

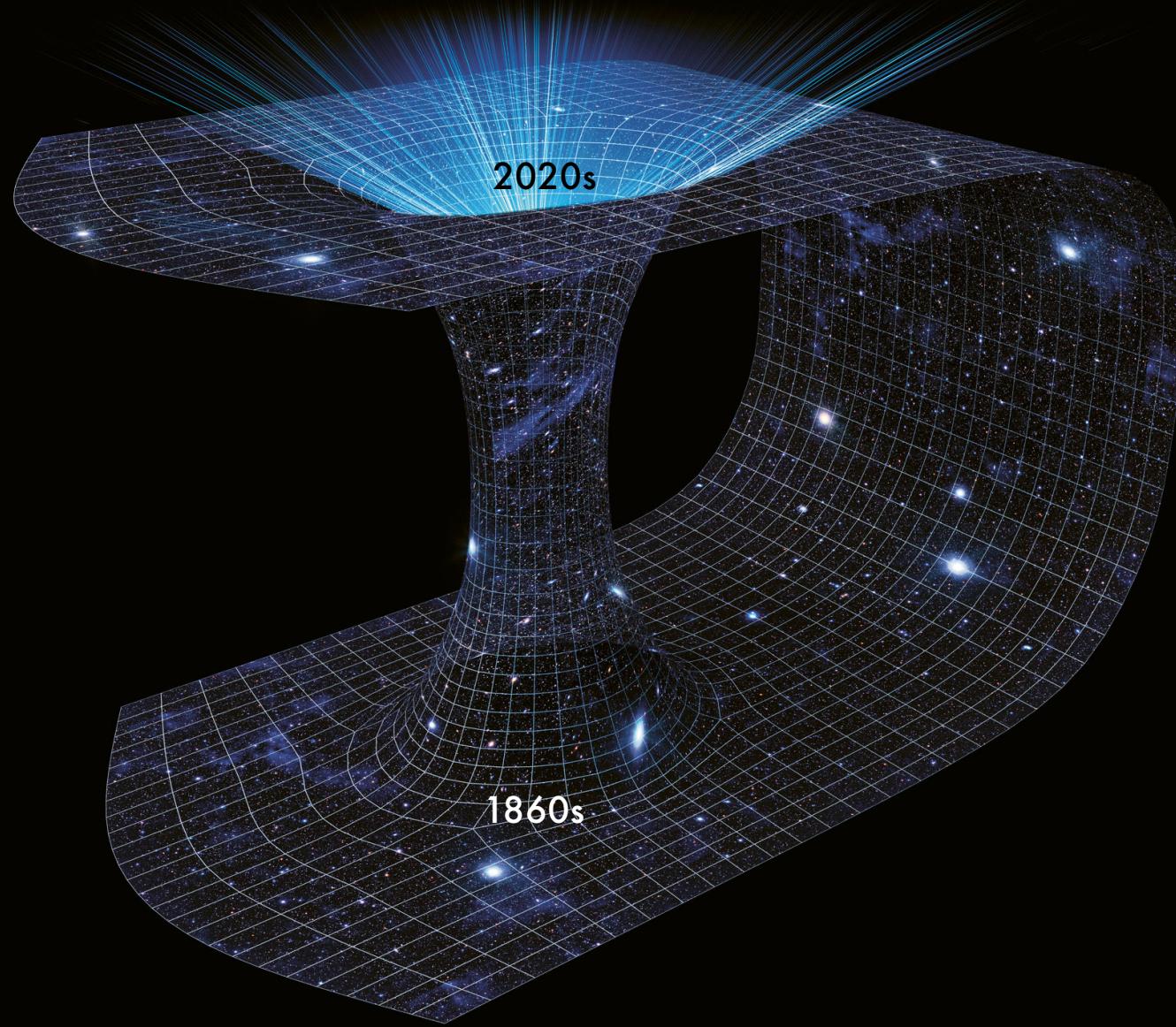
PSYCHOPHYSICS

Dr. Frederike H. Petzschner

University of Zurich & ETH Zurich & Brown University

Twitter: @rikepetzschner

Time travel





Civil war (America)



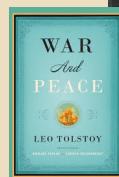
Taiping Rebellion



Bhutan war



Skiing was invented



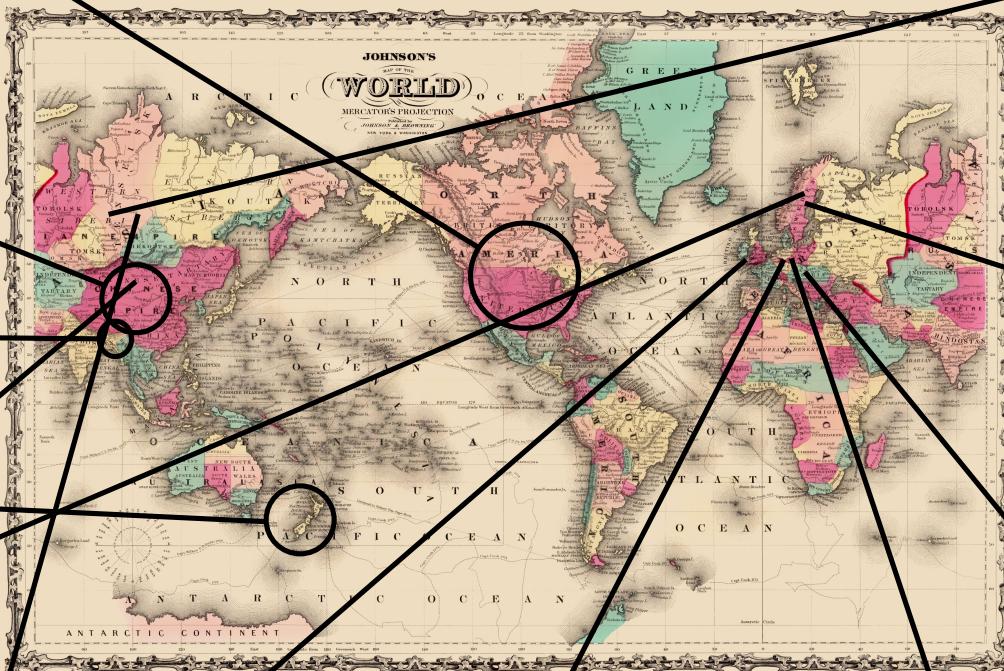
Leo Tolstoy



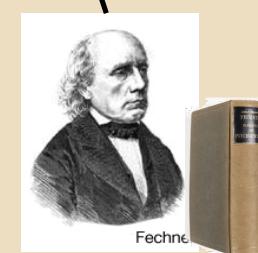
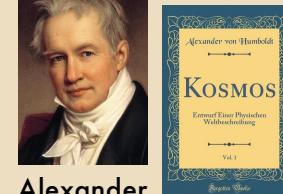
Lewis Carroll



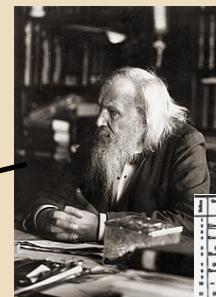
1860s



Alexander von Humboldt



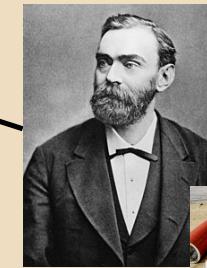
Gustav Theodor Fechner



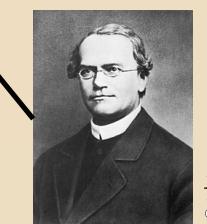
Dimitri Mendeleev



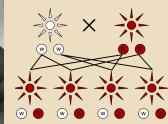
Periodic Table



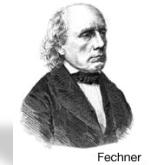
Dynamite



Inheritance

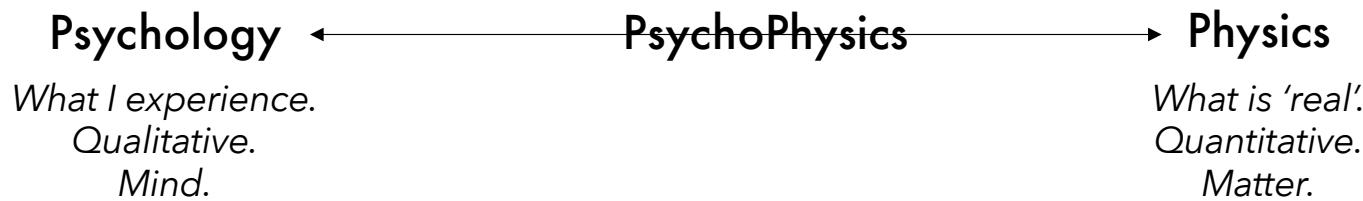


Gregor Mendel



Fechner

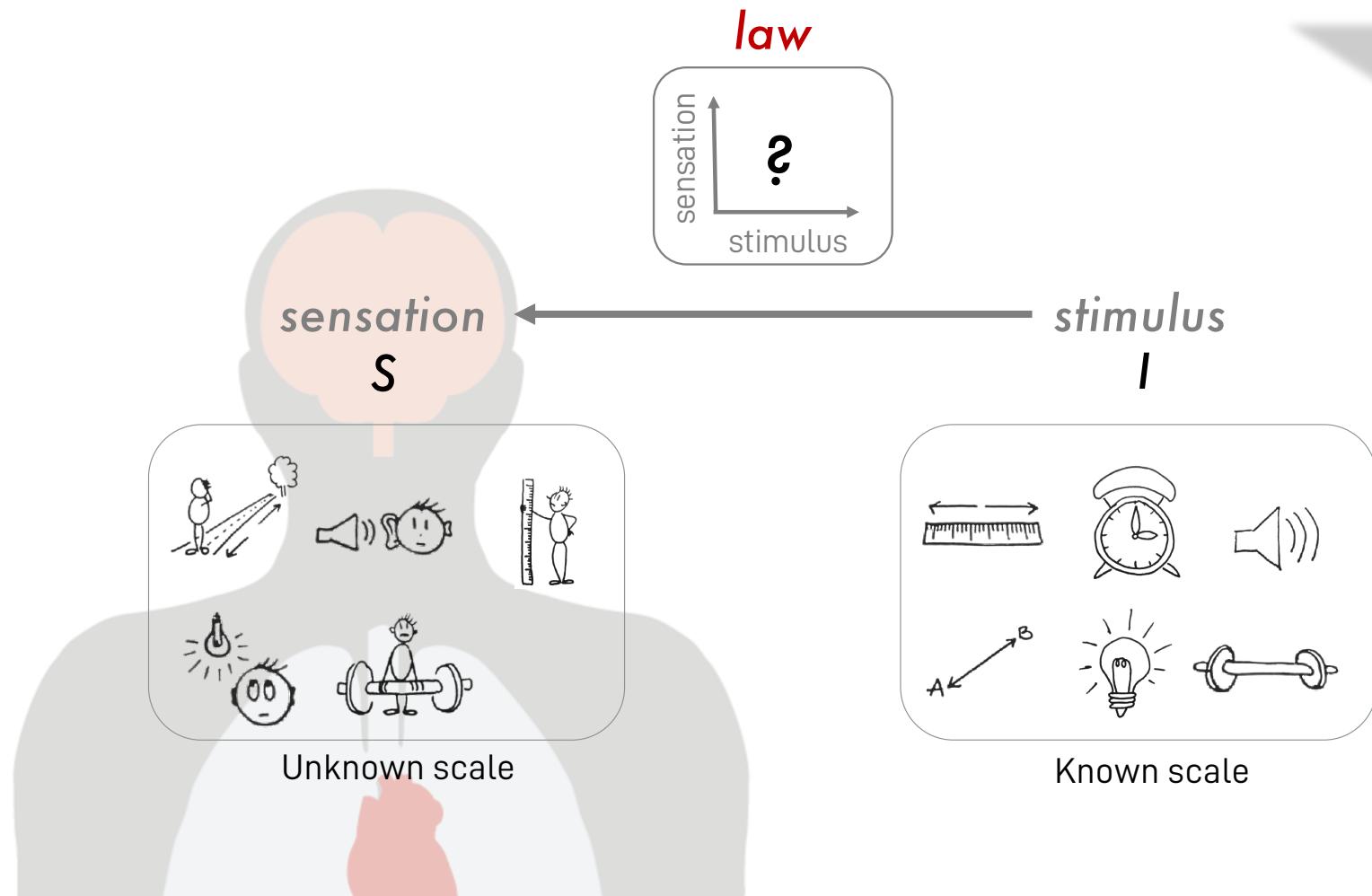
How do you measure sensation?



Psychophysics



Fechner

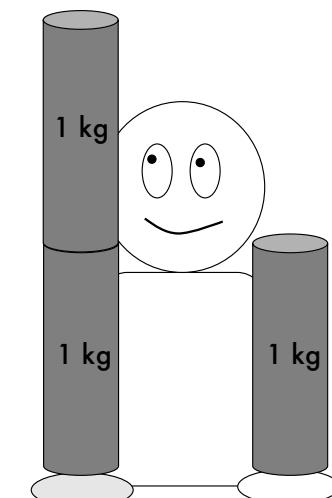
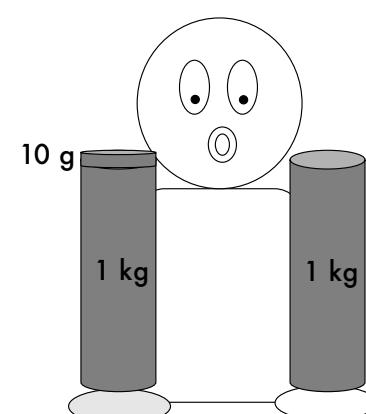
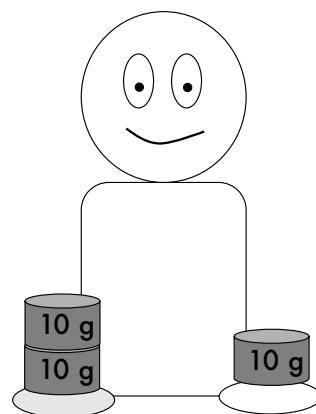


Just-noticeable difference

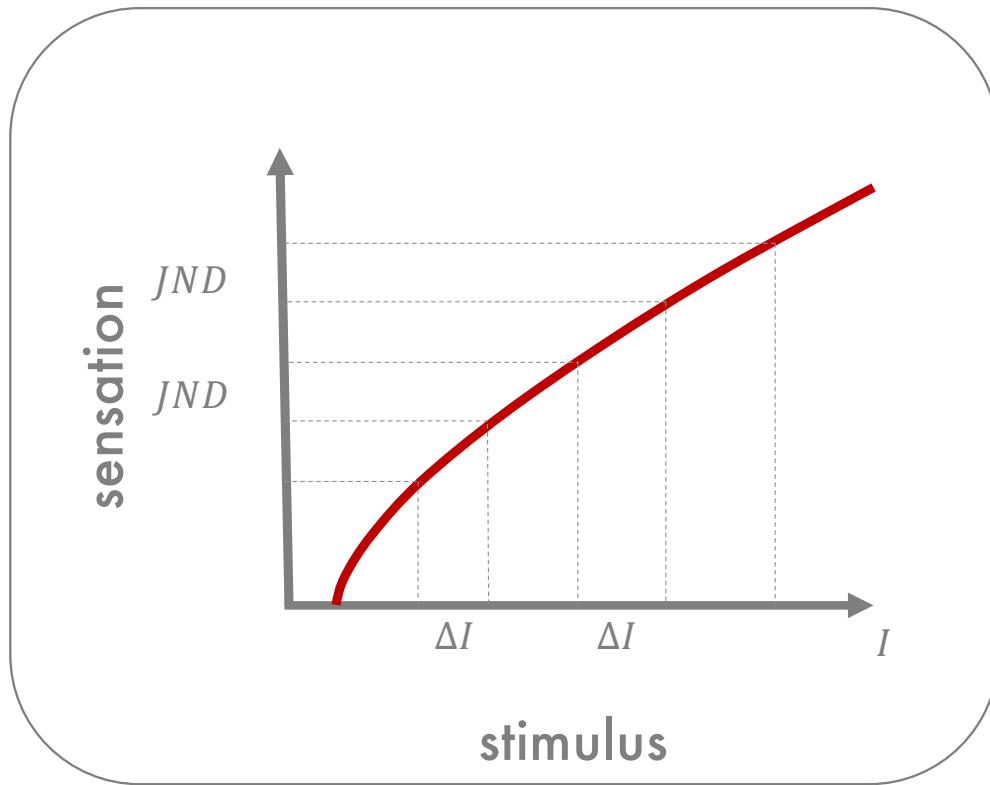


1834

$$\frac{\Delta I}{I} = k$$



Just-noticeable difference



$$JND = \frac{\Delta I}{I} = k$$

$$S \propto \log I$$

Weber-Fechner Law

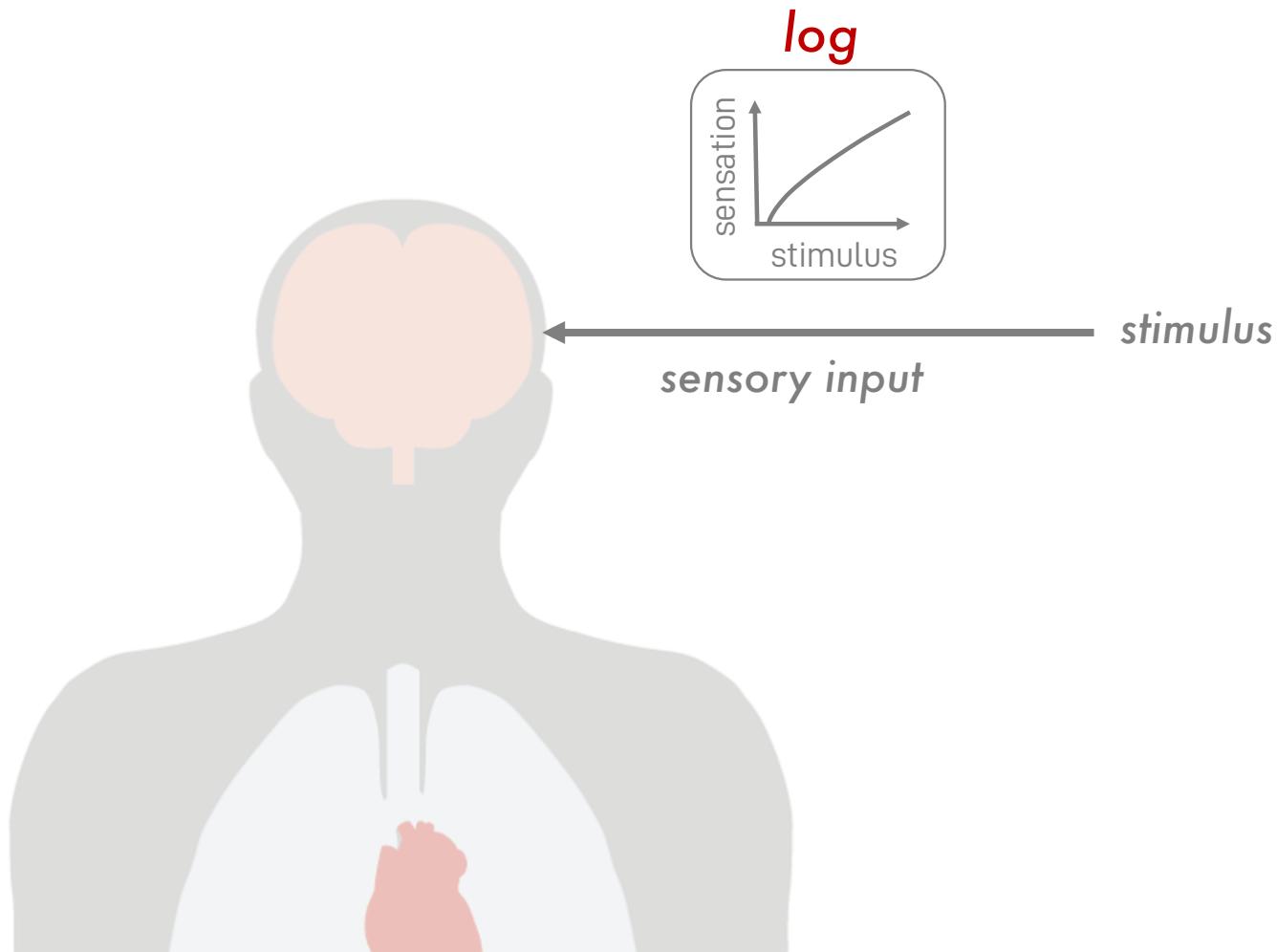


Fechner



Weber

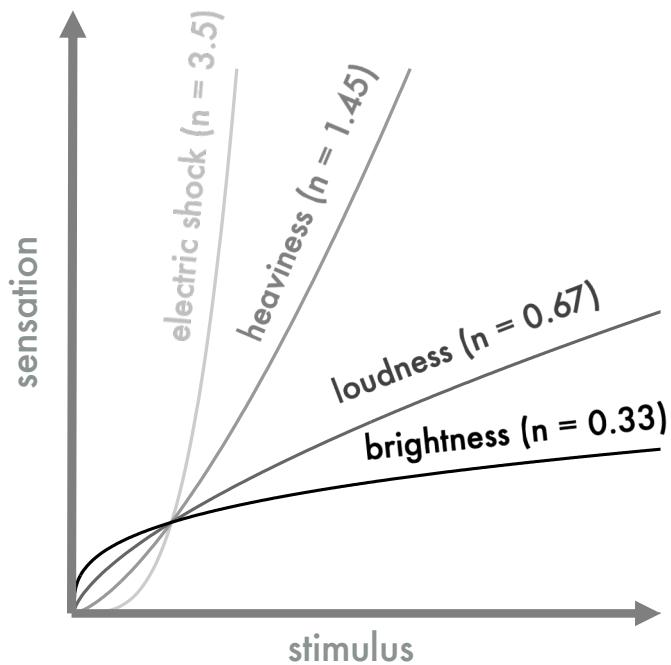
Psychophysical “LAW”



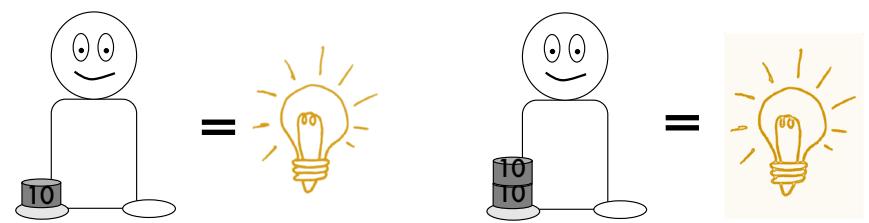
Steven's Power LAW



1961

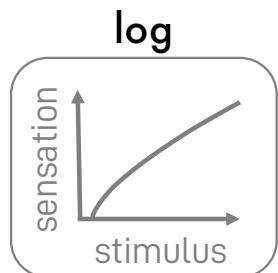
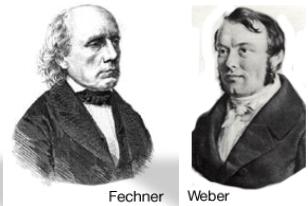


$$S \propto I^n$$



The importance of measurements...

Weber-Fechner Law



Steven's Power Law



To Honor Fechner and
Repeal His Law

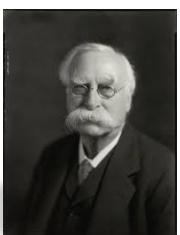
A power function, not a log function, describes the
operating characteristic of a sensory system.

S. S. Stevens

Theoretically derived
Just noticeable difference ($I \rightarrow S$)

MacKay 1963, Science

Empirical
cross/modality matching ($I_1 \rightarrow S_1 \rightarrow S_2 \rightarrow I_2$)



E. Poulton

Psychophysics
~~The new Pseudophysics~~
E. Poulton
1968

TICS-1416; No. of Pages 9

ARTICLE IN PRESS

Review

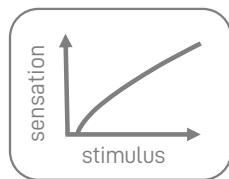
CellPress

A Bayesian perspective on magnitude
estimation

Frederike H. Petzschner¹, Stefan Glasauer^{2,3,4}, and Klaas E. Stephan^{1,5}

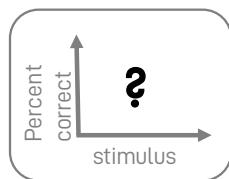
Next talk on
Bayesian
perception

The importance of measurements...



Methods of adjustment/ estimation

- cross/unimodality matching
 - production – reproduction
- no right or wrong response!

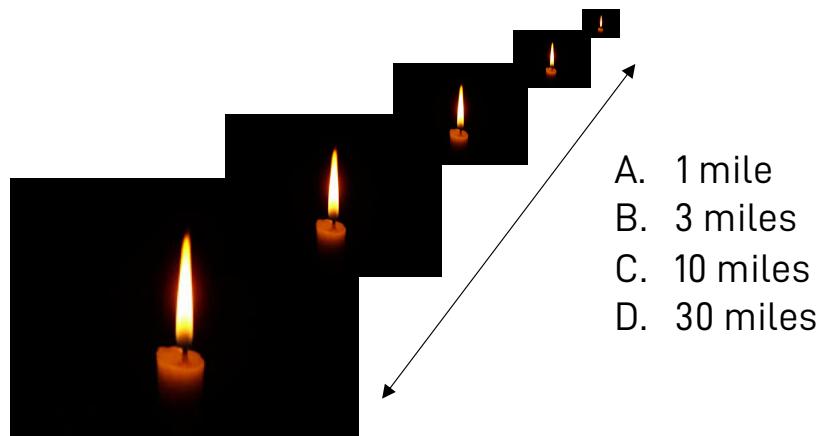


Methods of performance

- discrimination (e.g., bigger than)
- detection (yes/no)

Detection Threshold

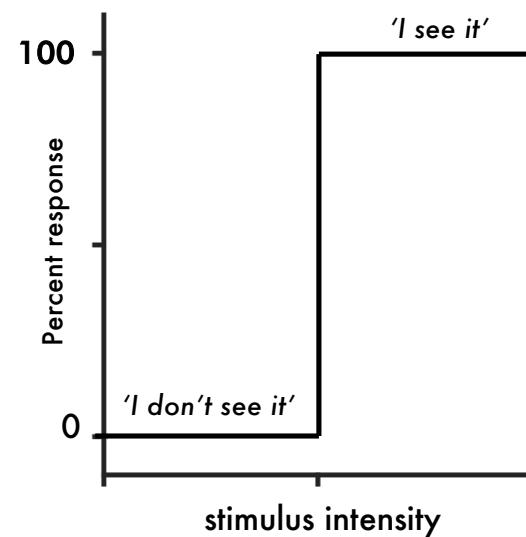
How far can you still see a candle flame on a dark clear night?



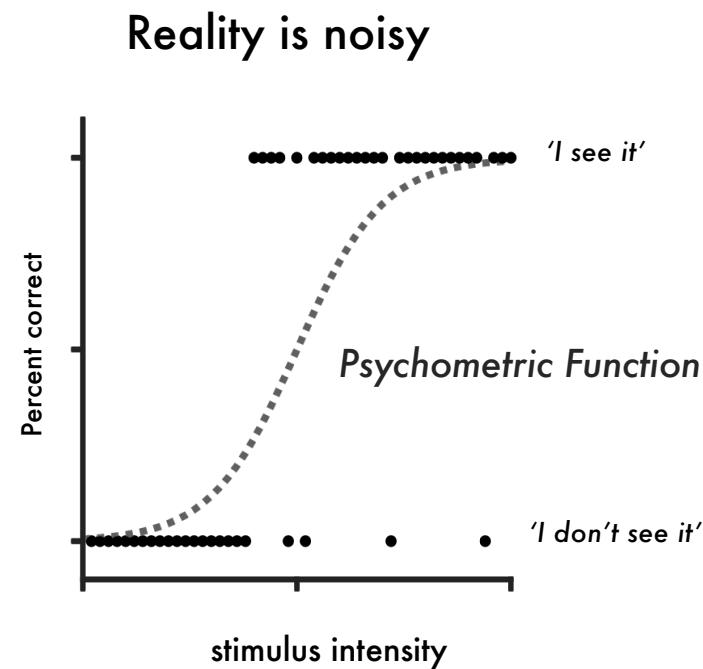
Estimating thresholds

Was there a light? Yes or No.

Perfect Threshold

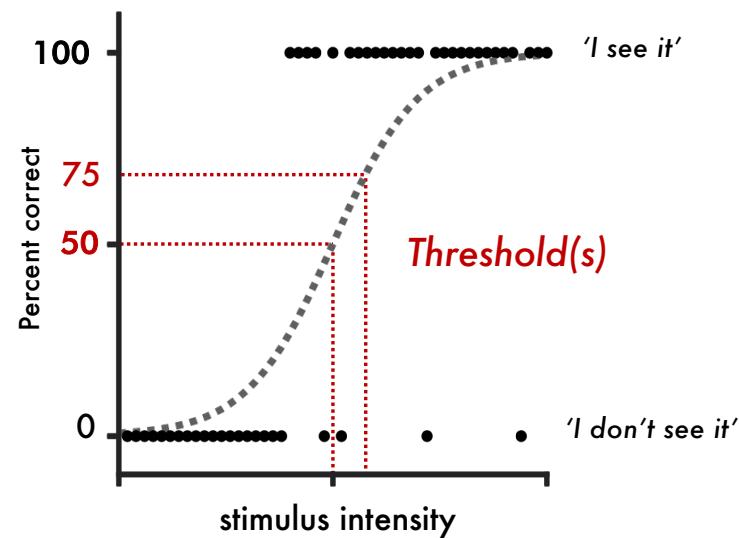


Estimating thresholds



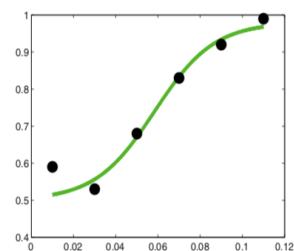
Estimating thresholds

Where is the threshold?



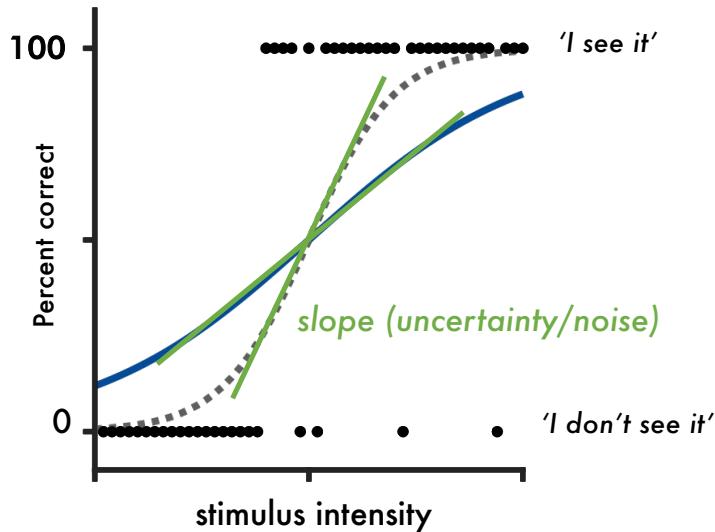
Fitting the psychometric function

Fitting the Psychometric function



- Cumulative Normal Distribution
- Logistic Function
- Weibull Function
- Cummulative Normal
- Gumble (Log-Weibull)
- Quick
- Hyperbolic Secant
-

Kingdom & Prins, Psychophysics, 2016



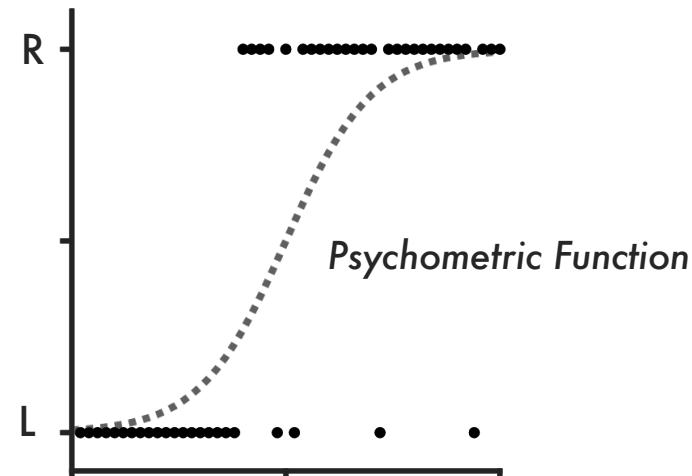
Psychometric function are universal

AFC: Alternative forced choice

1 AFC: Left-oblique or right-oblique?



2 AFC: Which one left-oblique?

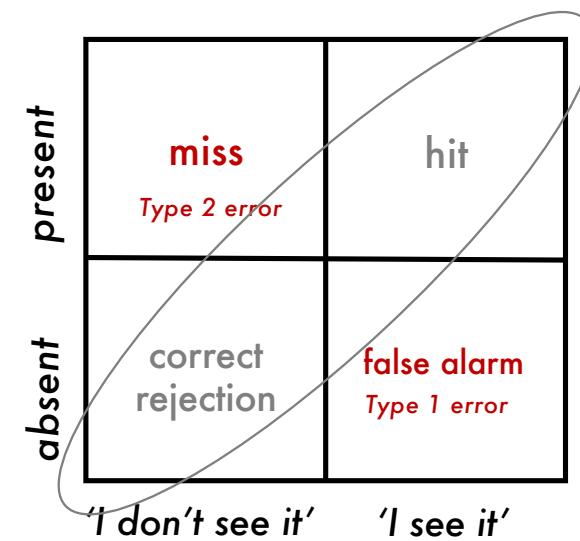
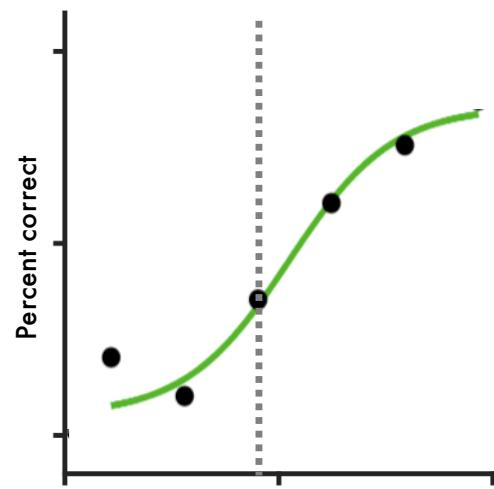


Relationship between physical quantity and detection/discrimination probability.

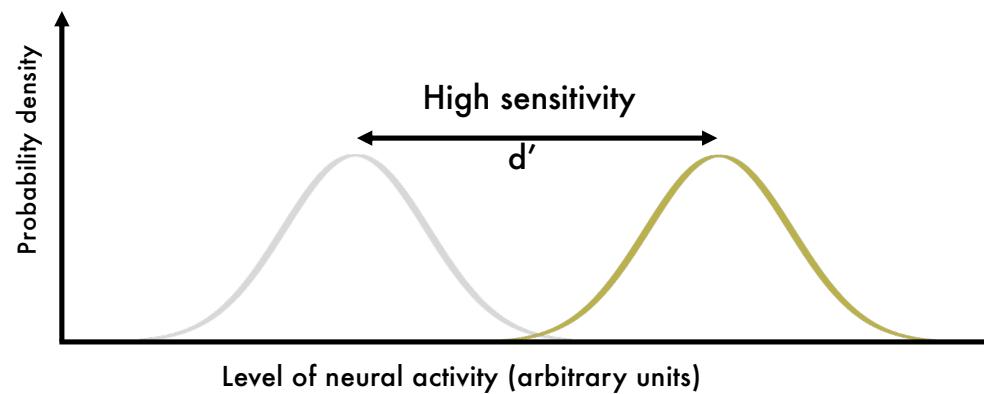
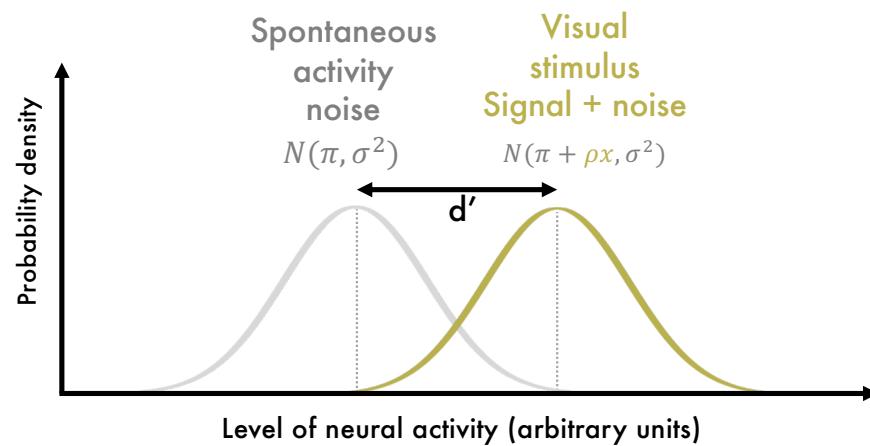
What is behind and beyond the Psychometric Function?

Signal detection theory

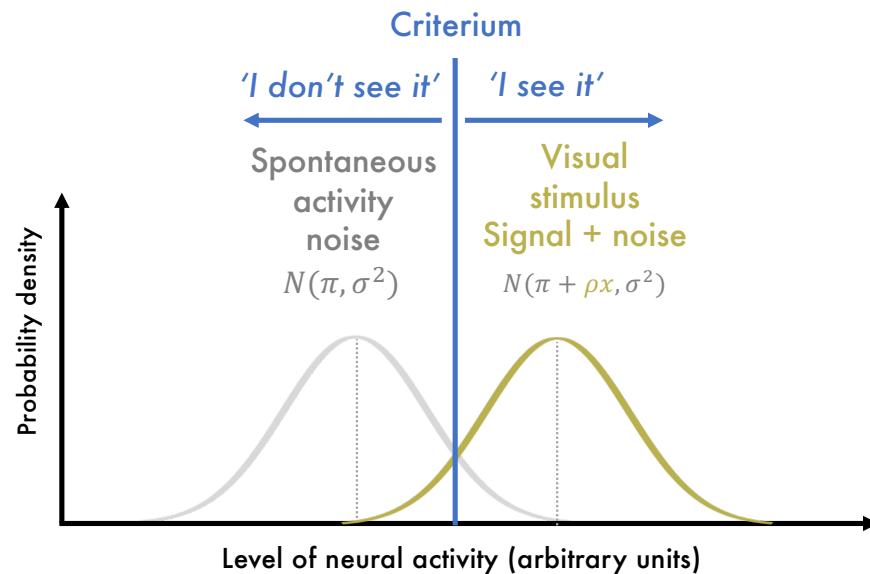
The details of probability correct



Signal detection theory

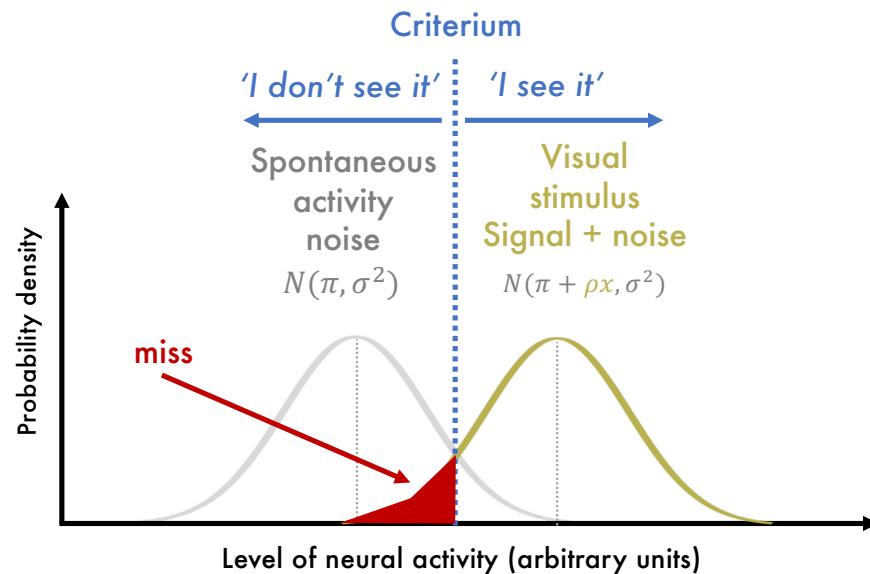


Signal detection theory



Criterium: Converting neural activity into an overt response

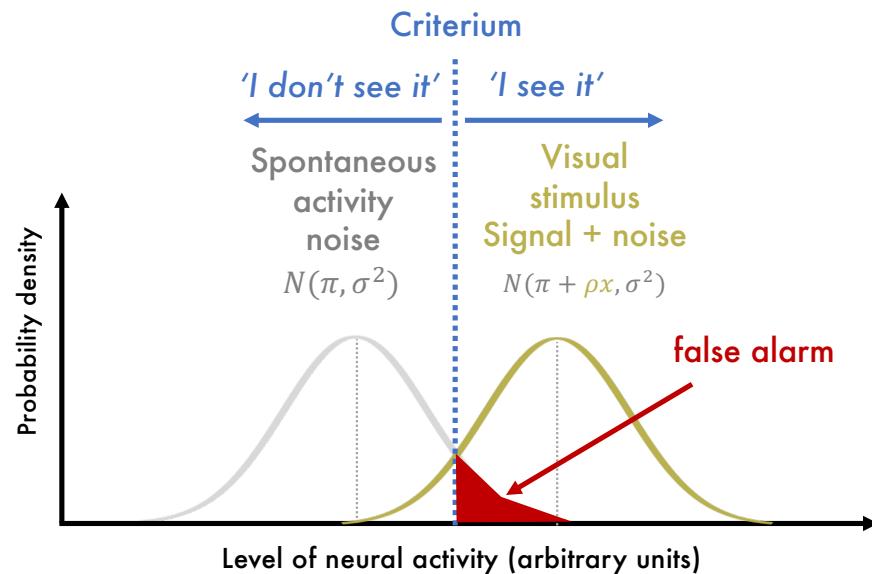
Signal detection theory



| | | |
|---------|----------------------|-----------------------------|
| present | miss Type 2 error | hit |
| absent | correct rejection | false alarm Type 1 error |

'I don't see it' 'I see it'

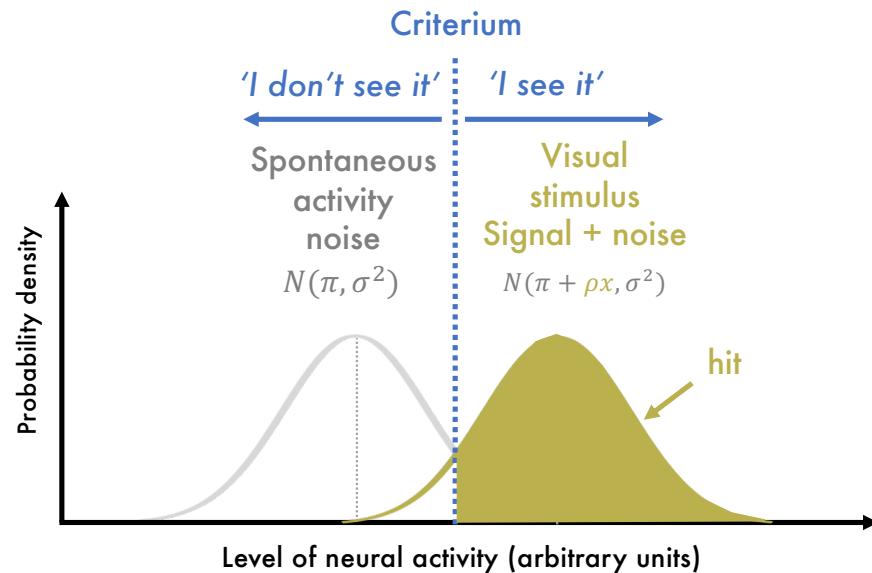
Signal detection theory



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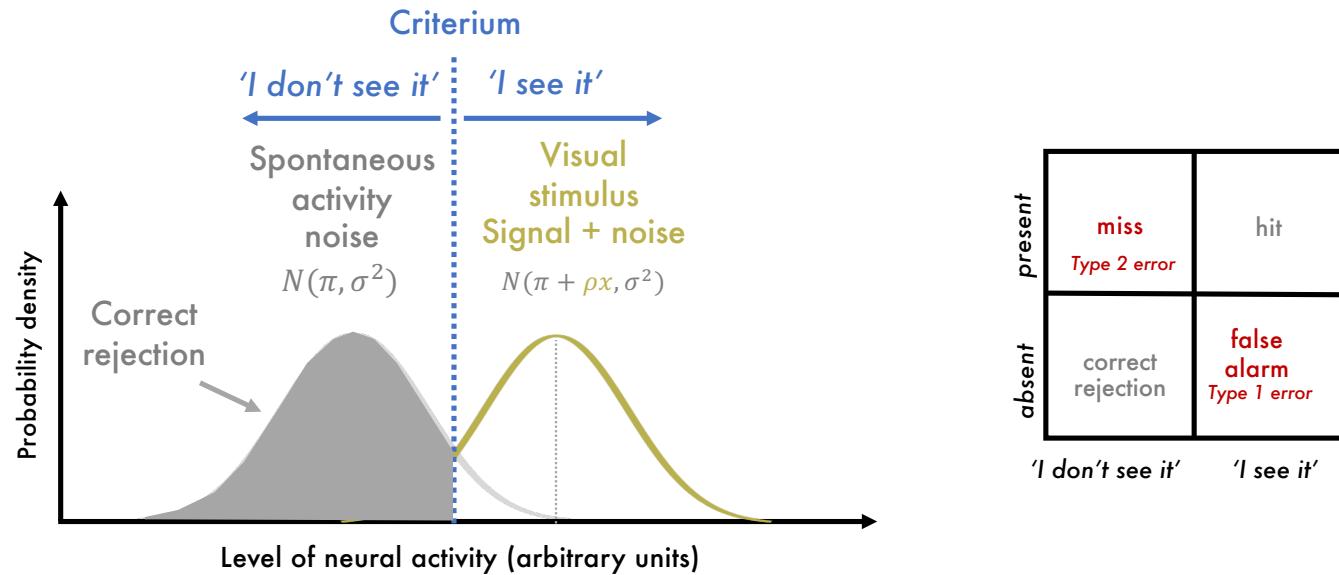
Signal detection theory



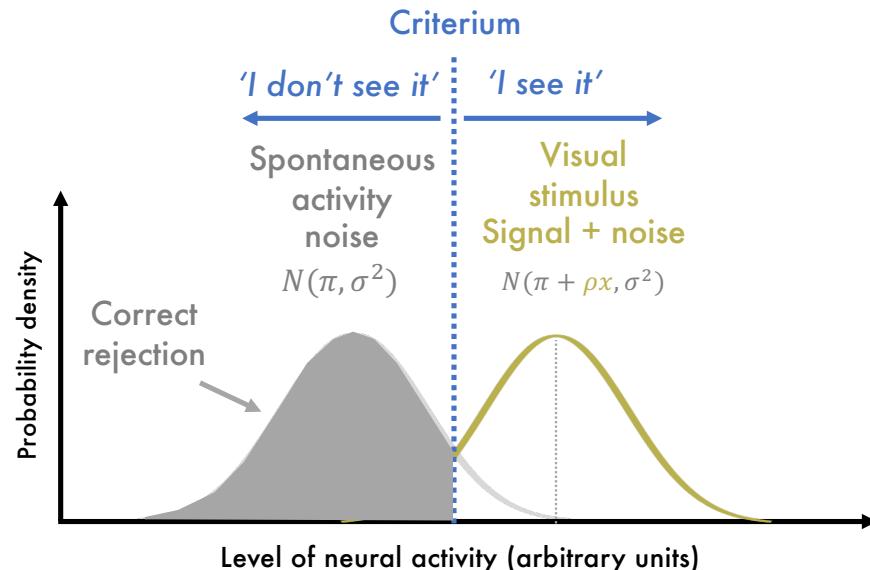
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'I don't see it' 'I see it'

Signal detection theory



Signal detection theory



Calculating d' and bias

- Depends on the exact experiment 2AFC, 1AFC
- Conversion maps from PC to d'

Code & Formula
Kingdom & Prins, Psychophysics, 2016

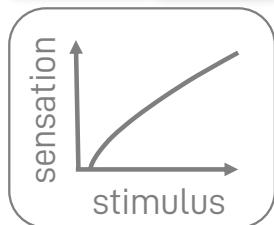
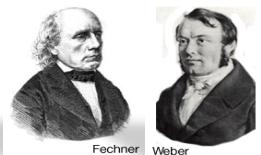
McNicol (2004),
Chapters 5-8 Gescheider (1997)
Nonexpert: Macmillan and Creelman (2005)
More mathematical: Wickens (2002)
More mathematical: Green and Swets (1974)

| | | |
|---------|----------------------|-----------------------------|
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'I don't see it' 'I see it'

Summary

Weber-Fechner Law



Steven's Power Law



To Honor Fechner and
Repeal His Law

A power function, not a log function, describes the
operating characteristic of a sensory system.

S. S. Stevens

Methods of adjustment

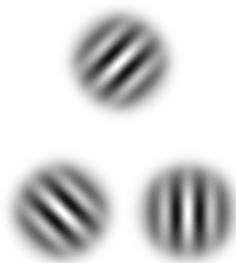


Psychophysics

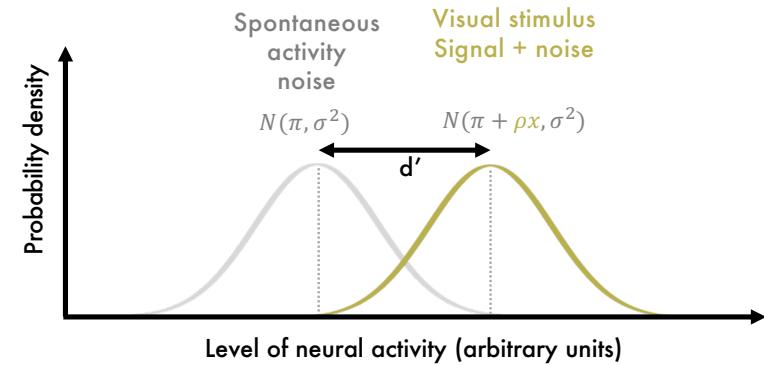
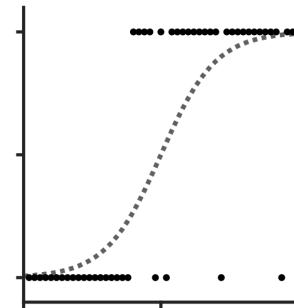
The new ~~Psychophysics~~
E. Poulton
1968

Performance measures

1 AFC: Left-oblique or
right-oblique?



2 AFC: Which one
left-oblique?



All measures only provide indirect measure of internal mental state

Thank you

@rikepetzschn

→ Find me in the beer garden

Read Me:
Kingdom & Prins, Psychophysics, 2016
Petzschn et al., TiCS, 2015