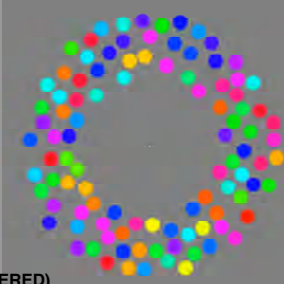


Announcements

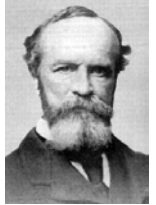
1. **Exam returned at the end of the class**
2. **Remember: Perception Journals are due on Nov 17th (16 days from now)**
3. **NO class Tuesday before Thanksgiving (additional office hours during that class time)**

Attention outline

1. **Intro**
 - History
 - What is attention
 - Types of attention
2. **Limits of attention**
 - Why limits?
 - Effects of divided attention
 - Experimental techniques
 - Crowding, Attentional blink, Inattention blindness and change blindness
3. **Effects of attention (NOT COVERED)**
4. **Visual Search**
5. **Deficits of visual attention**
6. **A bottom-up model of attention (NOT COVERED)**



What is attention?



"Everyone knows what attention is. It is the taking possession by the mind in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought..."

It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatterbrained state."

– William James, 1890

No one knows what attention is!

–Harold Pashler, 1998

Attention is: limited, focused, divided, fast, slow, involuntary, voluntary, top-down, bottom-up, overt, covert, object-based, location-based.....

2

Why we need attention and what is attention good for?

- We need attention to effectively deal with
 - Huge amount of sensory information
 - Limitations in brain's cognitive systems
 - Limitations in energy consumption of the brain
- Benefits of attention
 - Priority given to unexpected
 - Efficient exploration
 - Efficient filtering



Types of attention

Covert	Overt
Sustained Voluntary Conscious Endogenous Goal-driven Top-down	Transient Involuntary Unconscious Exogenous Stimulus-driven Bottom-up (pre-attentive)
Object-based Feature-based	Location-based Spatial attention

E.g., you can have **overt, sustained** attention on an **object**

4









Covert vs. Overt attention

- Overt attention:
 - Move the eyes to "foveate" the item to be attended (3-4 per sec)
- Covert attention
 - Attend to items in periphery without moving the eyes
 - needed for divided visual attention
 - sometimes is good to avoid direct gaze



5

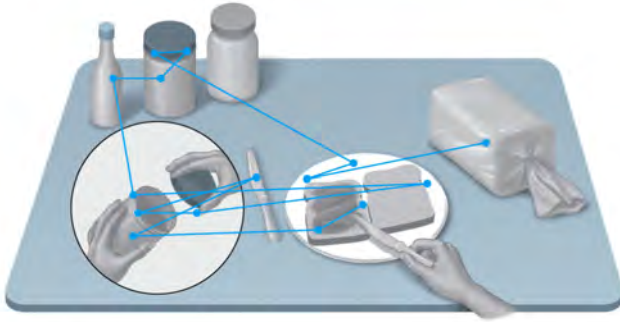
Overt attention

			Free Examine
What are the material circumstances of the family?			What are their ages?
What were they doing before arrival?			Remember the clothes
Remember object and person positions			How long has the unexpected visitor been away?

6

[Yarbus 1967]

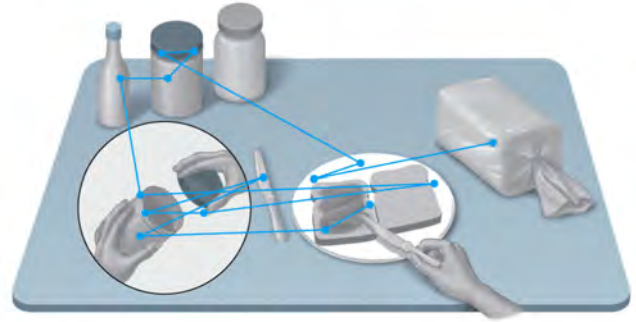
Overt attention



Sequence of fixations of a person making a peanut butter sandwich. The first fixation is on the loaf of bread. (From Land & Hayhoe, 2001.)

7

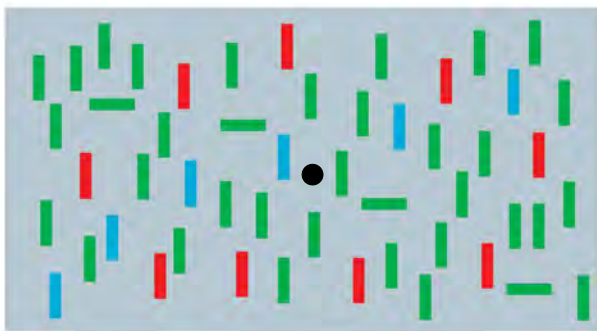
Covert attention



Sequence of fixations of a person making a peanut butter sandwich. The first fixation is on the loaf of bread. (From Land & Hayhoe, 2001.)

8

Covert attention



Can you attend to the red items and then, without moving your eyes, can you attend to the blue items?

9

Types of attention

Covert	Overt
Sustained	Transient
Voluntary	Involuntary
Conscious	Unconscious
Endogenous	Exogenous
Goal-driven	Stimulus-driven
Top-down	Bottom-up (pre-attentive)

300 ms...
cortical
feedback
informative cue only
resource demanding

80 - 120 ms
also subcortical
feedforward
occurs regardless of cue
few "resources" required

10

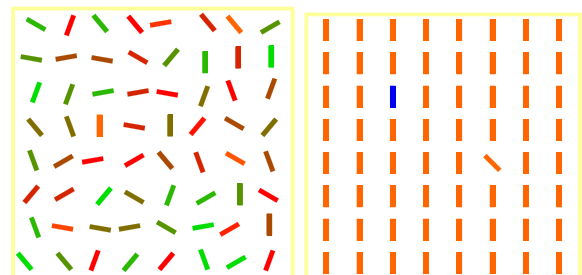
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Endogenous	Exogenous
Goal-driven	Stimulus-driven
Top-down	Bottom-up (pre-attentive)

- Exogenous shifts are elicited by **external** stimulus:
 - Bright flashes, Loud noises, Unexpected tactile stimulation, abrupt changes
 - the critical factor for attentional capture by abrupt onsets is their status as new perceptual objects that may require evaluation for rapid action
- Endogenous shifts are **internally** driven
 - Visual search, auditory search, preparing for an occurrence of a stimulus

11

Sustained	Transient
Voluntary	Involuntary
Conscious	Unconscious
Endogenous	Exogenous
Goal-driven	Stimulus-driven
Top-down	Bottom-up (pre-attentive)



Top-down

bottom-up

12

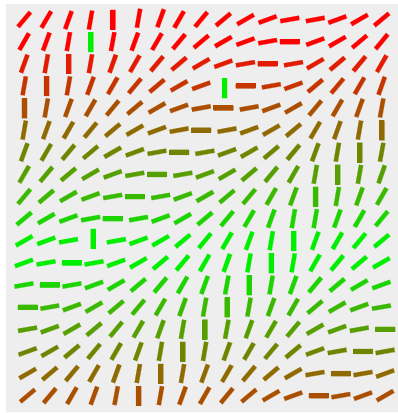
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Endogenous	Exogenous
Goal-driven	Stimulus-driven
Top-down	Bottom-up (pre-attentive)
Object-based Feature-based	Location-based Spatial attention

- Attention can be directed toward:
 - An object (e.g., reading a street sign)
 - A spatial location (e.g., checking your blind spot)

14

local differences create bottom-up salience



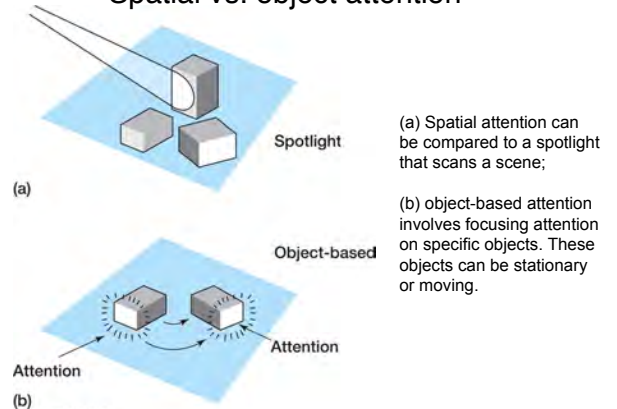
Time permitting, a **bottom-up** attention model will be described at the end of the class

Spatial vs. object attention



15

Spatial vs. object attention



16

Spatial vs. **object** attention



Attend to face:
Fusiform face area (FFA) activity increases

Attend to house:
Parahippocampal place area (PPA) activity increases

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18

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 - Efficient filtering



Factors limiting attention

- We need attention to effectively deal with
 - **Huge amount of sensory information**
 - Limitations in brain's cognitive systems
 - Limitations in energy consumption of the brain
- The amount of information coming down the optic nerve is estimated to be in the range of GB (gigabyte) per second. This is about 500 10-megapixel jpegs per second.
- This far exceeds what the brain is capable of fully processing and assimilating into conscious experience.
- Attention is the natural strategy for dealing with this overflow of information.

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Factors limiting attention

- We need attention to effectively deal with
 - Huge amount of sensory information
 - **Limitations in brain's cognitive systems**
 - Limitations in energy consumption of the brain
- Human information processing is massively parallel, up to a point where we have serial **bottlenecks**
 - **Bottleneck:** a restriction on the amount of information that can be processed at once forcing serial processing
- Serial bottlenecks:
 - limited sensory systems
 - limited effector systems
 - movements must be planned sequentially
 - words can only be spoken sequentially
 - Working memory can only handle limited information

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Factors limiting attention

- We need attention to effectively deal with
 - Huge amount of sensory information
 - Limitations in brain's cognitive systems
 - **Limitations in energy consumption of the brain**
- The high-energy cost of neuronal activity involved in cortical computation limits our ability to process information:
 - constant overall energy consumption available to the brain
 - neuronal metabolic cost depends on the spike rate
 - the cost of a single neural action potential (single spike) is high
 - average discharge rate of active neurons will determine how many neurons can be active concurrently [...1%]
- The brain needs machinery for the system to allocate energy according to task demands ... hence, selective attention.

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What are the limits of attention?



"Any man who can drive safely while kissing a pretty girl is simply not giving the kiss the attention it deserves"



Strayer et al (2006) found motorists who talk on cell phones while driving are as impaired as drunken drivers with blood-alcohol level of 0.08 percent.



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Limits of attention - divided attention

- Use of cell phones and driving:
 - 100-Car Naturalistic Driving Study (followed 100 cars over 2,000,000 miles)
 - 22% of all recorded crashes and near-crashes involved distracted drivers (mostly talking on cell-phone)
 - In 2009, almost 1000 driving deaths could be linked to cell phone use
 - Also in 2009, about 5000 deaths could be attributed to distracted driving (along with 450,000 injuries)

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Spatial resolution of attention: Visual crowding

•Whatever attention is, it must have some spatial limits!

F + DGFRB

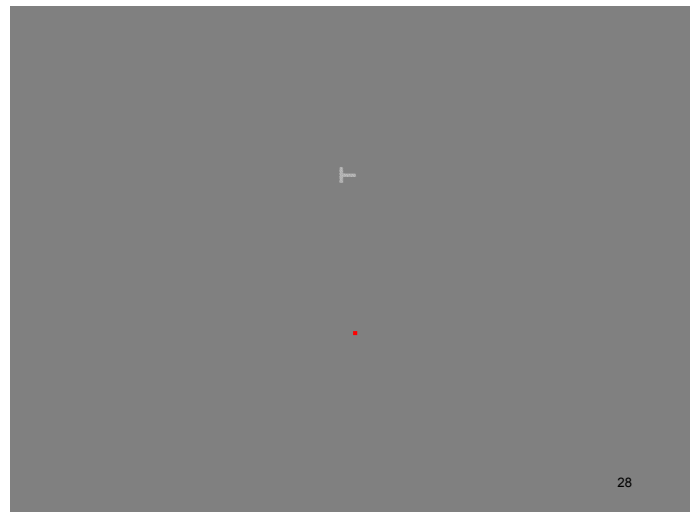
Resolution of attention is more coarse than visual resolution (acuity)

26

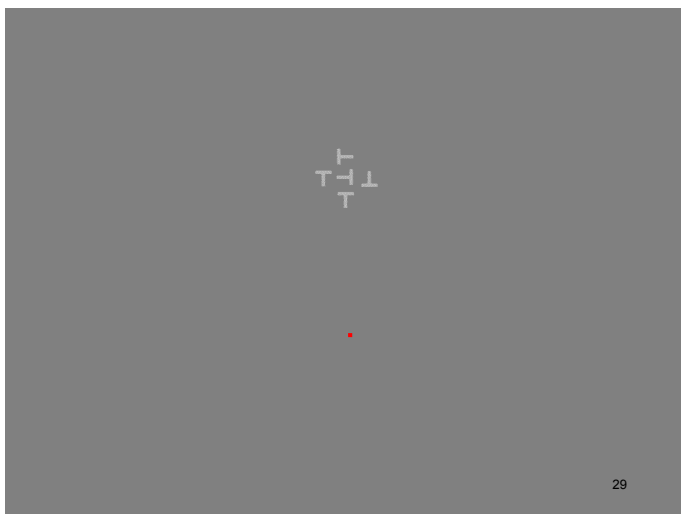
Spatial resolution of attention: Visual crowding



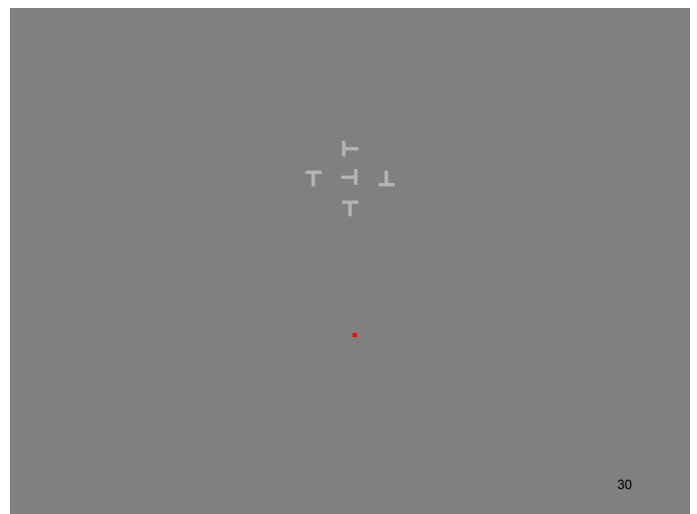
27



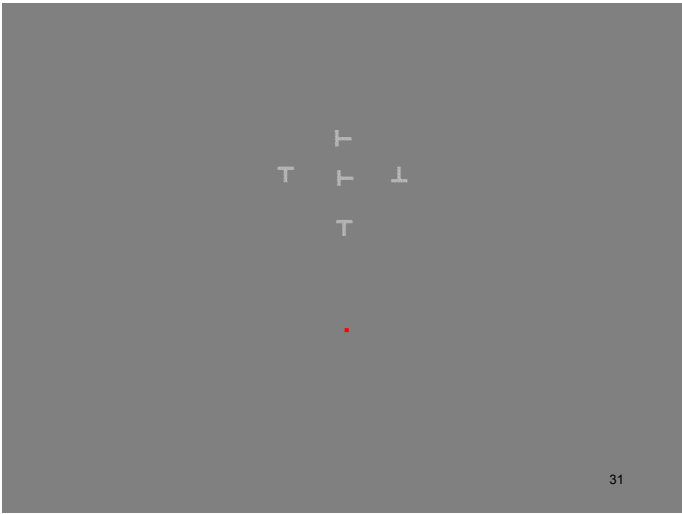
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29

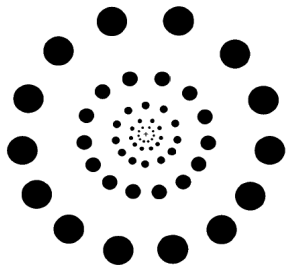
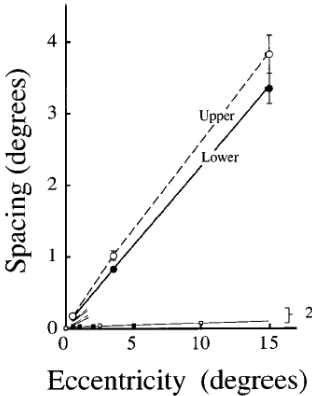


30



31

Spatial resolution of attention: Visual crowding



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Inattention blindness

Participant sees		3-4 more trials		
			Inattention trial	Recognition test
Participant's task	Indicate longer arm: horizontal or vertical?		Which arm is longer?	Which object did you see?

Inattention blindness experiment. Participants judge whether the horizontal or vertical arm is longer on each trial. After a few trials, the inattention trial occurs, in which a geometrical object is flashed, along with the arms. In the recognition test, the participant is asked to indicate which geometrical object was presented.

33

Inattention blindness

http://viscog.beckman.uiuc.edu/djs_lab/demos.html

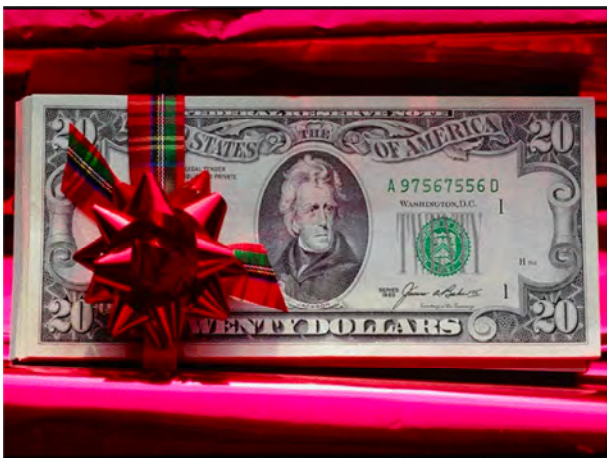
34

Change blindness

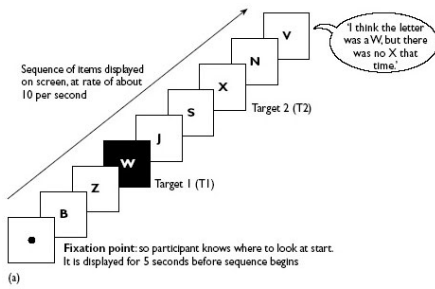


http://viscog.beckman.uiuc.edu/djs_lab/demos.html

35

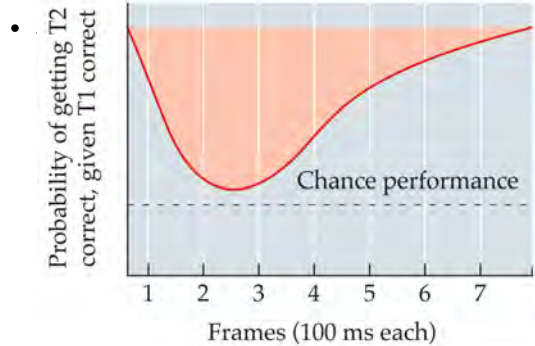


Attentional Blink



43

Attentional Blink



44

Attentional Blink

Get ready. Here come the letters. Your goal is to consciously notice R, followed by C.

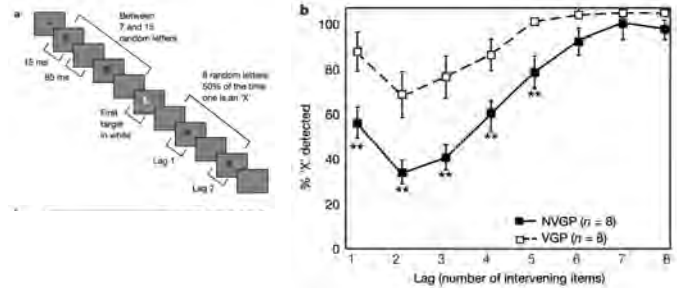
Look for a fruit and then a watch

Is the fruit an apple or a banana?
Is the watch digital or analog?

45

Changing the limits of attention

Green & Bavelier (2003)



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Attention outline

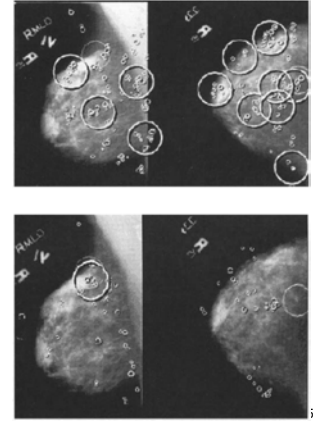
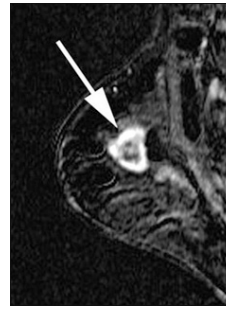
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Visual search



SENSATION AND PERCEPTION, Figure 6.8 © 2008 Sinauer Associates, Inc.



Visual search



Fig. 1. Example of a target-present stimulus image. The target (the blade and shaft show up in dark blue, and the handle in orange) is a little above the center of the image, to the left of the toy airplane.



51

“If you don't find it often, you often don't find it”
Wolfe et al (2005)

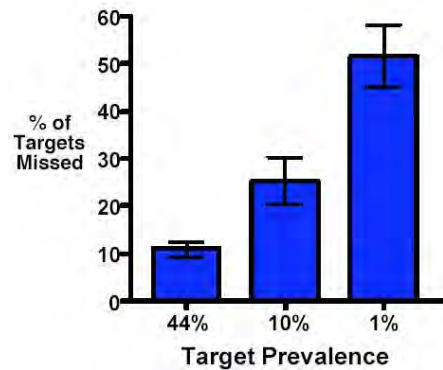
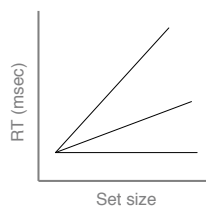


Fig. 1. Example of a target-present stimulus image. The target (the blade and shaft show up in dark blue, and the handle in orange) is a little above the center of the image, to the left of the toy airplane.



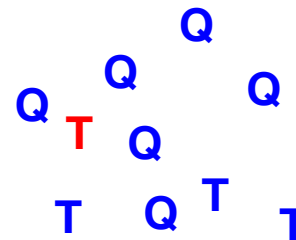
Visual Search

- Very important paradigm for studying human visual attention
- Typical measures used
 - RT as a function of set size
 - Slope
- Why?
 - Measures the “cost” of each item in the search
 - What does a flat slope mean?
 - What about steep vs. shallow?



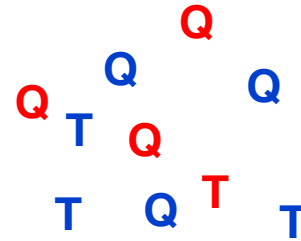
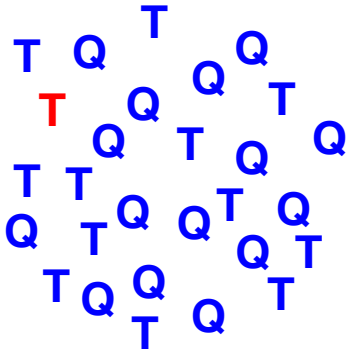
53

Feature Search (pop-up, parallel)



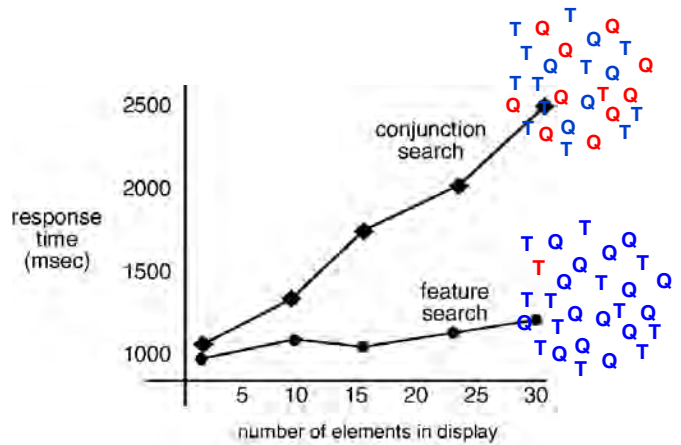
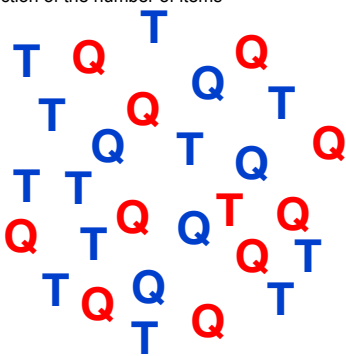
Conjunction Search (serial)

- Find...combination of features: red T



What do you suppose happens to RT when the number of objects is doubled?

- Each item must be attended to individually in order
 - A series of discrete shifts of attention
 - Much slower
 - Clearly a function of the number of items



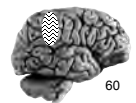
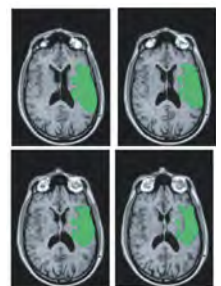
What do you suppose is the relationship between "target present" and "target absent" trials, on average?

Attention outline

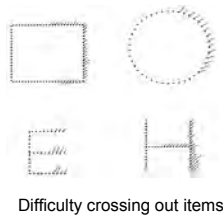
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Hemispatial Neglect

- Cause
 - often a stroke that has interrupted the flow of blood to the right parietal lobe that is thought to be critical inattention and selection.
- Symptoms:
 - Failure to acknowledge objects in the field **contralateral** to the lesion
 - fail to dress the left side of their body
 - disclaim "ownership" of left limbs
 - not recognize familiar people presented on the left side
 - deny the illness
- Often no perceptual deficit
 - Neglect patients still activate visual regions in occipital lobes that they claim not to be aware of



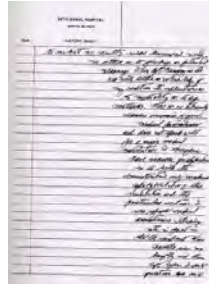
Hemispatial Neglect



Difficulty crossing out items



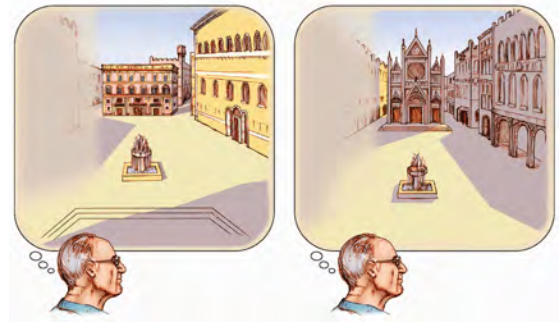
Difficulty copying items



55 y.o. right handed male R
TPJ infarct (Mesulam, 2000)

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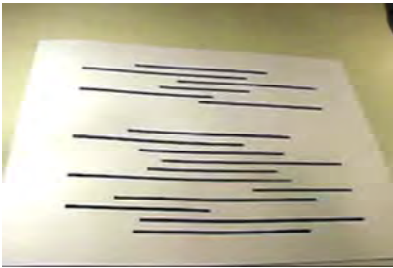
Hemispatial Neglect



62

Adapted from Bisiach, E., and Luzzatti, C., Unilateral neglect of representational space, Cortex 14 (1978): 129-133.

Hemispatial Neglect



Parietal lobe damage
(dorsal/m pathway)



63

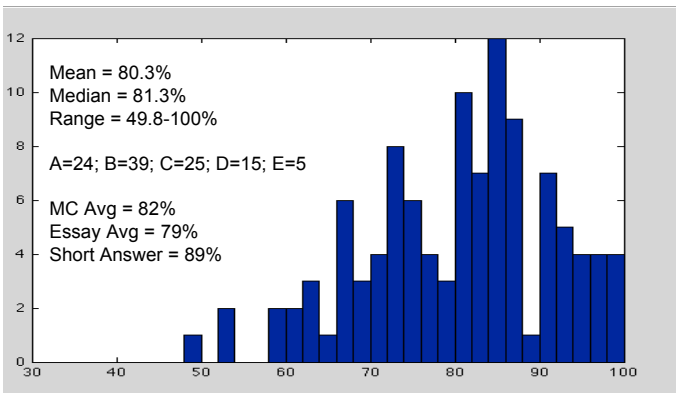
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Inattentional and

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6 point curved was added to your exam grade



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