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.....

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

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

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
Free Examine

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

[Yarbus 1967]

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

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.)

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

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300 ms...
cortical feedback
informative cue only resource demanding
80 - 120 ms also subcortical feedforward occurs regardless of cue few “resources” required

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

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

Spatial vs. object attention

(a) Spatial attention can be compared to a spotlight that scans a scene;
(b) object-based attention involves focusing attention on specific objects. These objects can be stationary or moving.

Spatial vs. object attention

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

Attend to house:
- Parahippocampal place area (PPA) activity increases
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
     - Inattentional
     - Change blindness

3. **Visual Search**
4. **Deficits of visual attention**
5. **A bottom-up model of attention**

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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

**What are the limits of attention?**

- 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.
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!

    D E C
    N U S
    R O Z

    D E C
    N R S
    R O Z

    U
    R

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

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

Inattentional Blindness

https://www.youtube.com/watch?v=j0BRdWMjqmw

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

Change blindness

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

- Schematic data from an attentional-blink experiment

### Changing the limits of attention

### Attention outline

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

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?

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

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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 in attention 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

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

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)

Hemispatial Neglect

Visual neglect syndrome can be object-based

Patients can neglect the left side of the object, rather than the left side of space. Black lines show expected left-sided person-centred versus red lines showing actual point where the patient neglected.

Tipper and Behrmann (1996) demonstrated that neglect is lack of a focus of attention.

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Exam 2, with a 6% curve added
(If your curved score is over 100%, your grade is 100%)

Mean = 80.00%
Median = 83.38%
Min = 44.1%
Max = 100%
A = 29
B = 38
C = 17
D = 14
E = 13