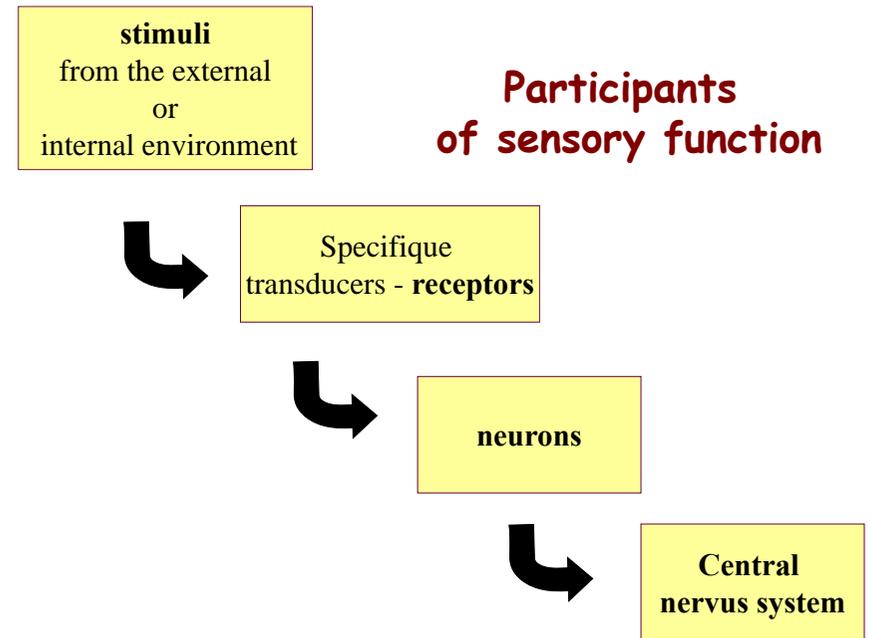


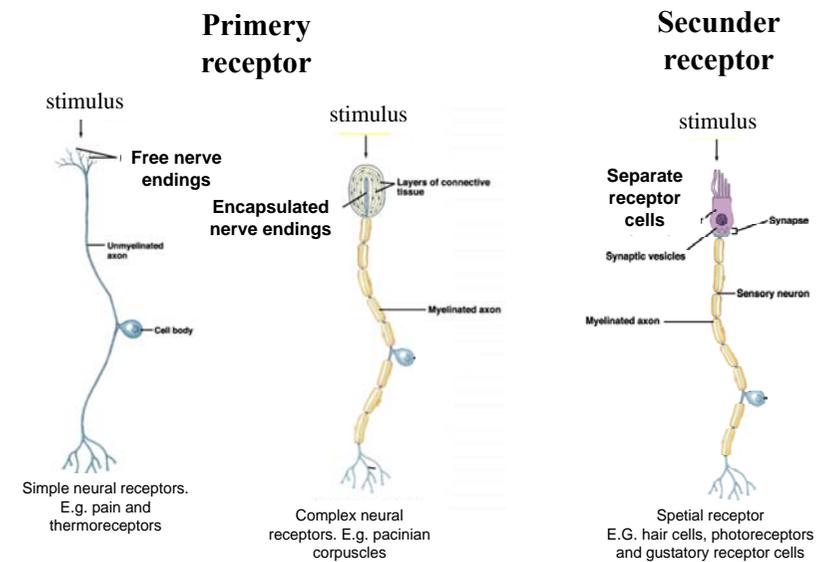
Biophysical principles of sensory function



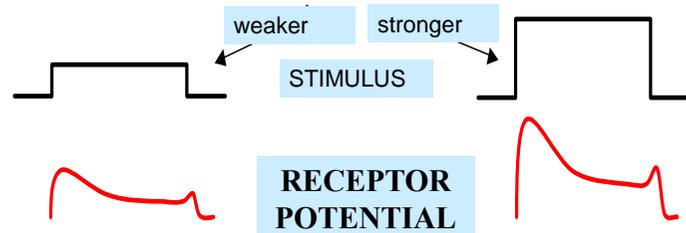
Parameters of the stimulus

- What?
- Where?
- How much?
- How long?

Types of Sensory Receptors



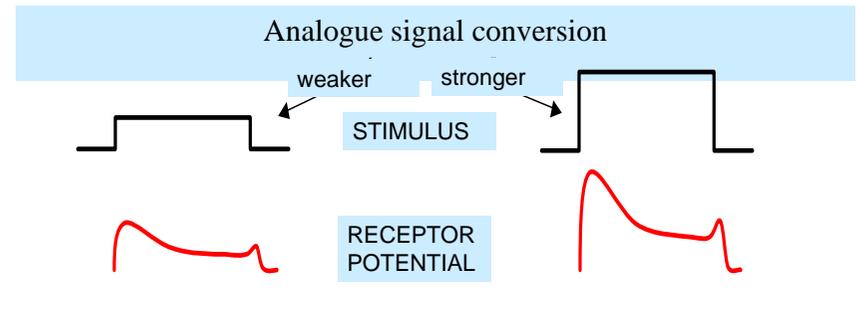
Reaction of receptor cell for specific stimulus



Answer is general and uniform:

alteration of the membrane potential on receptor cell

RECEPTOR POTENTIAL



Its amplitude is proportional to the stimulus amplitude.

Its duration is identical to the stimulus duration

It is a local potential change.

It is not Na-potential.

Stimulus

Code

What?



Type of receptor

Where?



Receptive field

How much?



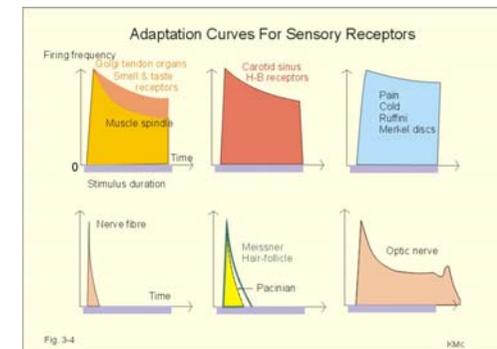
Amplitude of receptor potential

How long?



Duration of receptor potential

Adaptation of Receptors

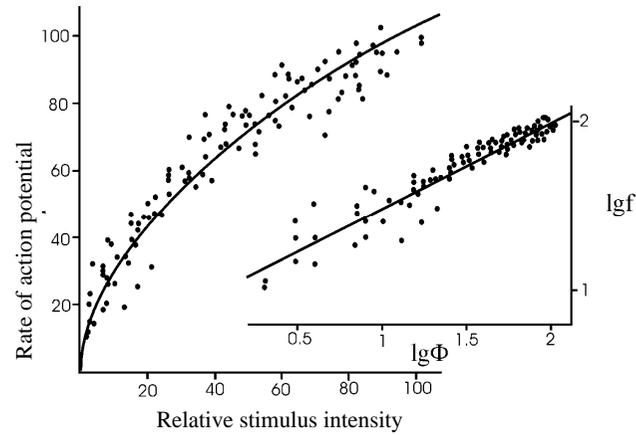


Rapidly adapting receptors (Rapid receptors): e.g. pacinian and hair receptors detect the change in stimulus strength (detect movement)

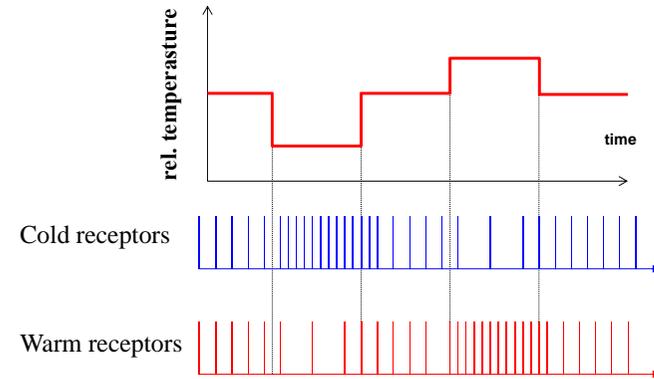
Slowly adapting receptors (Tonic receptors): e.g. joint capsule, muscle spindle detect continuous stimulus strength (give report to the brain about the status of the body).

Non adapting receptors: pain receptors and chemoreceptor

AP frequency and stimulus intensity



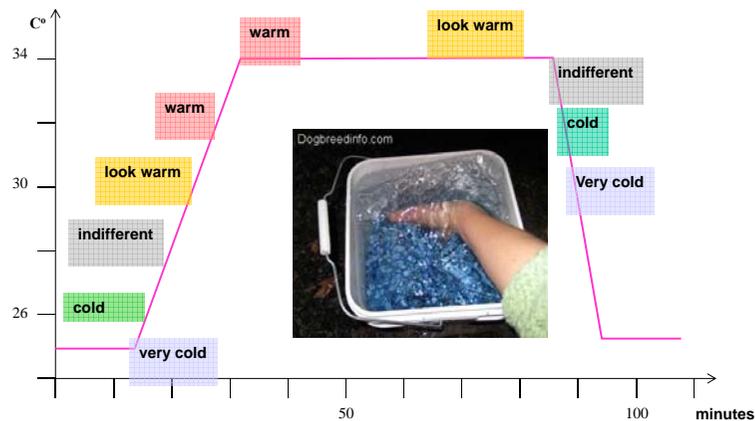
Persistent APs



For a warm receptor warming results in an increase in their action potential discharge rate, cooling results in a decrease in discharge rate. For cold receptors their firing rate increases during cooling and decreases during warming. Some cold receptors also respond with a brief action potential discharge to high temperatures, i.e. typically above 45°C, and this is known as a paradoxical response to heat.

Thermal receptors

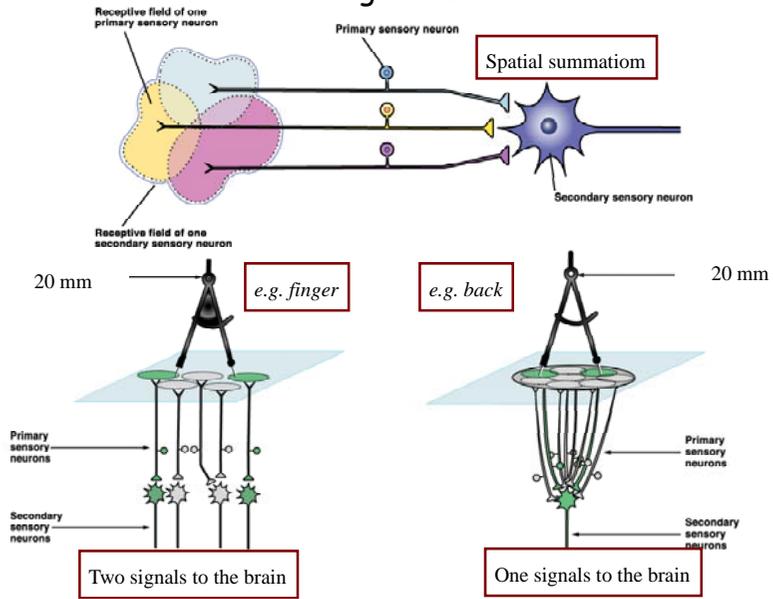
codes absolute and relative changes in temperature



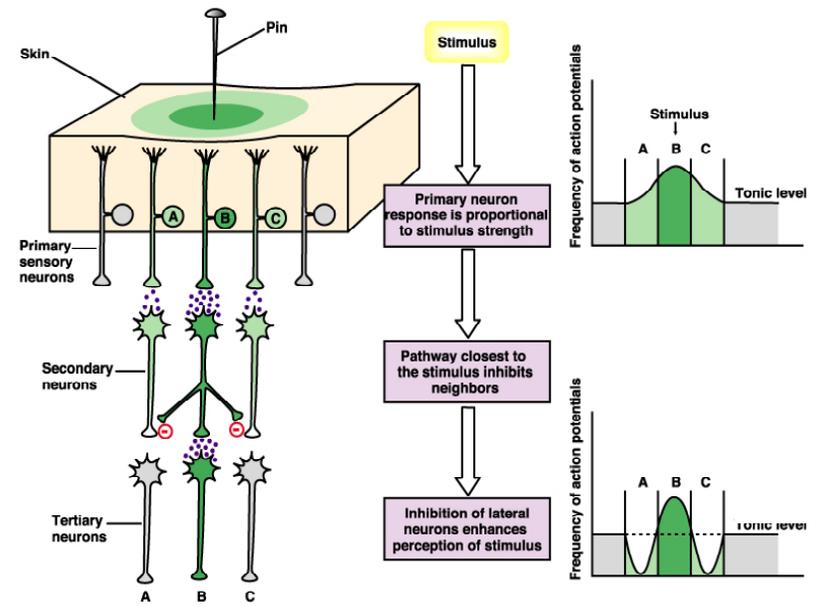
CNS is composed of neuronal pools with **different mechanisms of signal processing.**

- Excitation
- Facilitation
- Inhibition
- Convergence
- Divergence

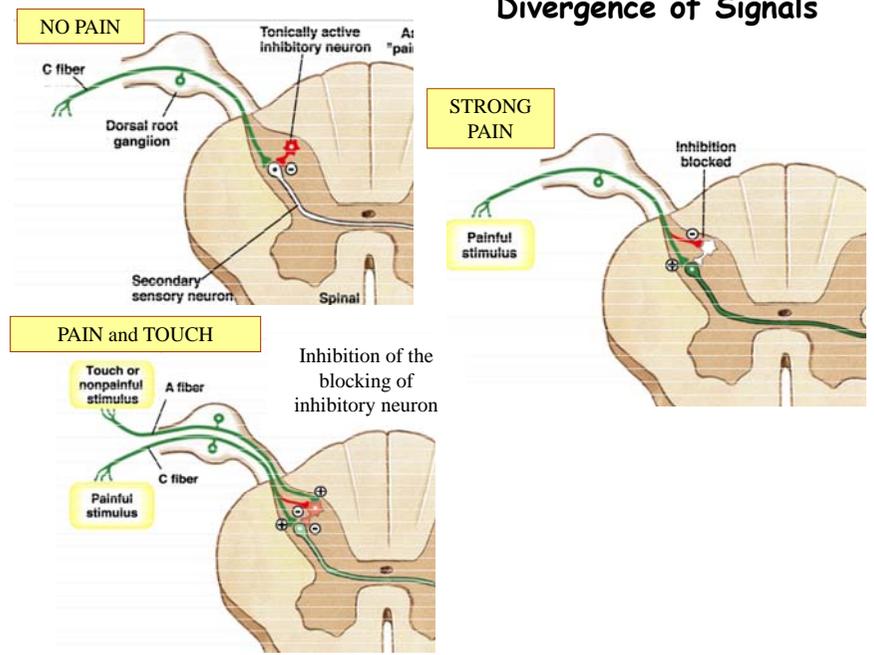
Convergence of Signals: multiple inputs uniting to excite a single neuron



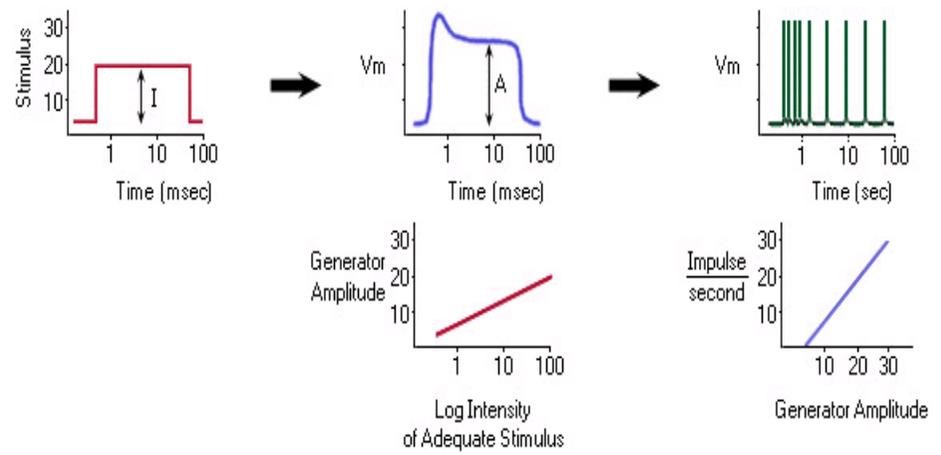
Divergence of Signals



Divergence of Signals



Summary



Psychophysics

Study the relationship between stimuli
&
our psychological response to them

Investigation of threshold stimulus

Absolute threshold

This is the minimum amount of a stimulus that is necessary for us to notice it 50% of the time

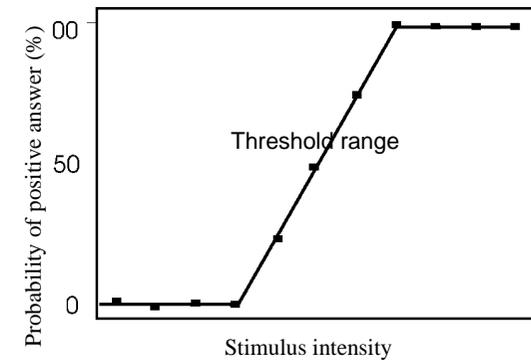
Decision method – yes - no

Determination of threshold by simple decision

	answer					YES (%)
	stimulus	V1	V2	V3	V4	
Increasing intensity ↓	I1	NO	NO	NO	NO	0 (0)
	I2	NO	NO	NO	NO	0 (0)
	I3	NO	NO	NO	NO	0 (0)
	I4	NO	NO	NO	NO	0 (0)
	I5	NO	NO	NO	NO	0 (0)
	I6	YES	NO	NO	NO	1 (25)
	I7	YES	NO	YES	NO	2 (50)
	I8	YES	NO	YES	YES	3 (75)
	I9	YES	YES	YES	YES	4 (100)
	I10	YES	YES	YES	YES	4 (100)
	I11	YES	YES	YES	YES	4 (100)
	I12	YES	YES	YES	YES	4 (100)

Determination of threshold by simple decision

Absolute threshold



Threshold is a variable

Threshold studies

Absolute threshold – the smallest intensity of stimulus to be recognized

Decision method – yes - no

Adjusting method – (see audiometry experiment)

Differential threshold : smallest difference between two intensities to be recognized as different

Forced decision method

Just Noticeable Difference: Smallest difference in amount of stimulation that a specific sense can detect

$$\text{Just Noticeable Difference} = I - I_0$$

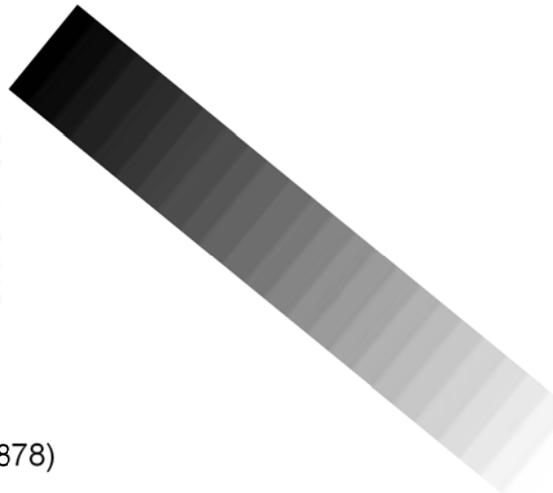
Intensity recognised as different

Reference intensity



Ernst Weber (1795-1878)

"just-noticeable difference" (JND)



How much more you have to be offered to change your workplace?

50000 + 5000



500000 + 5000



$$JND = I - I_0$$

Higher initial stimulus – bigger JND

Weber's law

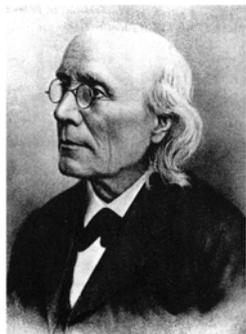
The size of the JND is a constant proportion of the initial stimulus. With other words the ratio of the increment threshold to the background intensity is a constant.

$$\frac{\Delta I}{I_0} = k$$

k : Weber ratio – can be determined by experiments

Each of the sensory perceptions has a consistent sensitivity to change.

<i>stimulus</i>	<i>Weber ratio</i>
brightness	0,079
loudness	0,048
touching	0,022
pressure	0,02
tasting (salt)	0,083
electric shock	0,013



Gustav Theodor Fechner
(1801-1887)

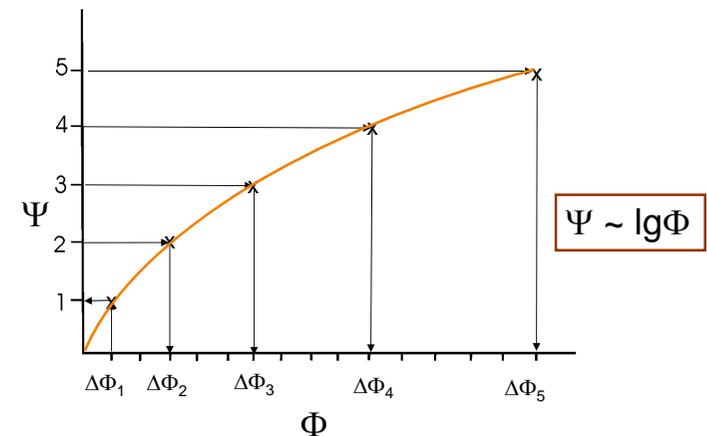
$$\Delta I = I - I_0$$

ΔI is a function

ΔI is the function of stimulus intensity

Fechner assumed that the relative change of the stimulus is proportional to the change in the sensation magnitude

$$\frac{\Delta \Phi}{\Phi} \sim \Delta \Psi$$





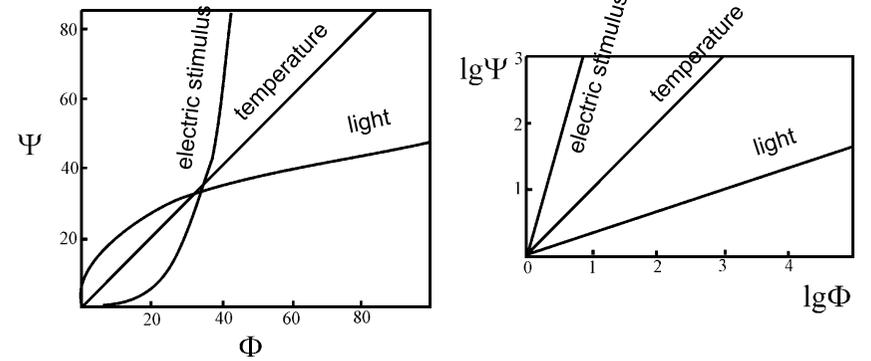
Establish relationship between relative stimulus intensity (Φ/Φ_0) and psychological magnitude (Ψ).

Performed measurements

Stanley Smith Stevens
(1906-1973)

sensation scale

Results of experiment



Sensation intensity increases with some expanding stimulus intensity. Equal stimulus ratios produce equal sensation ratios. This law is the power function

$$\Psi \approx \Phi^n$$

The exponent varies with the particular sensory modality, and also within a modality for different stimulus conditions, such as adaptation, inhibition, size, and duration of stimuli.

$$\Psi \approx \Phi^n$$

<i>stimulus</i>	<i>exponent</i>
short light pulses	0,5
smell (heptane)	0,6
loudness (3000 Hz sinus)	0,67
ambient temperature	1,00
taste (salt)	1,30

Summary

Two different approaches:

Weber – Fechner :

$$\Psi \sim \lg \Phi$$

Stevens :

$$\Psi \approx \Phi^n$$

The second one received better experimental support.

Perception - Organizing sensations into meaningful patterns

- analyzing
- organizing
- understanding

Perception might be correct or false.

