

PSYCHOPHYSICS

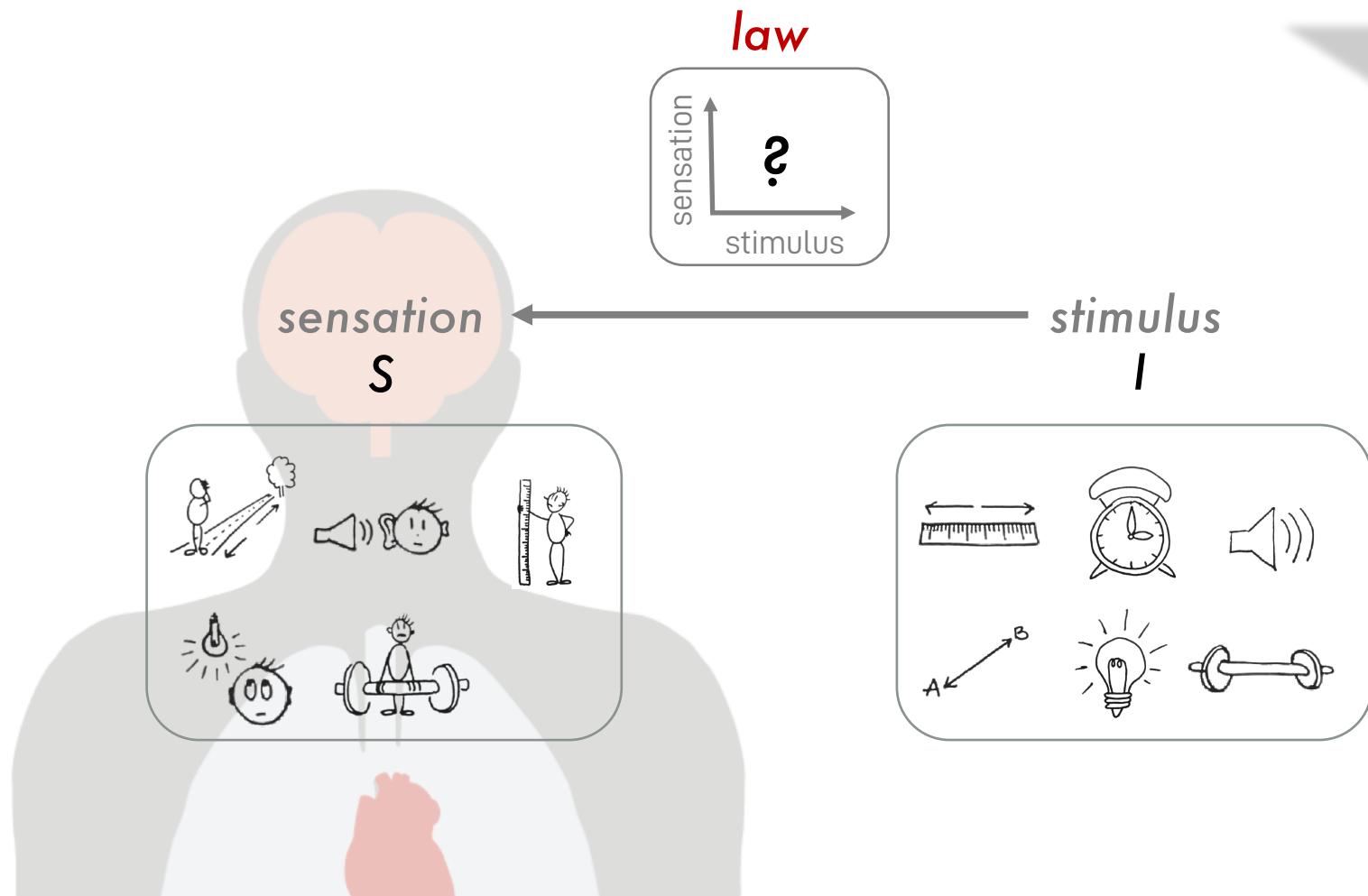
DR. FREDERIKE H. PETZSCHNER

On the search for the laws of psychophysics...

Psycho-Physics



Fechner

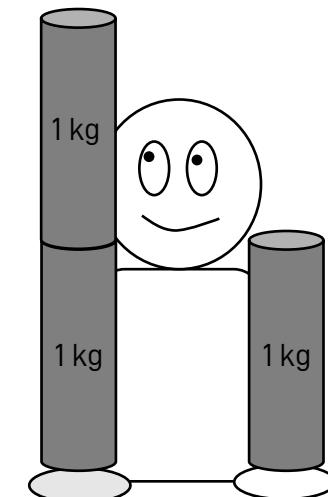
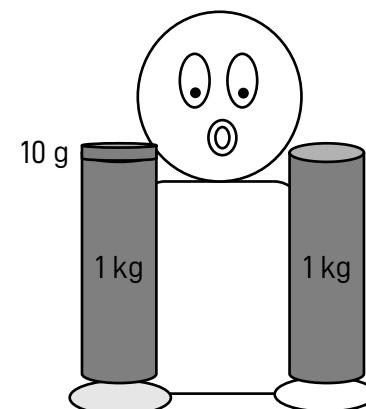
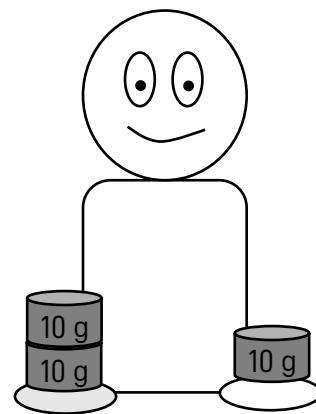


Just-noticeable difference

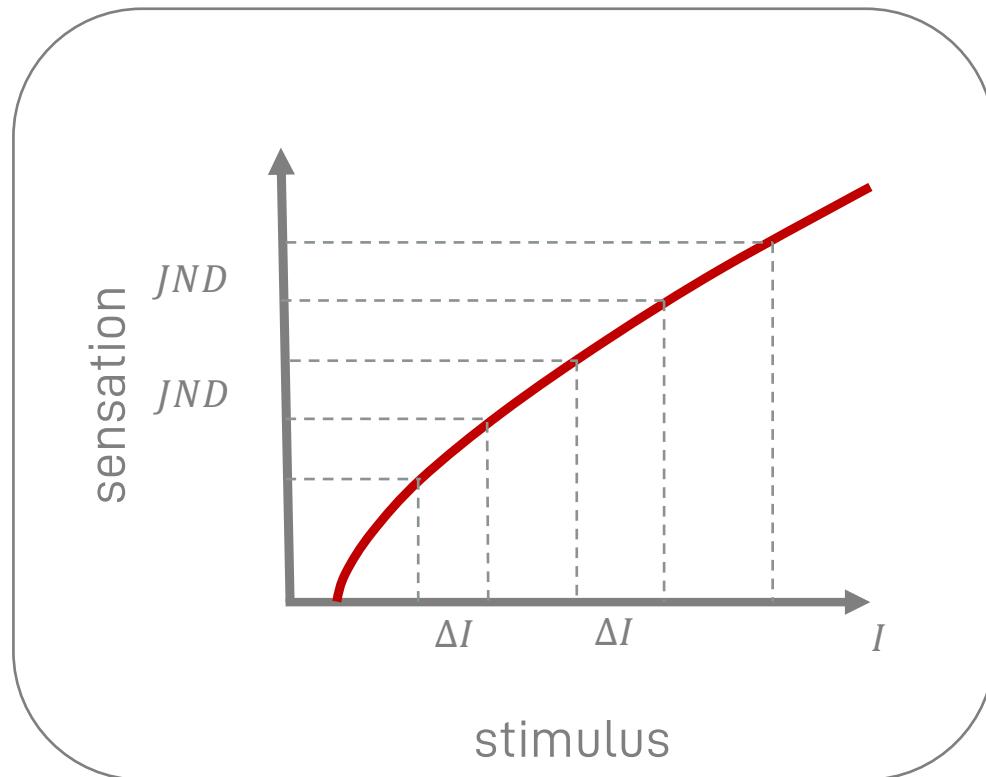


1834

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



Just-noticeable difference



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

$$S \propto \log I$$

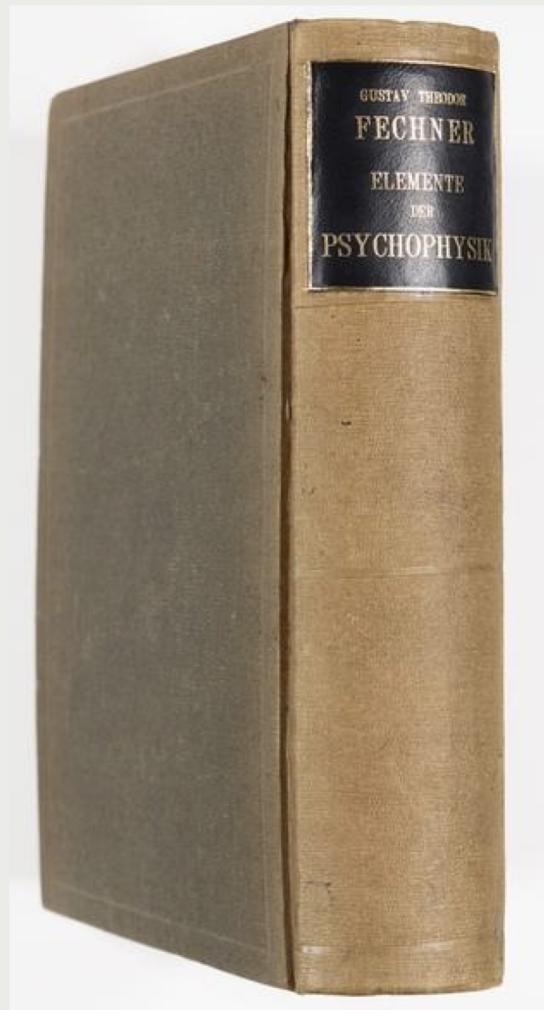
Weber-Fechner Law



Fechner

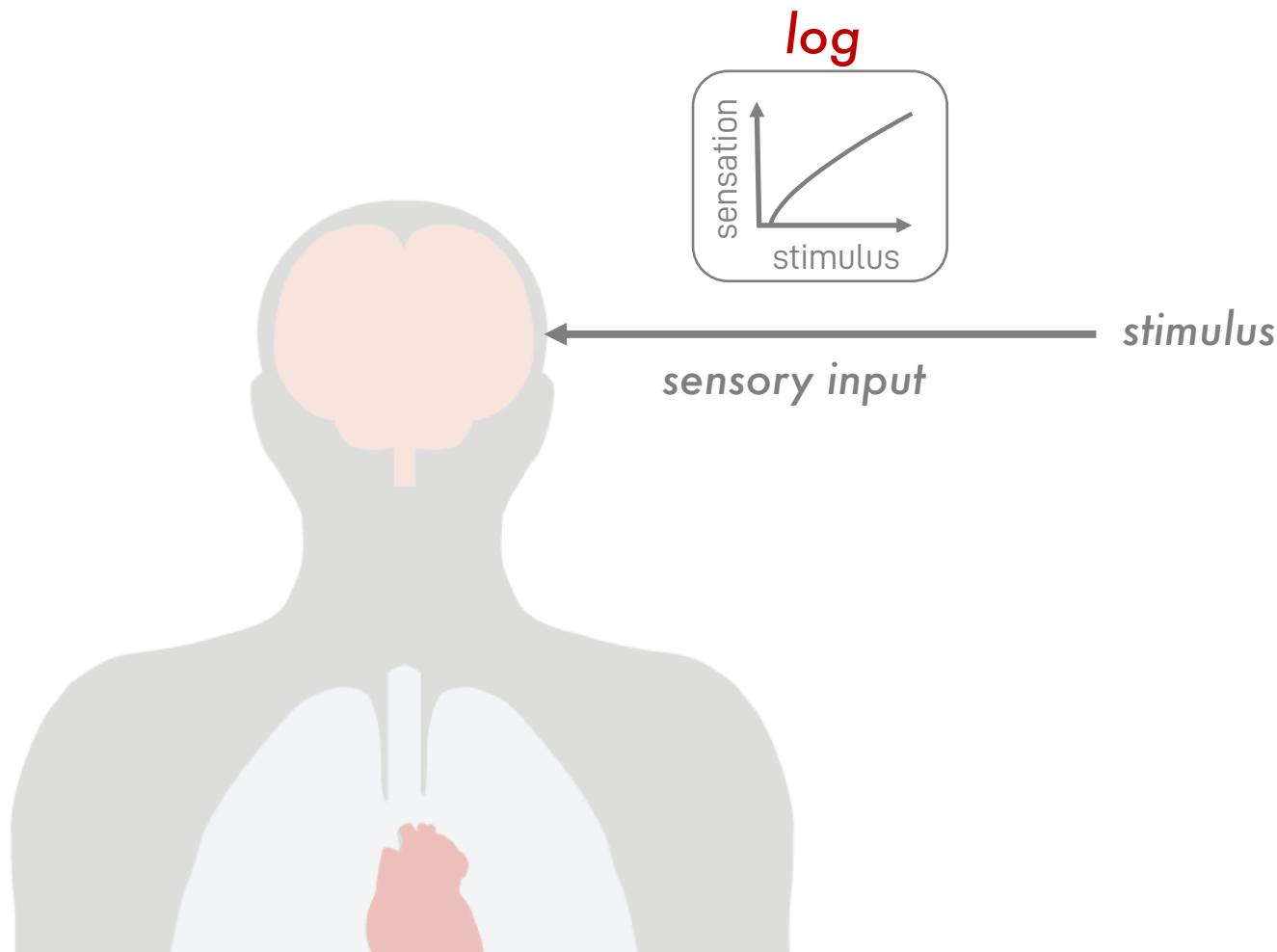


Weber



1860

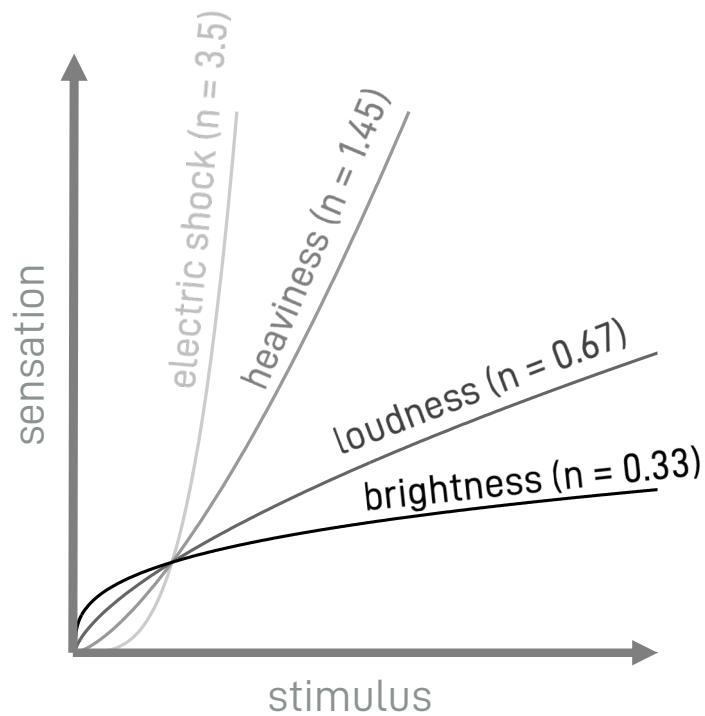
Psychophysical "LAW"



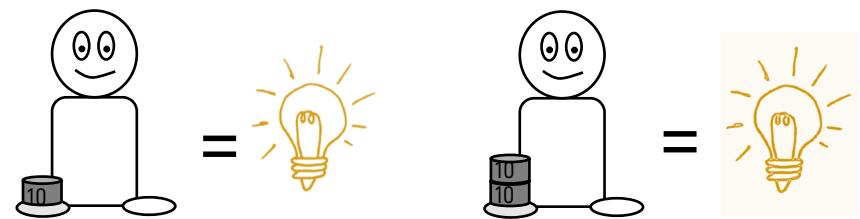
Steven's Power LAW



1961



$$S \propto I^n$$



Stevens S S. To honor Fechner and repeal his law. Science. 1961

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



S.S. Stevens

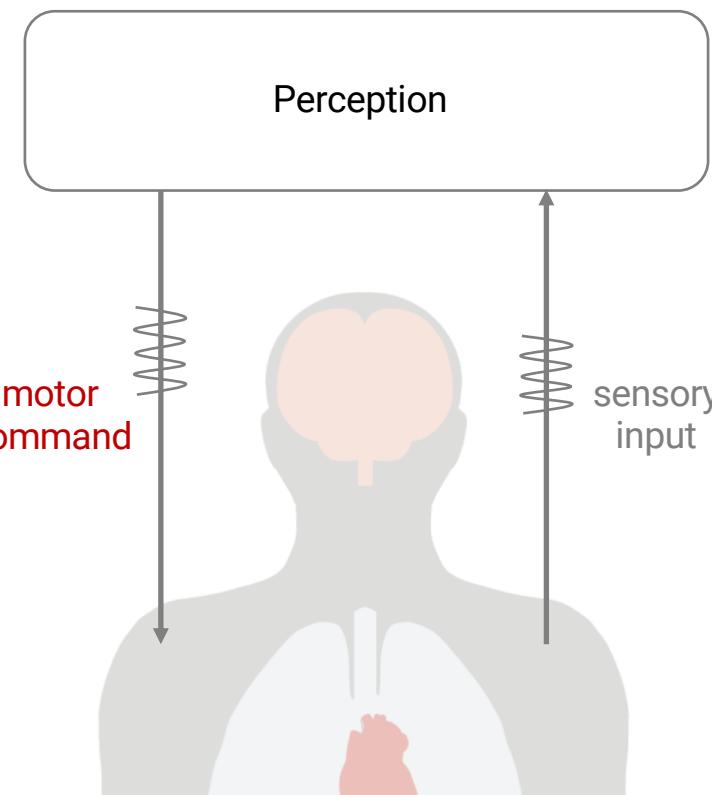
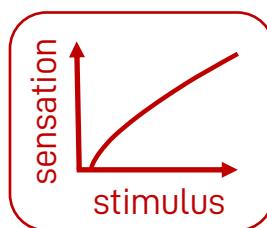
Psychophysics
~~The new Pseudophysics~~
E. Poulton
1968



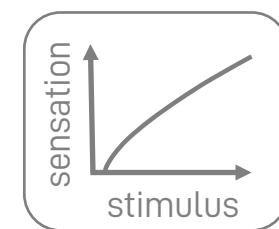
E. Poulton

The importance of the experimental method

*Cross/modality Matching:
Adjust the
size/brightness/heaviness
until they match*



*Discrimination:
Adjust the size, brightness
heaviness until you can not
notice a difference anymore*



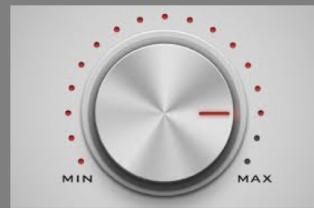
From laws to measurements...

*Say we want to learn something about
how humans perceive orientations?*

“Rotate till you are at 45 degrees.”



"Rotate till they match."

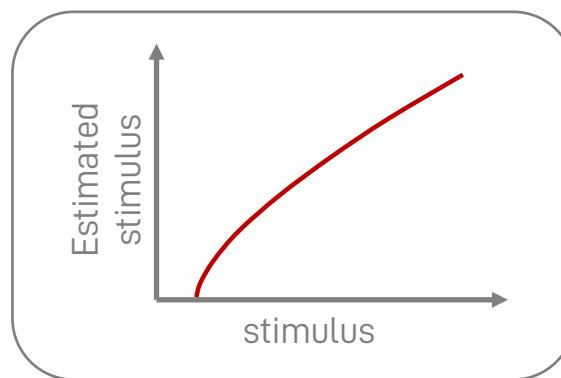
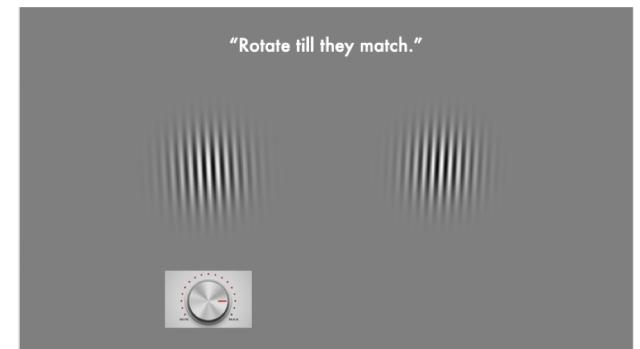


Appearance and estimation tasks

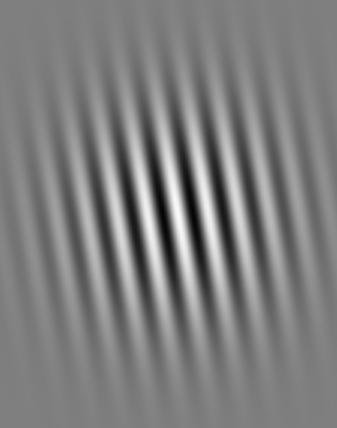
Type 2: No correct, incorrect but a continuous readout

Methods of adjustment:

- *Unimodality matching*
- *Multi-modality matching*
- *Production-Reproduction*



Left or right oblique?



Left or right oblique?

OR

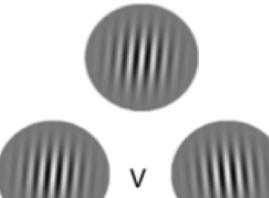
Which one is left oblique?

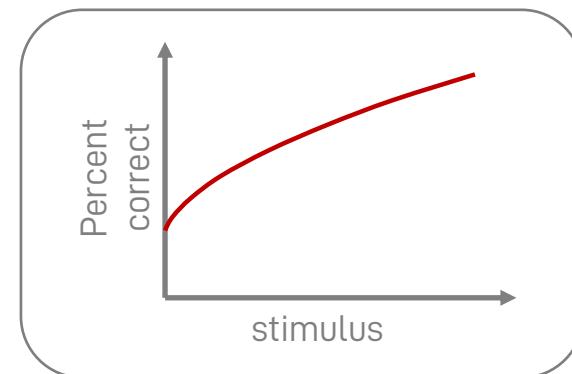
Which one is left oblique?

Performance tasks

Type 1: Correct or incorrect response

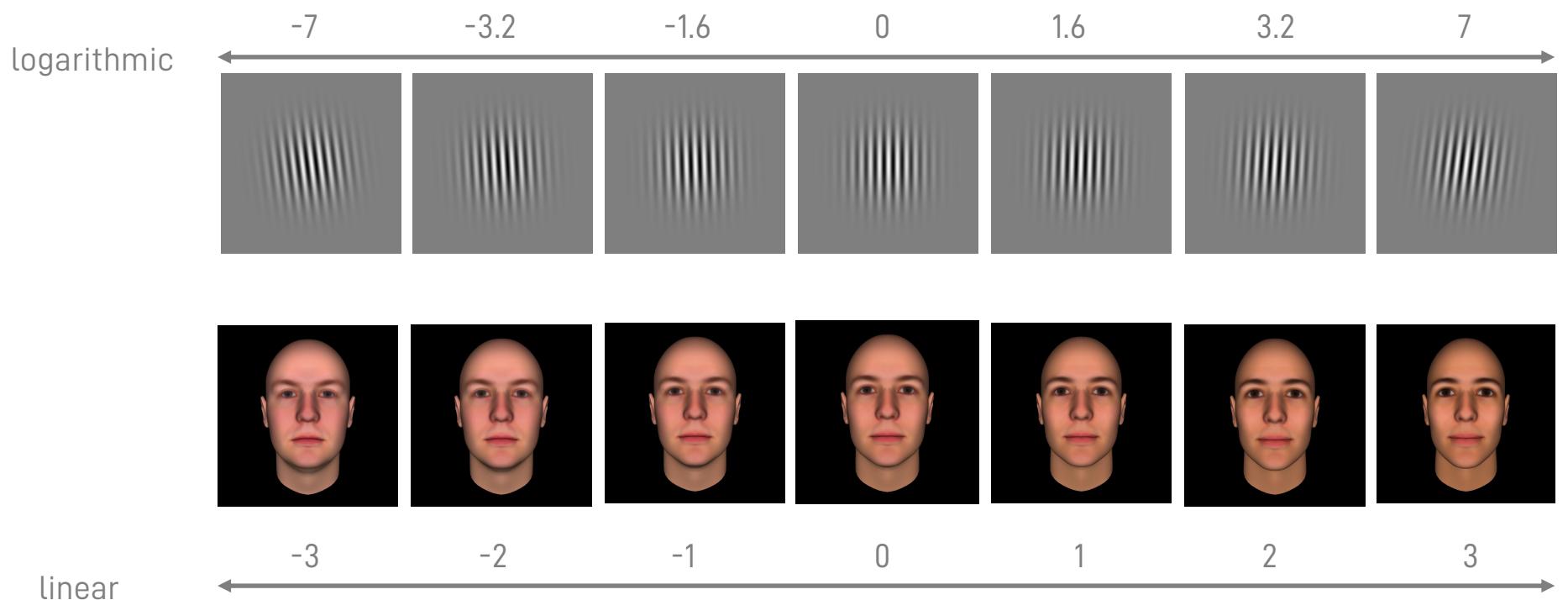
AFC: Alternative forced choice

N	Task name	Stimuli per trial	Task
1	1AFC Symmetric		"Left-oblique or right-oblique?"
2	2AFC Standard		"Which one left-oblique?"
2	1AFC Same-Different		"Same or different?"
3	3AFC Oddity		"Which one the oddity?"
3	2AFC Match-to-Sample		"Which of the bottom pair is the same (or different from) the top one?"

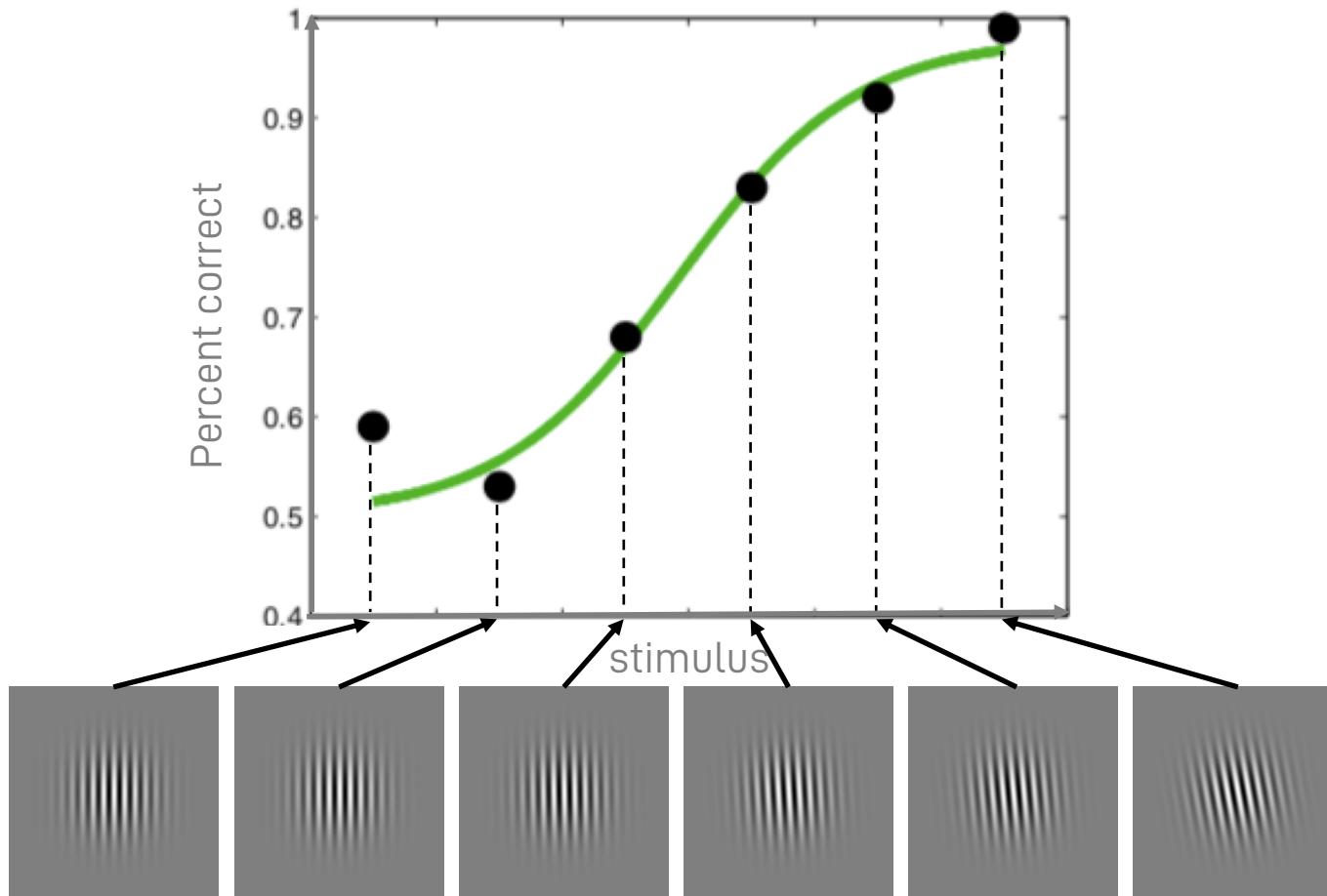


Varying stimulus intensity/ difficulty

stimulus →

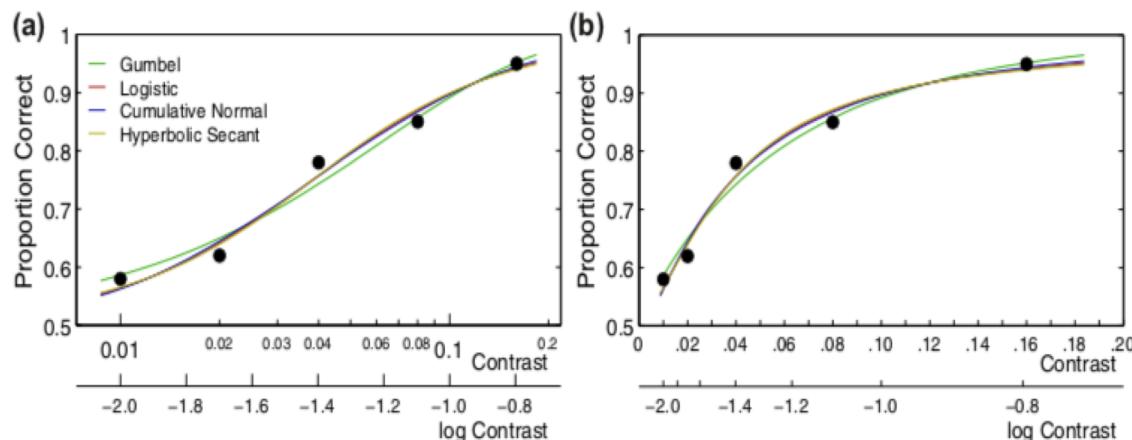


Psychometric function

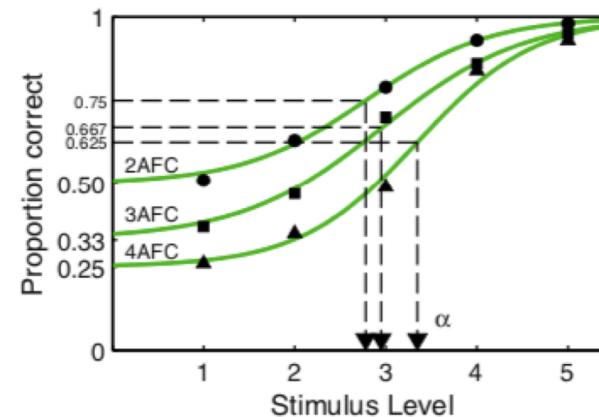


Variations in the Psychometric function

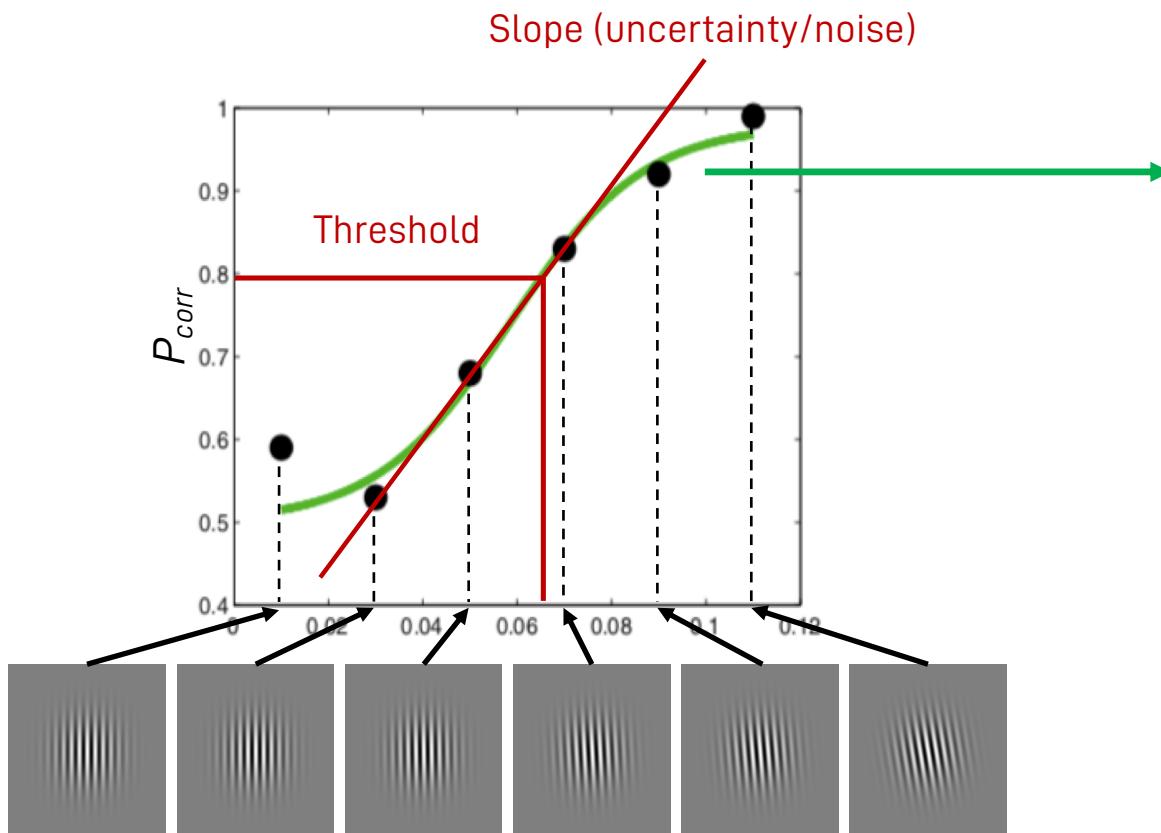
As a function of stimulus spacing (log versus linear)



As a function of the task design



Psychometric function



- Cumulative Normal Distribution

$$F_N(x; \alpha, \beta) = \frac{\beta}{\sqrt{2\pi}} \int_{-\infty}^x \exp\left(-\frac{\beta^2(x - \alpha)^2}{2}\right)$$

- Logistic Function

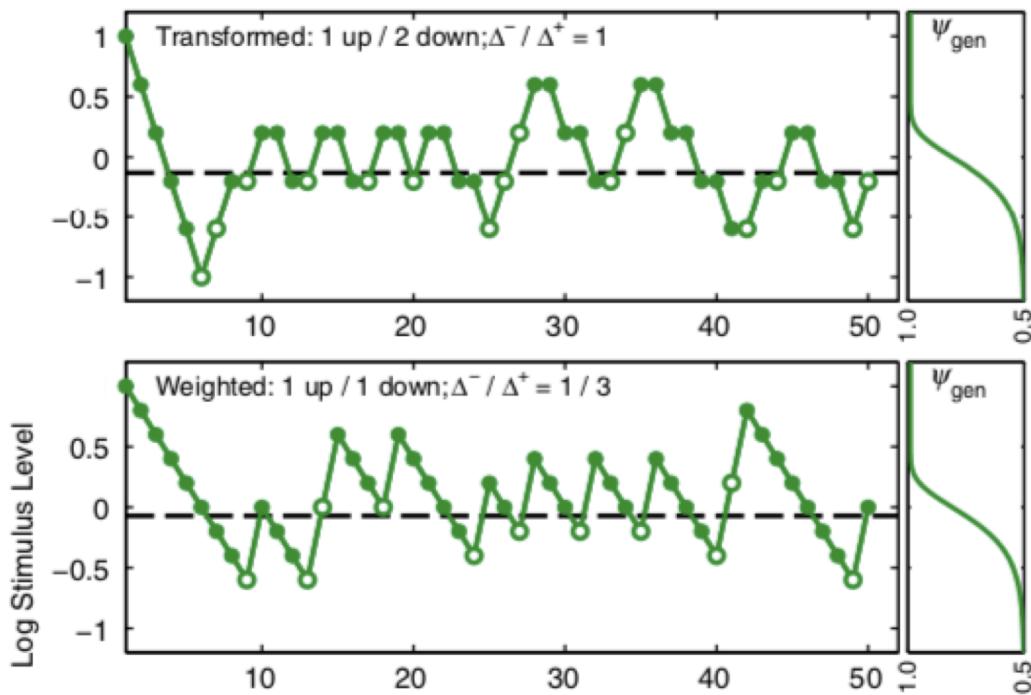
$$F_L(x; \alpha, \beta) = \frac{1}{1 + \exp(-\beta(x - \alpha))}$$

- Weibull Function

$$F_W(x; \alpha, \beta) = 1 - \exp\left(-\left(\frac{x}{\alpha}\right)^\beta\right)$$

- Cummulative Normal
- Gumble (Log-Weibull)
- Quick
- Hyperbolic Secant
-

Adaptive Methods (Staircases)



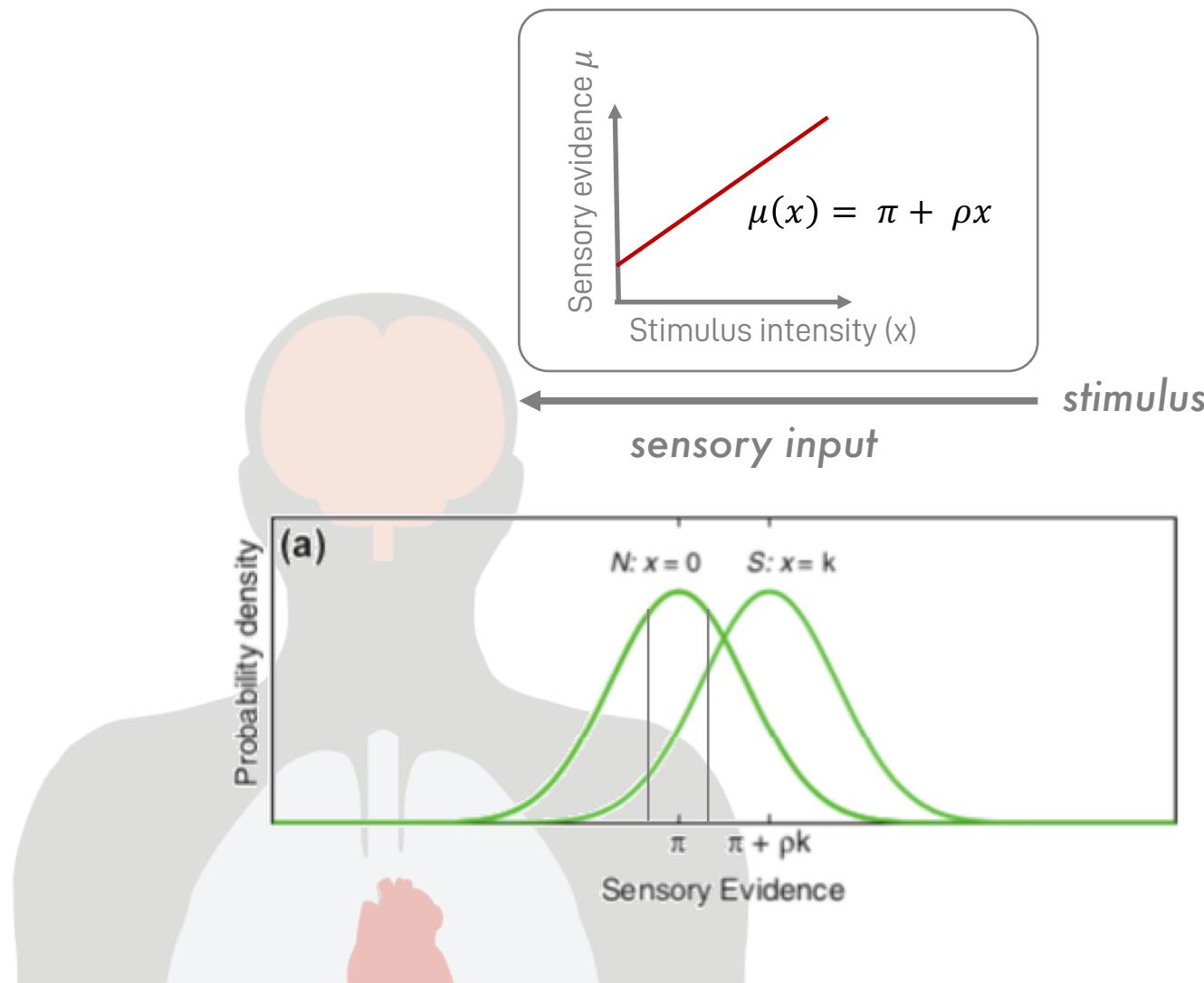
$$\psi_{\text{target}} = \left(\frac{\Delta^+}{\Delta^+ + \Delta^-} \right)^{\frac{1}{D}}$$

Rule	Δ^-/Δ^+	Targeted ψ (%)
1 up/1 down	0.2845	77.85
1 up/2 down	0.5488	80.35
1 up/3 down	0.7393	83.15
1 up/4 down	0.8415	85.84

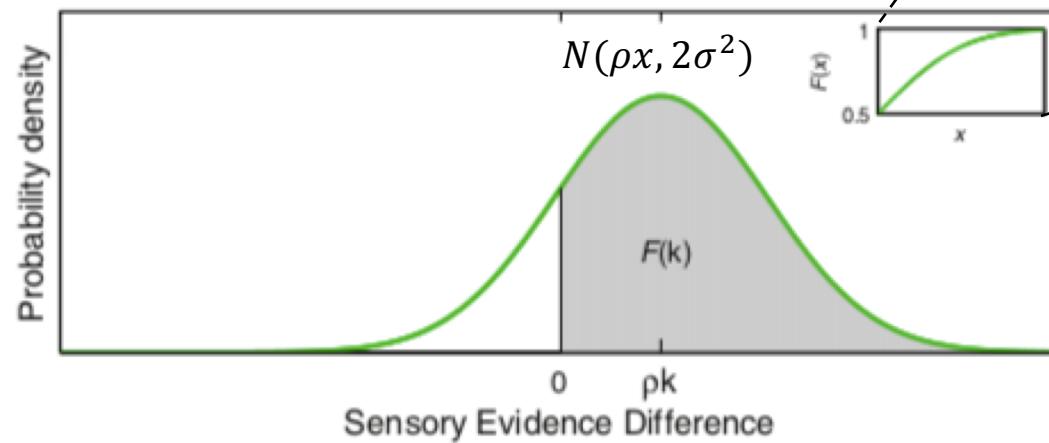
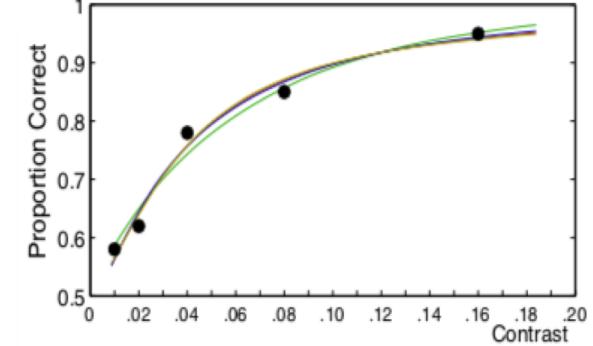
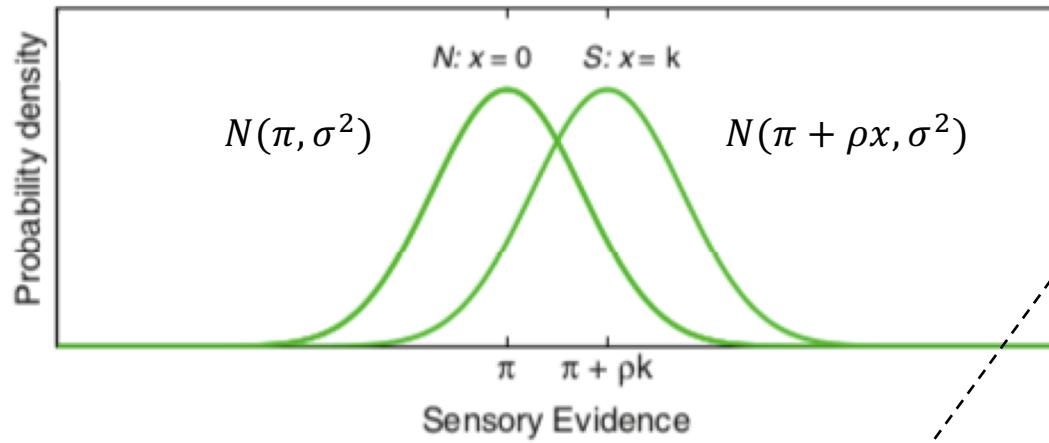
Recommendation: 1/3 ratio; Interleaved

From measurements to theories...

Signal detection theory



Signal detection theory to probability correct

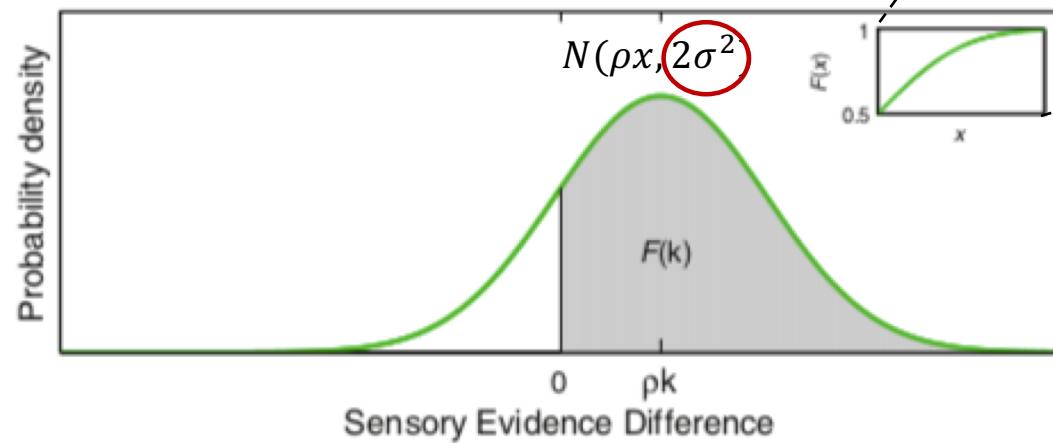
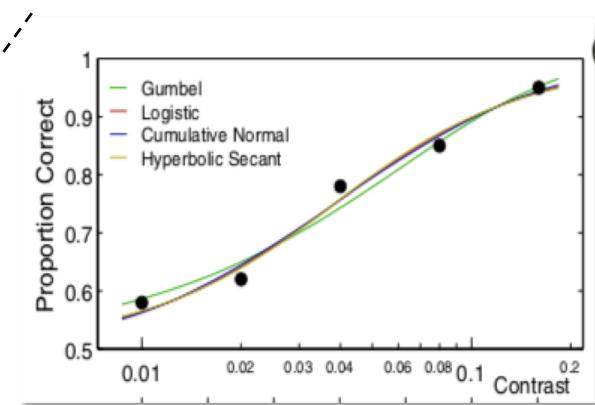
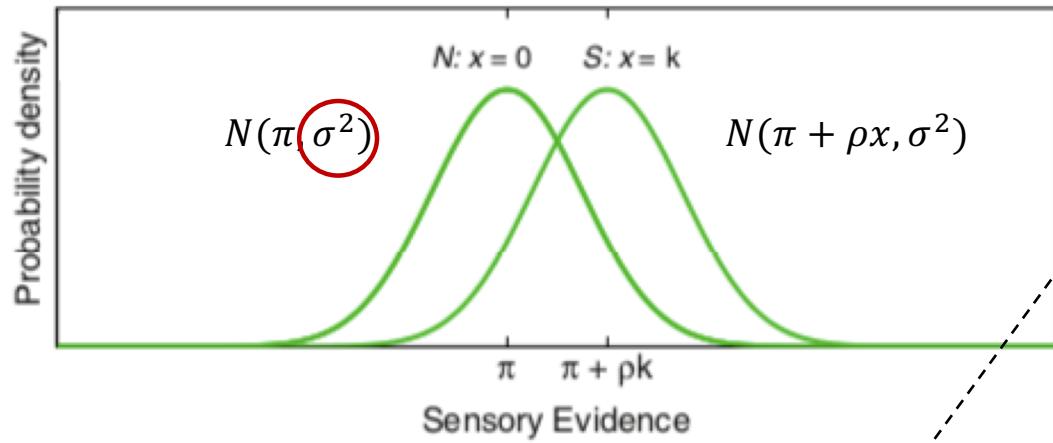


Correct resp: $x(\text{stimulus}) > x(\text{noise})$
 Incorrect resp: $x(\text{noise}) > x(\text{stimulus})$

Probability density of difference between $N(\pi + \rho x, \sigma^2)$ and $N(\pi, \sigma^2)$

$F(x=k) > 0.5$
 $F(0) = 0.5$

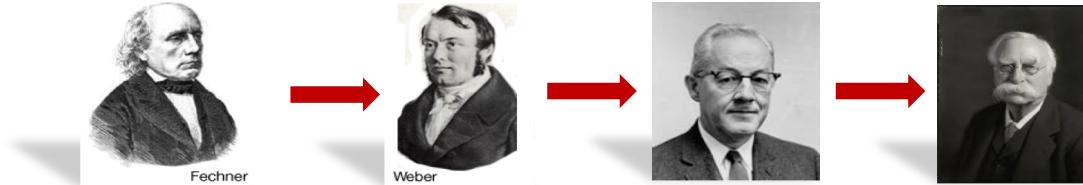
Signal detection theory to probability correct



Correct resp: $x(\text{stimulus}) > x(\text{noise})$
 Incorrect resp: $x(\text{noise}) > x(\text{stimulus})$

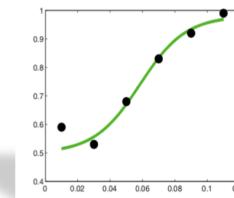
Probability density of difference between $N(\pi + \rho x, \sigma^2)$ and $N(\pi, \sigma^2)$
 $F(x=k) > 0.5$
 $F(0) = 0.5$

On the search for the laws of psychophysics...



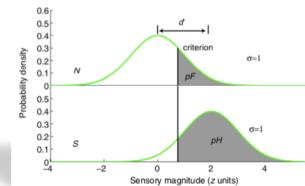
From laws to measurements...

Performance versus appearance based
Psychometric function



From measurements to theories...

Signal detection theory
Sensory evidence and uncertainty



Next: Beyond classical psychophysics...

Accumulation of sensory evidence over time (DDM) → Ariel's Talk Wednesday
Integration of different types of information → Next Talk on Perception

Thank you

Read Me: **Kingdom & Prins, Psychophysics, 2016**