

Combining psychophysical measures with fMRI

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Psychophysics

The relationship between physical stimuli and perception

(conscious) Perception

First-person, subjective experience of sensory stimuli (and internal states) by conscious brain processes

(unconscious) Sensation

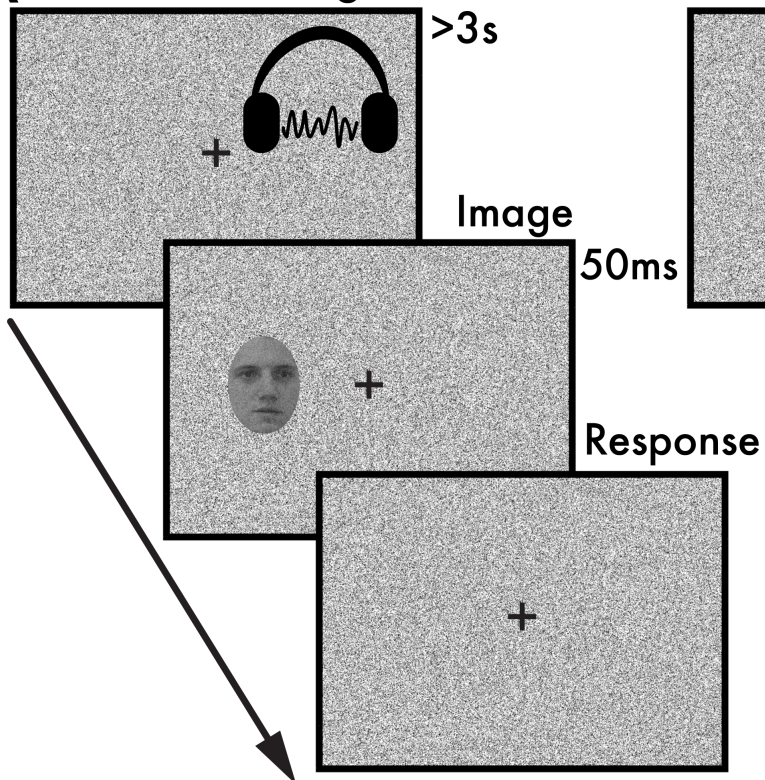
Detection of physical stimuli by sensory receptors and
unconscious brain processes

**(conscious) perception = (conscious) awareness
= consciousness**

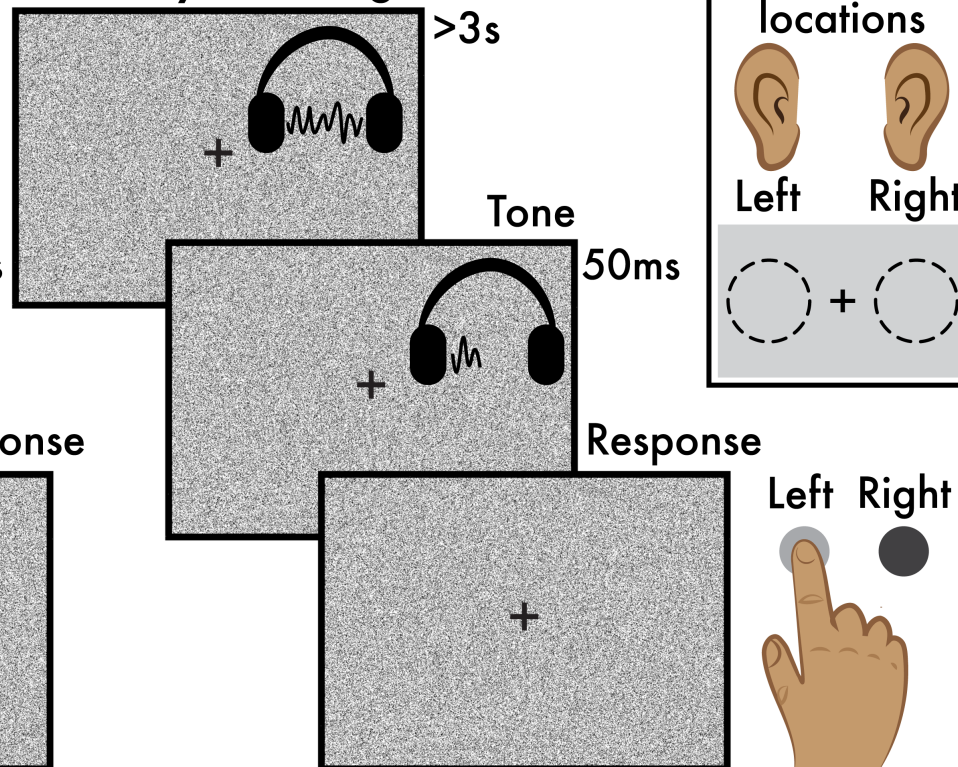
Psychophysical subjective measures

- Detection threshold (“Did you see the stimulus?”)
- Discrimination (“Which stimulus was brighter?”)
- Identification (“Which stimulus was shown?”)
 - Confidence (“How sure are you?”)
 - Many more ...

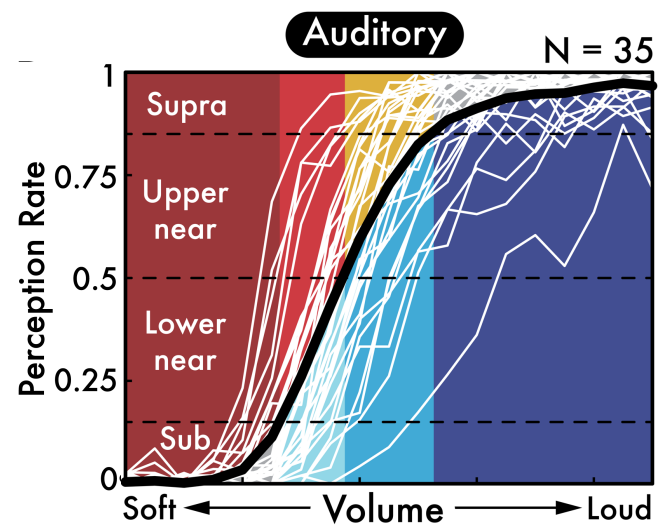
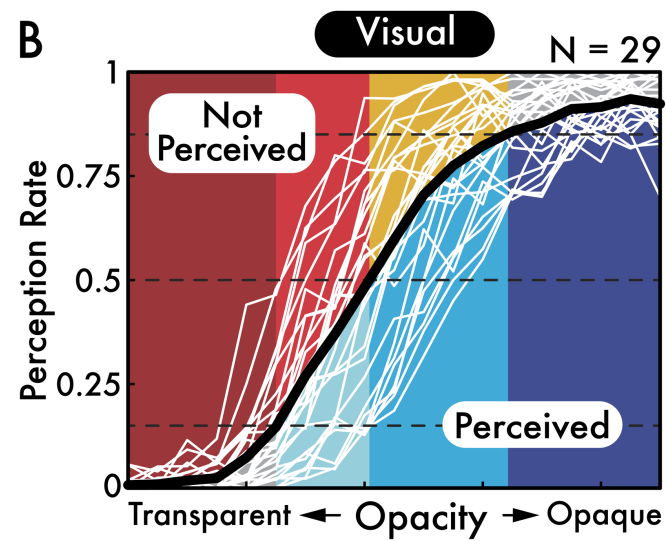
A Visual Paradigm



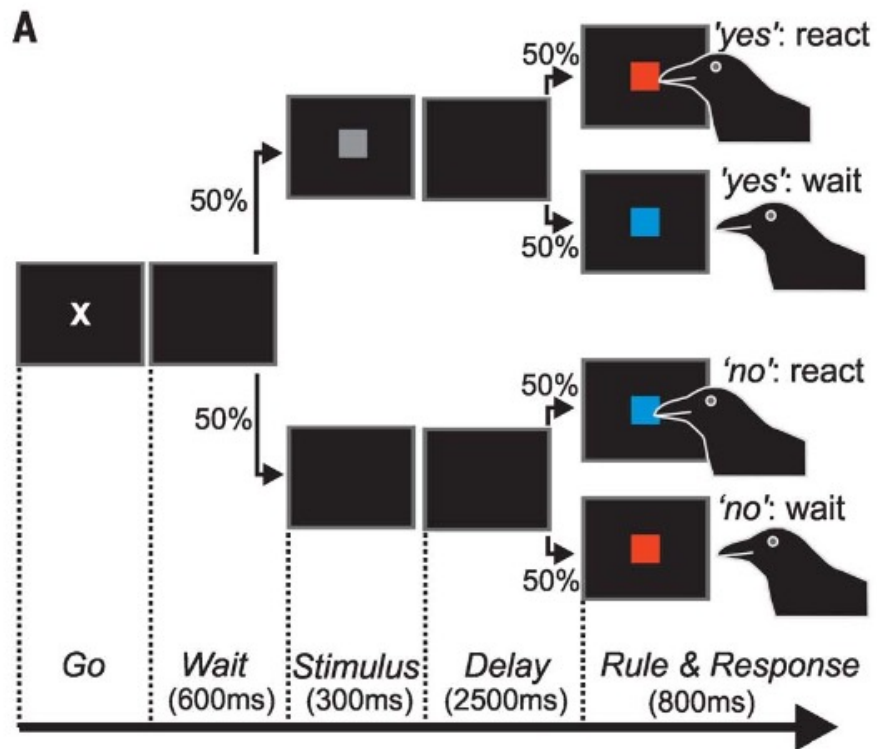
Auditory Paradigm



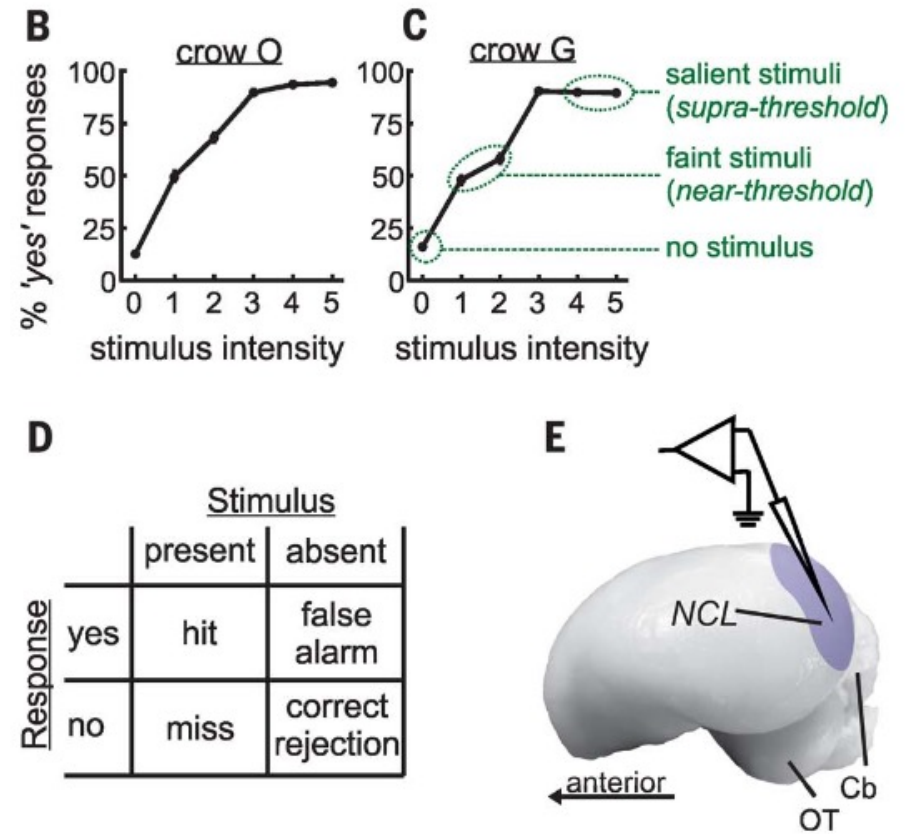
Kronemer, Suwanamalik-Murphy *et al.*, in preparation



Kronemer, Suwanamalik-Murphy *et al.*, in preparation

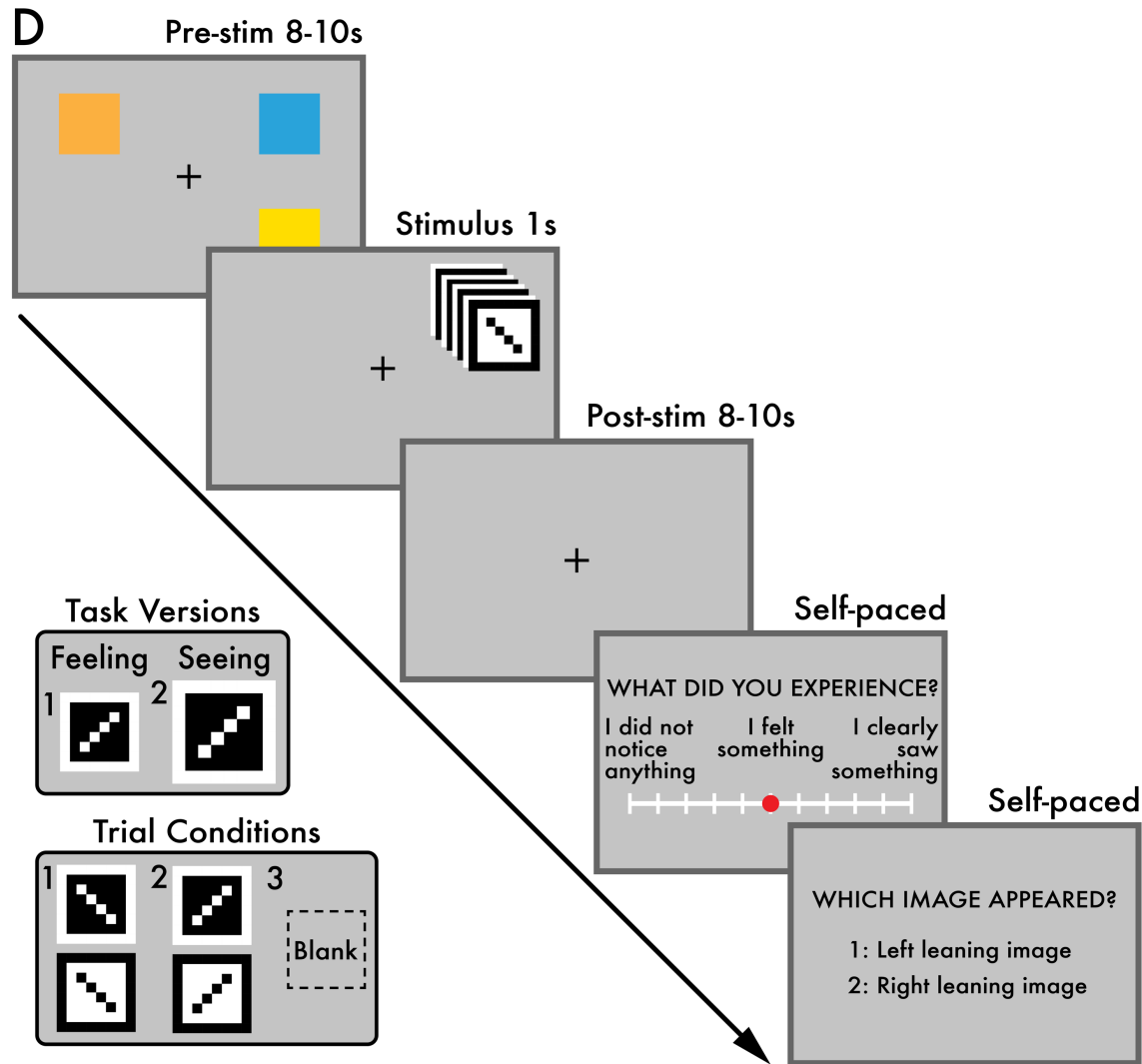


Nieder et al., Science, 2020

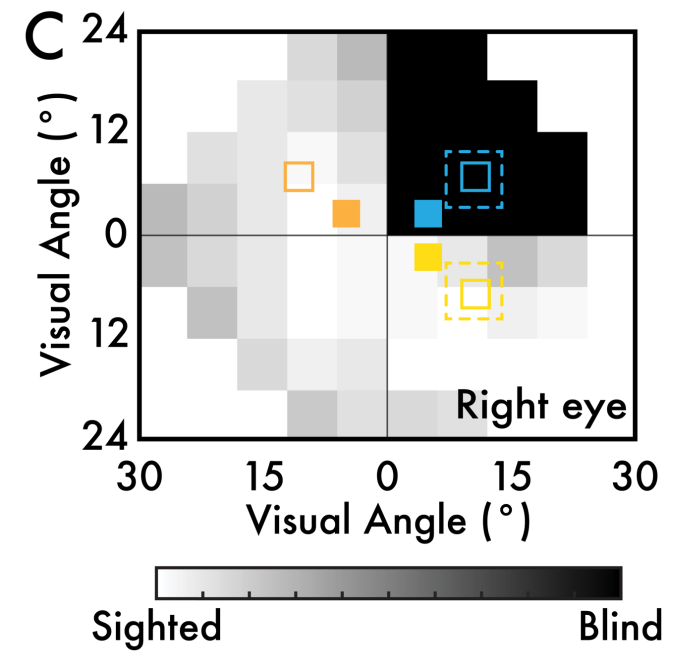
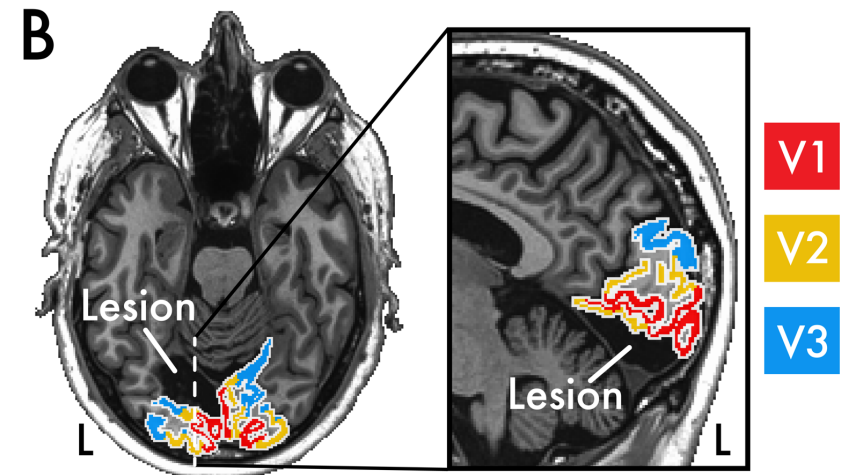


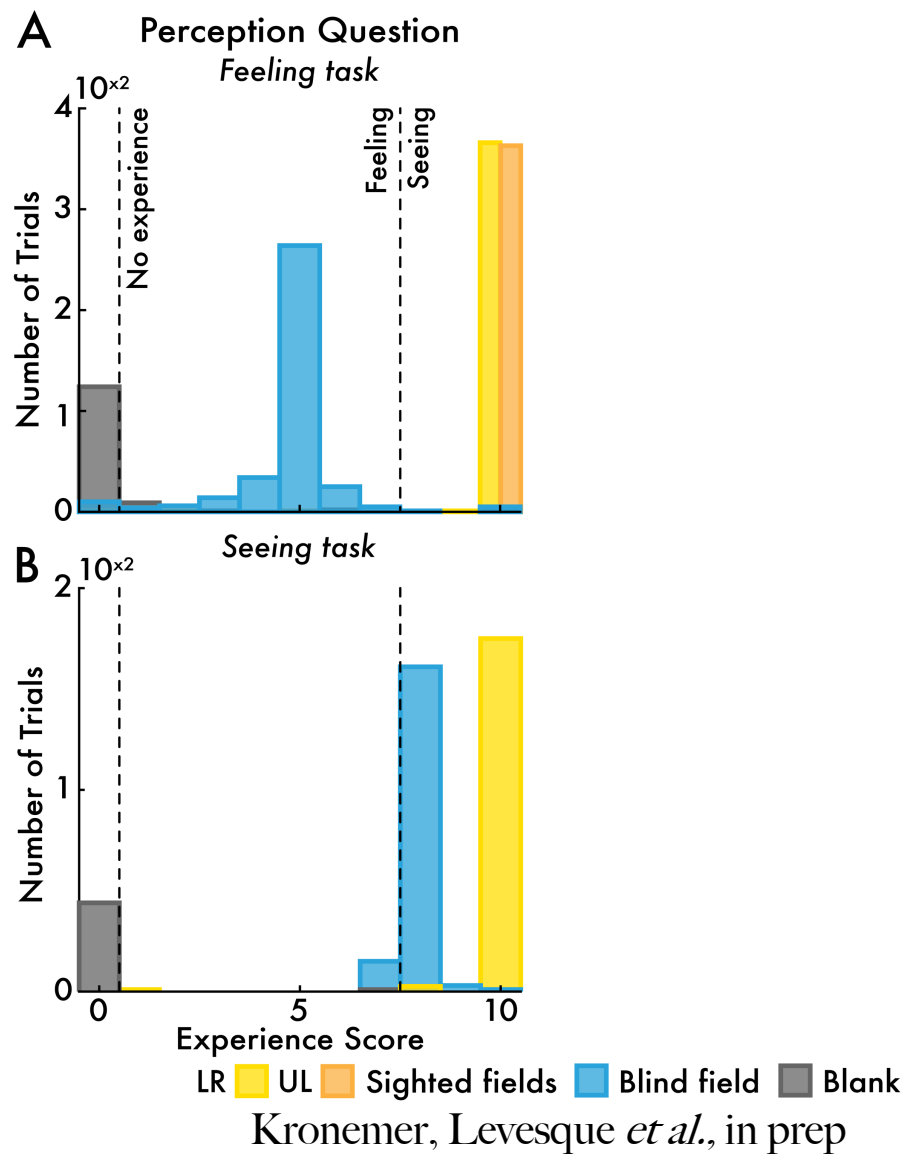
Psychophysical objective measures

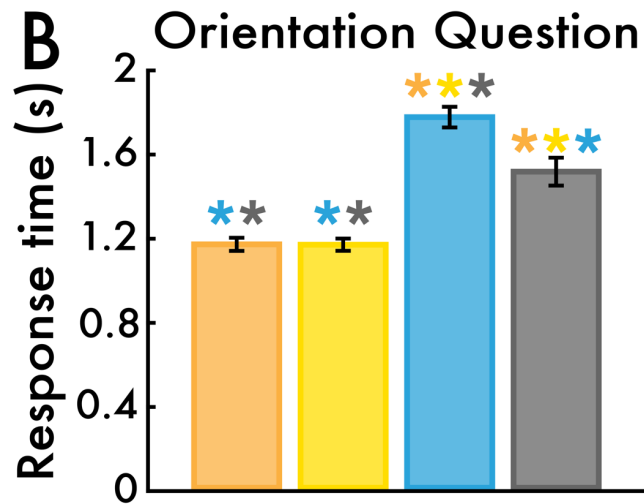
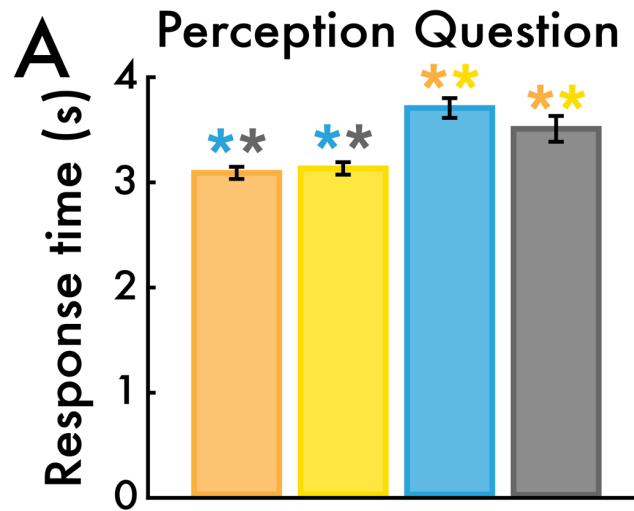
- Accuracy
- Response bias
- Sensitivity (d')
- Reaction time
- Physiological markers (e.g., eye behaviors)
 - Many more ...



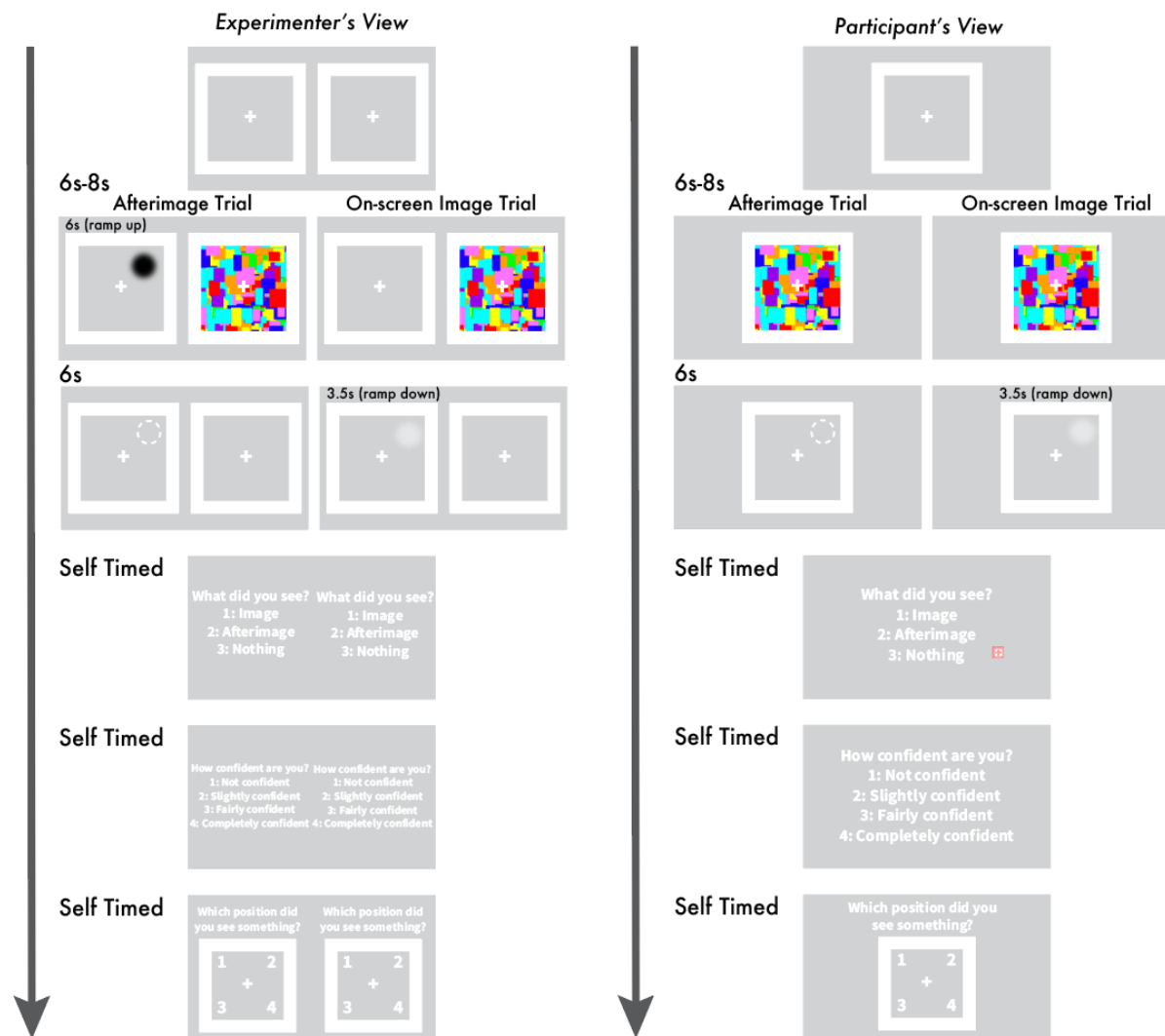
Kronemer, Levesque, et al., in prep





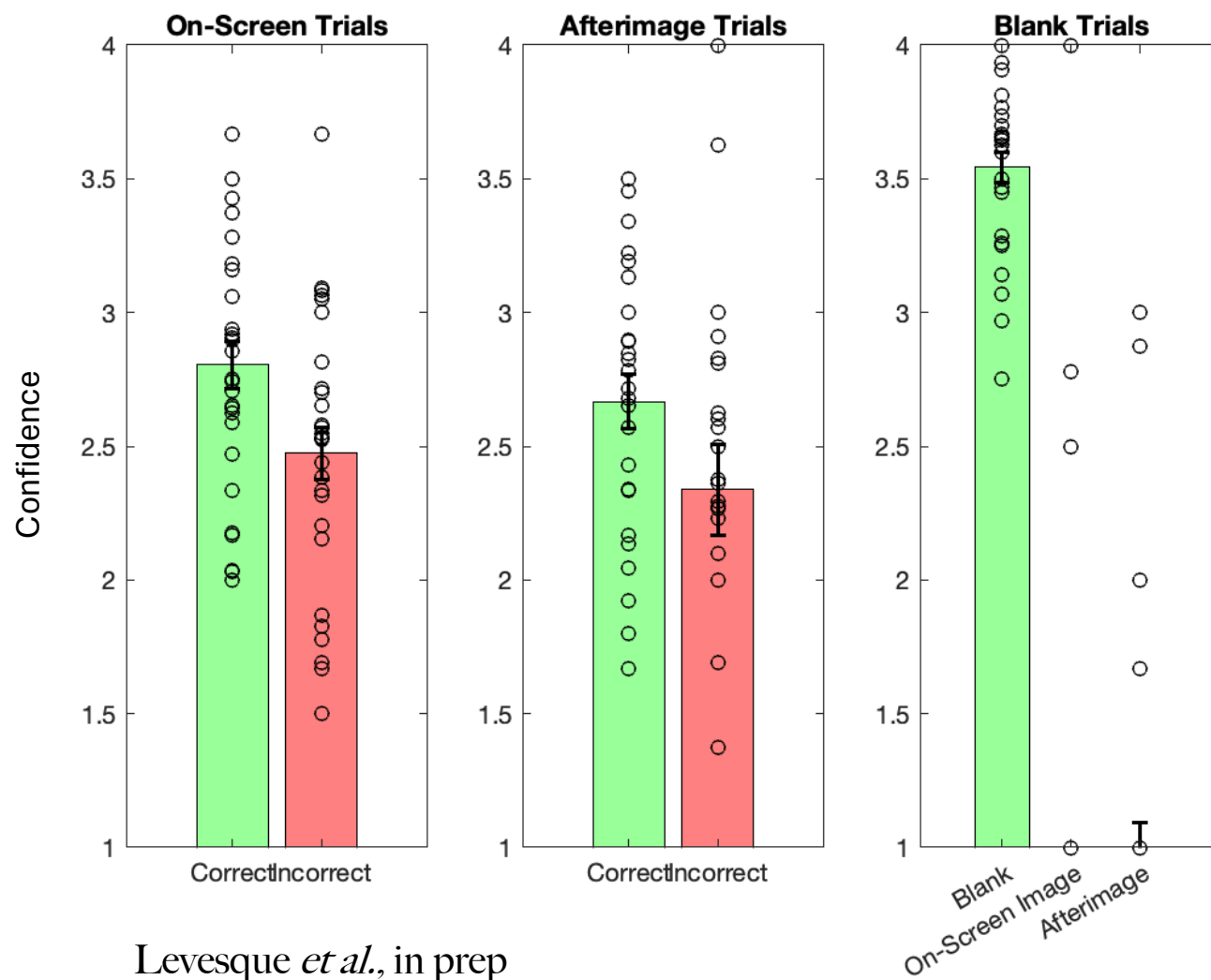


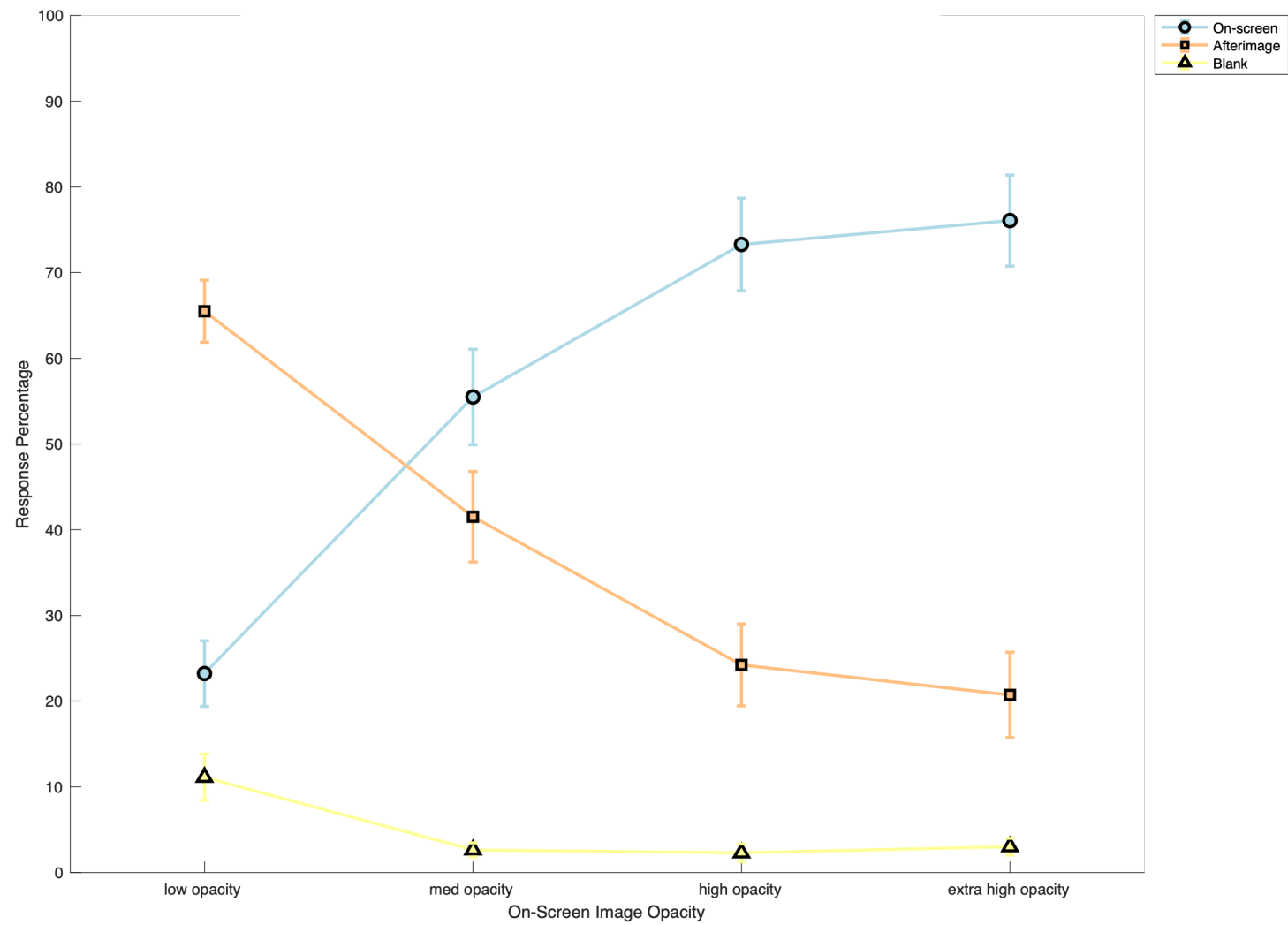
Kronemer, Levesque *et al.*, in prep



Levesque *et al.*, in prep

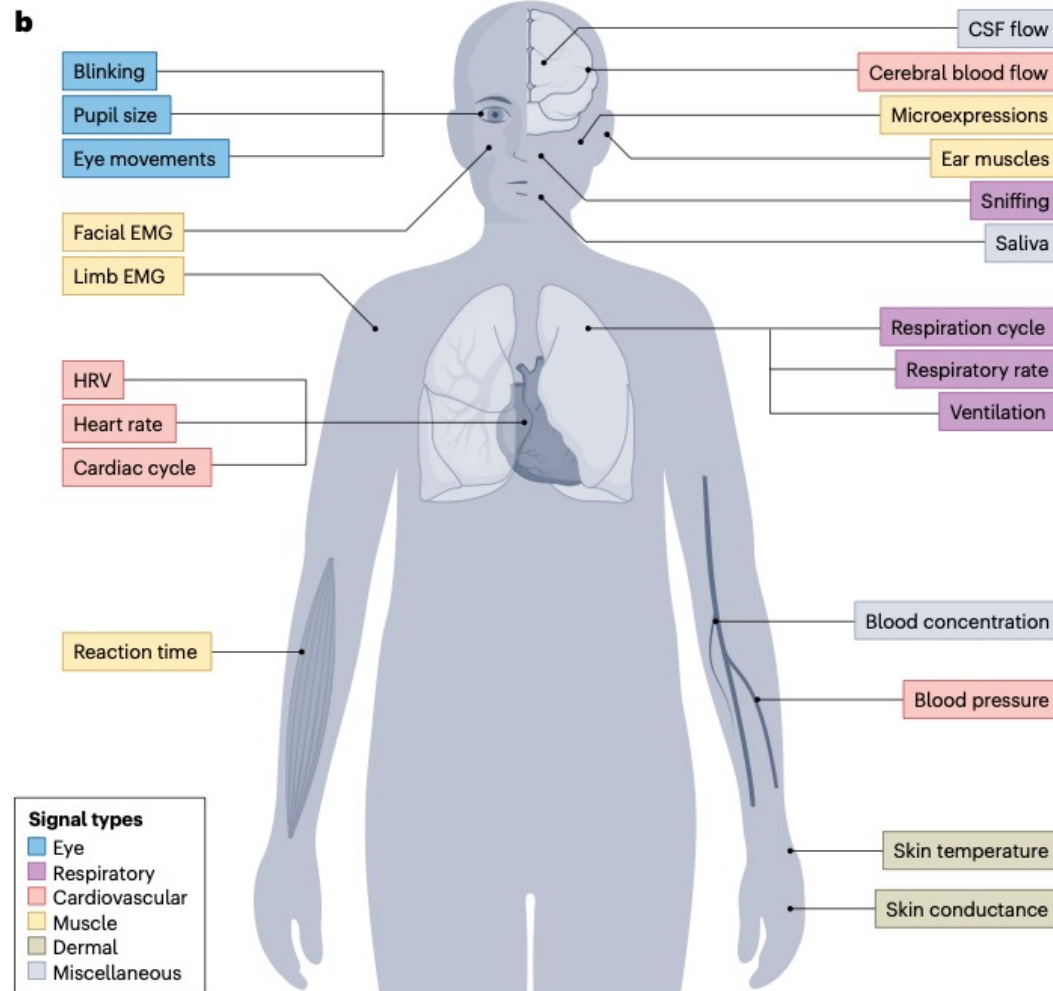
Groupwise Average Confidence Levels for Trial Types



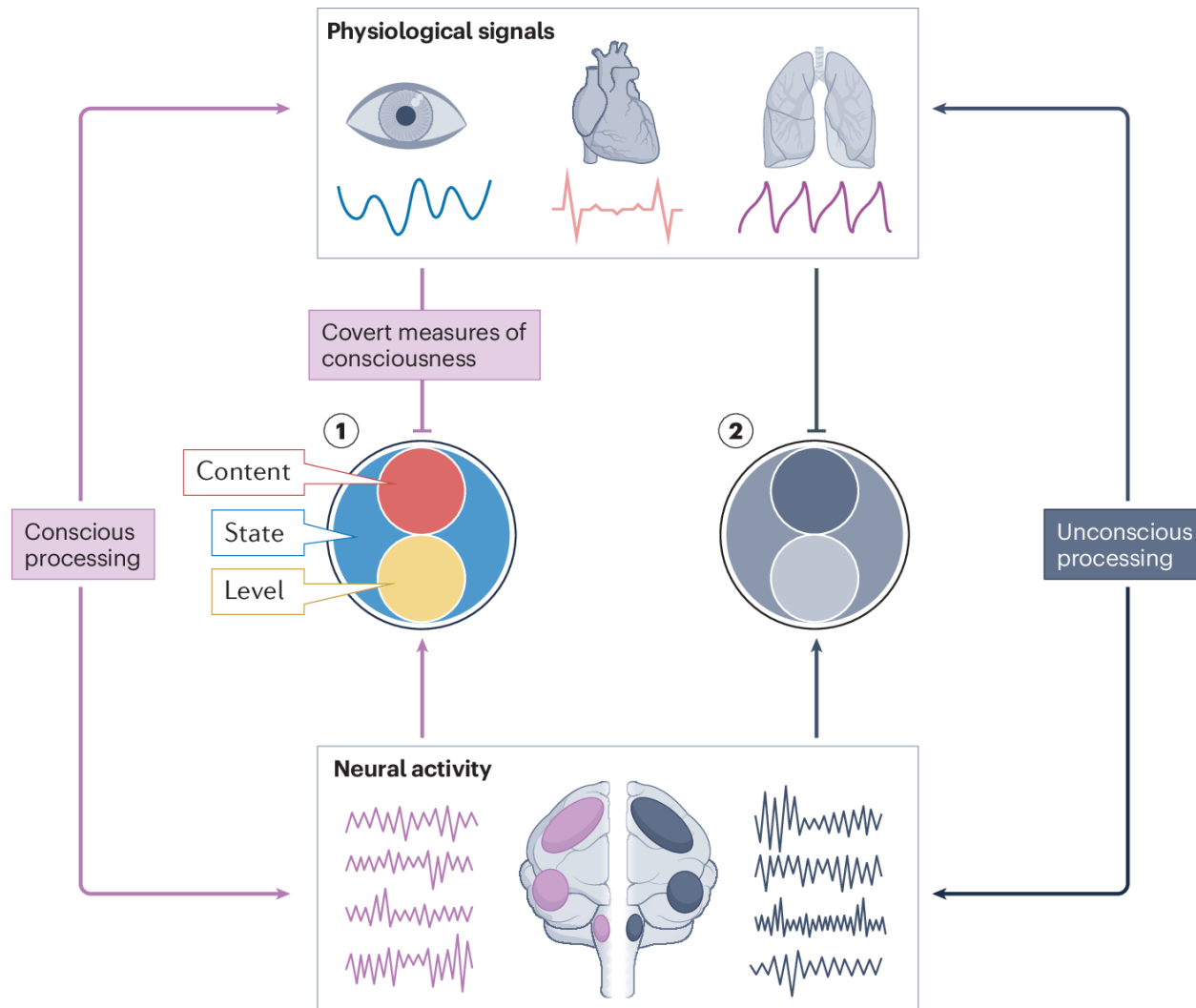


Levesque *et al.*, in prep

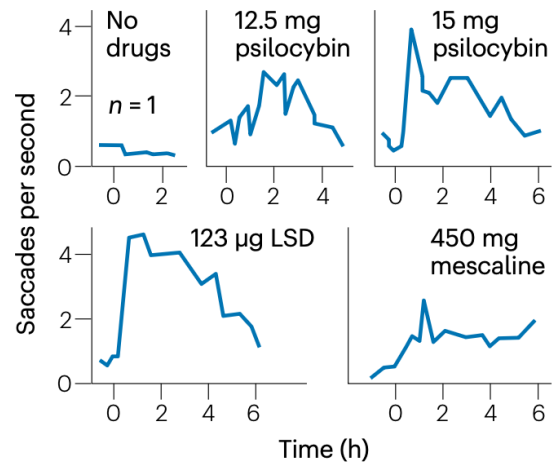
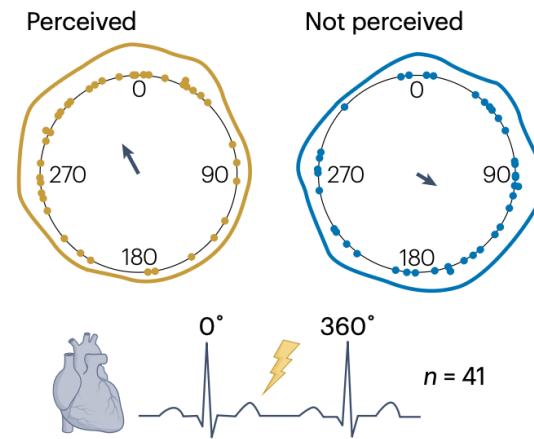
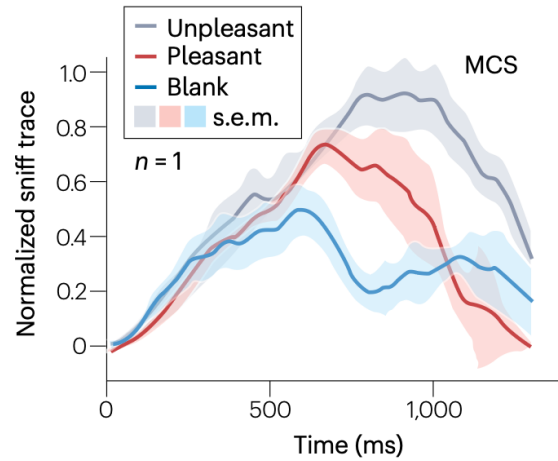
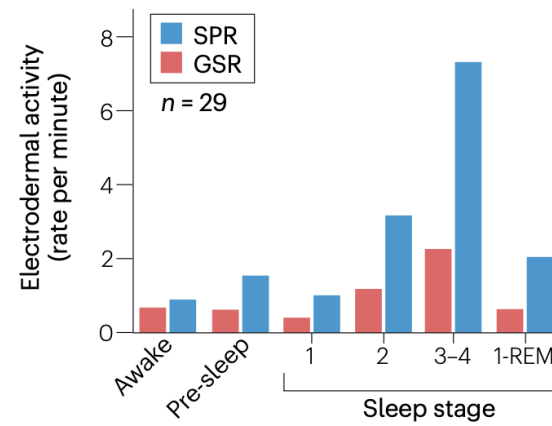
Physiological markers



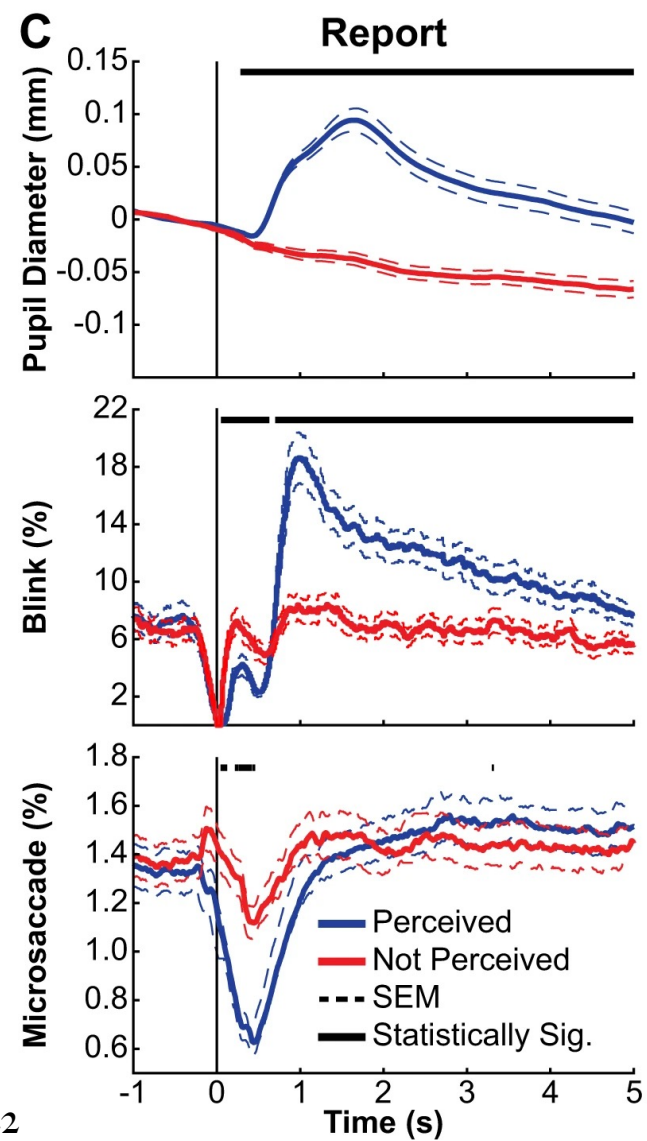
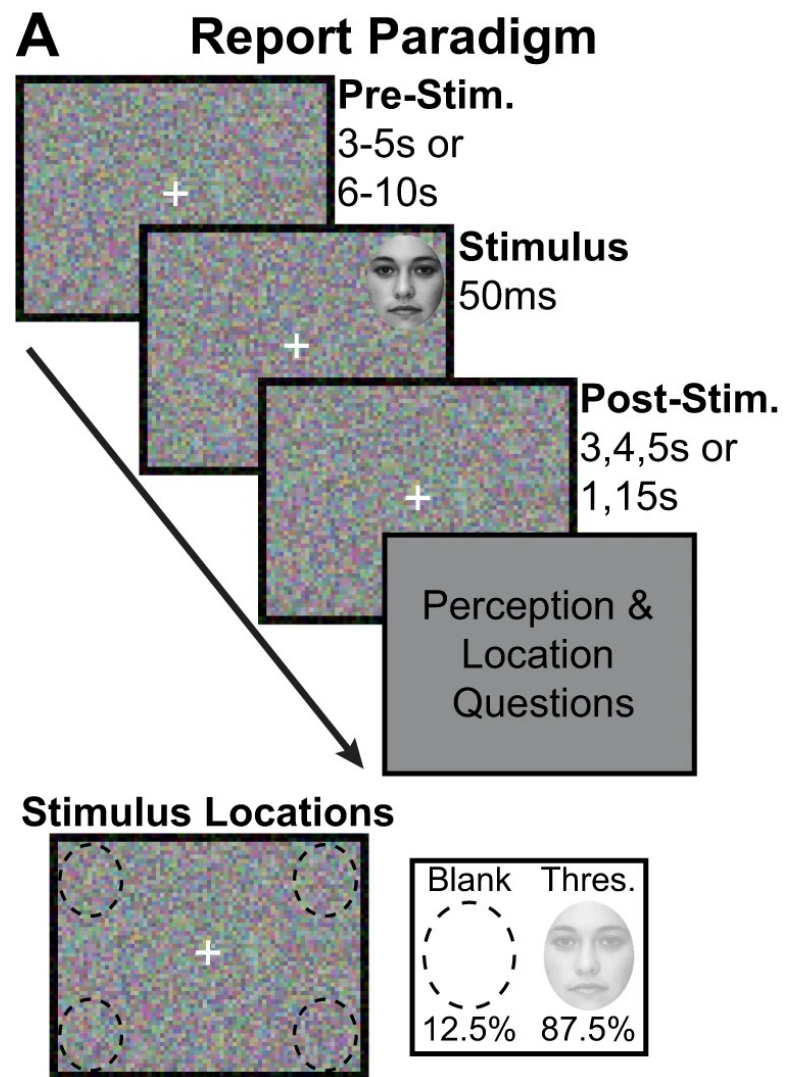
Kronemer *et al.*, *Nature Reviews Neuroscience*, 2025



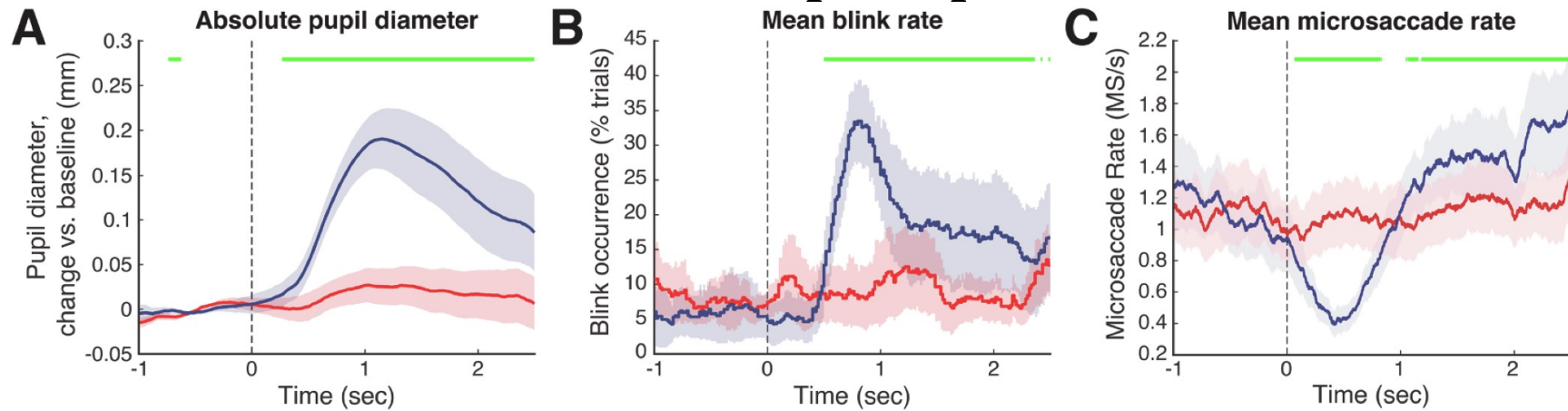
Kronemer *et al.*, *Nature Reviews Neuroscience*, 2025

a Eye movements**b Cardiac cycle****c Sniffing****d Skin conductance**

Kronemer *et al.*, *Nature Reviews Neuroscience*, 2025

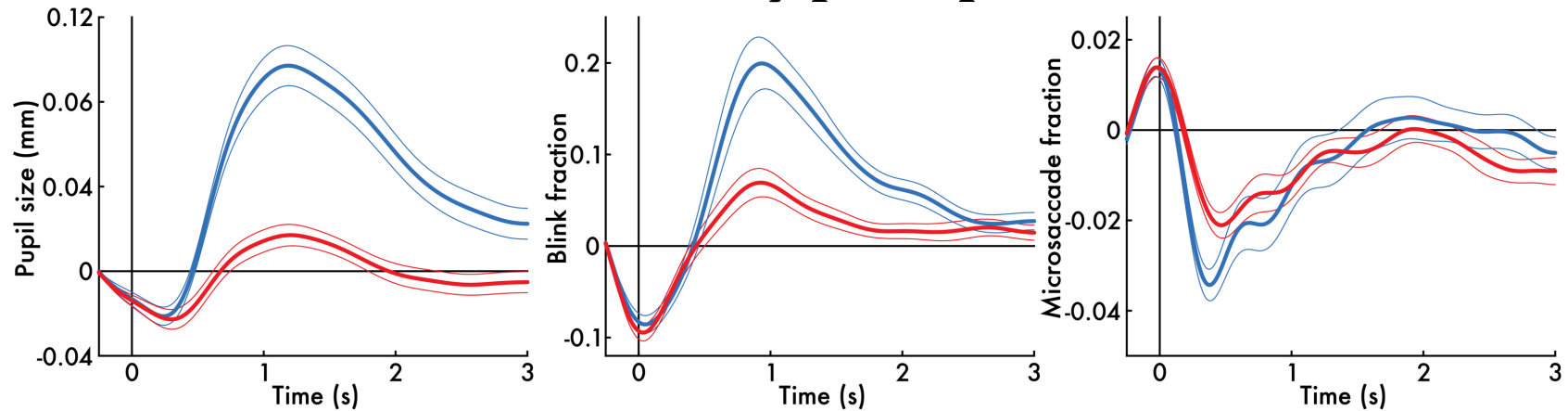


Tactile perception



Gusso *et al.*, Consciousness & Cognition, 2022

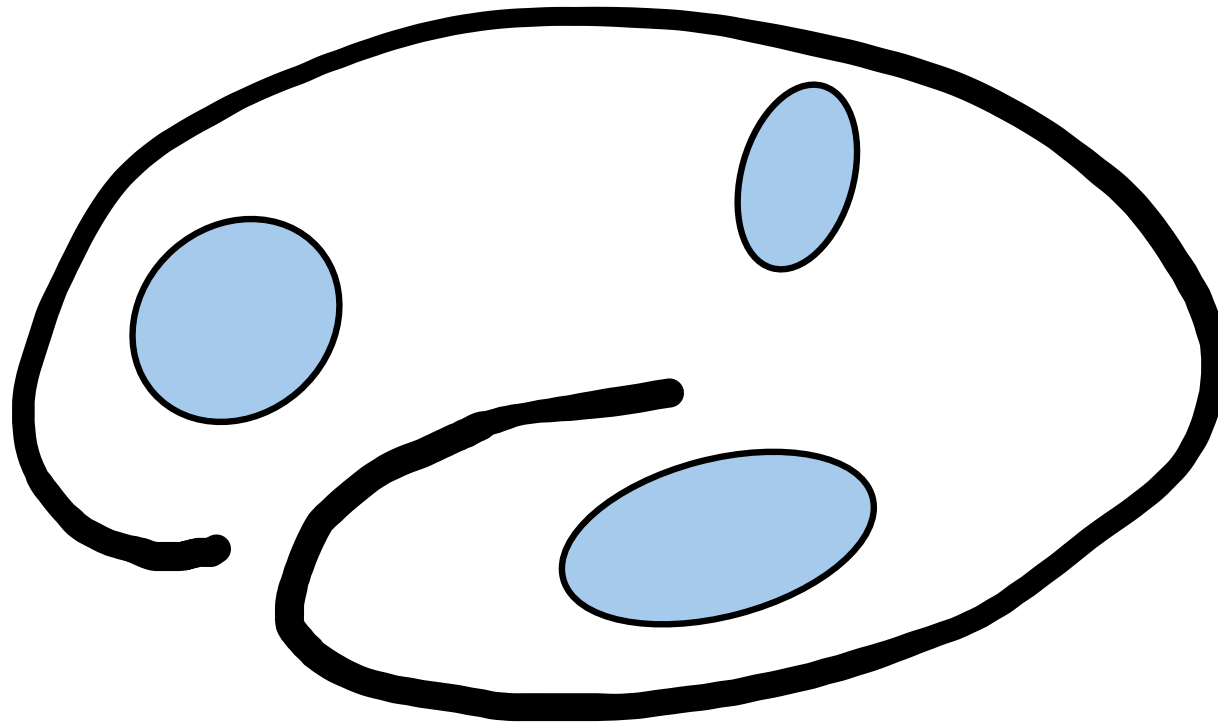
Auditory perception



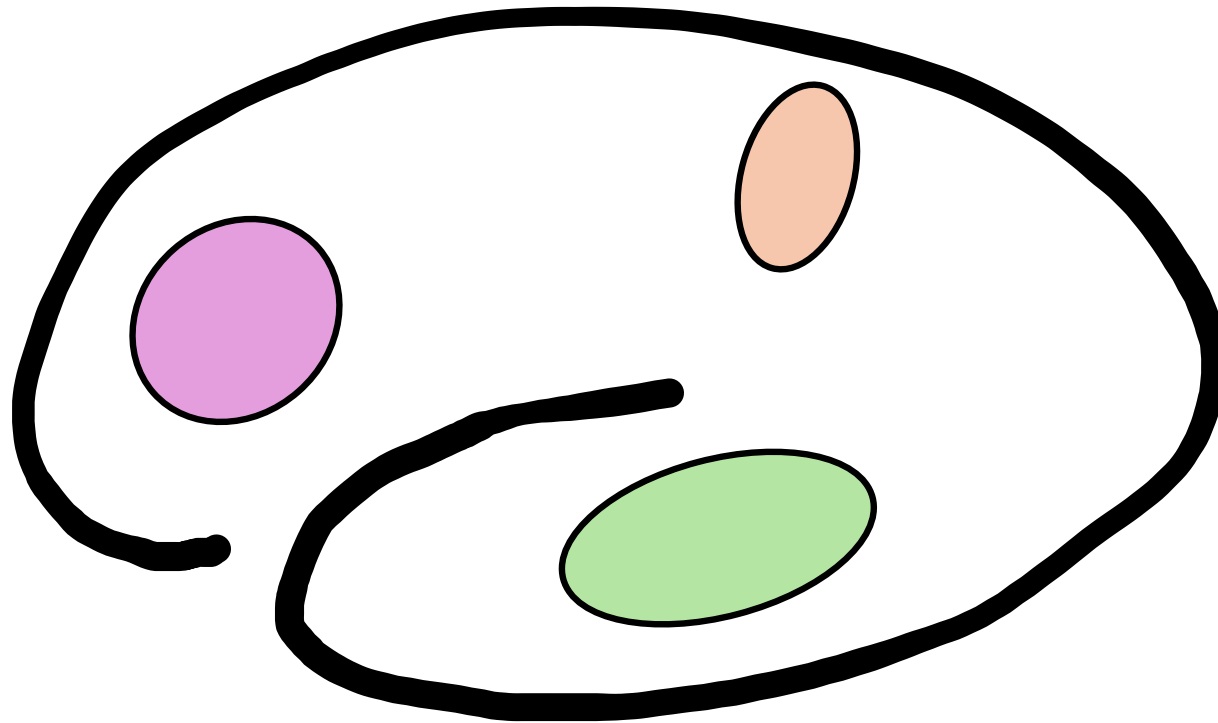
Kronemer, Suwanamalik-Murphy *et al.*, in preparation

Psychophysical measures' relationship to fMRI (and other neuroimaging methods)

fMRI = where
(neural processing occurs)

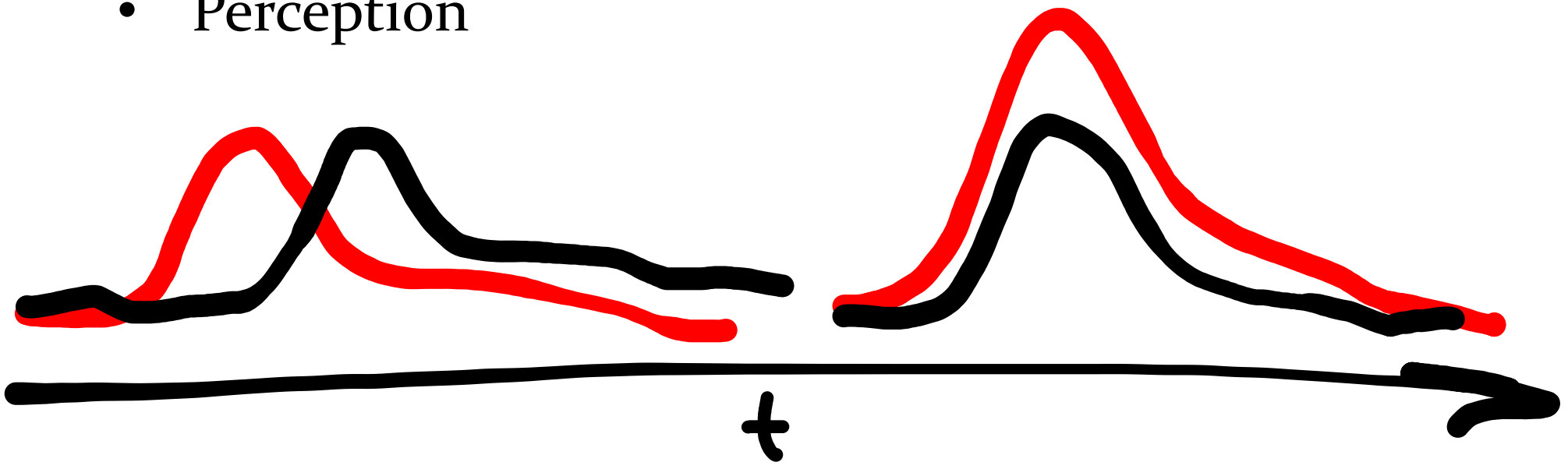


Psychophysics = what
(neural processing accomplishes)



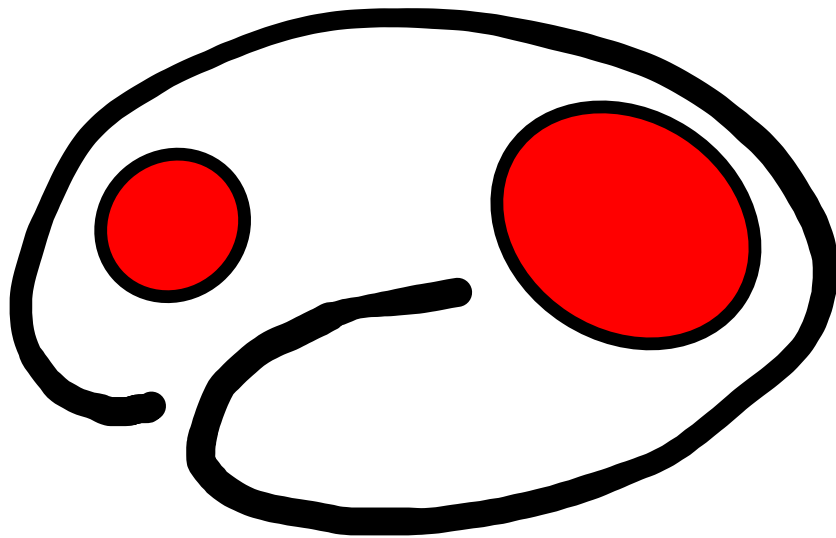
Psychophysics helps interpret activation patterns

- Increased attention
- Increased arousal
- Cognitive load
- Perception

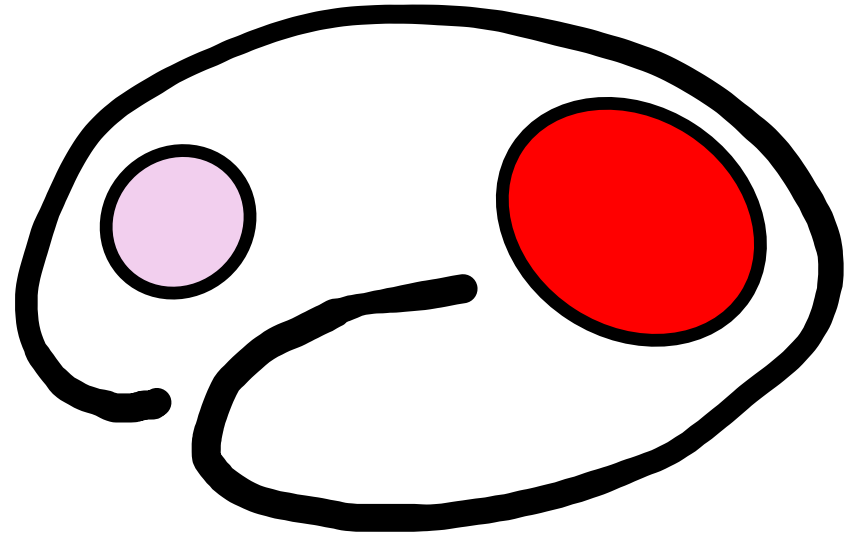


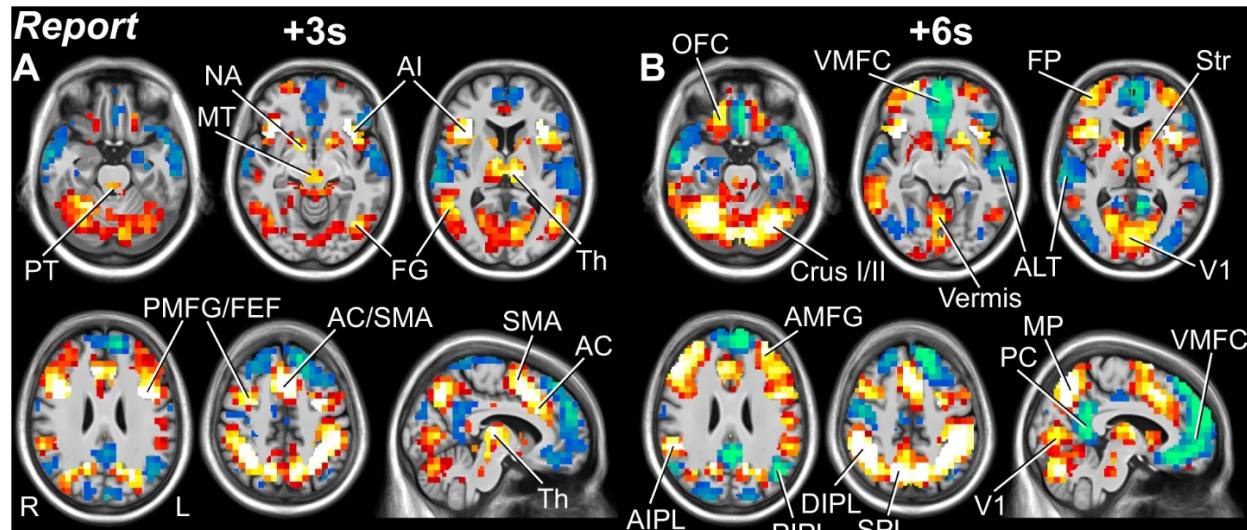
Where does conscious processing occur in the brain?

Theory 1



Theory 2





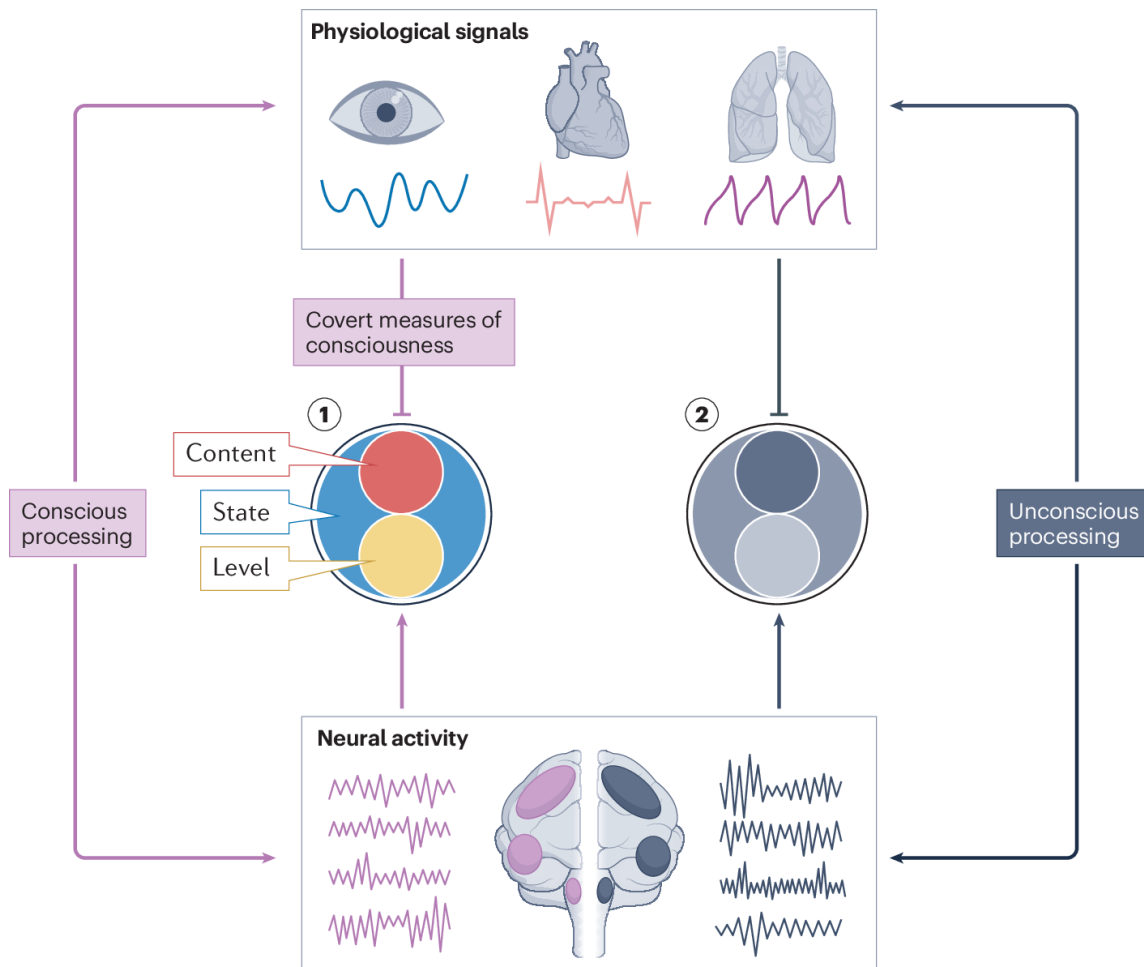
Kronemer *et al.*, *Nature Communications*, 2022

Observed

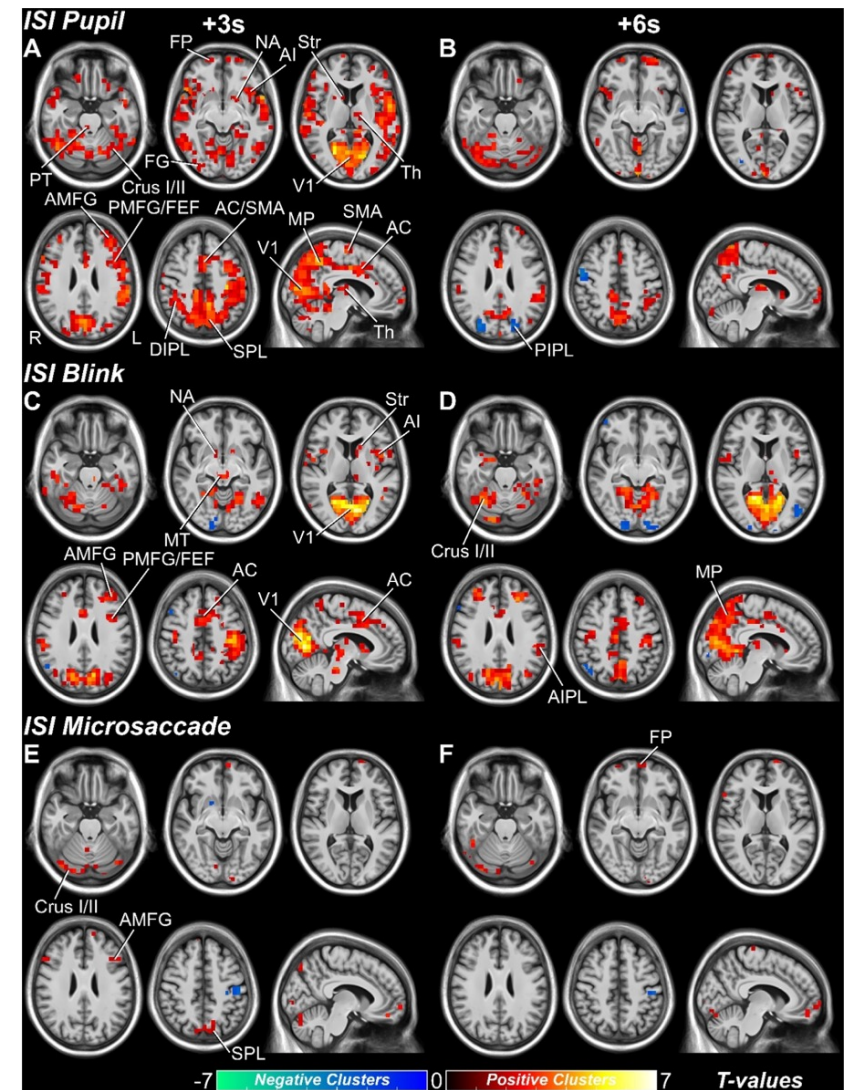


**fMRI (and EEG, MEG, PET, etc.) + psychophysics
links brain and perception**

Behavior influences fMRI (and perception)



Kronemer *et al.*, *Nature Reviews Neuroscience*, 2025



Kronemer *et al.*, *Nature Communications*, 2022

fMRI and psychophysics: Complementary observations of the same underlying neural process

fMRI

Measures: Blood responses

Reflects: Neural activity

Strength: Spatial localization

Answers: “Where?”

Psychophysics

Measures: Behavior/perception

Reflects: Neural computation

Strength: Functional specificity

Answers: “What?”

Questions?



National Institutes of Health



Peter Bandettini



Burak Akin



Catherine Walsh



A. Tyler Morgan



Pete Molfese



Cassie Levesque



Dan Handwerker



Tori Gobo



Javier Gonzalez-Castillo



Josh Teves



Micah Holness



Shruti Japee



Grace Edwards



Amaia Benitez Andonegui



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