

9.00 BLINDSIGHT & NEGLECT

Professor John Gabrieli

Objectives

- *Blindsight*

 - what it is

 - brain basis

 - unconscious perception

- *Neglect*

 - what it is

 - brain basis

 - construction of visual attention

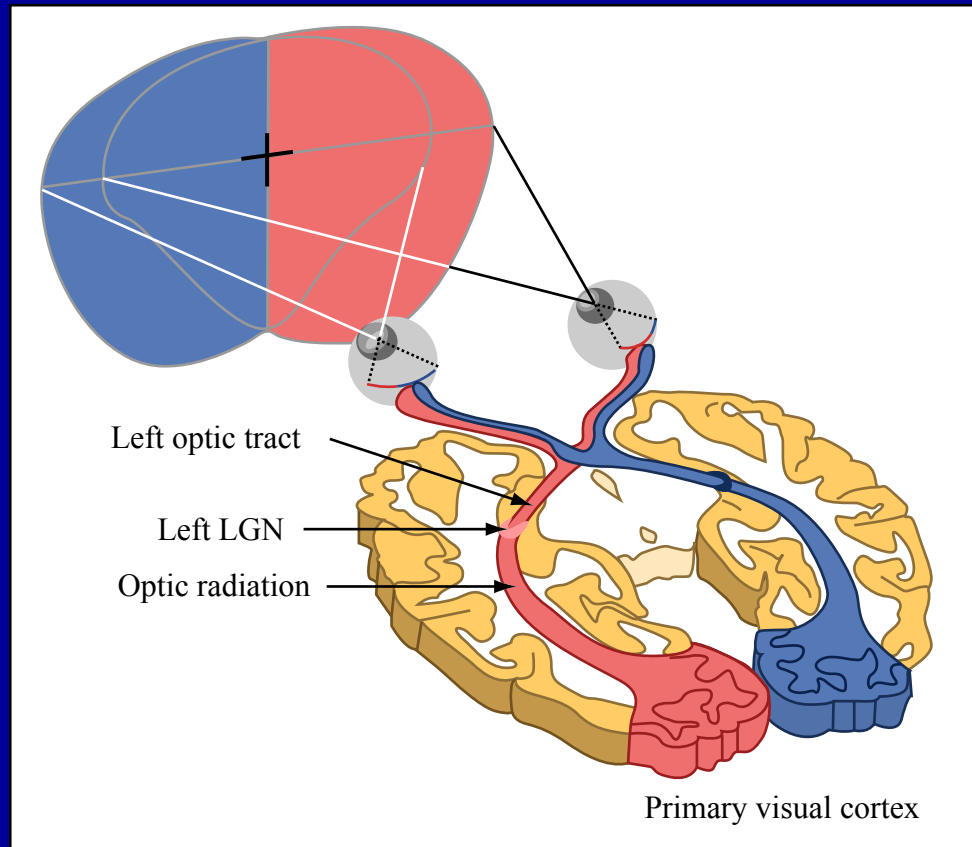


Image by MIT OpenCourseWare. After Figure 10-4b in Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. *Neuroscience: Exploring the Brain*. 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2007. ISBN: 9780781760034.

Blindsight & Tectopulvinar Visual System

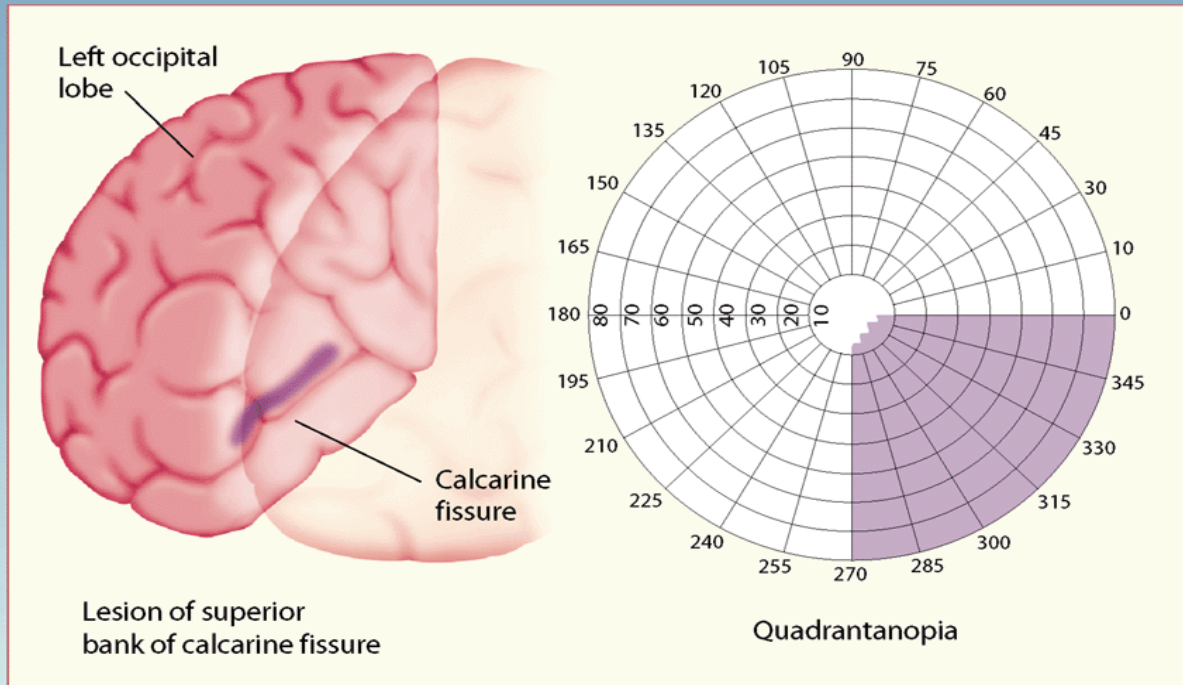
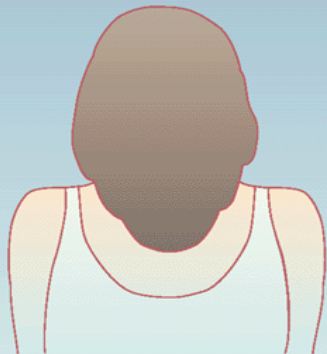
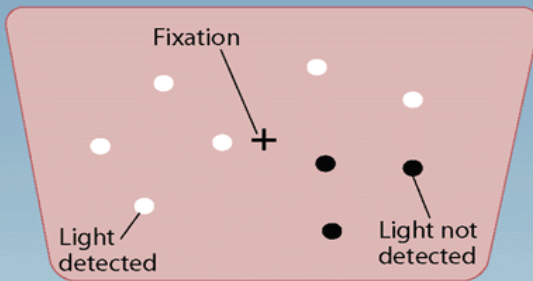
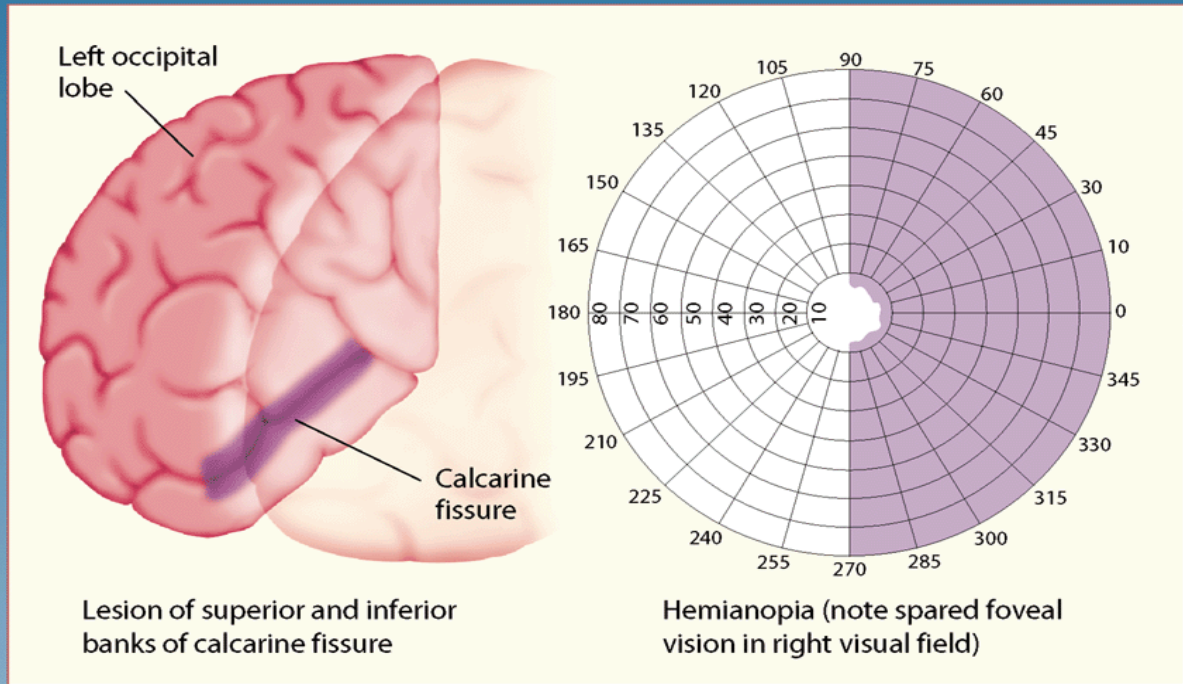
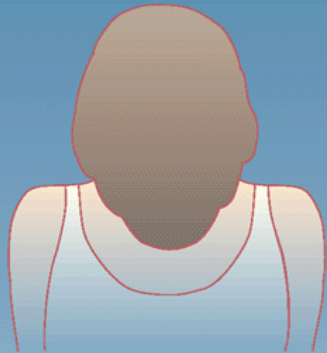
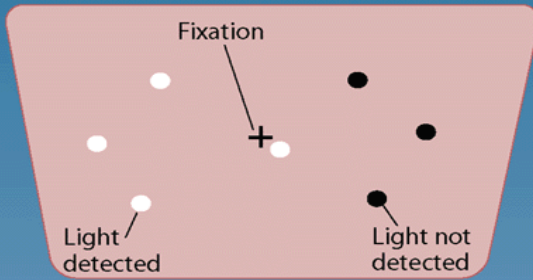
Sensation without perception

Three subcortical retinal projections:

- pretectal area of midbrain controls pupillary reflexes
- lateral geniculate nucleus & *geniculostriate system* (90%)
- superior colliculus & *tectopulvinar system*

What is not done by the *geniculostriate system* ?

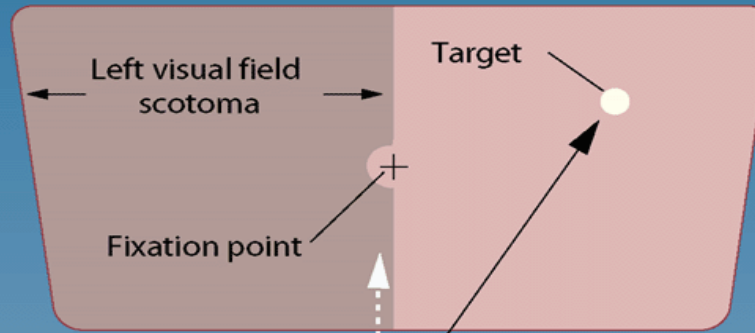
- **consequence of unilateral or bilateral occipital lesions**
- **Munk (1881) dogs with bilateral occipital lesions avoided obstacles in path that they failed to recognize**
- **monkeys with complete visual cortex ablations recover ability to do spatial localization, orientation detection, very simple shape discrimination**



Blindsight

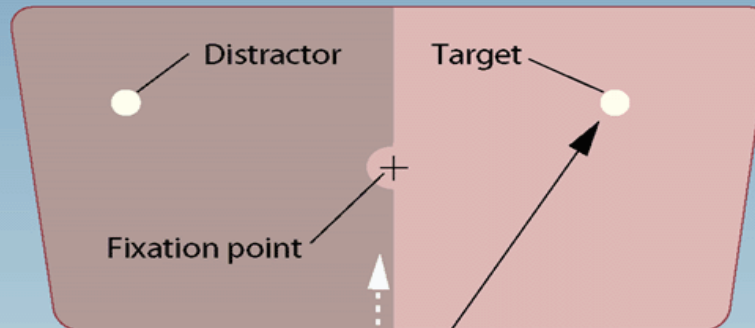
- **Patient DB (Weiskrantz) –**
 - arteriovenous malformation in right occipital pole**
 - right visual cortex removed**
 - tested in blind region by dynamic perimetry**
 - LVF scotoma**
 - light flash, move eye toward light**
 - tendency to move eye toward correct spot**
 - reaching was more accurate**
- **better than chance in LVF guesses about presence/absence of small patches of light, orientation of lines**
- **97% accurate at discriminating long from short line with exposure as short as 100 msec**
- **could discriminate circle/cross and X/O - 90% accurate**
- **could not do square/rectangle discrimination**

Control condition



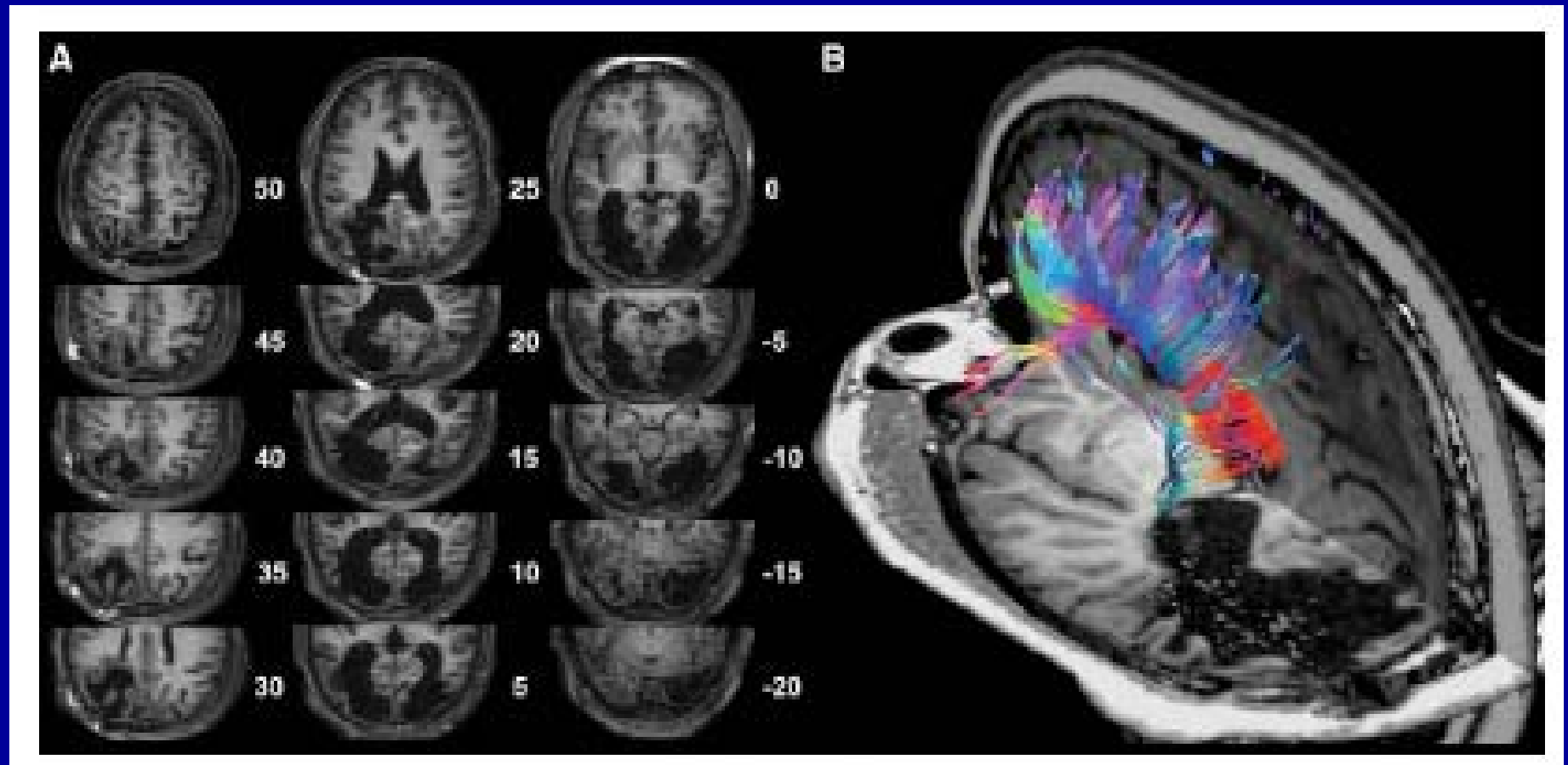
Response time 359 msec

Experimental condition



Response time 500 msec

Patient TN: Left and Right Occipital Strokes 36 Days Apart



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CONSCIOUS & UNCONSCIOUS VISION IN MONKEYS

Are monkeys with occipital lesions also "unconscious" of visual stimuli in blindsight?

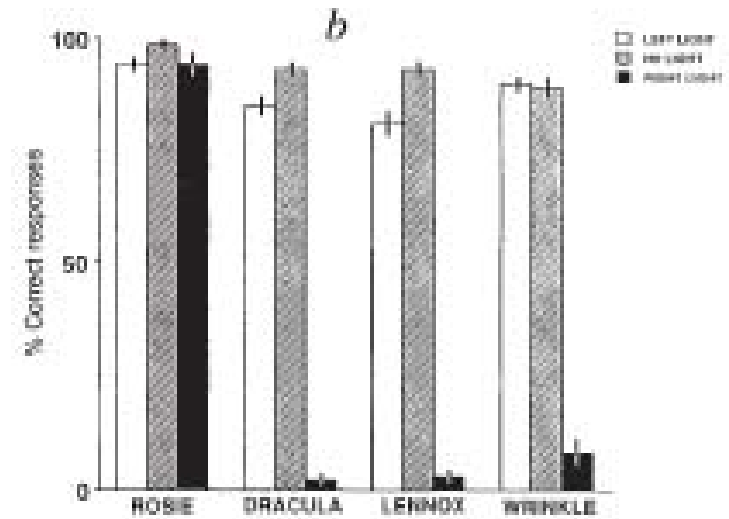
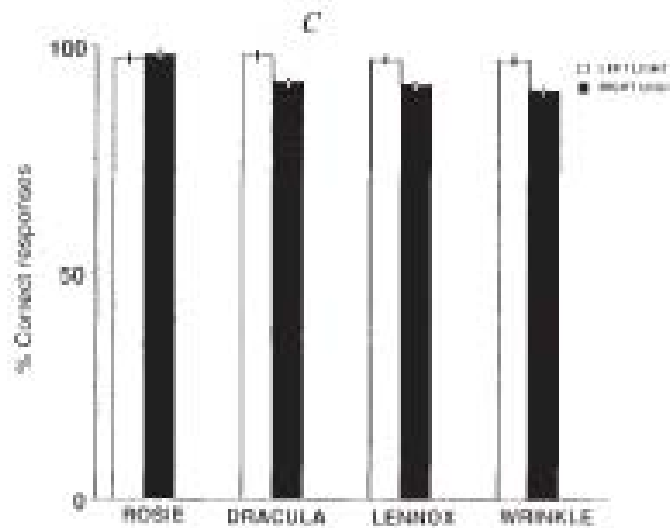
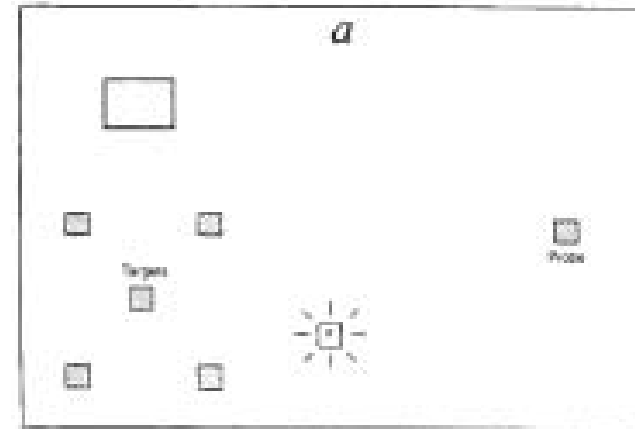
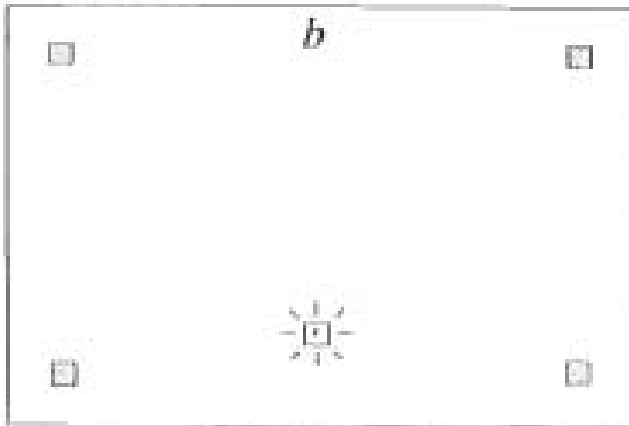
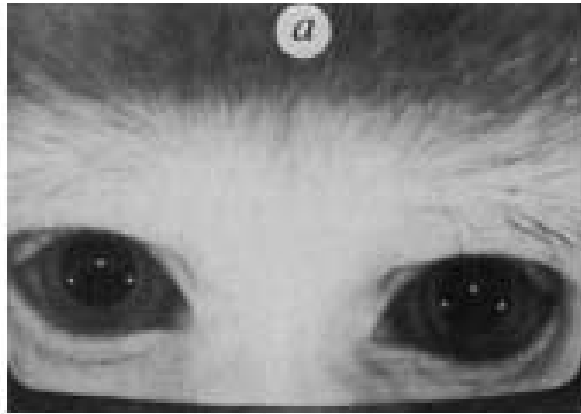
1 intact monkey

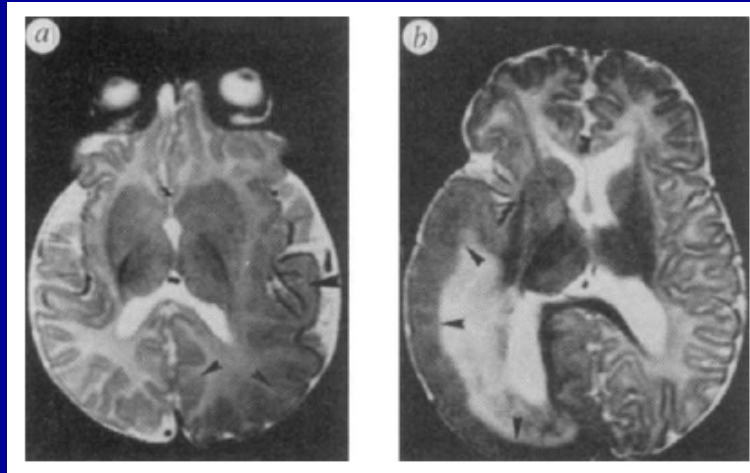
3 monkeys with ablation of left striate cortex and of splenium of corpus callosum

task 1 - touch position where a light comes on – blind animals good in both fields

task 2- half the trials had one of five target illuminated - for blank trials, press large rectangle

what happens on probe trials in blind field? treated as blank



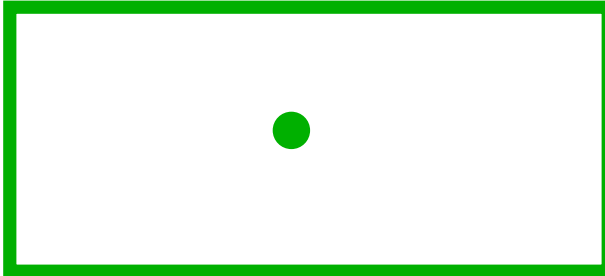


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- **two infants with hemispherectomies in first year - single, conspicuous targets in blind vf elicited fixations**
- **PP fixates on central stimulus - stimulus comes on in lvf or rvf - in "competition" condition central fixation stays on**
- **growth of conscious visual system?**

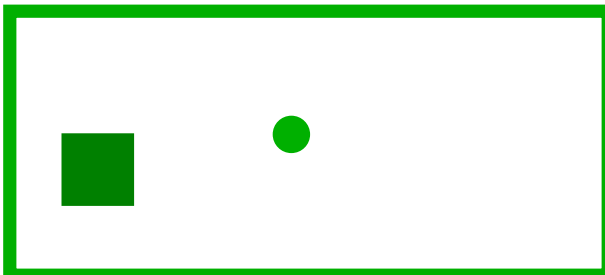
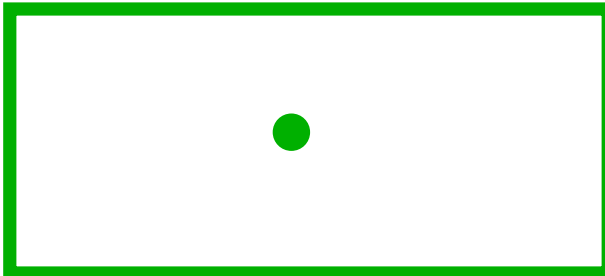
Non Competition

Blind LVF



Intact RVF

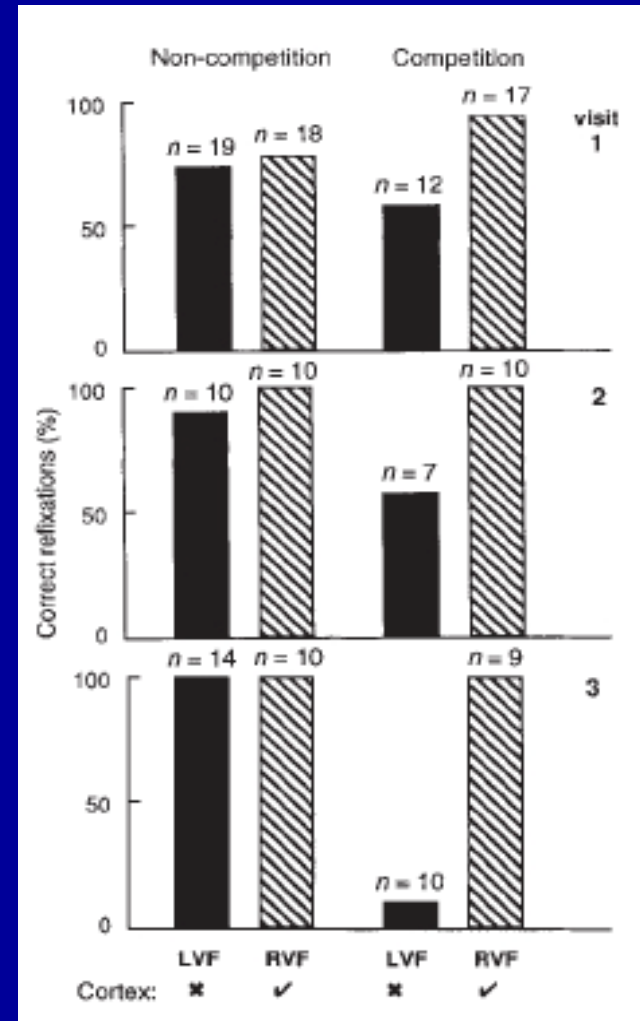
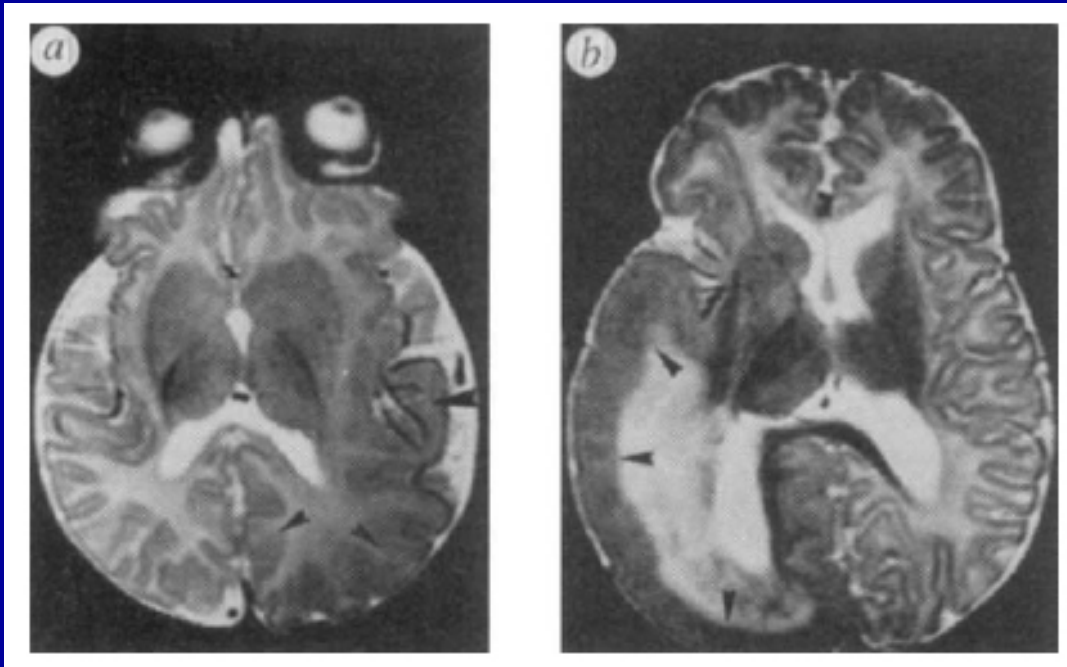
Competition



Central Target

goes off

stays on



8 weeks

10 weeks

12 weeks

Blind in LVF

ATTENTION & NEGLECT

- **Neglect**
- **Anosagnosia**
- **Measures of Neglect**
- **Brain Mechanism of Neglect**
- **Neglect of Imagined Representations**
- **Psychological Model of Neglect**
- **Rotation of Neglect**
- **Levels of Attention in Neglect**

NEGLECT

- **Failure to report, respond or orient to a stimulus presented contralateral to lesion that cannot be accounted for by elementary sensory or motor deficits - florid early on - patient may deny left half of body, dress one side, eat from one side of plate**
- **Extinction to double simultaneous stimulation - seen in late stages**

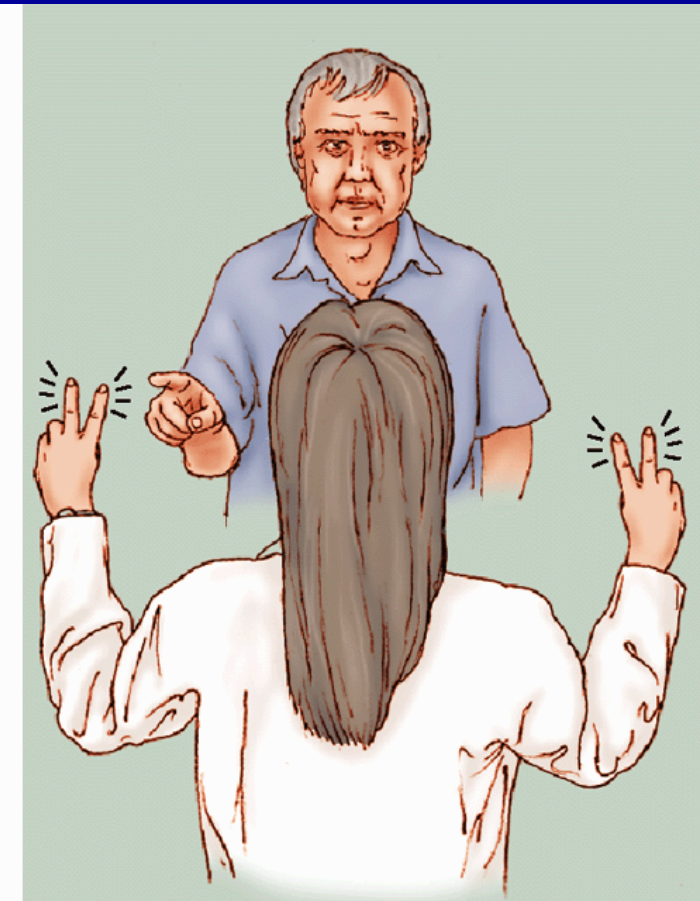
Extinction to double simultaneous stimulation



OK in left field for unilateral stimulation



OK in right field for unilateral stimulation



Neglect of left field for bilateral stimulation

**Anosagnosia - be unaware of or deny
hemiparesis, hemianopia**

Right-sided lesions; 5% of cases

Ramachandran Studies – Patients cannot use left arm after stroke

- Can you use your right hand?
 - Yes.
- Can you use your left hand?
 - Yes.
- Are both hands equally strong?
 - Yes.
- Can you point to my nose with your right hand?
 - *(she does)*
- Can you point to my nose with your left hand?
 - *(paralyzed hand does not move)*
- Are you pointing to my nose?
 - Yes.
- Can you clearly see it pointing?
 - *Yes, it is about two inches from your nose.*
- Can you clap?
 - *Of course I can clap (right hand alone moves).*
- Are you clapping?
 - *Yes I am clapping.*

rationalization - arthritis

\$5 - screw in light bulb

\$10 - tie shoelaces

**tray of cocktail glasses filled with water -
ask patient to hold tray - does so with
right hand - tray tumbles**

**Syringe with ice cold water - irrigated left
ear canal - patient's eyes started to
move -**

- **Do you feel ok?**

- *My ear is very cold, but other than that I am fine.*

Syringe with ice cold water - irrigated left ear canal - patient's eyes started to move -

- **Do you feel ok?**

- *My ear is very cold, but other than that I am fine.*

- **Can you use your hands?**

- *I can use my right arm, but not my left arm. I want to move it, but it doesn't move.*

- **Whose arm is this? (holding paralyzed arm)**

- *It is mine, of course.*

- **Can you use it?**

- *No, it is paralyzed.*

- **How long has your arm been paralyzed? Did it start just now or earlier?**

- *It's been paralyzed for several days now.*

90 minutes later - back to anosagnosia

Measures of neglect

a. writing in RVF

b. reading in RVF

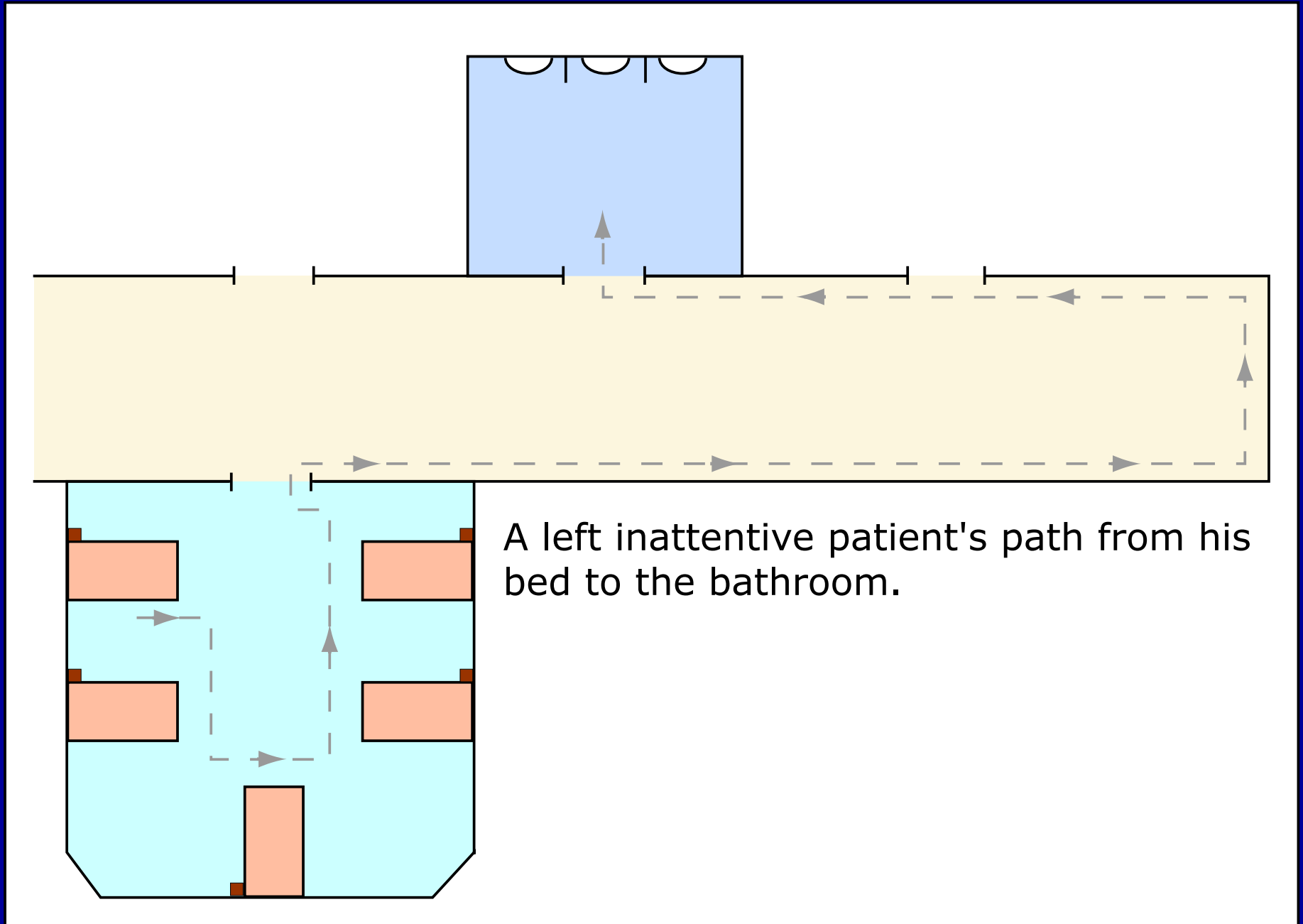
c. drawing clock, copying scenes

- drawing clock may be better if subject does not see drawing

d. cancellation or search tasks

e. line bisection

- improved if subject is asked to read letter at neglected end - letter read ok if a single letter at left end
- left-end letter often missed if letters at each end
- greatest when letter at right end
- improved by varying starting position of hand



A left inattentive patient's path from his bed to the bathroom.

Cancellation Task

mark all the A's

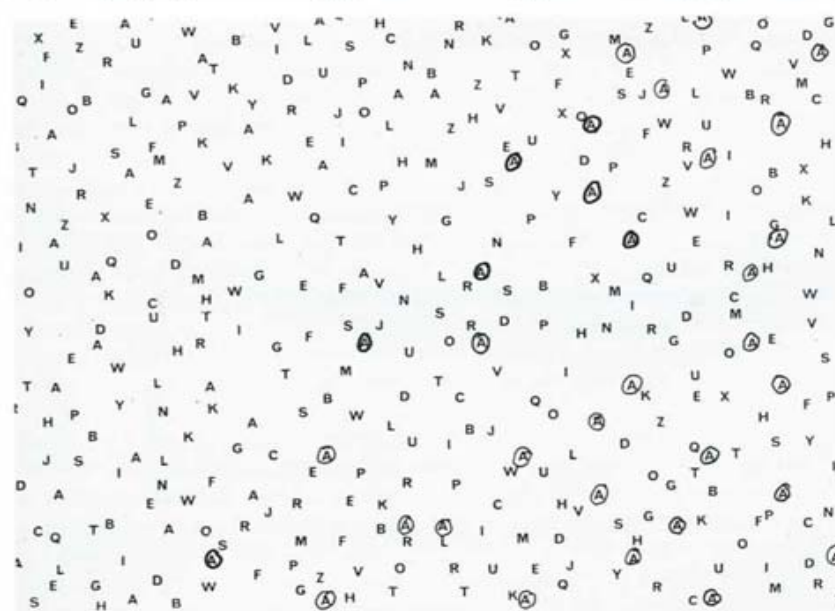
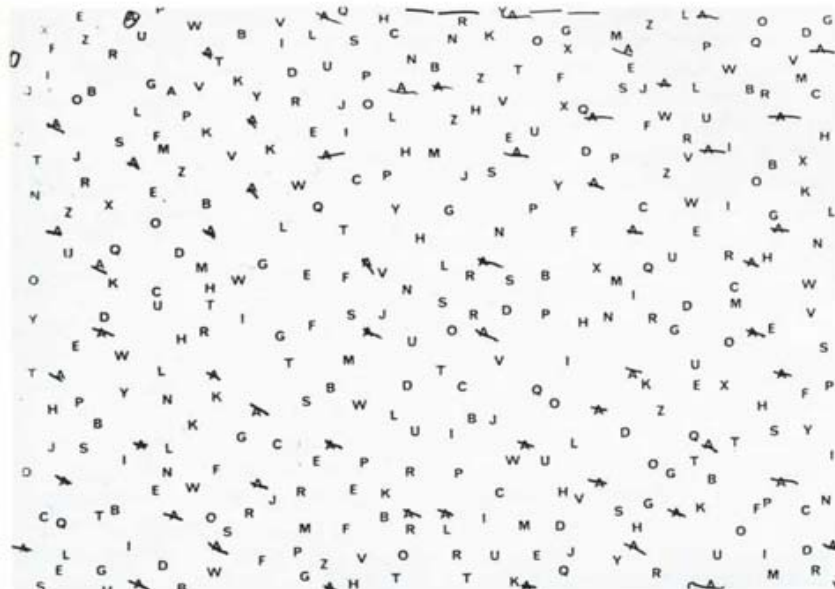


FIGURE 3. This figure shows the performance of two different patients on the random letter cancellation task. An 8 × 10 sheet of paper containing 15 As in each quadrant is placed directly in front of the patient, who is then asked to check or encircle all the As without moving the sheet of paper. *Top:* A 59-year-old right-handed woman suffered a left-sided stroke that left her with a dense right homonymous hemianopia. Despite the blind right hemifield, she does not miss any targets on the right. *Bottom:* A right-handed woman in her 70s had an infarct in the right frontal region. She developed a hemiparesis. Visual field testing did not reveal any hemianopia. However, she has marked neglect for targets on the left. These two patients demonstrate that there is no obligatory relationship between hemianopia and unilateral neglect.

Visual loss in RVF - does fine by moving eyes

Neglect of LVF no visual loss neglects LVF

**On his way out the town he// had to pass the
prison, and as he looked in at the// windows, whom
should he see but William himself peeping out of the
bars, and looking very sad indeed.// “Good morning
brother,” said Tom, “have you any// message for the
King of the Golden River?” William// ground his
teeth with rage, and shook the bars// with all his
strength; but Tom only laughed at him// and
advising him to make himself comfortable till// he
came back, shouldered his basket, shook the// bottle**

Patient V.S.N. read only those words to the right of the parallel bars (Kartsounis & Warrington, 1989).

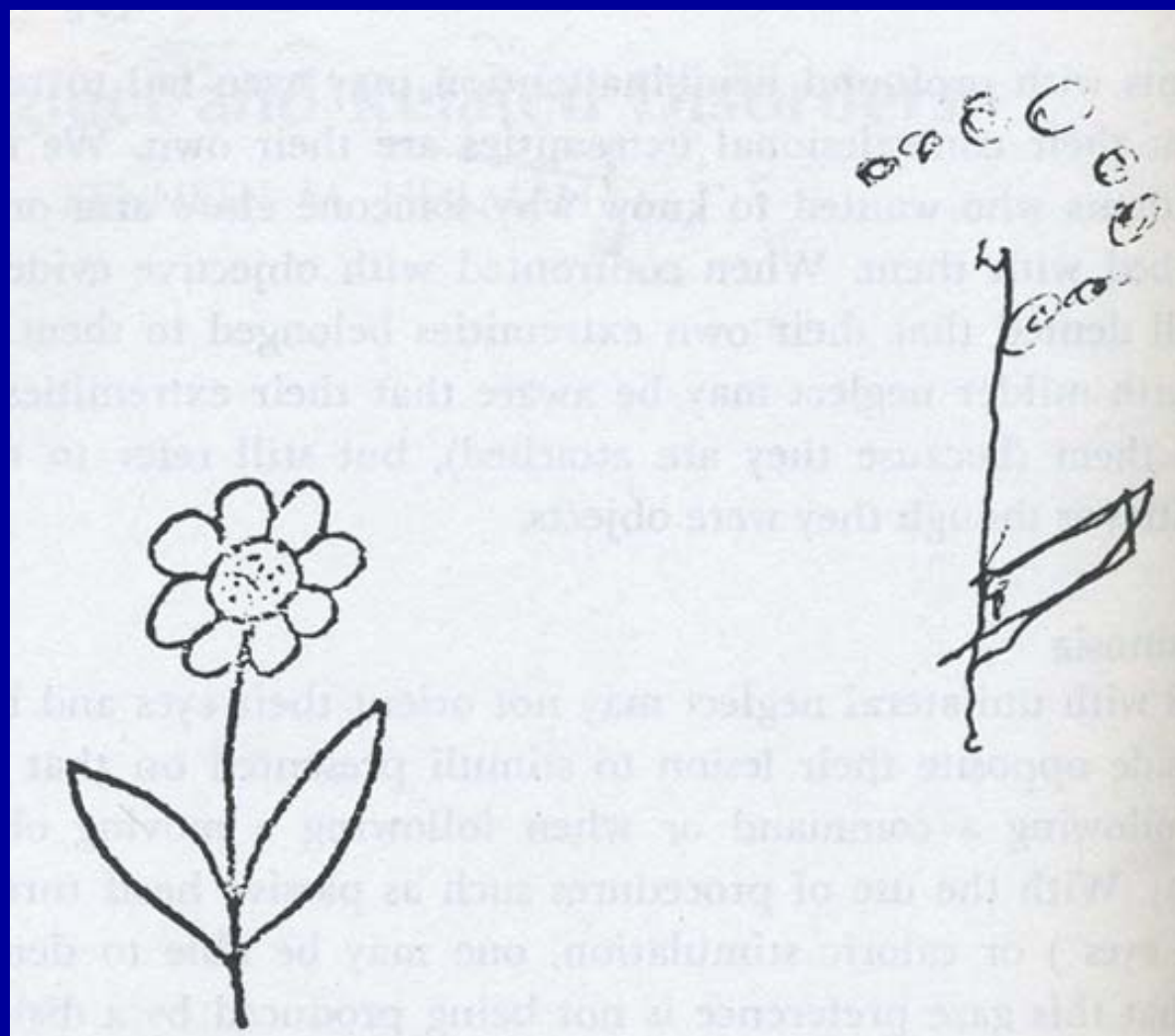


Fig. 10-1 An example of hemispatial neglect (visuospatial agnosia). Drawing on left performed by examiner. Drawing on right performed by patient.

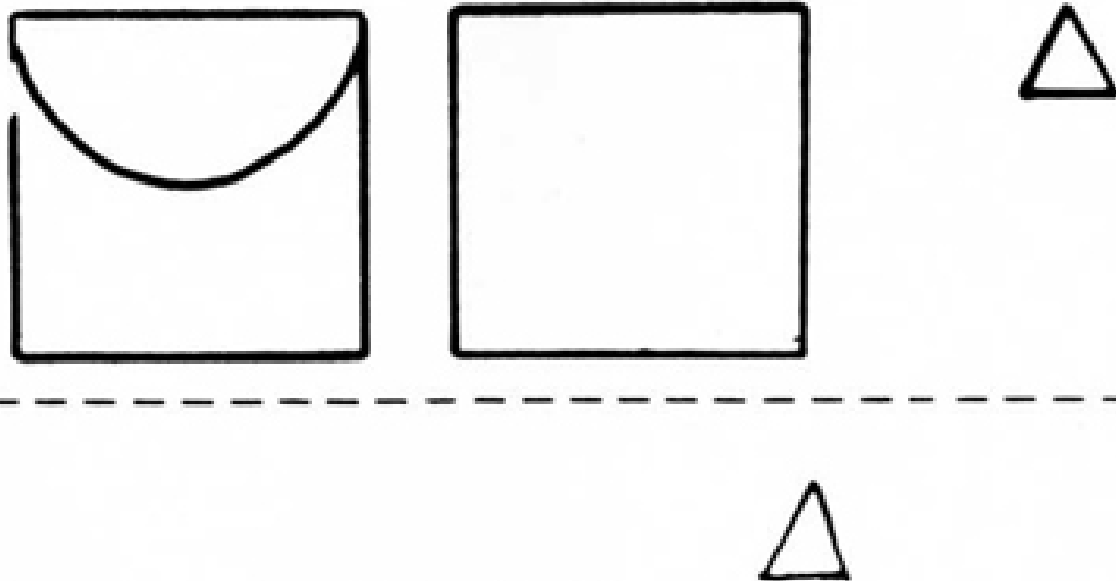
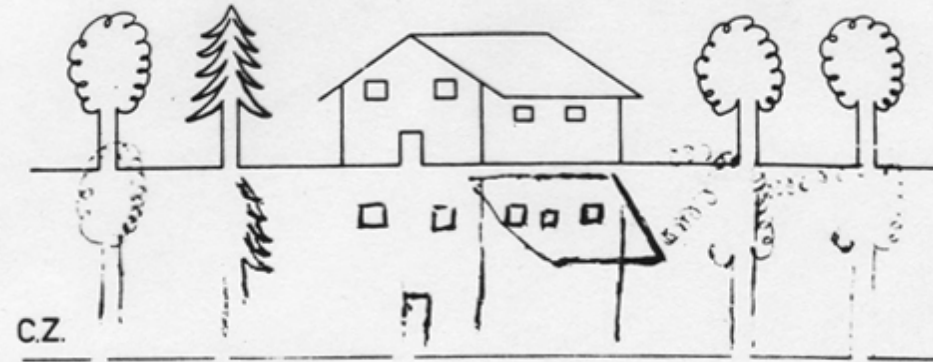
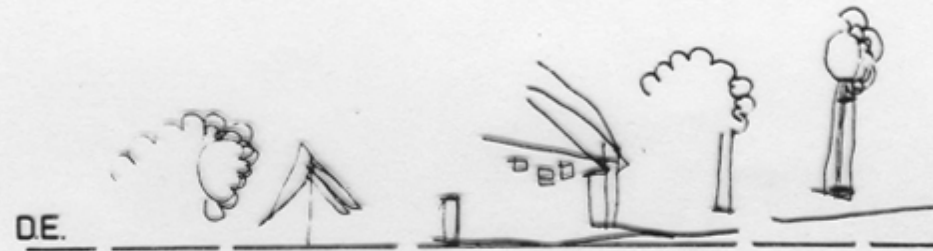


Figure 4.4 Example of omission of left-sided elements in a copying task. (Adapted from Kartsounis & Warrington, 1989.)

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C.Z.



DE.



B.R.

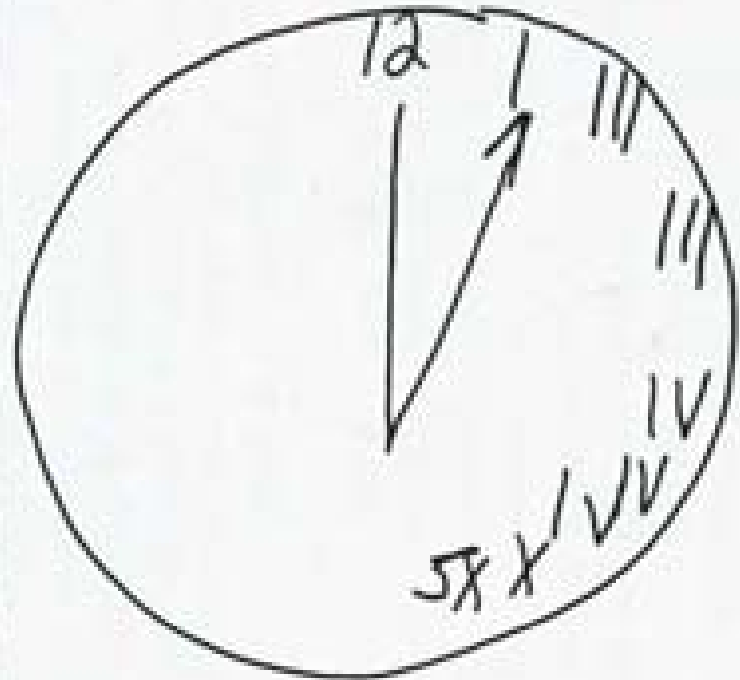
Guido Gainotti 22-4-55

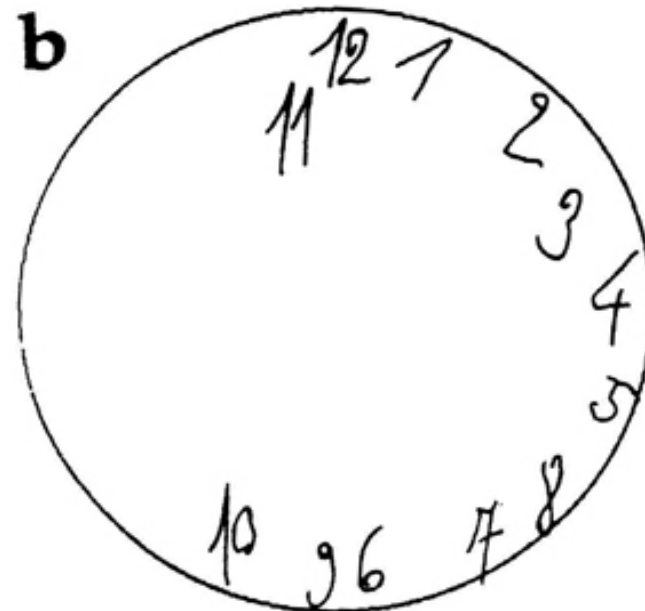
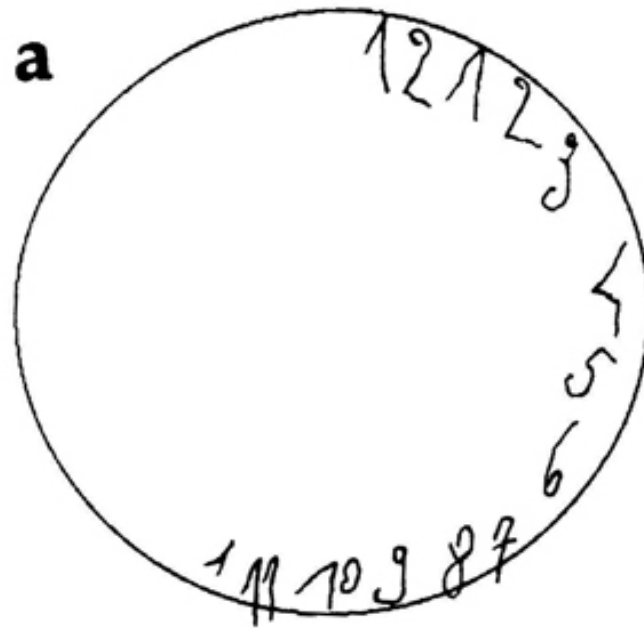
FIG. 3. Examples of copies made by right brain-damaged patients of the composite figure shown on the top. In each case patients left unfinished half of one or more elements, reproducing, however, parts of the model placed even more laterally on the neglected side of space.

Date

HISTORY SHEET

As a result 30 results were discussed with
me either in the morning or particular
evening. I was left happy in the
end with little or no knowledge of
my condition or implications
to mortality or to life
methods. There is an obvious
desire on the part of good
medical procedure
and does not feel well
for a major medical
institution & therefore
that serious procedure
is to hold the
demonstration and make
appreciating the
importance and the
particular situation &
was afraid medical
equipment already
etc. is just in
the 1st instance that
Cassidy was not
happy and then
left before I could
question the result





(a) Example of C.B.'s clock-drawing in condition 1. Note that hours were compressed on the right side of the dial as if there was no left space. (b) Example of clock-drawing in condition 2; numbers drawn inside the circles were given to the patient one at a time in the following order: 12, 6, 11, 4, 9, 1, 3, 7, 10, 5, 8, 2.

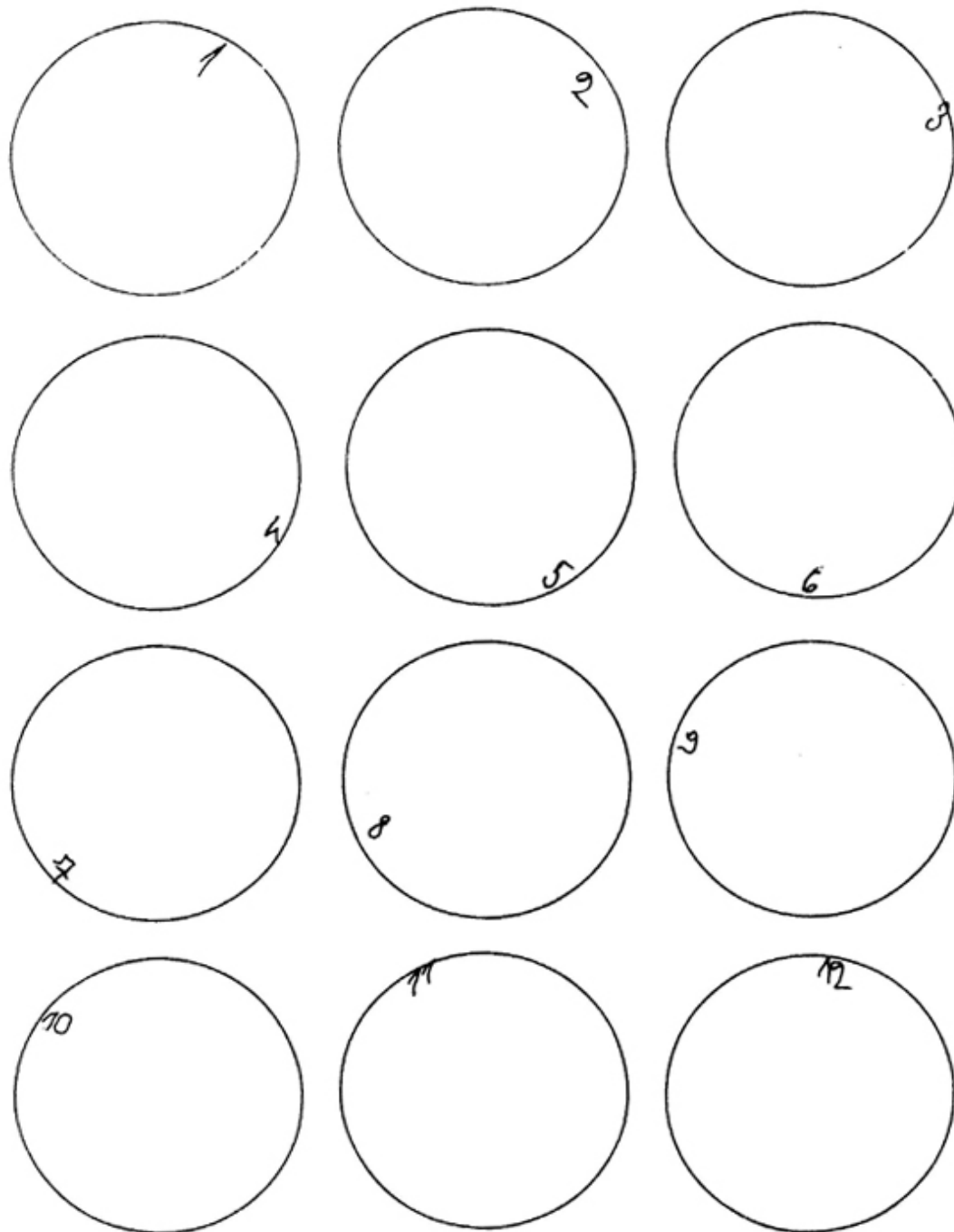
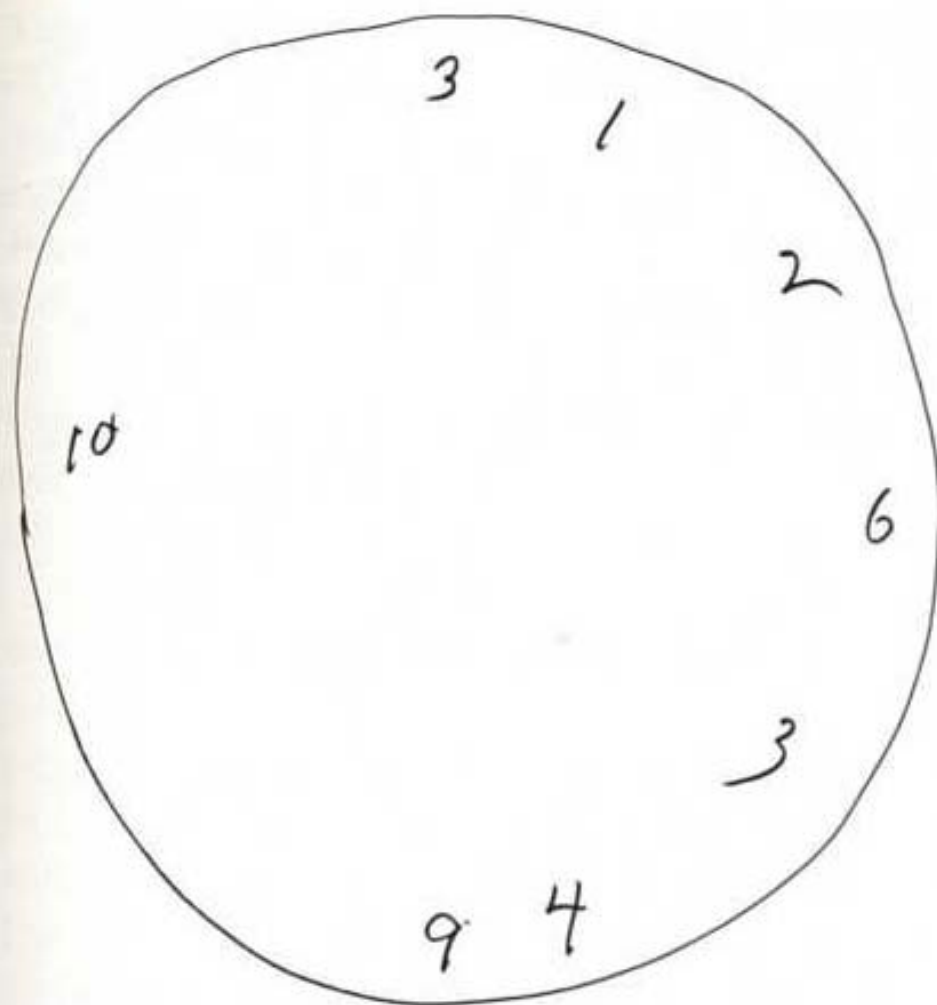
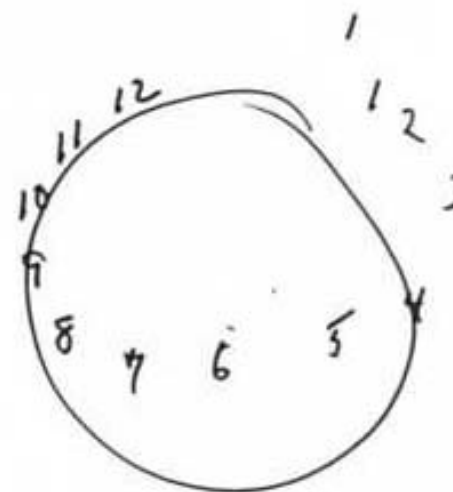


Fig. 2. Examples of C.B.'s performance on condition 3. The patient received one blank dial at a time, and drew inside it a number (hour) given by the experimenter following a sequence identical to that reported in Fig. 1(b).



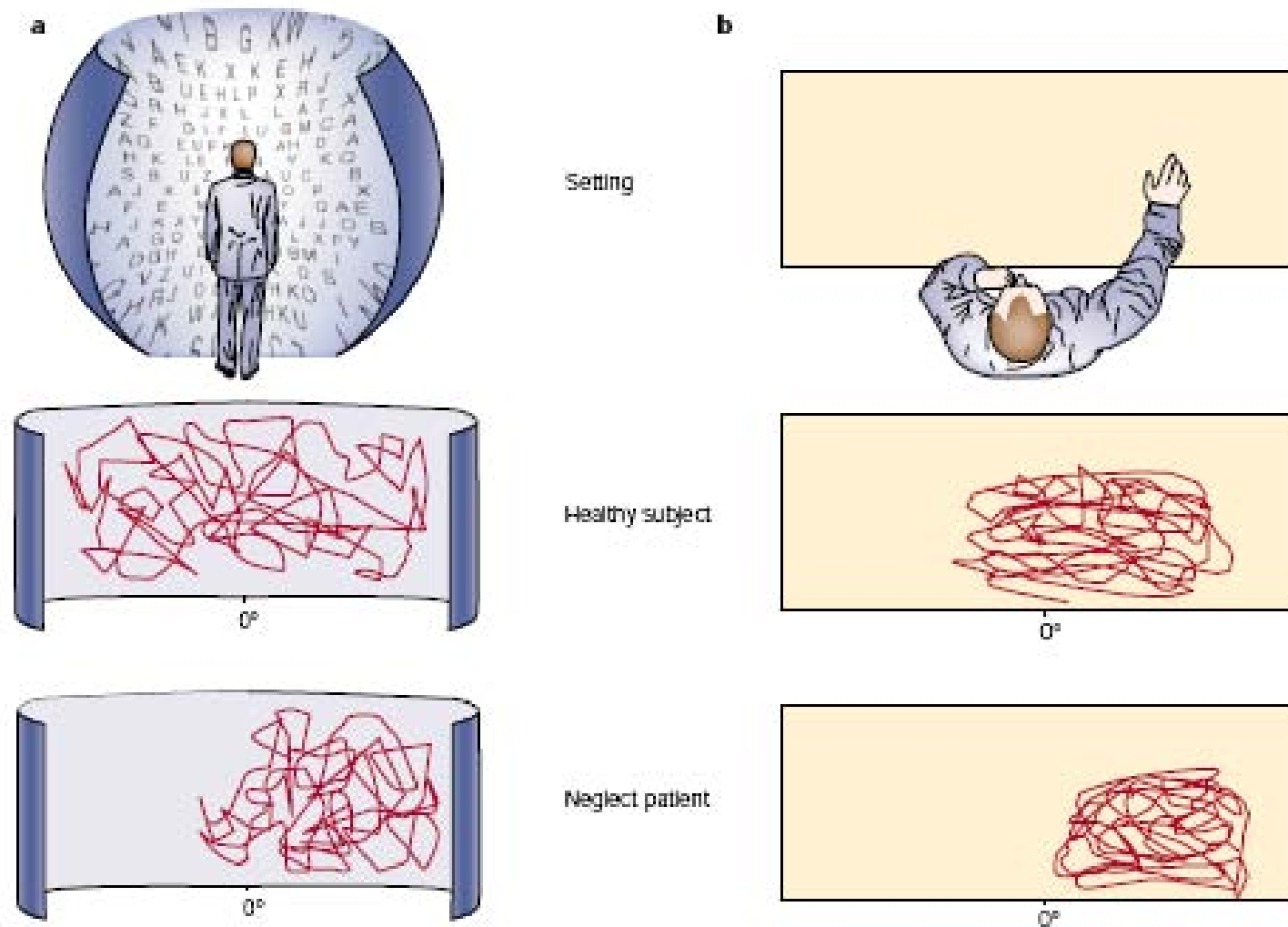
EYES OPEN



EYES CLOSED

FIGURE 4. A 60-year-old right-handed man had a right frontoparietal stroke that left him with left unilateral neglect and severe aphasia. The clock on the left was drawn with the eyes open and shows neglect of the left. The clock on the right was drawn with the eyes closed and shows a marked reduction of the neglect.

NEGLECT OCCURS ACROSS MODALITIES



Karnath,
Nature, 2001

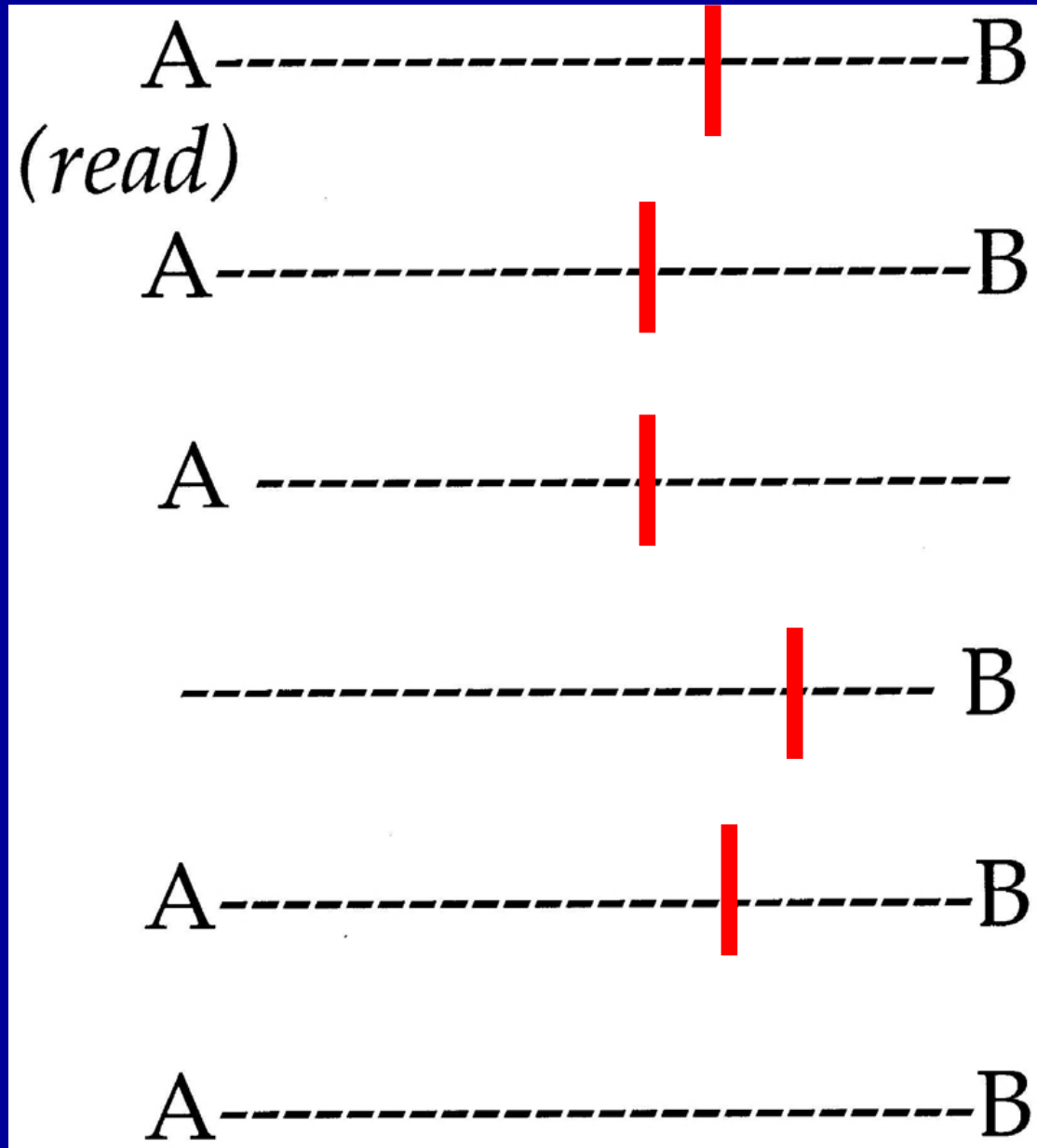
<http://www.nature.com/nature/journal/v411/n6840/abs/411950a0.html>

visual exploration

tactual exploration

Line Cancellation

Mark the Middle of the Line



mark the middle

read A - mark the middle

mark the middle

mark the middle

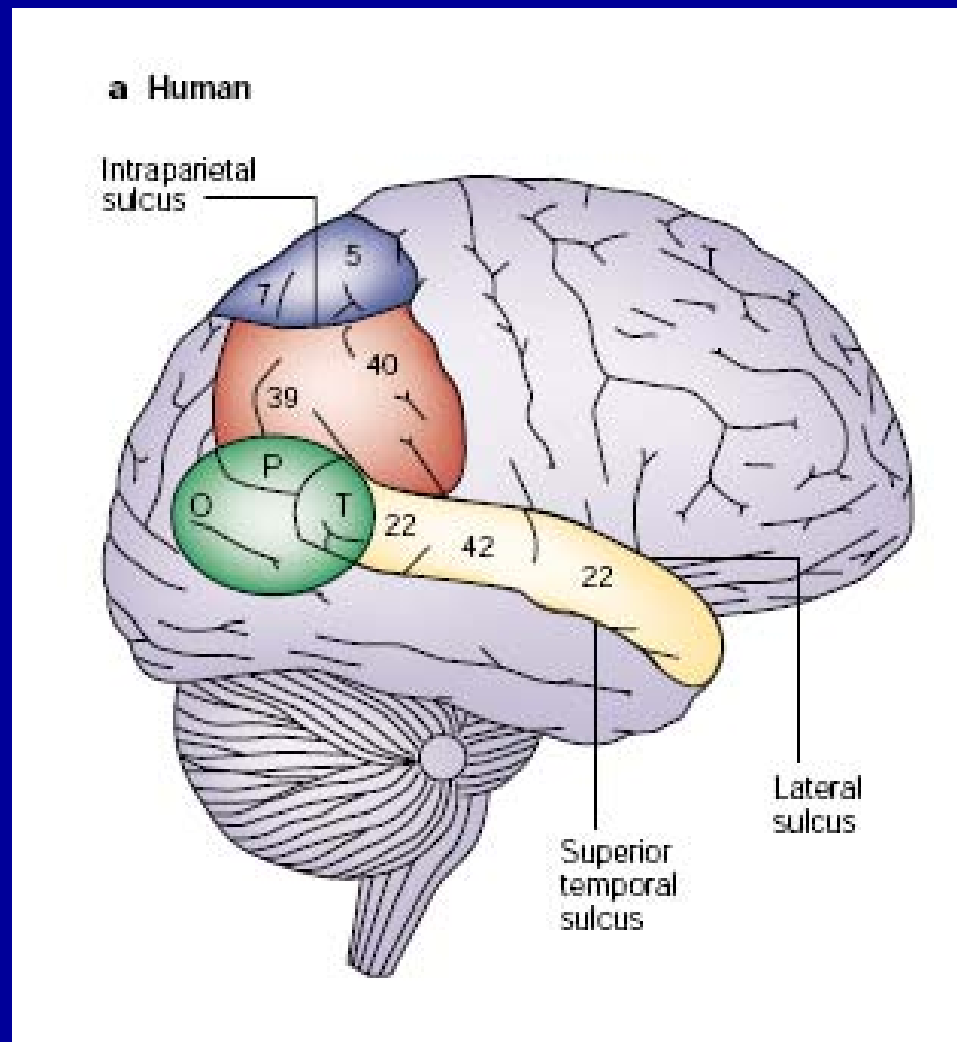
hand starts at middle

hand starts at A

WHERE IS THE LESION?

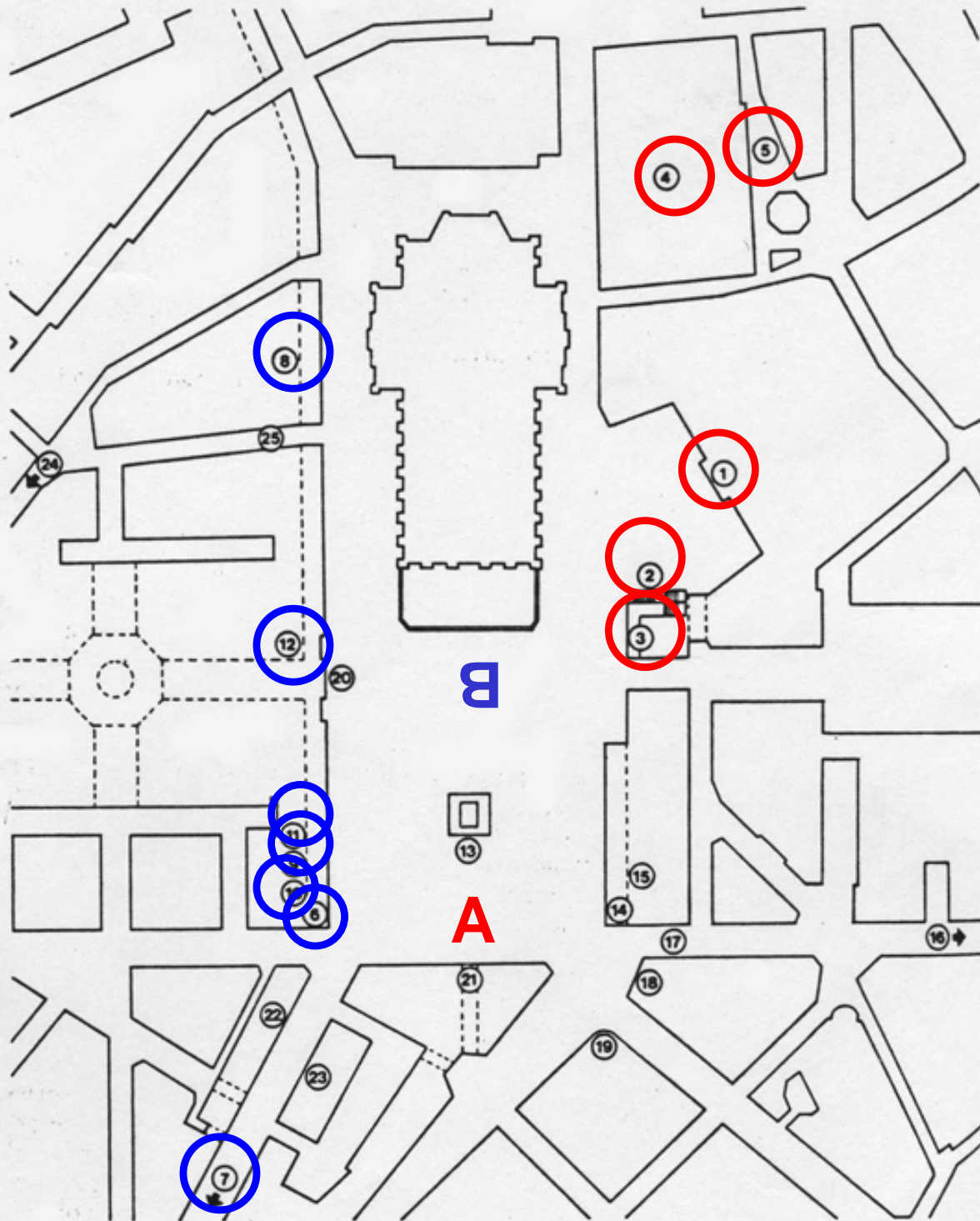
- **old idea – parietal cortex – where deficit**
- **new idea – temporal cortex that leads to ipsilateral hypofunction in intact parietal cortex, contralateral hyperfunction in intact parietal cortex**
- **parietal cortices become balanced with recovery**

Superior temporal and parietal cortex

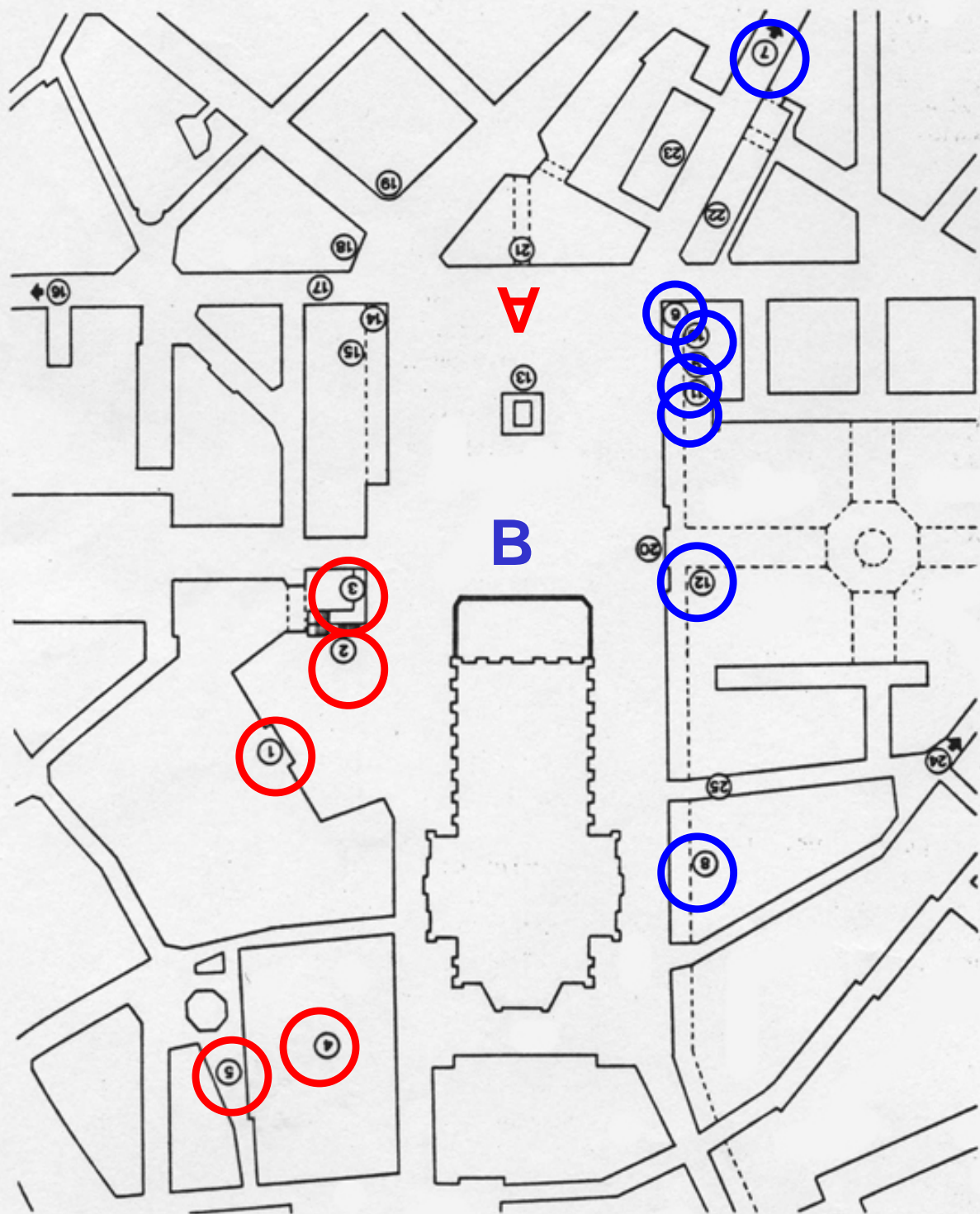


Representational Theory

- **Bisiach & Luzzati (1978)** - Milanese patients asked to describe the Piazza del Duomo looking at or looking from cathedral
- **Bisiach, Luzzati, & Perani (1979)**
 - random, cloud-like stimuli seen only through a slot
 - two sequentially seen stimuli - same or different?
 - patients with left-sided neglect made more errors when stimuli differed on left side

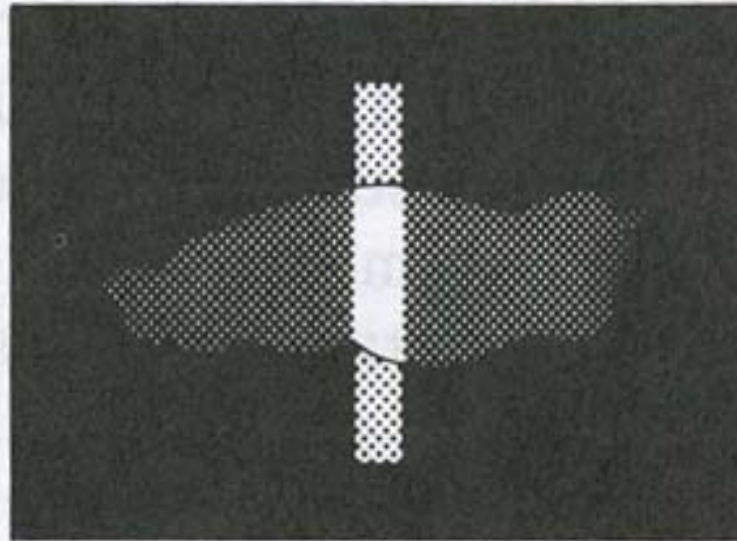
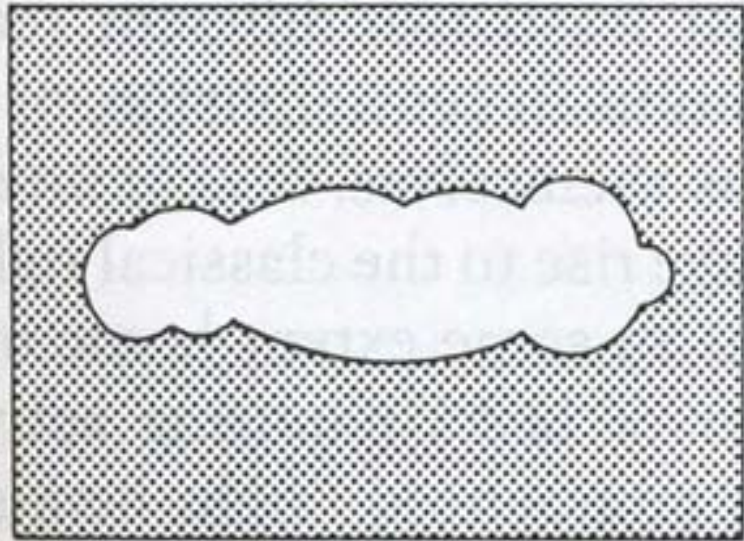
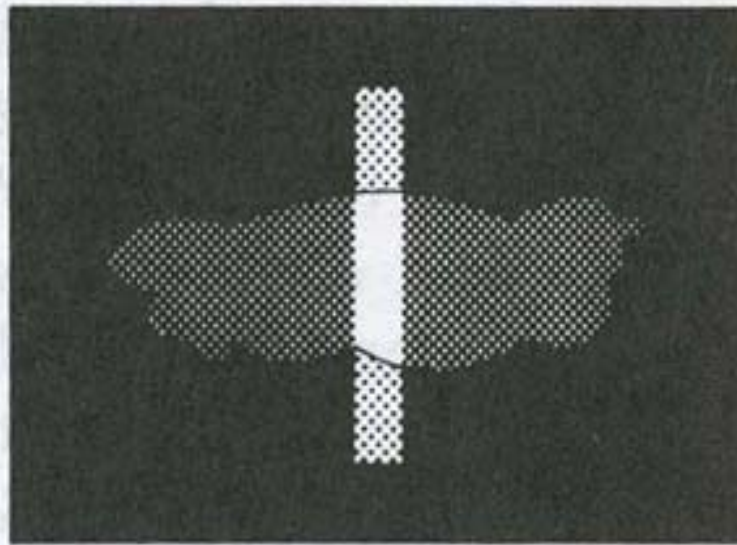
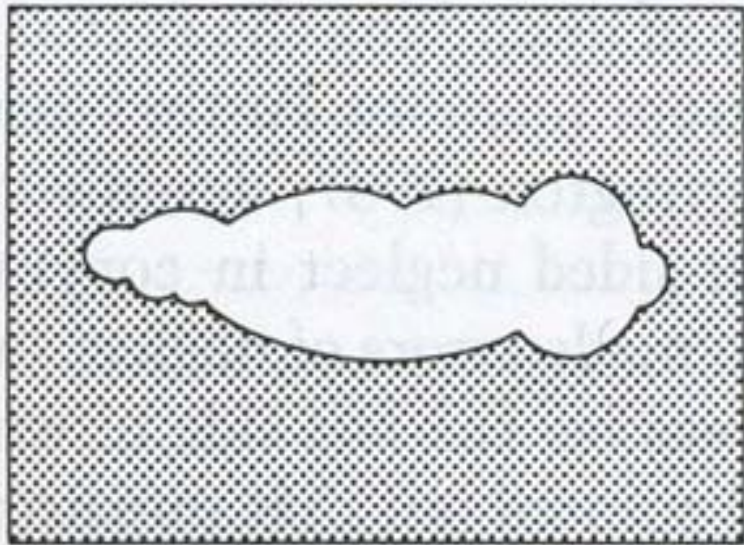


from imagined
perspective A,
only reports
places circled in
red



E. Bistach and C. Luzzatti

from imagined
perspective B,
only reports
places circled in
blue



A

B

— two sequentially seen stimuli - same or different?

— patients with left-sided neglect made more errors when stimuli differed on left side

Posner's Disengagement Deficit of Cortical Visuospatial Neglect

Engage Attention

Disengage Attention

Move Attention

Tasks to measure allocation of "spotlight" of attention

Simple Reaction Time (RT) to onset of light in a box

Cue Location

Central - arrow points to right or left

Endogenous/voluntary

Cue Type

Valid - 80%

Invalid - 20%

Neutral - (central cross)

Subjects benefit from valid cue, are slowed by invalid cue

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Fixation
<input type="checkbox"/>	+	<input type="checkbox"/>	
<input type="checkbox"/>	X	<input type="checkbox"/>	Neutral
X	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	→	<input type="checkbox"/>	Cued valid 80% expected
<input type="checkbox"/>	<input type="checkbox"/>	X	
<input type="checkbox"/>	→	<input type="checkbox"/>	Cued invalid 20% unexpected
X	<input type="checkbox"/>	<input type="checkbox"/>	

Task - press button when X appears on either side

Normal Subjects

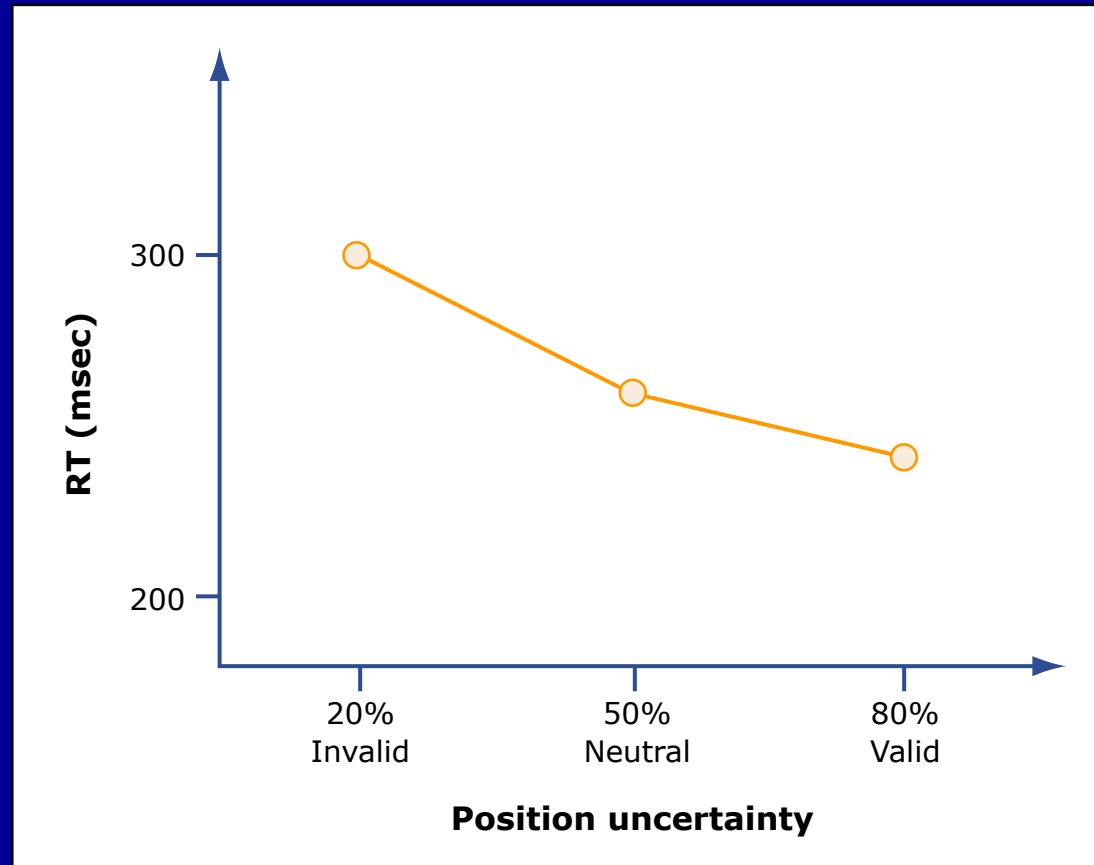
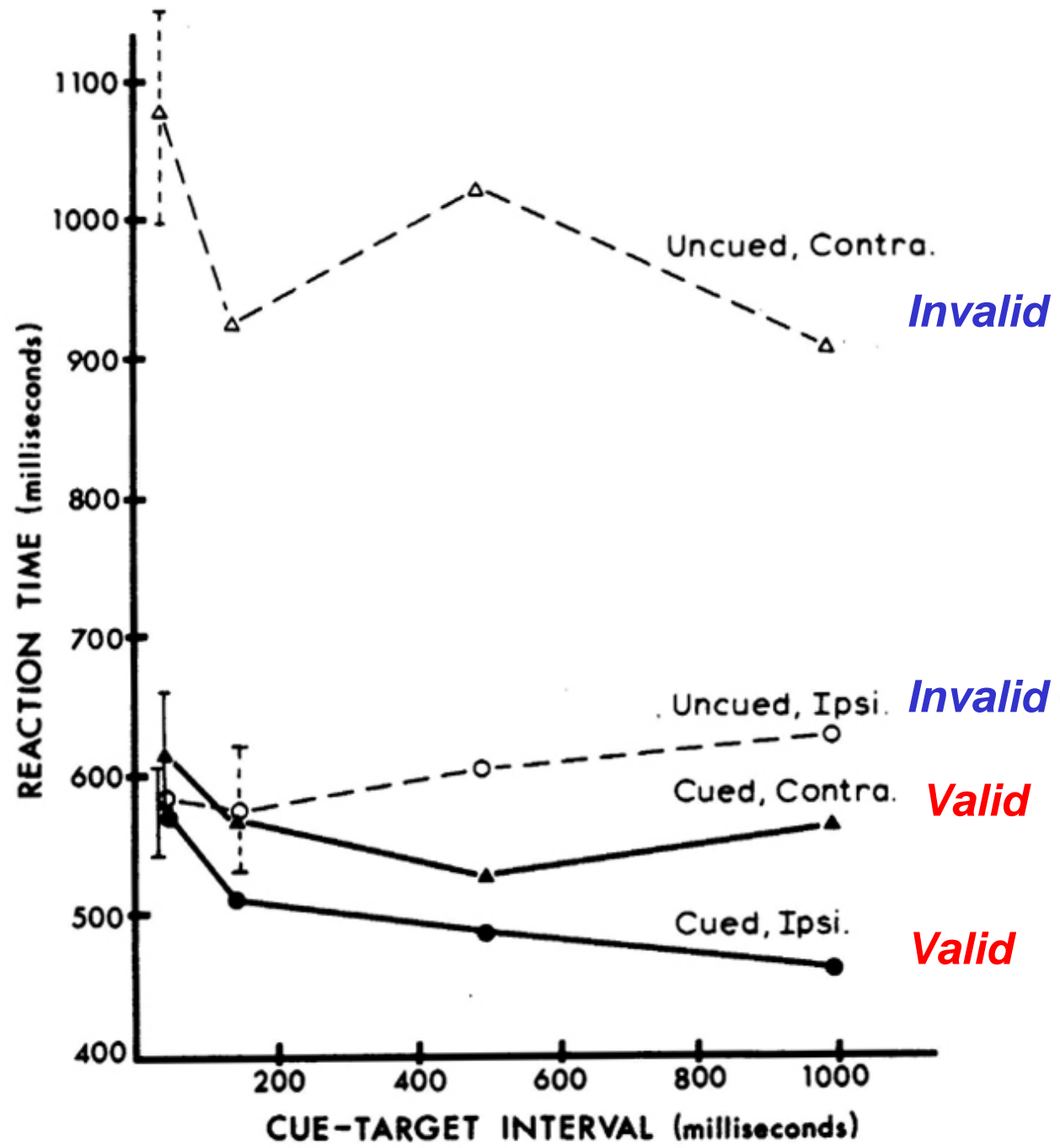


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Patient Performance

Parietal Stroke

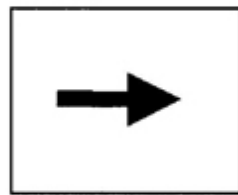
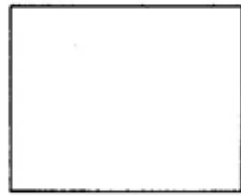
- major deficit in responding to invalid cues on contralesional side
- mild deficit to cued contralateral stimuli indicates that subjects can engage contralateral stimuli
- similar RT patterns to cued stimuli indicates that patients could move attention
- problem is one of disengagement from invalid, ipsilateral location



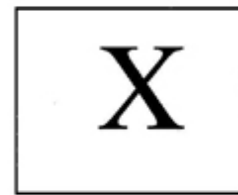
Courtesy of Journal for Neuroscience. Used with permission.

*Neglected
LVF*

NEGLECT

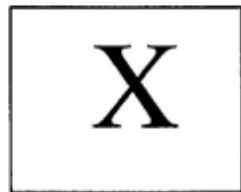


move

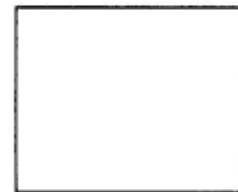


engage

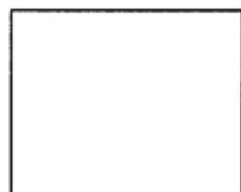
**good
valid**



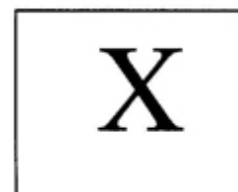
move



engage



move



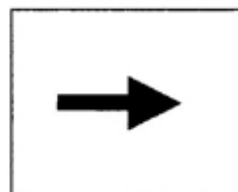
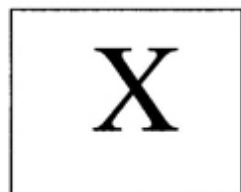
engage

disengage

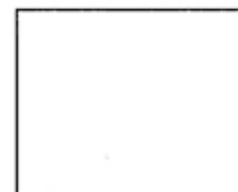
move

engage

**poor
invalid**



move



engage

engage

move

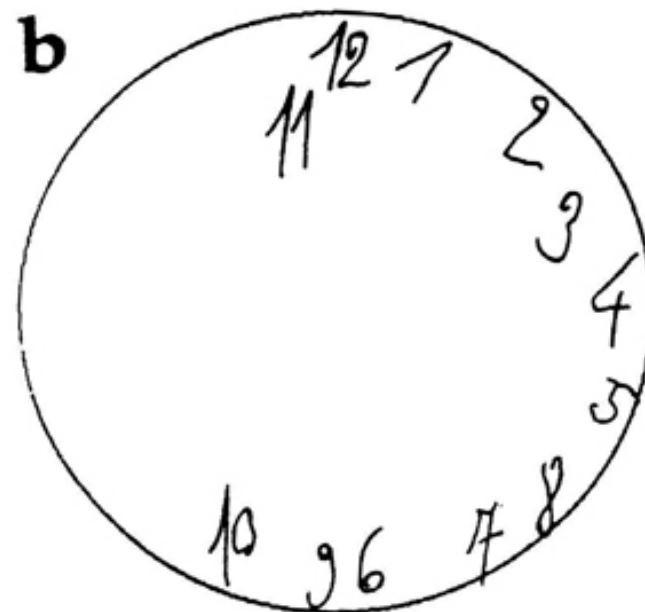
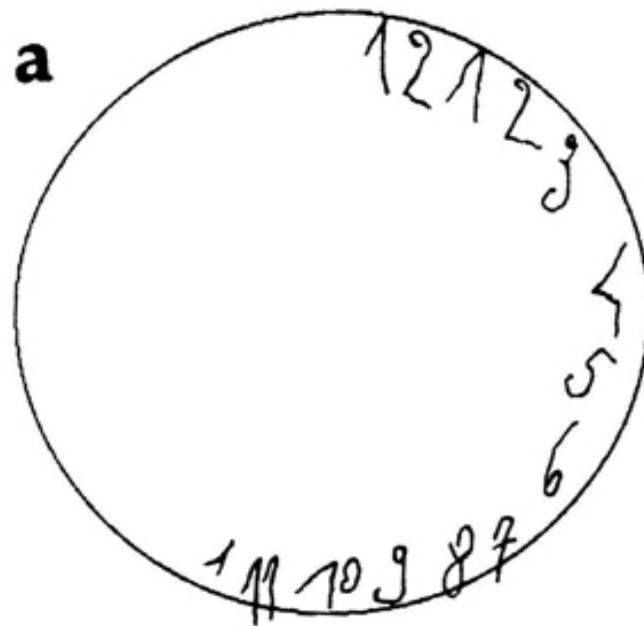
disengage

*Intact
RVF*

**good
valid**

**good
invalid**

*Failure to
disengage
attention in
intact field*



(a) Example of C.B.'s clock-drawing in condition 1. Note that hours were compressed on the right side of the dial as if there was no left space. (b) Example of clock-drawing in condition 2; numbers drawn inside the circles were given to the patient one at a time in the following order: 12, 6, 11, 4, 9, 1, 3, 7, 10, 5, 8, 2.

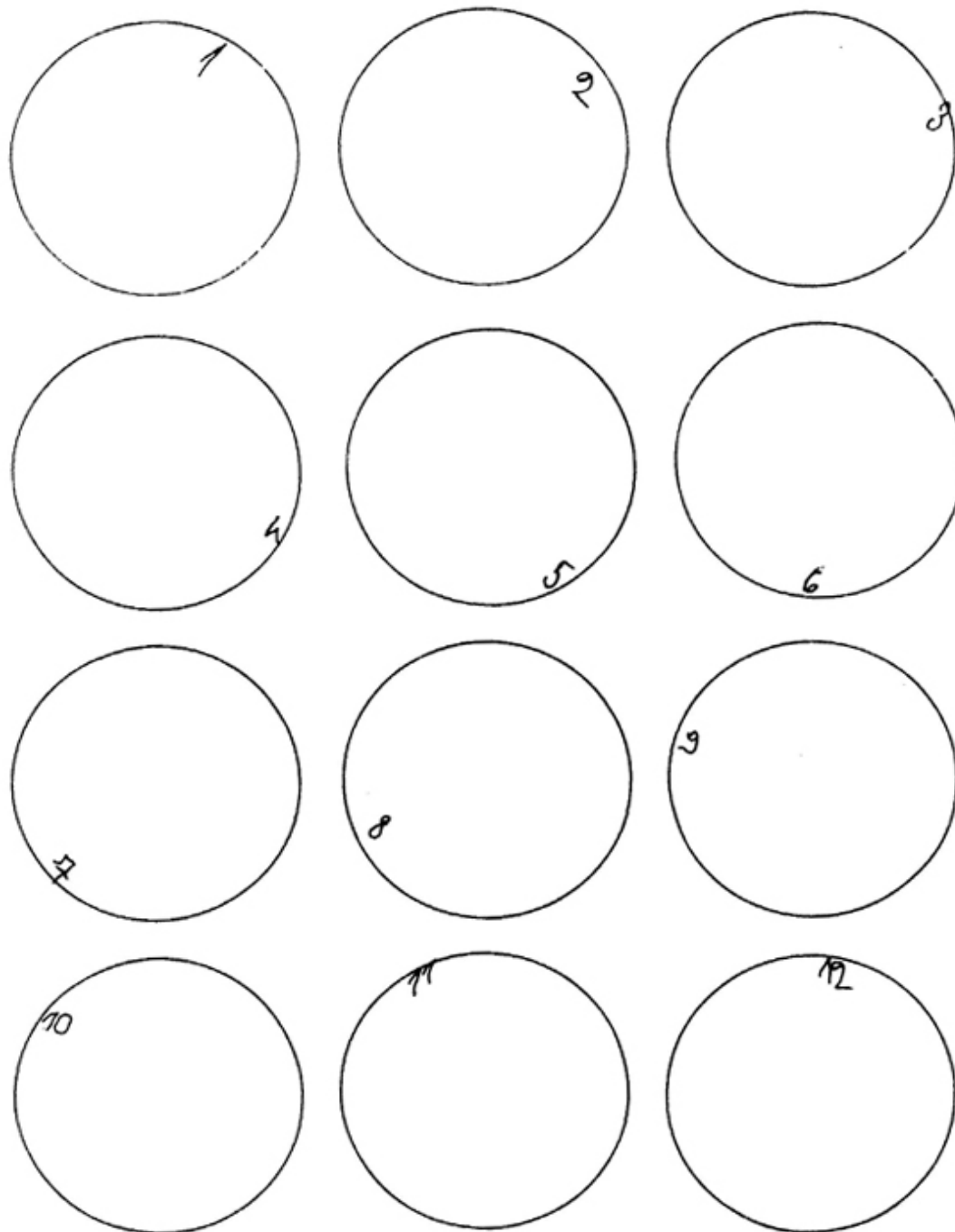
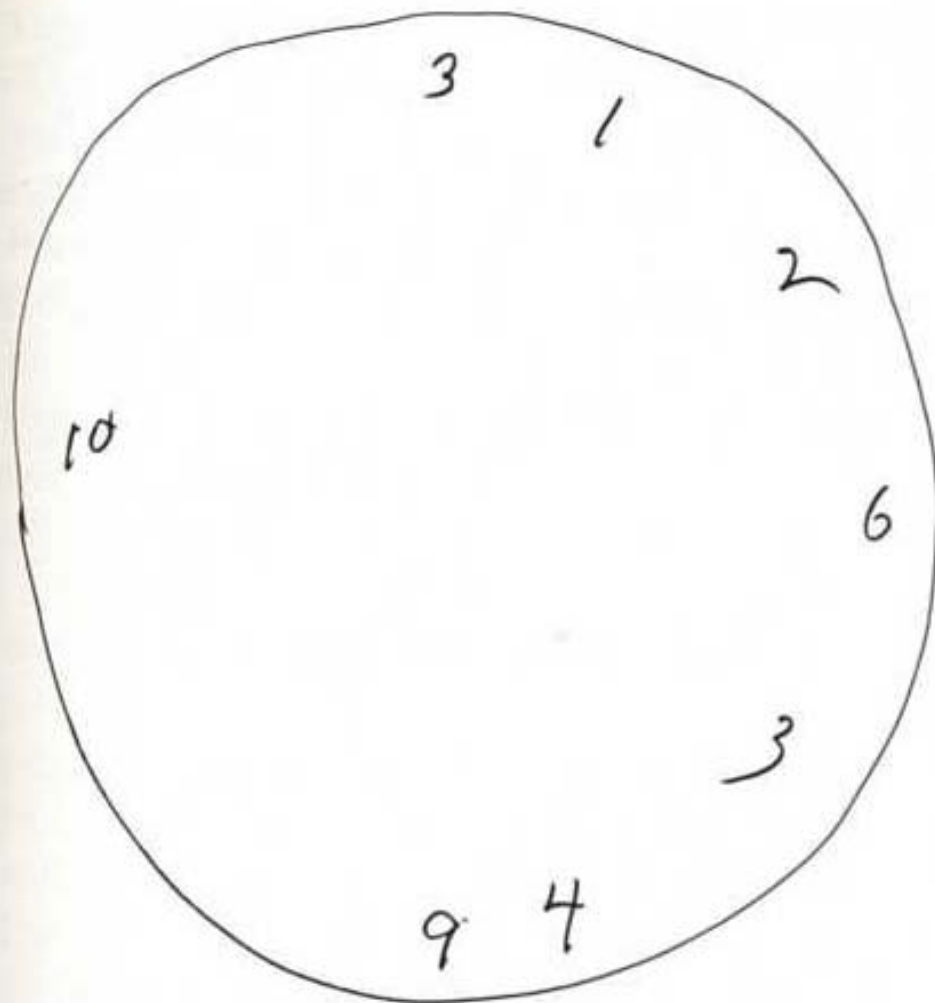
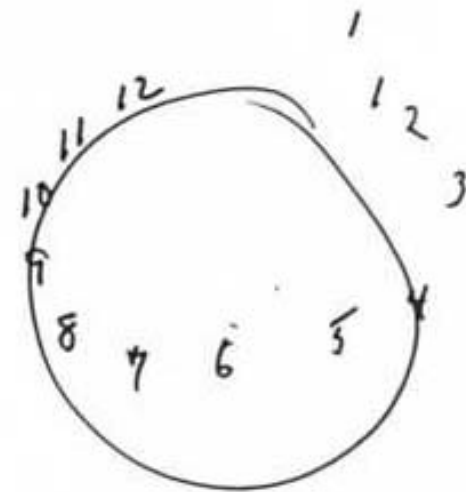


Fig. 2. Examples of C.B.'s performance on condition 3. The patient received one blank dial at a time, and drew inside it a number (hour) given by the experimenter following a sequence identical to that reported in Fig. 1(b).



EYES OPEN



EYES CLOSED

FIGURE 4. A 60-year-old right-handed man had a right frontoparietal stroke that left him with left unilateral neglect and severe aphasia. The clock on the left was drawn with the eyes open and shows neglect of the left. The clock on the right was drawn with the eyes closed and shows a marked reduction of the neglect.

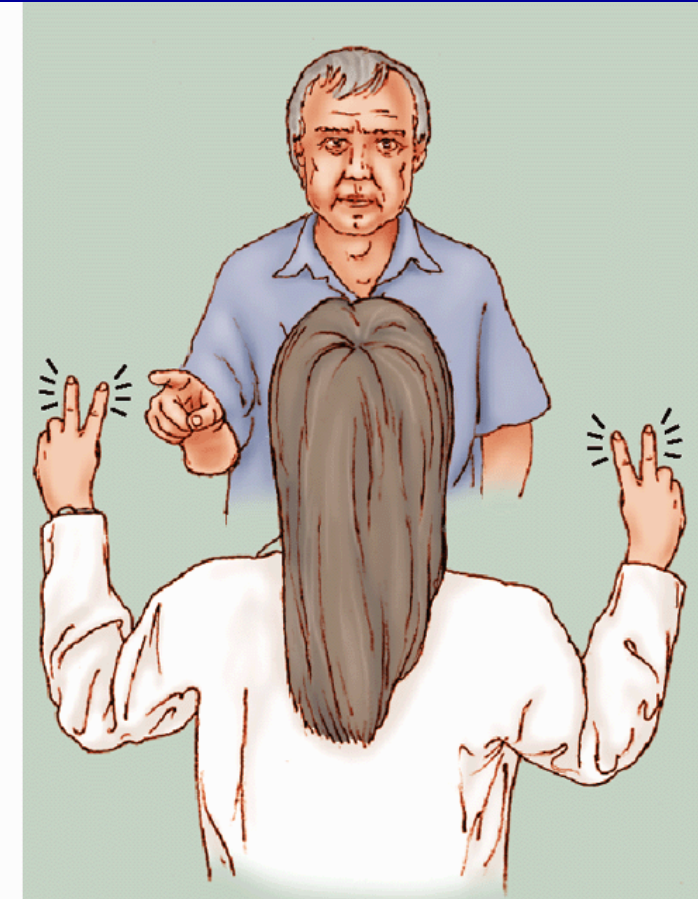
Extinction to double simultaneous stimulation



OK in left field for unilateral stimulation



OK in right field for unilateral stimulation



Neglect of left field for bilateral stimulation

**What happens if a display is rotated
180-degrees?**

(so that visual fields are now reversed?)

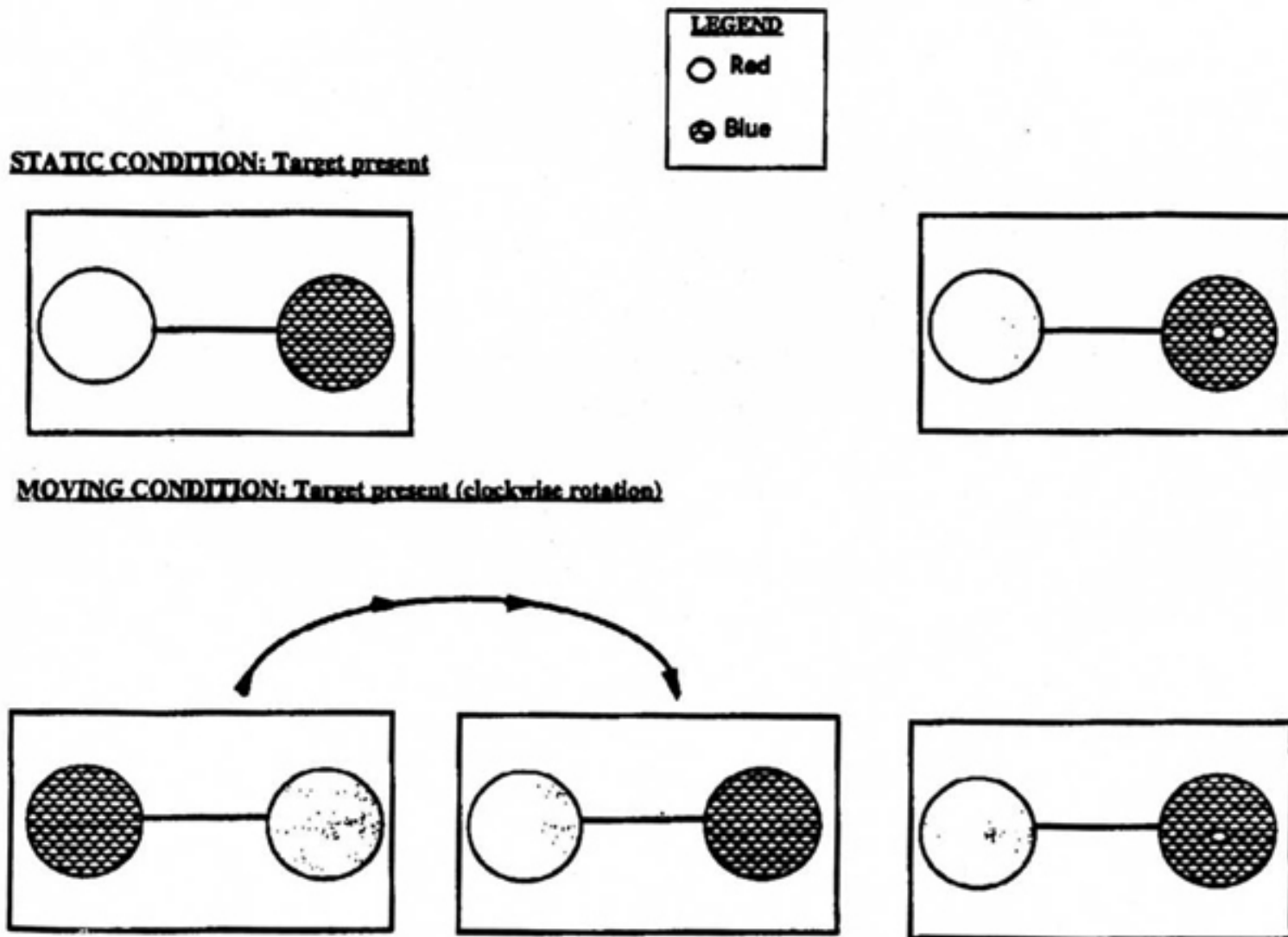


Figure 14.1 Diagram depicting the barbell in the static and the moving condition.

Object-based Neglect

Static - slower responses to targets in LVF than RVF

Moving - slower responses to targets in RVF than LVF
neglect has moved

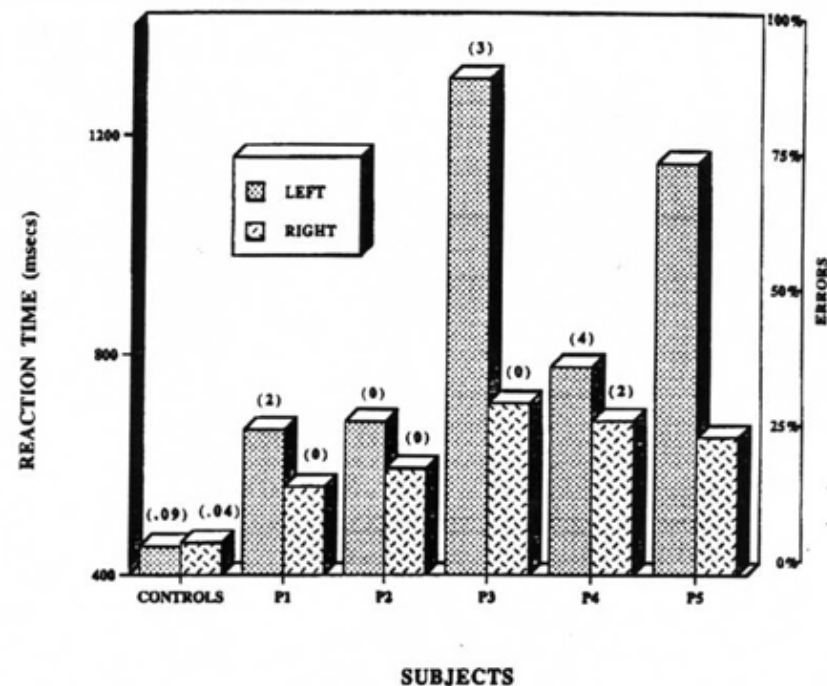


Figure 14.3 Mean reaction time to detect the targets in the static condition as a function of side for control subjects and for patients. Error proportion for all except P5 are shown in brackets. The Y-axis of percentage errors on right side applies only to P5.

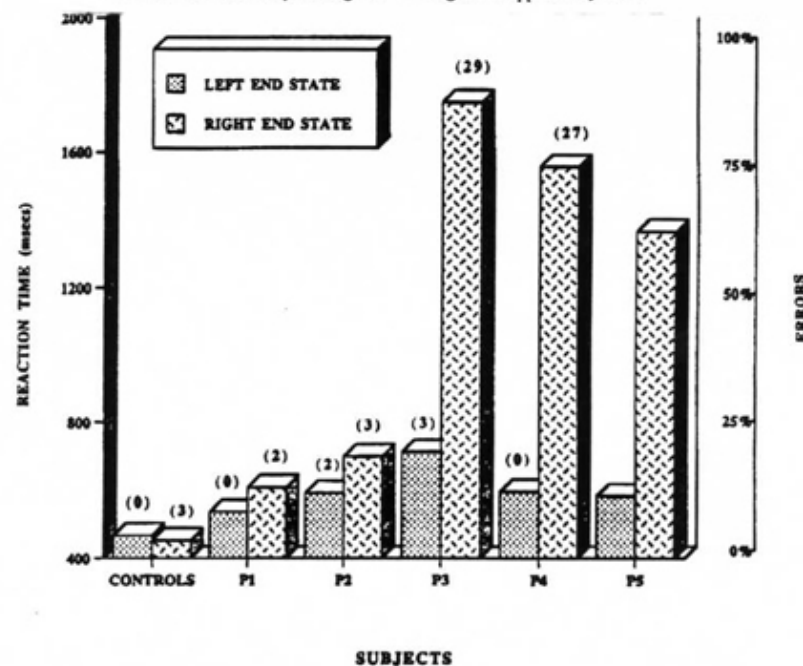
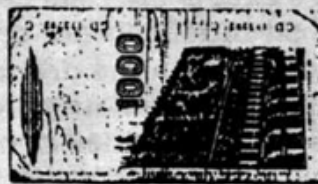


Figure 14.4 Mean reaction time to detect the targets in the moving condition as a function of end state for control subjects and for patients. Error proportion for all except P5 are shown in brackets. The Y-axis of percentage errors on right side applies only to P5.

Levels of attention & consciousness

- to what level is information in neglected field processed?**

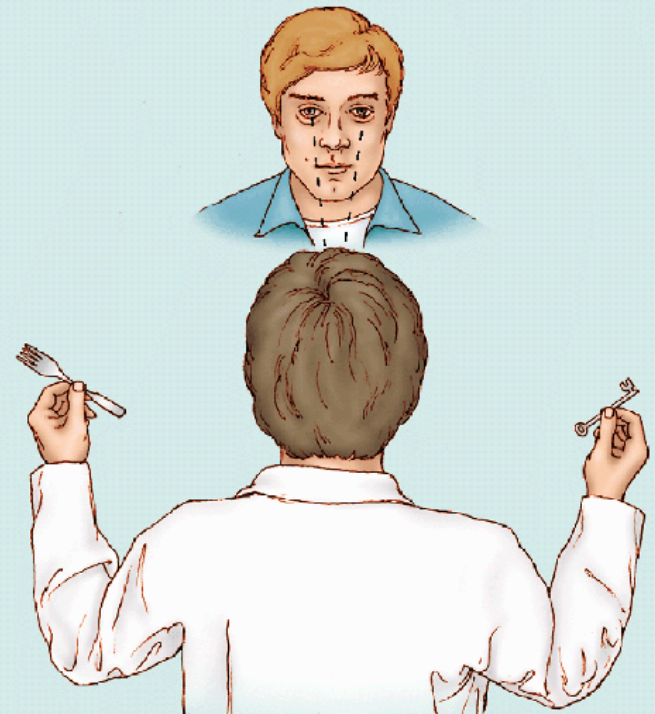
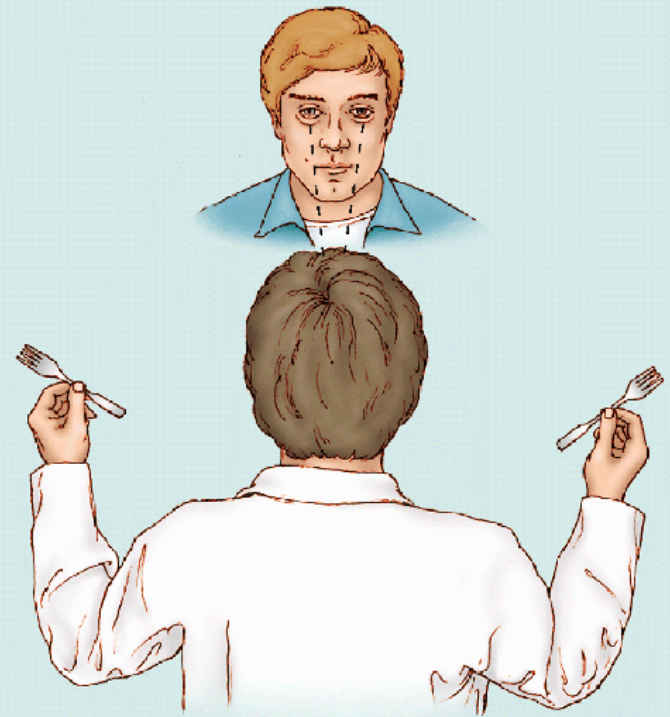


**Conscious report
*no difference***

Unconscious preference

Does object identity matter for neglect?

If it does, one must know what object is in neglected VF



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