Electrical stimulation, Agnosia, Epilepsy, Sleep Walking, DID and more…

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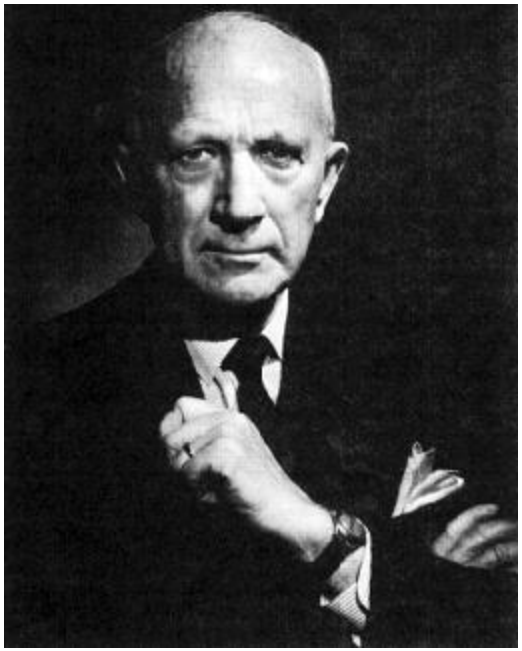
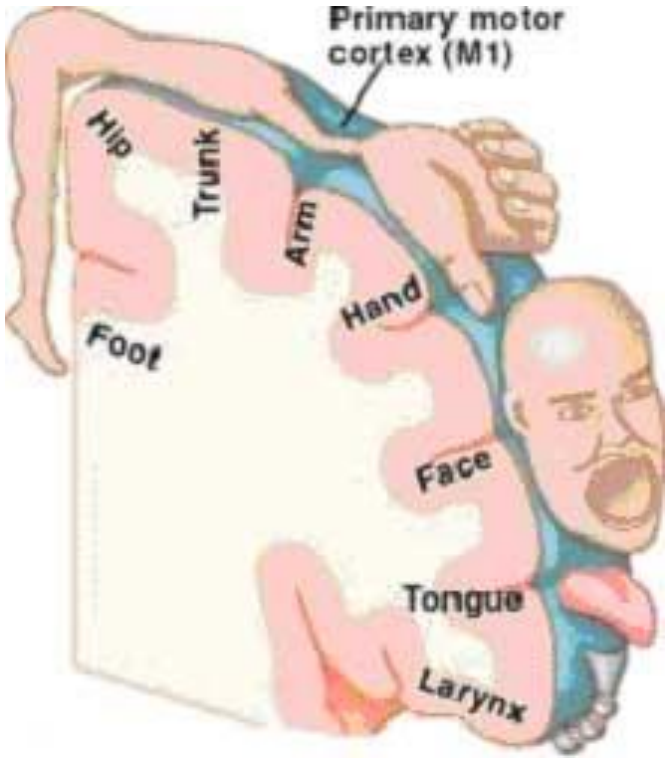
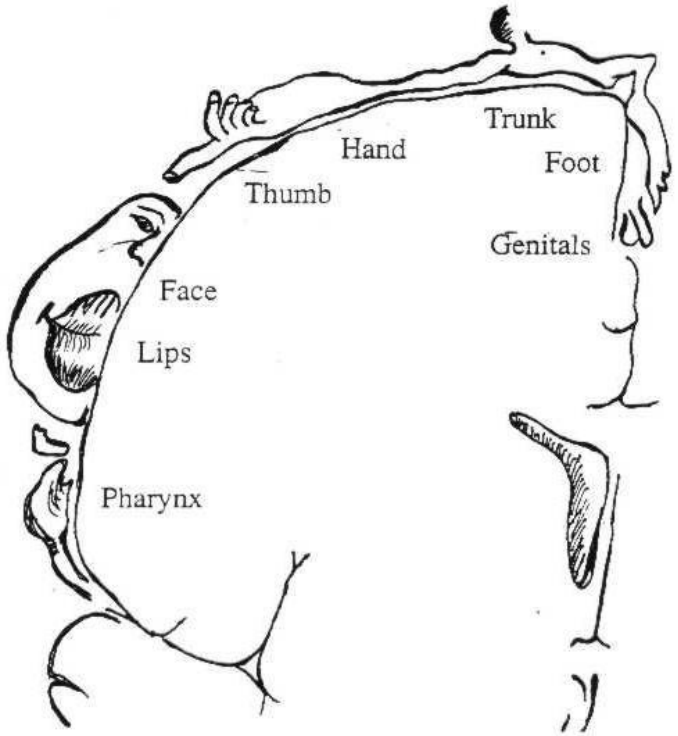
Wilder Penfield (1891-1976)



Motor homonculus



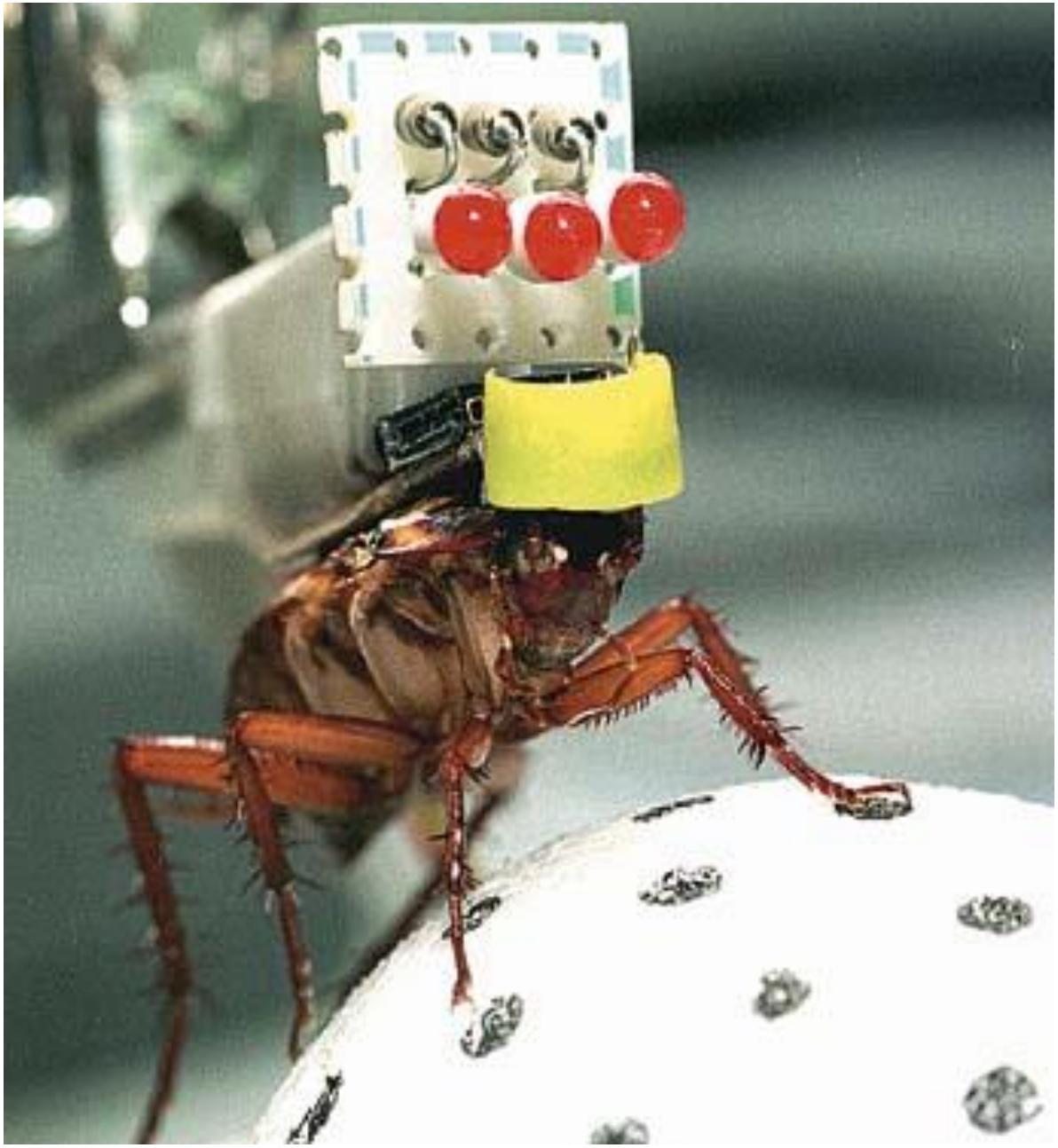
Somatosensory homonculus



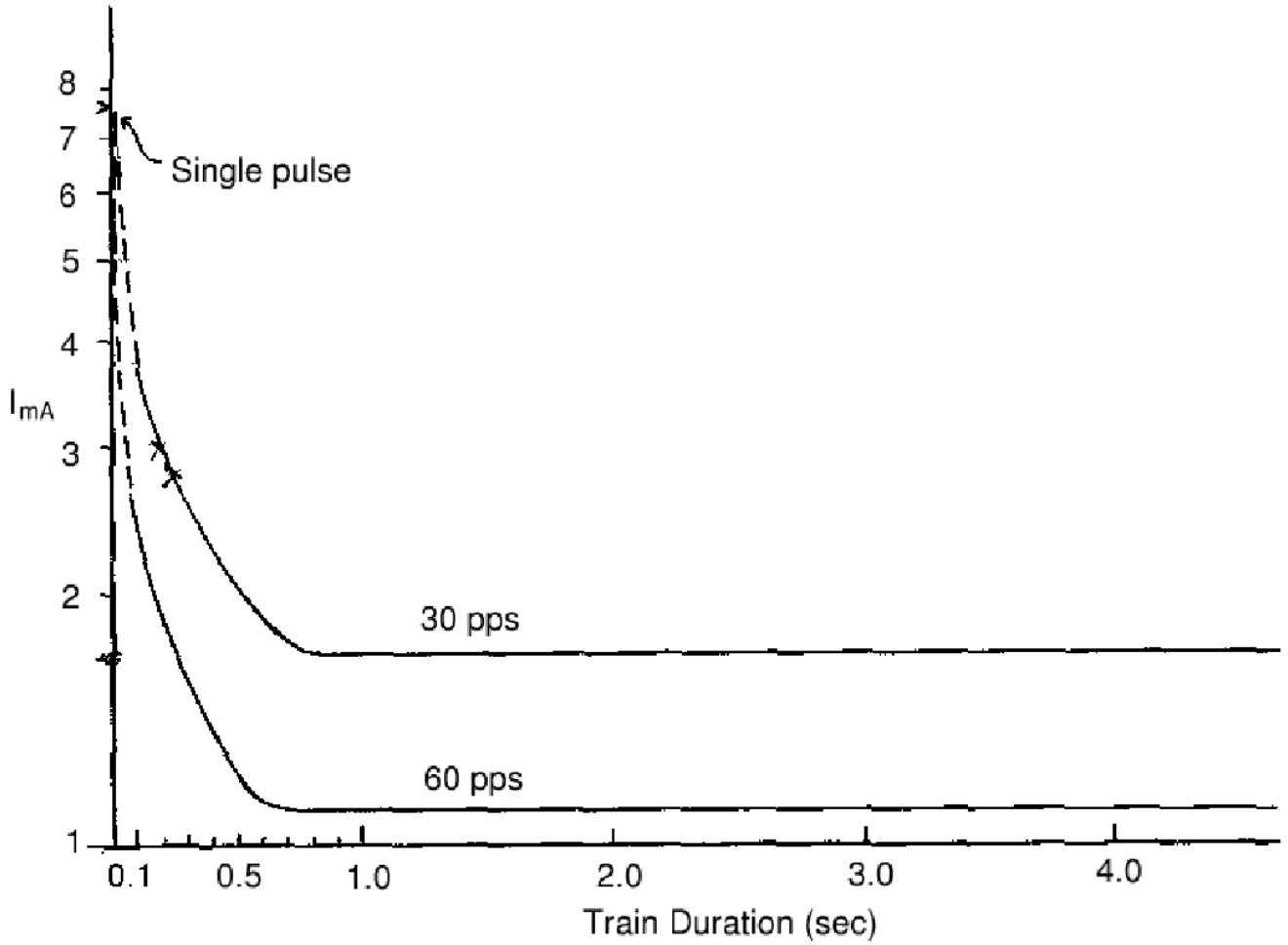
Wilder Penfield's Brain Stimulation Work

- Penfield's Research (as it is usually reported):
  - Penfield stimulated the cortexes of patients about to under go brain surgery
  - Some of these patients reported vivid memories during stimulation
  - Penfield concluded that memories are highly stable, and that the brain contains a complete record in great detail of past experience
- Penfield's Data (which is usually not reported):
  - Penfield had 1,132 cases
  - Penfield only found memories during stimulation in those patients whose temporal lobe cortex was stimulated. The number who had temporal lobe cortex stimulation was 520 patients.
  - Of these, only 40 patients -- 7.7% -- had a memorial event!
  - Of these 40 patients, not all had a multisensory perceptual event.
    - 24 had an auditory experience
    - 19 had a visual experience
    - 12 had combined auditory and visual experiences
    - 5 had a vague experience like a thought or flashback
- How Truthful Were the Memories Recalled?

José Manuel Rodriguez Delgado

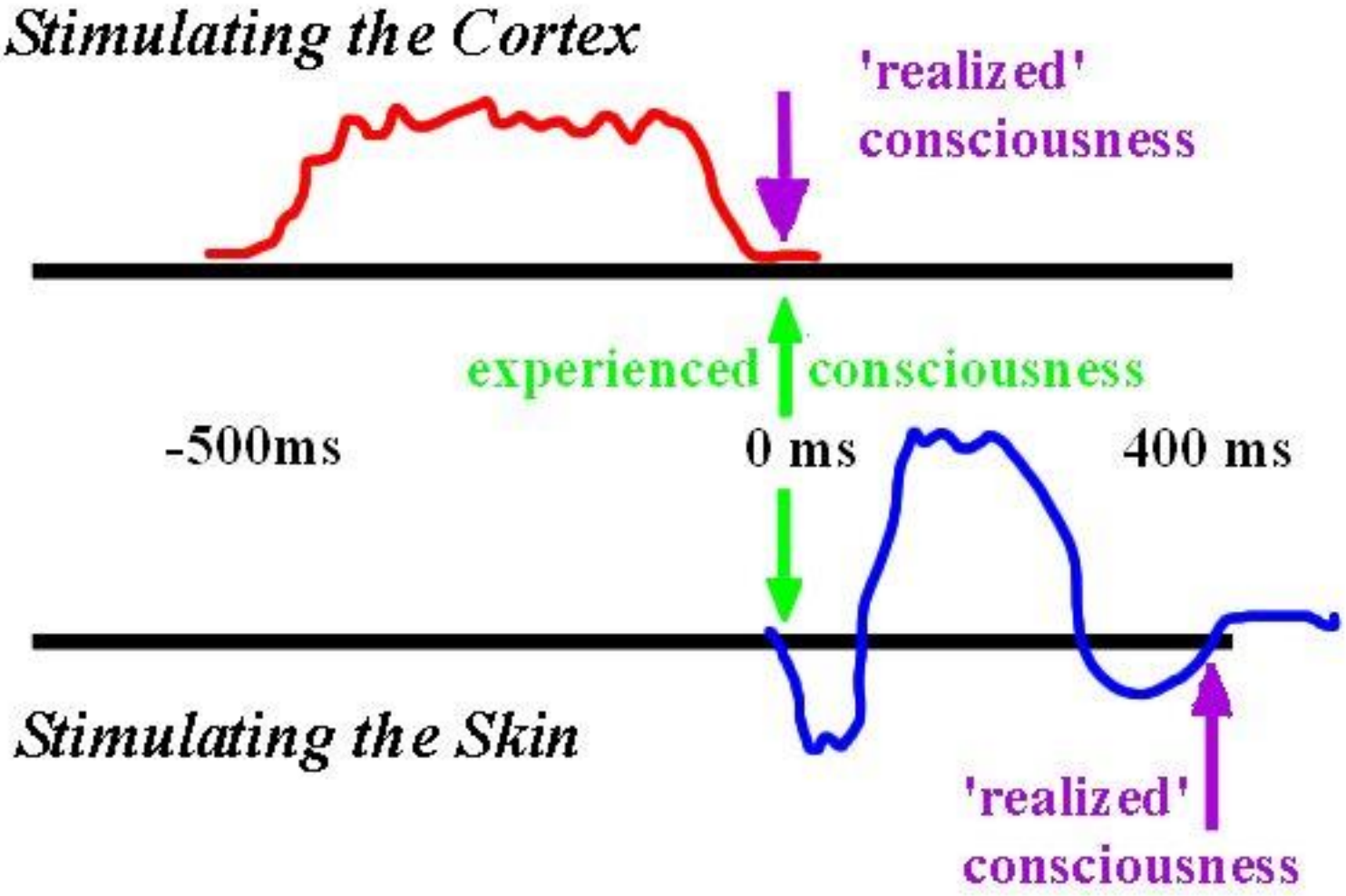


Brain stimulation experiments



Libet's Time-On Theory

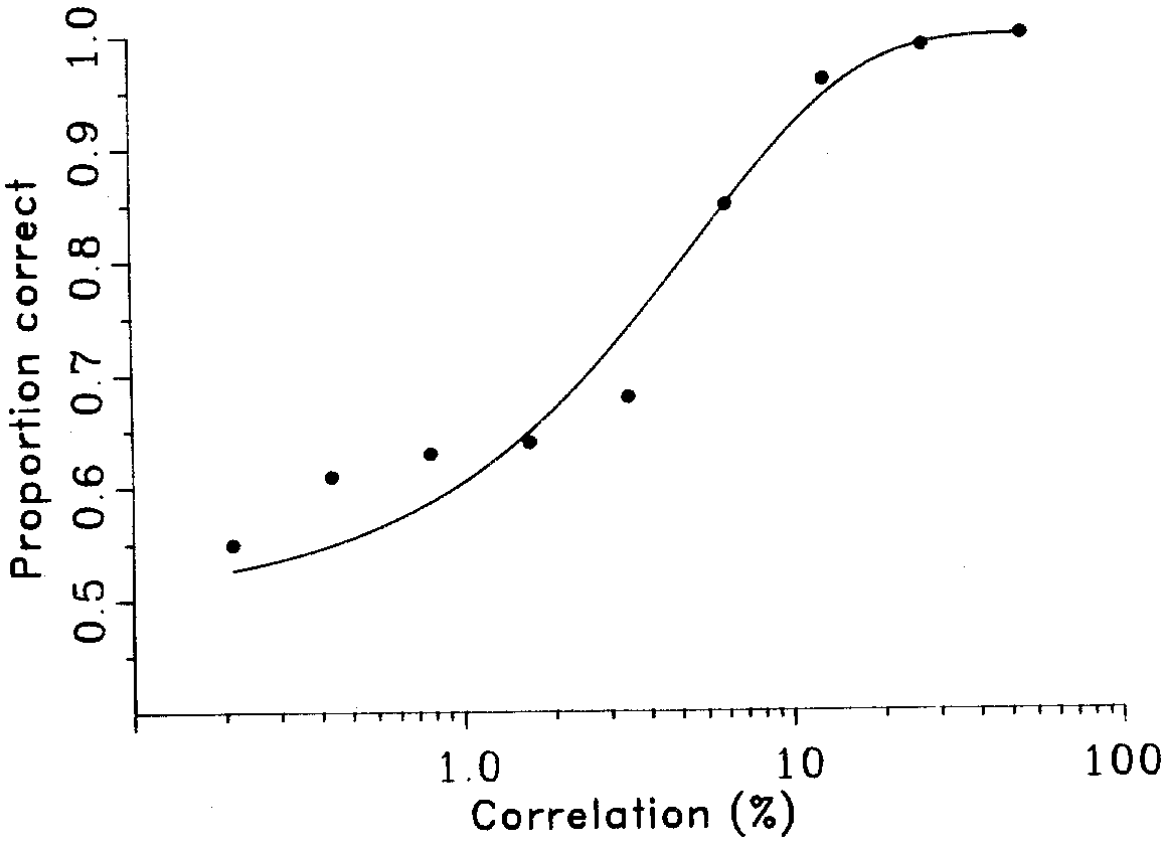
Libet‘s dual stimulation studies: cortex and skin



Area MT and the perception of visual motion

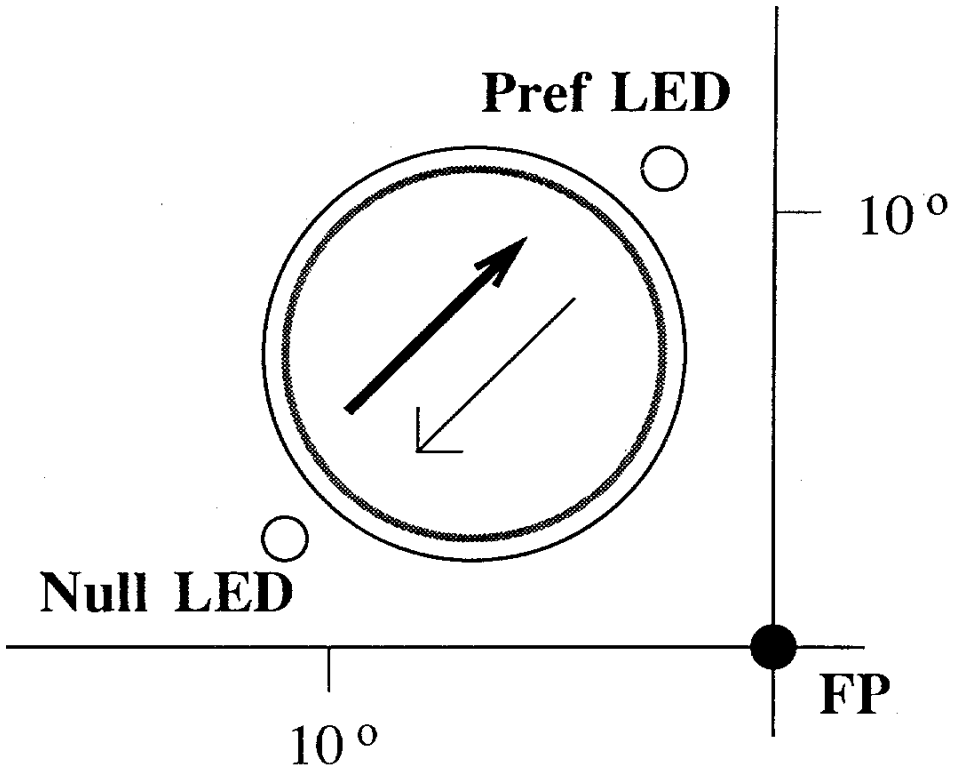
William T. Newsome

Motion sensitivity of a macaque

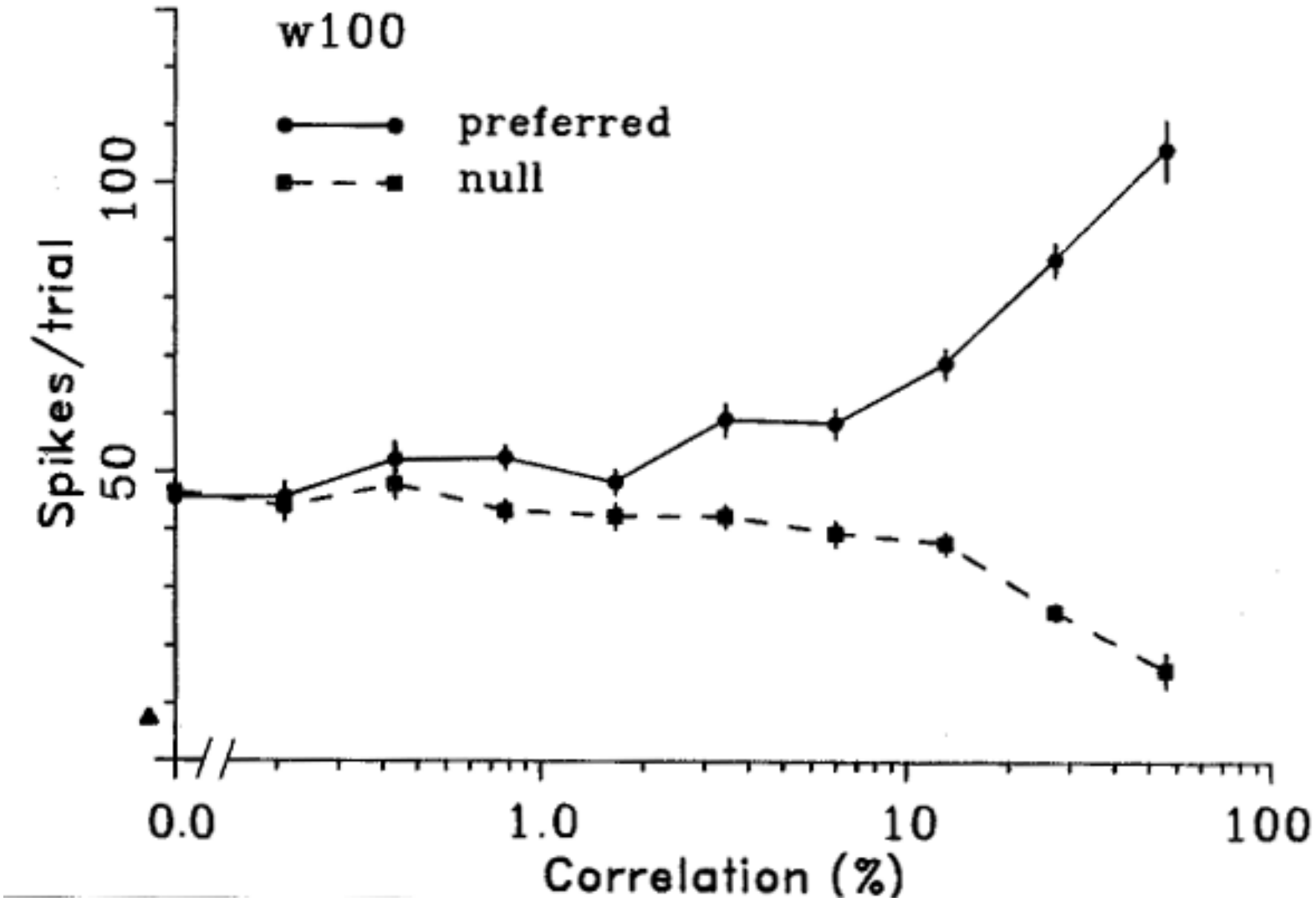


Newsome, Britten, Movshon and Shadlen

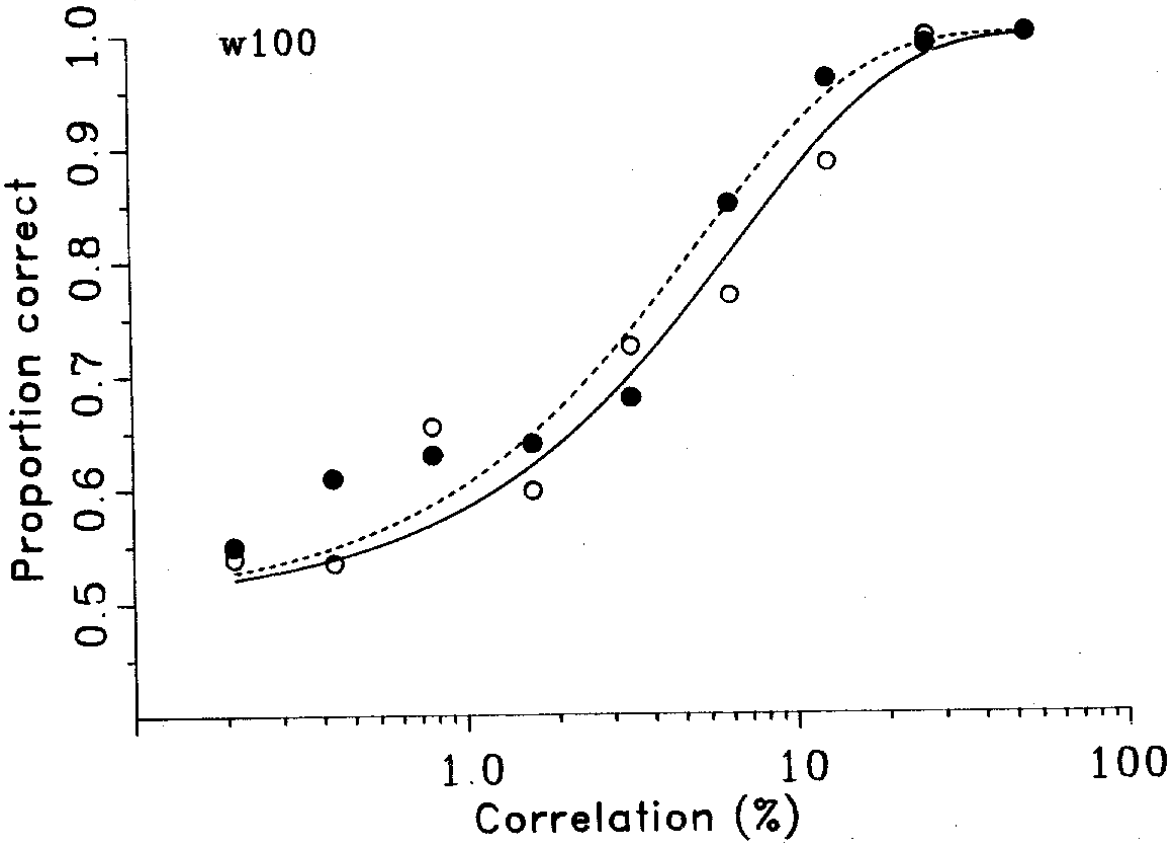
Protocol for measuring motion sensitivity of an MT cell and of the whole macaque



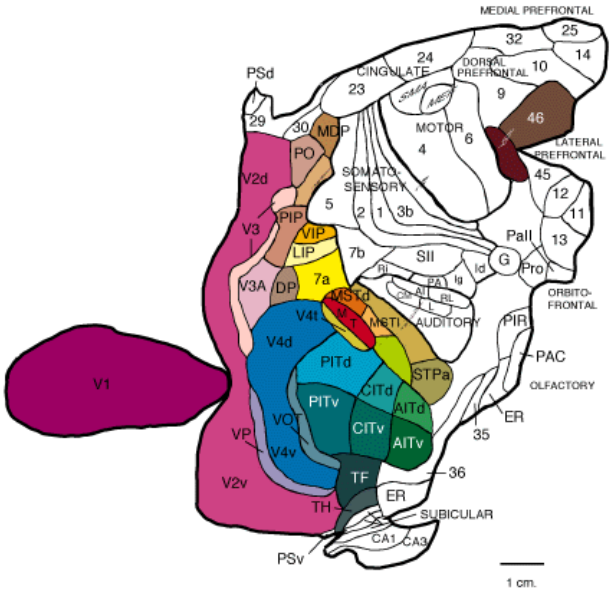
Responses of an MT cell

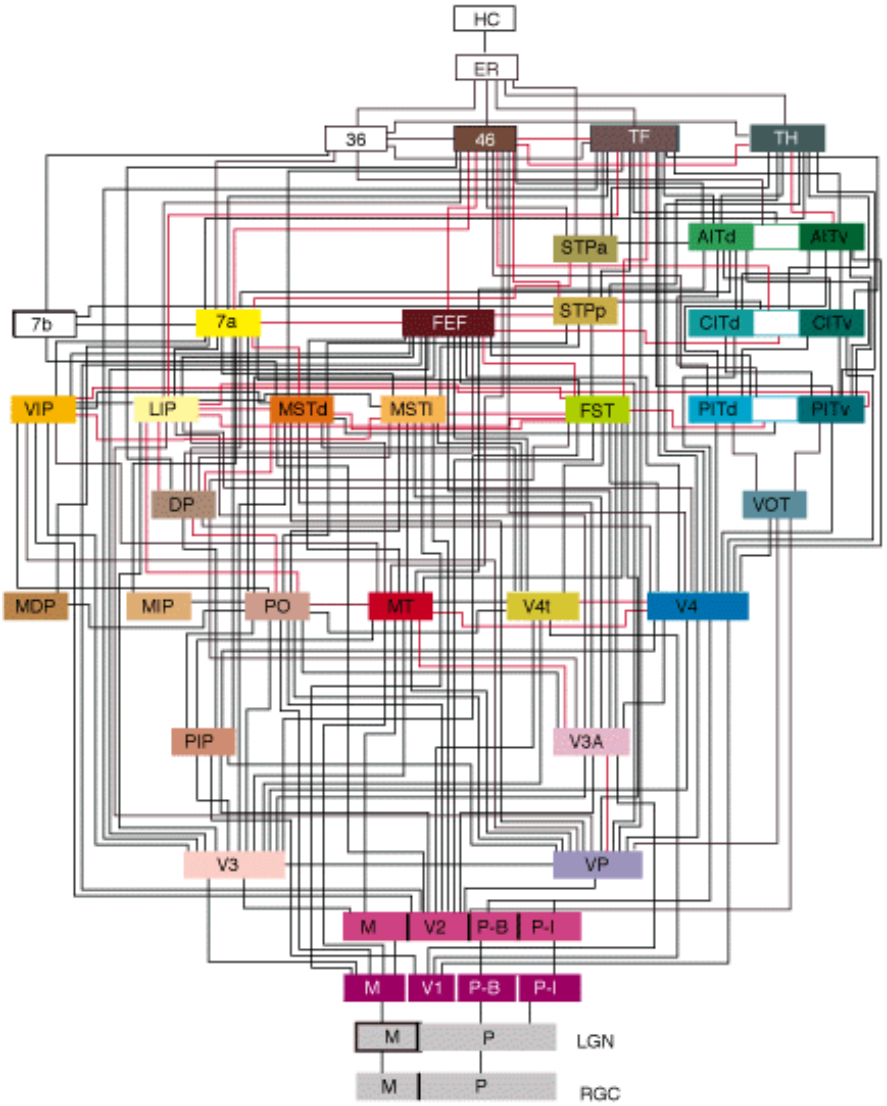


Perceptual and neural sensitivity

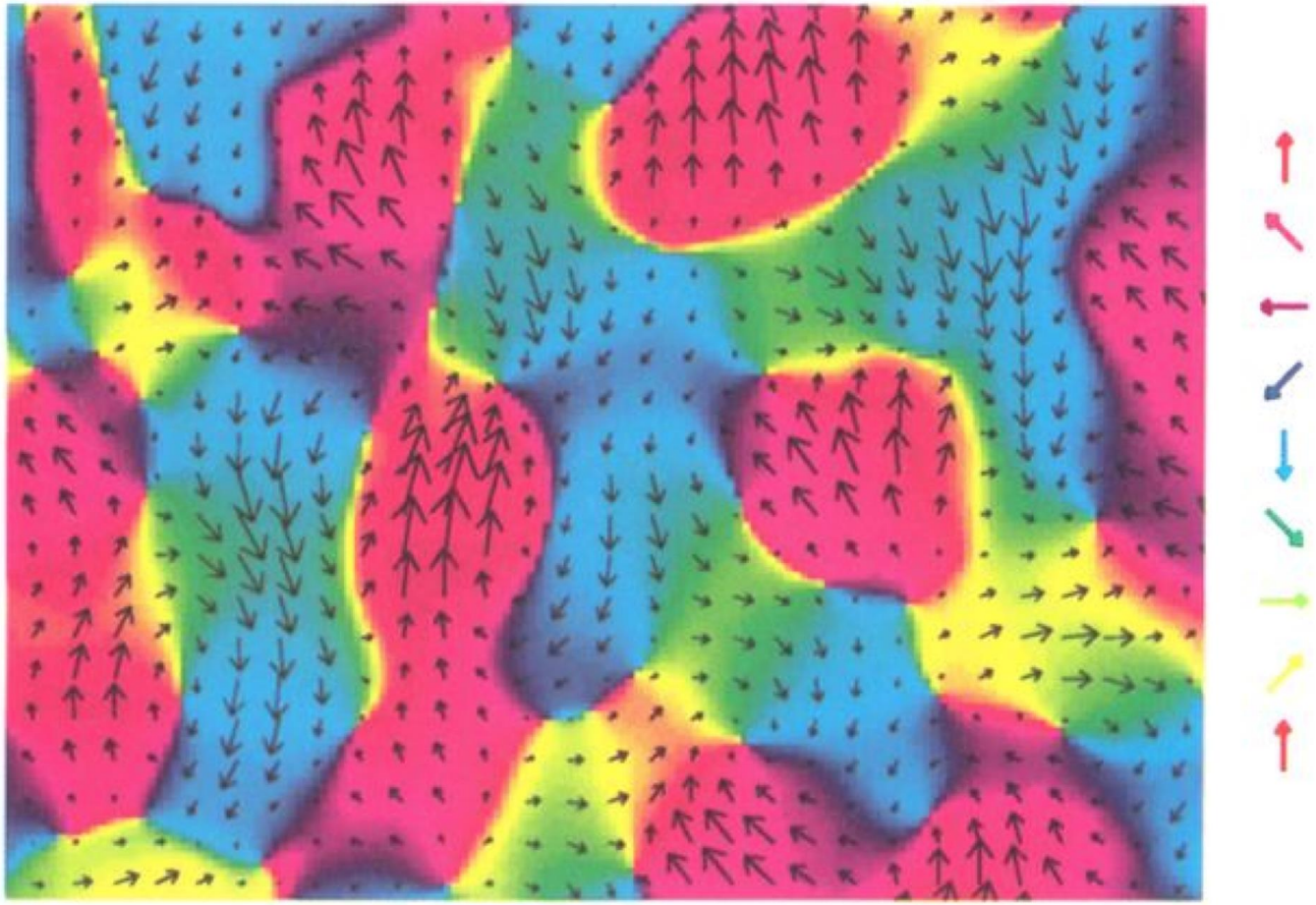


A hierarchy of visual areas

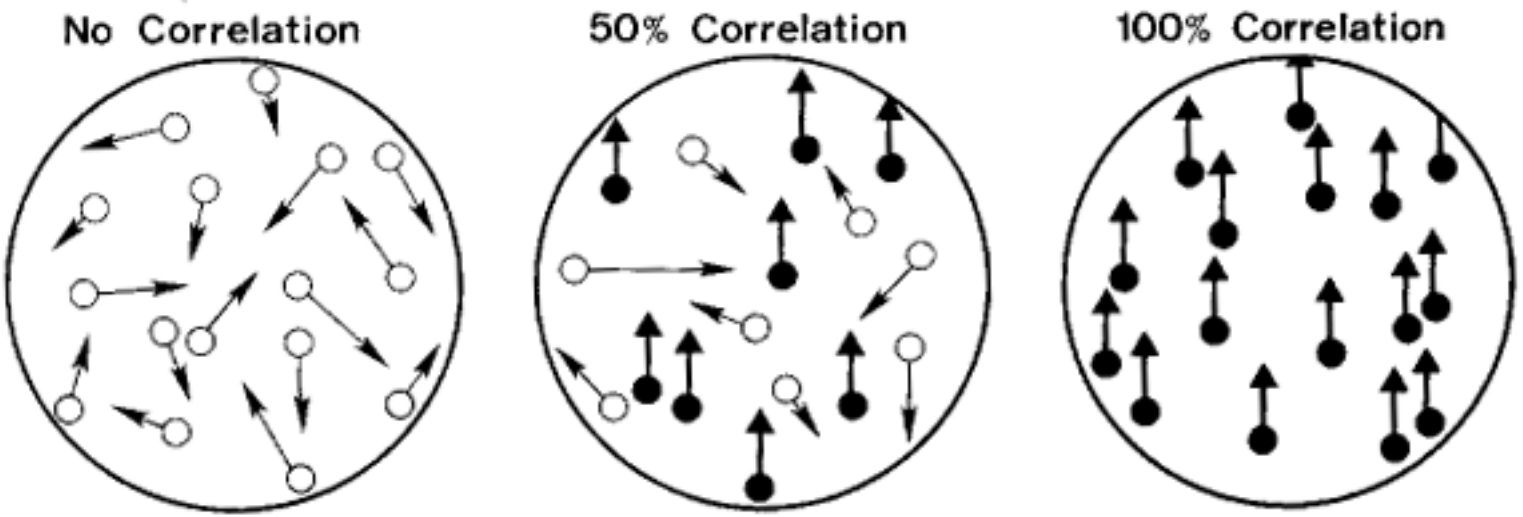




Direction columns in MT



Stimulus for measuring motion sensitivity

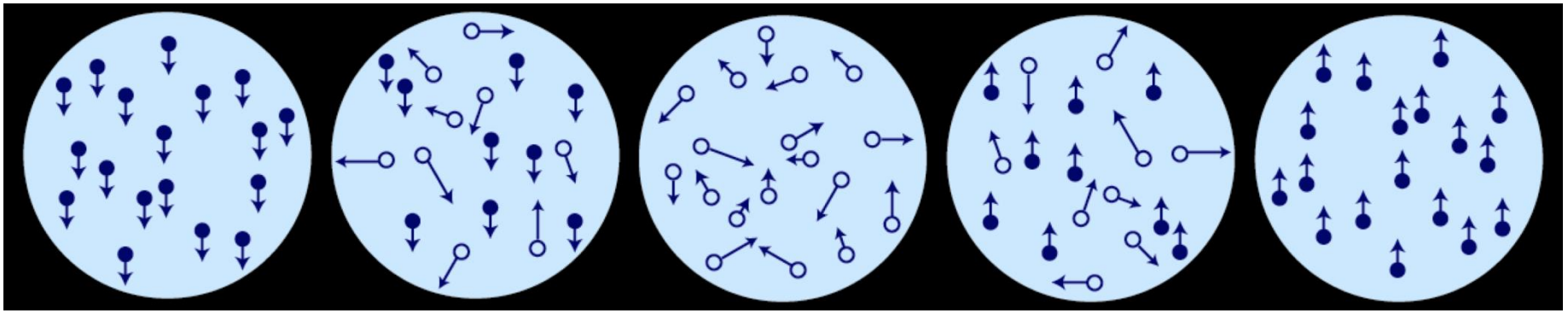


Newsome, Britten, Movshon and Shadlen

Wahrnehmung von Bewegung

nach unten ***nach oben***

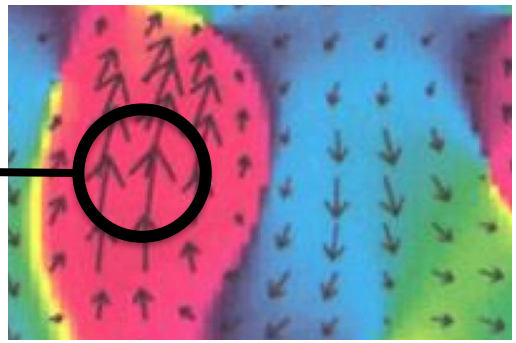
stark *schwach* *schwach* *stark*



? ? ? ? ?

Wahrnehmung

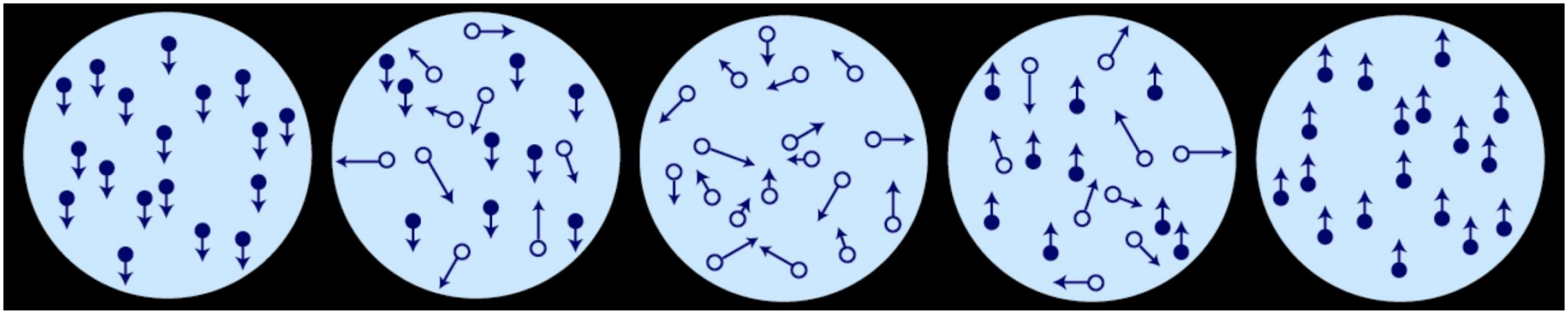
Künstliche Aktivierung



Wahrnehmung von Bewegung

nach unten ***nach oben***

stark *schwach* *schwach* *stark*

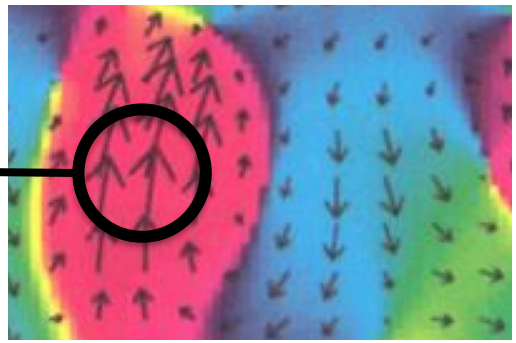


30% ↑ *50%* ↑ ***70%*** ↑ ***100%*** ↑ ***100%*** ↑

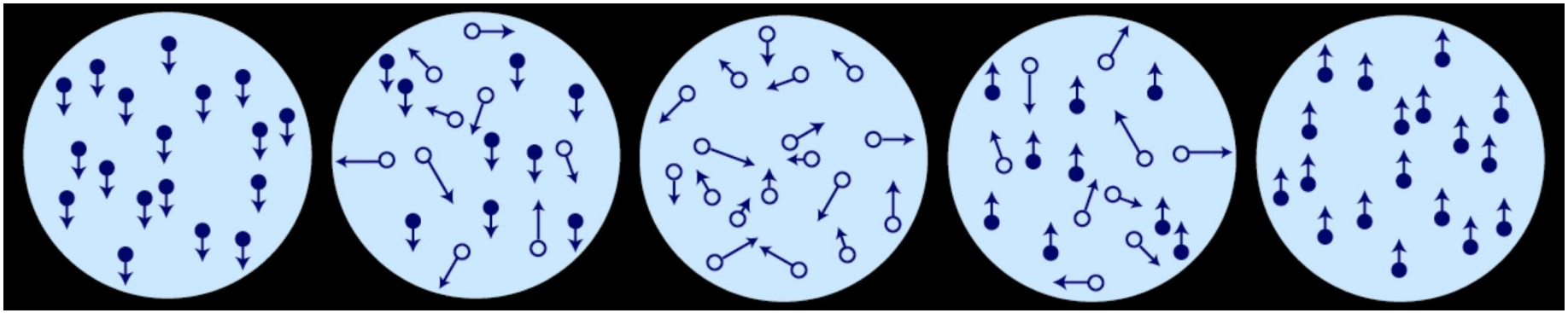
70% ↓ *50%* ↓ *30%* ↓

Wahrnehmung

Künstliche Aktivierung



Wahrnehmung von Bewegung *nicht vorhandener*

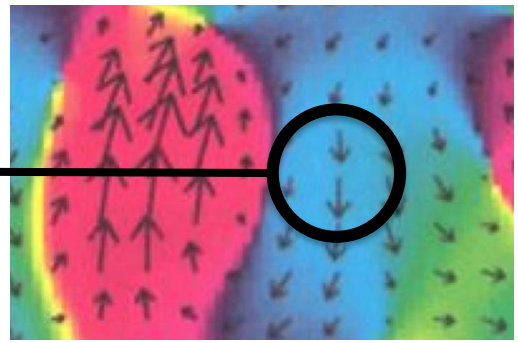


30% ↑ *50%* ↑ ***70%*** ↑

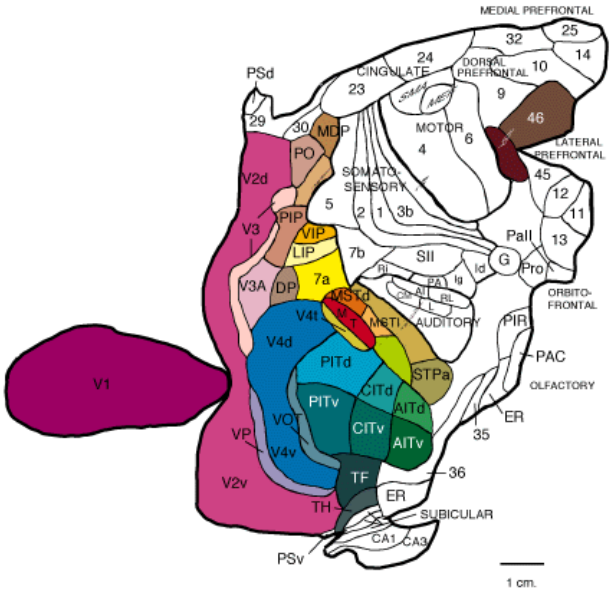
100% ↓ ***100%*** ↓ ***70%*** ↓ *50%* ↓ *30%* ↓

Wahrnehmung

Künstliche Aktivierung



~1‘000 *aktivierte Nervenzellen (von 1‘400‘000‘000)*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CINGULATE
DORSAL PREFRONTAL
MOTOR
LATERAL PREFRONTAL
SOMATO-SENSORY
ORBITO-FRONTAL
AUDITORY
OLFACTORY
PAC
SUBICULAR
PSv
1 cm.
V1
V2d
V2v
V3
V3A
V4d
V4v
V4t
VP
VOT
PIP
VIP
LIP
7a
7b
DP
MDP
PO
MSTd
MSTl
PITd
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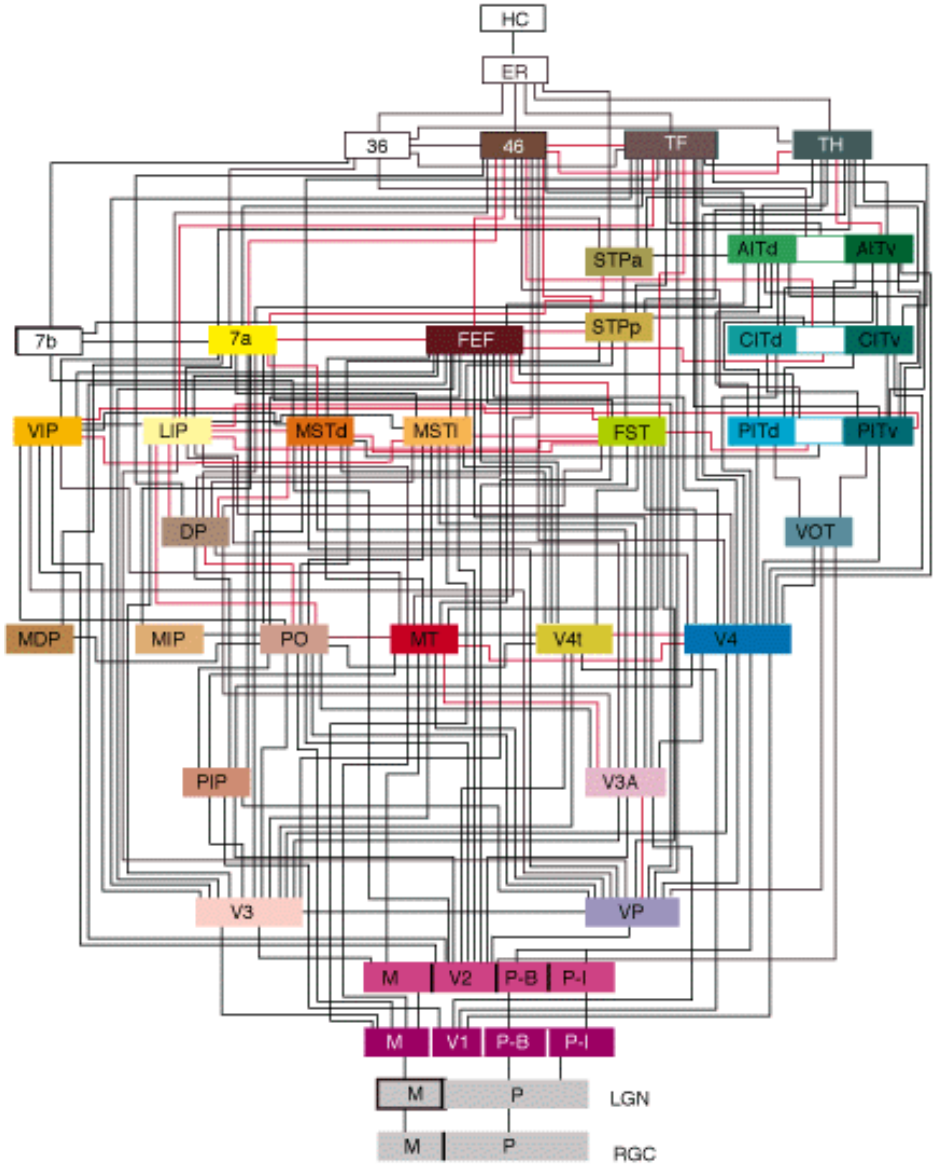
HC
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46
TF
TH
STPa
AITd
AITv
7b
7a
FEF
STPp
CITd
CITv
VIP
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MSTd
MSTl
FST
PITd
PITv
DP
VOT
MDP
MIP
PO
MT
V4t
V4
PIP
V3A
V3
VP
M
V2
P-B
P-I
M
V1
P-B
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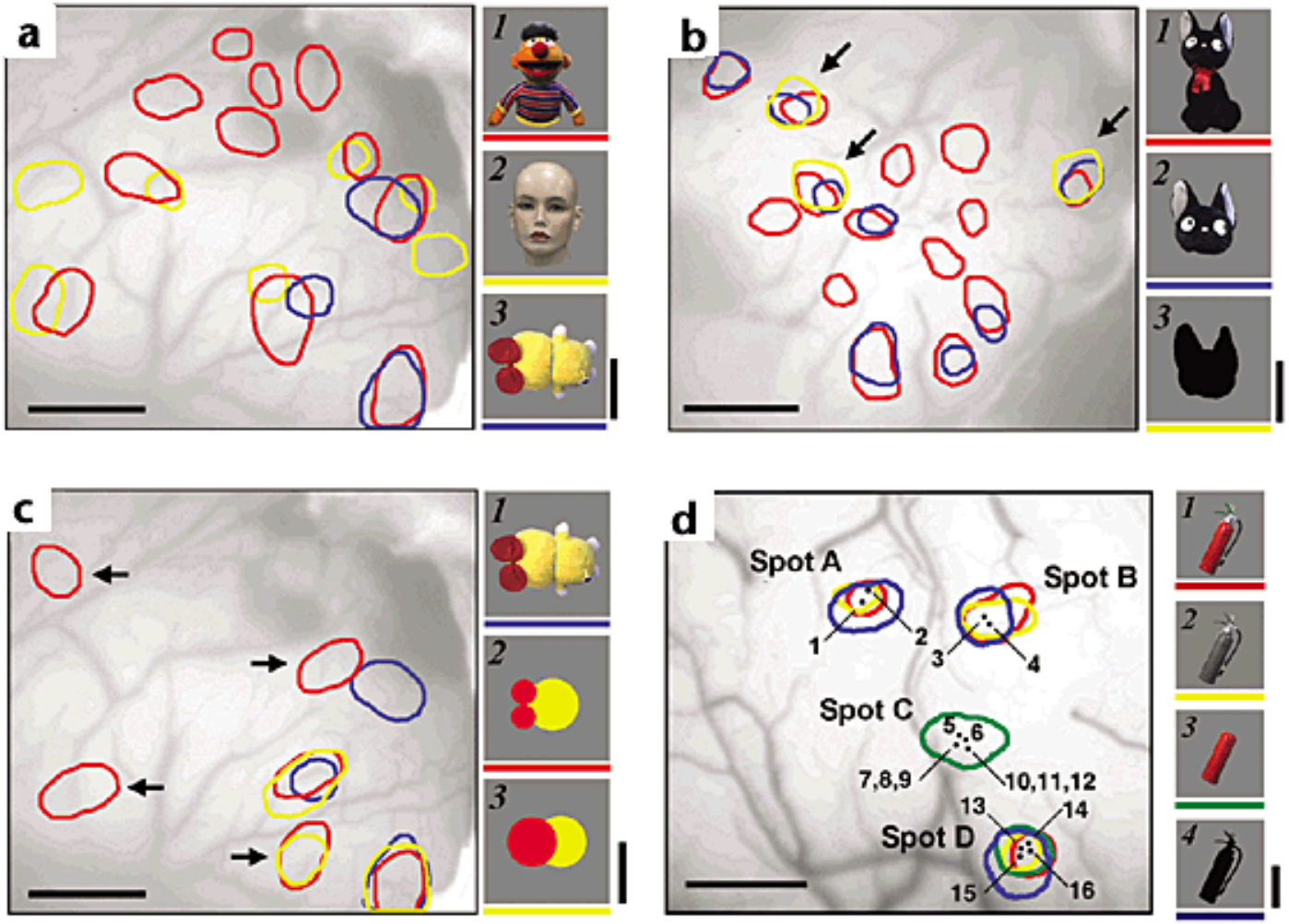
M
P
LGN
M
P
RGC

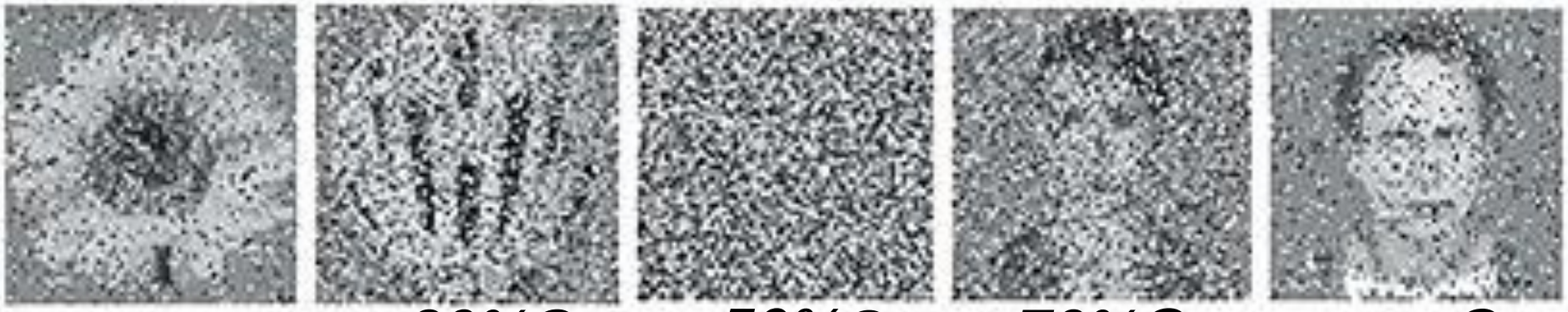
Darstellung von ganzen Objekten (Areal IT)



Nicht vorhandene wahrgenommene Gesichter

Objekt (O) ***Gesicht (G)***

stark *schwach* *schwach* *stark*



*30%**G*** *50%**G*** ***70%G*** ***100%G***

100%O ***70%O*** *50%**O*** *30%**O***

Wahrnehmung

Nicht vorhandene wahrgenommene Gesichter

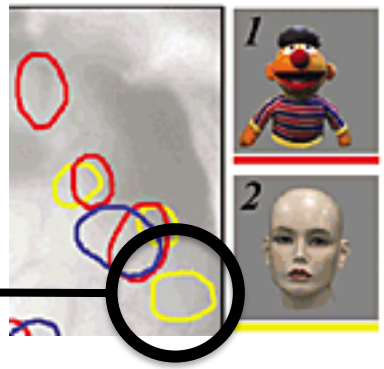
Objekt (O) ***Gesicht (G)***

stark *schwach* *schwach* *stark*

*30%**G*** *50%**G*** ***70%G*** ***100%G*** ***100%G***

70%O *50%**O*** *30%**O***

Wahrnehmung



Künstliche Aktivierung

«Patients»

- Agnosia
- Epilepsy
- Split-brain
- The Hogan sisters
- Sleepwalking
- DiD
- Coma

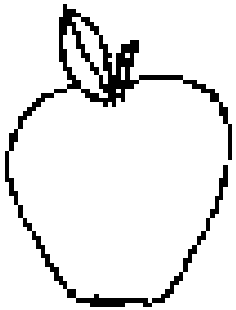
Agnosia

- *A-gnosis* (absence of knowledge); *Seelenblindheit;* agnosia (Freud)
  - *Akinetopsia*
  - *Achromatopsia*
  - *Capgras syndrome*

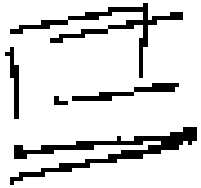
DF: A Visual Agnostic

- DF suffered irreversible brain damage following carbon monoxide intoxication. MRI imaging reveals diffuse damage, mainly in extrastriate cortex
- Her low-level vision is relatively intact: she can detect flashes within 30^{o}, her contrast response function is relatively normal and she can discriminate & perceive colors
- She can catch a ball or stick thrown at her, can navigate on her own, can follow a target with her eyes
- She can't recognize 2-D line drawings or copy them. She can draw objects from memory, but can't recognize them later
- DF has profound lack of form perception (apperceptive agnosia).

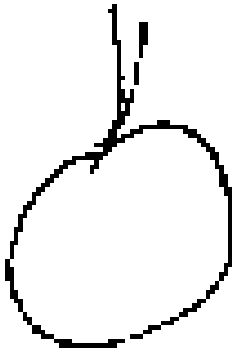
Model

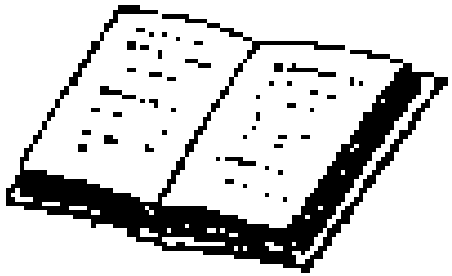


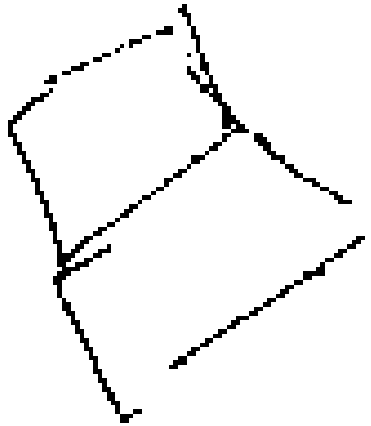
Copy



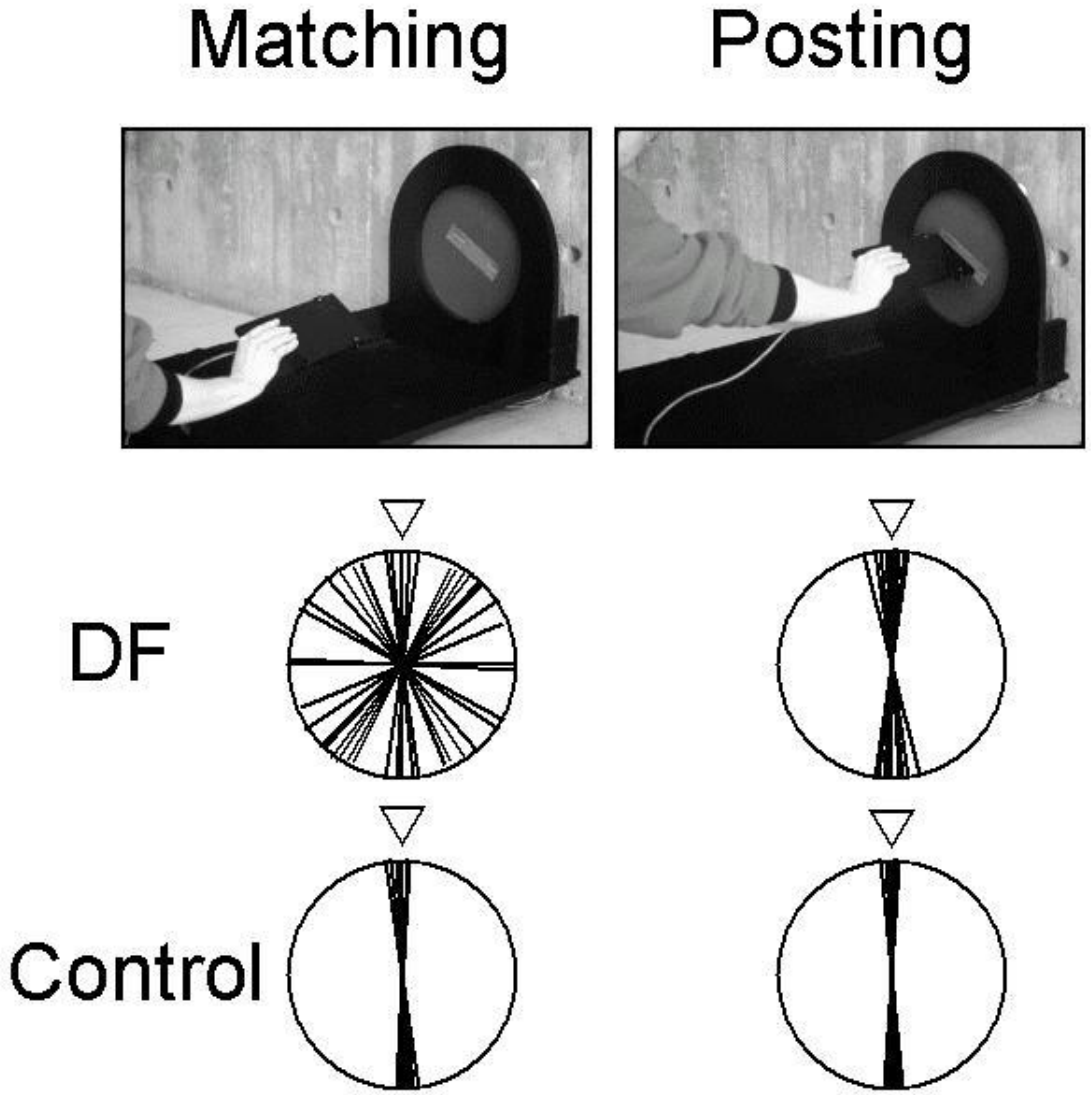
Memory







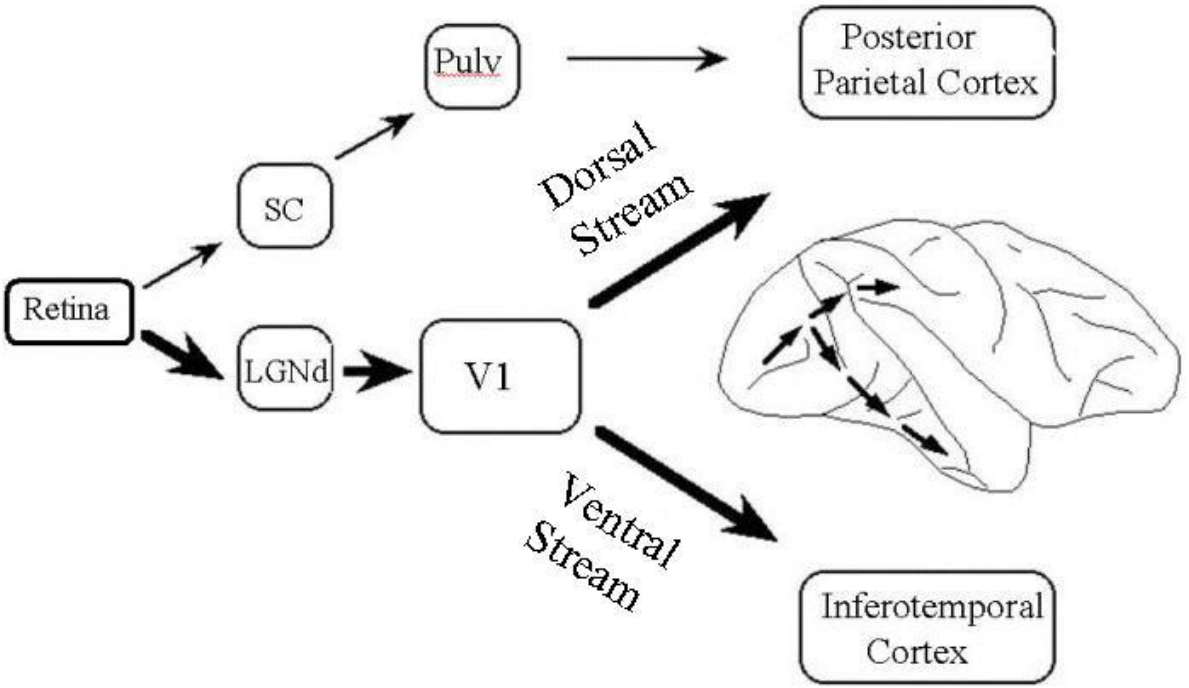
(Milner & Goodale, 1995)



(Goodale, 2000)

DF: A Visual Agnostic

- DF can’t perceive the orientation of a slot, but can rapidly `post' a card into the slot at the correct orientation
- She is unable to judge the size of a block, but when asked to pick it up, her thumb-index finger aperture scales correctly
- If a 2 sec delay is interposed between visual exposure and motor execution, her performance deteriorates. Her short-term memory for more cognitive tasks is intact



fMRI confirms that DF has more serious impairments in her ventral pathway than in her dorsal regions (Goodale and Milner, 2004).

Epileptic Seizures: Definitions

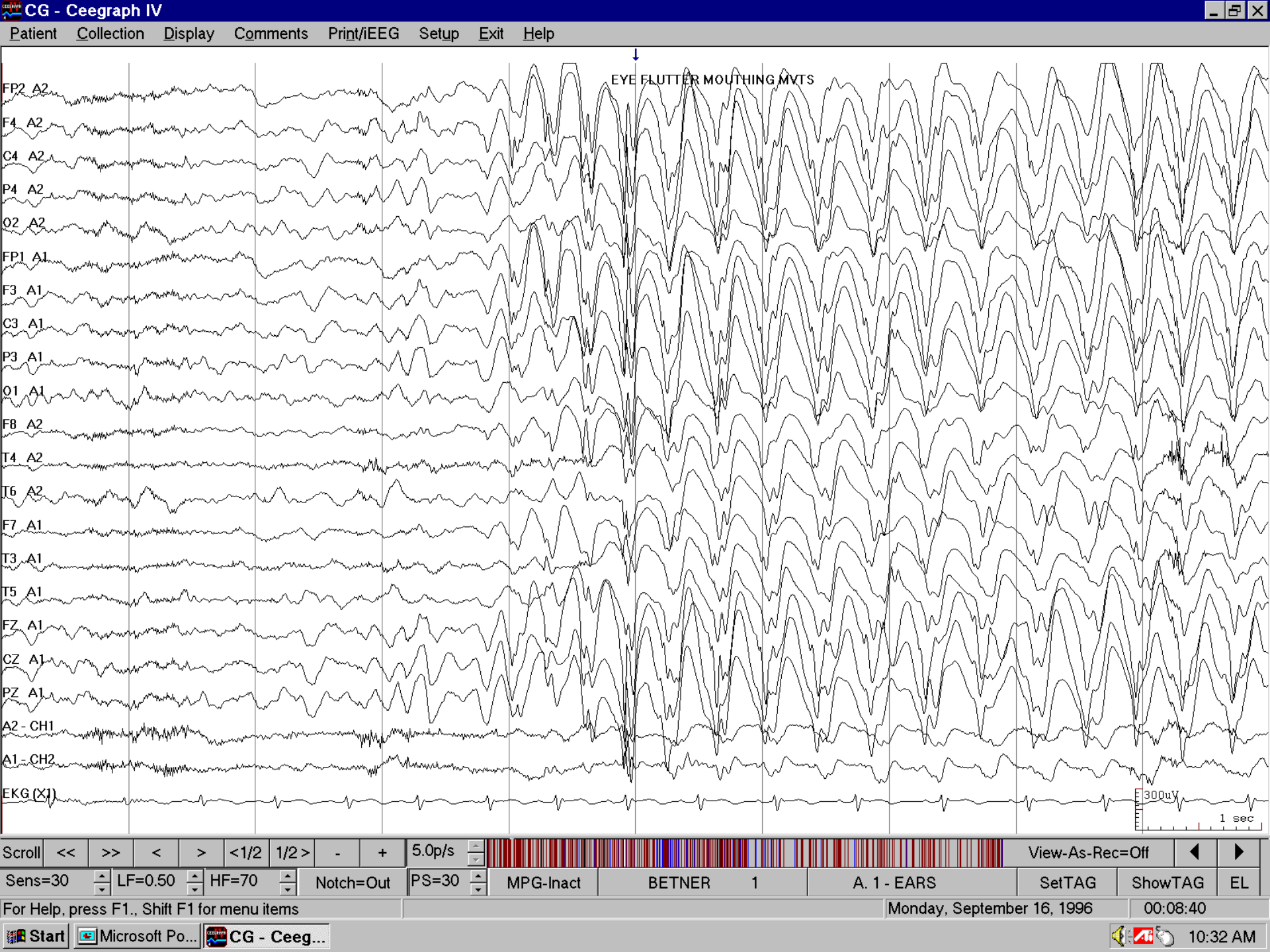
- Seizures (convulsions)
  - abnormal motor, sensory and/or behavioral activity resulting from excessive, abnormal cortical electrical activity
  - 10% will have at least 1 seizure
- Epilepsy (primary/epileptic seizures)
  - recurrent unprovoked seizures 24h or more apart
  - <1% of population is affected

Epileptic Seizure Classification

- Simple seizure: consciousness not impaired
- Complex seizure: consciousness impaired
- Focal seizure: only part of cortex involved
- Generalized seizure (*grand mal*) *:*involve entire cortex

Note: A focal seizure may become generalized

- Absence seizure (*petit mal*): brief periods of wakeful unconsciousness


CG - Ceegraph IV
Patient Collection Display Comments Print/iEEG Setup Exit Help
EYE FLUTTER MOUTHING MVTS
FP2 A2
F4 A2
C4 A2
P4 A2
O2 A2
FP1 A1
F3 A1
C3 A1
P3 A1
O1 A1
F8 A2
T4 A2
T6 A2
F7 A1
T3 A1
T5 A1
FZ A1
CZ A1
PZ A1
A2 - CH1
A1 - CH2
EKG (X1)
300uV
1 sec
Scroll << >> < > <1/2 1/2 > - + 5.0p/s View-As-Rec=Off
Sens=30 LF=0.50 HF=70 Notch=Out PS=30 MPG-Inact BETNER 1 A. 1 - EARS SetTAG ShowTAG EL
For Help, press F1., Shift F1 for menu items
Monday, September 16, 1996 00:08:40
Start Microsoft Po... CG - Ceeg... 10:32 AM

Automatic Behaviors in Epileptic Patients

In a major seizure a patient suddenly loses consciousness and has generalized convulsion. There is no evidence of psychical activity, only silence. There is gross, purposeless somatic and visceral activity. The return to normal may be much more deliberate. The storm of the convulsion having passed, the patient lies motionless. Electrical potentials in the brain are damped or almost completely absent. The respiratory centers continue to function, although, perhaps imperfectly.

Gradually body movements reappear. The patient stirs, opens his eyes, but obviously is not conscious of his environment. There is a lag in the return of consciousness during which somatic coordination becomes steadily more complete. The patient places himself in a more comfortable position. He may then go to sleep. If so, he probably awakens some hours later to a normal state with no recollection of the whole affair.

But if he does not sleep and if consciousness is slow to return, he may get up and go about in a confused manner. It is easy to see that his behavior is automatic. There is for the time being freedom or release from conscious control. In this state, consciousness is apt to return to him gradually. He may first seem to be aware of himself, then of his environment, and finally, after a little confusion, he gains access to memory, to understanding and insight.

– Penfield, W. and Jasper, H. Epilepsy and the Functional Anatomy of the Human Brain, Little, Brown and Company: Boston, Massachusetts, 1954.

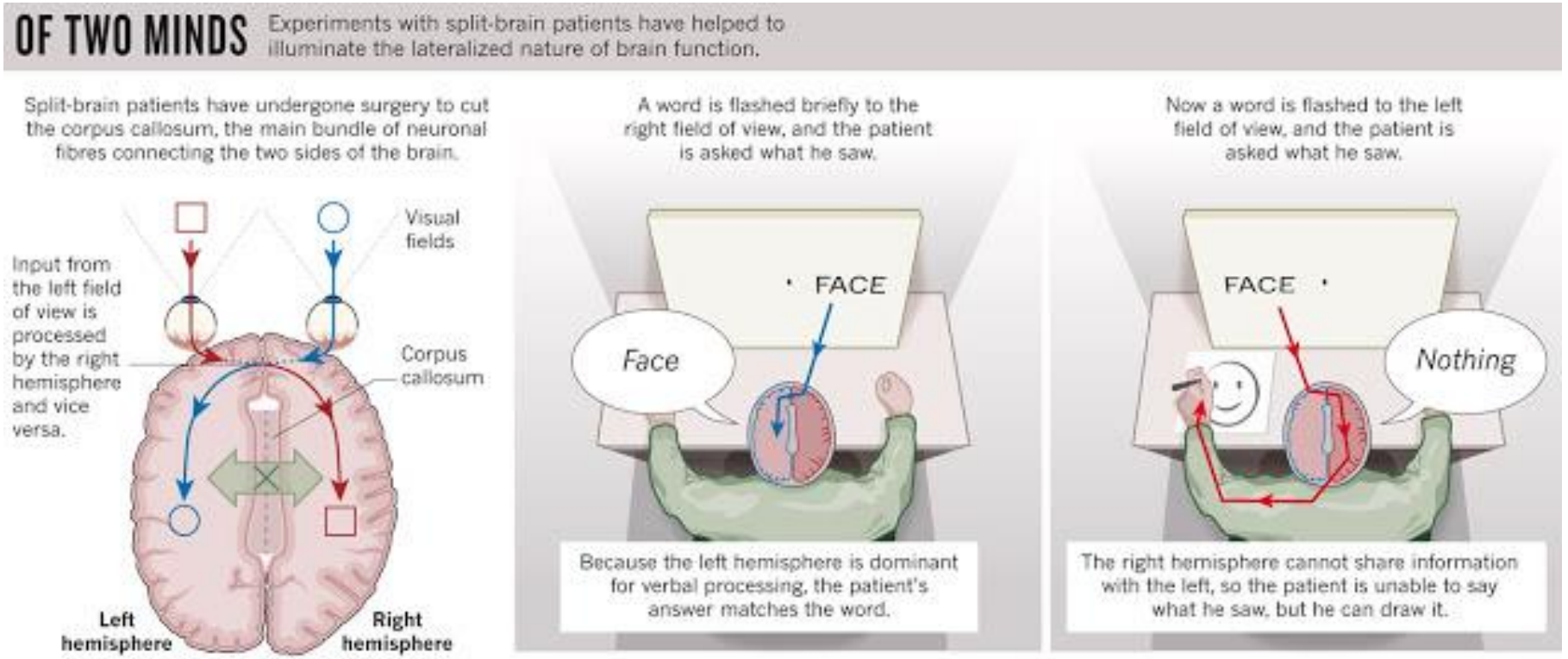
Psychomotor or partial, complex temporal lobe seizures

A seizure of a different nature was observed in a 24-year old man, A.C., with a right temporal epileptogenic EEG focus and attacks classified in his chart as ``complex partial.'' The seizures were described as starting with a feeling of fear or sadness followed by ``loss of awareness of his surroundings with loss of consciousness'' accompanied by staring, face and neck movements, spitting, chewing, elevation of the left arm, and uttering phrases like ``I love you'' or obscene words.

The patient reported that after an initial feeling of fear he loses the capacity to recall anything that happens during the spell. He is usually able to alert people around him that he is having a seizure, but he has no memory of this. He has a glassy look to his eyes, spits, chews and makes other lip movements. He is, however, not totally unresponsive, and his fiancée could give many examples of this. For example, if she asks him his name or how old he is, he is wont to reply correctly, yet he subsequently has no recollection of this. When asked to execute certain movements during an attack, he will do so correctly, again not remembering anything of this later. The patient has said to his fiancée during an attack ``I am going to marry you, honey,'' again without being able to recall this. Frequently during an attack he would say to anyone around him ``I love you,'' and if the person's name was known to him, add the name to the phrase. While in hospital he said to his roommate during one of these attacks ``I love you, David,'' even though he had known David for only 1-1/2 days. He had no recollection of this. . . .

– (Gloor, 1986).

Split-brain patients



Source: http://ib-psych-alzherimers.blogspot.com/p/1.html

Krista and Tatiana Hogan

Are Sleepwalkers Zombies?

- Somnambulistic activities include talking, sitting up in bed, mumbling, undressing/dressing, walking, going to the bathroom, moving furniture, jumping out of windows, driving…
- Episodes last between half a minute and half an hour
- More frequent in children than in adults
- Occurs during non-REM
- Leaves no explicit recollection
- Rarely, propensity for violence, including homicide (➔ no-insane automatism defense)
- Eyes can be frequently open, clumsy movements (➔ zombies)

- "They appeared, although in a state of frenzy and intense autonomic arousal, as automatons unaware of what they were doing and unresponsive to stimuli from their environment"
  - (Moldofsky, H et al. Sleep-related violence *Sleep* **18**: 731-739, 1995).

Dissociative Identity Disorder (DID)

DSM-IV Diagnostic criteria:

A. The presence of 2 or more distinct identities or personality states (each w/ its own relatively enduring pattern of perceiving, relating to, & thinking about the environment & self).

B. At least 2 of these identities or personality states recurrently take control of the person's behavior.

C. Inability to recall important personal info that is too extensive to be explained by ordinary forgetfulness.

D. The disturbance is not due to the direct physiological effects of a substance (e.g., blackouts or chaotic behavior during Alcohol Intoxication) or a general medical condition (e.g., complex partial seizures). **Note:** In children, the symptoms are not attributable to imaginary playmates or other fantasy play.

Diagnostic & Statistical Manual of Mental Disorders, 4th Ed, Text Revision (2000) Amer. Psychiatric Assoc.

Psychobiological characteristics of DID

(Reinders et al. 2006, *Biol Psychiatry*)

- DID pts have 2 or more dissociative identity states (DIS), categorized as 'neutral identity states' (NIS) & 'traumatic identity states' (TIS).
- NIS inhibit access to traumatic memories thus enabling daily life functioning.
- TIS have access & responses to these memories
- Do DIS pts show different psychobiological reactions to trauma-related memory?
- DIS have been shown to have different psychobiological characteristics that cannot be simulated by controls: electrodermal activity, EEG, visual evoked potentials, autonomic variables, optical variables, & arousal
- Affected brain regions are generally directly or indirectly linked w/ emotional & memory processing.

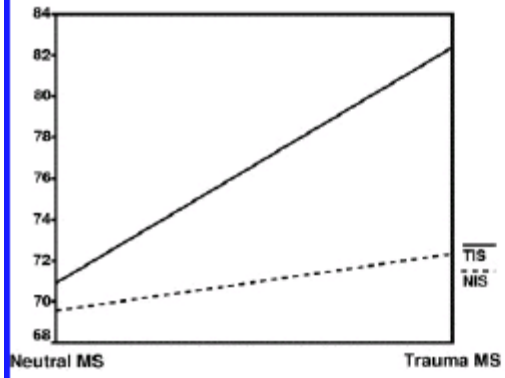
Methods

- 11 female DID pts (27-48 yrs) w/ self-controlled switching btw 1 NIS & at least 1 TIS (subjective age >10)
- Neutral memories endorsed by both states; traumatic memories experienced as personal only by TIS
- Using $H_2{}^{15}O$ PET explored rCBF patterns in the NIS & TIS states when exposed to neutral vs traumatic autobiographical memory scripts
- 120 sec scripts audiotaped in neutral tone by one of PIs
- 3 psychobiological parameters were tested:
  - rCBF determined w/ $H_2{}^{15}O$ PET
  - subjective ratings (emotional & sensori-motor)
  - cardiovascular responses (heart rate, blood pressure, heart rate variability)

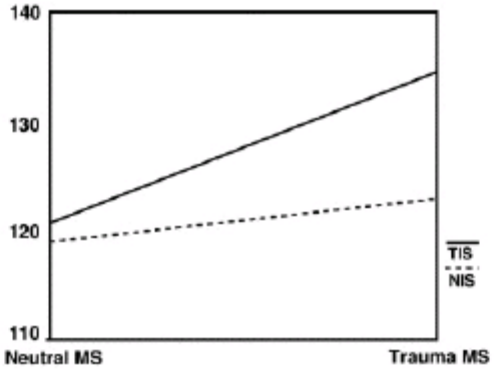
•Both NIS and TIS gave informed oral consent.

Graphical rep of subjective emotional & sensori-motor experiences, & cardiovascular responses

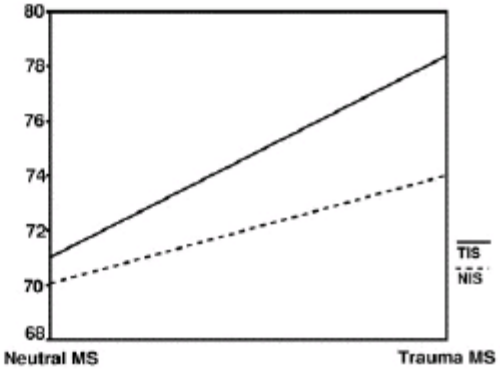
Heart rate frequency

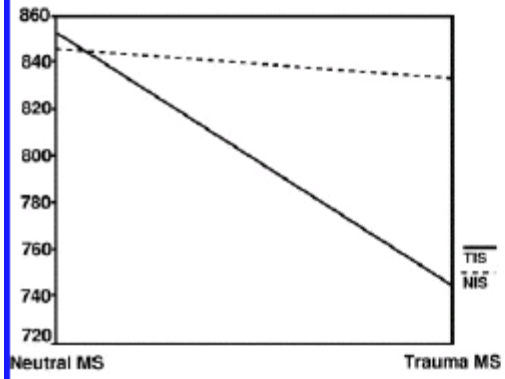


Systolic blood pressure

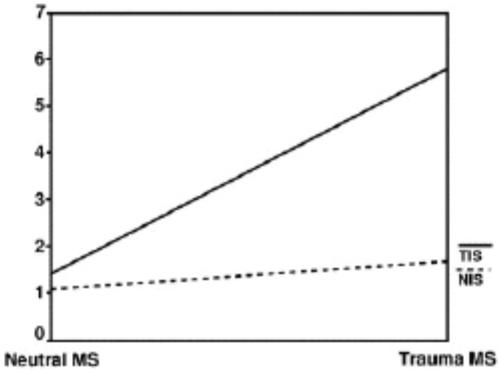


Diastolic blood pressure (n.s.)

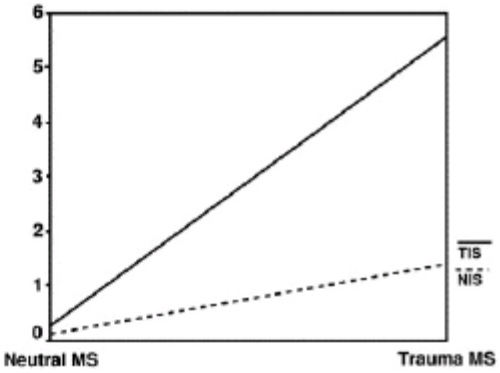




Heart rate variability



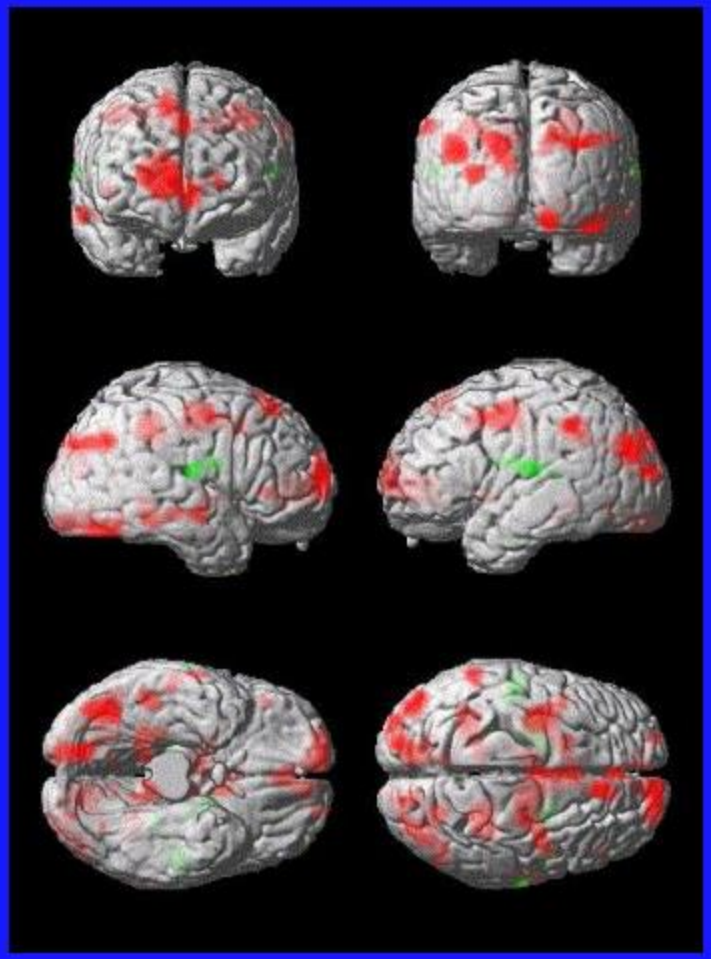
Sensori-motor rating



Emotional rating

Dashed line = response of the NIS when listening to the neutral or trauma-related MS.
Solid line = response of the TIS when listening to the neutral or trauma-related MS.

(Only sig or near sig interaction effects are depicted)



Brain areas which display a sig increase in rCBF for the DIS main effect.

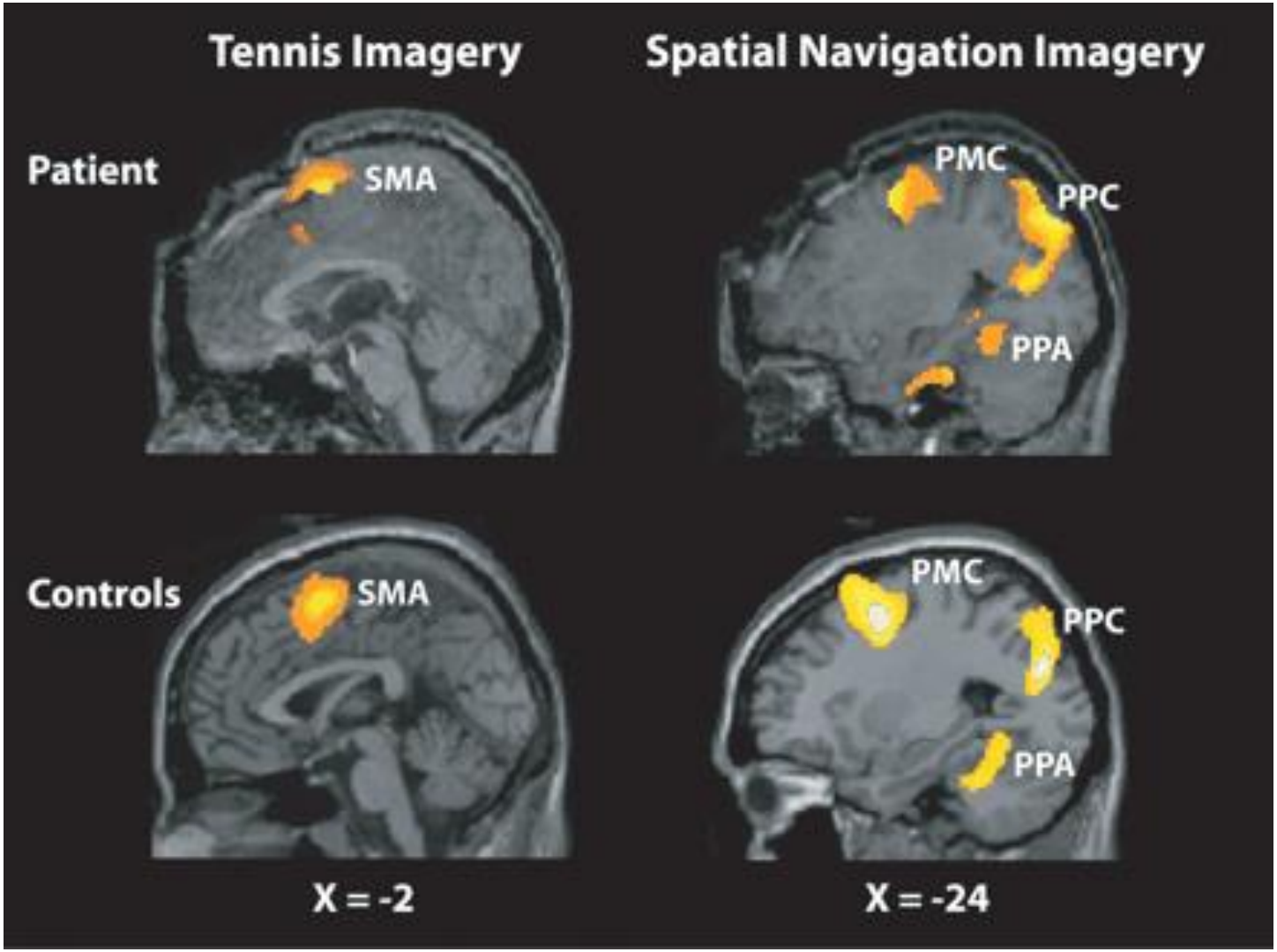
Green = rCBF changes (activations) for the TIS.
Red = rCBF changes (activations) for the NIS.

- Main effects: Sig diff in rCBF patterns for the 2 DIS, but not for MS.
  - NIS had broad pattern of brain area activations compared to only a few brain areas in the TIS
- No interaction effect; these patterns indifferent to MS
- Functioning as a DIS is of a more general nature, maintaining a different brain state, rather than directly linked to the effect of particular memories

In Sum

- DID pts encompass at least 2 different DIS.
- Psychobiological differences were found for the different DIS.
- These identities involve different subjective reactions, cardiovascular responses, & cerebral activation patterns to a trauma-related MS.
- rCBF data revealed different neural networks associated w/ different processing of the neutral & trauma-related memory script by NIS & TIS.
- So there seems to be a type of “splitting” on C in these pts

Imagery in a coma patient



A. Owen et al,2006