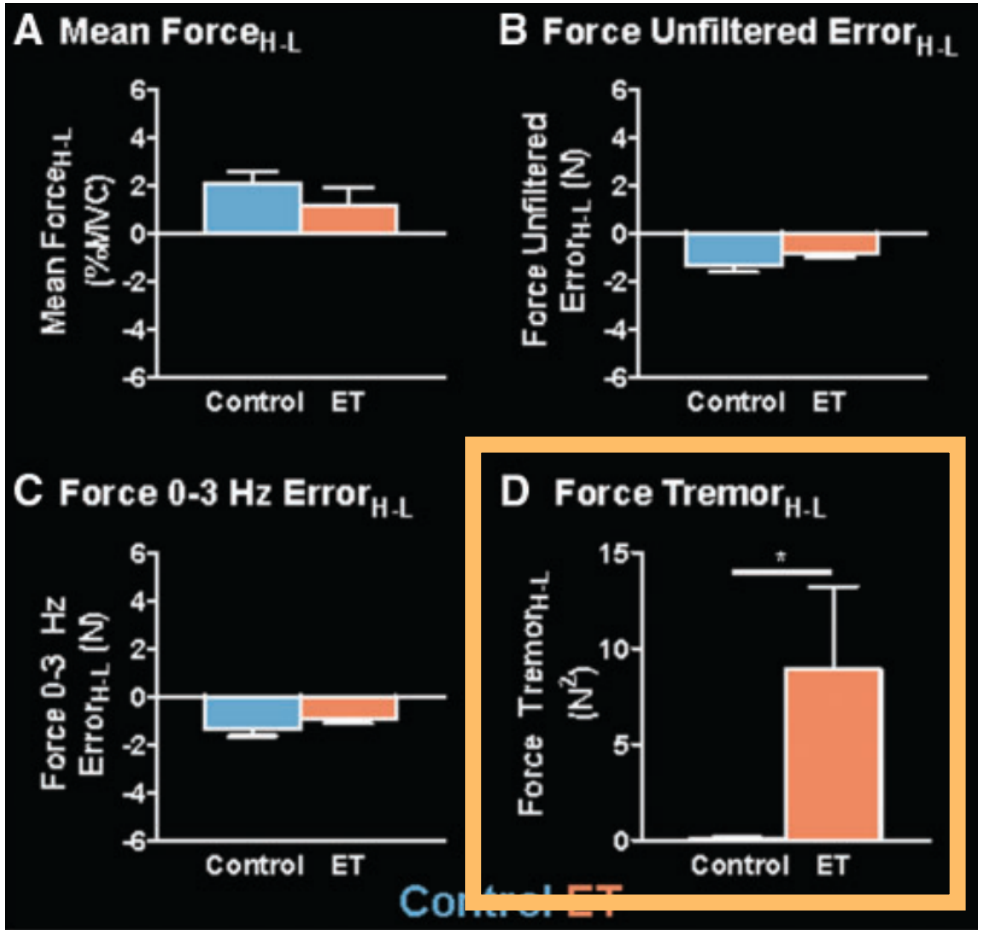
Visual feedback | Archer ea., 2017

A widespread visually-sensitive functional network relates to symptoms in essential tremor



Intention tremor | visual?



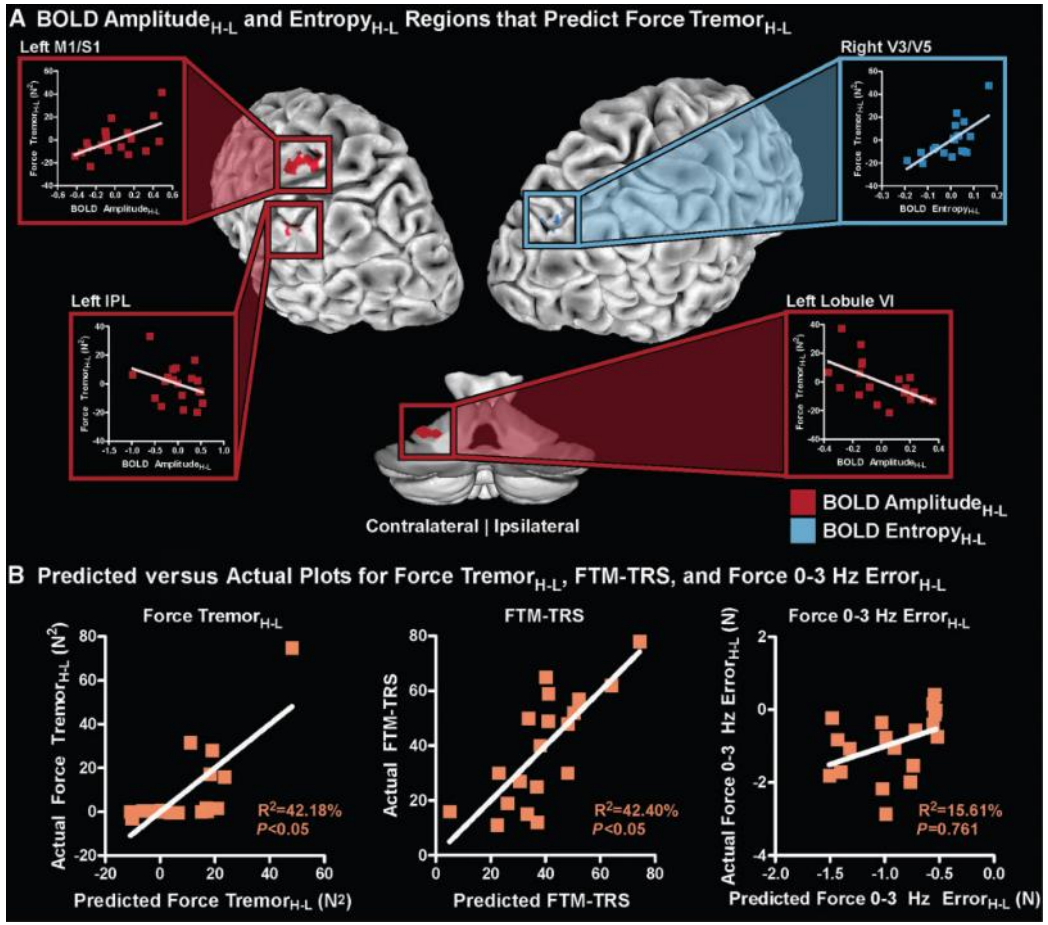


Archer ea., *Brain*, 2017

Visual tremor?

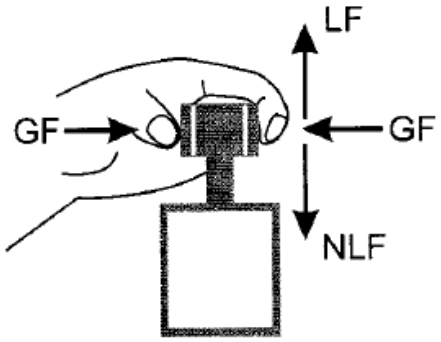
- bidirectional stepwise regression analysis
- R^2_{adj} = 42.18%; p > 0.05

- Associating Force Tremor$_{H-L}$
  - BOLD Amplitude$_{H-L}$
    - left M1/S1, IPL
    - cerebellar lobule VI
  - BOLD Entropy$_{H-L}$
    - right V3/V5
  - age

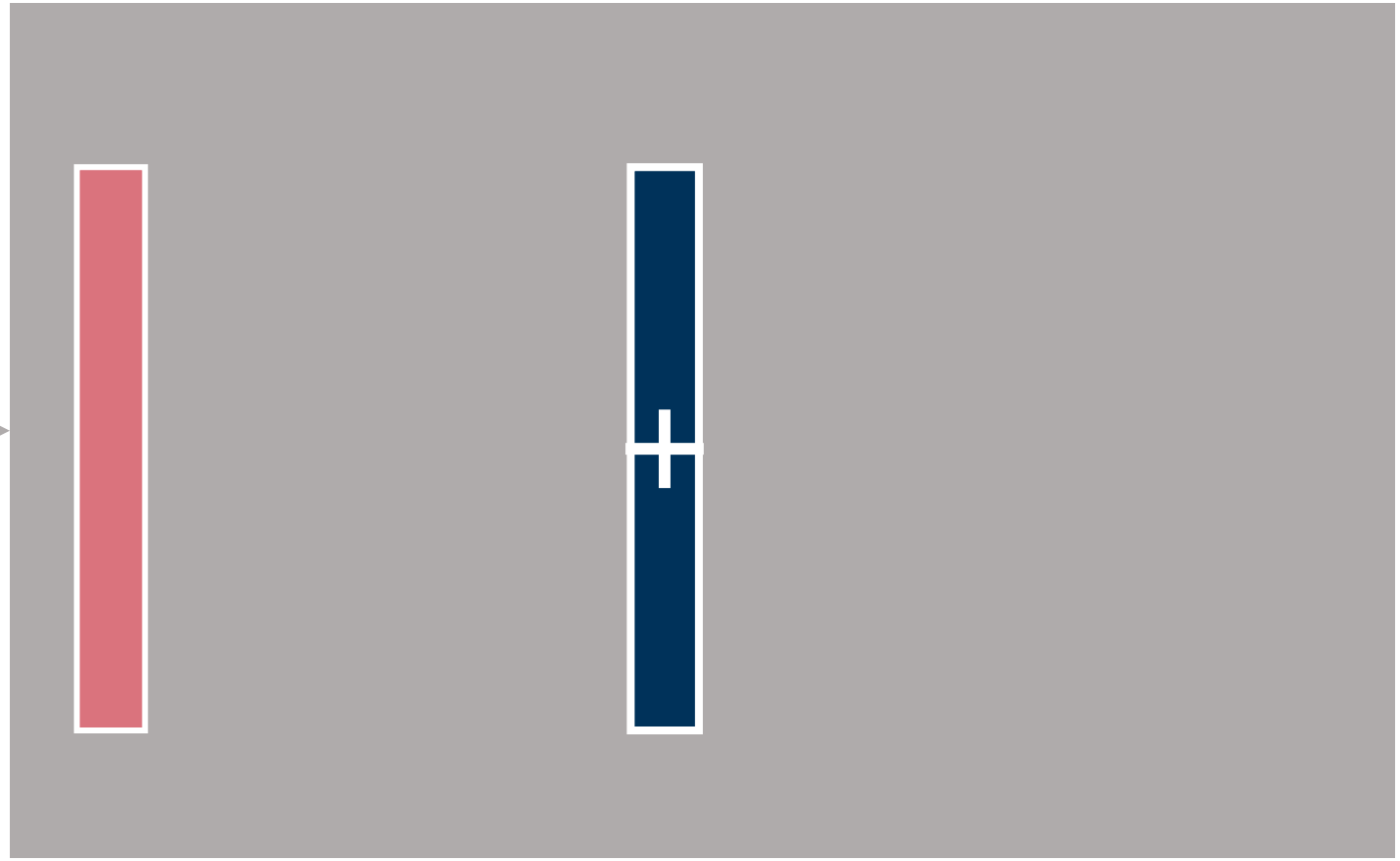


Archer ea., *Brain*, 2017

Exp design | basic idea

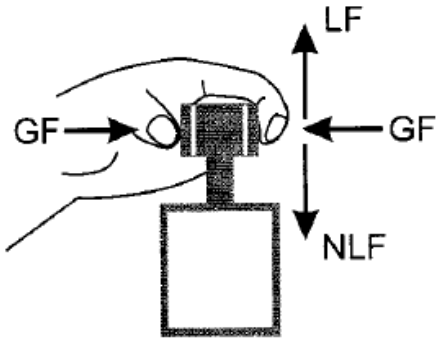


Raw signal (force)



1.5-3.5 sec | 8 sec

Exp design | visual manipulation



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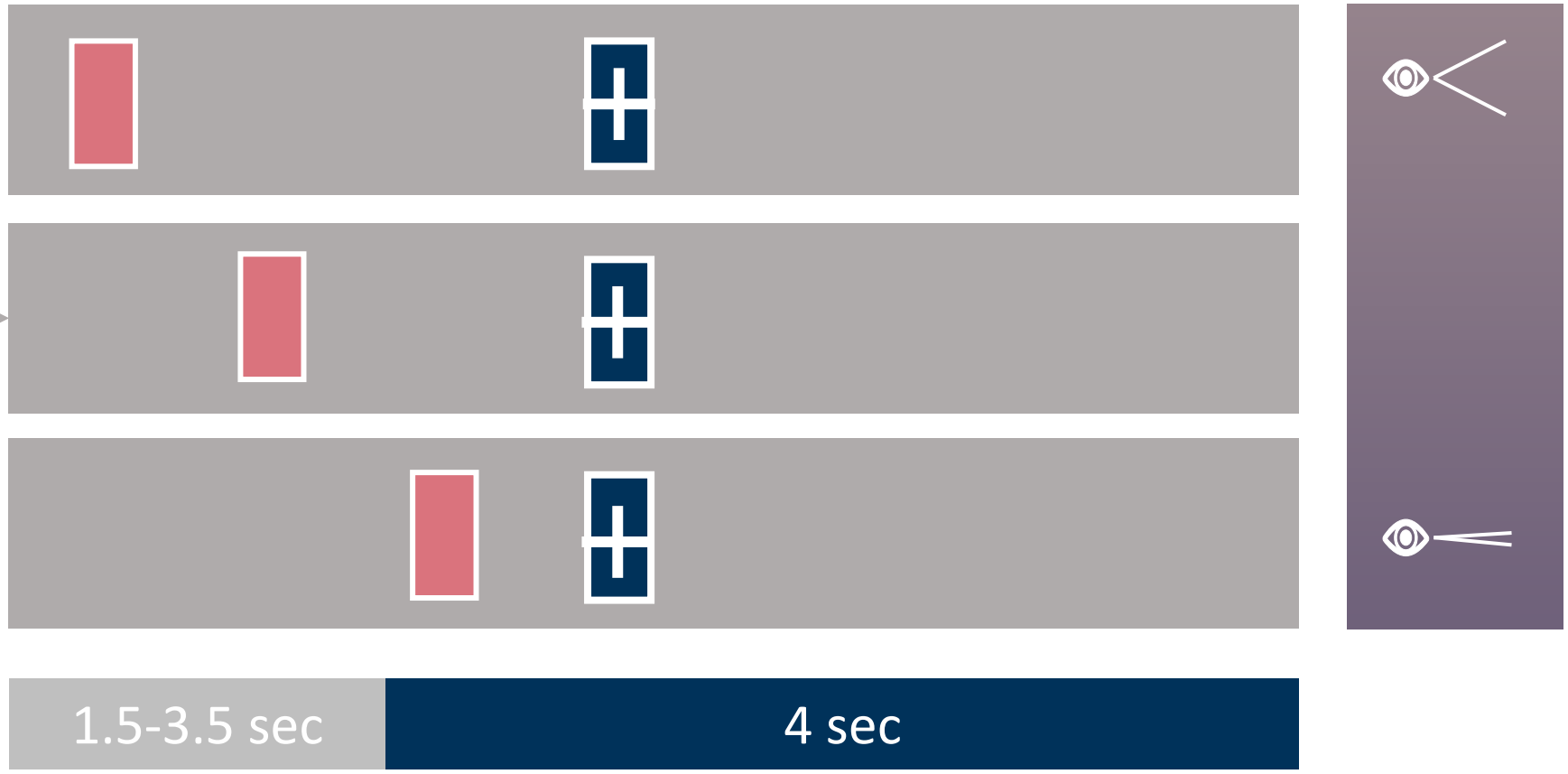
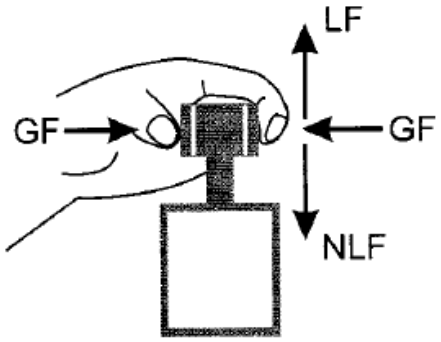


Exp design | basic idea



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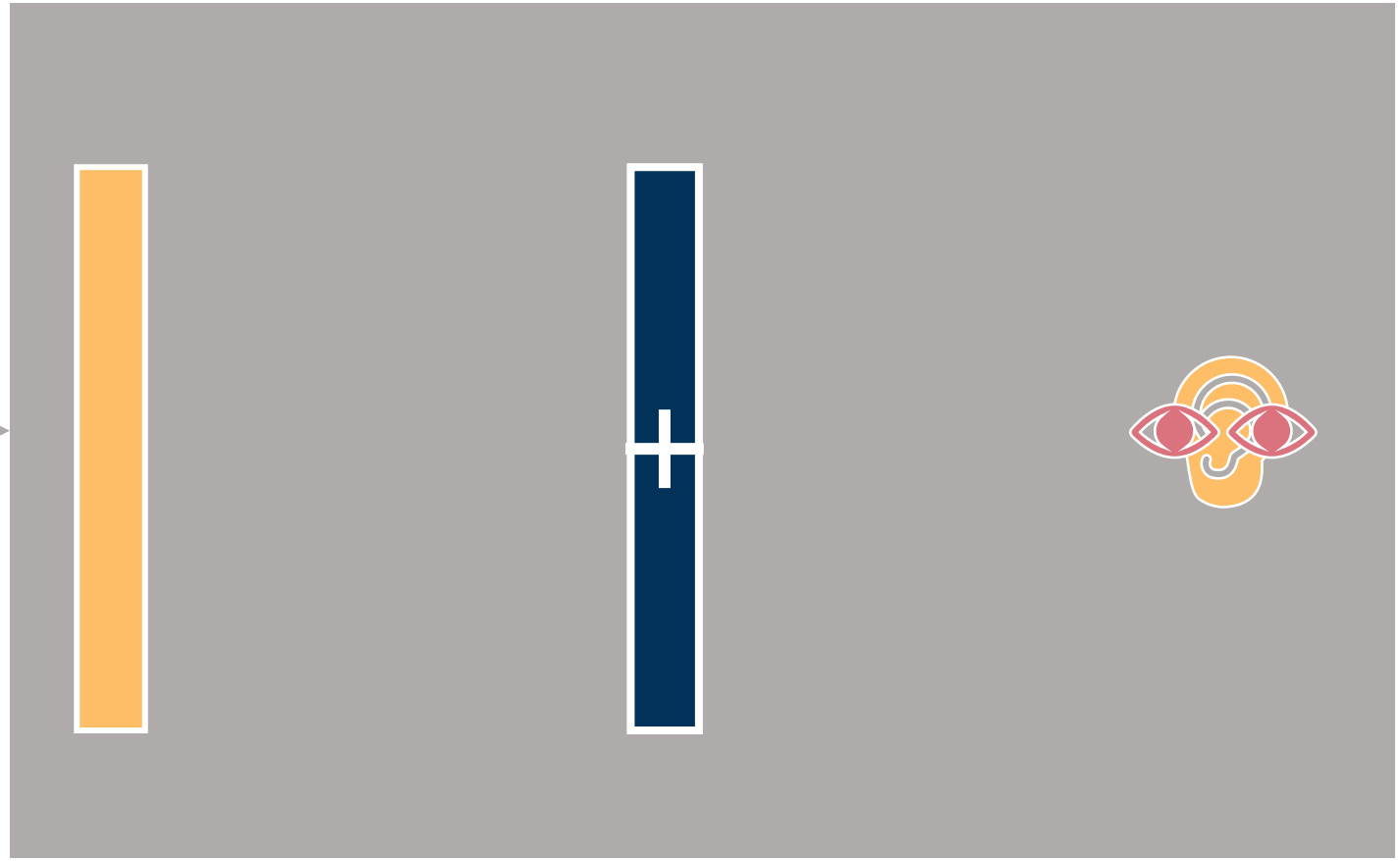

1.5-3.5 sec | 8 sec

Exp design | find the intention

Rest
[3 min]

80 trials
[~7 sec]

80 trials
[~7 sec]

160 trials
[20-30 min]

Hold
[3 min]

Technical setup | EEG & tremor

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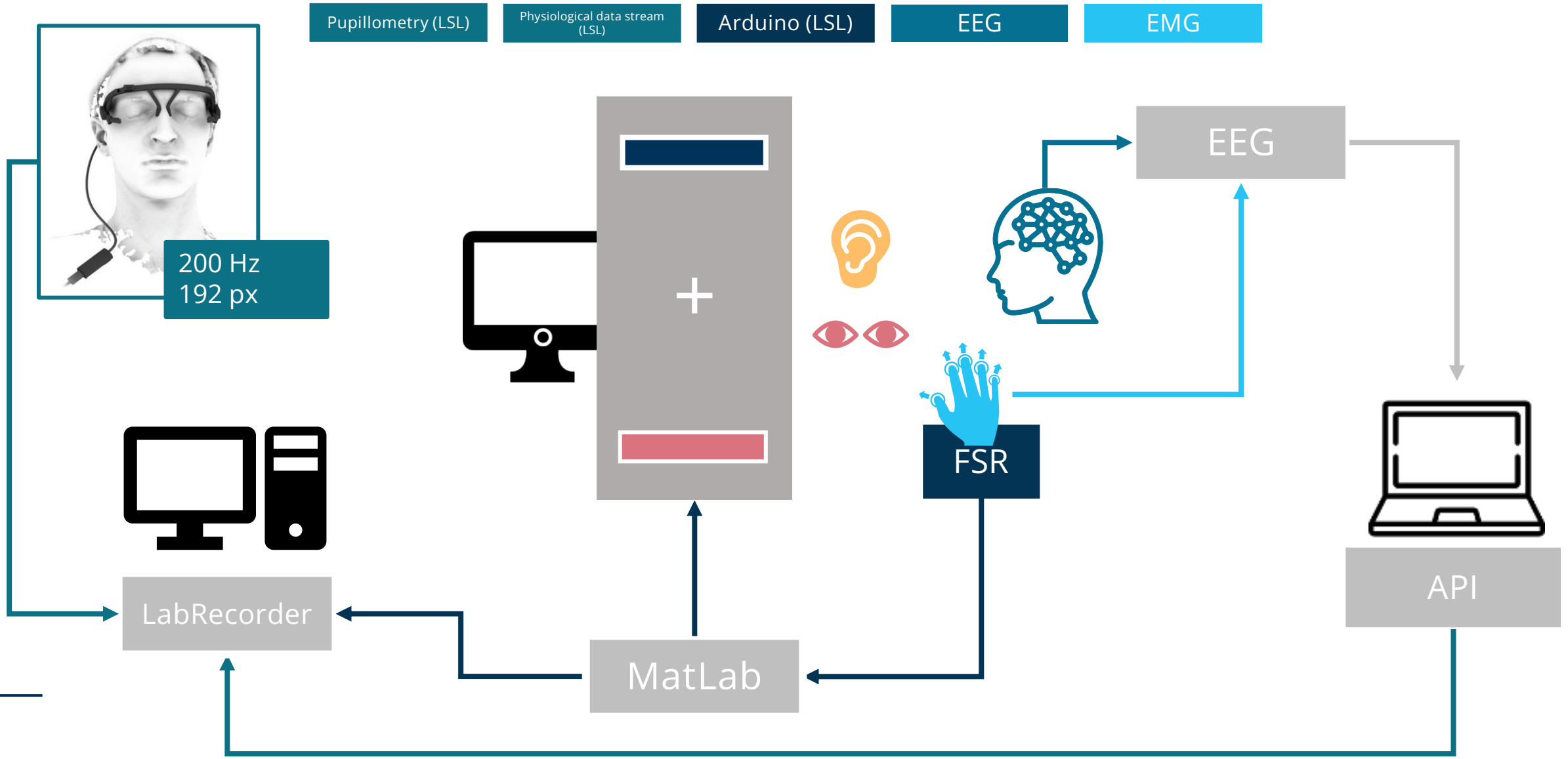
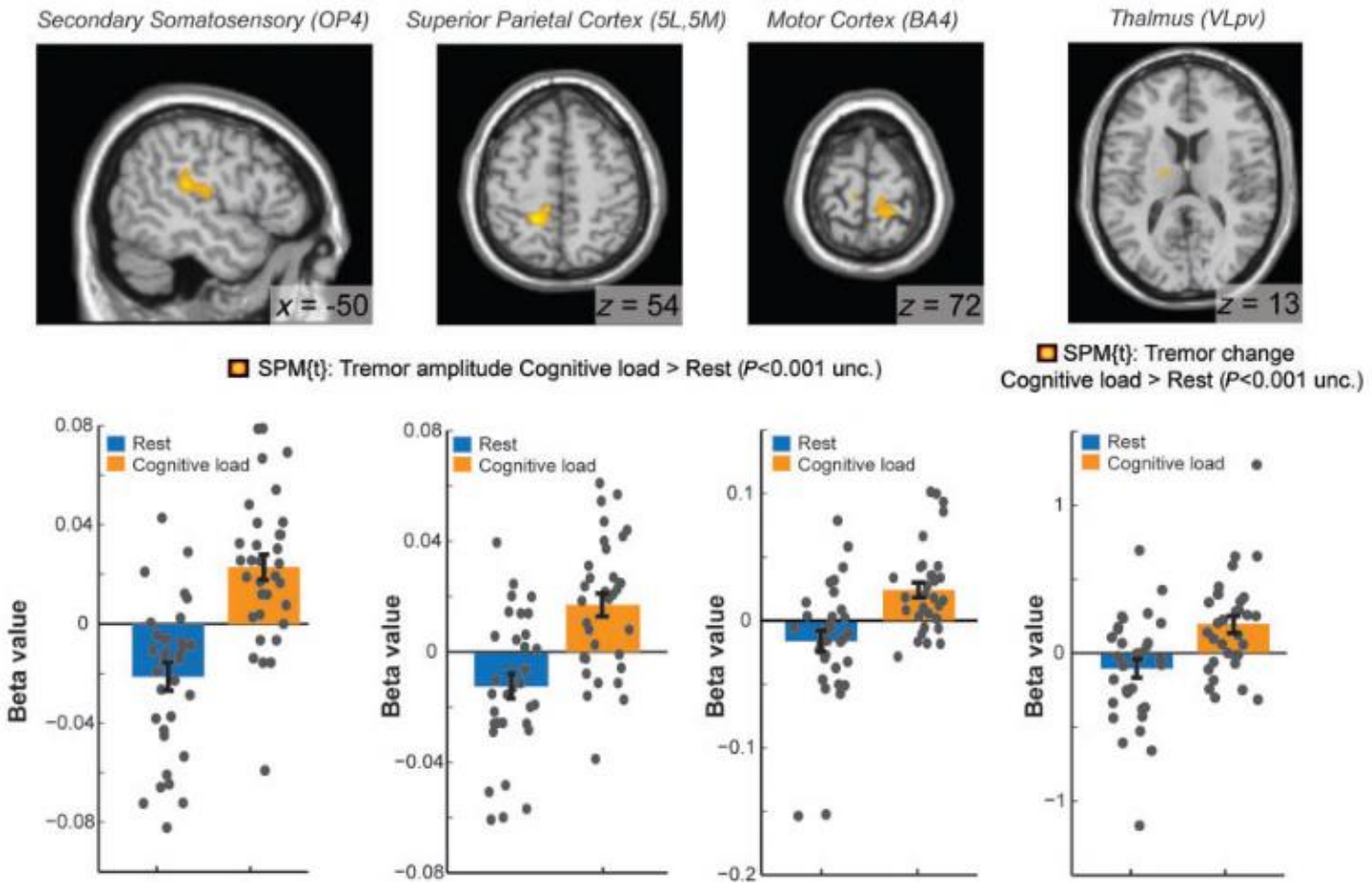


Research question

- Tremor is modulated by both visual & auditory feedback
- Not sensory input drives the tremor but stress



Dirkx ea., *Brain*, 2020

Feedback

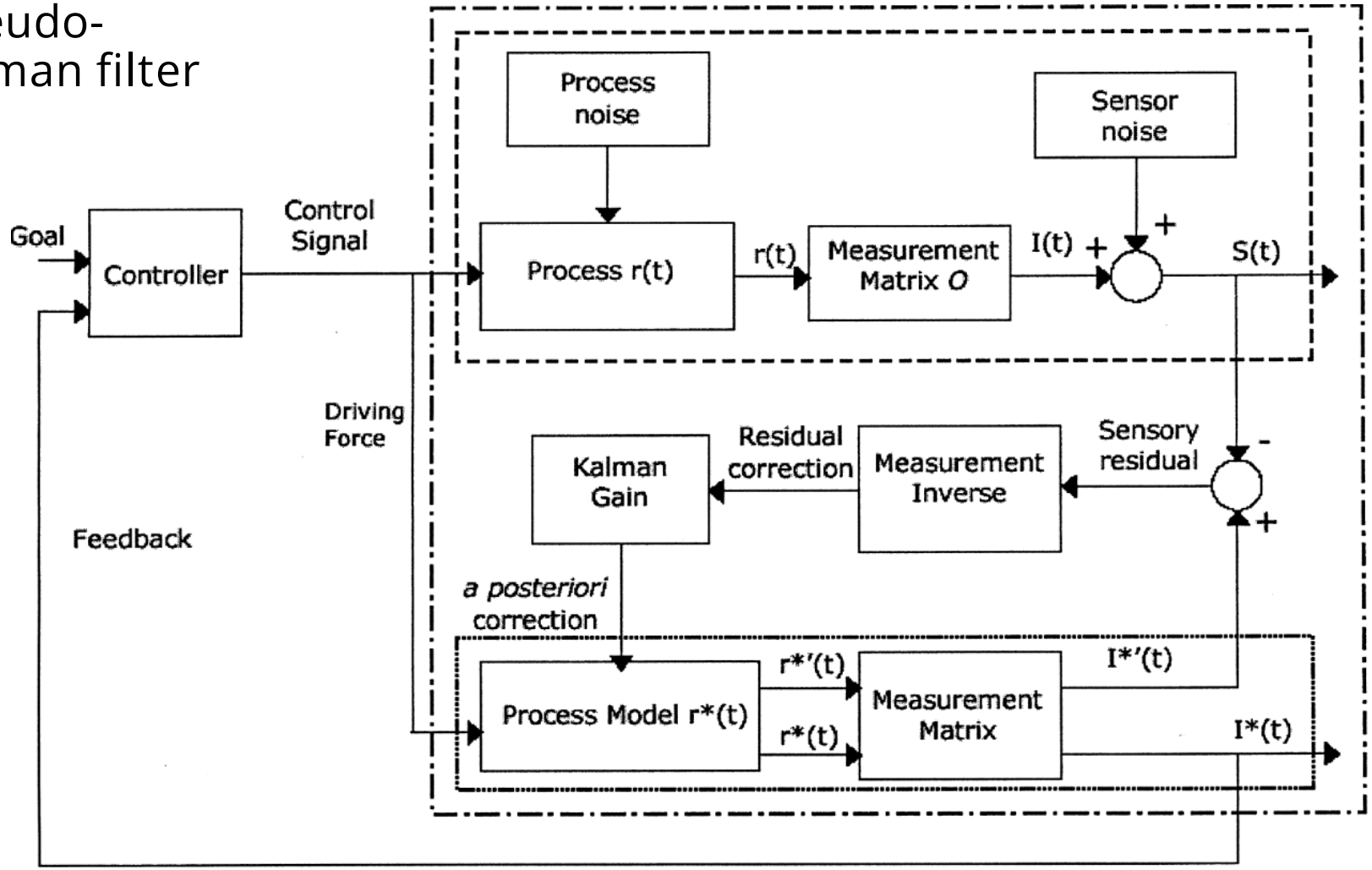
A control scheme blending pseudo-closed-loop control and a Kalman filter

Controller gets gradually worse while approaching the target (goal stays the same)

Feedback gets worse

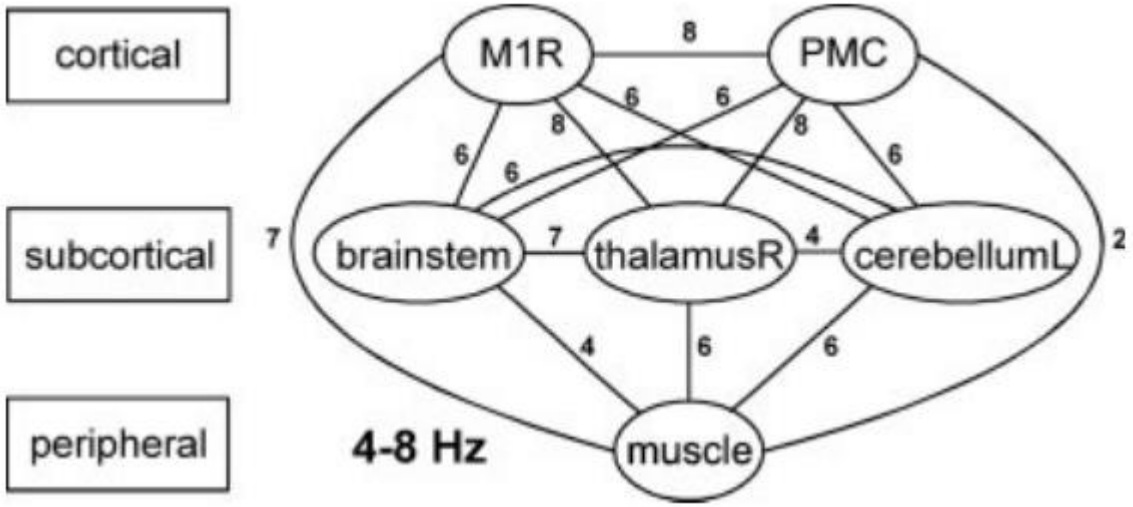
1. More intense feedback

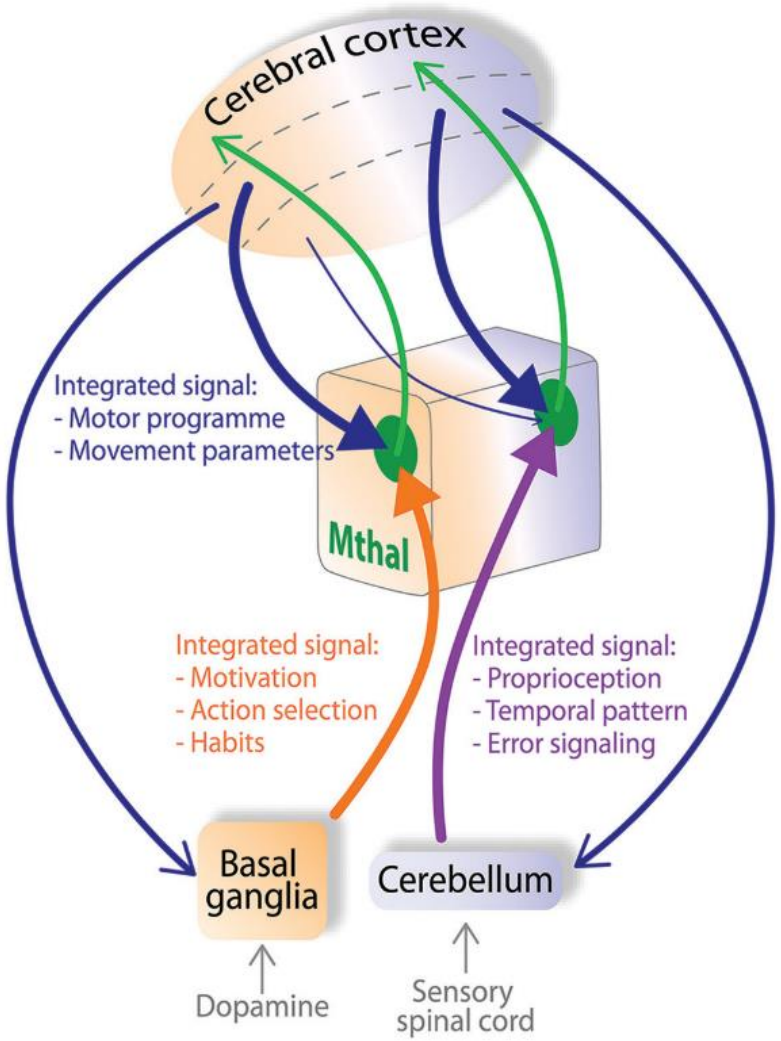
2. Visual/ auditive



Grush, *Behavioural and Brain Sciences*, 2004

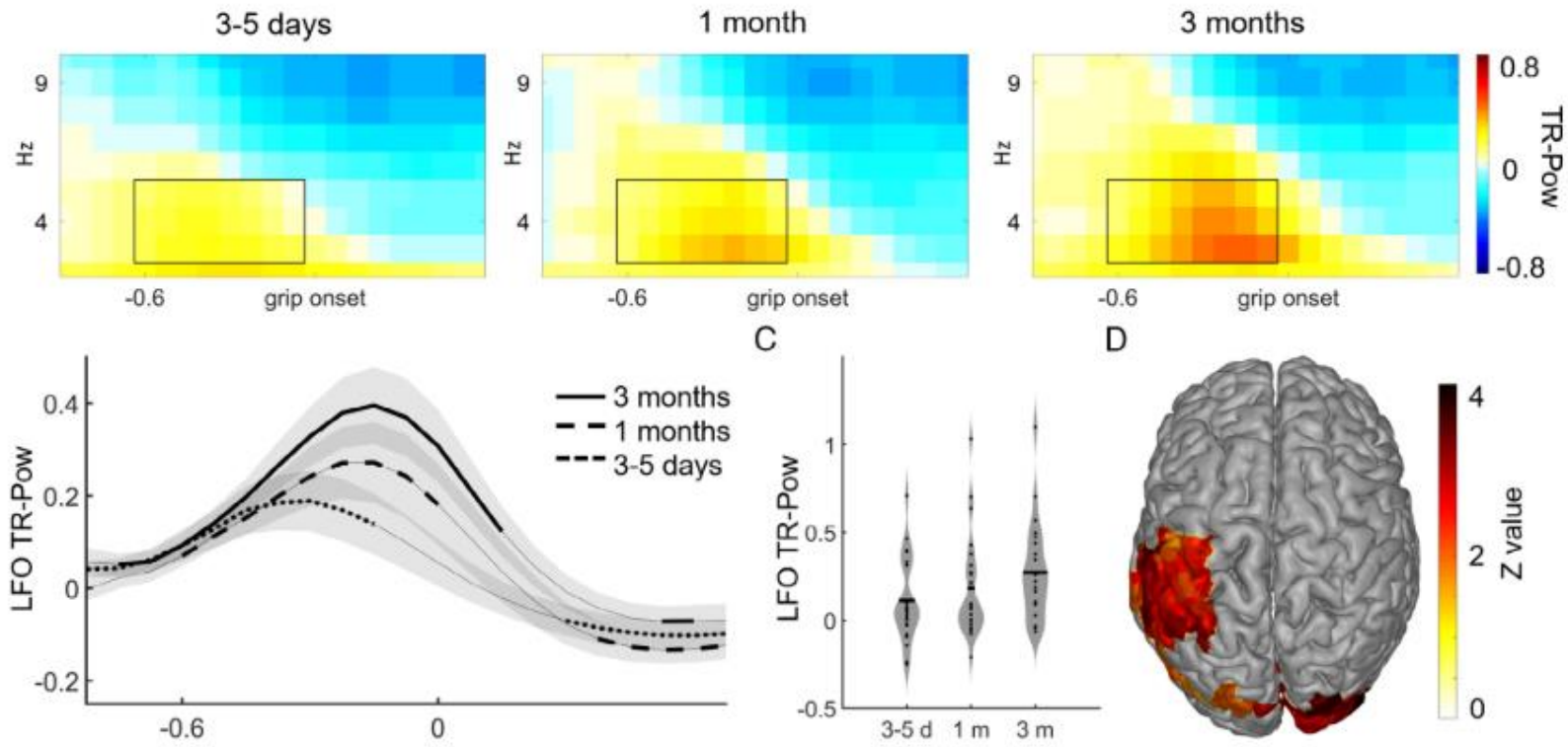
Feedback in the brain | anatomy





Schnitzler ea., *Movement Disorders*, 2009; Bosch-Bouju ea., *Frontiers in Computational Neuroscience*, 2013

Feedback in the brain | EEG



Bönstrup ea., *Annals of Neurology*, 2019

Expected outcomes | hopefully 2020

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Tremor force modification (visual vs. auditive)

i. Feedback modification (stress)
ii. Intention (towards vs. at target)

EEG coherences

Optional

- Low frequency oscillations at movement preparation
- Beta-rebound at different tremor feedback (sensorimotor integration)

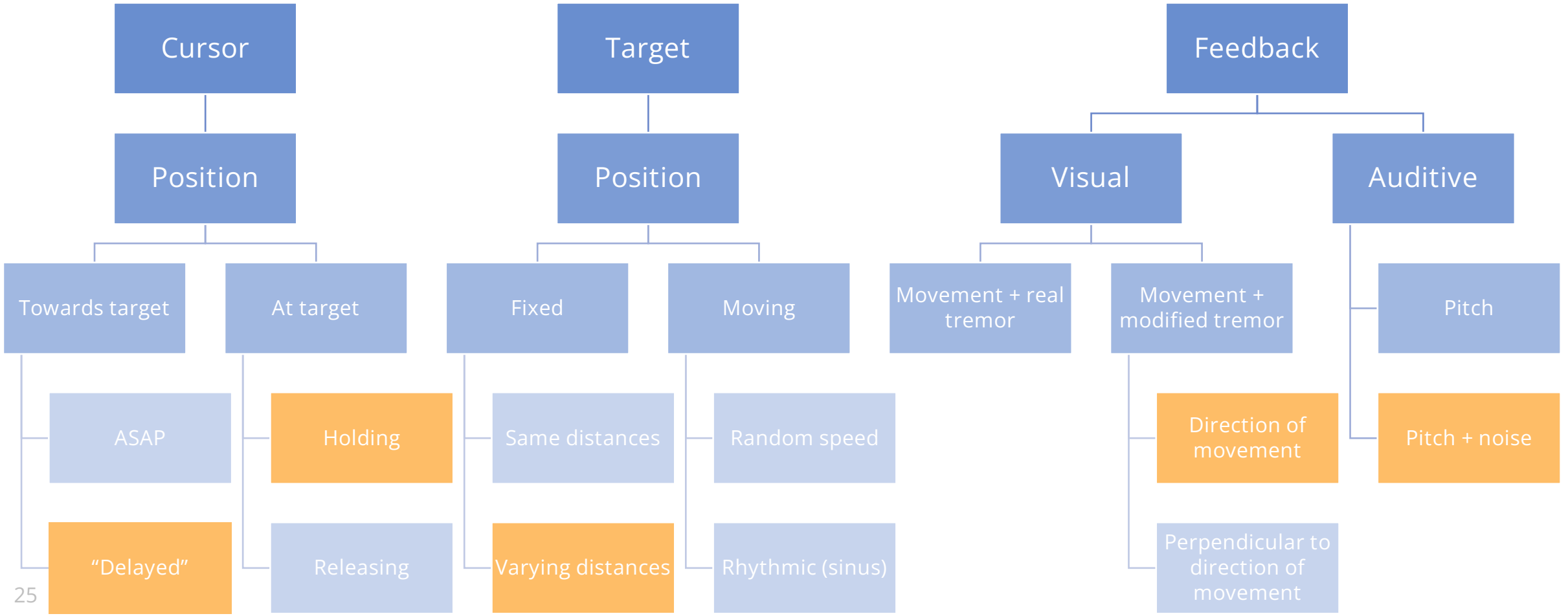
Open Questions

1. How comparable are visual vs. auditive conditions?
2. “Realness” of feedback
3. How dynamic are brain states during trials?
4. …

outlook

Thank you for listening carefully

Design complexity



Classification | rehabilitation BCIs

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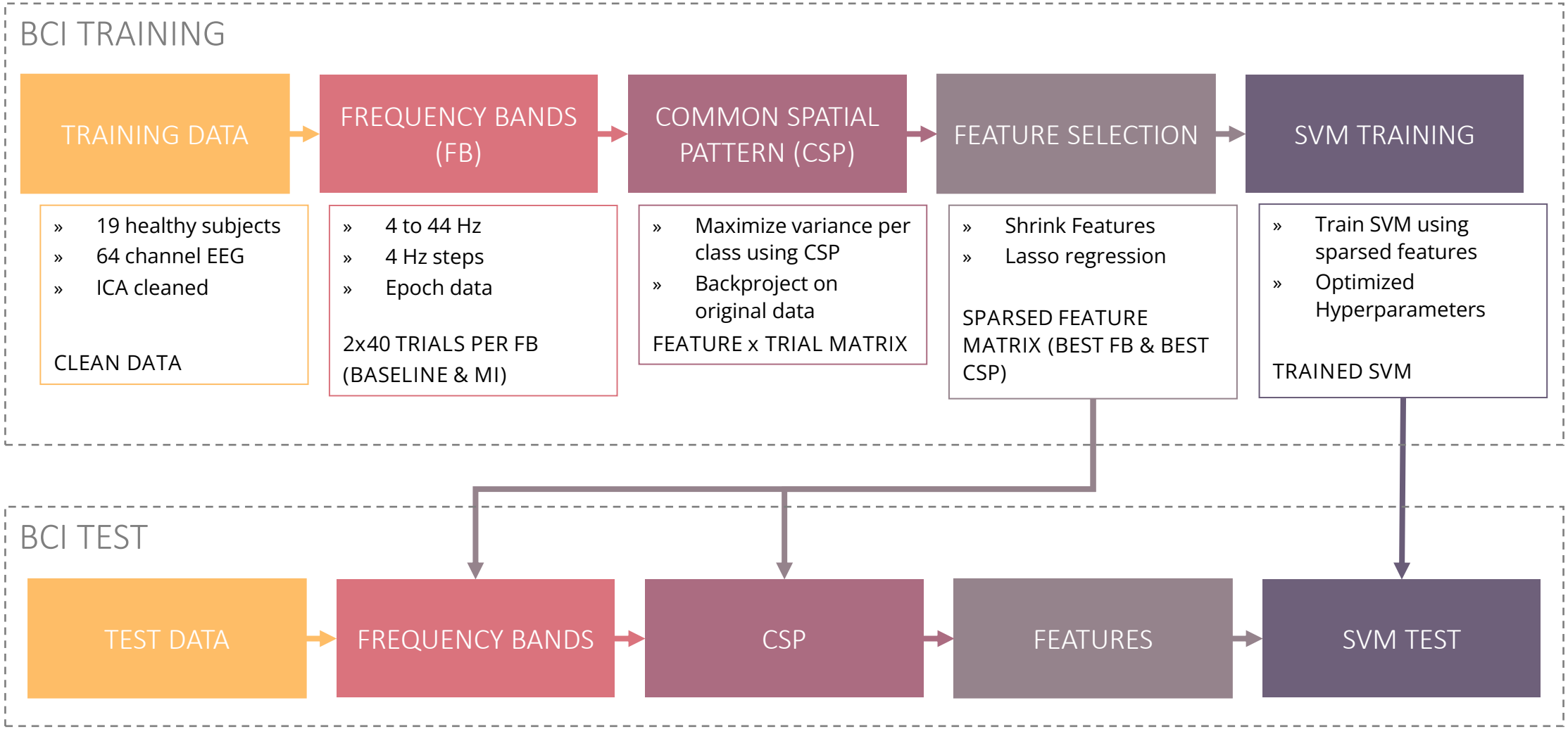

Welzel, cuttingEEG, 2019

Data collection | overview

- 256 channel EGI system
- ET patients (vs. healthy control or PDs)
- 2 x 3 min [rest, hold]
- 160 trials

- Clinical scores (TDC MDS, MoCA, TMT, EHI)
- Structural MRI + resting state