

Percezione e Psicofisica

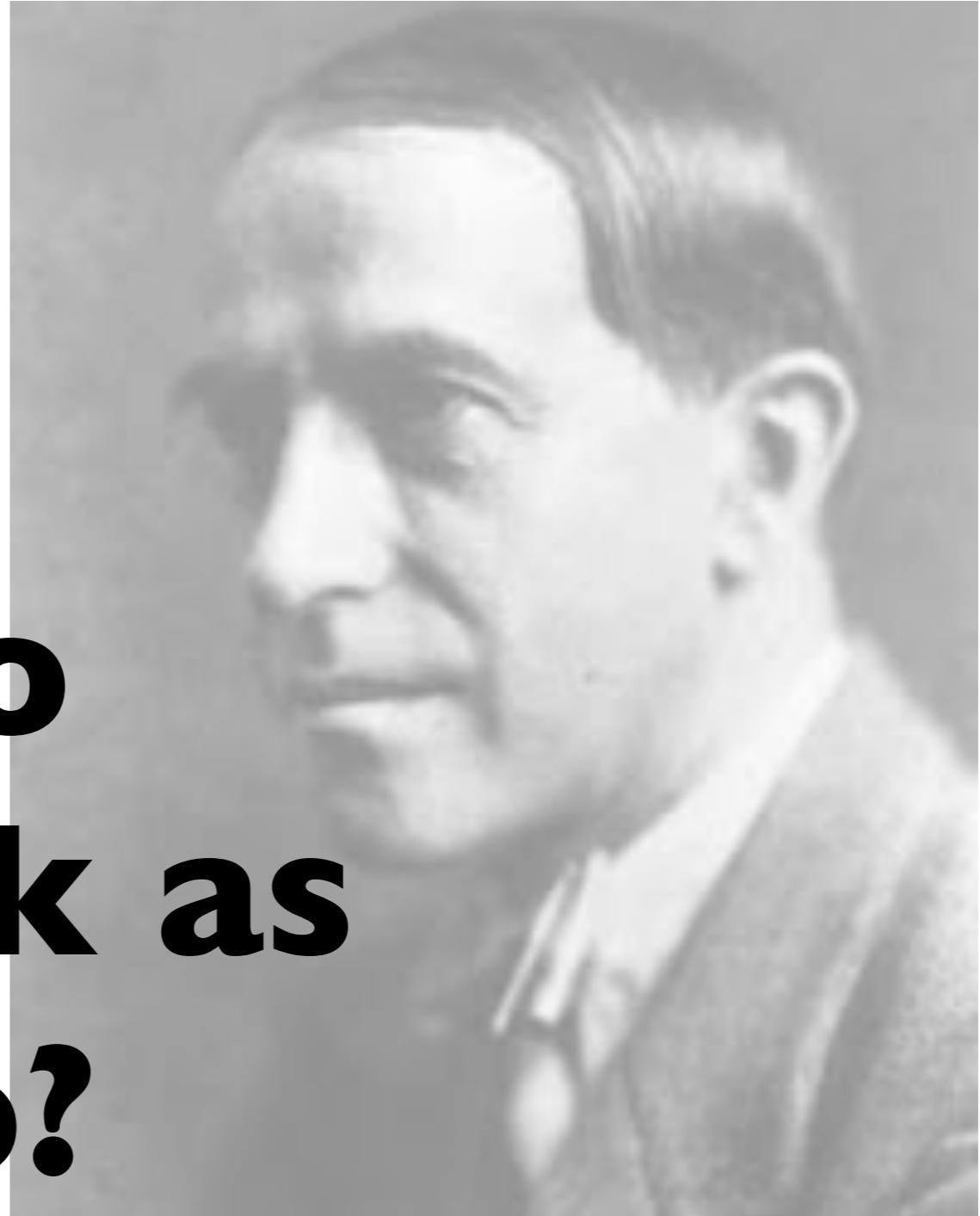
a.a. 2023/24

Nicola Bruno

Lezione 1

**Presentazione: lezioni,
testi, esami**

**Why do
things look as
they do?**



Koffka, K. (1935). *Principles of Gestalt Psychology*, Chap. 1

**Anyone who can
read these words,
including you,
experiences
conscious
awareness. What
explains this?**



Postle, B.R. (2015) *Essentials of Cognitive Neuroscience*, Introduction to Section I

Bruno, N. (2021). *Introduzione alla psicologia della percezione visiva: Come facciamo a vedere*. Bologna: Il Mulino.

Bruno & Pavani (2018). *Perception: a Multisensory Perspective*. Oxford university press. (eccetto 8,9, 10)



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Riferimenti bibliografici

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IllusoriaMente. Mostra organizzata da ECVP 2012, Alghero 2-4 Settembre.

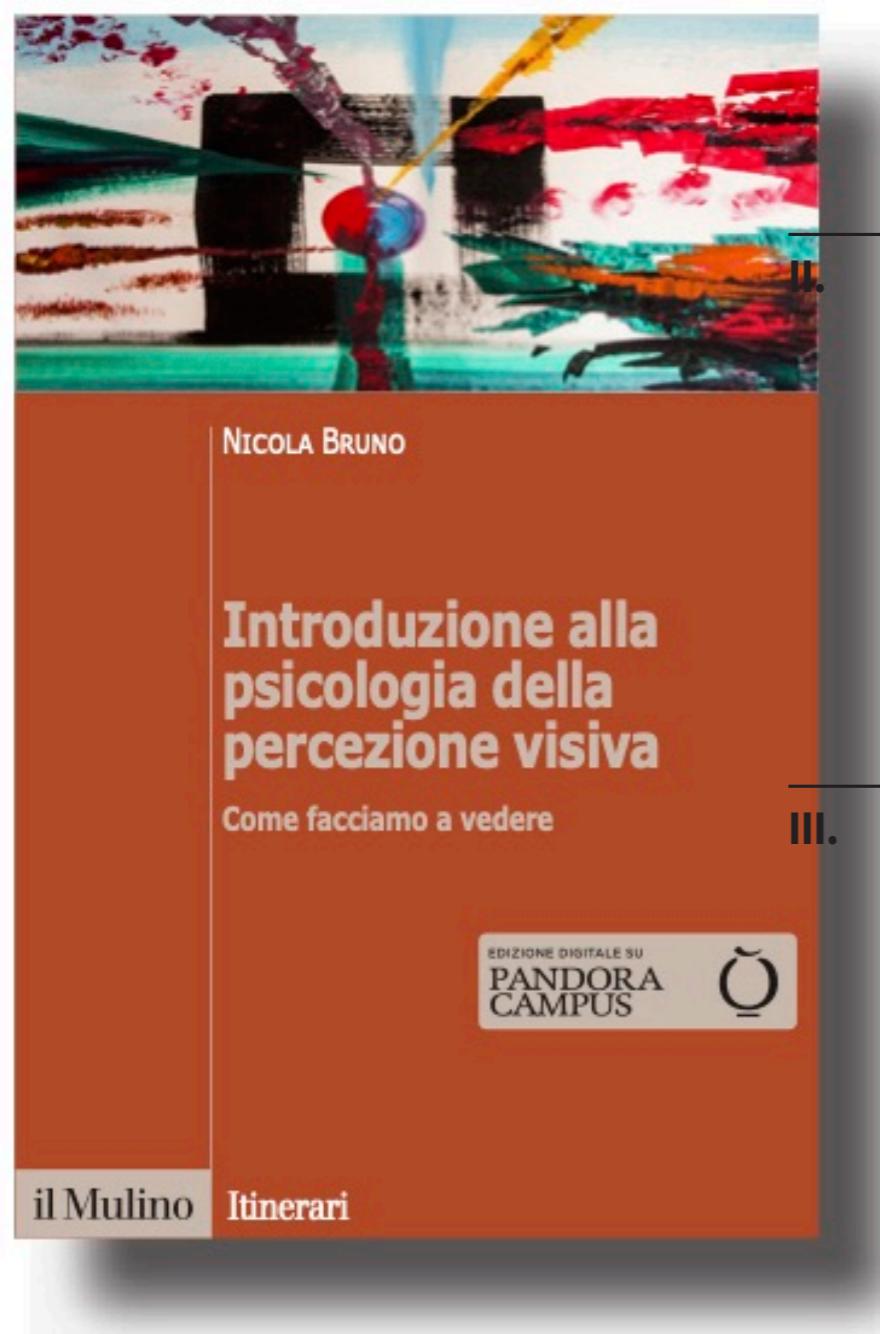


IllusoriaMente. Mostra organizzata da ECVP 2012, Alghero 2-4 Settembre.

Percezione e Psicofisica

a.a. 2023/24

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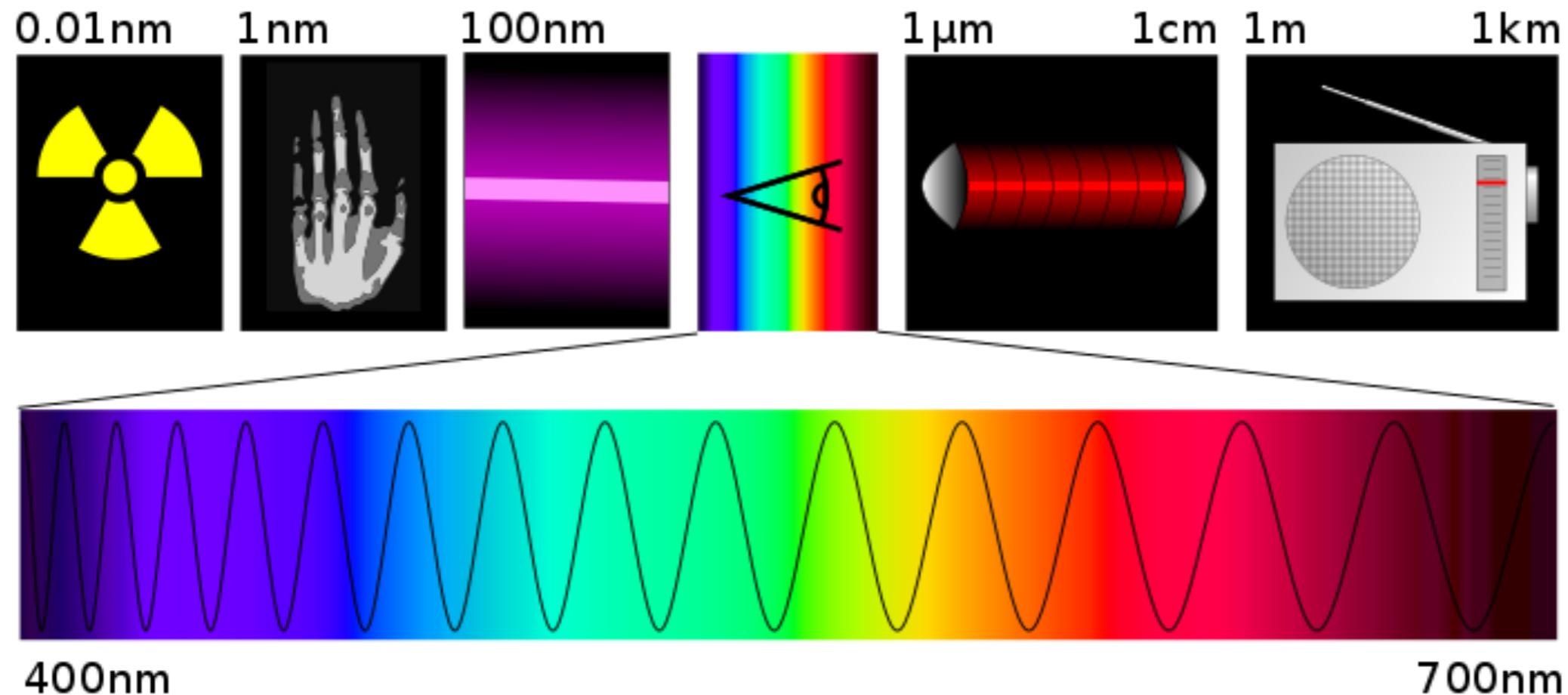
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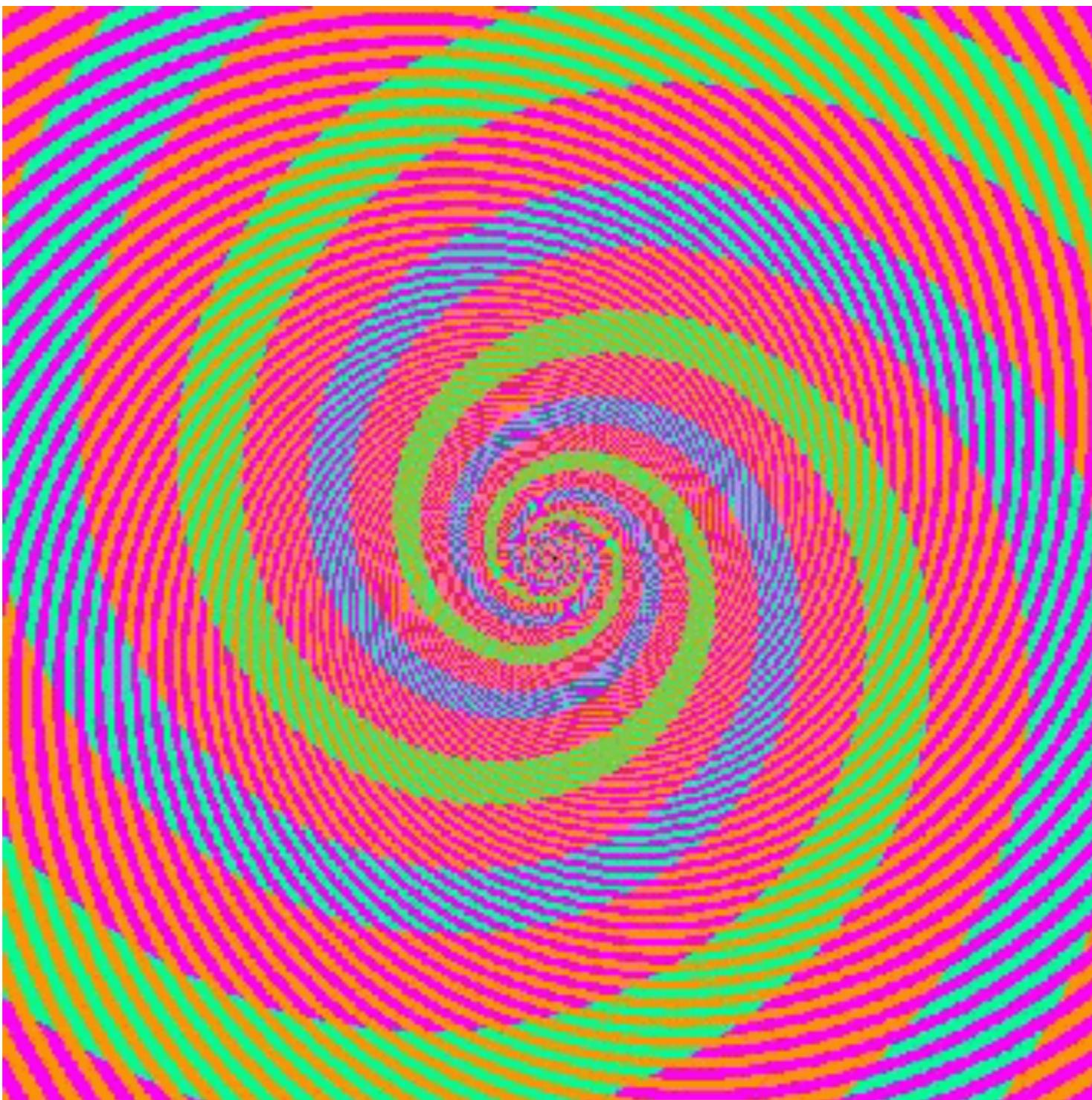
Lezione 3-4

Dall'ambiente all'occhio

energia elettromagnetica

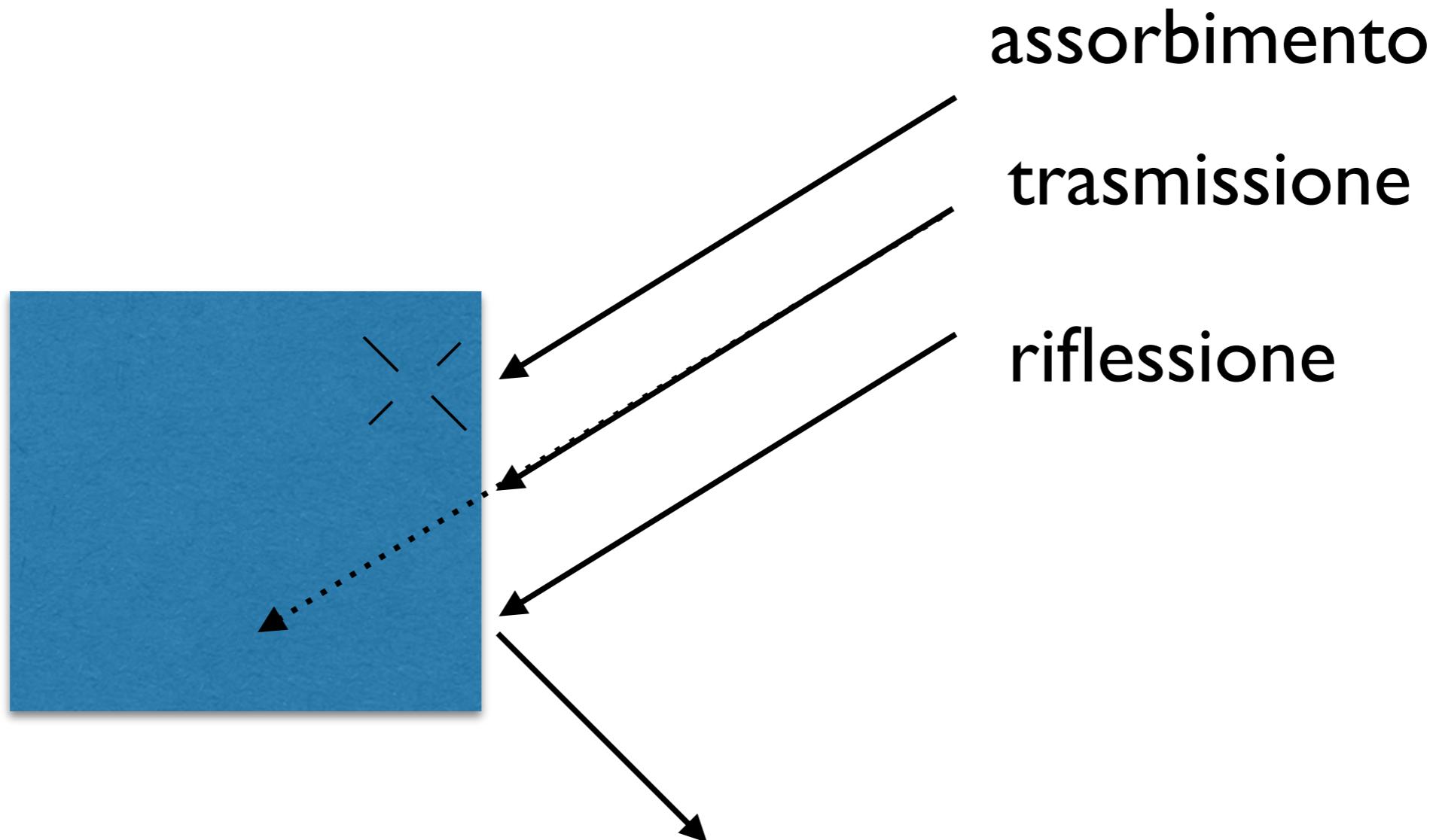


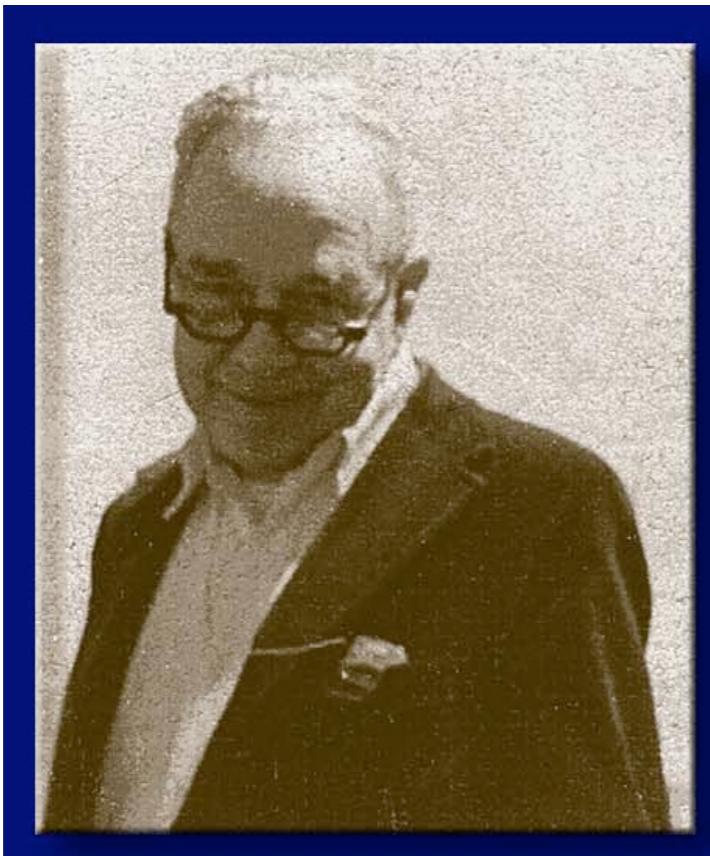
nanometro (nm) = 10^{-9} metri (un miliardesimo di metro)



**le
spirali
blu e
verdi
sono
fatte
con gli
stessi
pixel**

interazione luce - superfici





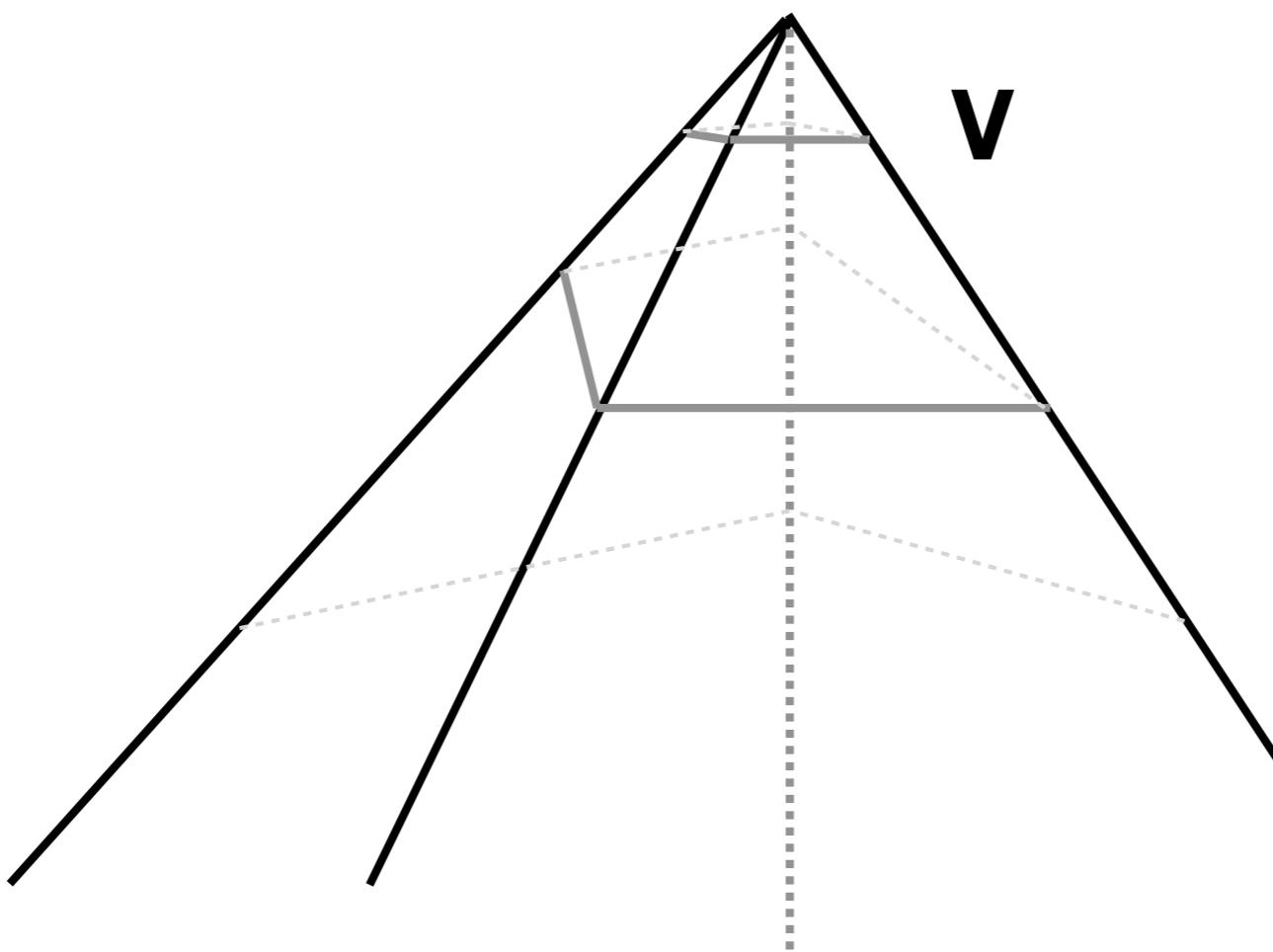
ottica ecologica

**James J. Gibson
(1904-1979)**

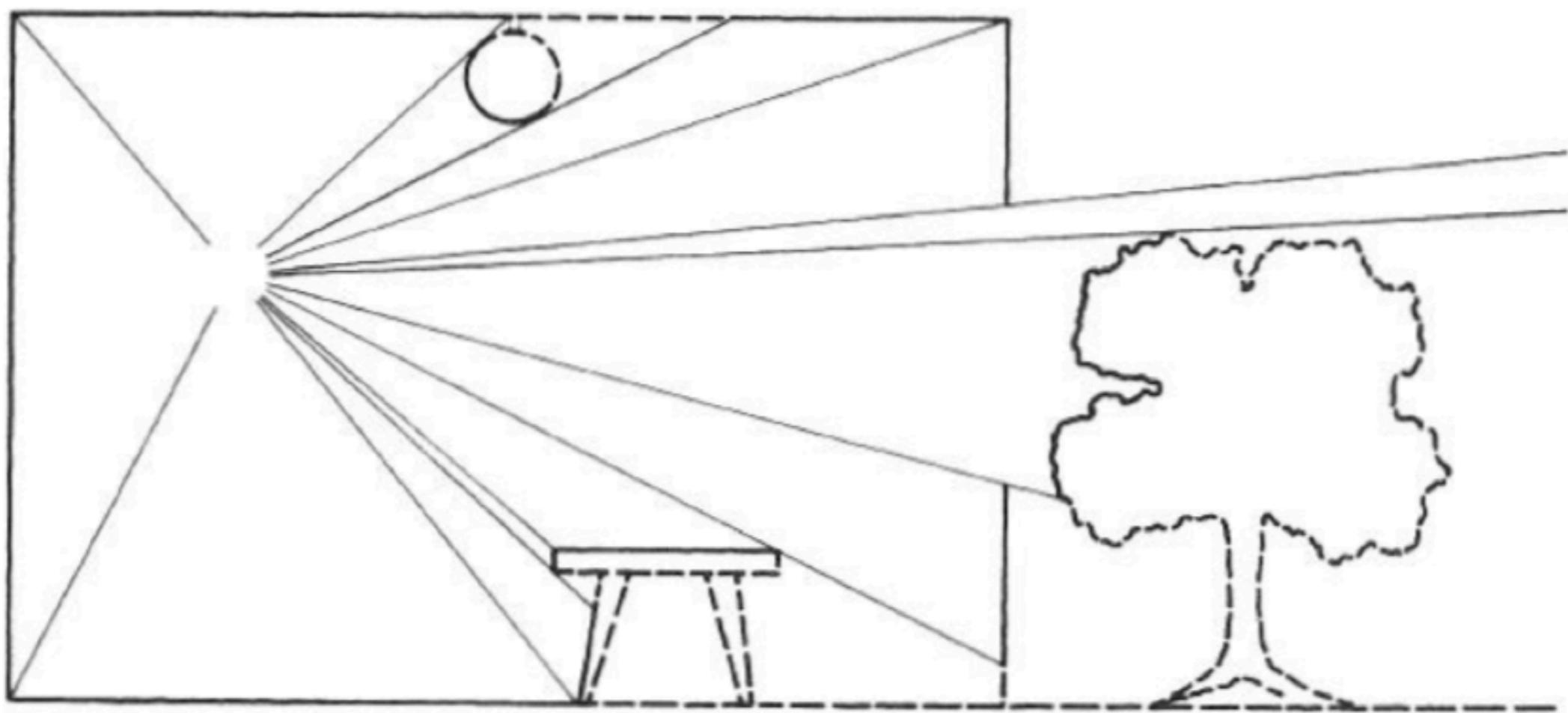


**Eleanor J. Gibson
(1910-2002)**

angolo solido



assetto ottico ambientale



assetto ottico ambientale (*ambient optic array*)

- un costrutto teorico per descrivere l'informazione ottica
- descrive una struttura spaziale di angoli solidi
- evolve nel tempo (spazio-temporale)
- è duale

informazione ottica

**l'energia luminosa è una condizione
necessaria ma non sufficiente per
la visione**

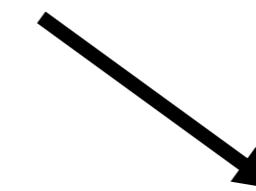
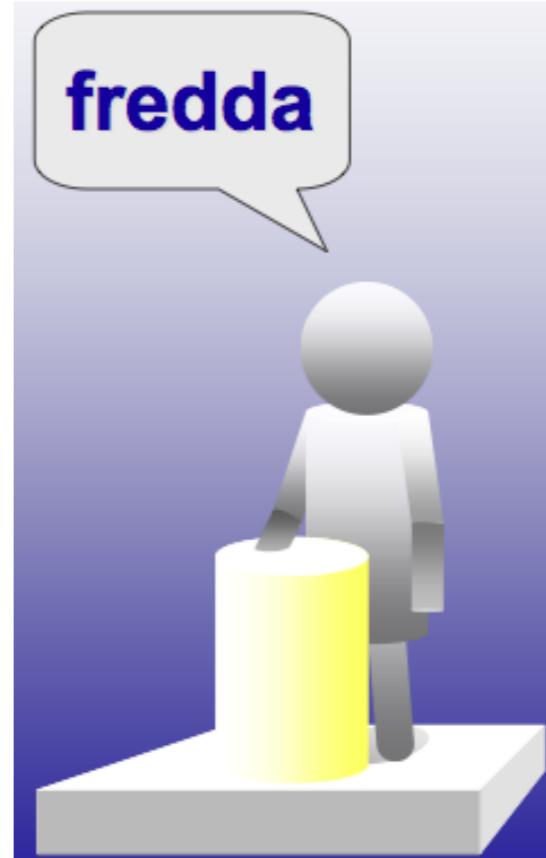
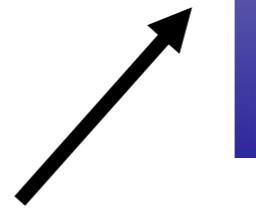
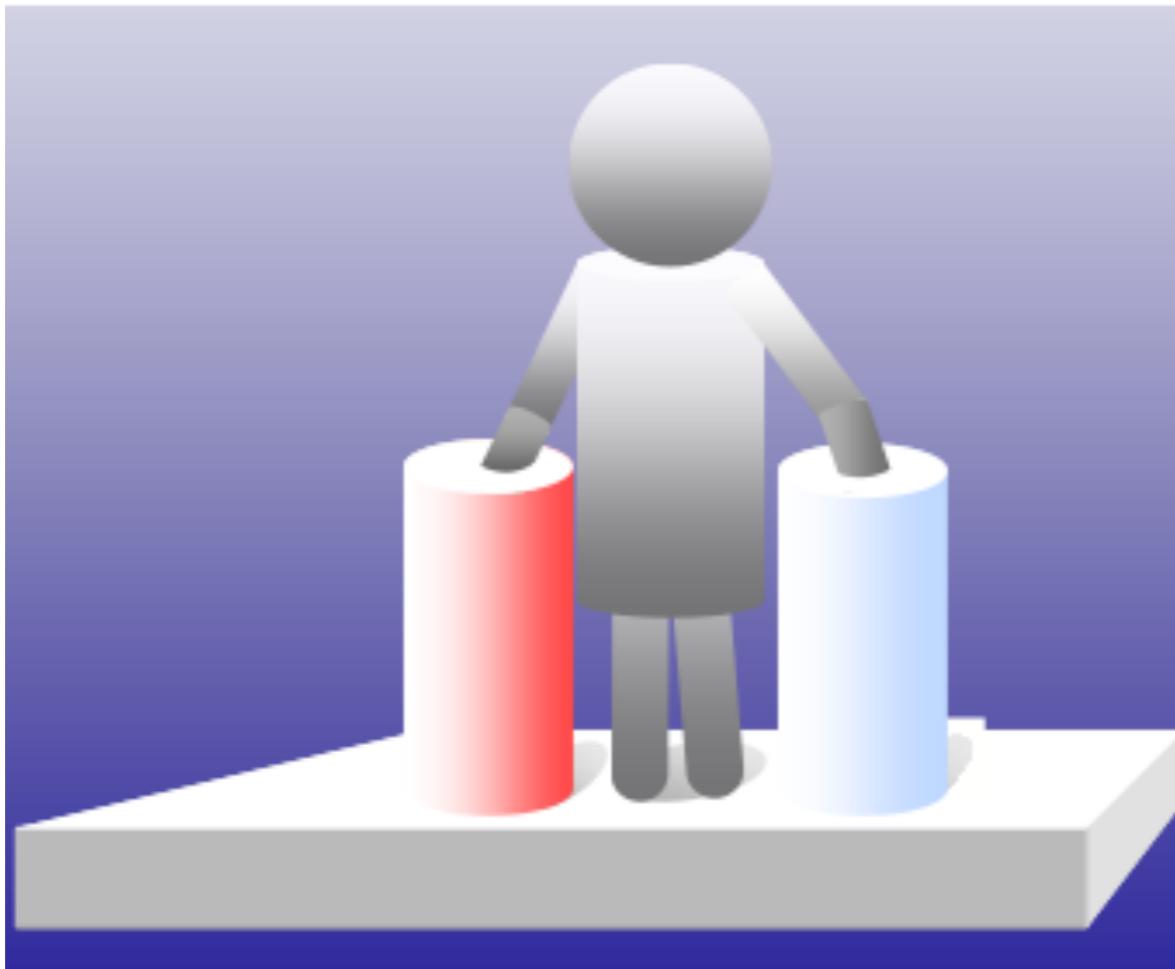
**perché ci sia visione occorre che ci
sia informazione ottica:
disomogeneità nella distribuzione
della luce (rispetto allo spazio o al
tempo)**

determinazione relazionale

“...uno stimolo non è confinato in un punto sulla superficie dei recettori o in un istante nel tempo. Per essere tale, uno stimolo implica cambiamento; quindi uno stimolo è una relazione, non una quantità”

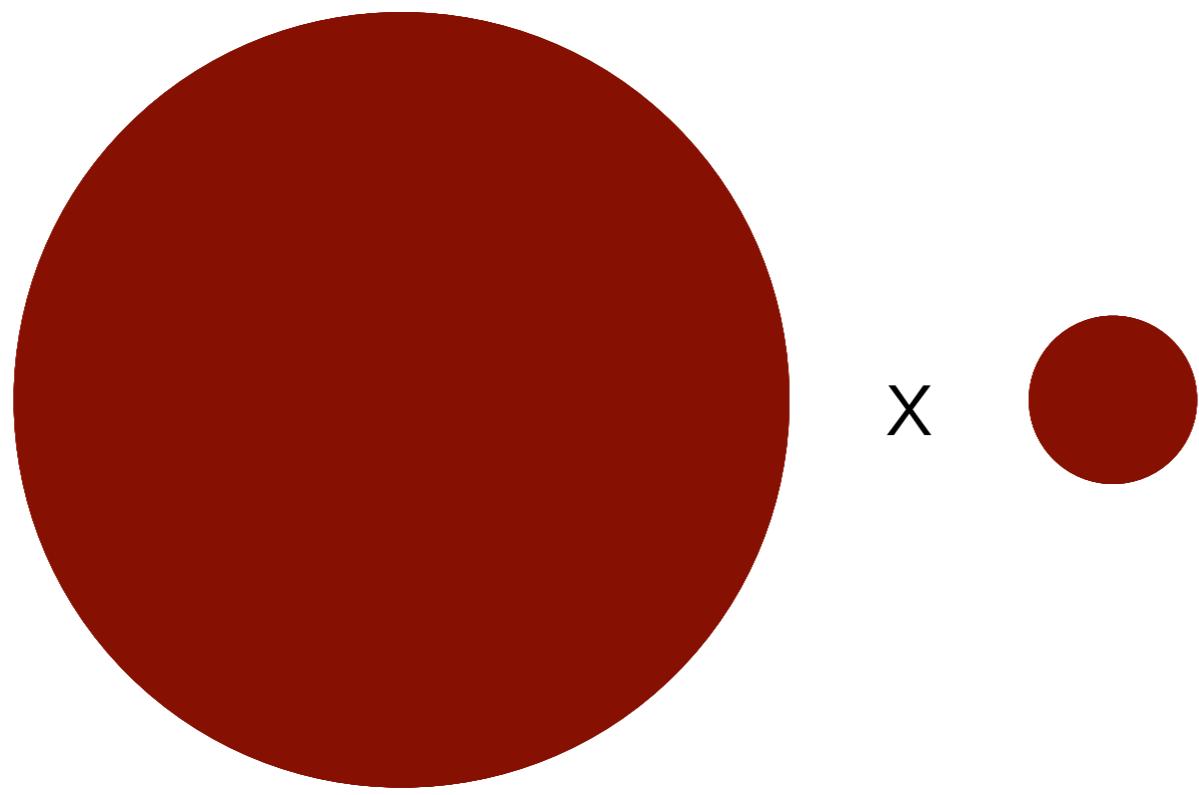
E. J. Gibson, *Principles of Perceptual Learning*

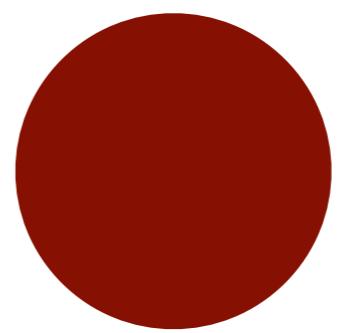
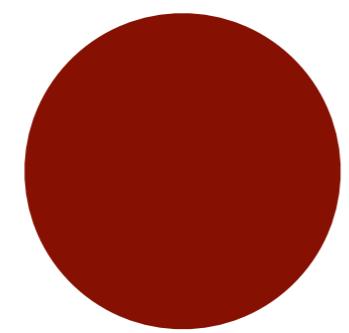
percezione della temperatura



grandezza percepita







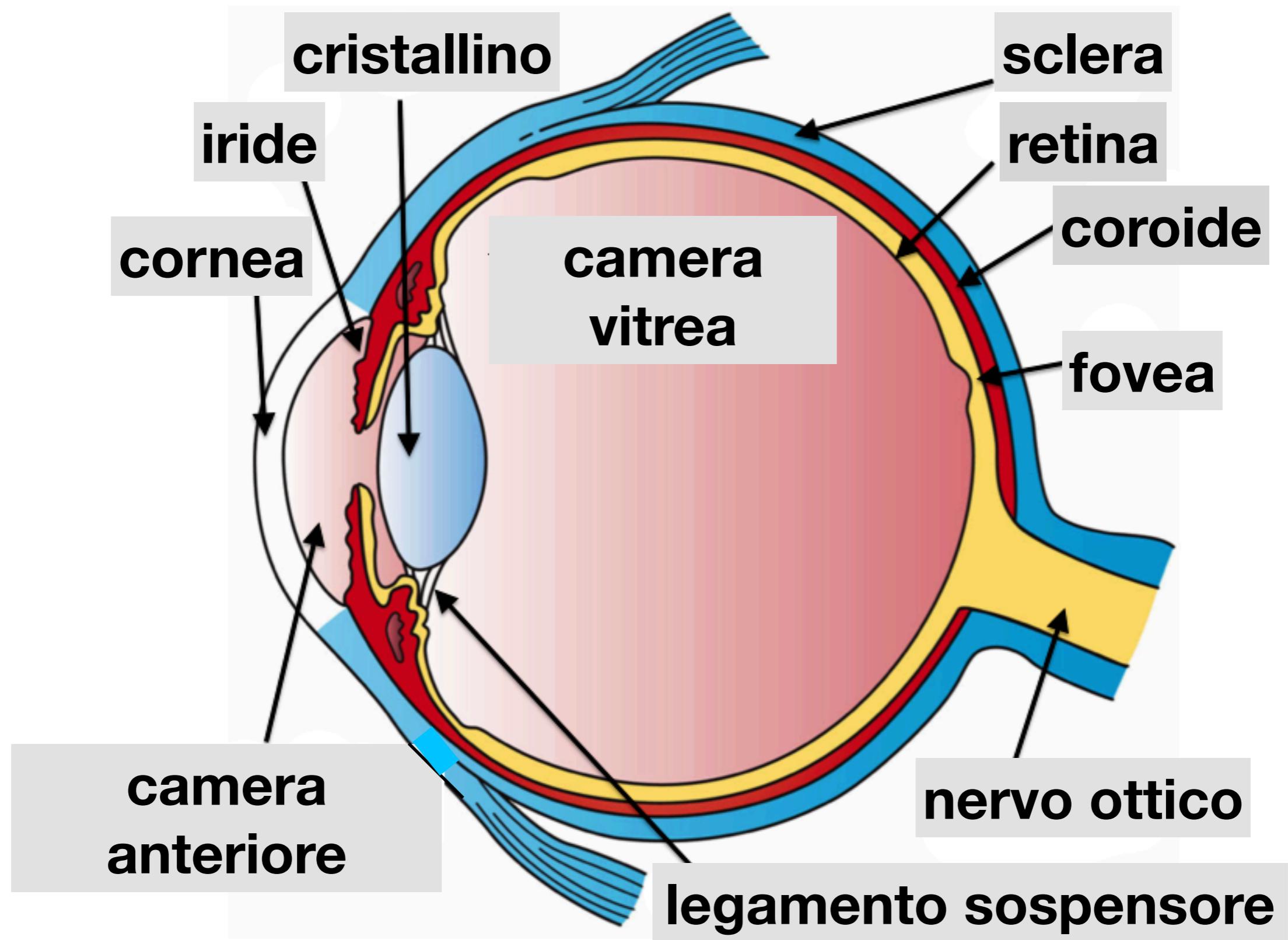
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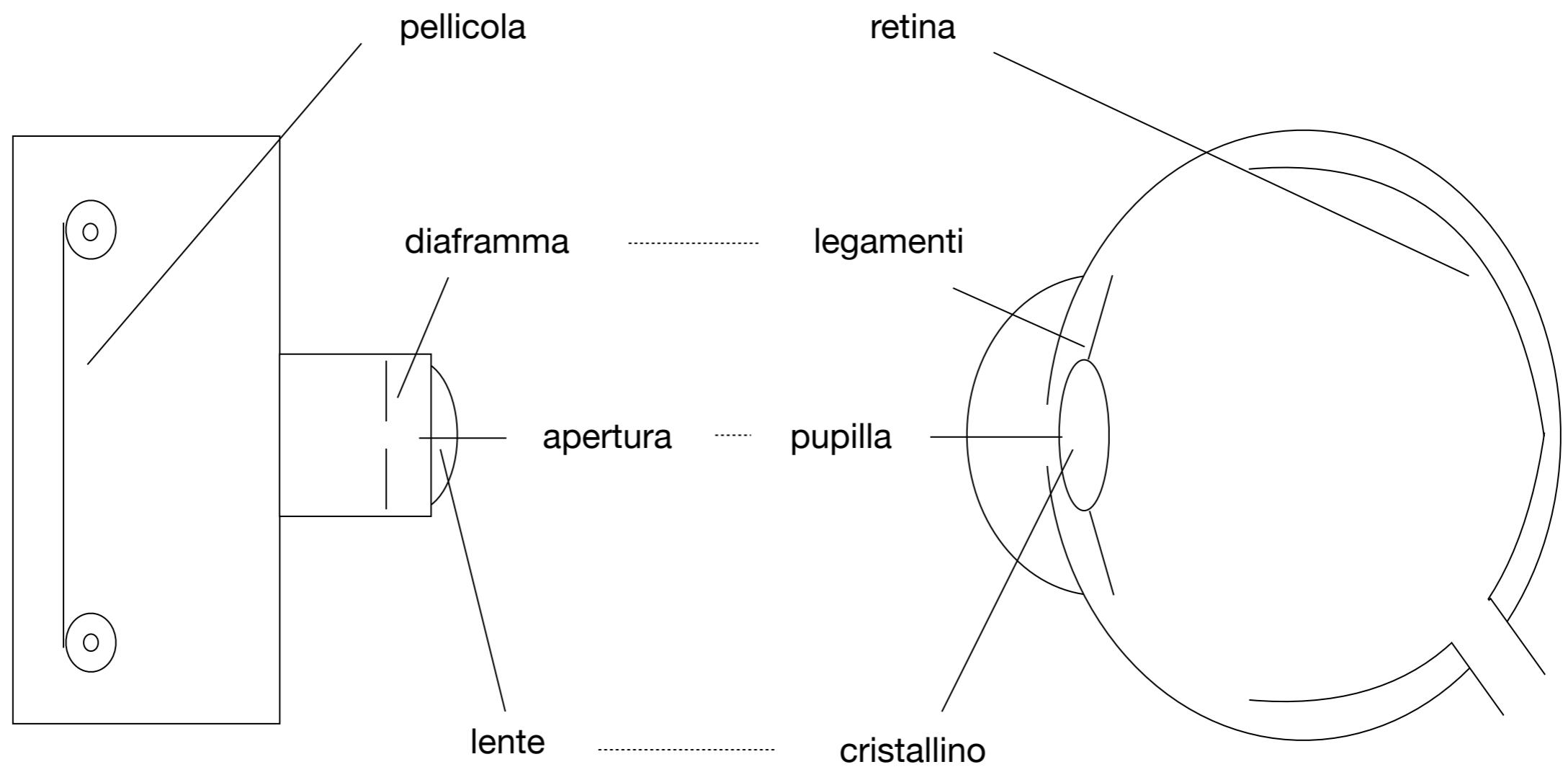
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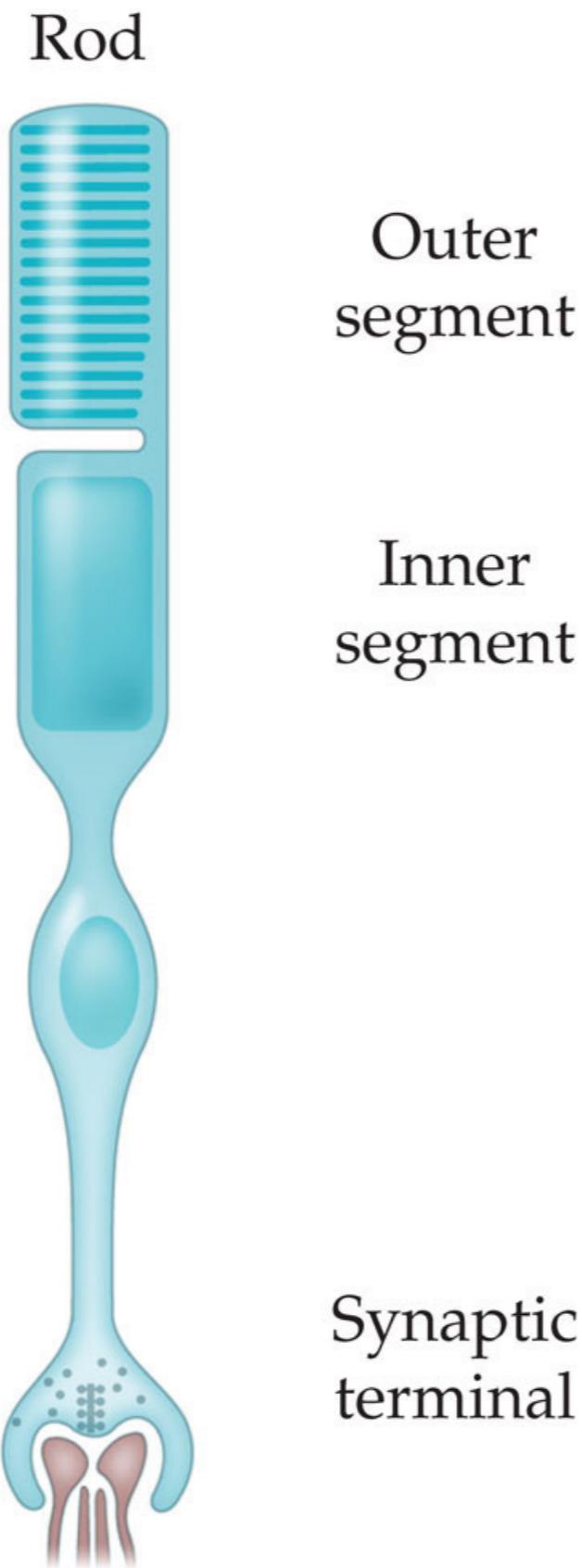
Lezione 5-6

**Dall'occhio al
cervello**





**about
90
million**



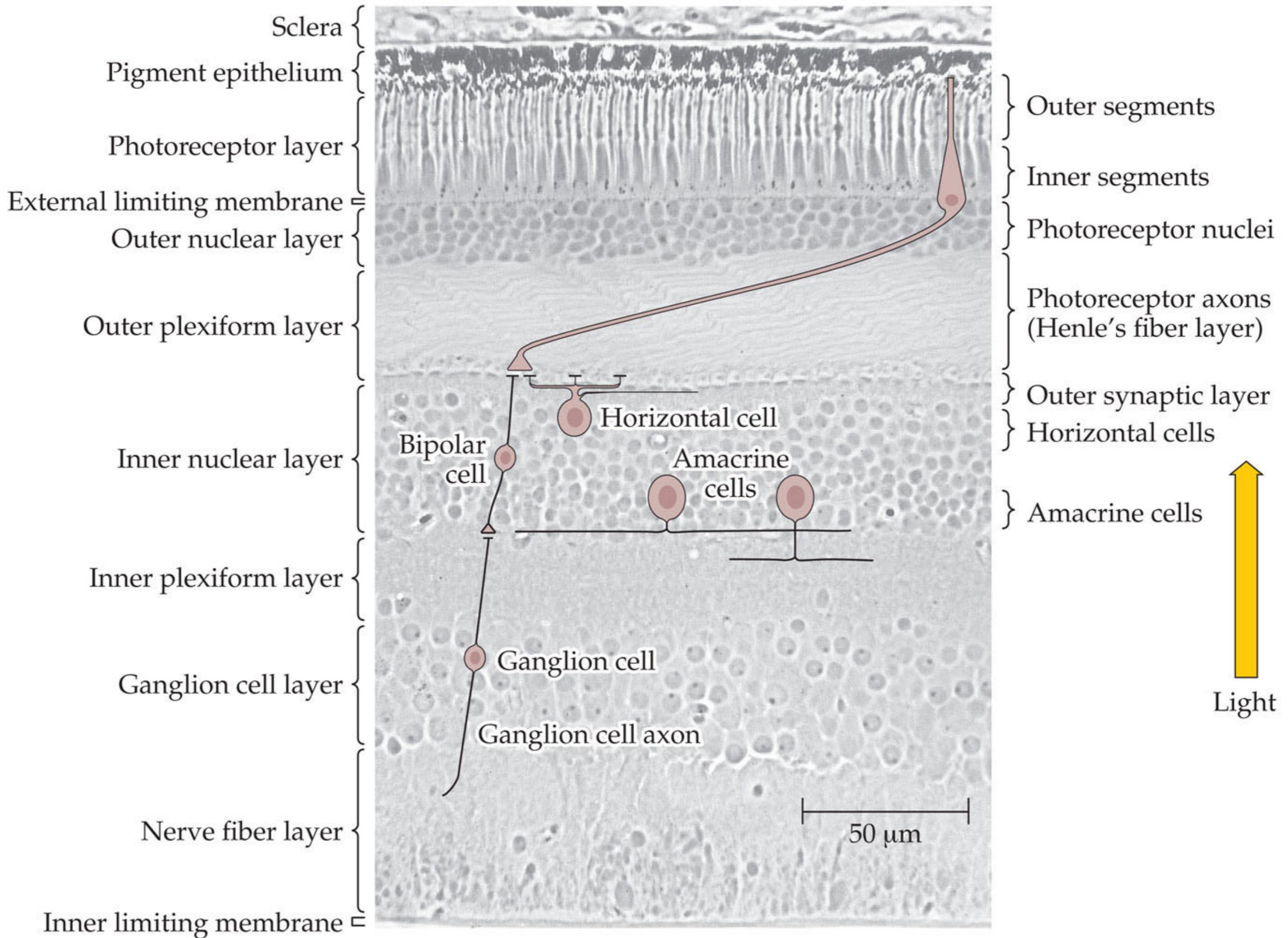
**about
4.5
million**

TABLE 2.2
Properties of human photopic and scotopic vision

Property	Photopic system	Scotopic system
Photoreceptors	4–5 million cones	90 million rods
Location in retina	Throughout retina, with highest concentration close to fovea	Outside of fovea
Acuity (detail)	High	Low
Sensitivity	Low	High

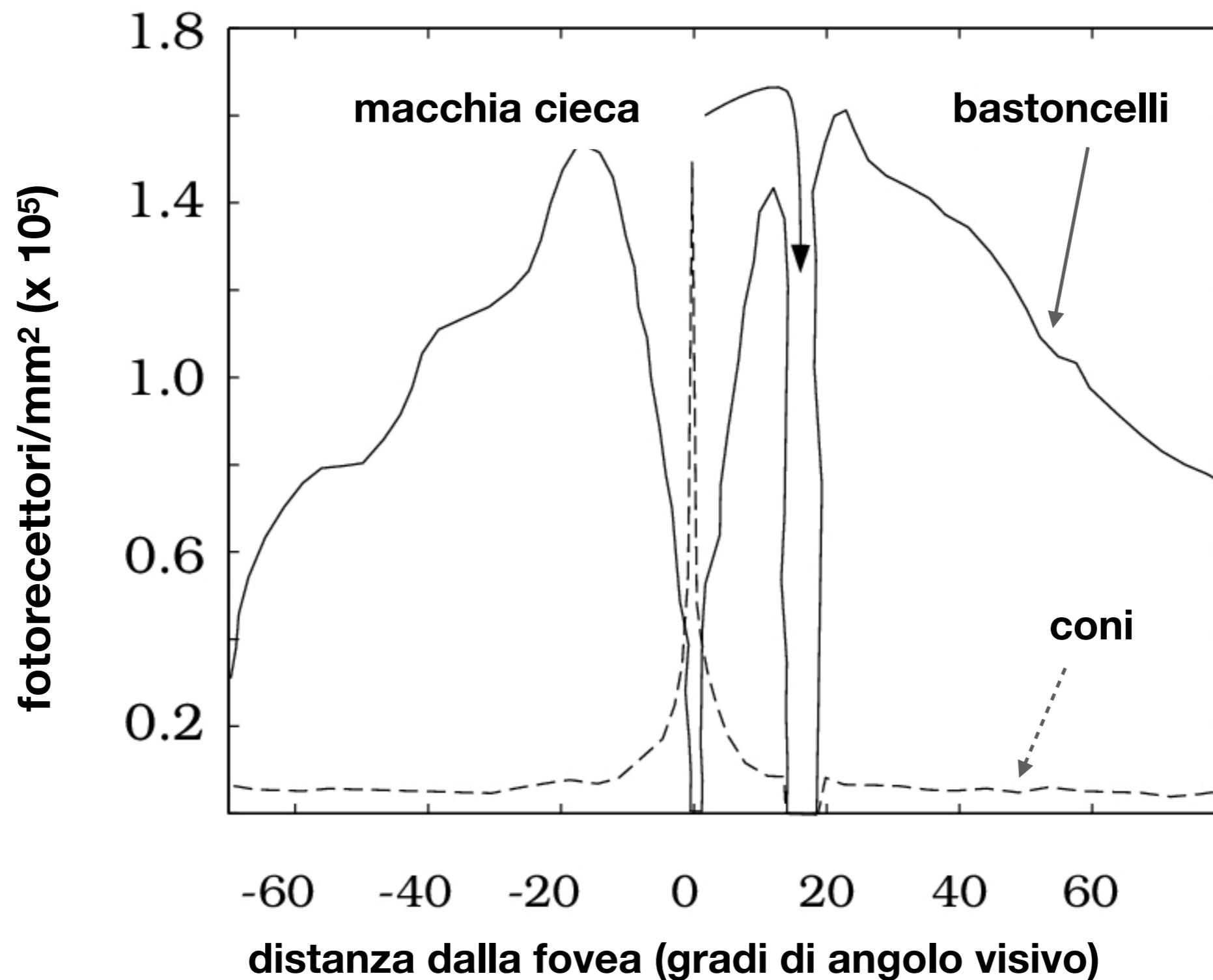
SENSATION & PERCEPTION 4e, Table 2.2

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SENSATION & PERCEPTION 4e, Figure 2.8

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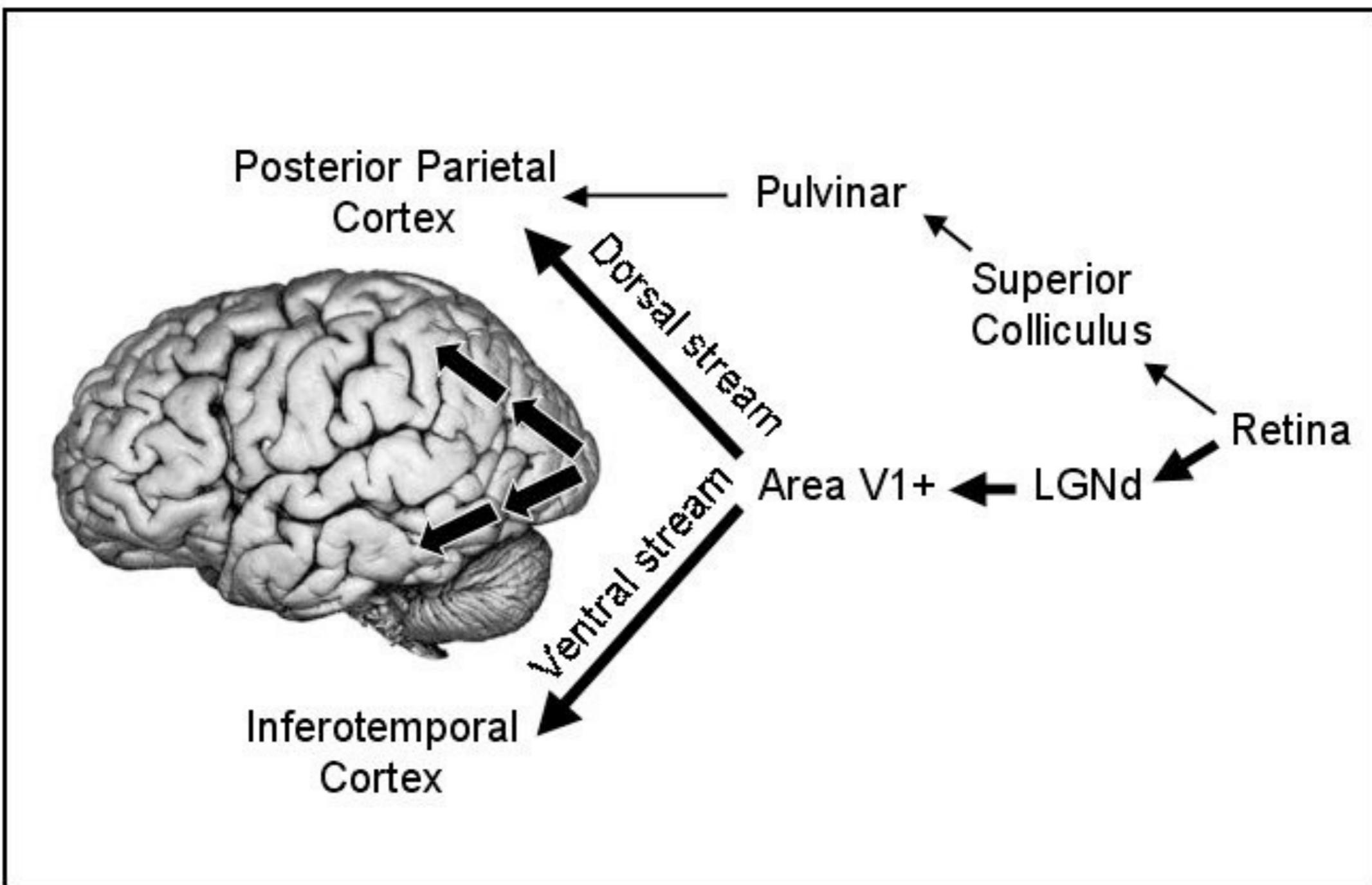
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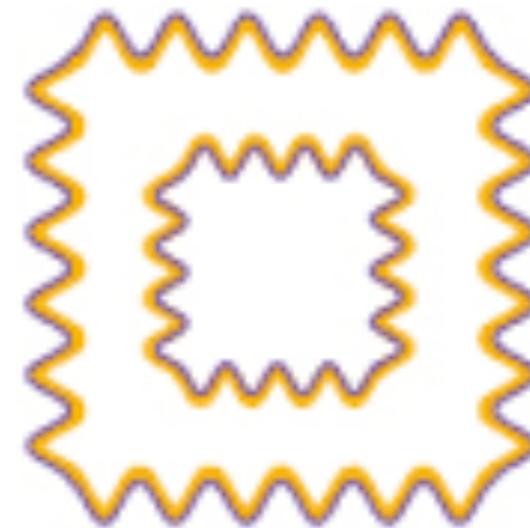
the blind spot

+





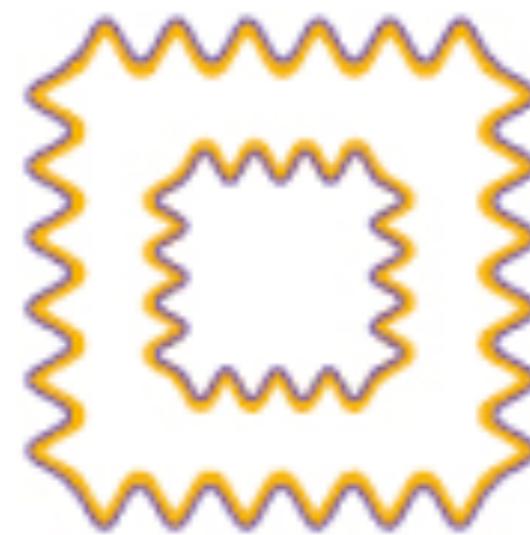
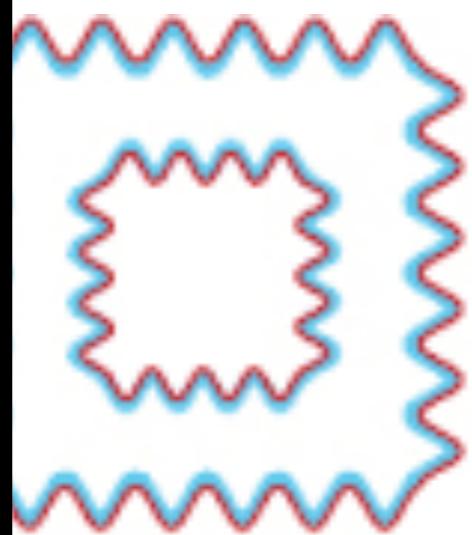
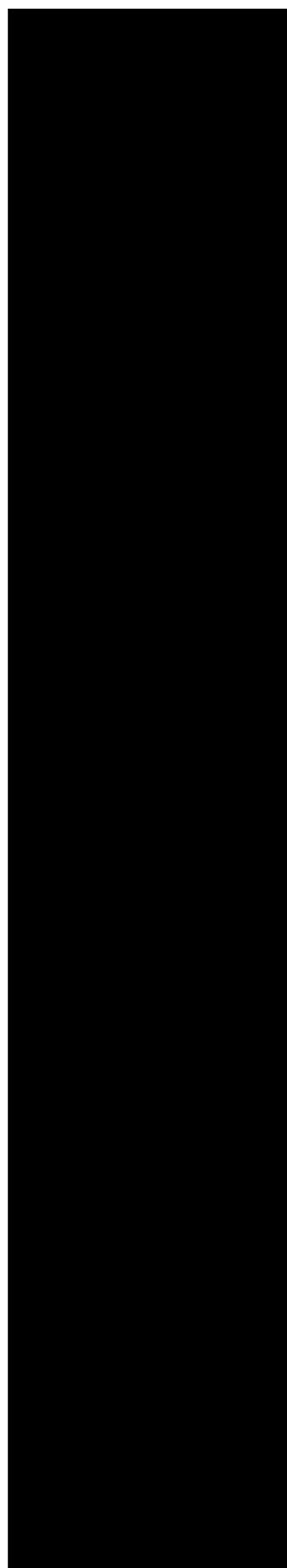
watercolor illusion



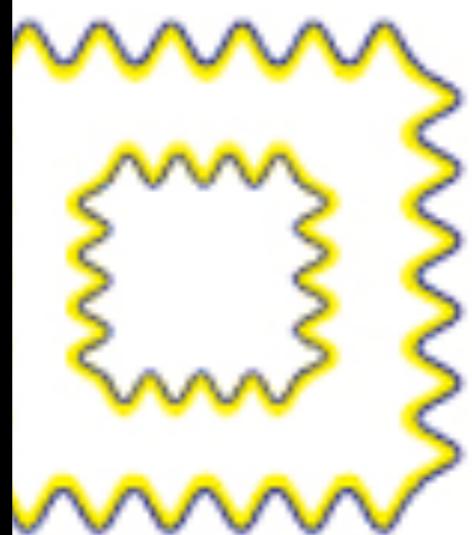
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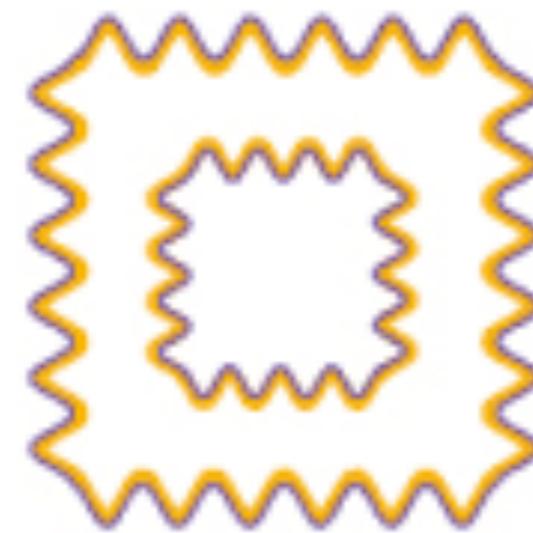
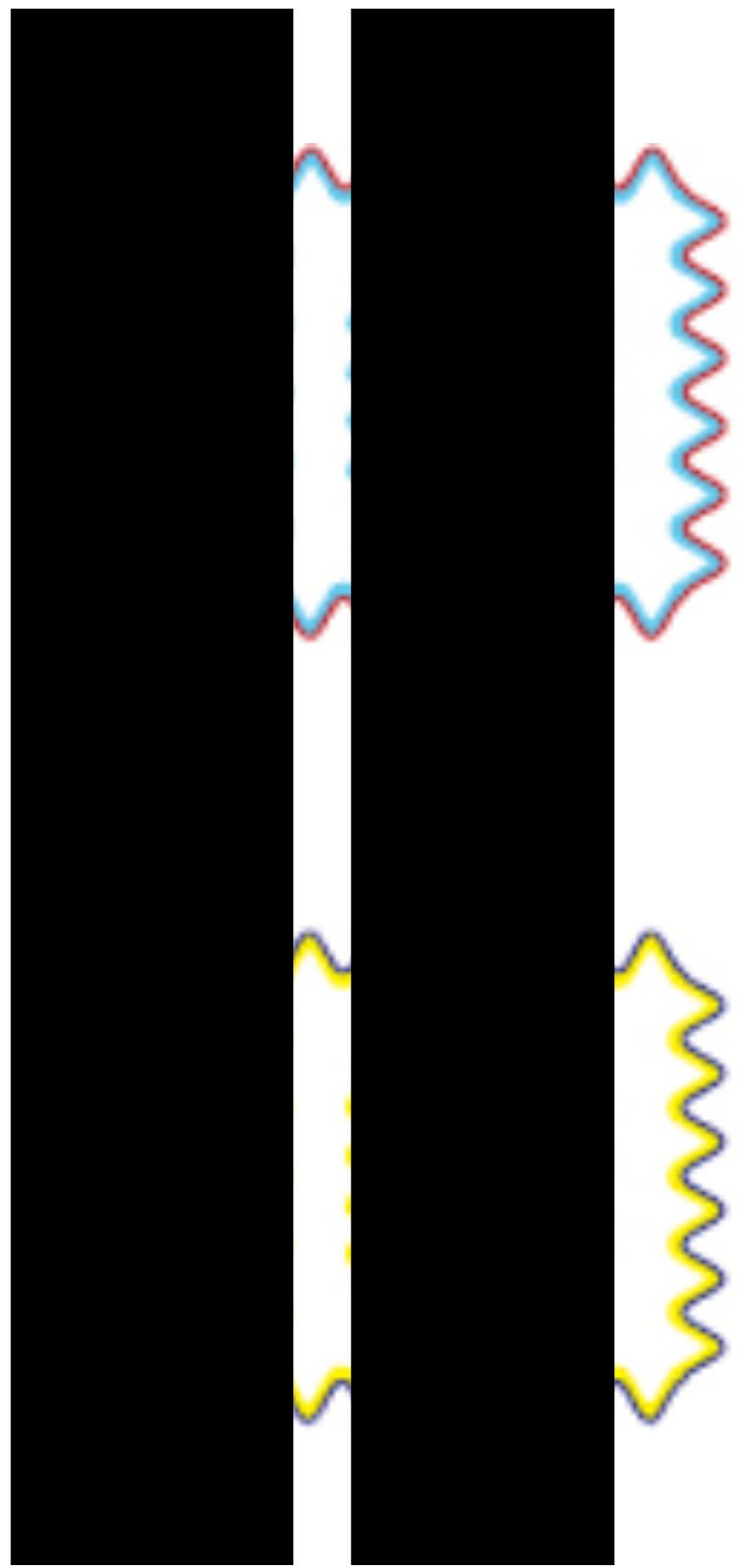


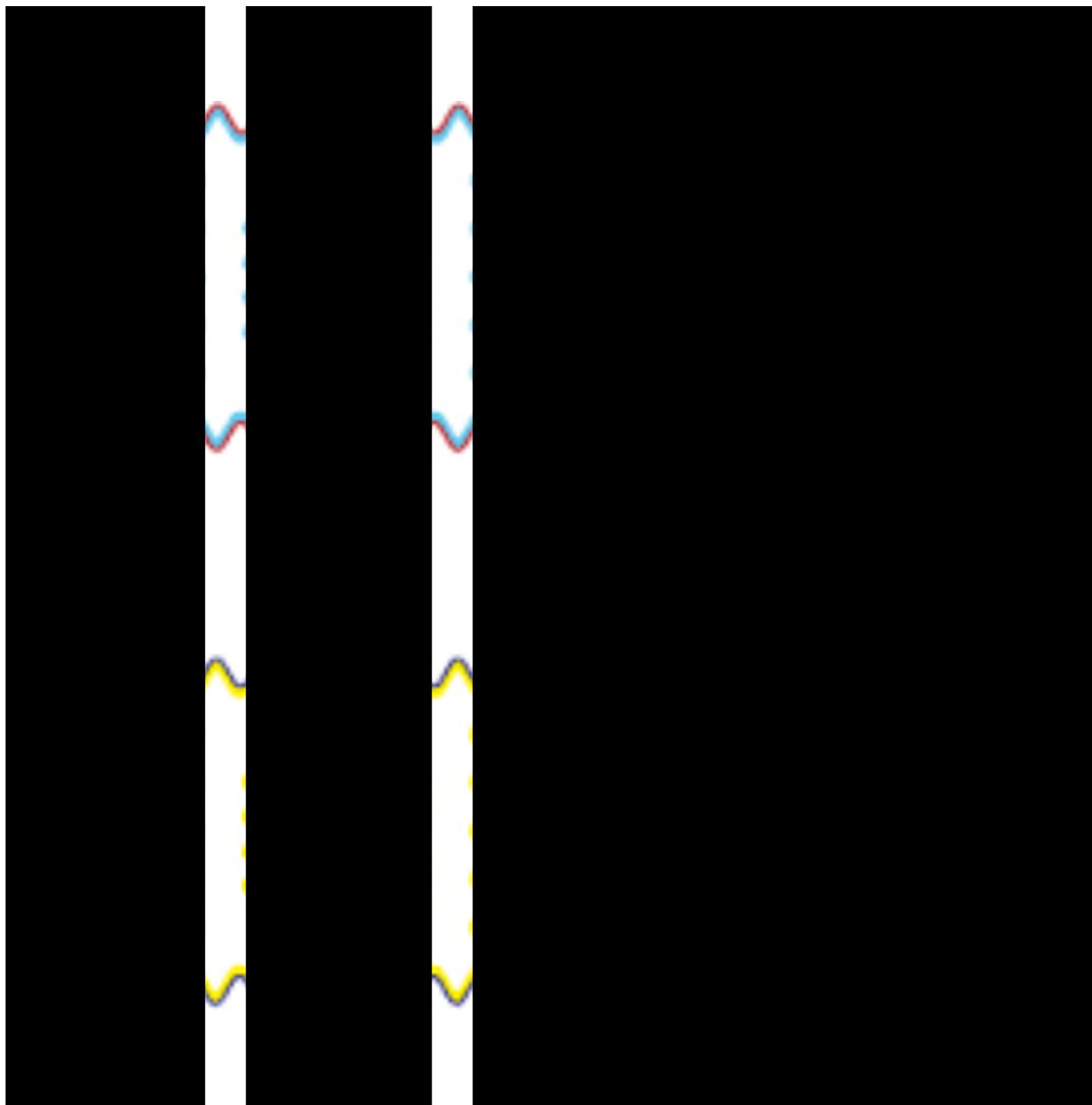
Pinna (1987)

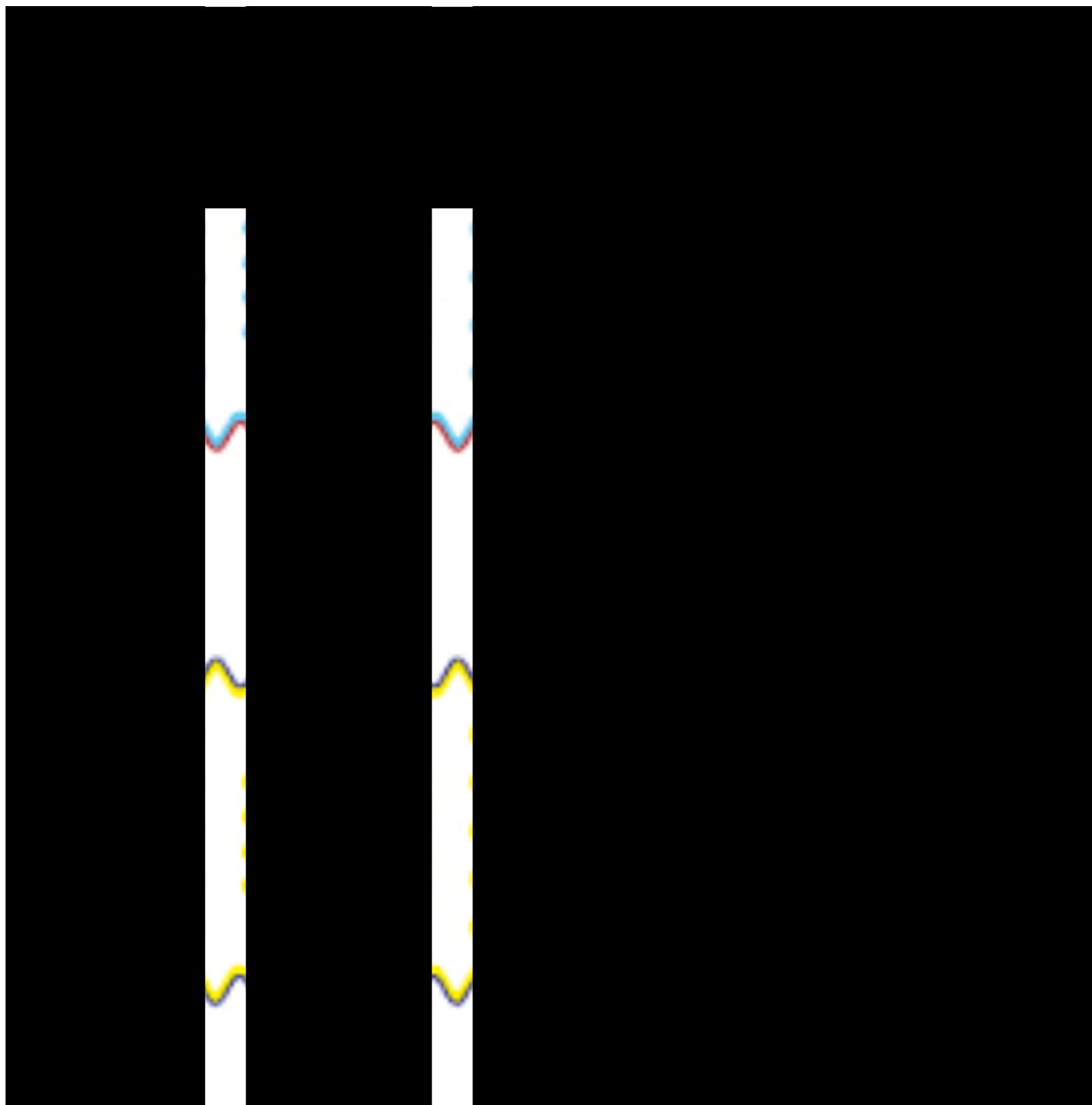


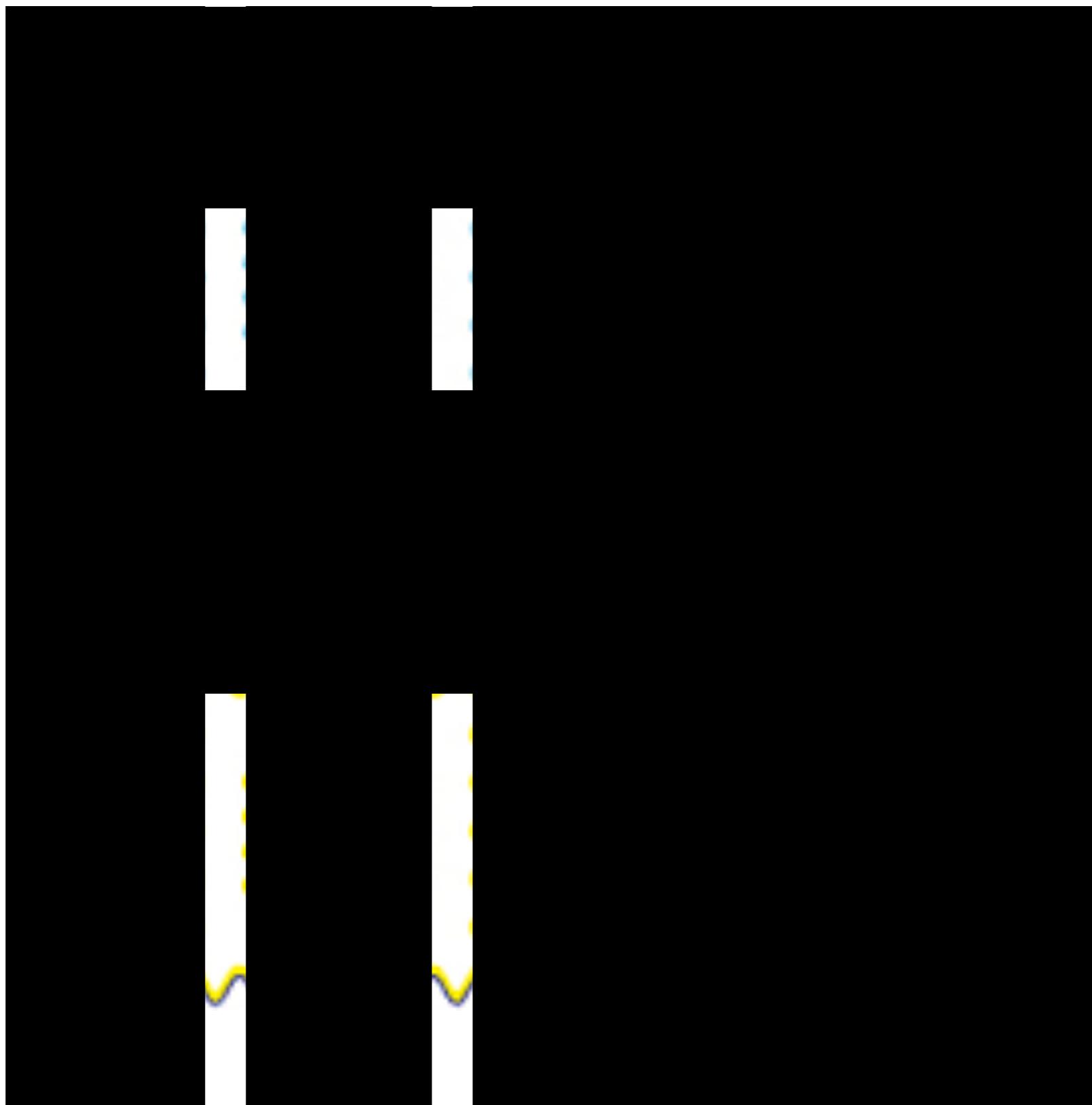
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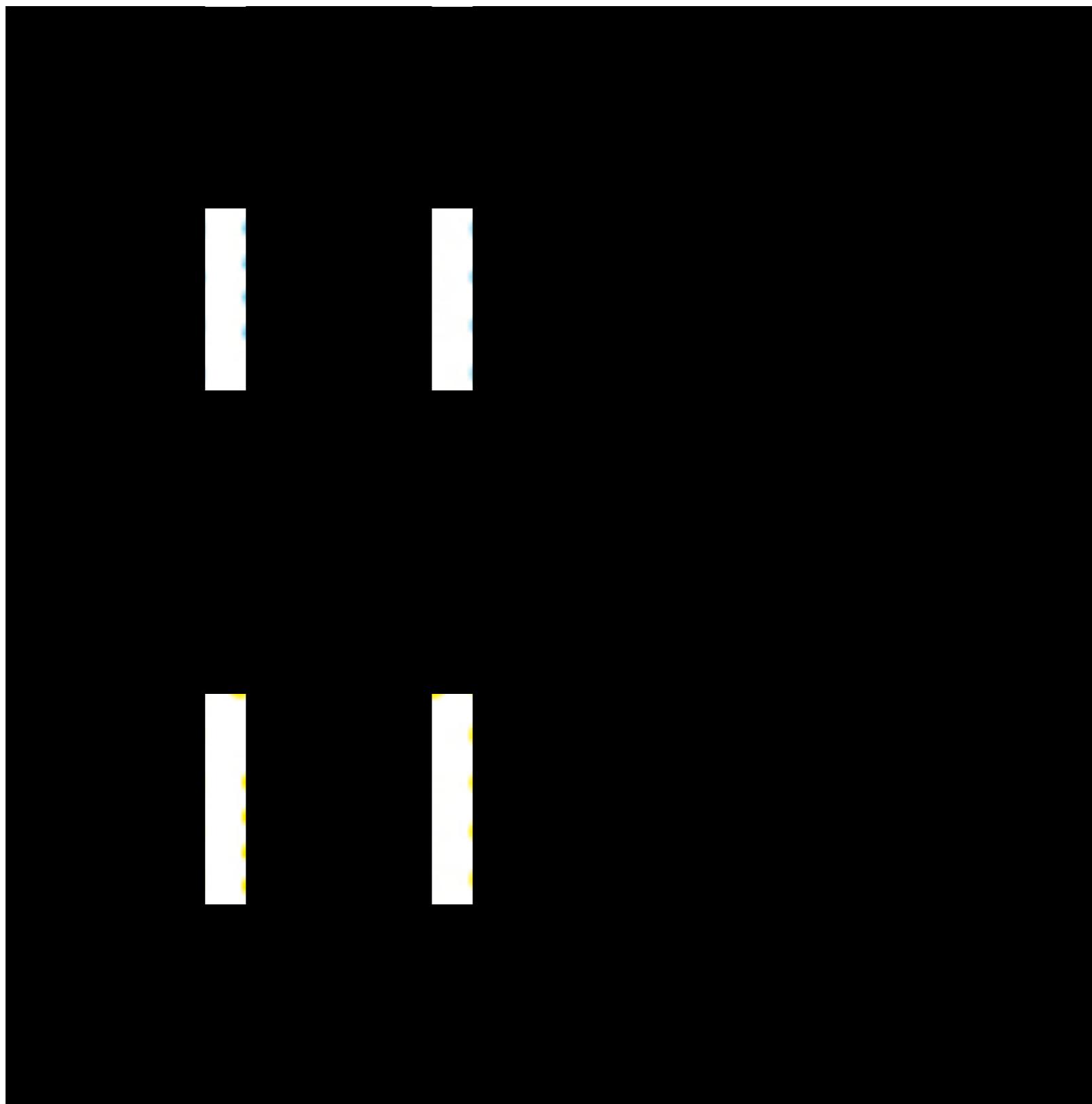


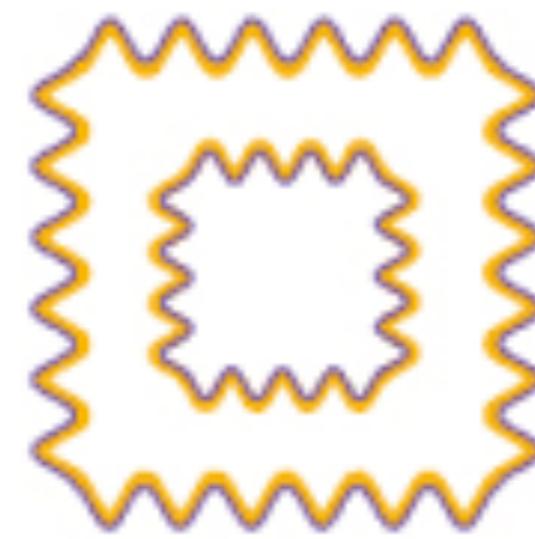
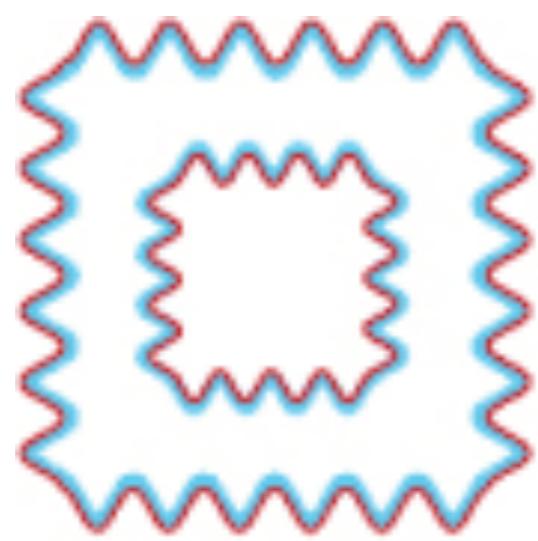




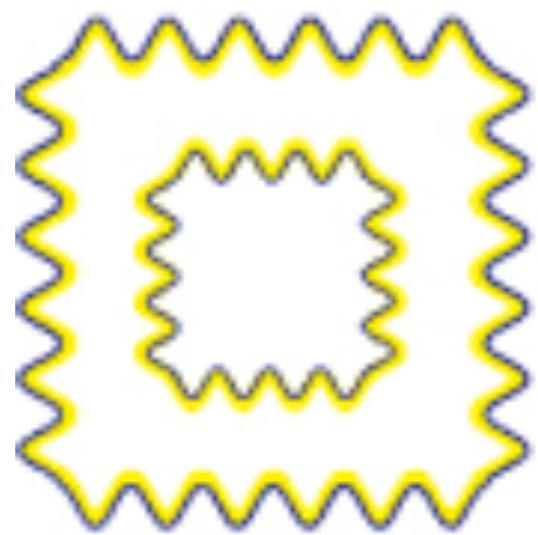


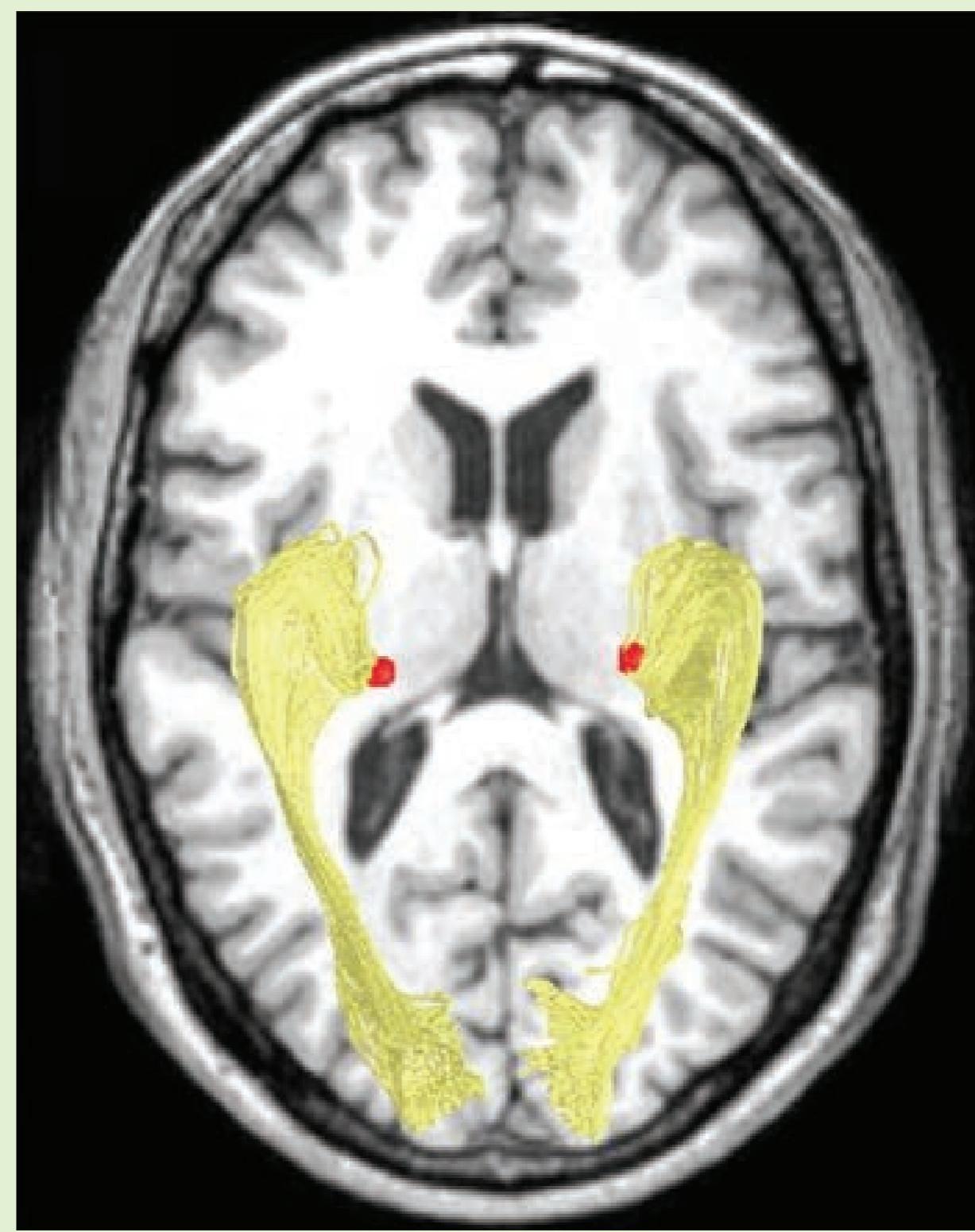
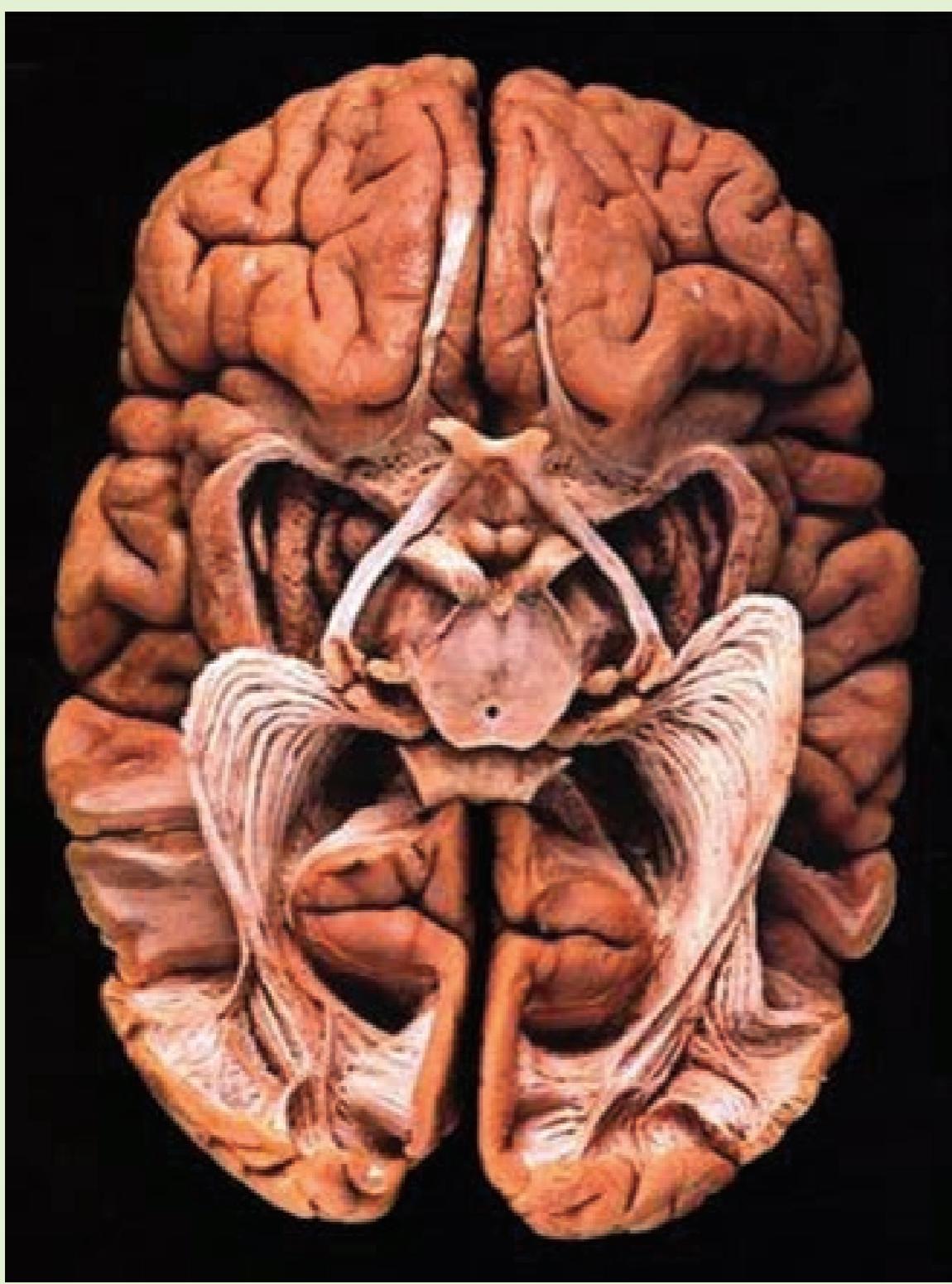




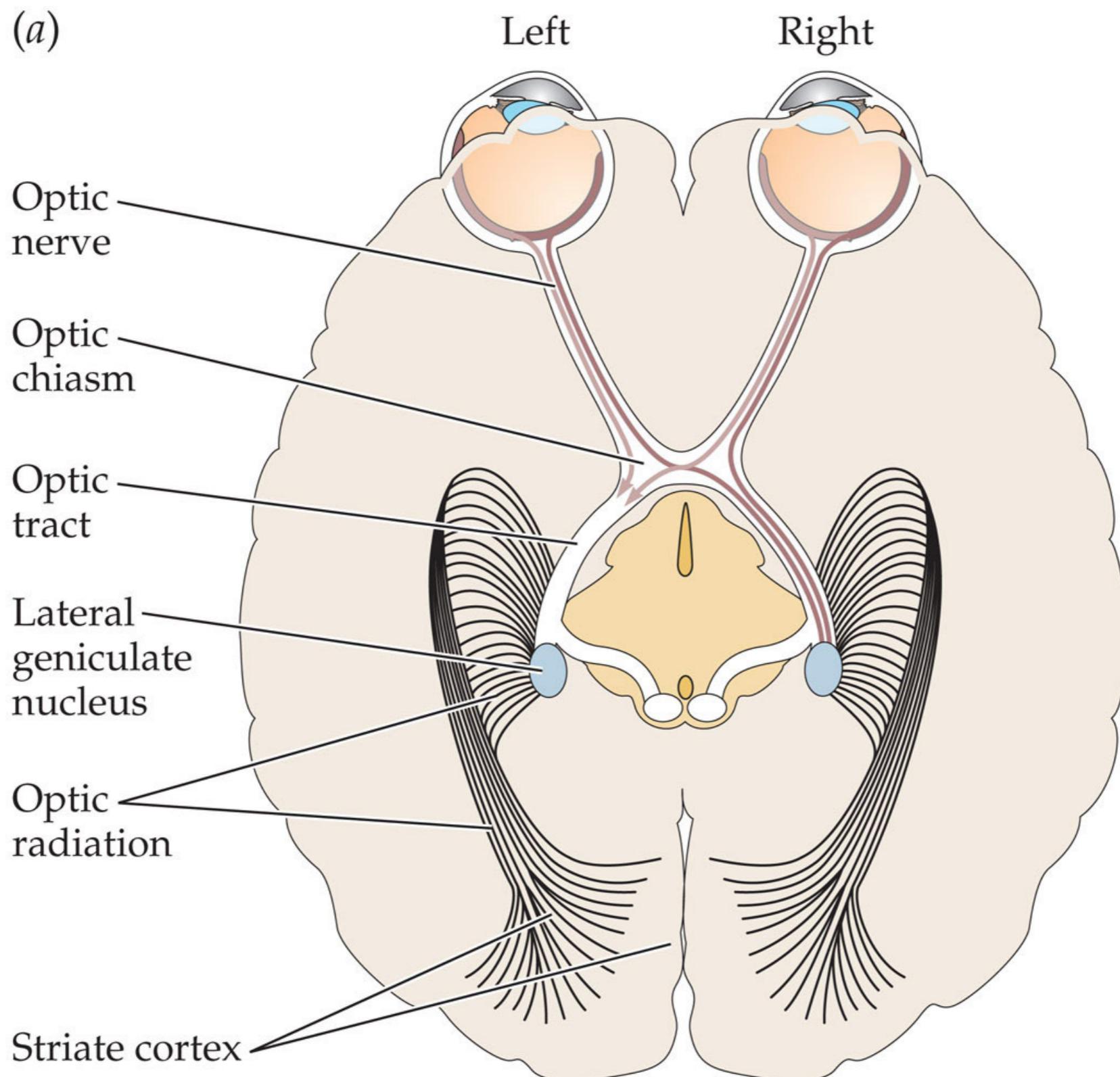


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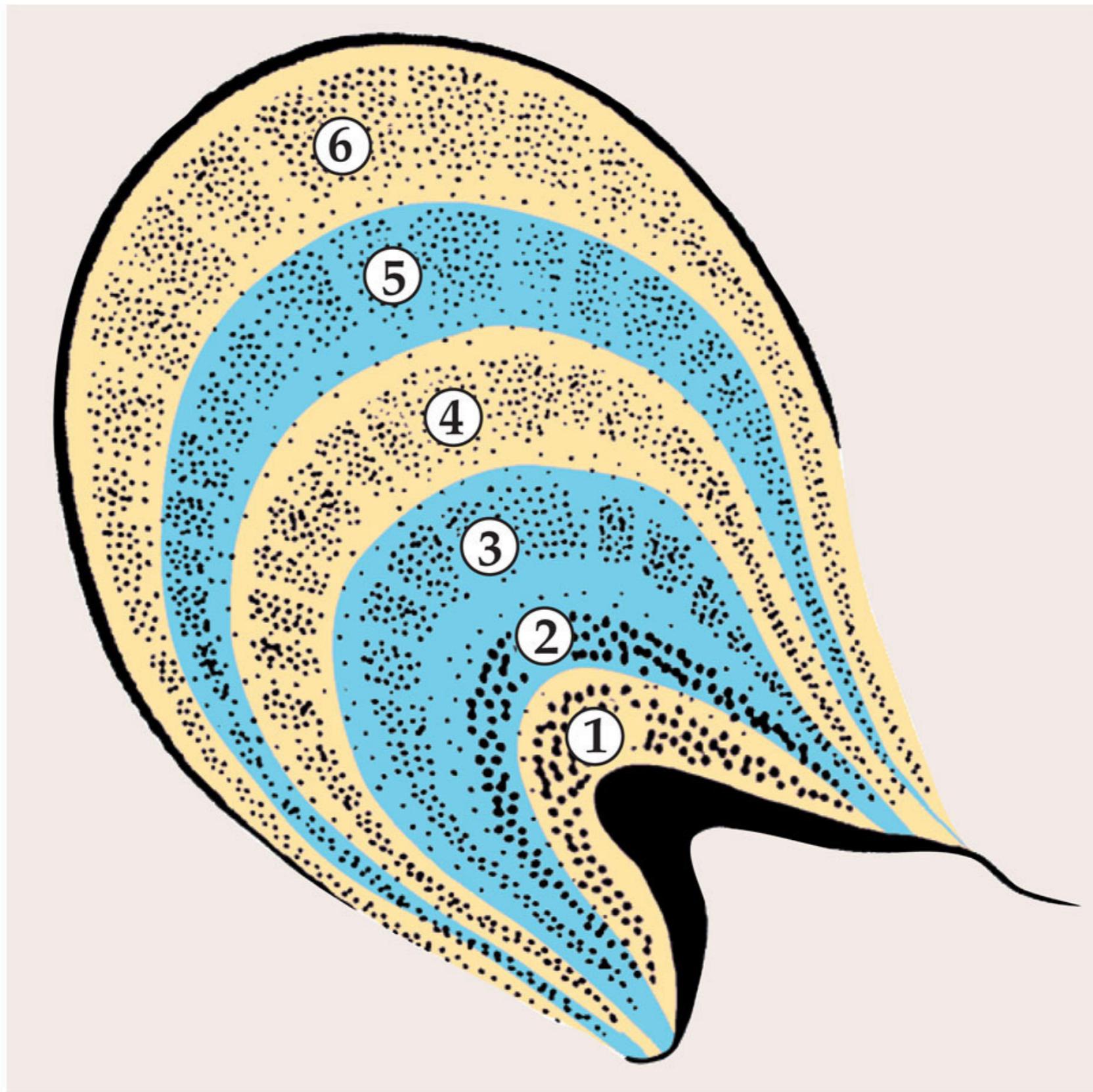


(a)

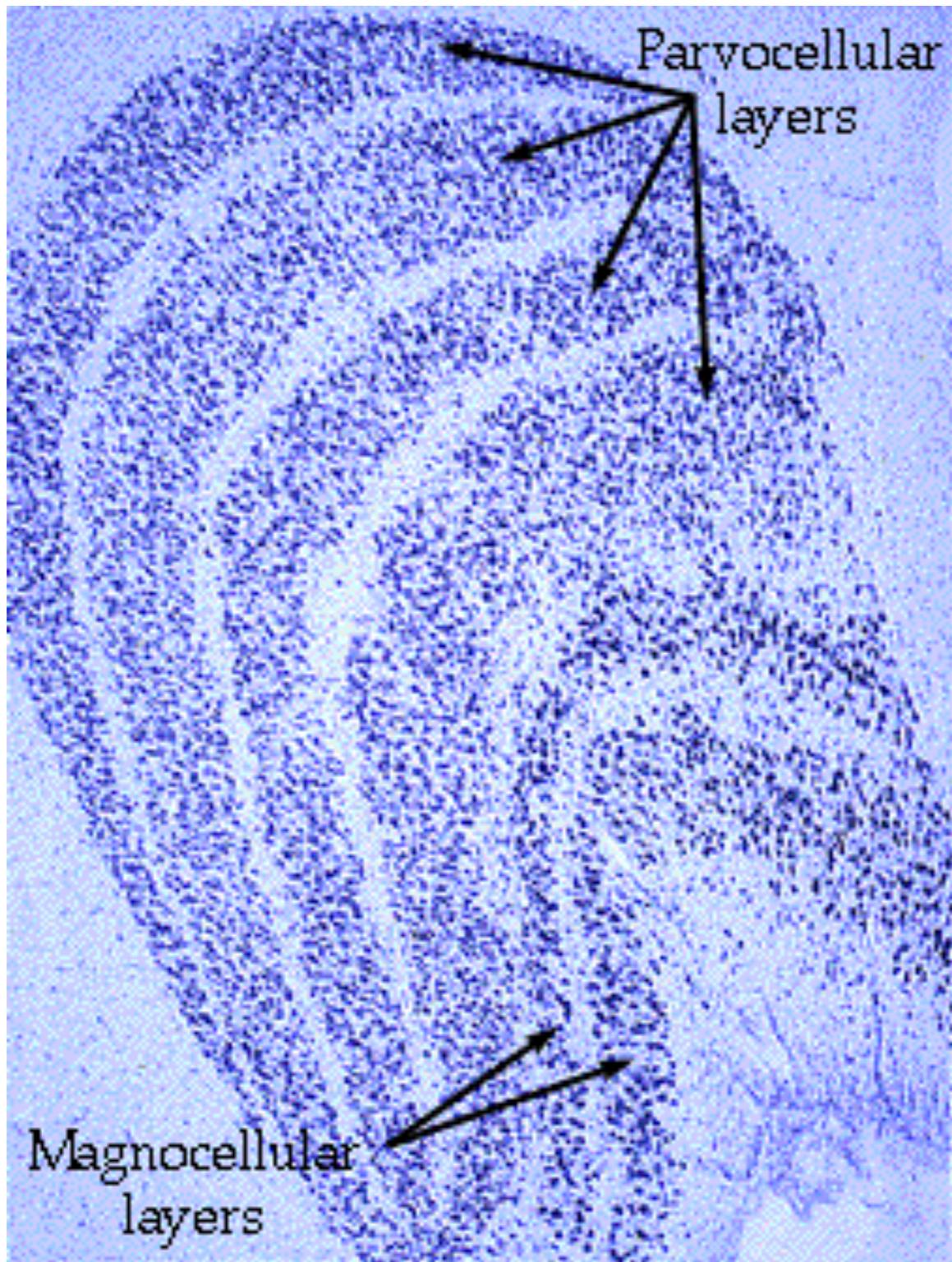


SENSATION & PERCEPTION 4e, Figure 3.1 (Part 1)

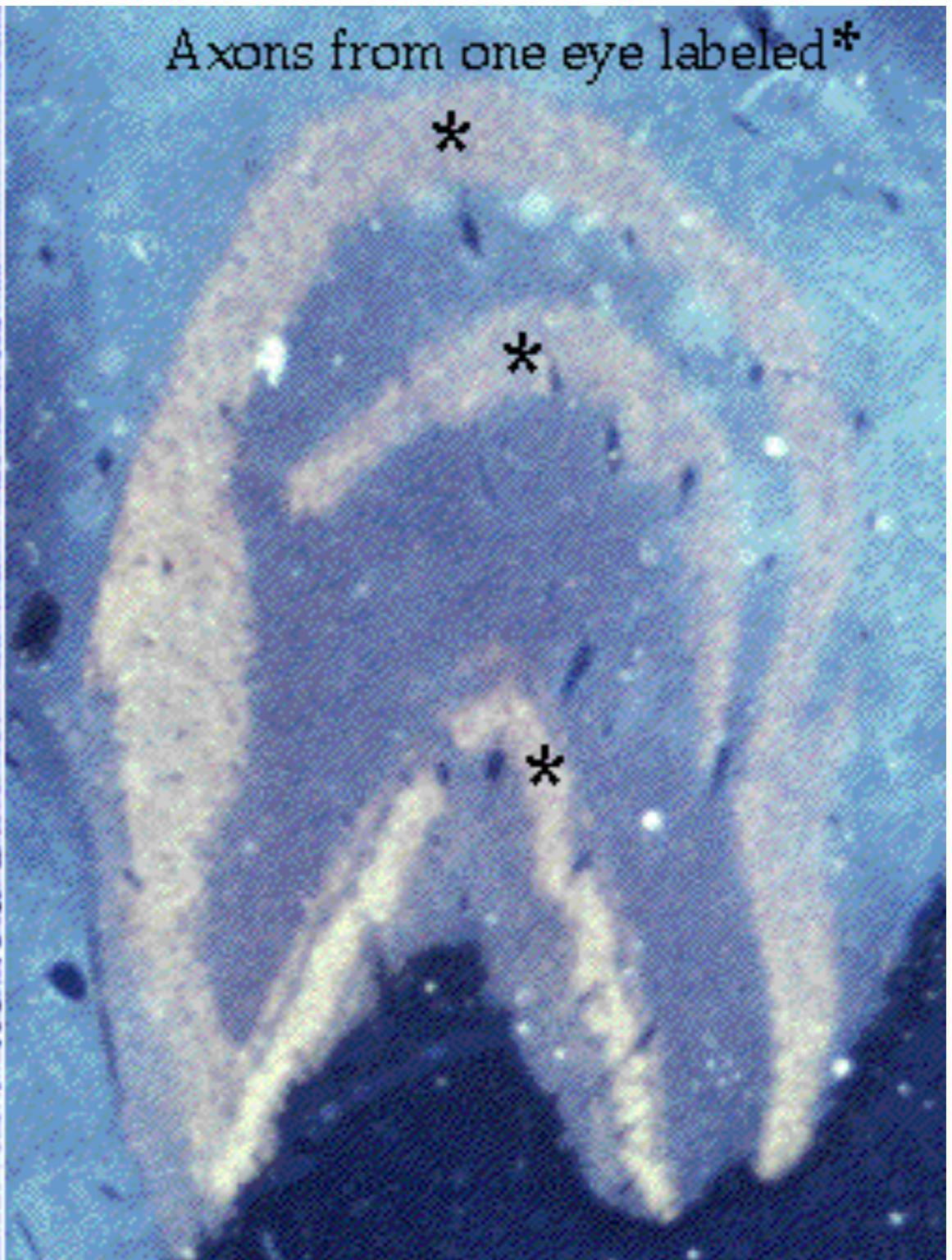
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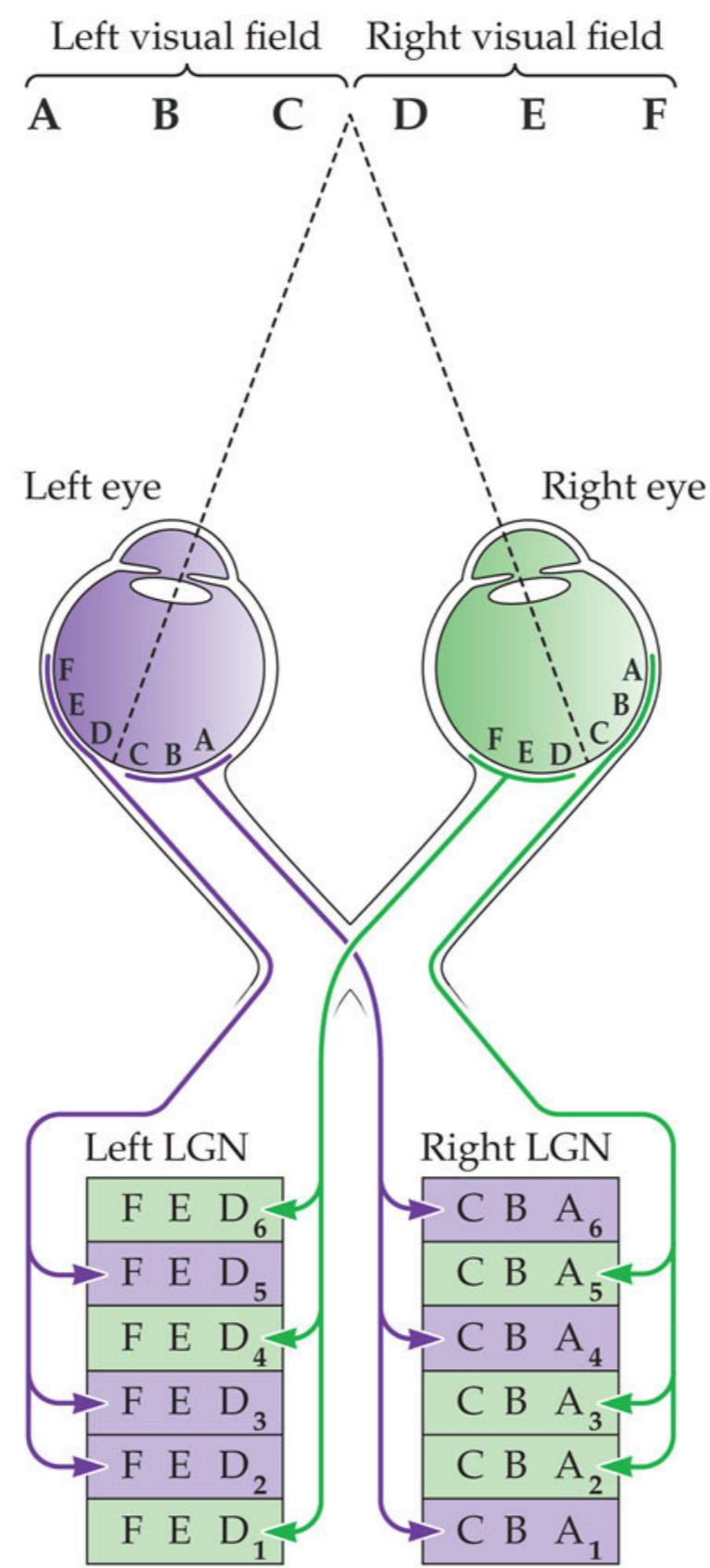
SENSATION & PERCEPTION 4e, Figure 3.13
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M- and P-ganglion cells project to separate LGN layers

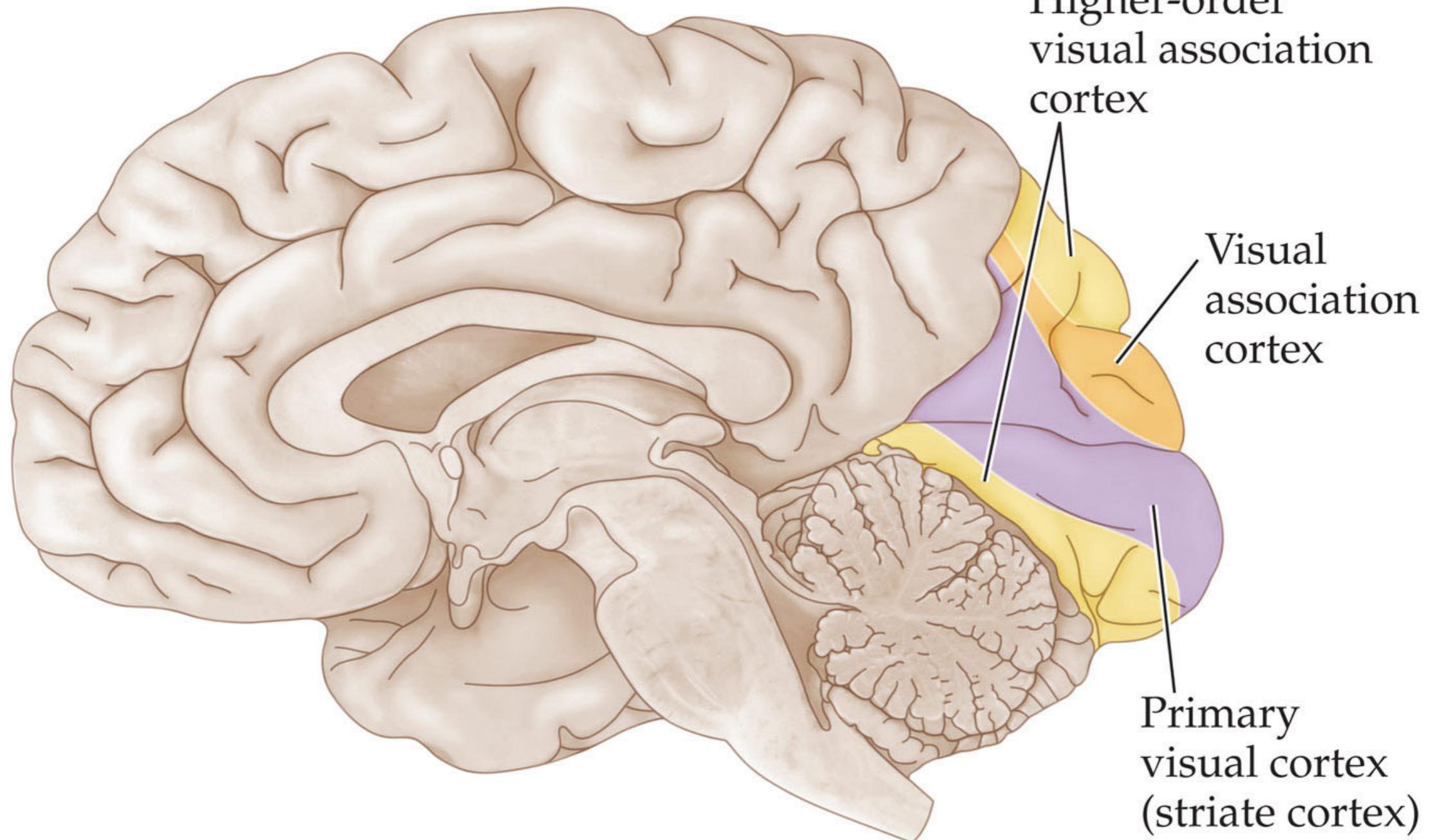


LGN layers receive input from one hemifield but both eyes (alternating between layers)

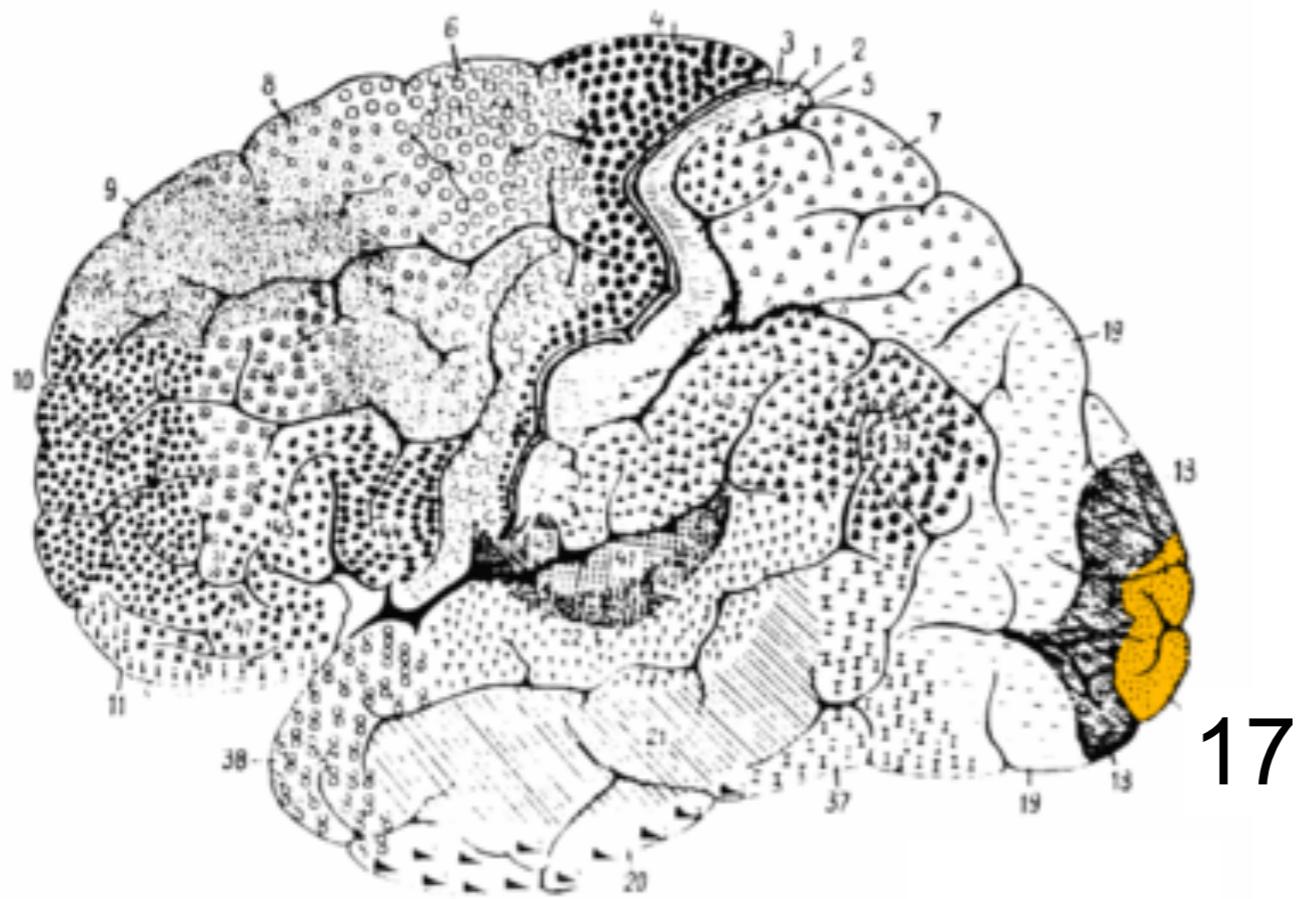


SENSATION & PERCEPTION 4e, Figure 3.14
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(b)

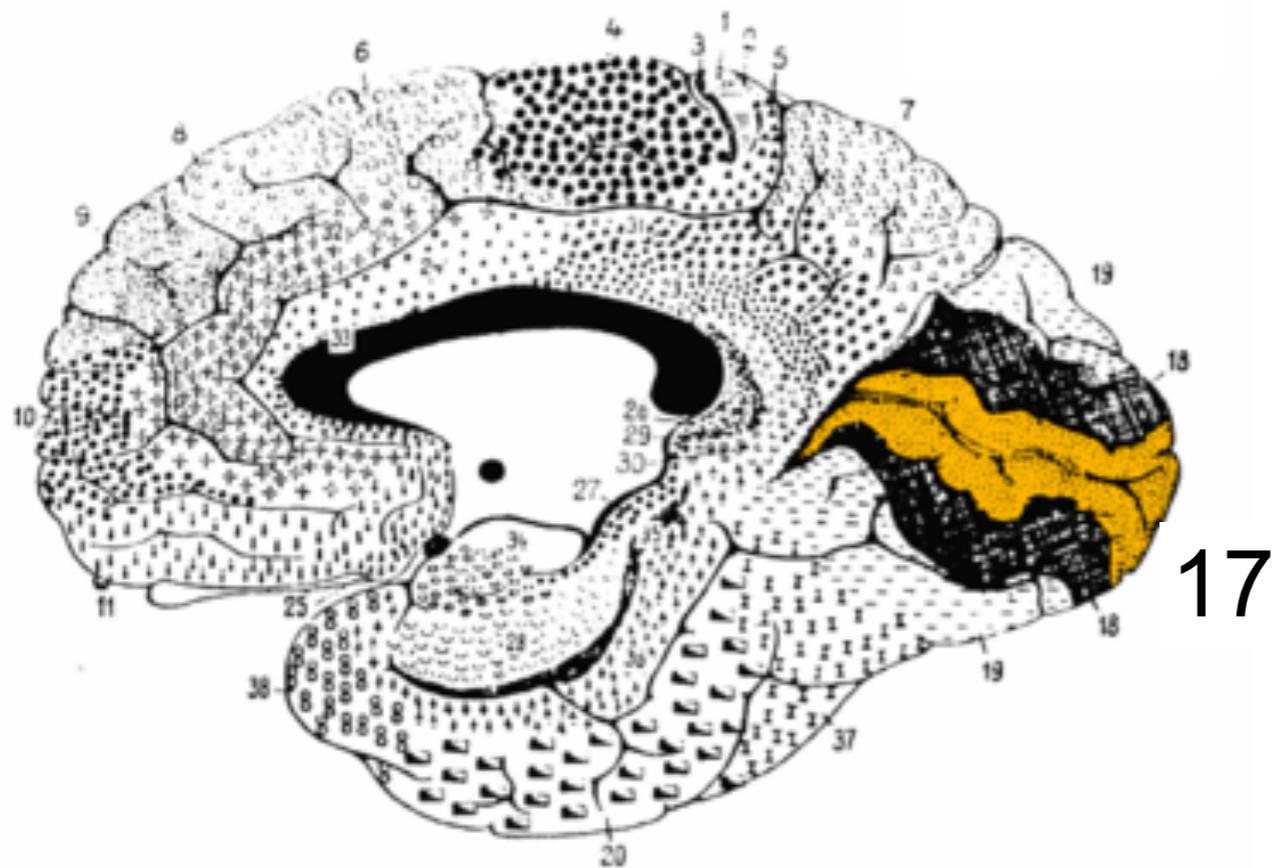


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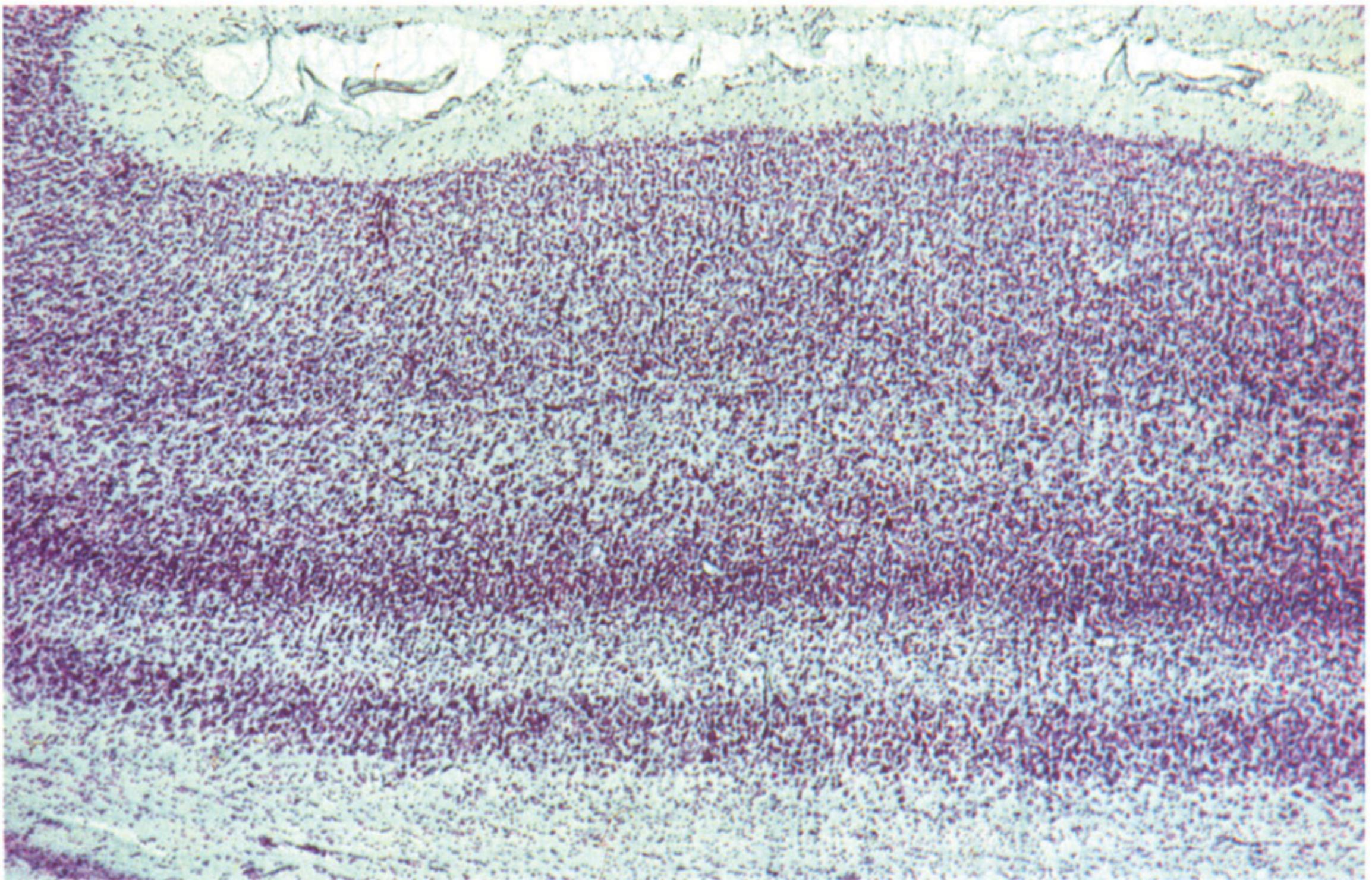


17

striate cortex is
Broadmann's
area 17

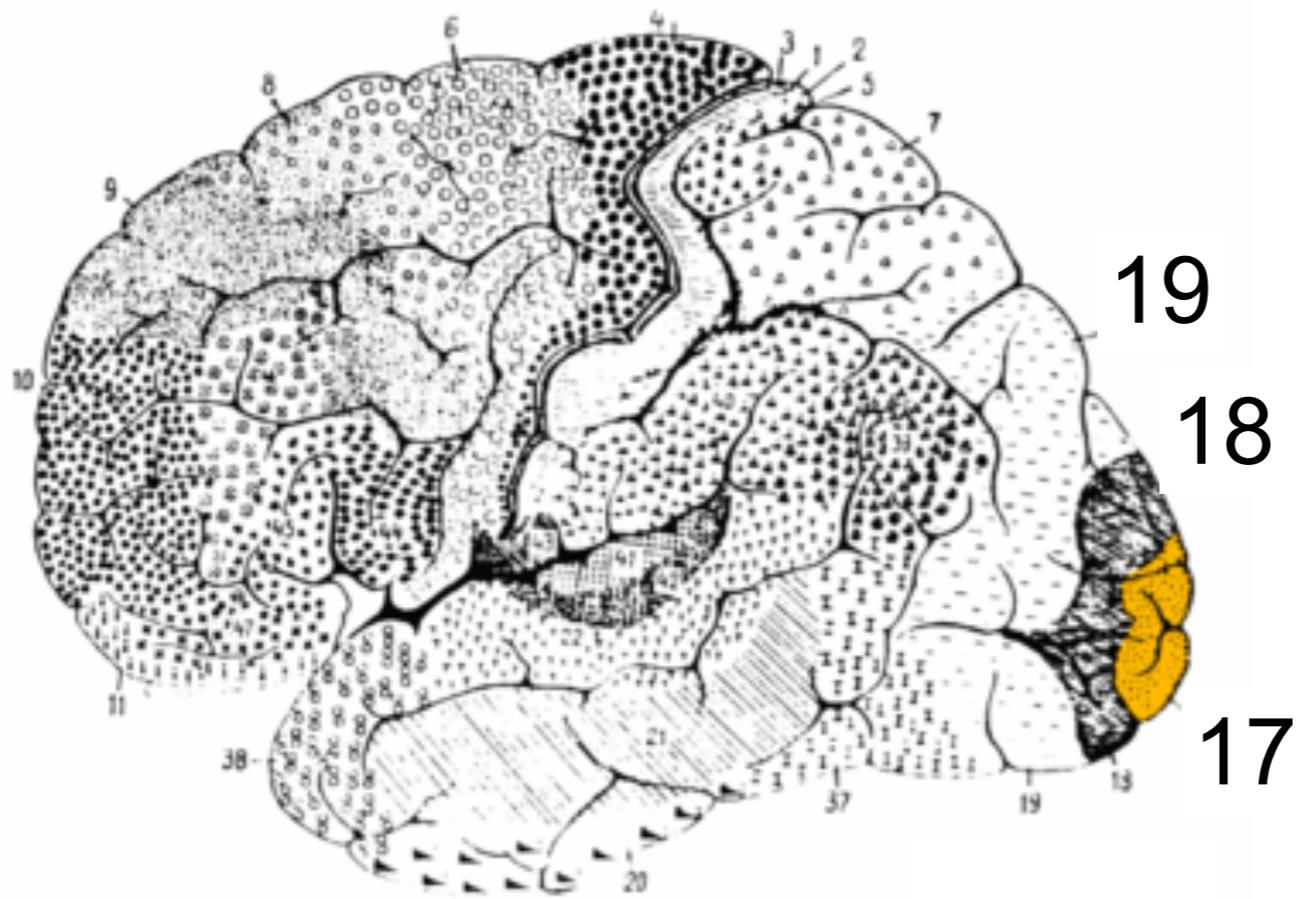


17

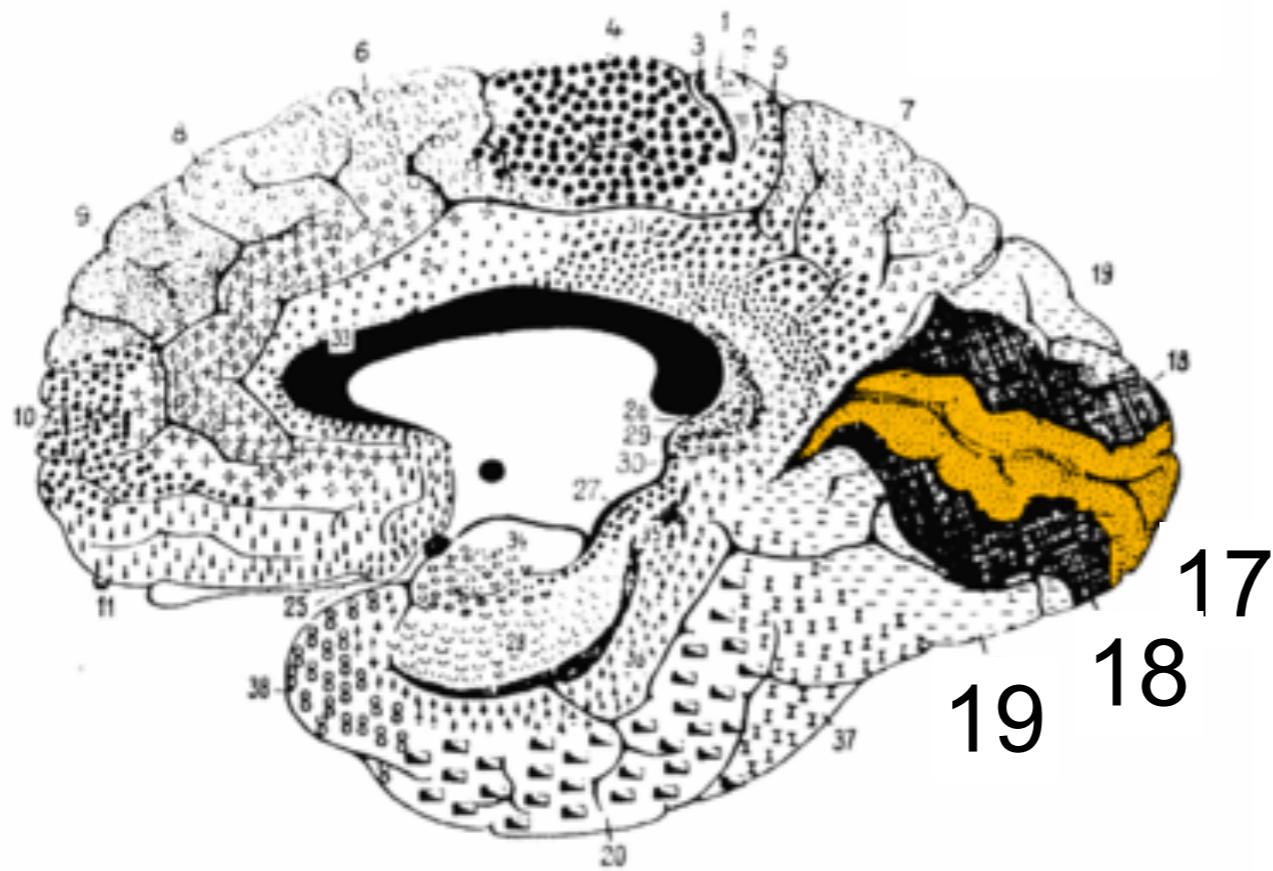


1 mm

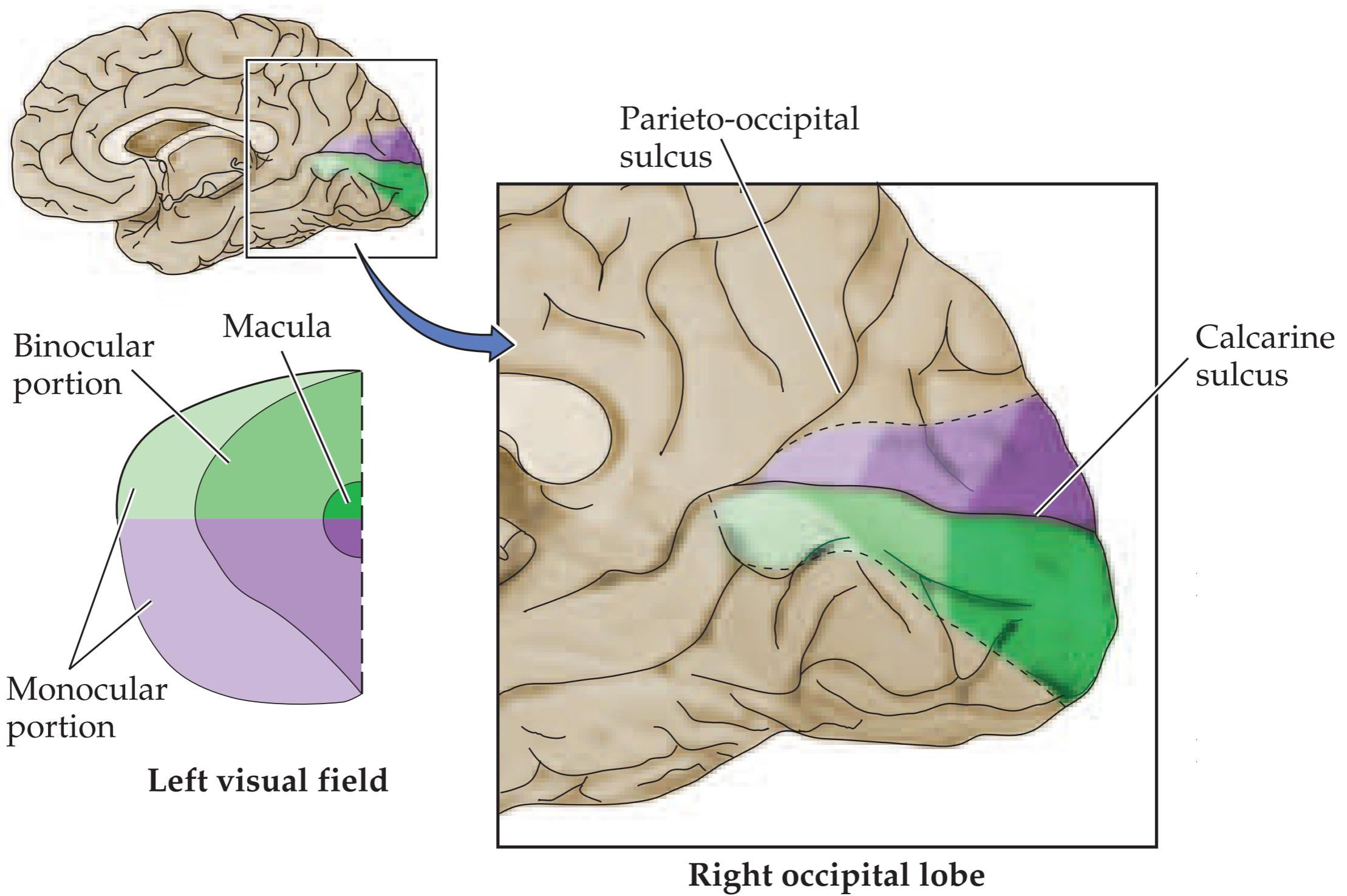
1
2
3
4A
4B
4C
5
6



extrastrate
cortex is
Broadmann's
areas 18 & 19



visual field maps onto V1



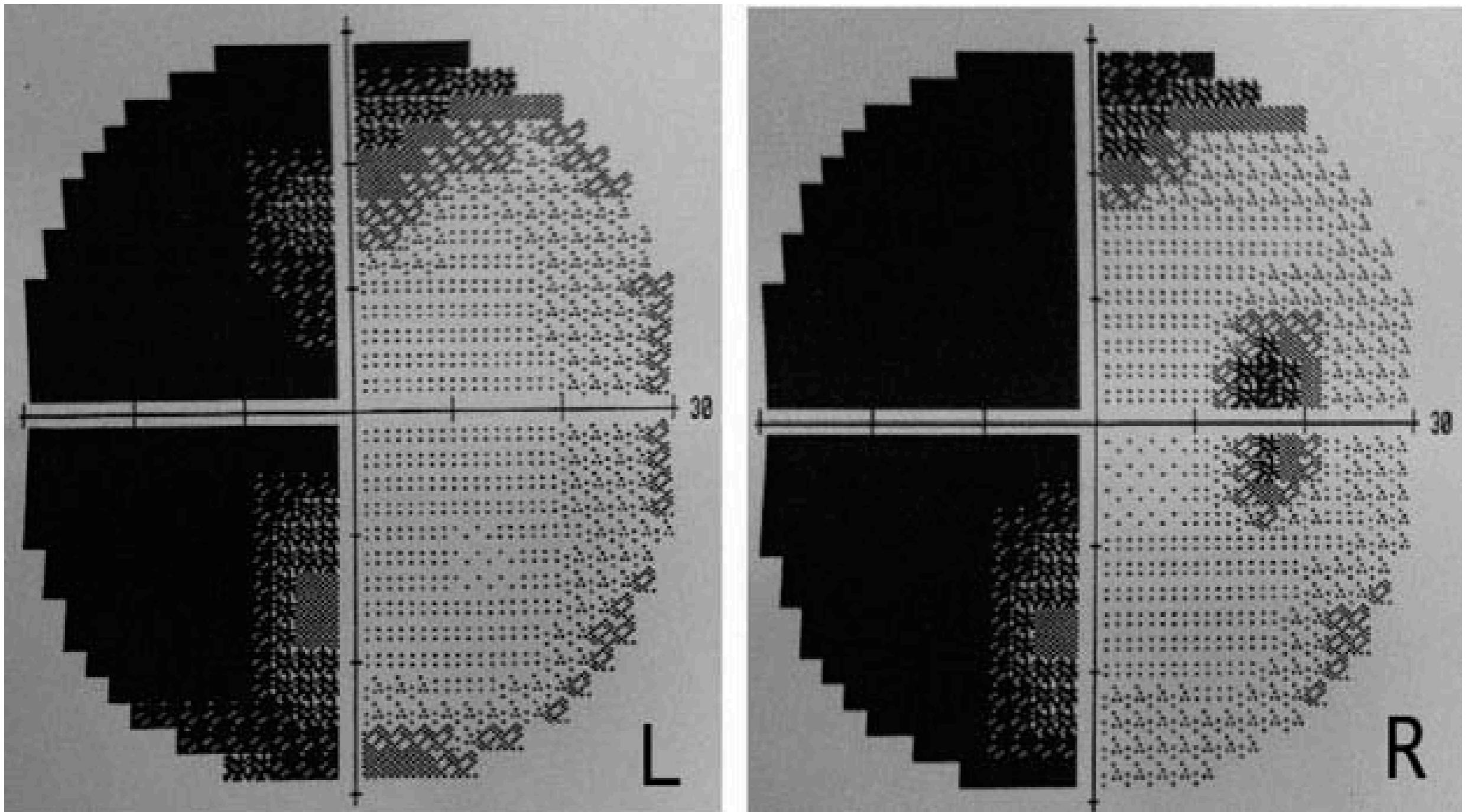
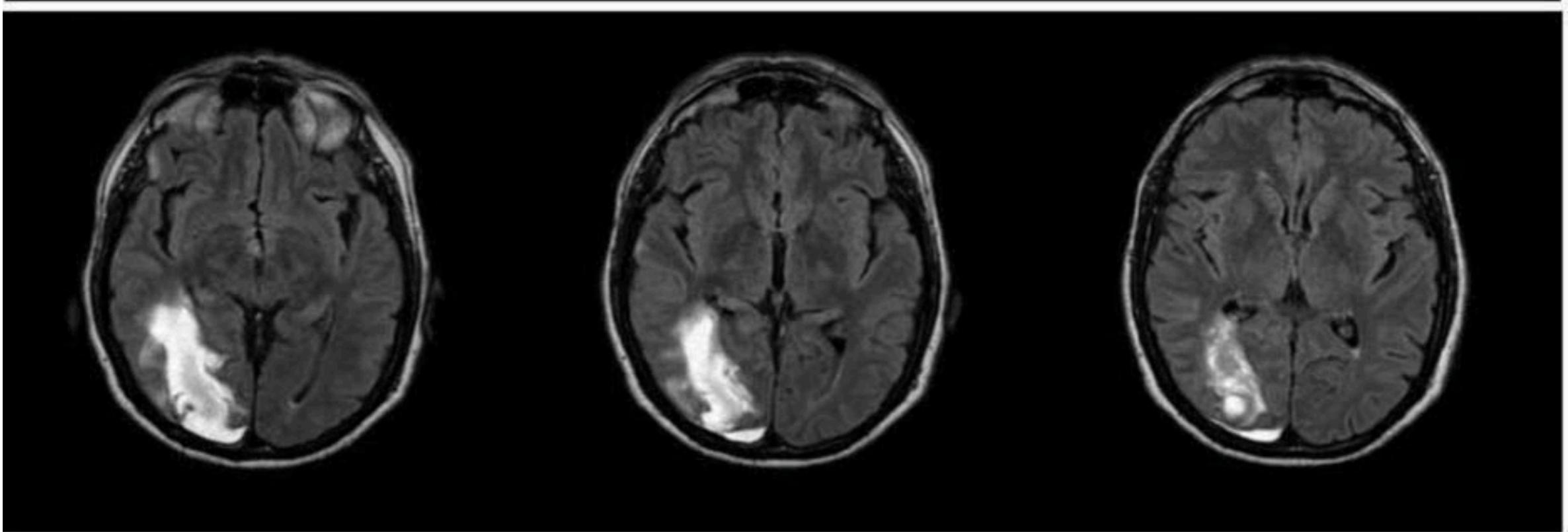
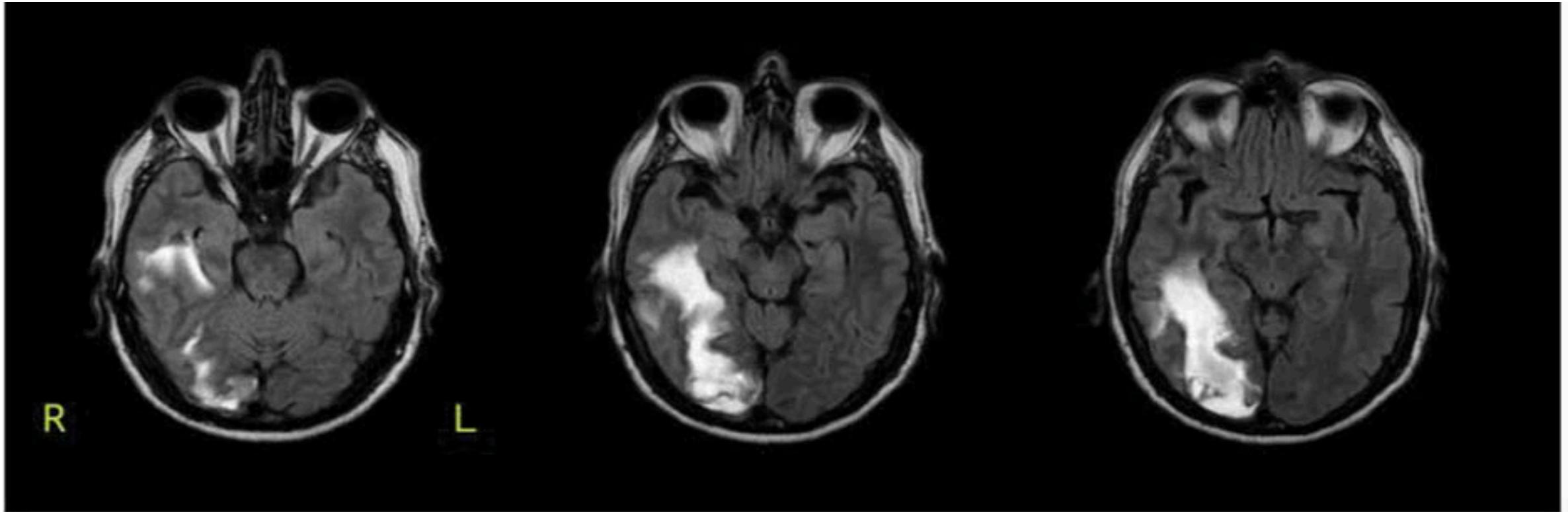
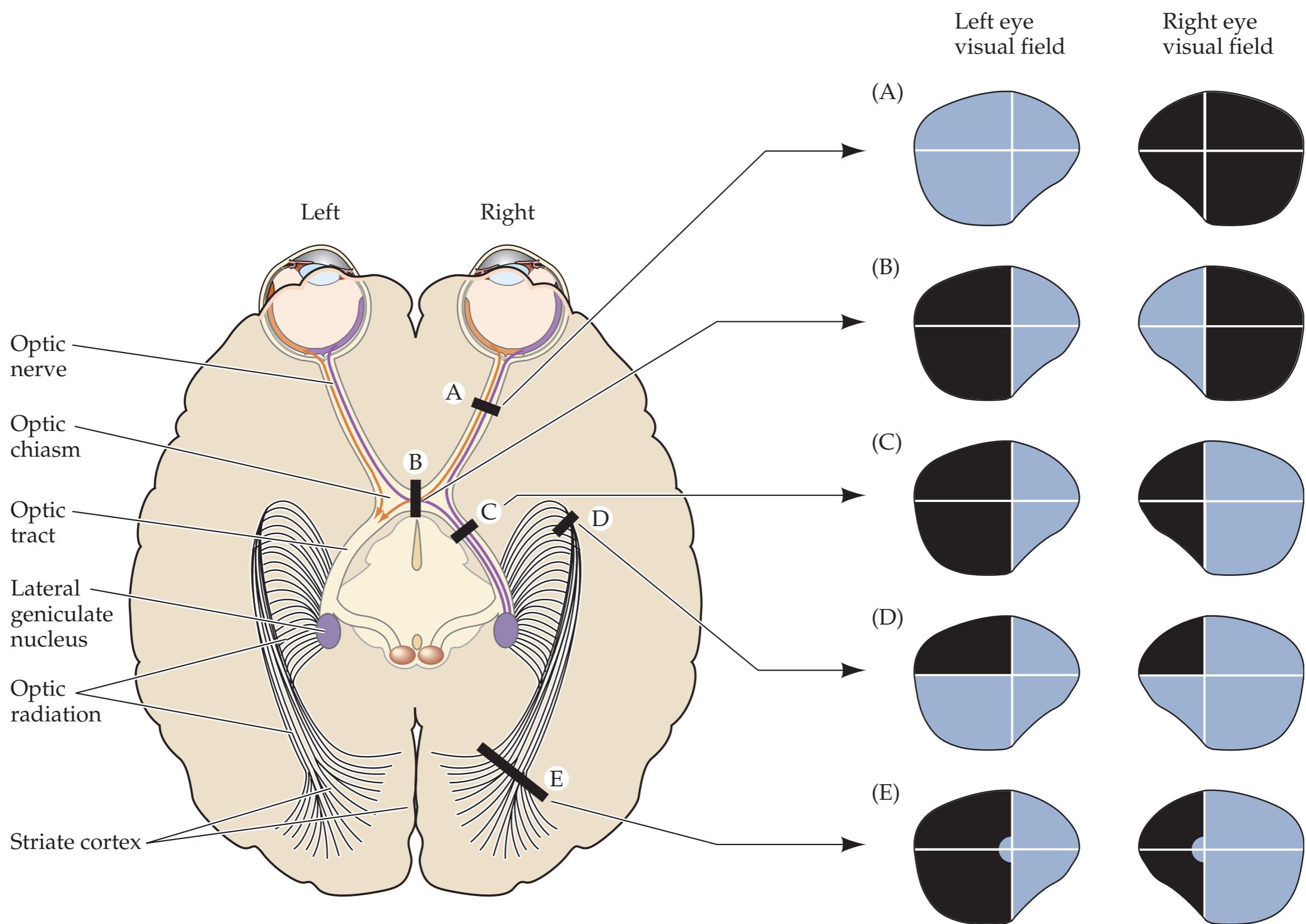


Figure 1. Visual field testing results, documenting M.B.'s almost complete loss of the left hemifield (L = left eye, R = right eye). Dark areas on the uppermost part of the right hemifields are artifacts due to blepharoptosis. The dark area in the center of the right hemifield of the right eye corresponds to the blind spot. The visual field assessment was performed using Humphrey's automated perimetry and the SITA threshold testing program.



horizontal sections from MRI (FLAIR) of MB's brain



Percezione e Psicofisica

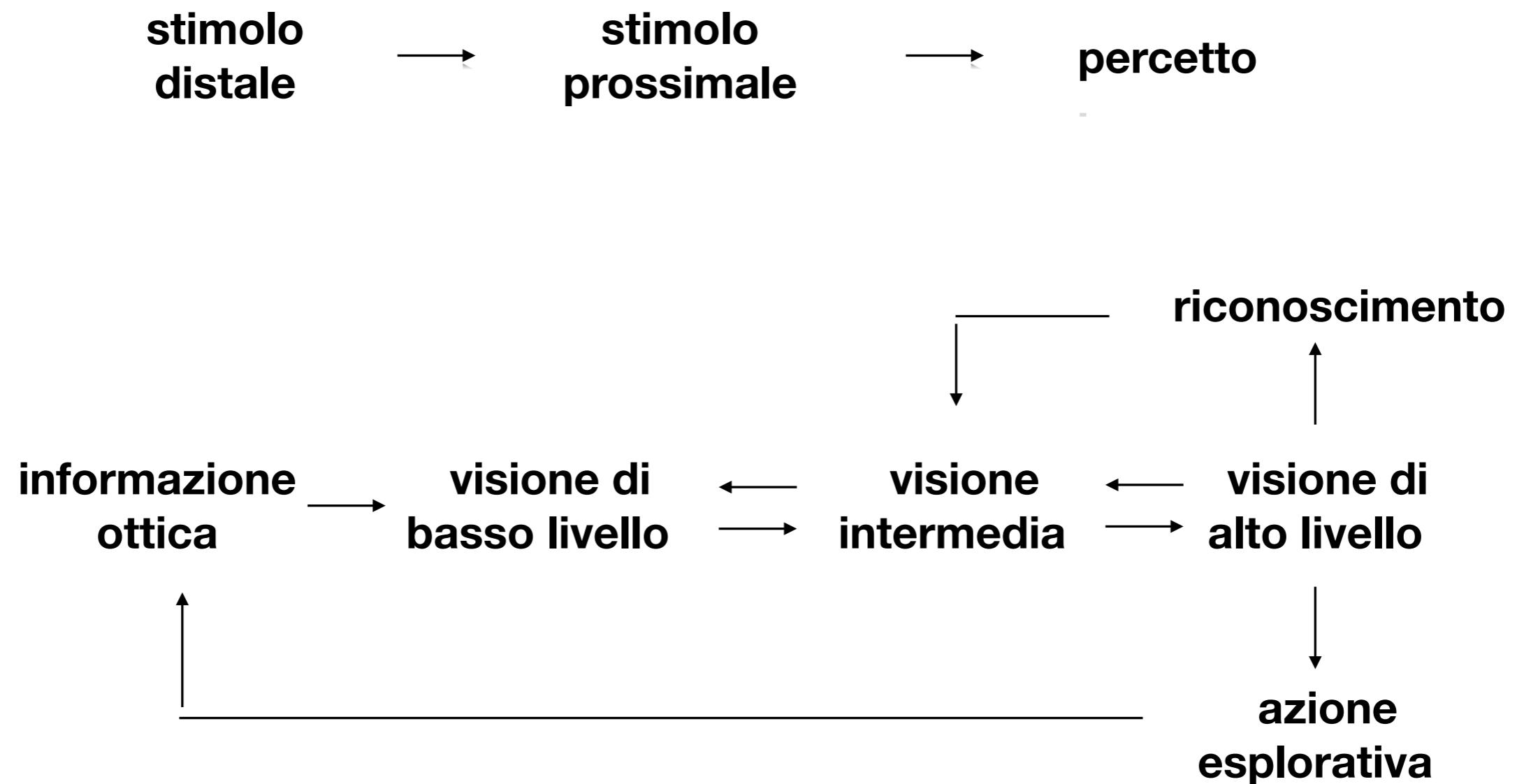
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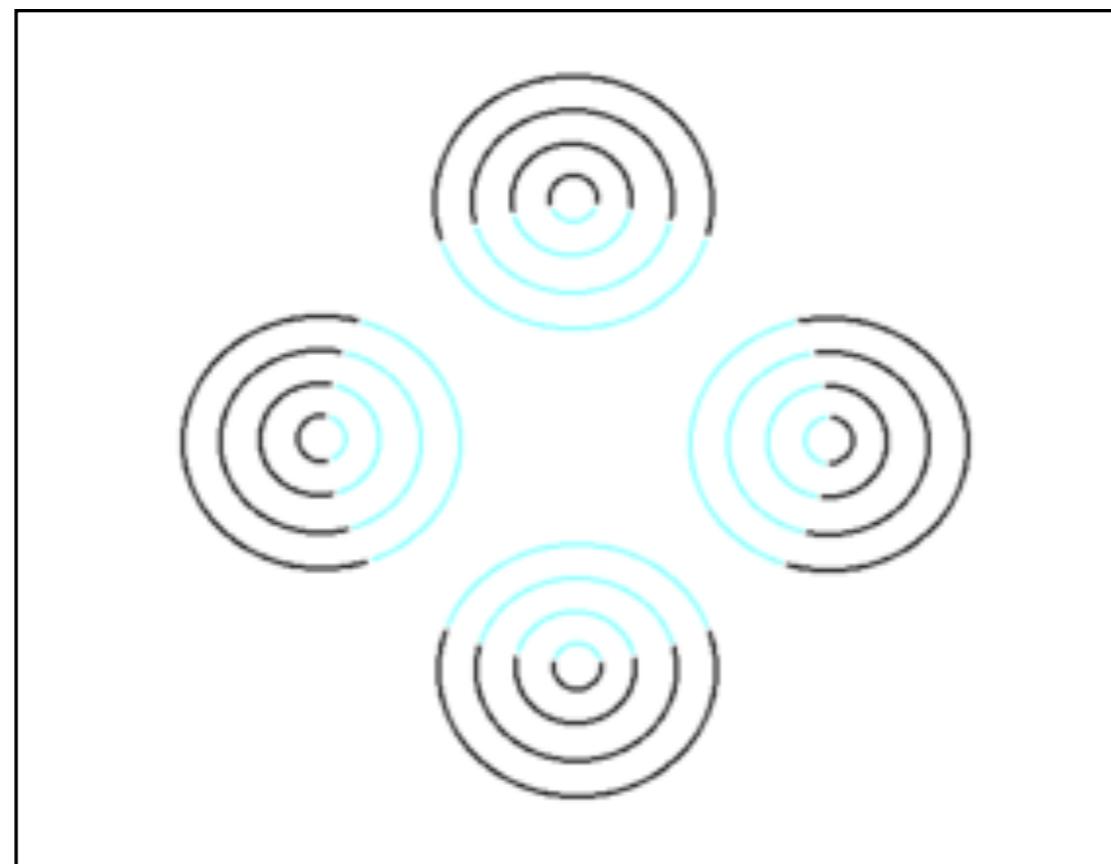
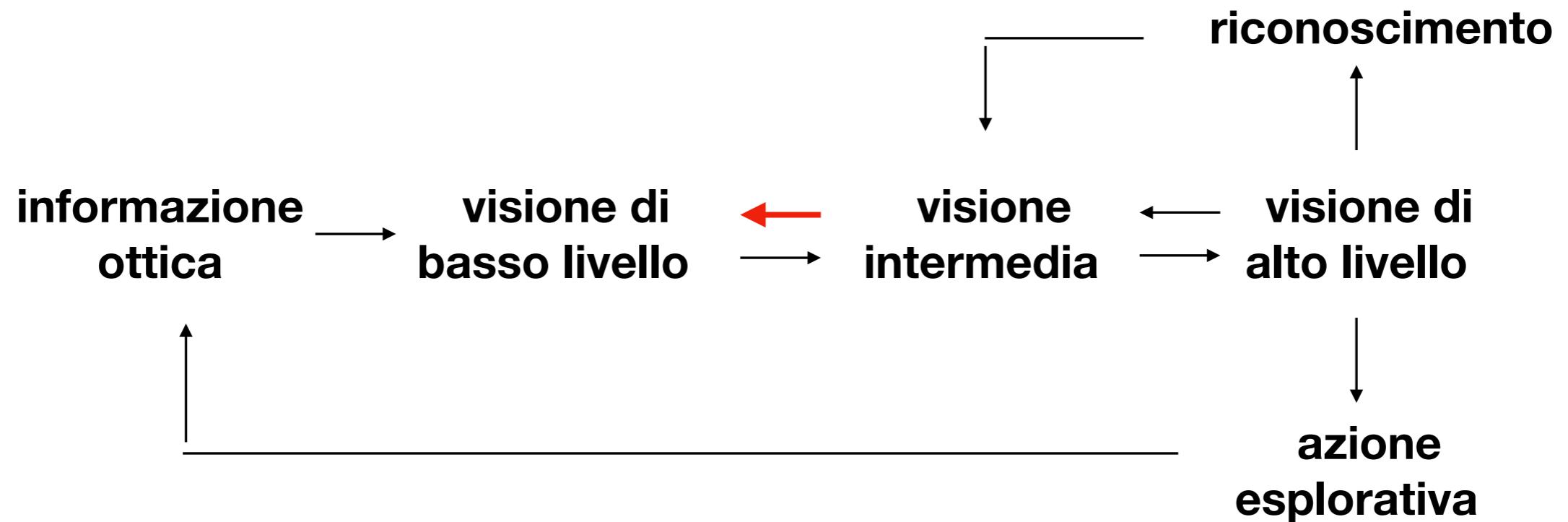
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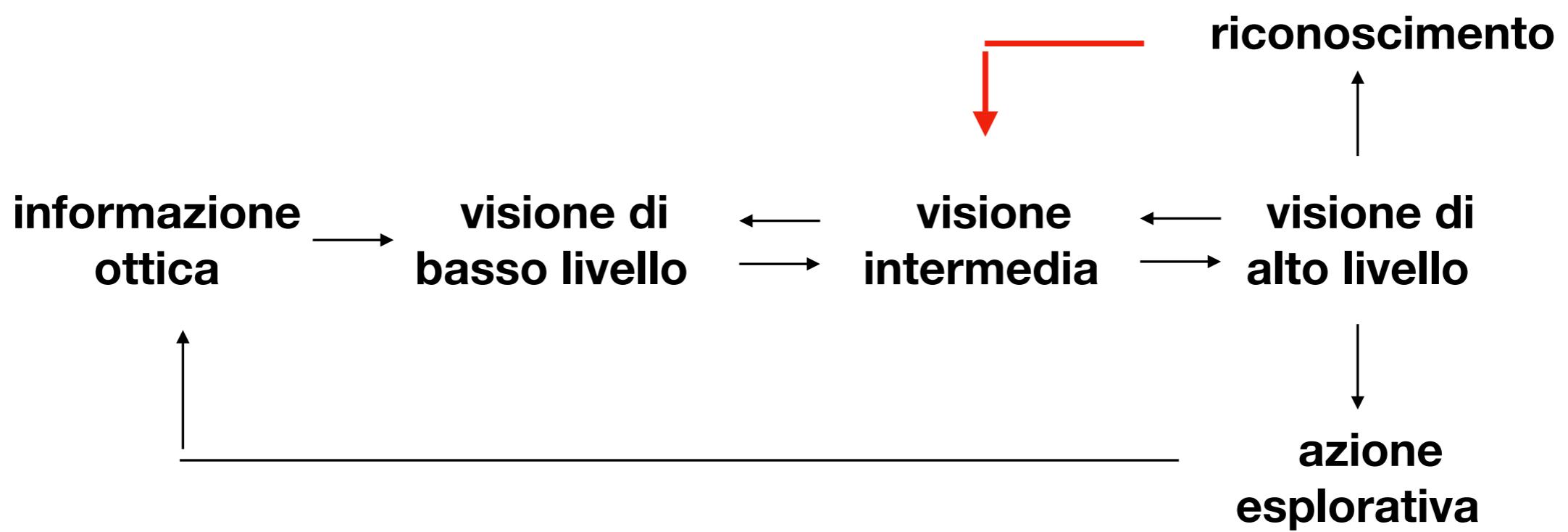
Lezione 7-8

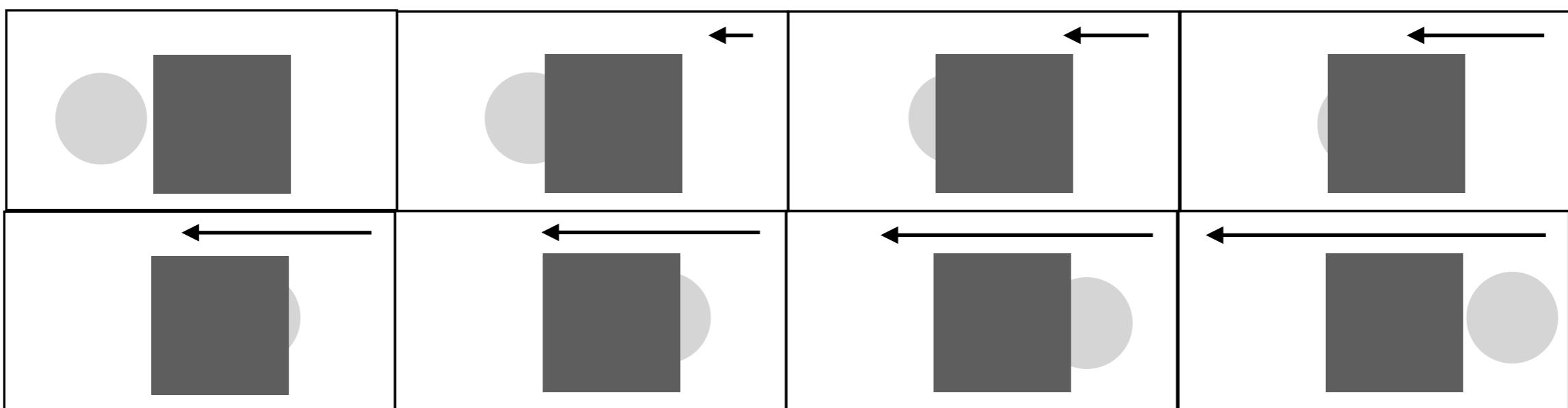
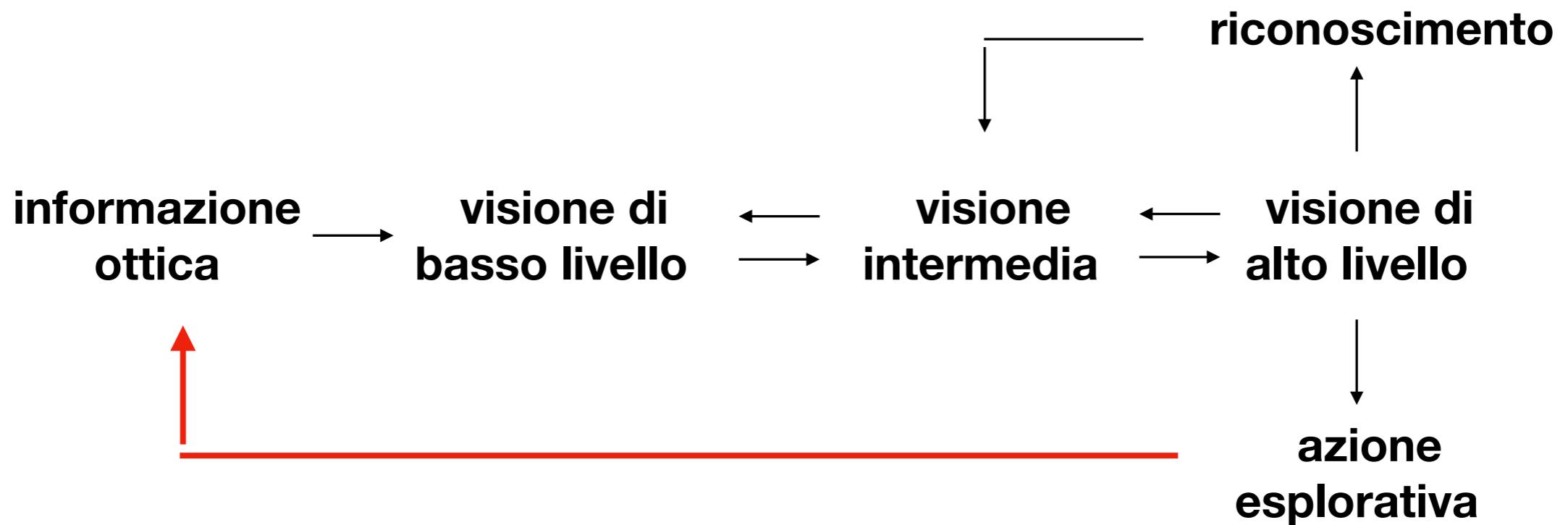
Dal cervello all'ambiente

dalla catena psicofisica al ciclo percezione-azione









VOL. 69, NO. 6

NOVEMBER 1962

PSYCHOLOGICAL REVIEW

OBSERVATIONS ON ACTIVE TOUCH¹

JAMES J. GIBSON

Cornell University

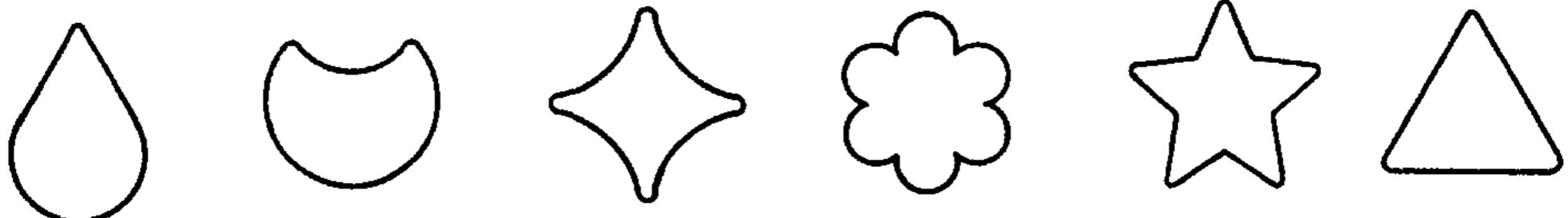


FIG. 1. The six forms to be identified by touch.



Lezione 9-10

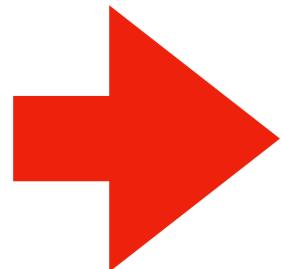
Psicofisica 1: sensibilità, soglia e legge di Weber



Elementen der Psychophysik (G. Fechner, 1860)

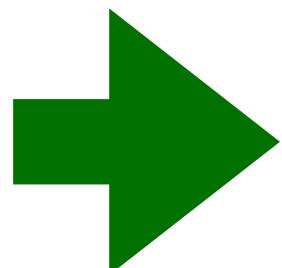
**“la psicofisica va intesa come
una teoria esatta delle relazioni
di dipendenza funzionale tra
corpo e anima o più in generale
fra materiale e mentale, fra
mondo fisico e mondo
psicologico.”**

sensibilità = “quanto bene” un meccanismo percettivo è in grado di elaborare l’informazione negli stimoli



capacità/efficienza discriminativa

soglia differenziale = minimo incremento nell’energia fisica di uno stimolo in grado di produrre sistematicamente un cambiamento nella percezione

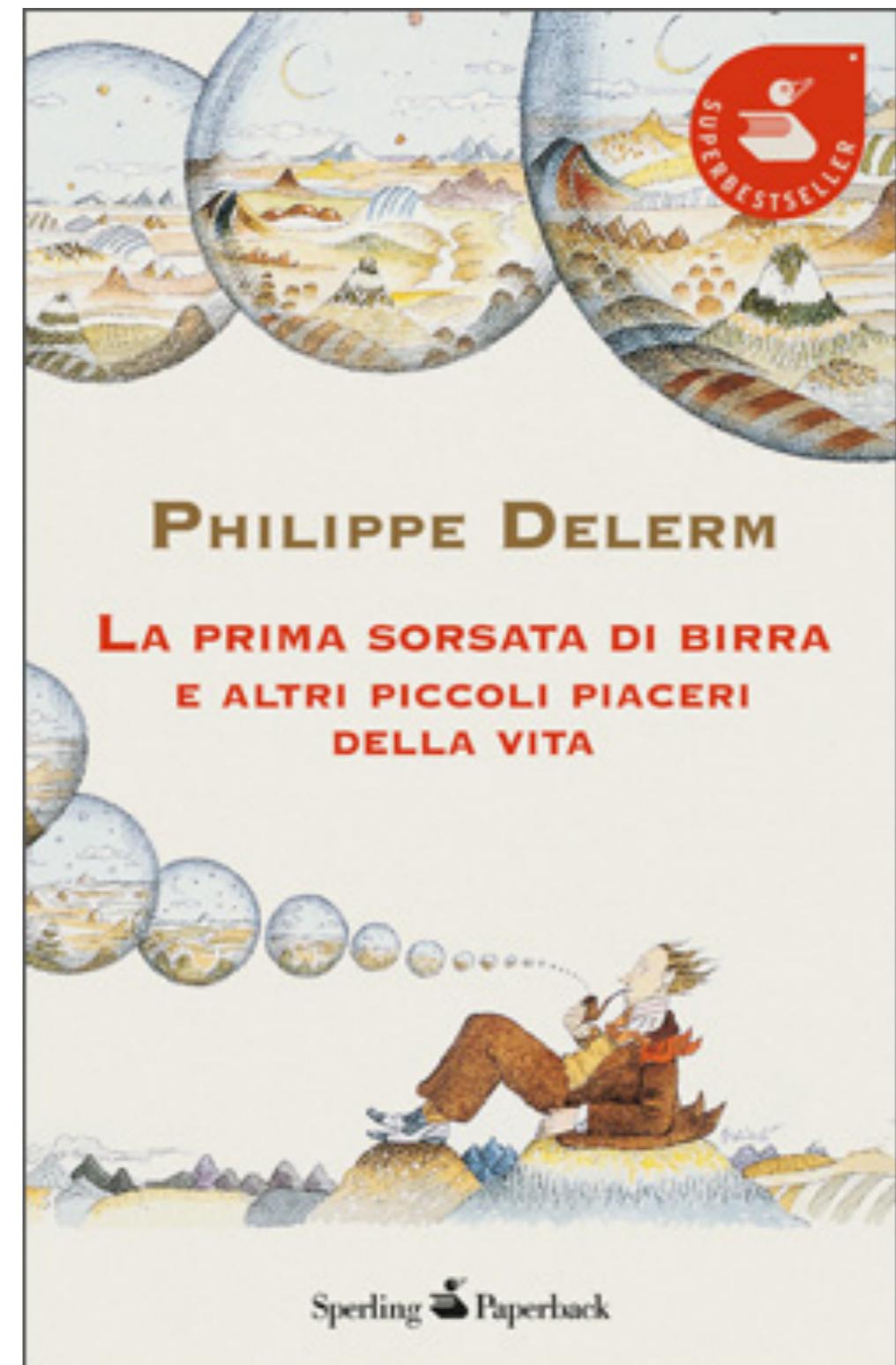
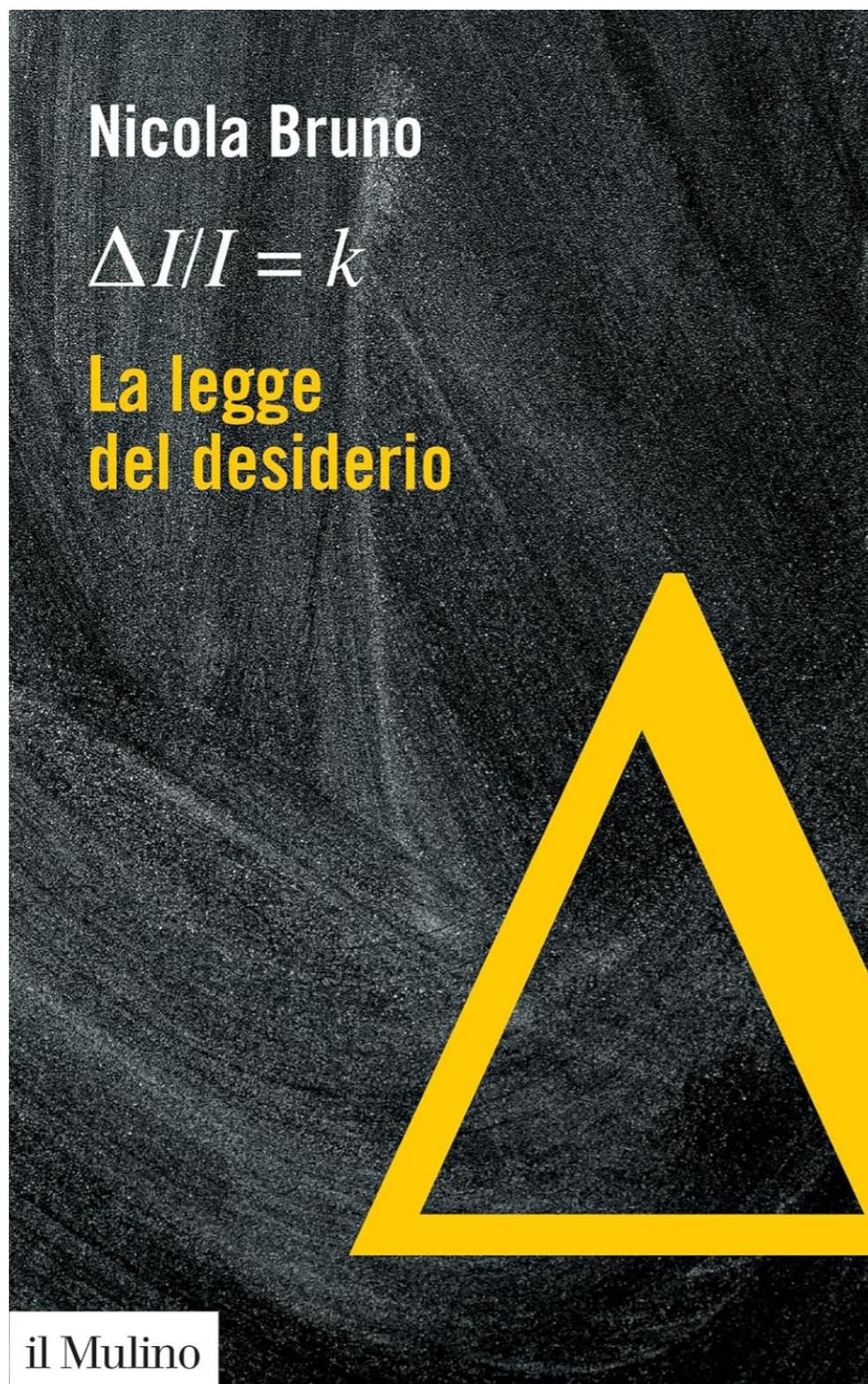


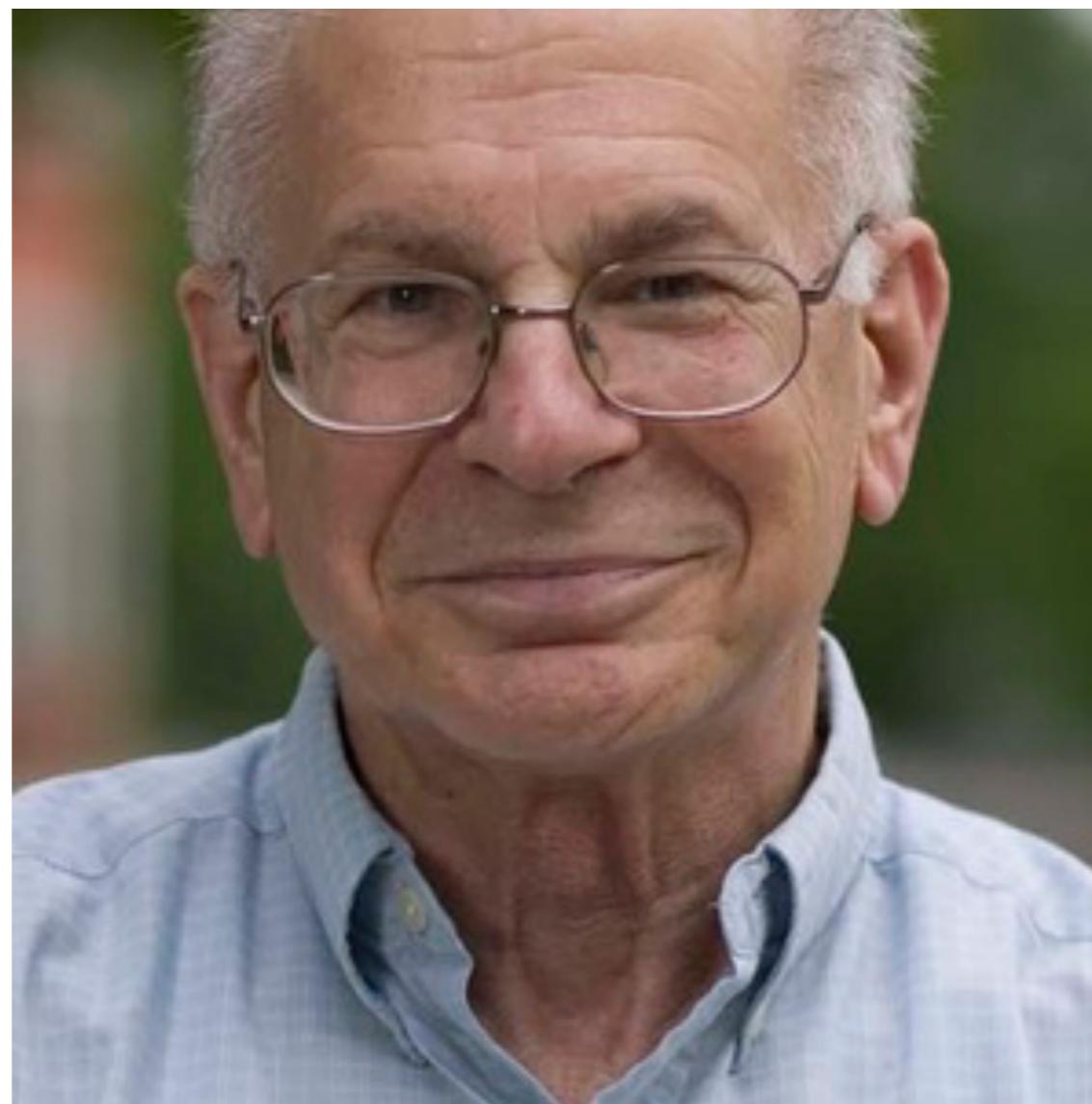
reciproco della sensibilità



**Ernst H.
Weber
(1795-1878)**

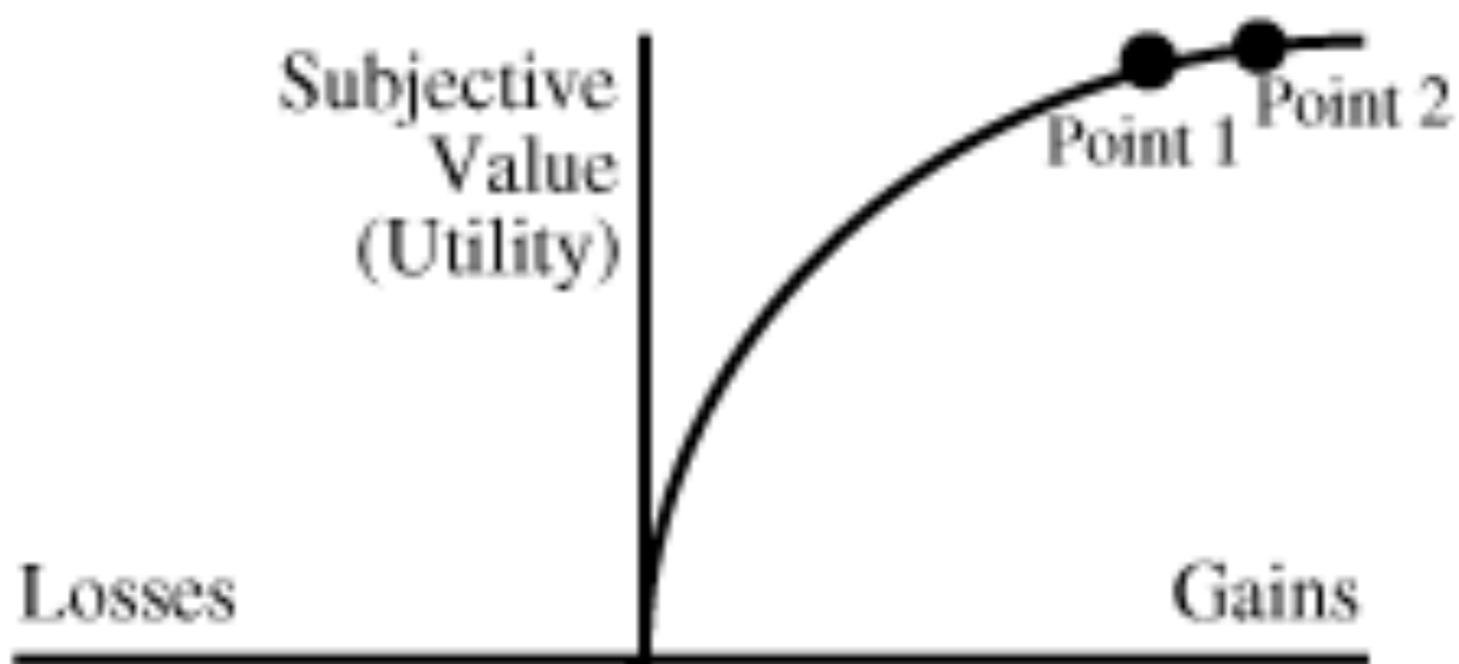
**secondo
wikipedia, il
fondatore della
psicologia
sperimentale**



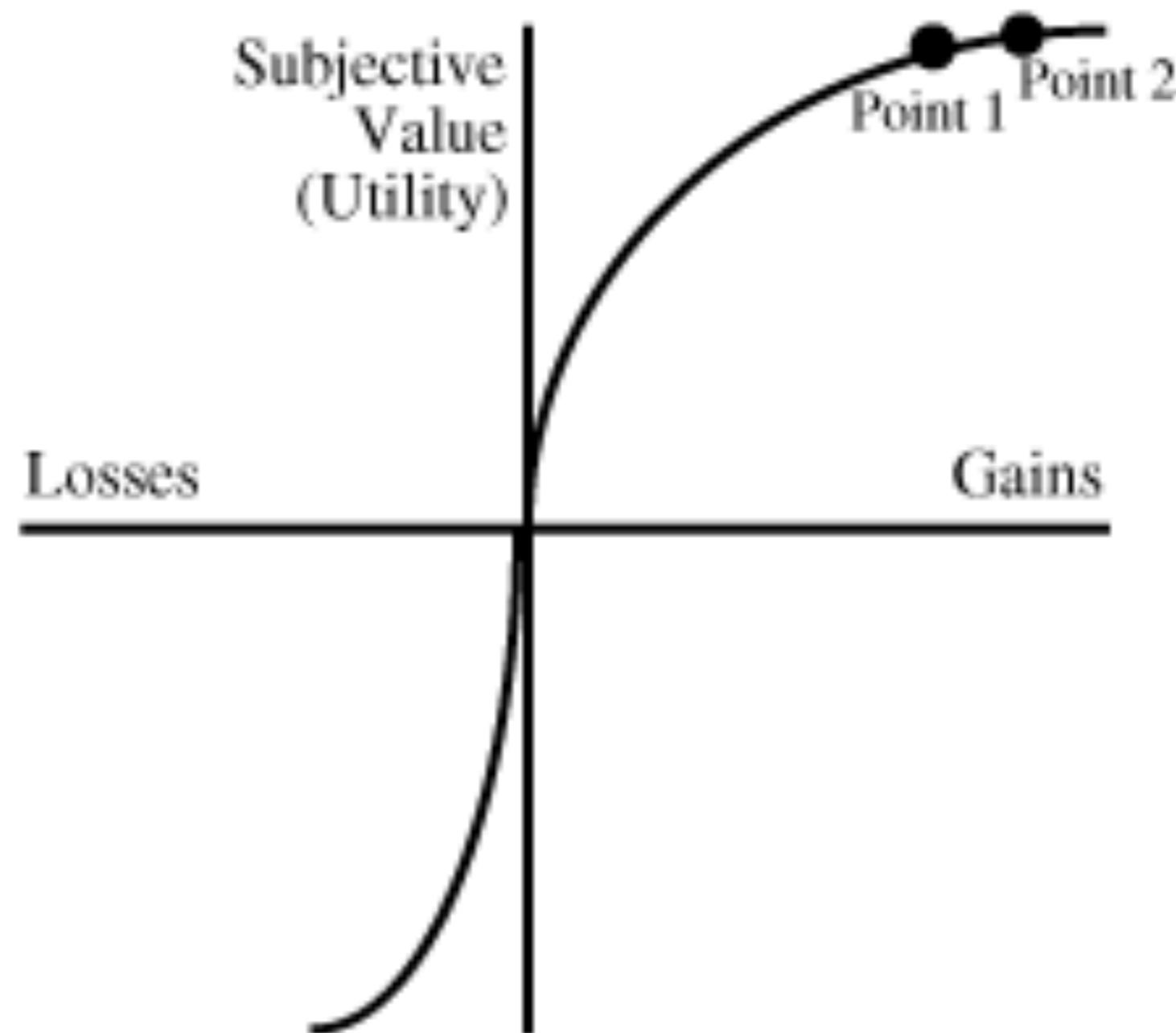


Daniel Kahneman
Nobel per l'economia (2002)

Kahneman & Tversky

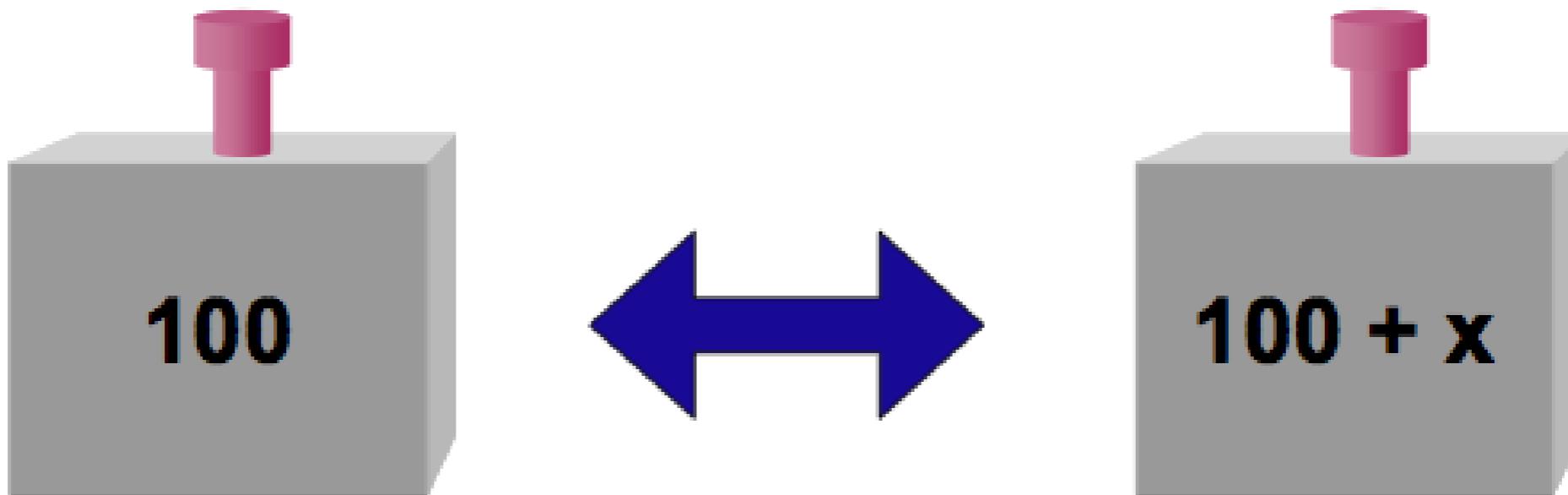


Kahneman & Tversky





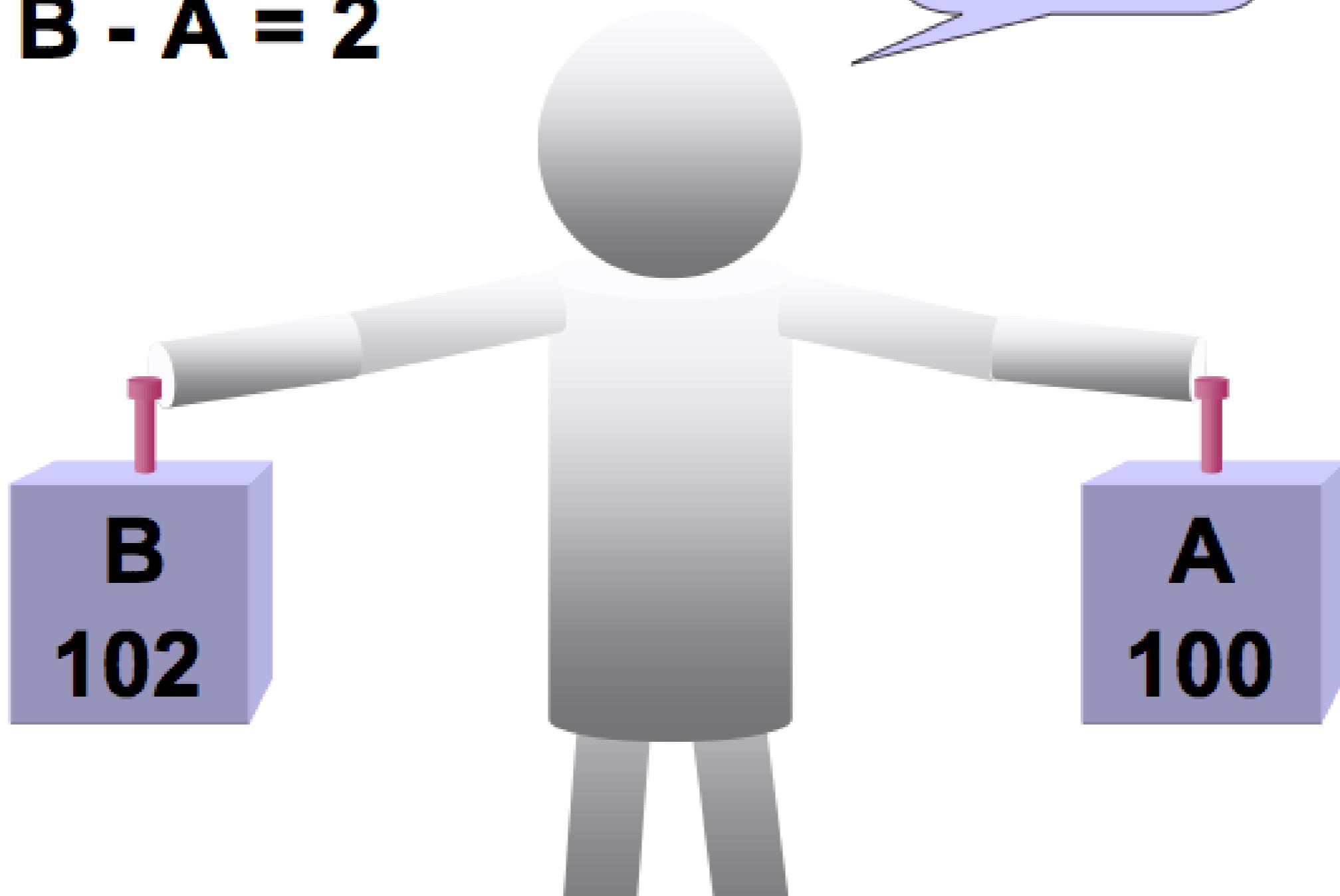
le osservazioni di Weber



x?

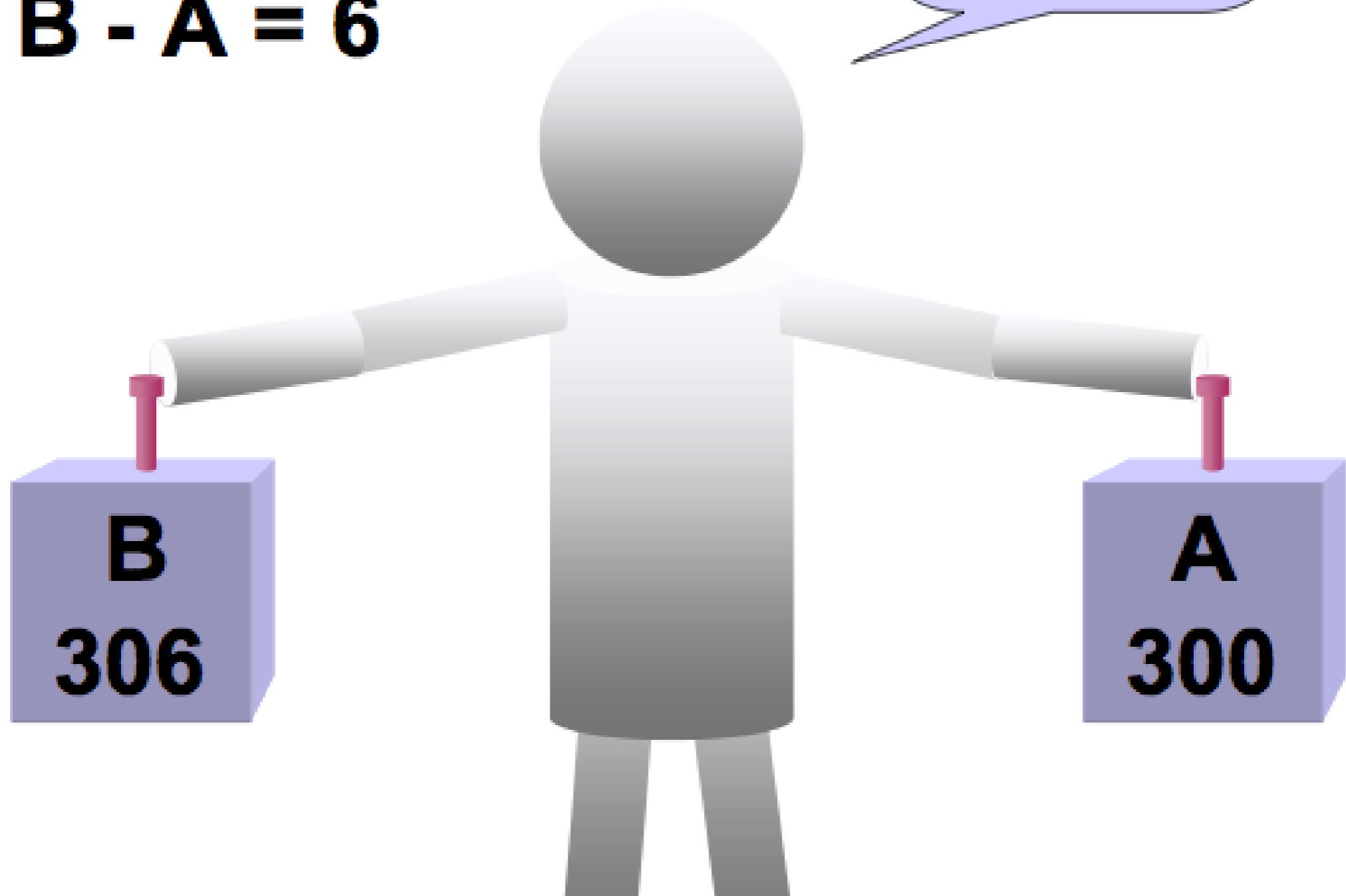
B > A

→ **B - A = 2**



$$\rightarrow B - A = 6$$

B > A



generalizzazione empirica (“legge”)

$$\frac{2}{100} = \frac{6}{300} = \frac{\Delta I}{I} = k$$

frazione di Weber per il peso → 0,02

legge di Weber

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

ΔI : minimo incremento discriminabile

I : intensità di riferimento

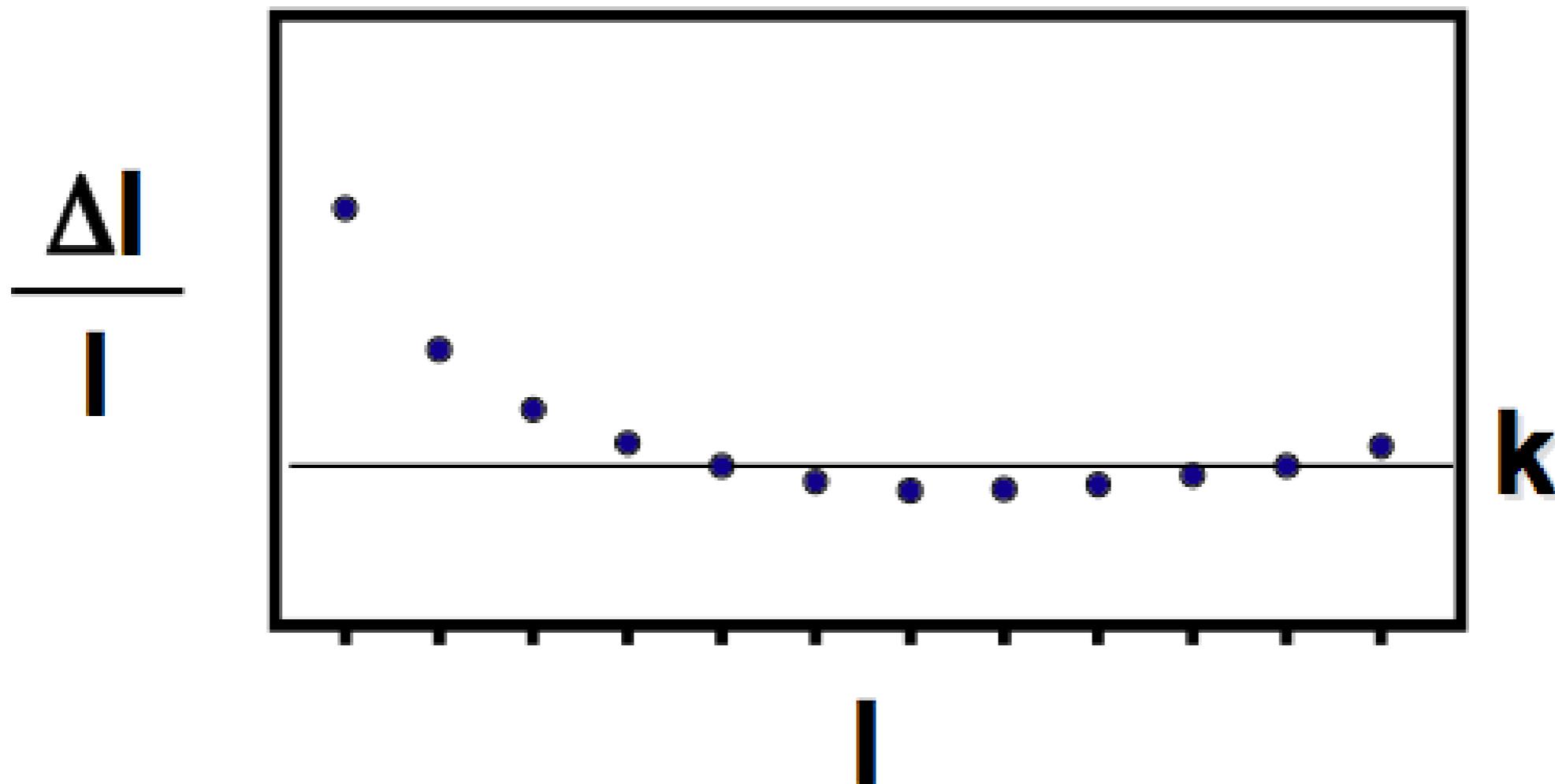
k : costante specifica per la modalità

legge di Weber in italiano

**la sensibilità di un sistema sensoriale
è inversamente proporzionale
all'intensità dello stimolo di
riferimento**

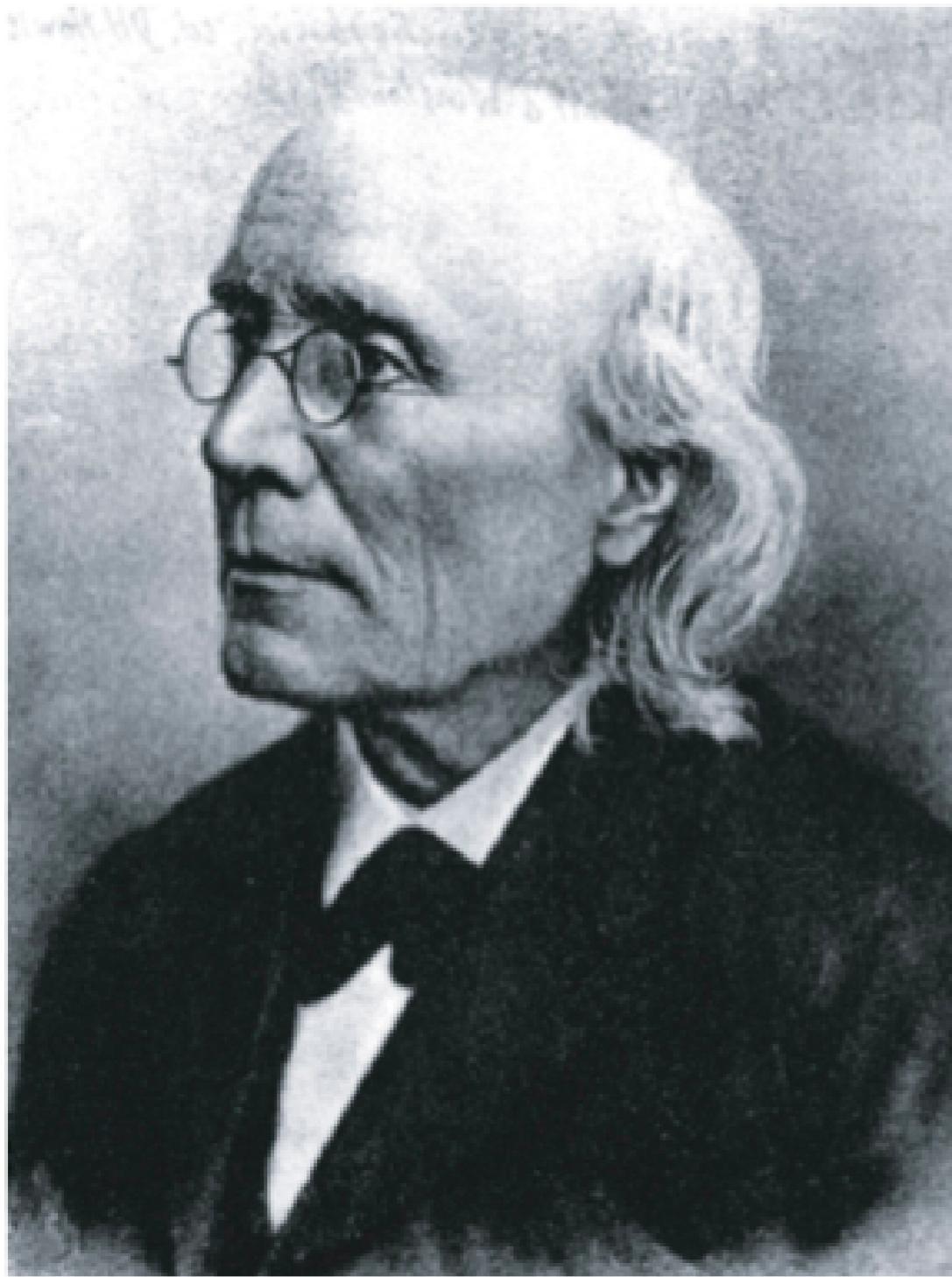
**infatti, la soglia è direttamente
proporzionale all'intensità, e la
sensibilità è $1 / \text{soglia}$**

**approssimativamente
valida per intensità
intermedie**



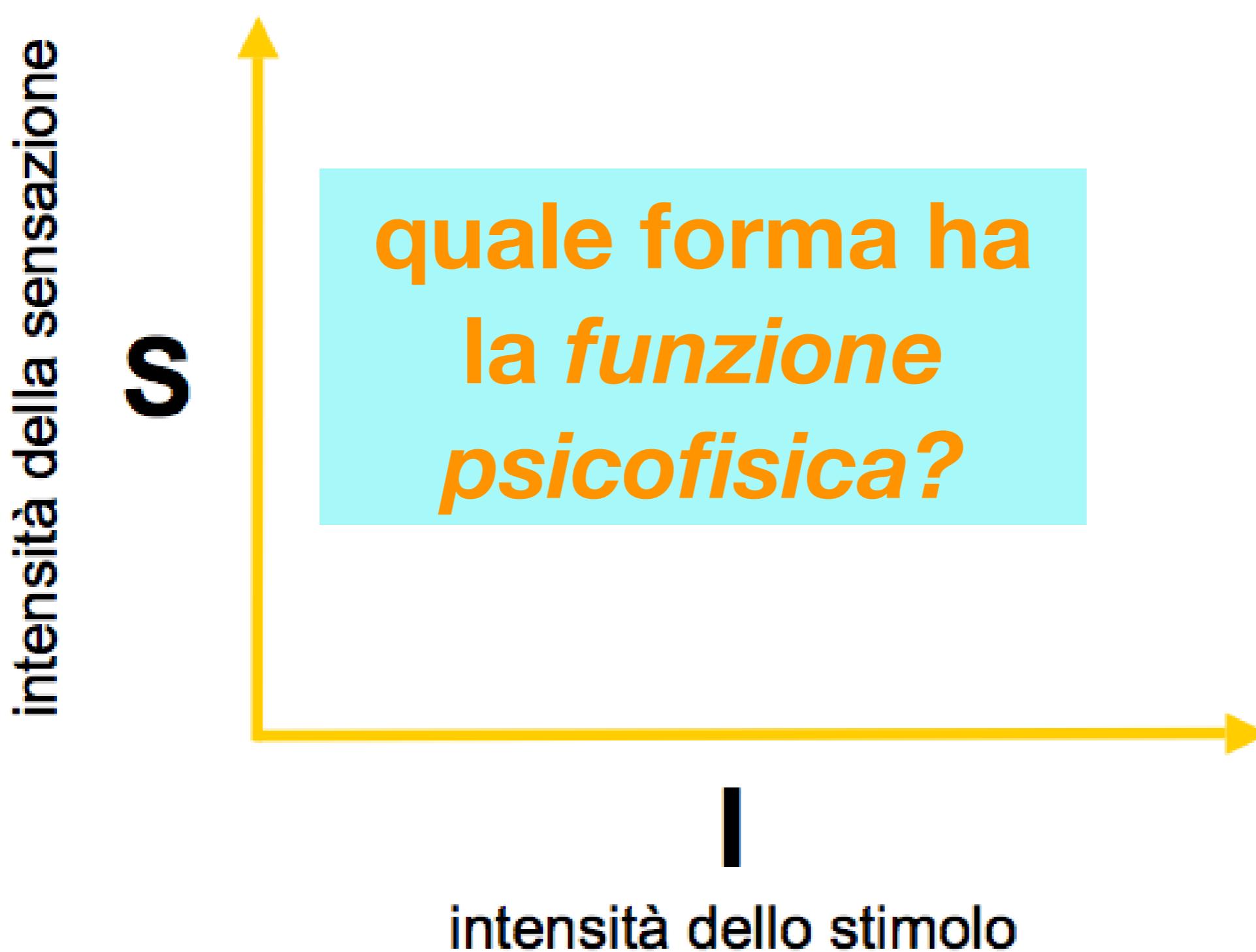
Lezione 11-12

Psicofisica 2: funzione di Weber- Fechner e metodi di Fechner



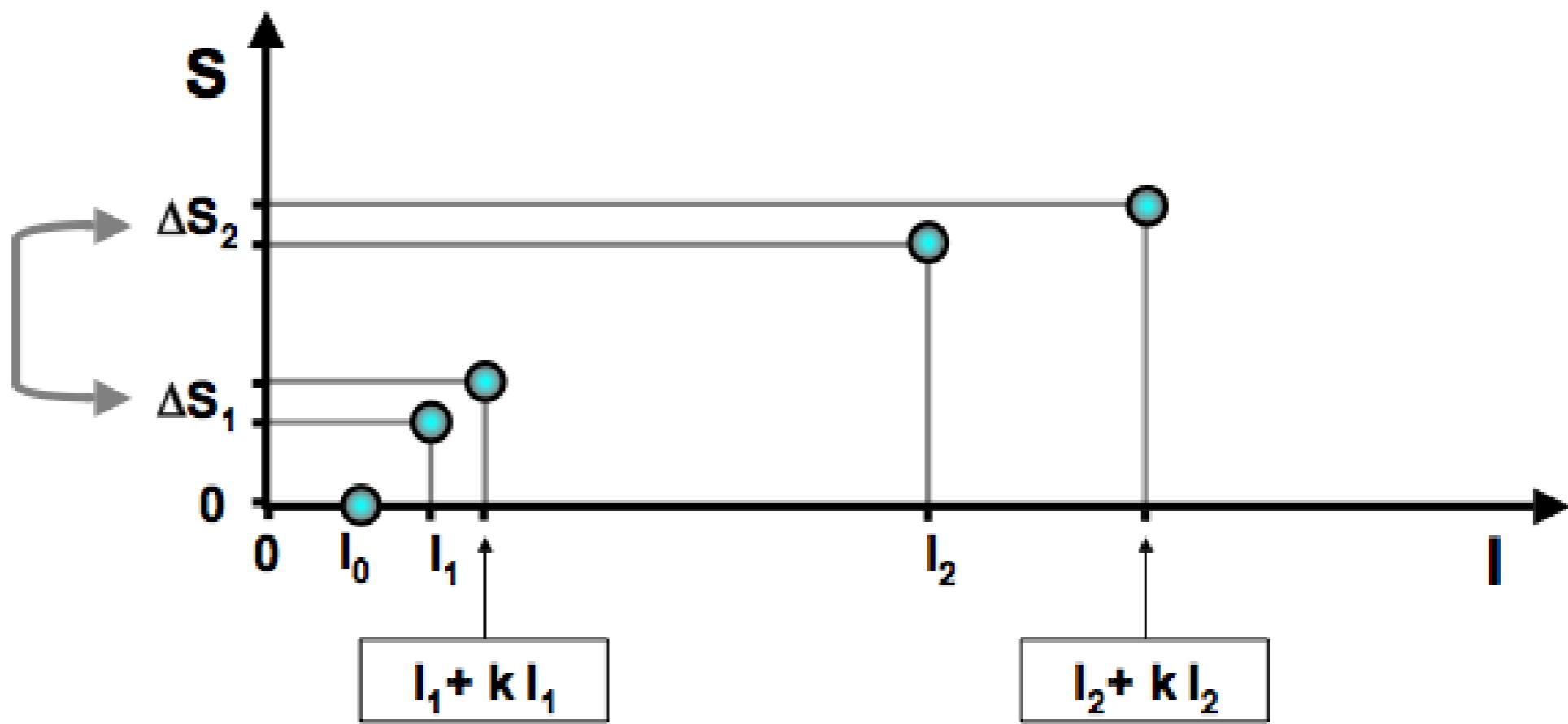
Gustav T. Fechner (1801-1887)

il problema di Fechner



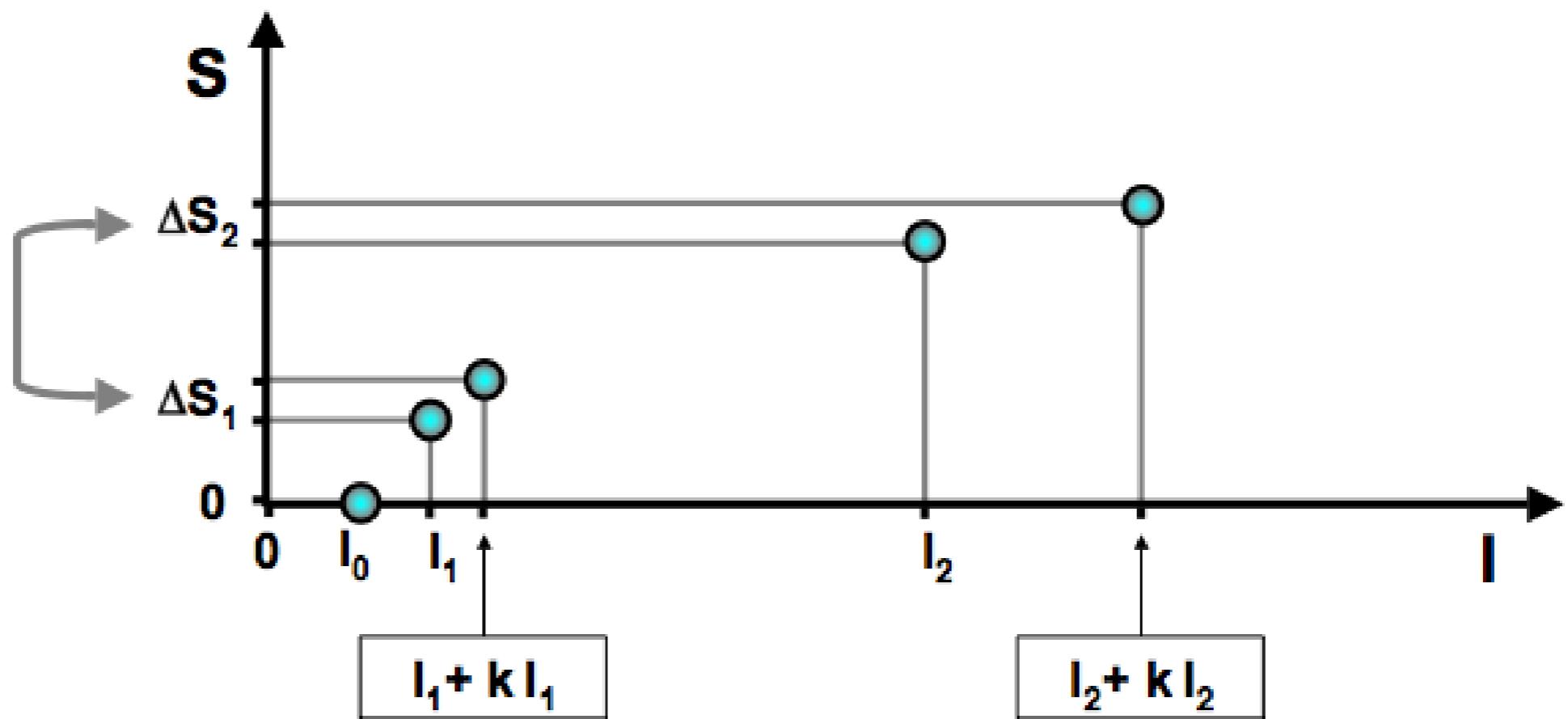
la soluzione

incrementi uguali
(in unità percepite)



jnd crescenti
(in unità fisiche)

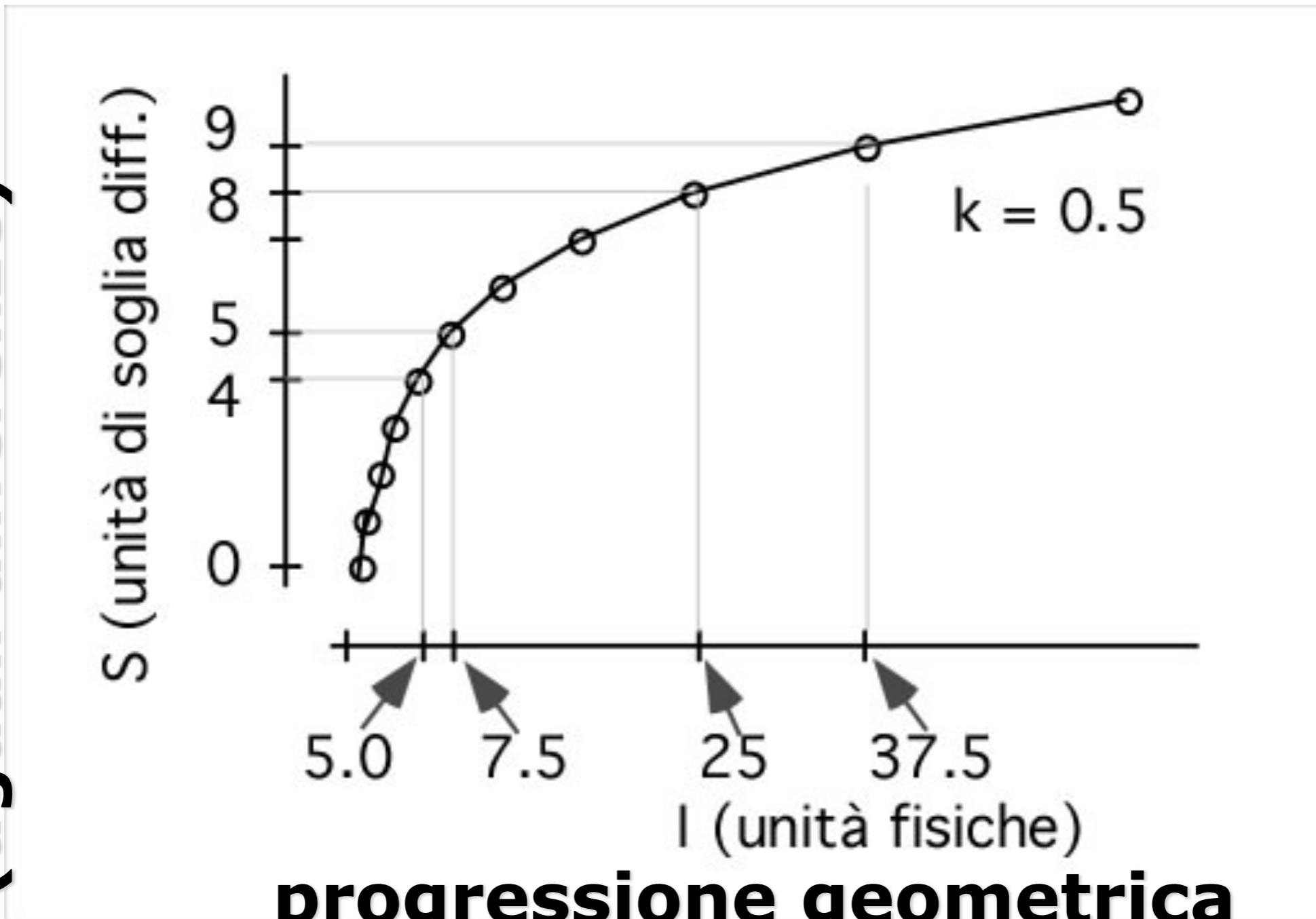
la soluzione



progressione geometrica
(uguali rapporti)

funzione di Weber-Fechner $k = 0.5$

**progressione aritmetica
(uguali differenze)**



**progressione geometrica
(uguali rapporti)**

“legge” di Weber-Fechner

$$S = c \log(I)$$

**I’intensità percepita è proporzionale
al logaritmo dell’intensità fisica
dello stimolo**

c è la costante di proporzionalità
 $c = 1 / \log(1 + k)$

da Weber a Fechner

$$ds = c \, dI / I$$

l'incremento ΔI (Weber) viene interpretato come un incremento infinitesimo dI , "piccolo a piacere", nello stimolo fisico I , a cui corrisponde un incremento infinitesimo ds in una quantità psicologica s , la *sensazione*.

da Weber a Fechner

$$ds = c \, dI / I$$

integrandando entrambi i membri si ottiene

$$s = c \log(I) + C$$

da Weber a Fechner

$$s = c \log(I) + C$$

per trovare C, poniamo I = soglia assoluta

$$C = -c \log(I_0)$$

da Weber a Fechner

$$S = c \log(I) + C$$

$$C = -c \log(I_0)$$

$$S = c \log(I) - c \log(I_0)$$

da Weber a Fechner

$$s = c \log(I) - c \log(I_0)$$

$$s = c [\log(I) - \log(I_0)]$$

$$s = c \log(I/I_0)$$



espressione formale della legge di W-F

da Weber a Fechner

$$s = c \log(I/I_0)$$

ponendo soglia assoluta = 1

$$s = c \log(I)$$



espressione abituale della legge di W-F

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

Weber

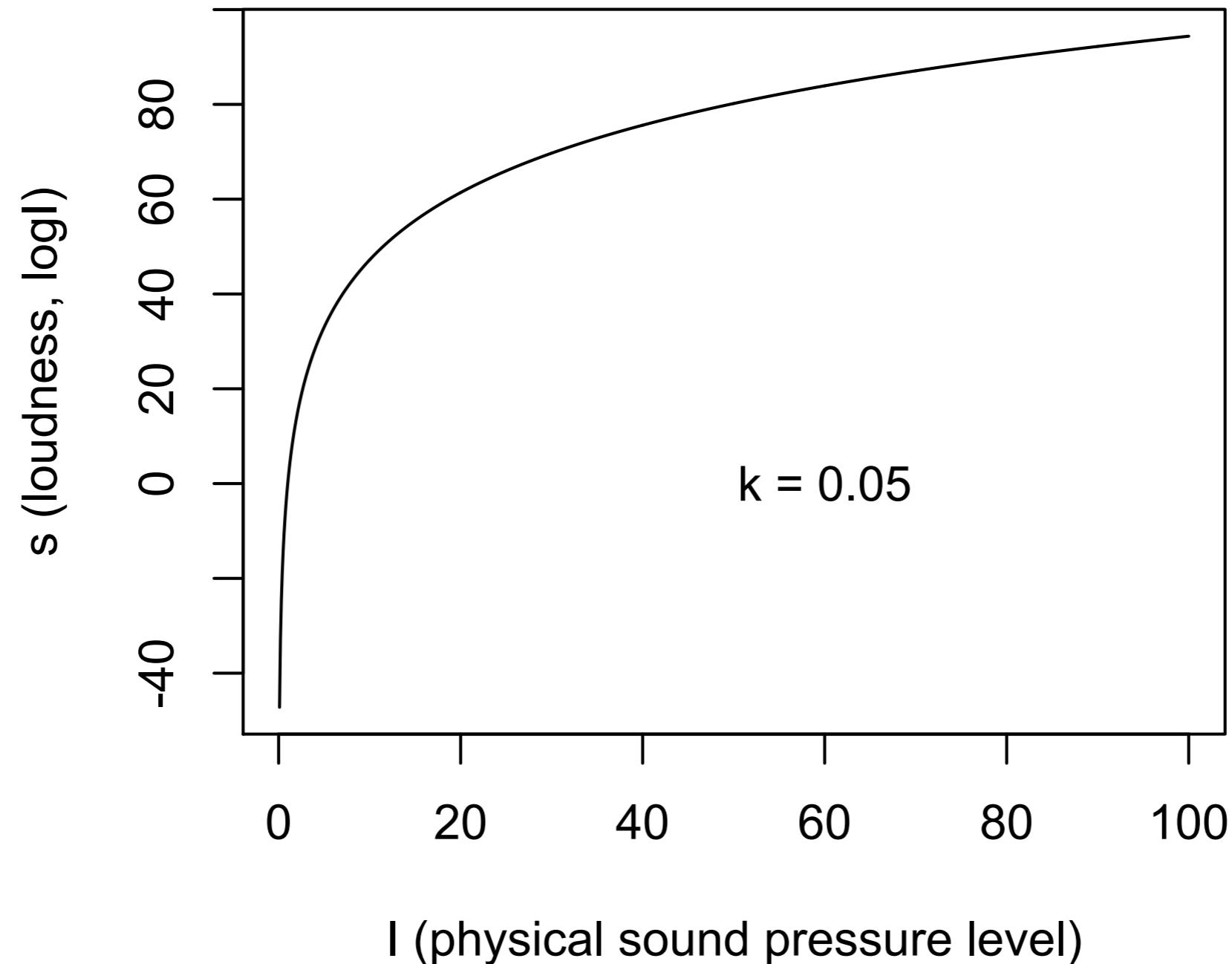
$$s = c \log(I/I_0)$$

Fechner

$$s = c \log(I)$$

Fechner*

***loudness* di un tono a 4 kHz**



scala dB

1 dB = 10 BEL

potenza = I

$$1 \text{ BEL} = \log_{10}\left(\frac{P}{P_0}\right)$$

$$1 \text{ dB} = 10 \log_{10}\left(\frac{P}{P_0}\right)$$

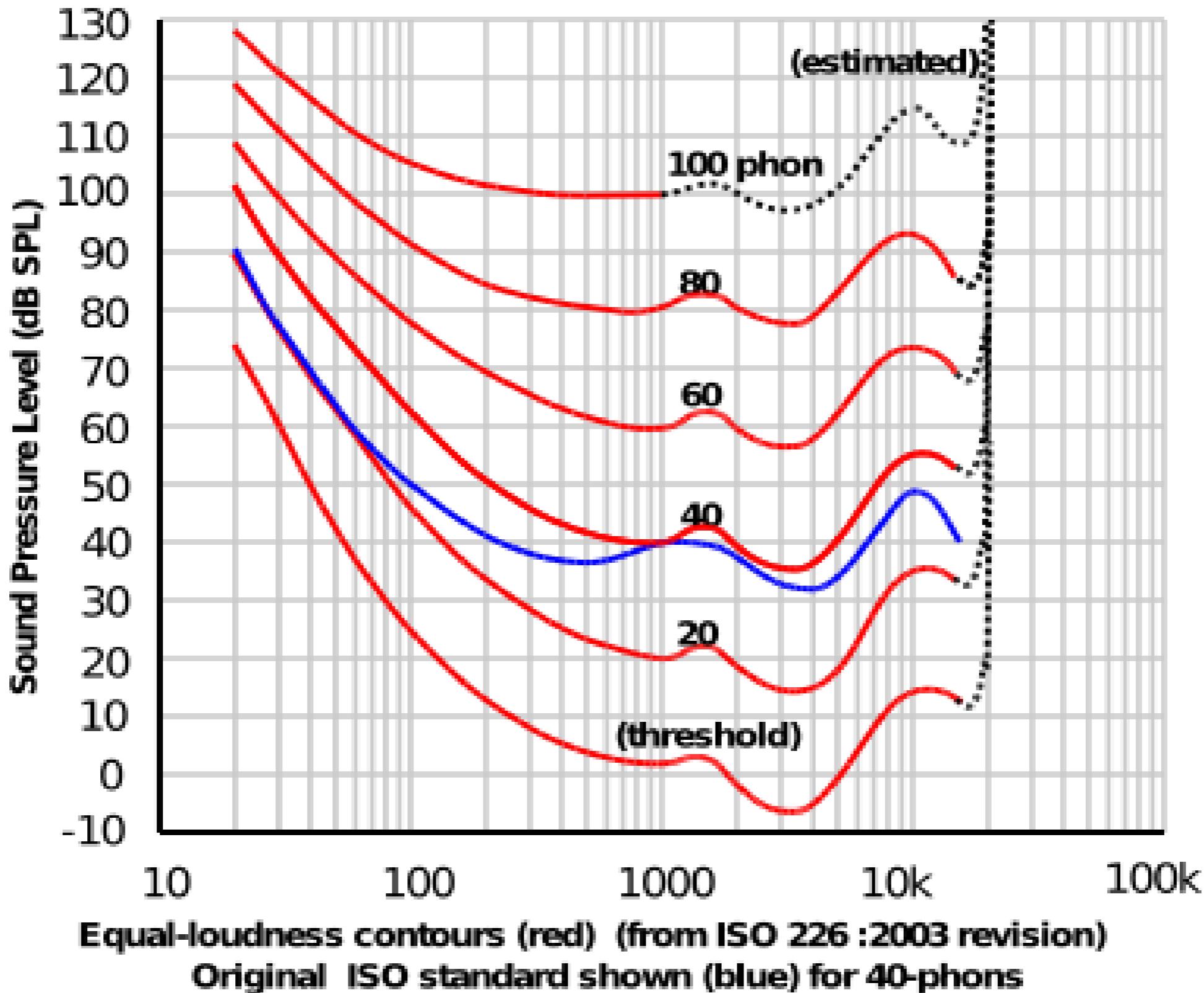
scala dB_{SPL}

riferita al *sound pressure level*

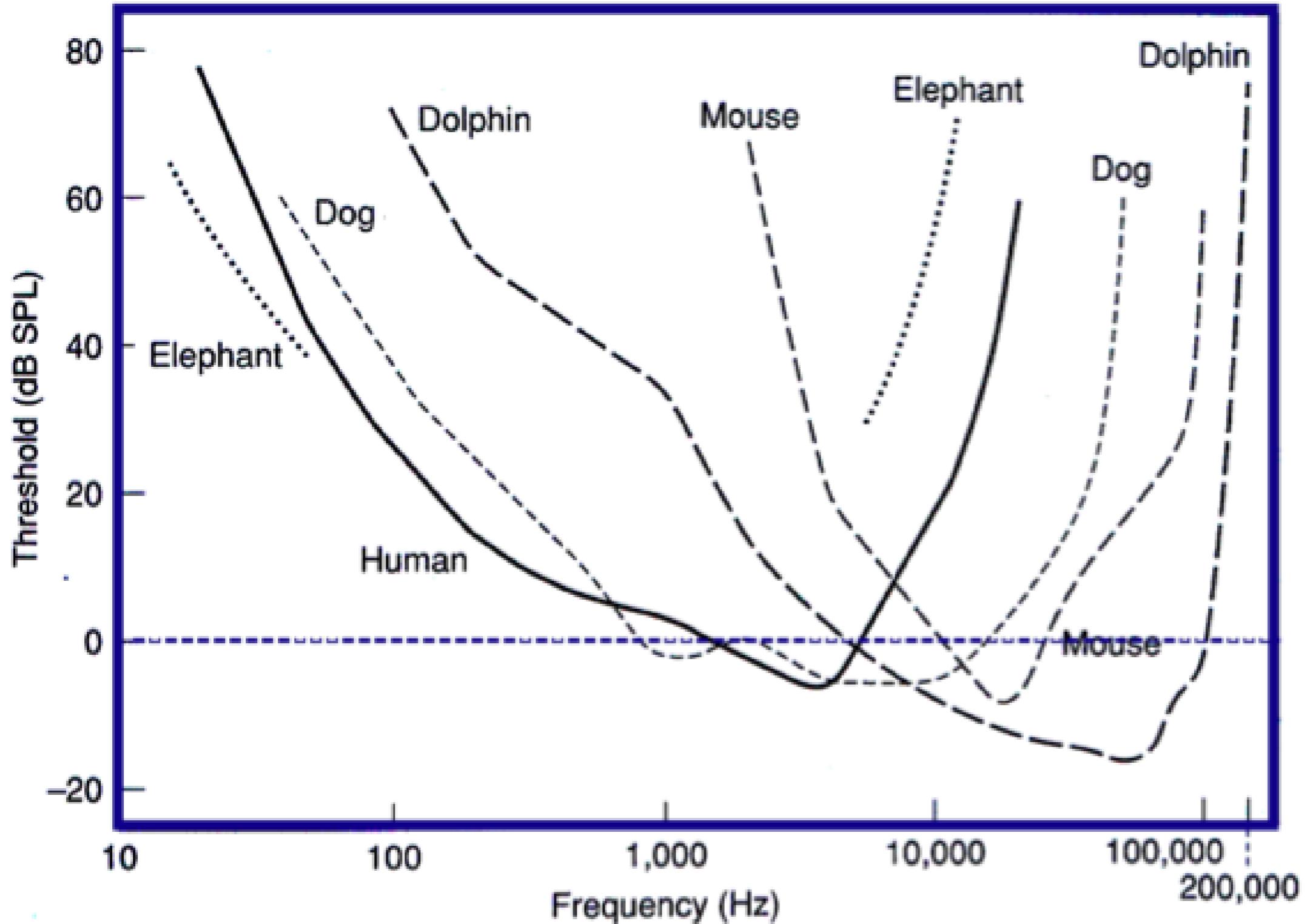
SPL = soglia assoluta

1 dB_{SPL} ≈ 1 j.n.d.

audiogrammi



curve di udibilità



metodi di Fechner

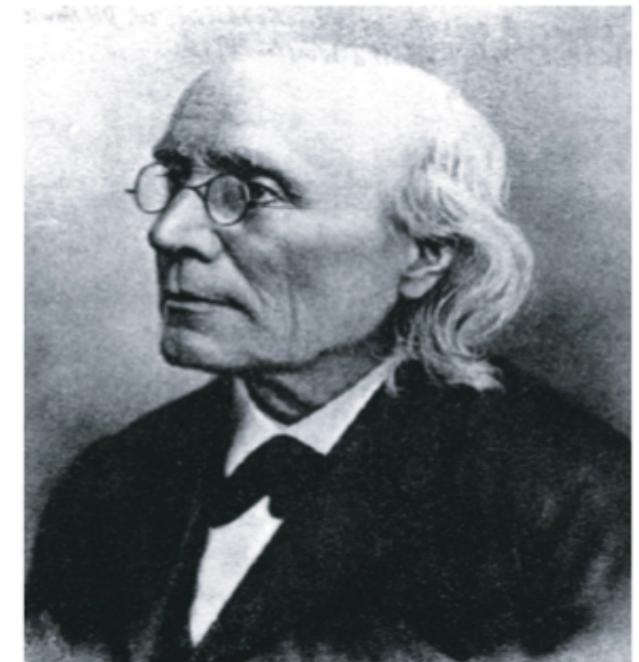
psicofisica “indiretta”

i) aggiustamento

ii) limiti

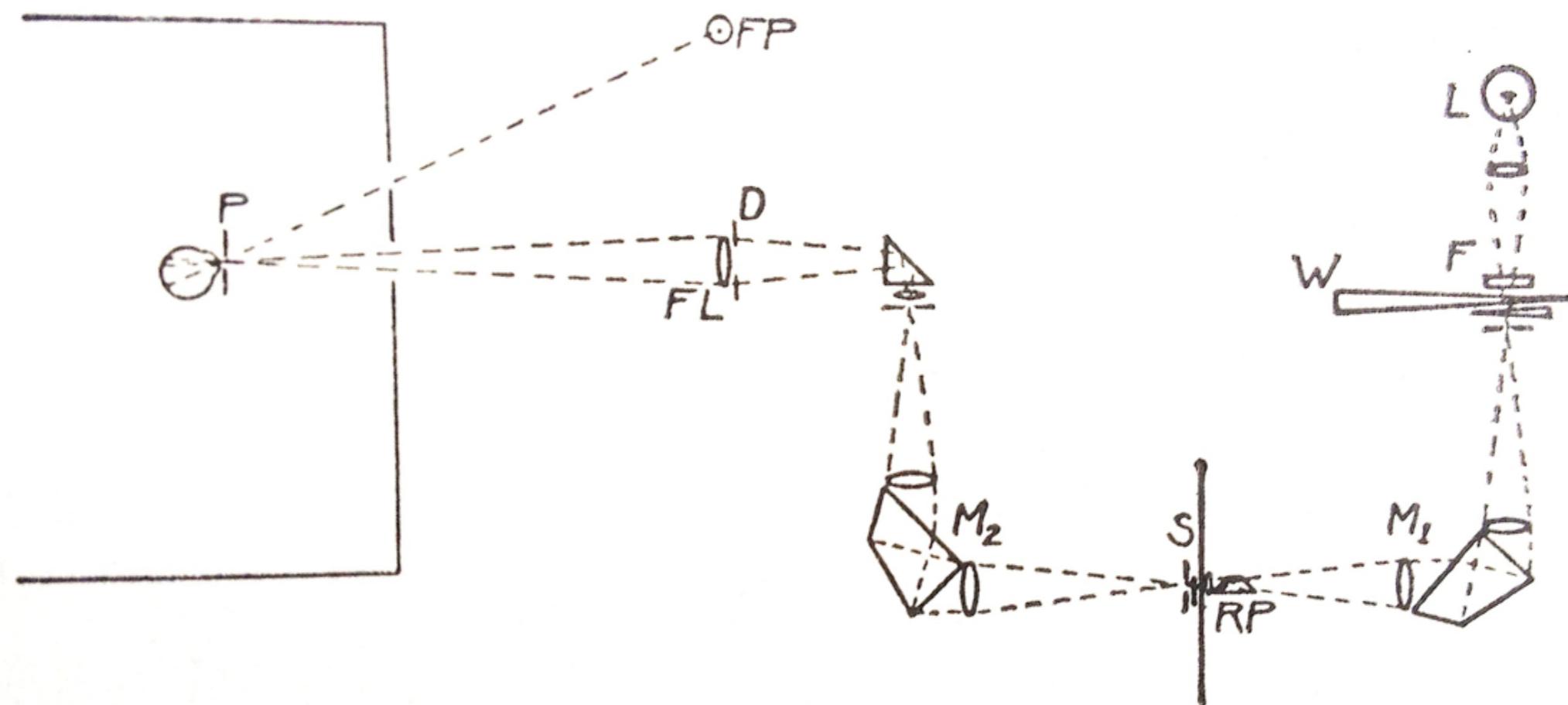
iii) stimoli costanti

**Gustav T.
Fechner
(1801-1887)**

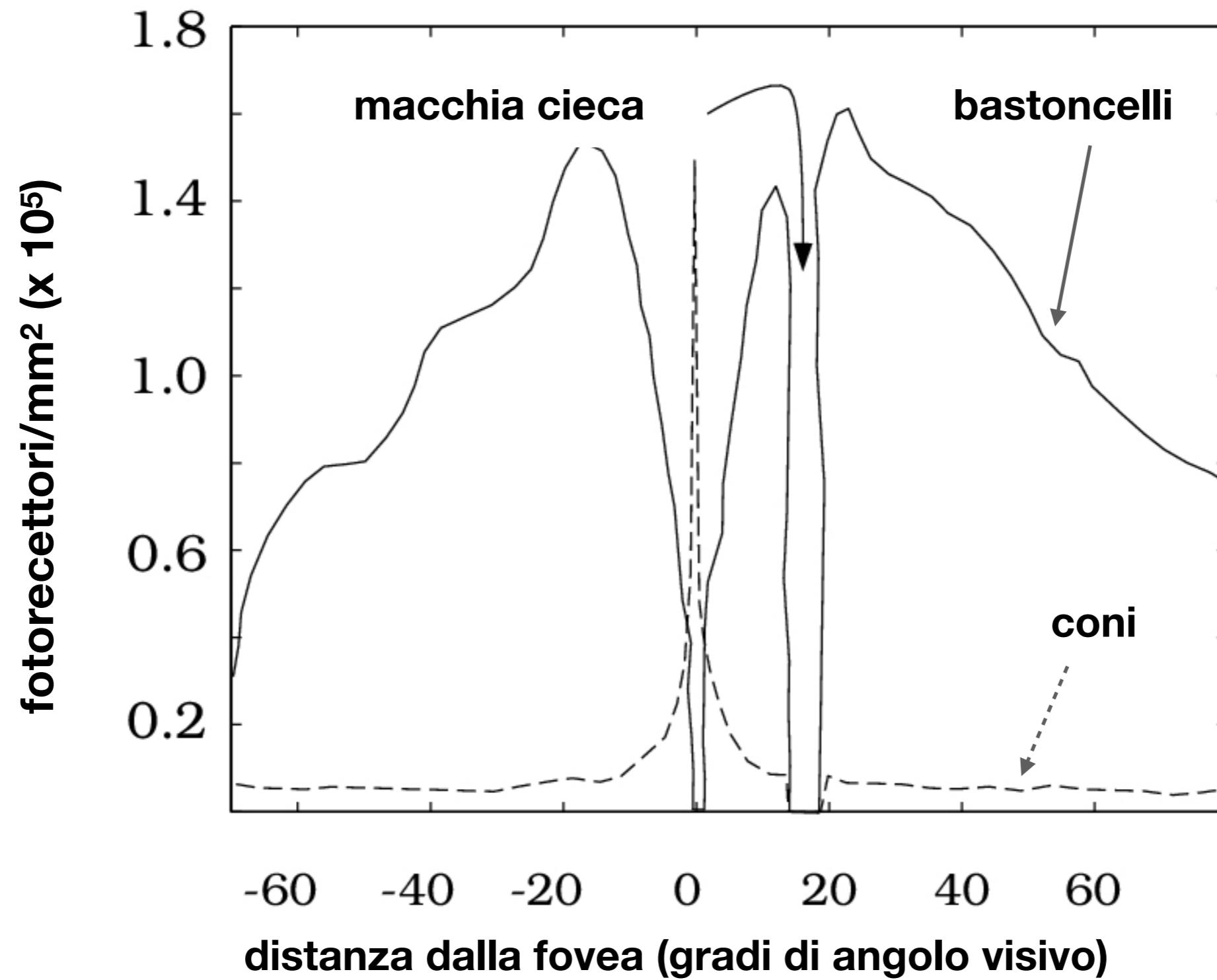


**metodo degli
stimoli costanti
con compito si-no**

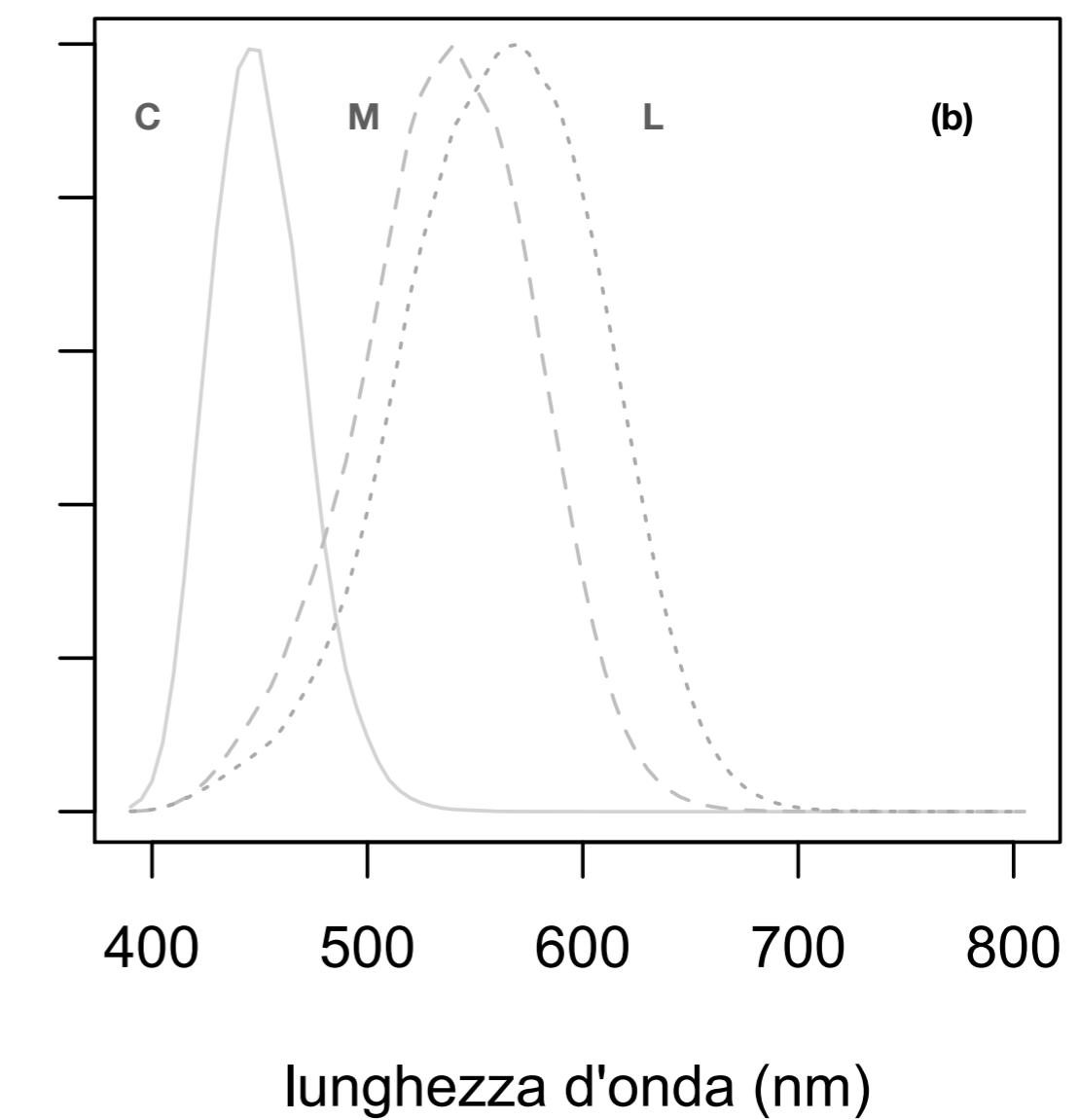
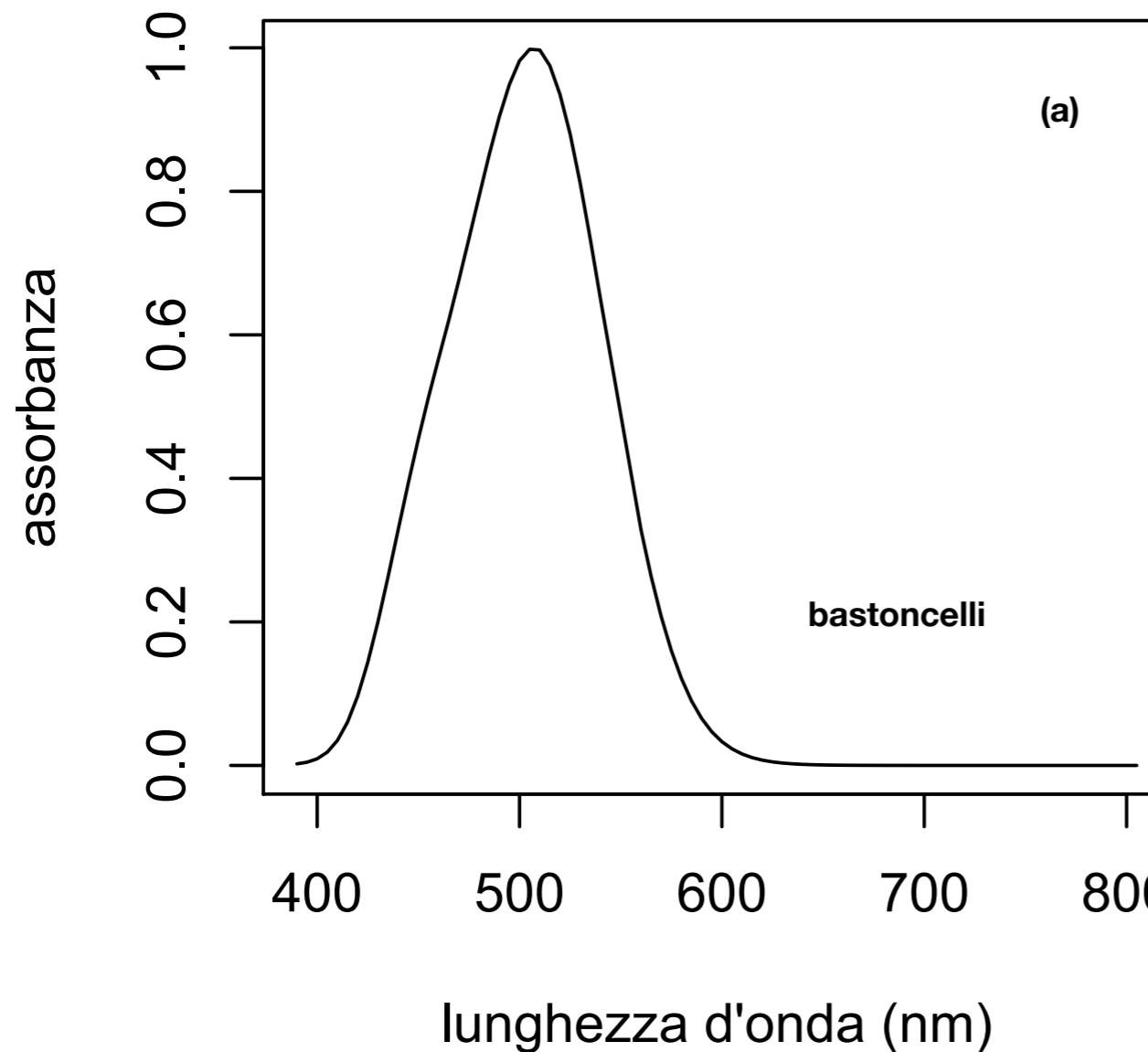
esperimento di Pirenne



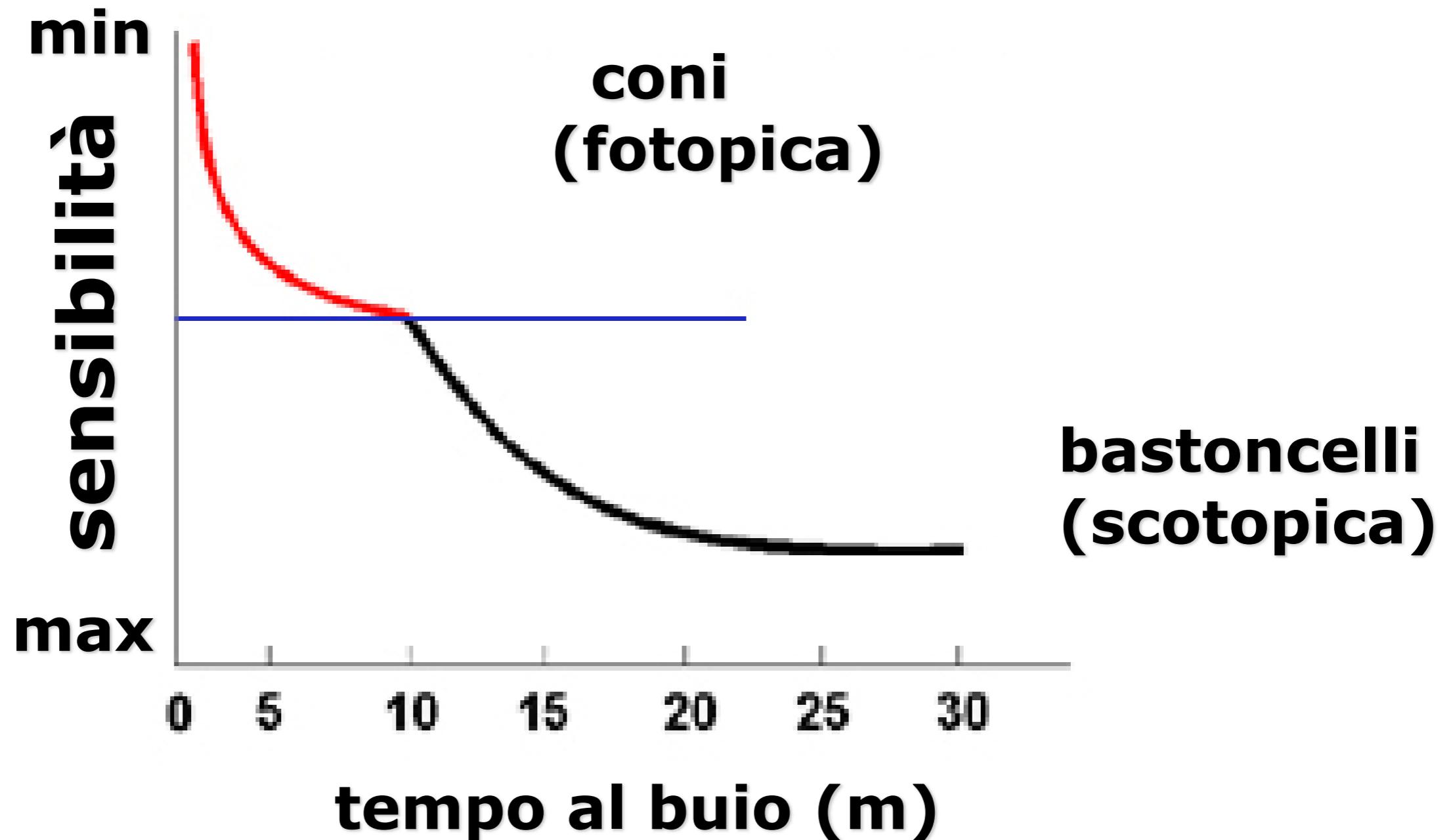
distribuzione sulla retina dei fotorecettori



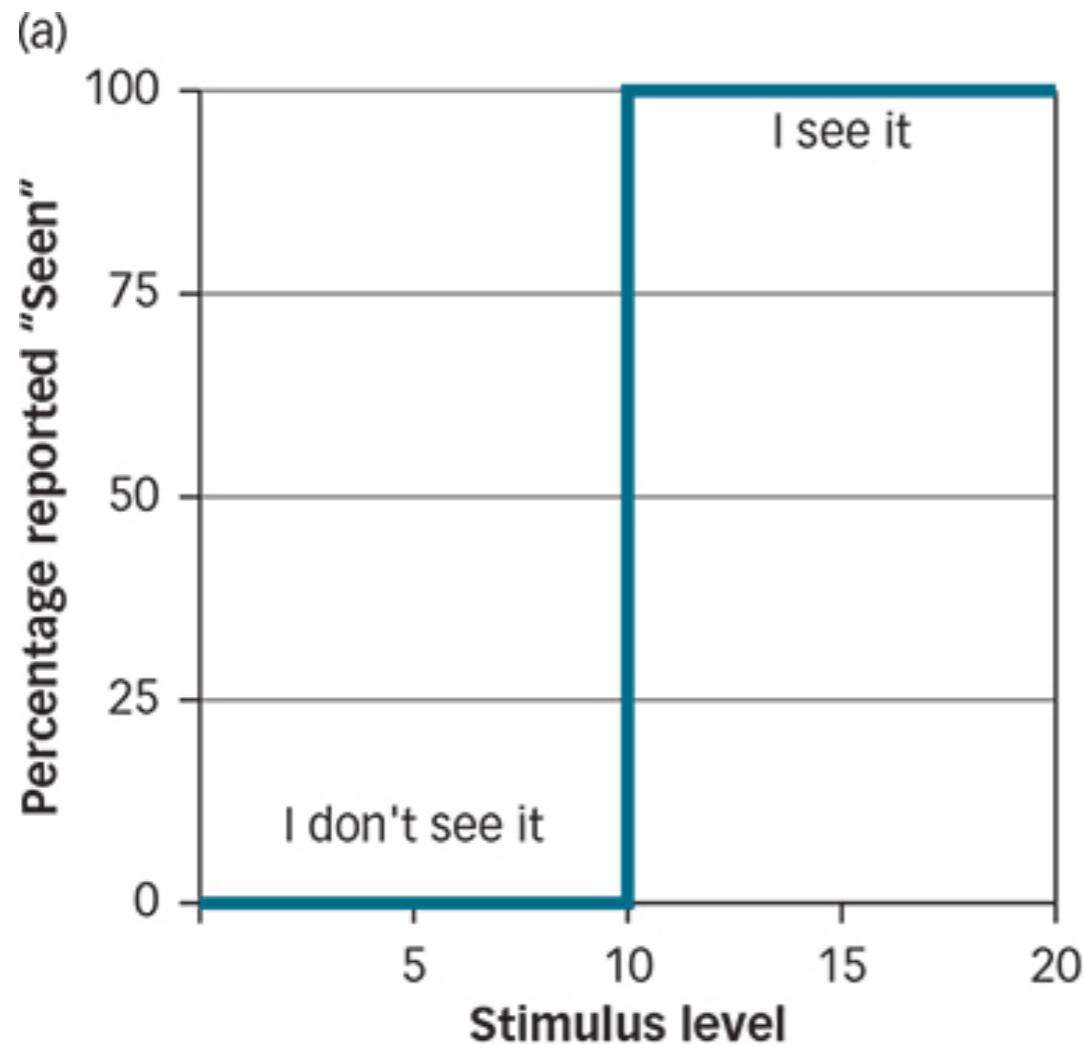
assorbanza spettrale dei fotorecettori



adattamento al buio

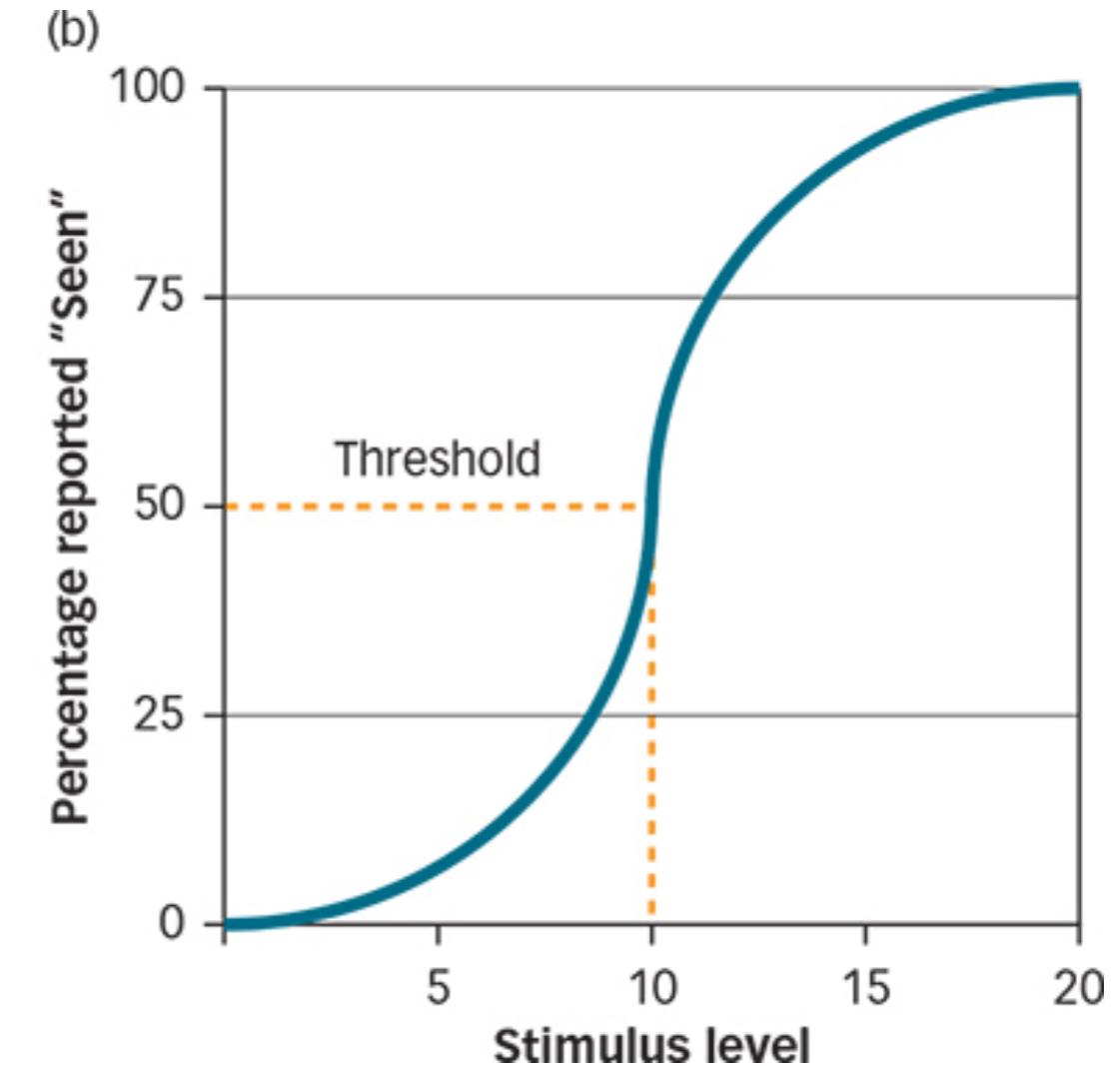
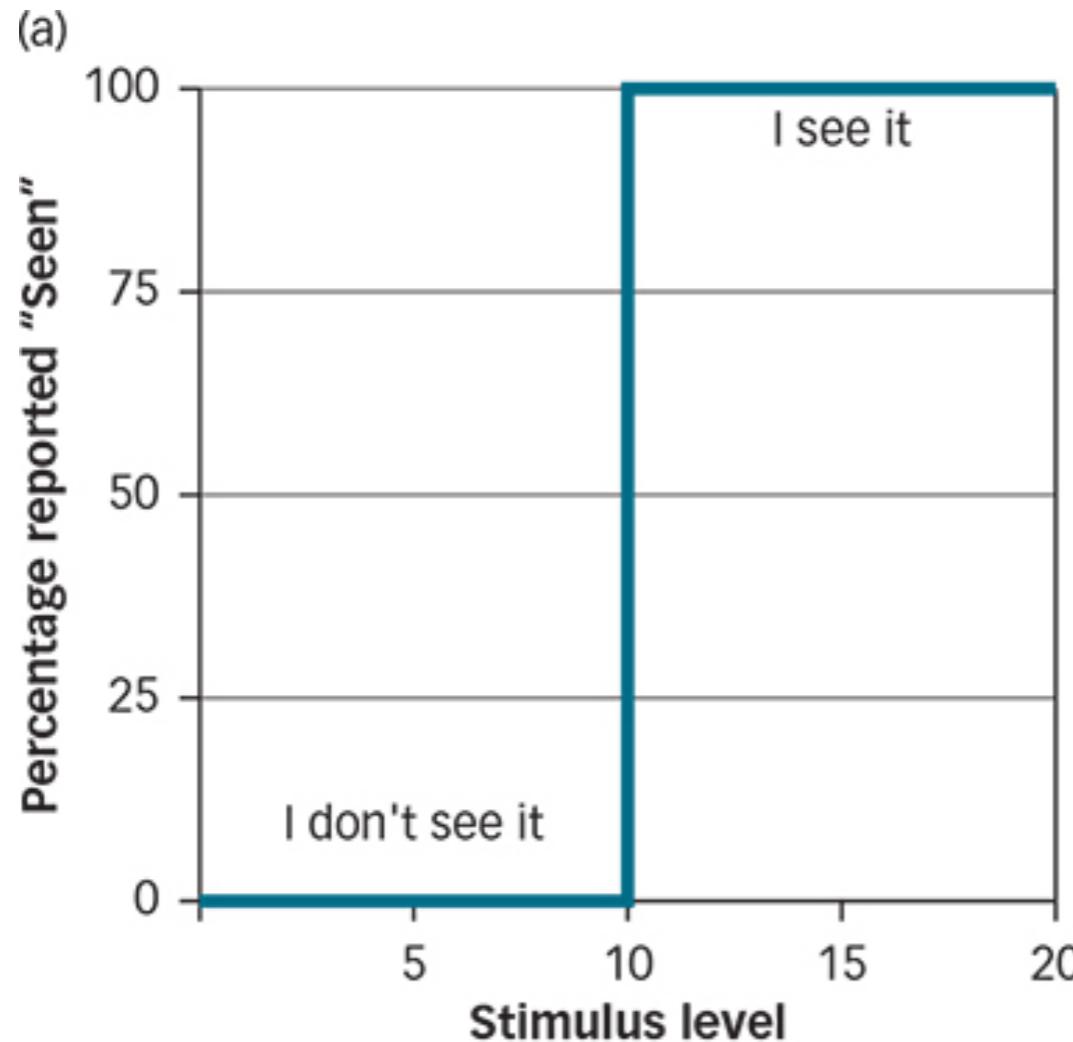


soglia ideale



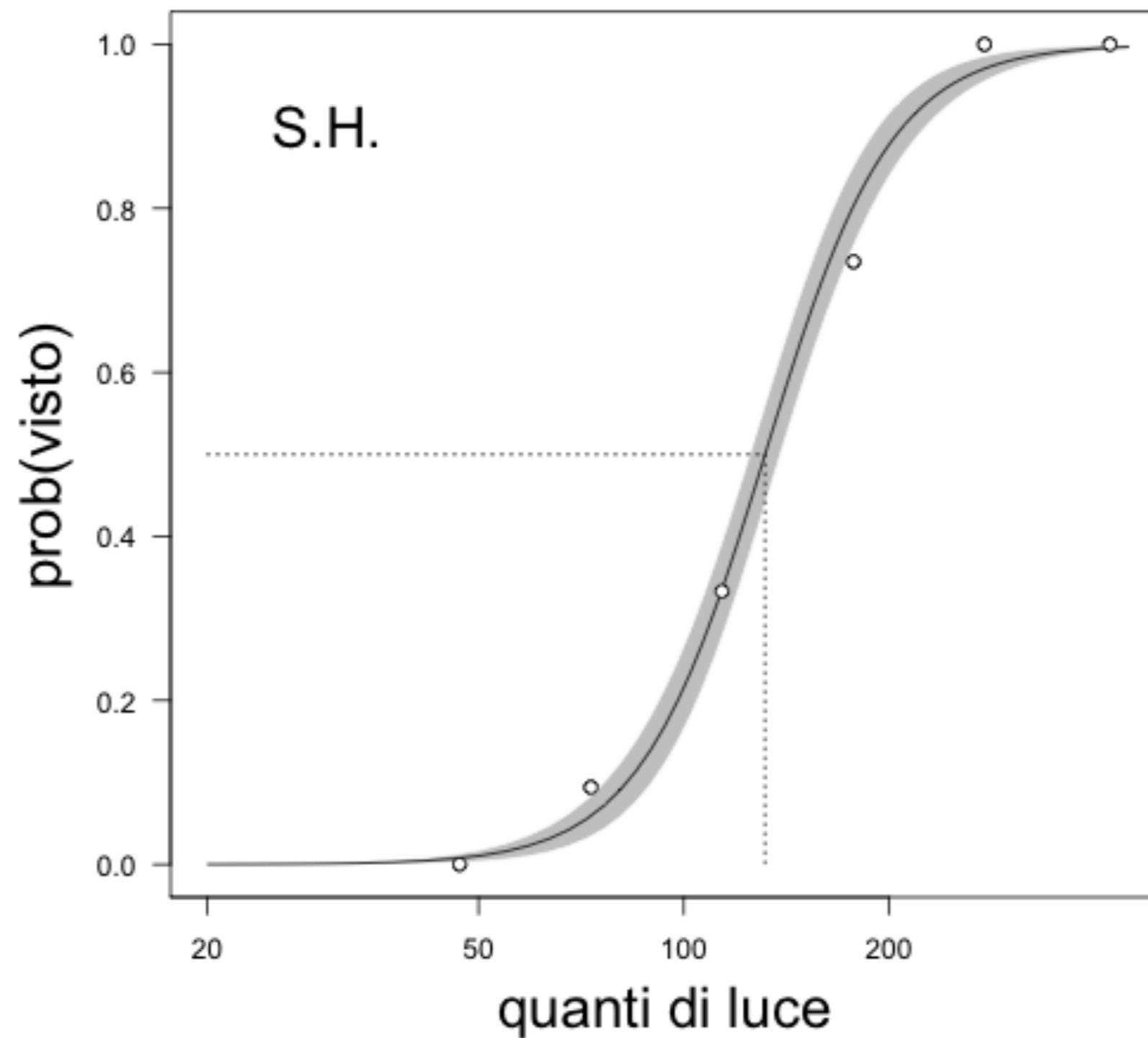
se fosse così sarebbe facile.....

soglia ideale e soglia reale



↑
se fosse così sarebbe facile.....

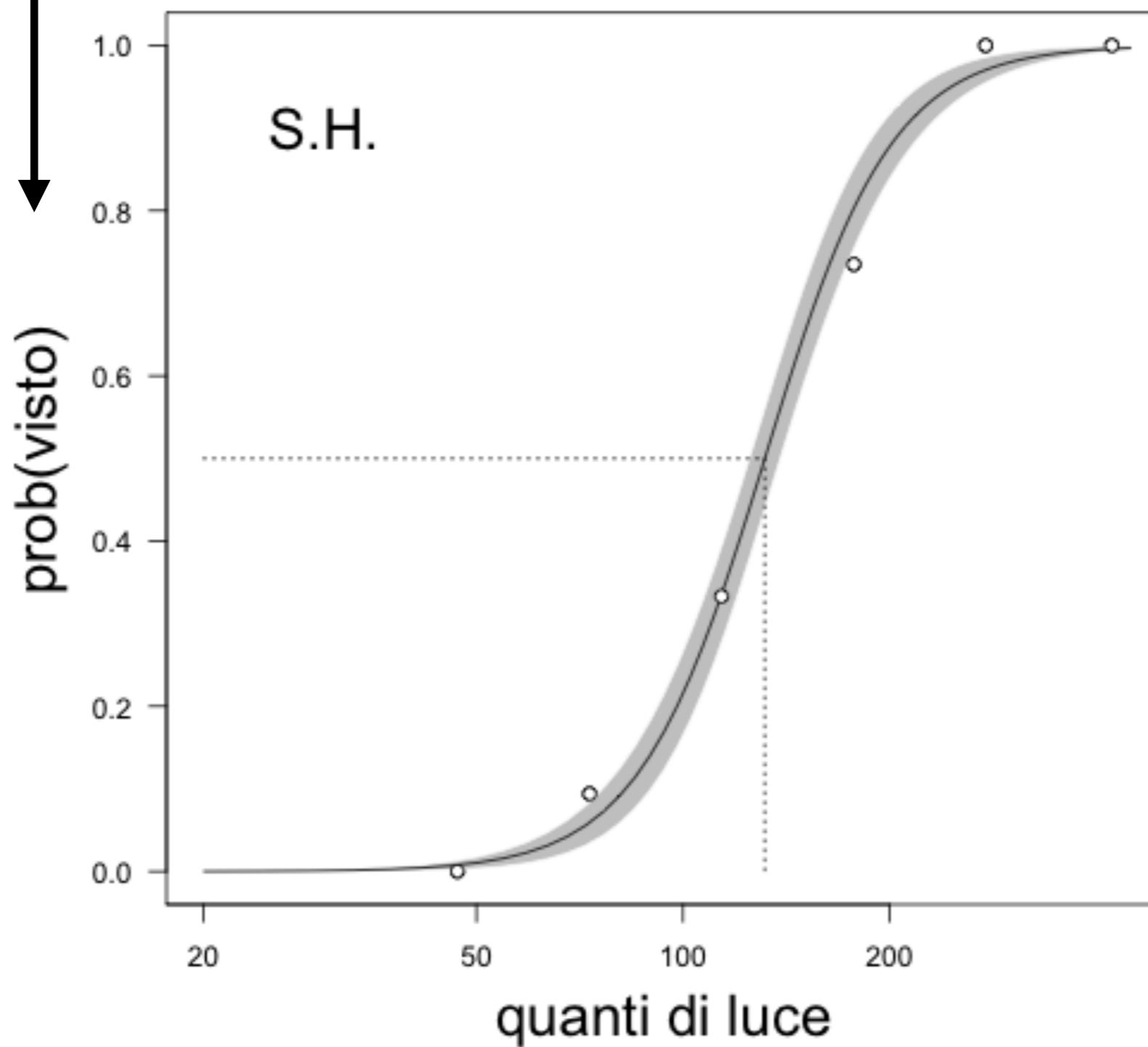
funzione psicometrica



Lezione 13-14

Psicofisica 3: altri metodi

metodo si-no



**metodo degli
stimoli costanti
con compito 2AFC**

2AFC

**2AFC: (*two-alternative forced choice*) due stimoli, scelta forzata
(p.e. quale è più grande?)**

2AFC oppure 3AFC, oppure *m*AFC...

**metodo migliore (risposte
oggettivamente corrette o meno)**

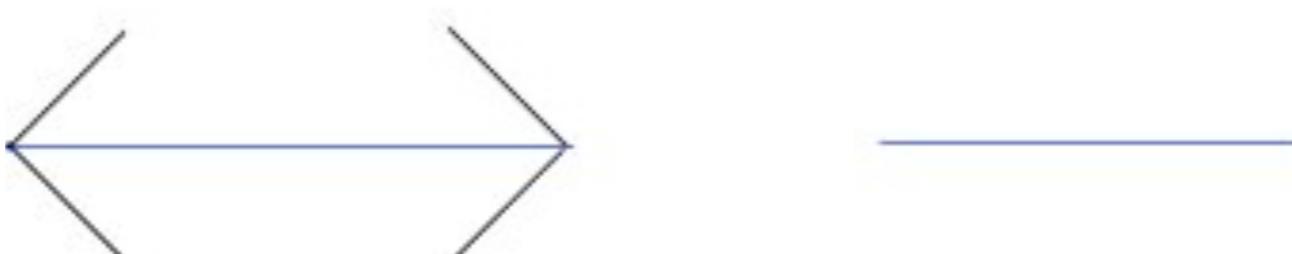
**come le usereste nell'esperimento
di Pirenne?**

cosa significa 2AFC

significa che ci sono *due stimoli* fra cui i partecipanti sono costretti a scegliere

non che ci sono due opzioni di risposta!

PES e PEO





Contents lists available at [ScienceDirect](#)

Acta Psychologica

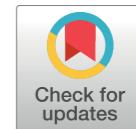
journal homepage: www.elsevier.com/locate/actpsy



Visual similarity modulates visual size contrast

N. Bruno*, G. Garofalo, O. Daneyko, L. Riggio

Università di Parma, Italy



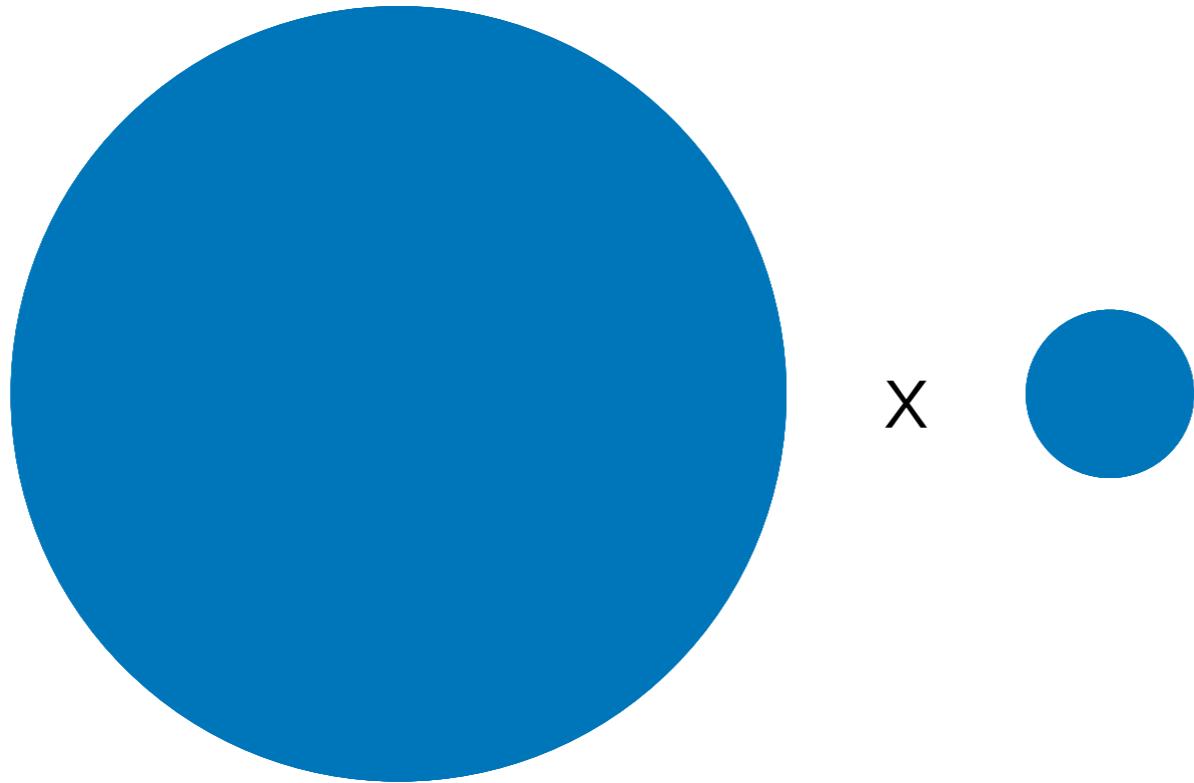
ARTICLE INFO

Keywords:
Size contrast
Adaptation
Uznadze effect
Similarity
Gestalt

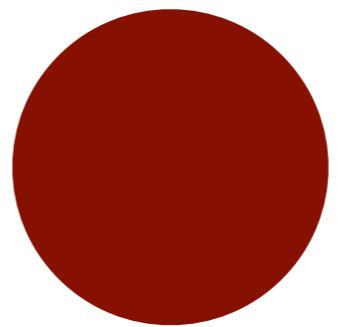
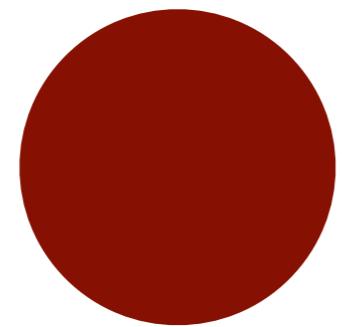
ABSTRACT

Perception is relational: object properties are perceived in comparison to the spatiotemporal context rather than absolutely. This principle predicts well known contrast effects: For instance, the same sphere will feel smaller after feeling a larger sphere and larger after feeling a smaller sphere (the Uznadze effect). In a series of experiments, we used a visual version of the Uznadze effect to test whether such contrast effects can be modulated by organizational factors, such as the similarity between the contrasting inducer stimulus and the contrasted induced stimulus. We report that this is indeed the case: size contrast is attenuated for inducer-inducing pairs having different 3D shapes, orientations, and even – surprisingly – color and lightness, in comparison to equivalent conditions where these features are the same. These findings complement related work in revealing basic mechanisms for fine-tuning local interactions in space-time in accord to the global stimulus context.

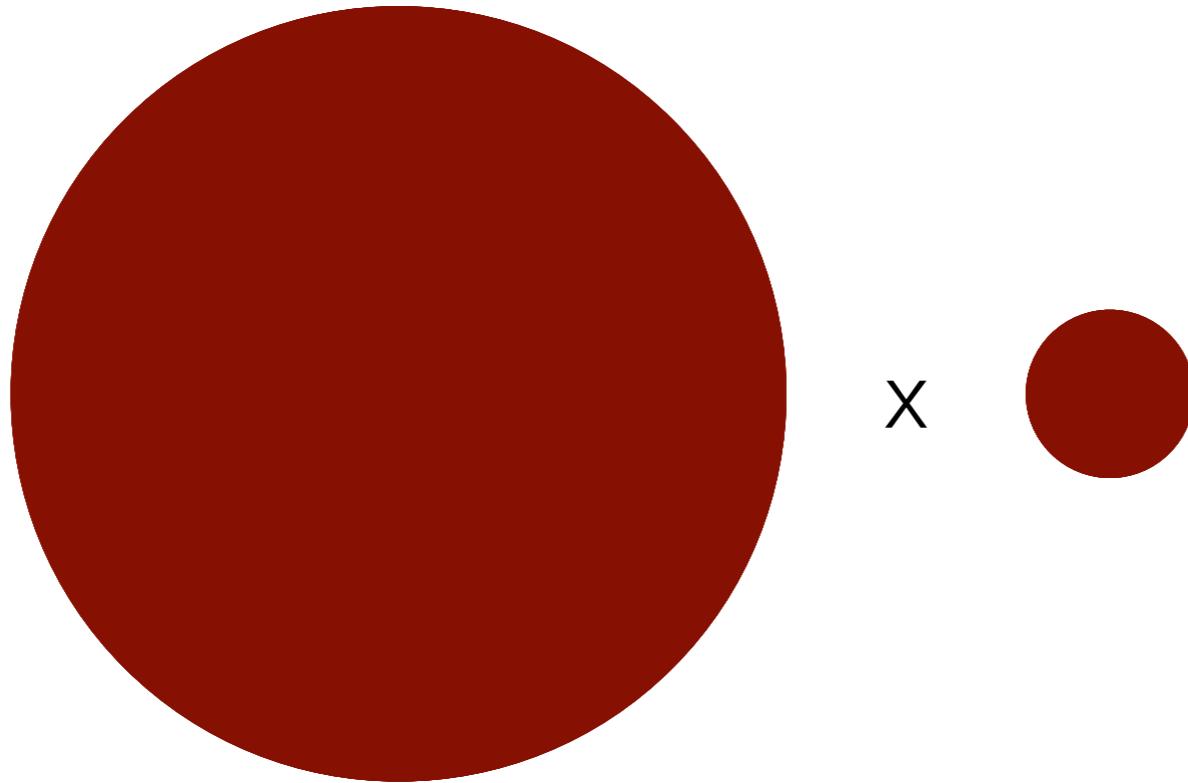
inducers



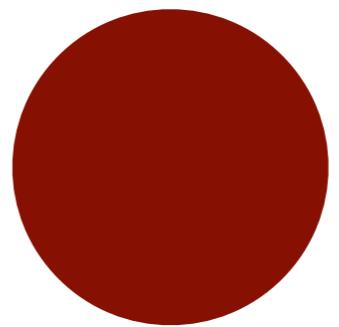
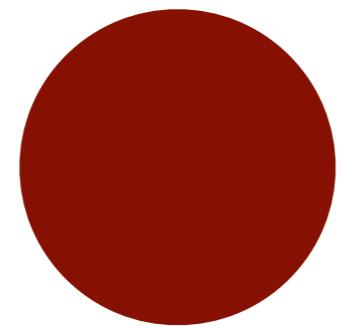
test



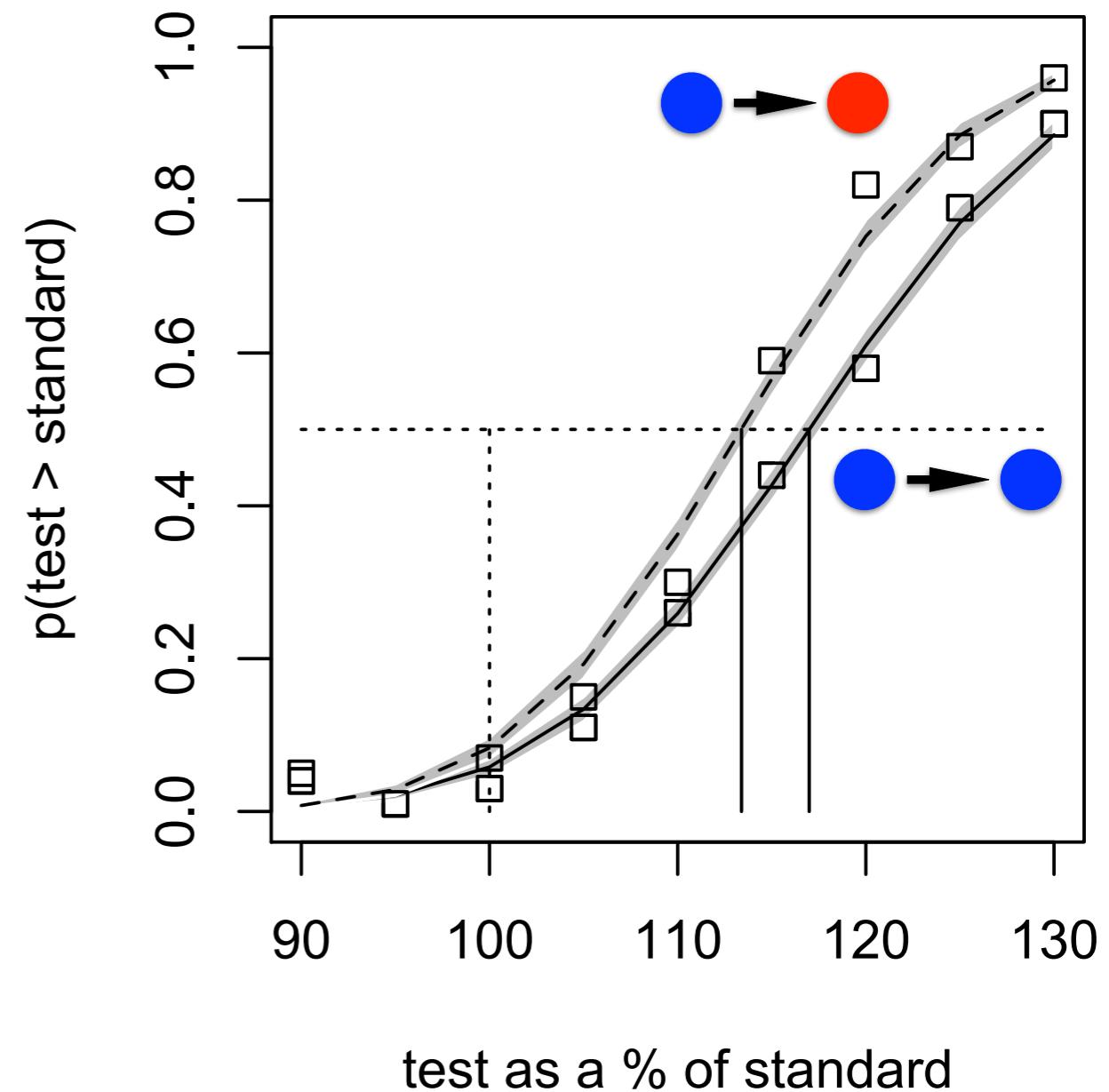
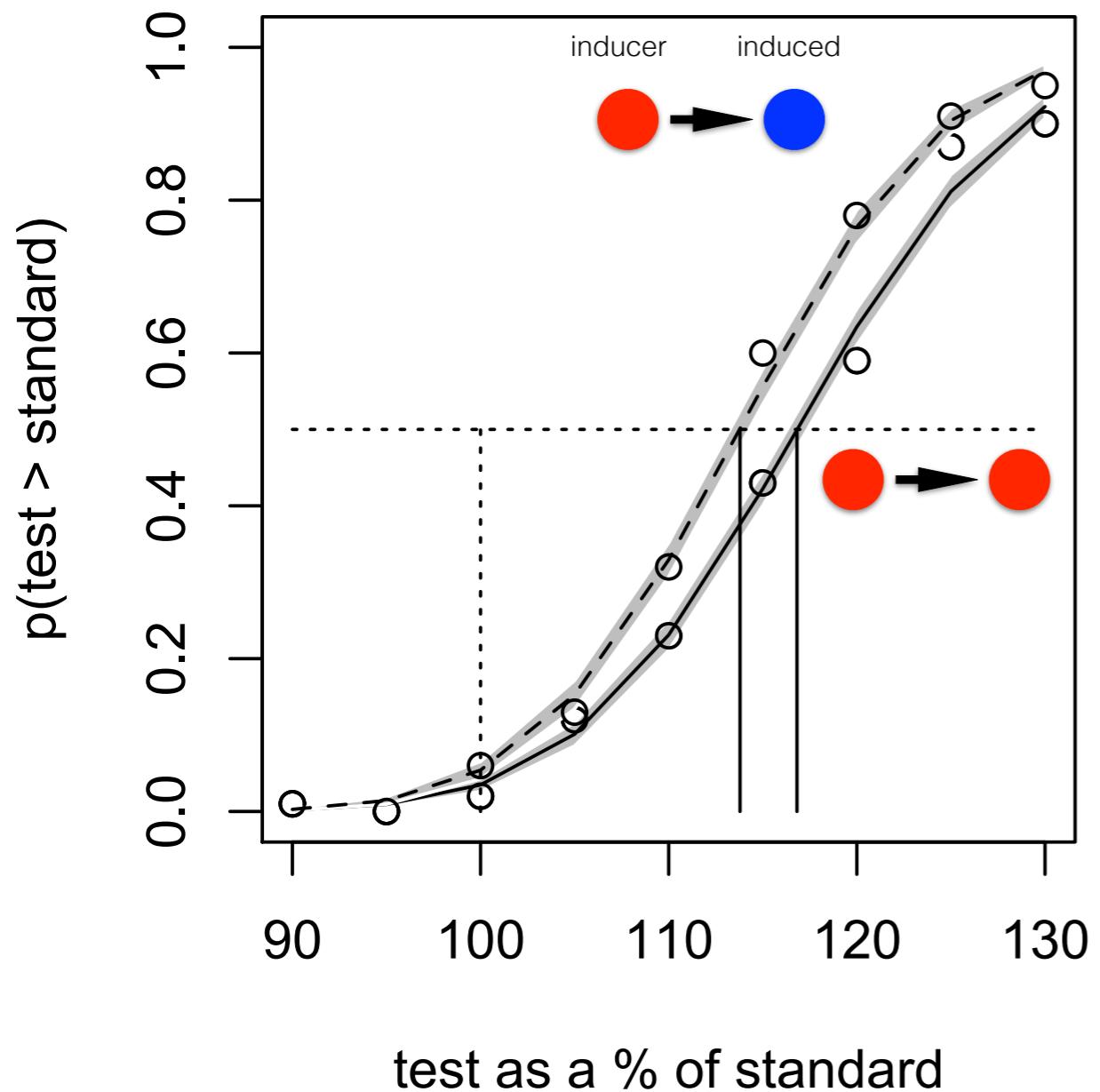
inducers



test

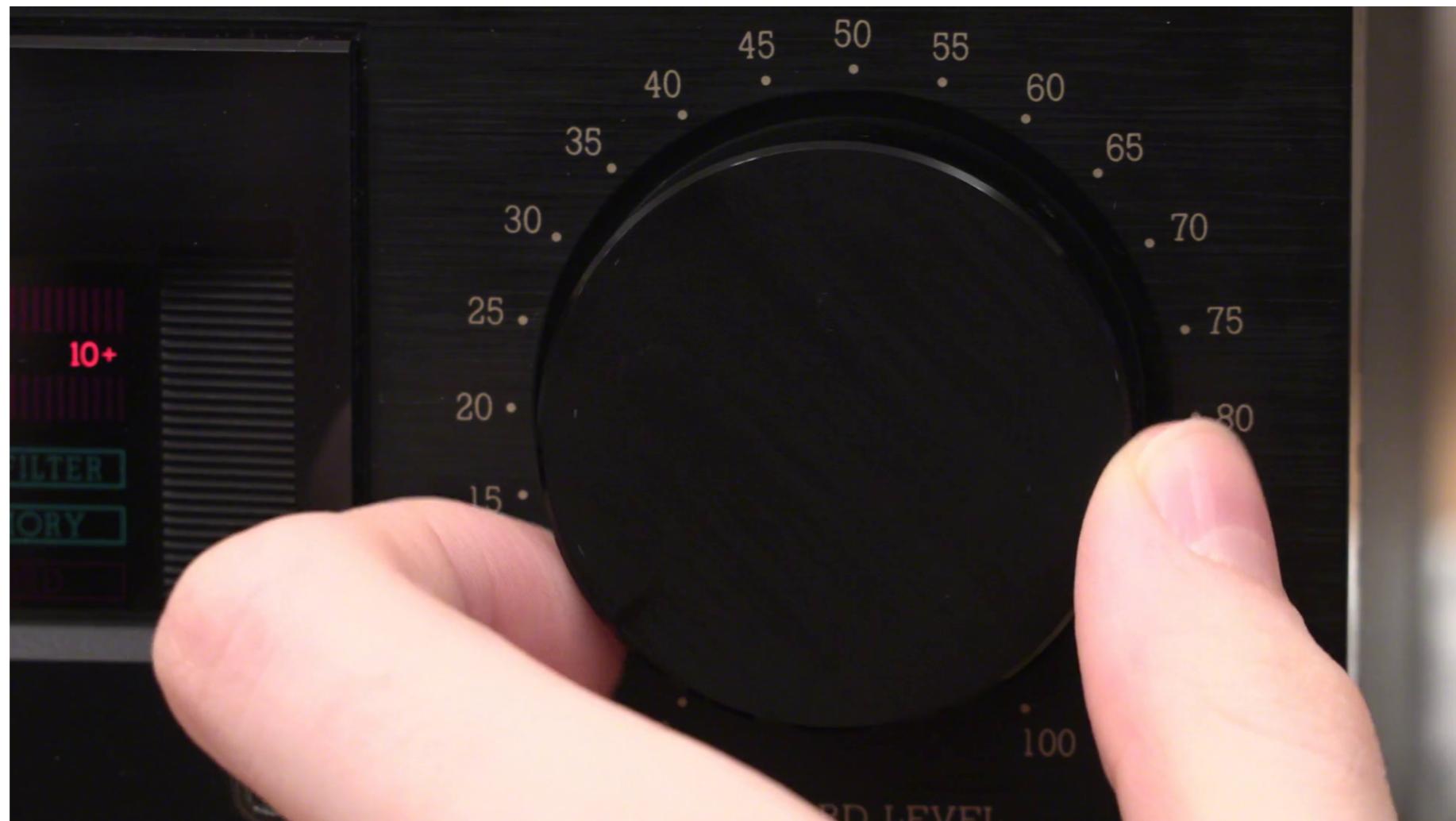


experiment 1: overall



altri metodi (accenni)

metodo dell'aggiustamento



metodo dei limiti

Intensity	Trial Number									
10	Y		Y		Y		Y			Y
9	Y		Y		Y		Y			Y
8	Y		Y		Y		Y			Y
7	Y		Y		Y		Y			Y
6	Y		Y		N		Y			Y
5	Y		N	Y		Y	Y			Y
4	N	Y		N		N	Y	Y	N	
3		N		N		N	N	N	N	
2		N		N		N		N		
1		N		N		N		N		
Crossover	4.5	3.5	5.5	4.5	6.5	4.5	3.5	3.5	4.5	

Threshold = mean crossover = 4.5

metodo della *staircase*

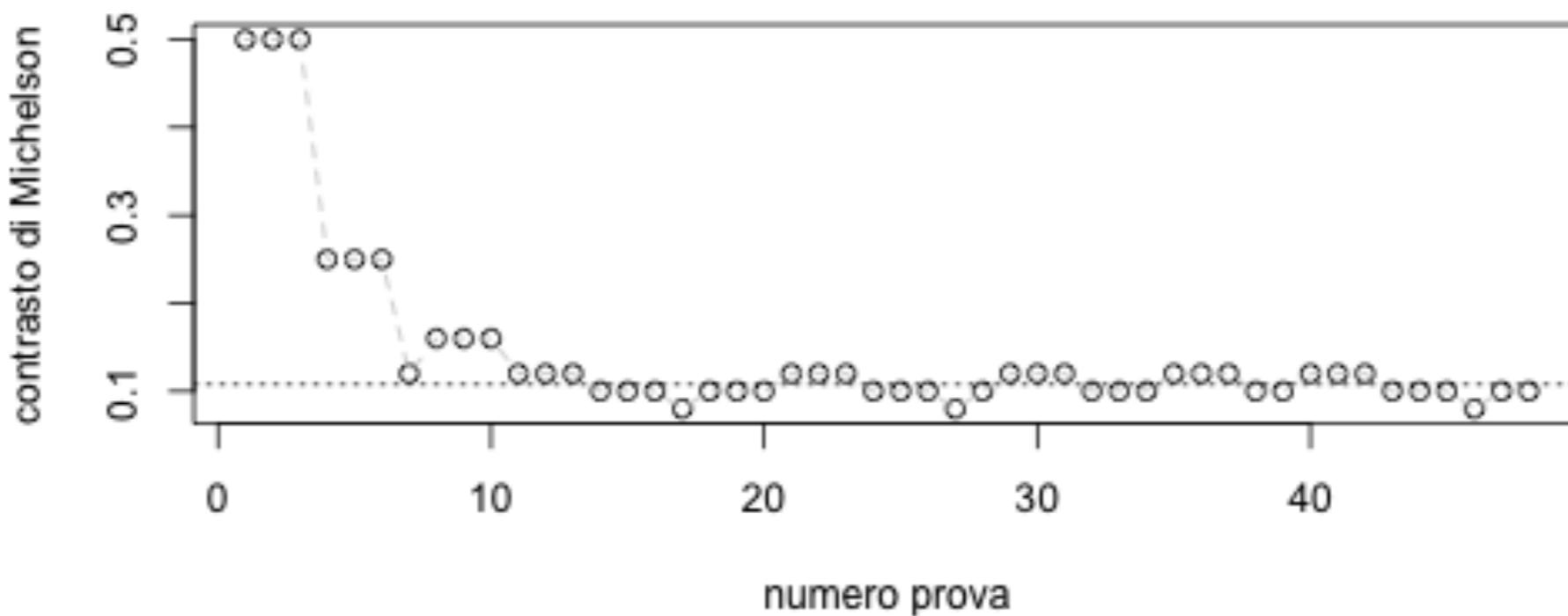
metodo “adattivo”

si parte soprasoglia

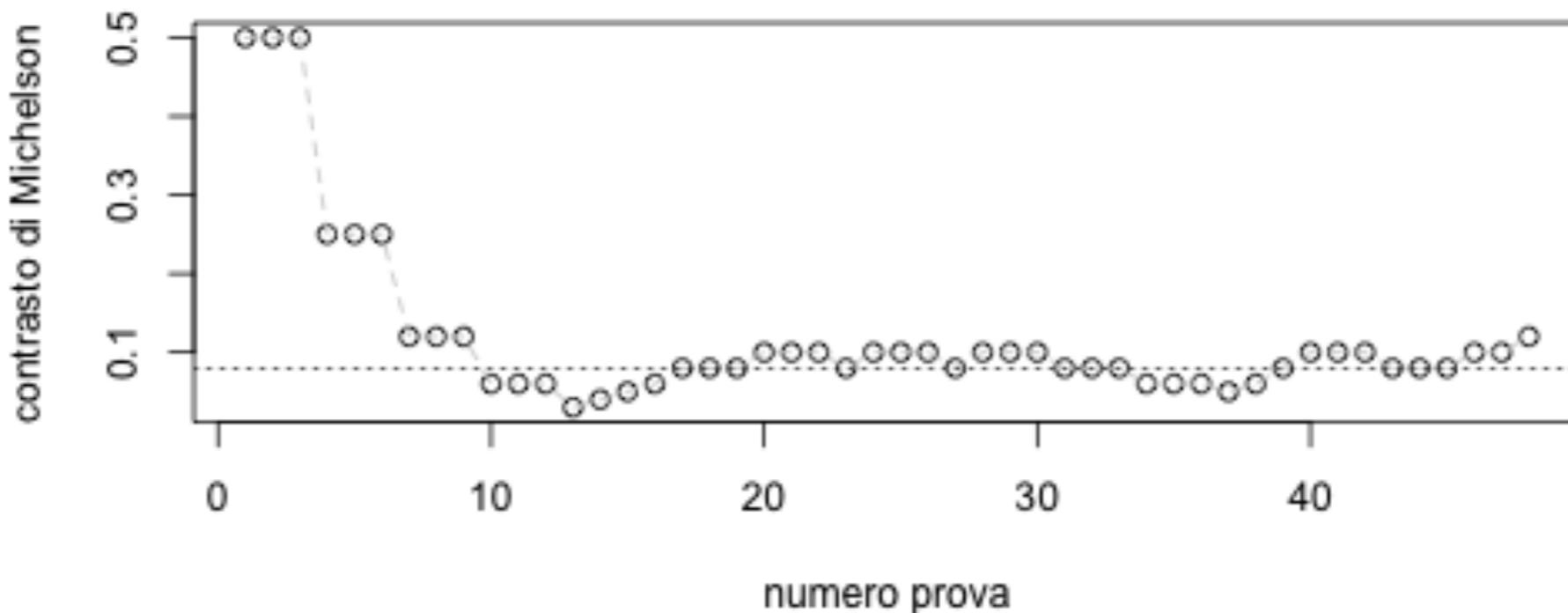
**ogni nuovo stimolo viene scelto in
funzione delle risposte
precedenti**

**si usano almeno due staircase
“interlacciate” per evitare errori
da aspettativa**

prima staircase



seconda staircase



**psicofisica
diretta e legge di
Stevens**



**Stanley Smith
Stevens
(1906-1973)**

metodi di Stevens

psicofisica “diretta”

- i) stima di magnitudine (o di grandezza)**
- ii) confronto (*match*) cross-modale**

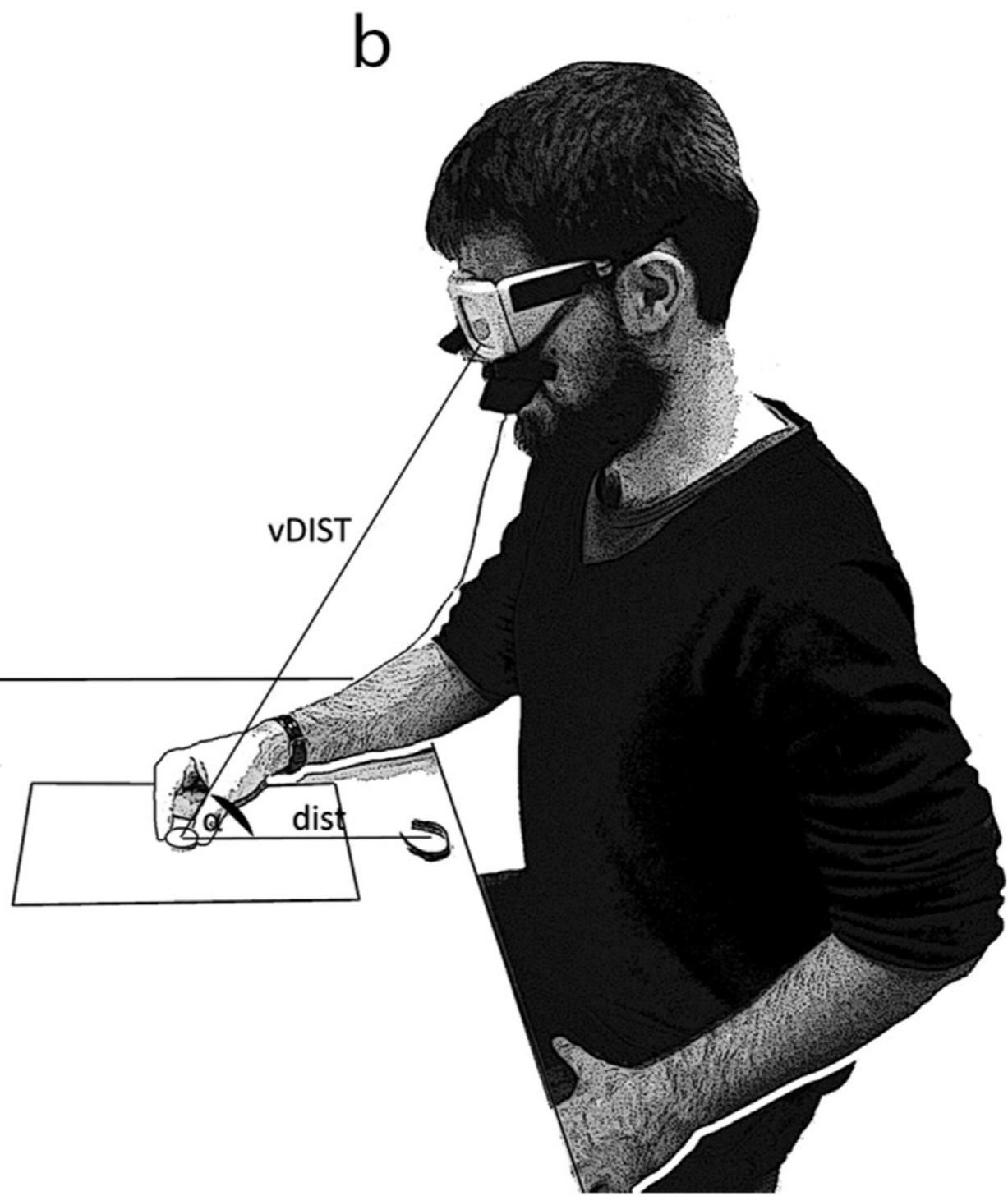
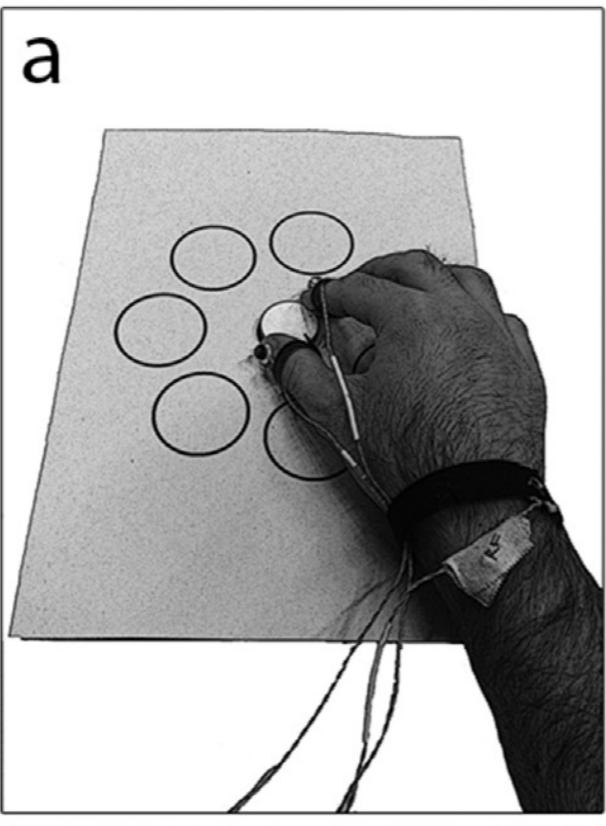


Wolfgang Köhler (1887-1967)

mому

keki





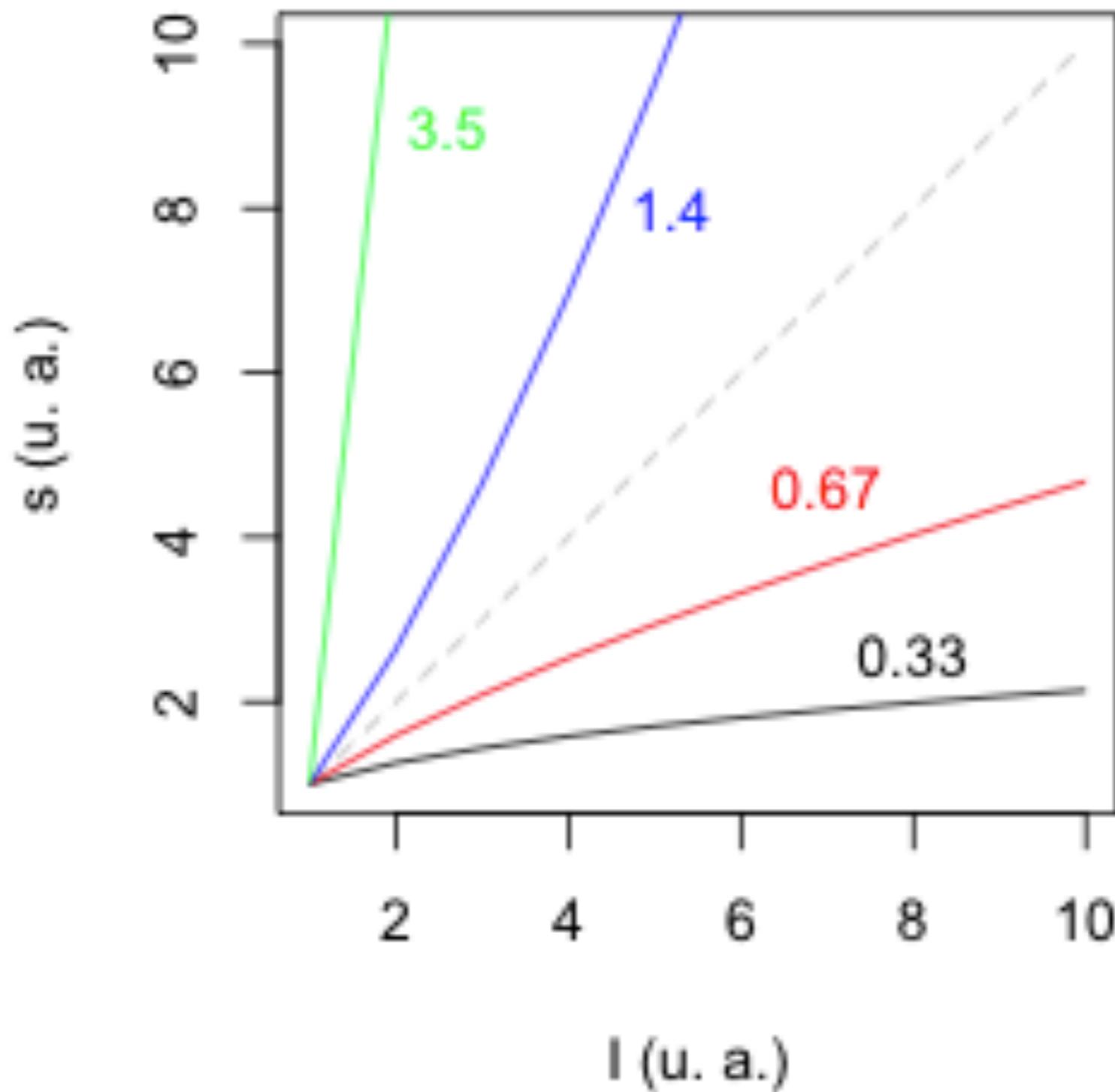
In the *grasping task*, participants were asked to grasp the target disc with their right hand...

The *open-loop manual estimation task* started with participants resting their right hand at a starting position on the table. When they saw the stimulus, they were asked to lift their right hand and indicate the size of the target stimulus with their right thumb and index finger.

$s = c I^a$

shok elettrico
sulle dita

NaCL
sulla lingua

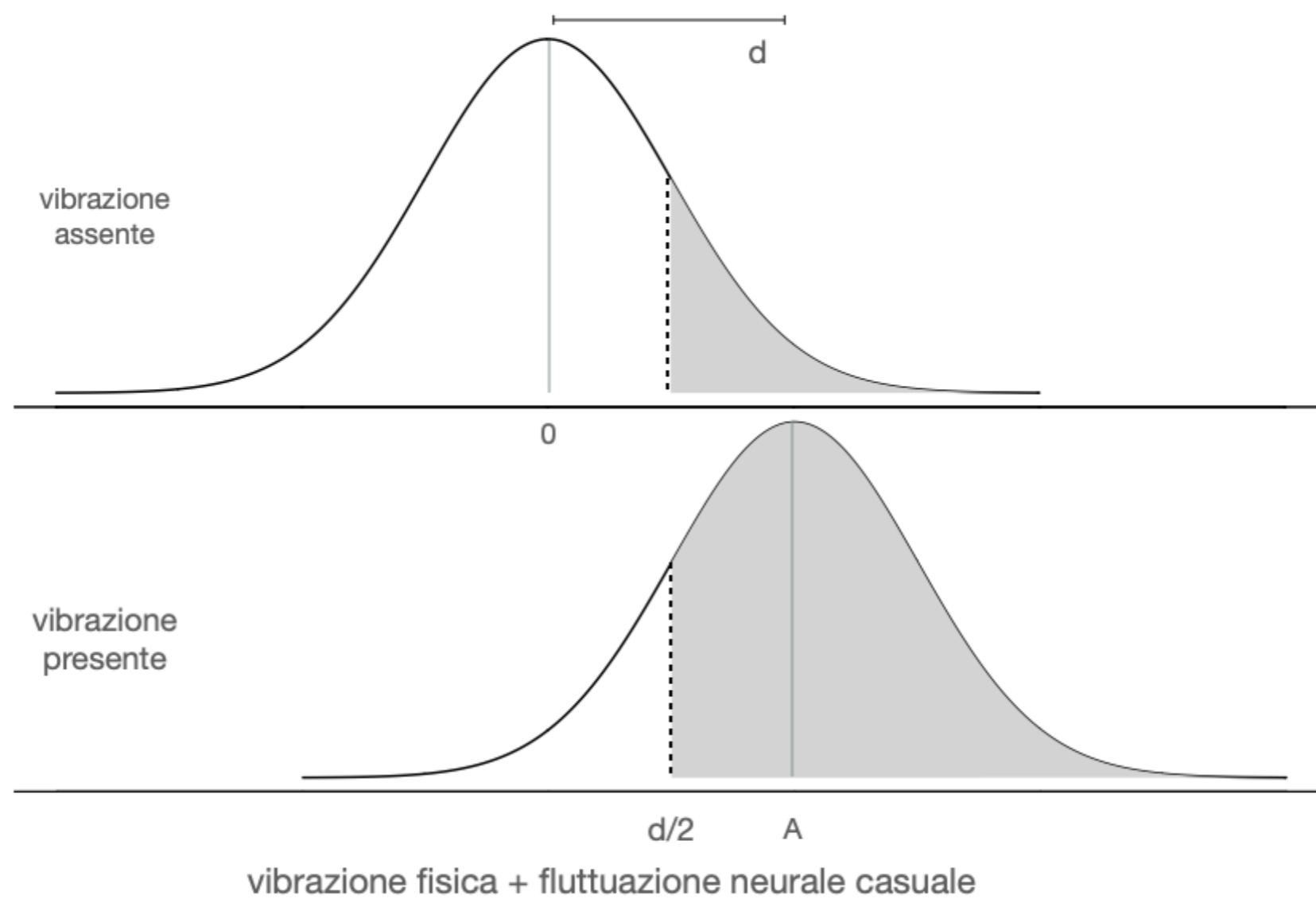


*loudness a
3000Hz*

*brightness di
disco luminoso di
5 gradi a. v.*

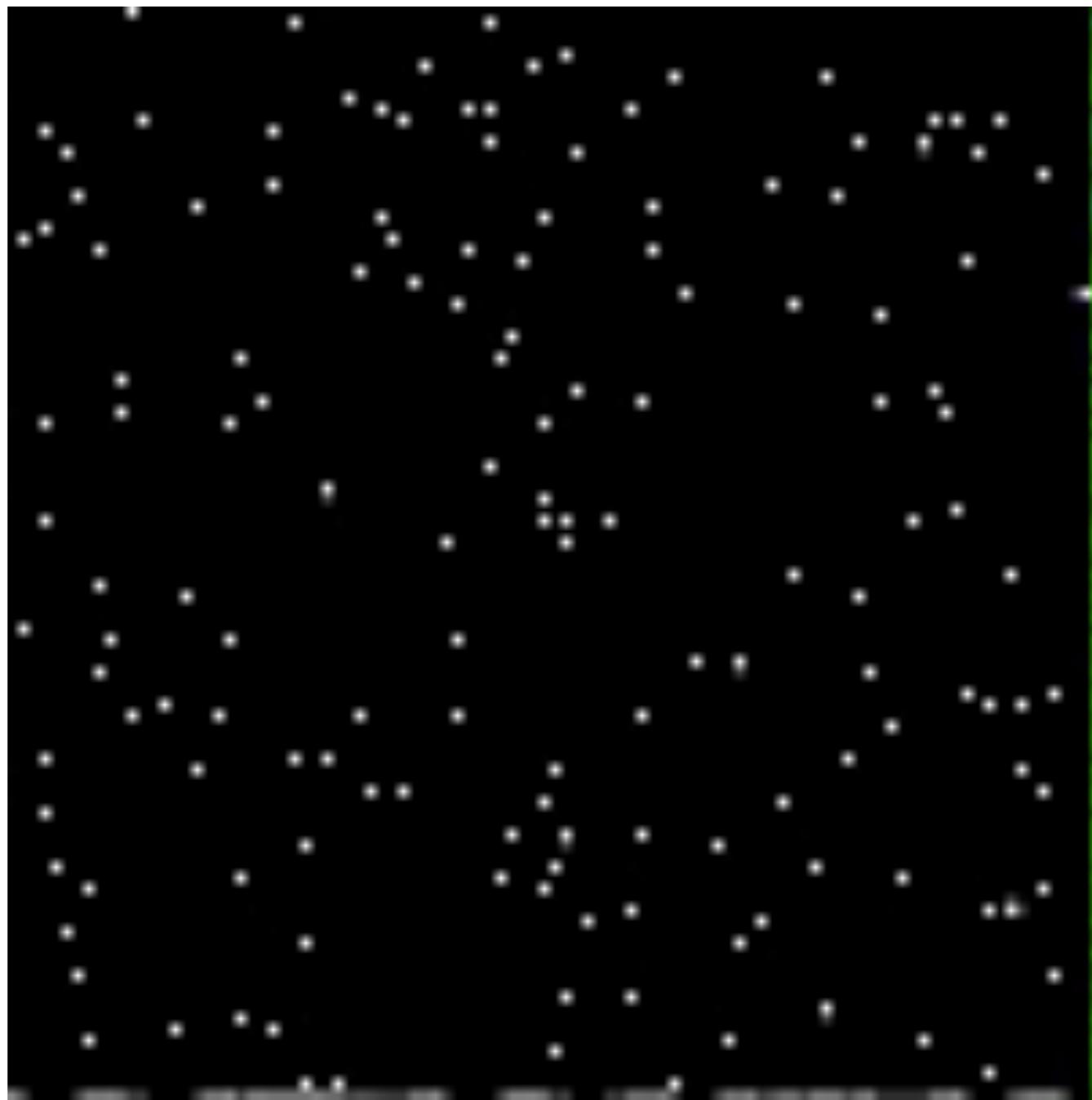
teoria della detezione del segnale

il suono del silenzio

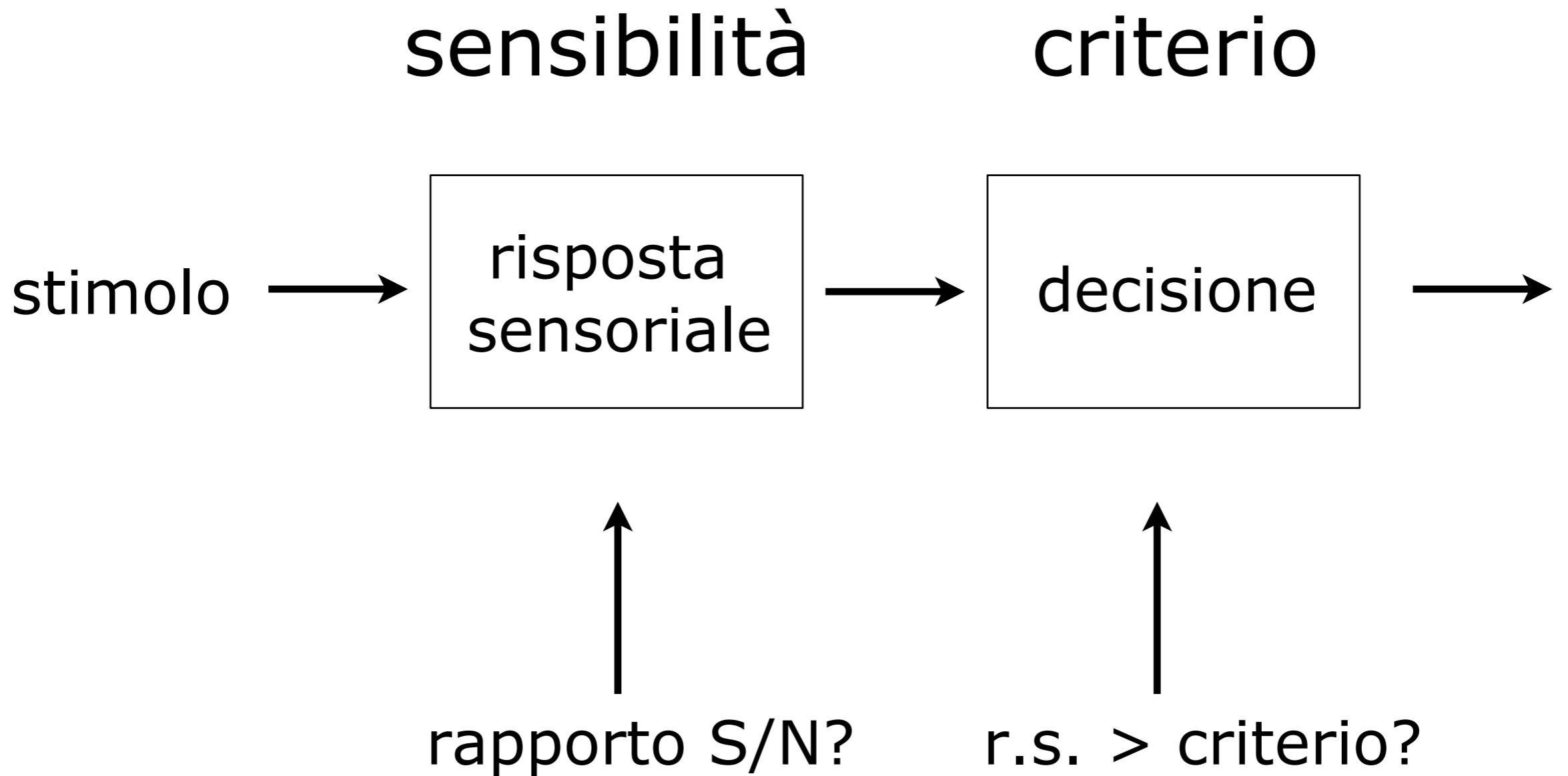


random-dot kinematogram (RDK)









due compiti molto diversi

**yes-no: il compito di Pirenne
(non esiste maniera di calcolare %RC)**

**classificazione: $S+N$ o solo N ?
(N anche detti *catch trials*, è possibile calcolare %RC,
stimare il criterio e la sensibilità)**

risposta

si
no

stimolo
segnale rumore

hit

miss

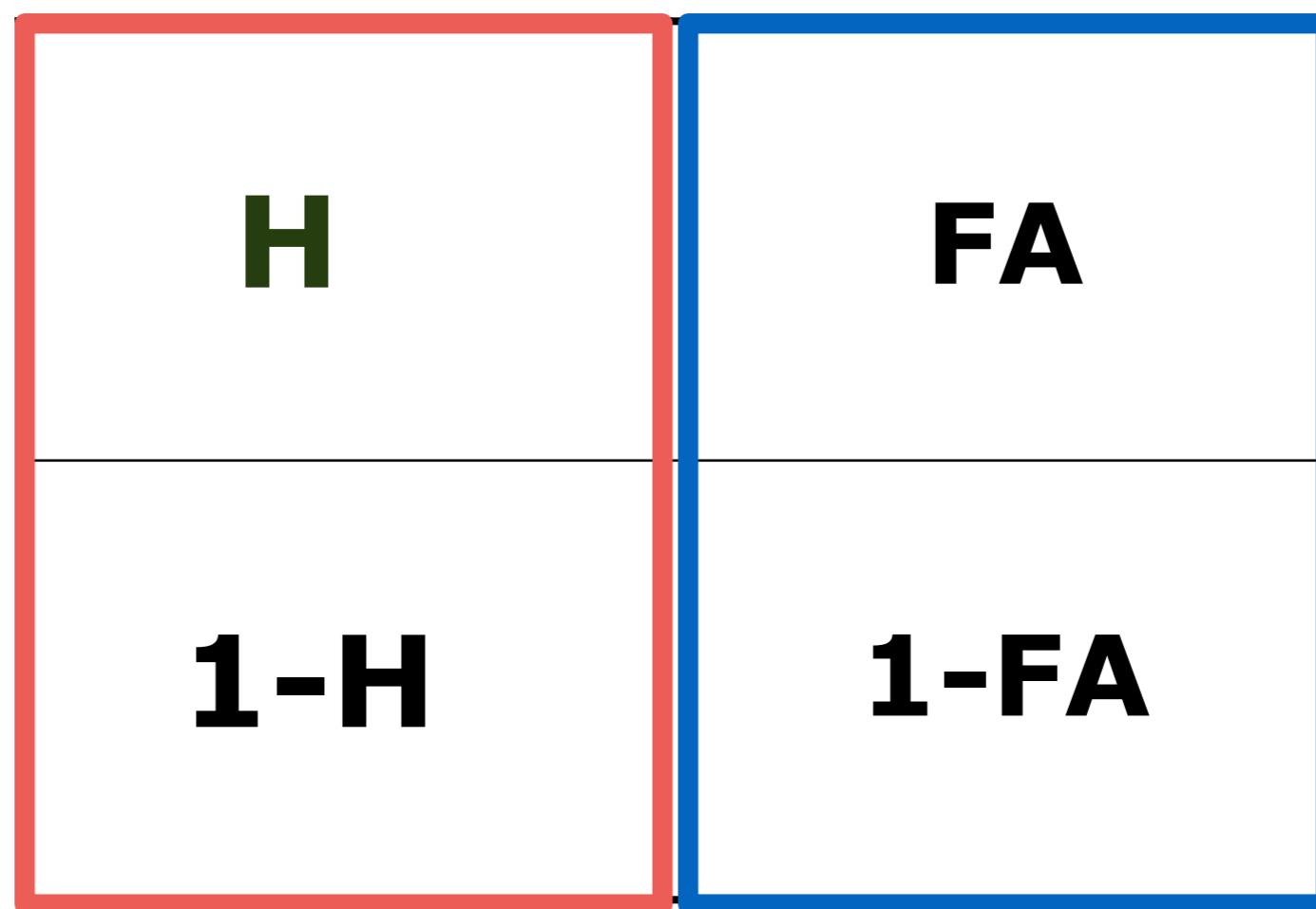
**false
alarm**

**correct
rejection**

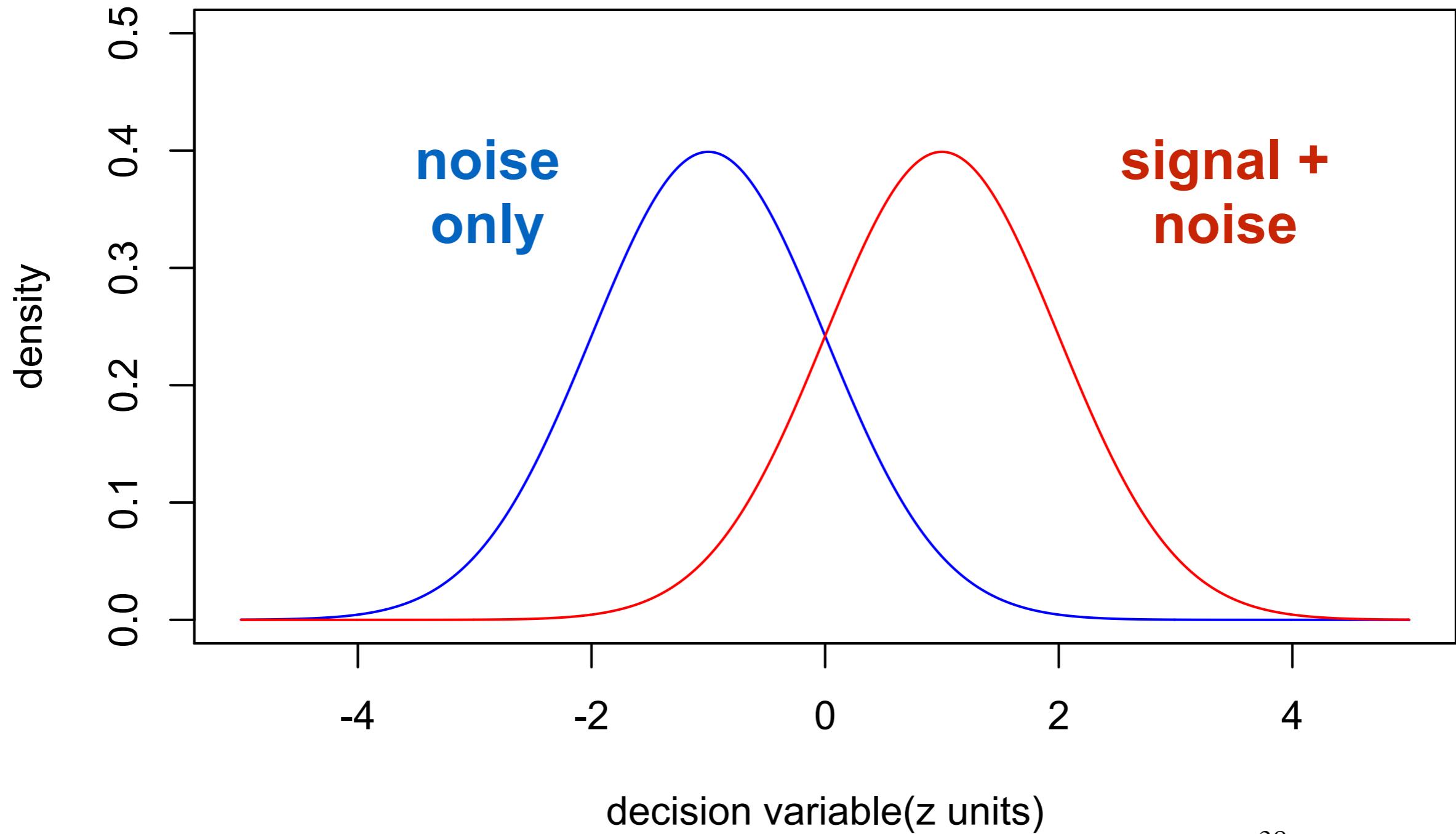
risposta

'sì'
no

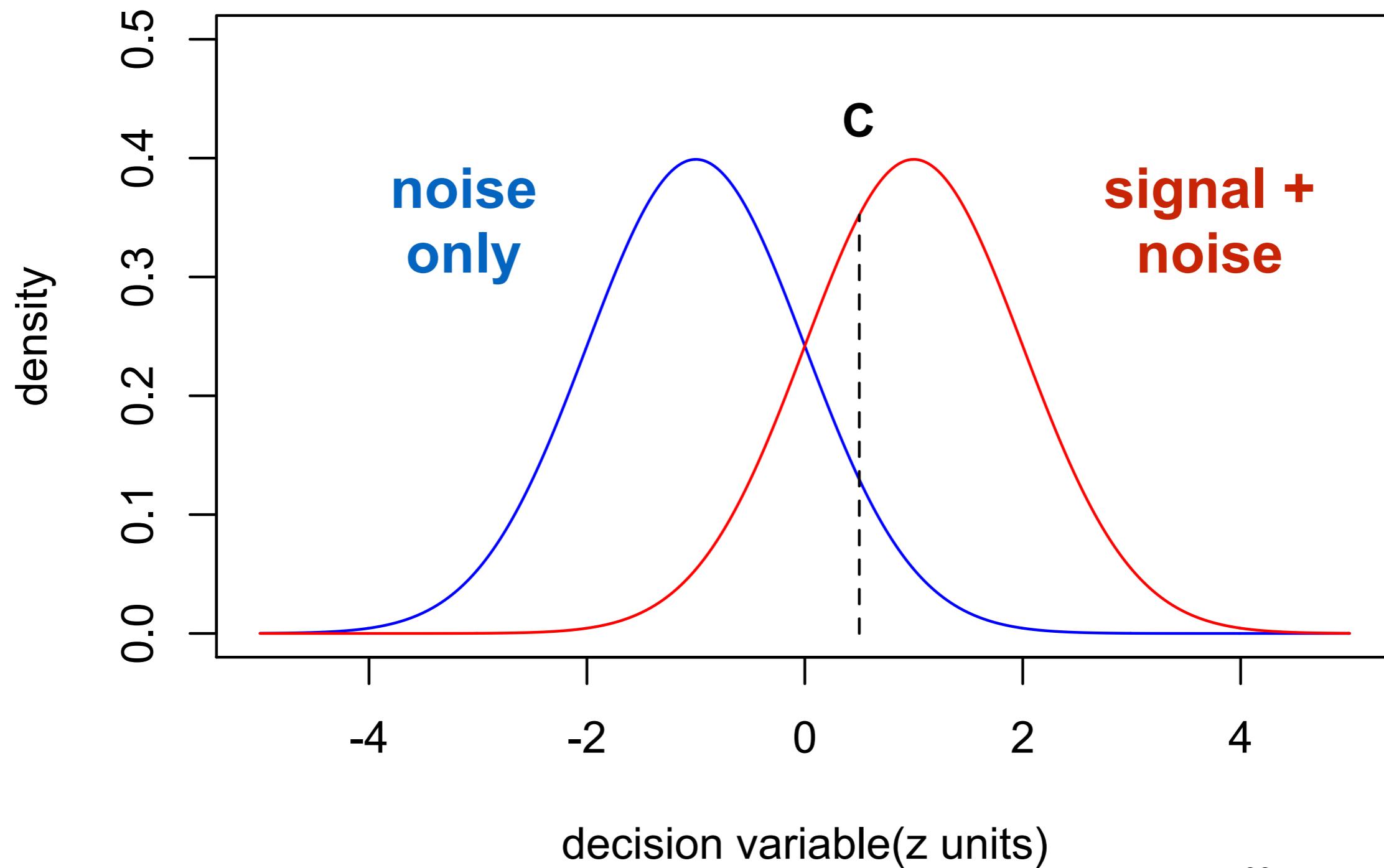
stimolo
segnale rumore

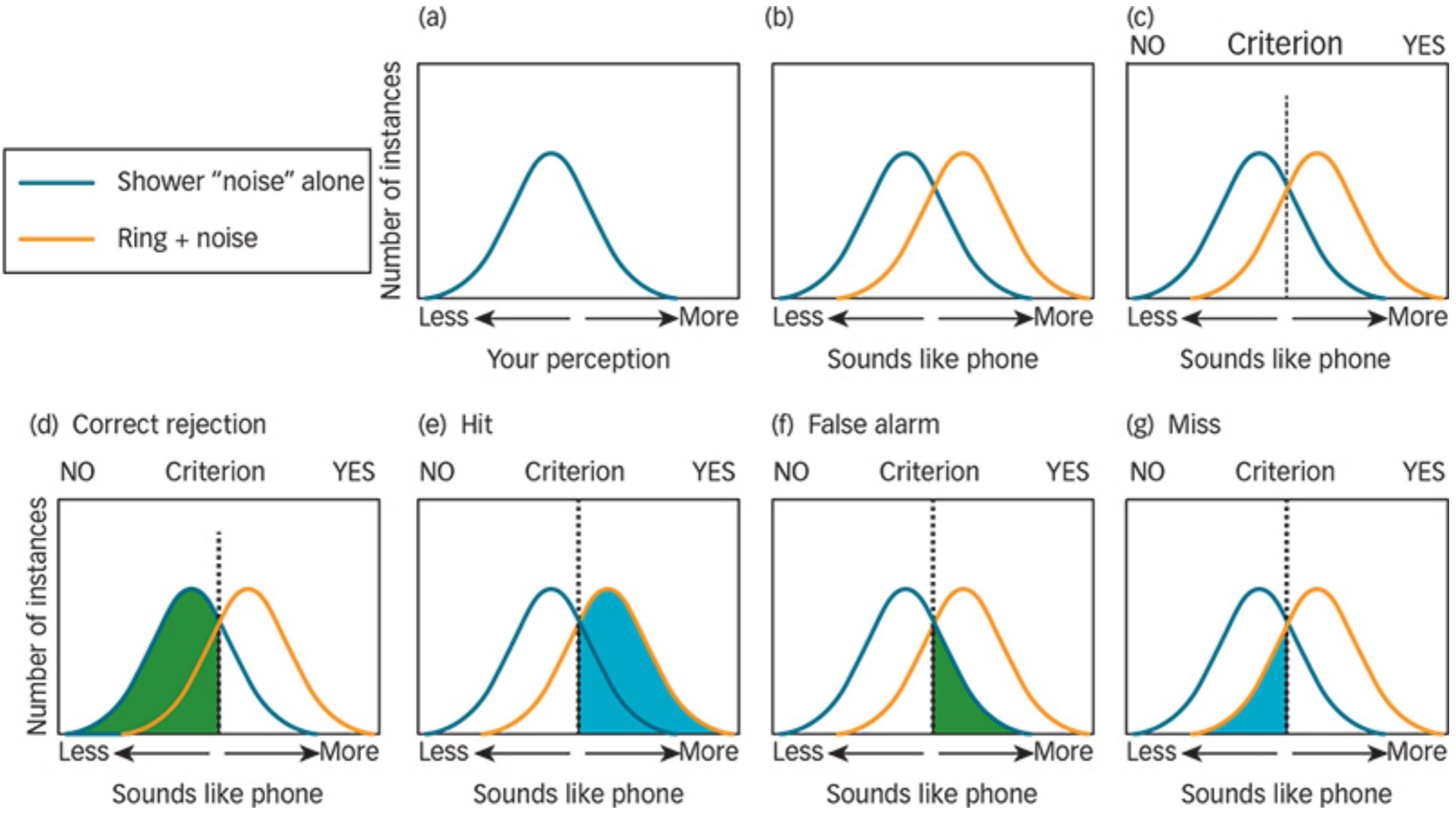


modello gaussiano con uguali varianze

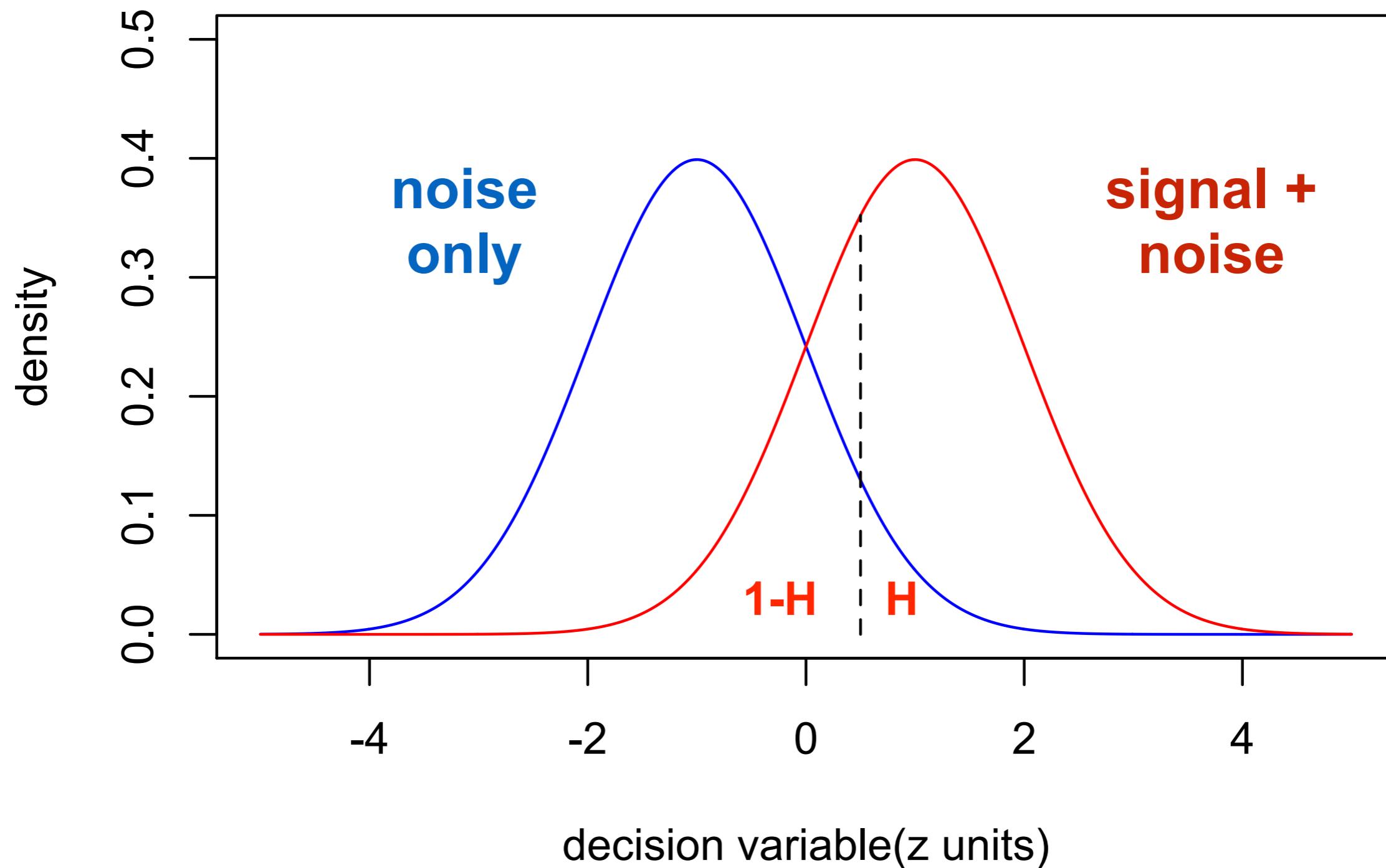


modello gaussiano con uguali varianze

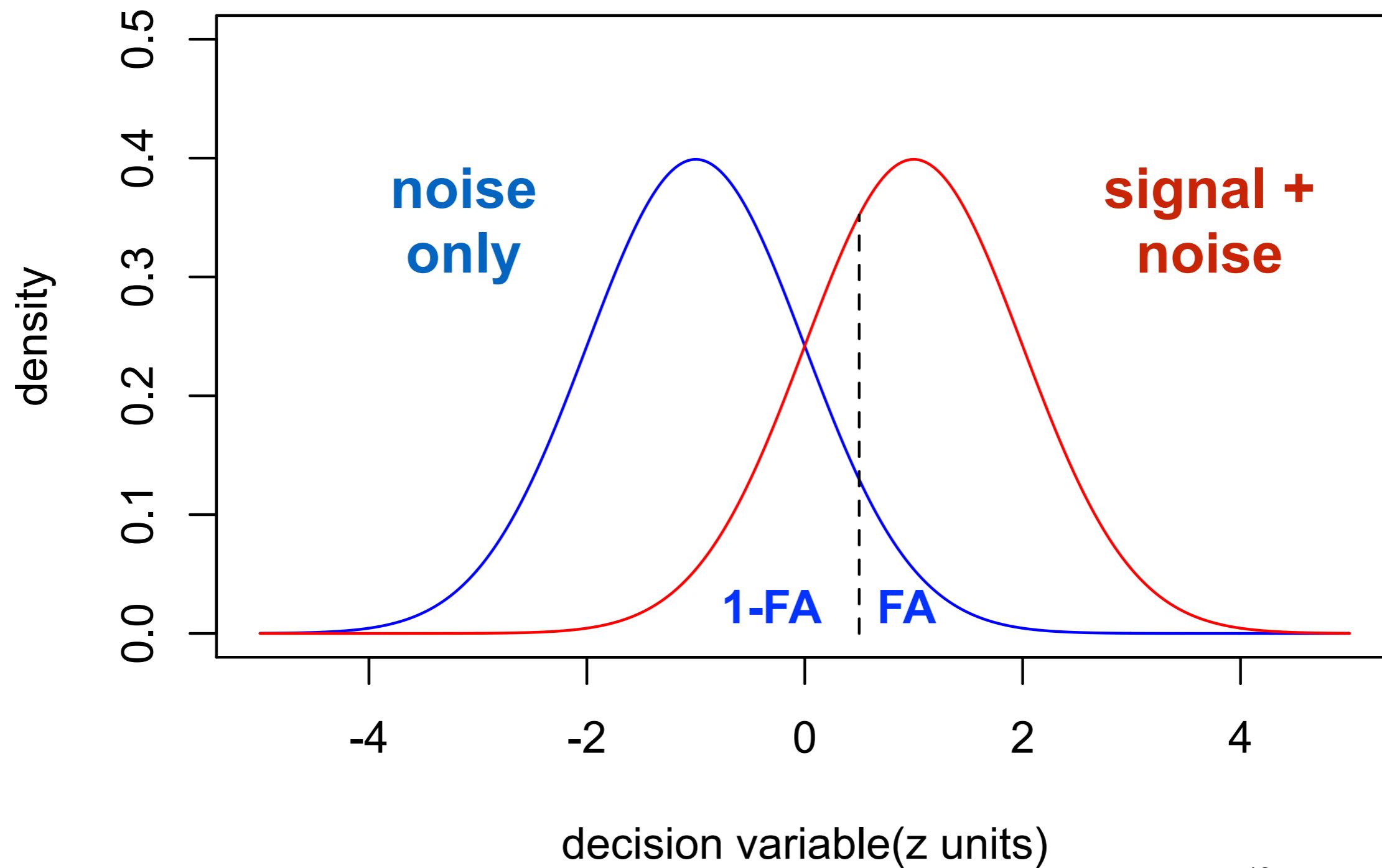




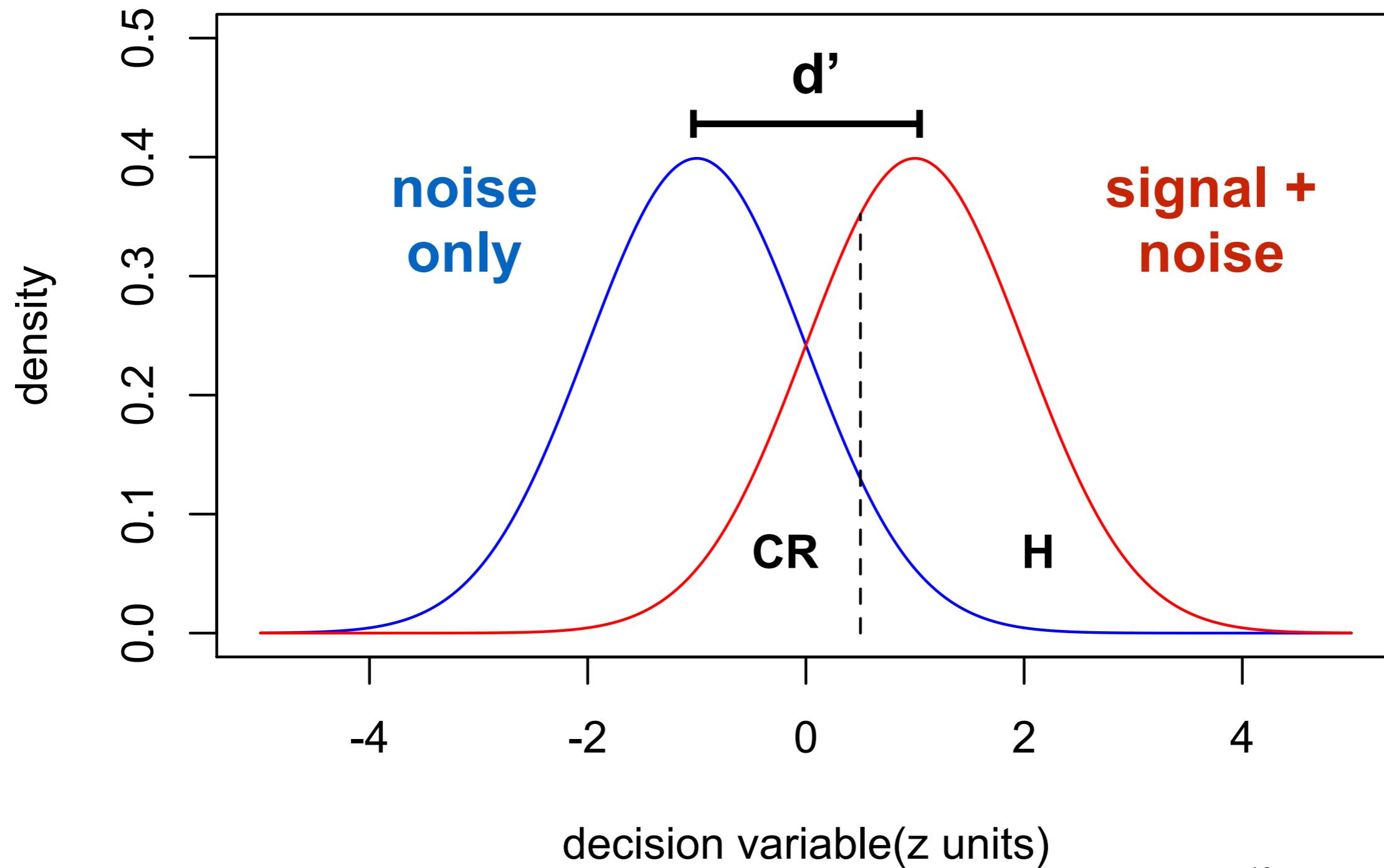
modello gaussiano con uguali varianze



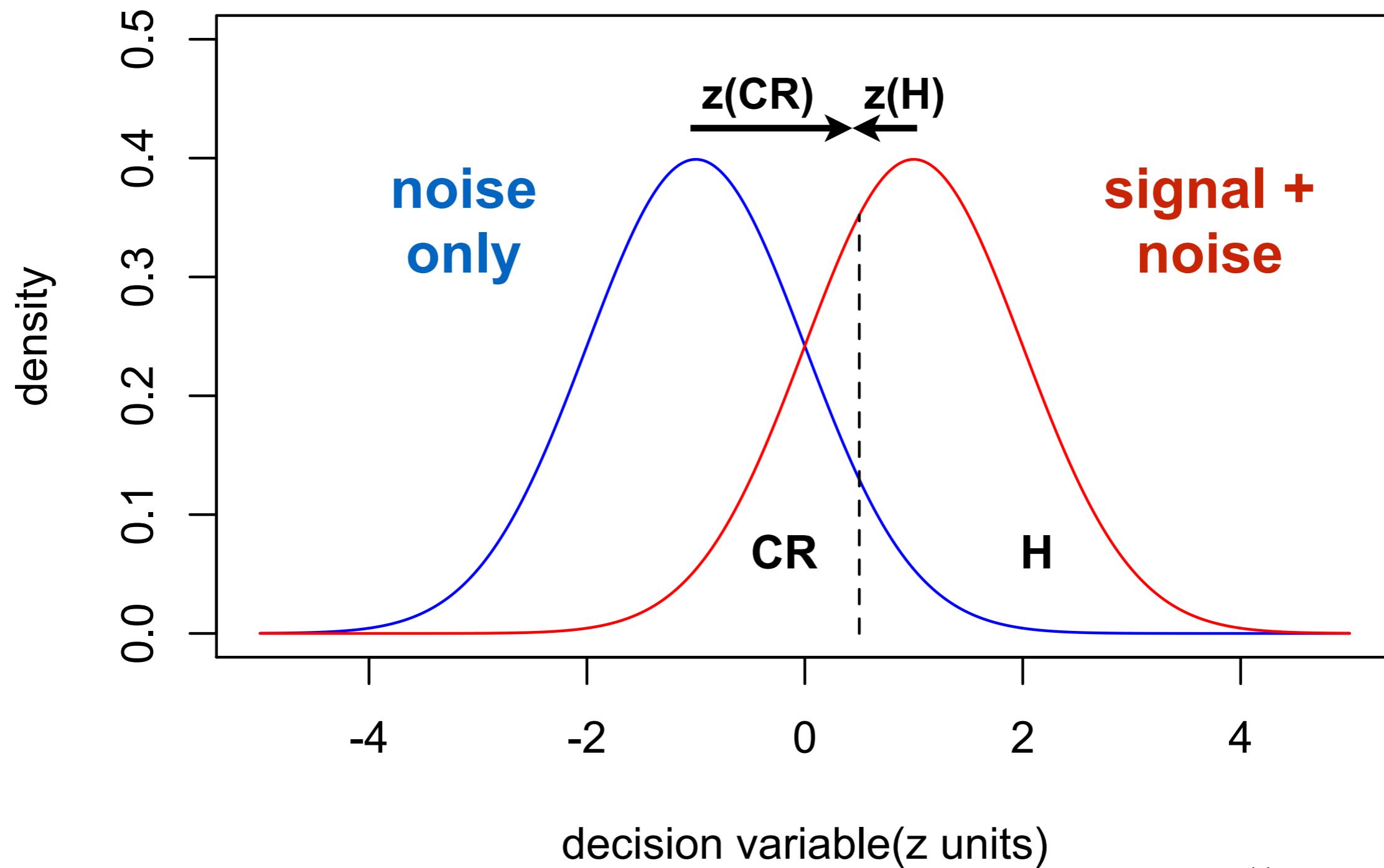
modello gaussiano con uguali varianze



indice di discriminabilità



modello gaussiano con uguali varianze



$$d' = z(H) + z(CR)$$

MA: CR = 1-F, e quindi $z(CR) = z(1-F)$

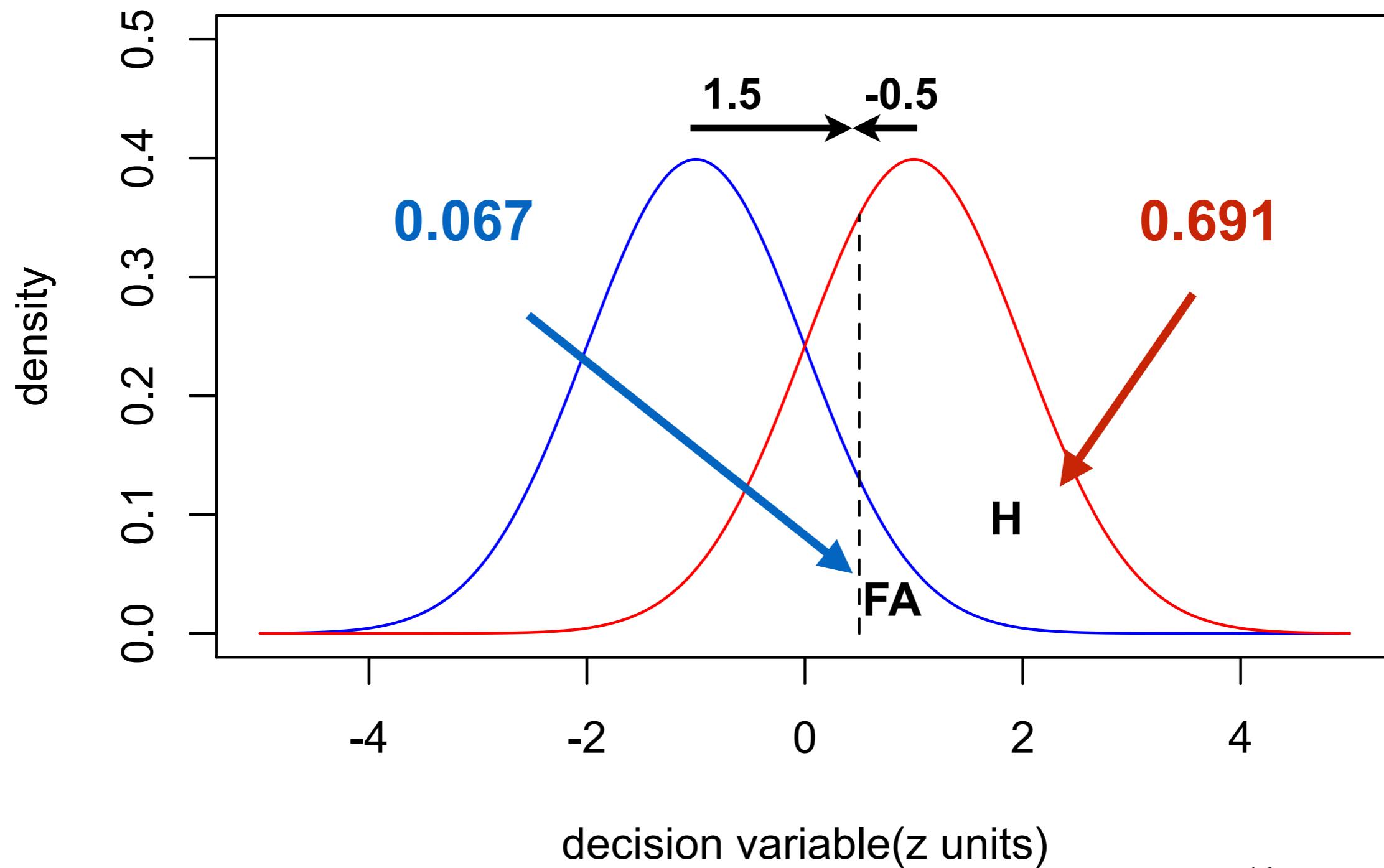
INOLTRE: $z(1-F) = -z(F)$

DA CUI: $z(CR) = -z(F)$

QUINDI:

$$d' = z(H) - z(F)$$

calcolare d' con R



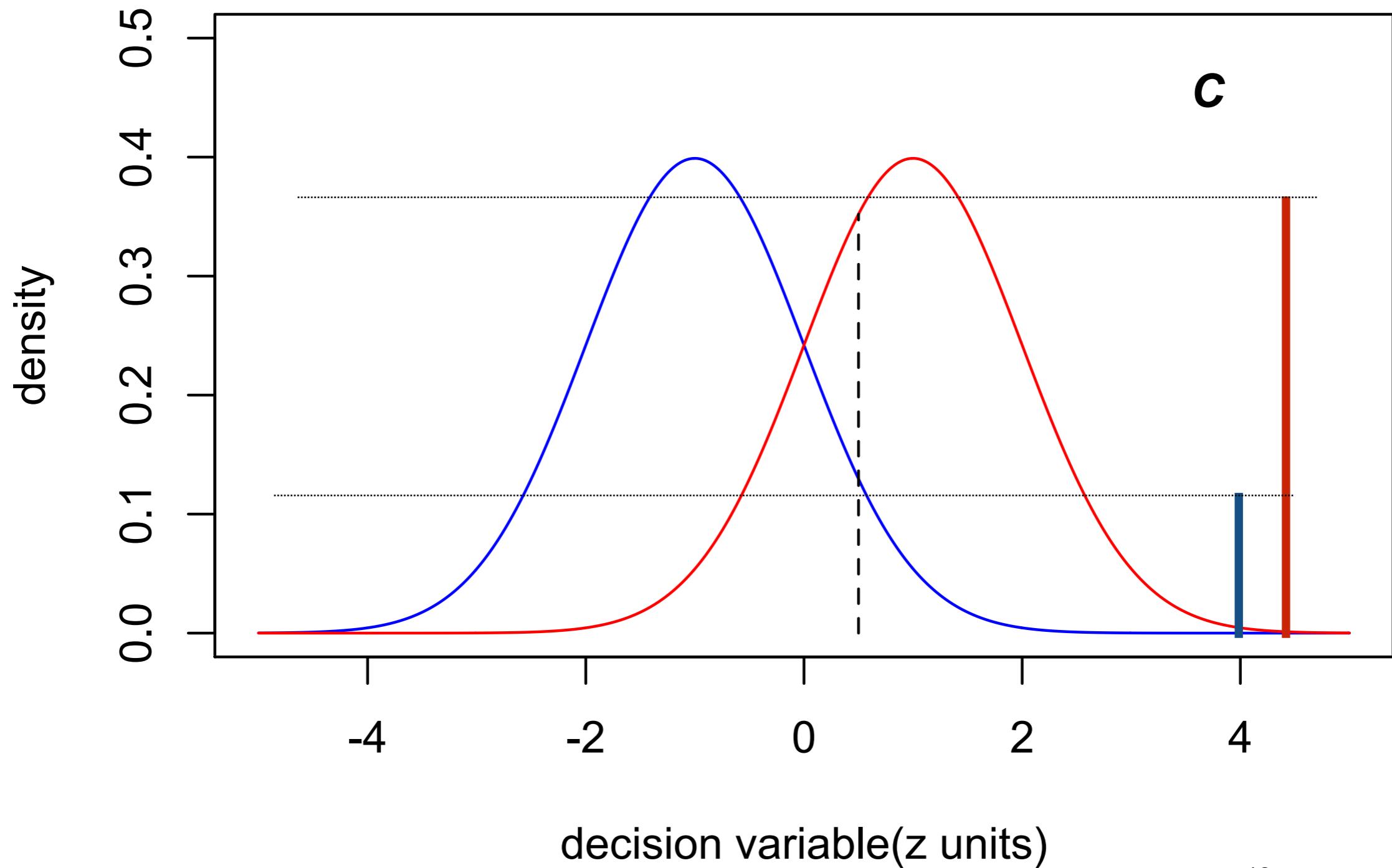
calcolare d' con R

```
> fa <- 1 - pnorm(1.5)  
> h <- 1 - pnorm(-0.5)  
> dp <- qnorm(h) - qnorm(fa)  
  
> dp  
[1] 2
```

calcolare d' con R

```
dprime <- function(h,fa) {  
  zh <- qnorm(h)  
  zfa <- qnorm(fa)  
  zh - zfa  
}
```

il criterio (C)



calcolare d' e C con R

```
dprime <- function(h,fa) {  
  zh <- qnorm(h)  
  zfa <- qnorm(fa)  
  zh - zfa  
}
```

```
Criterion <- function(h,fa) {  
  zh <- qnorm(h)  
  zfa <- qnorm(fa)  
  dnorm(zh)/dnorm(zfa)  
}
```

interpretare d'

