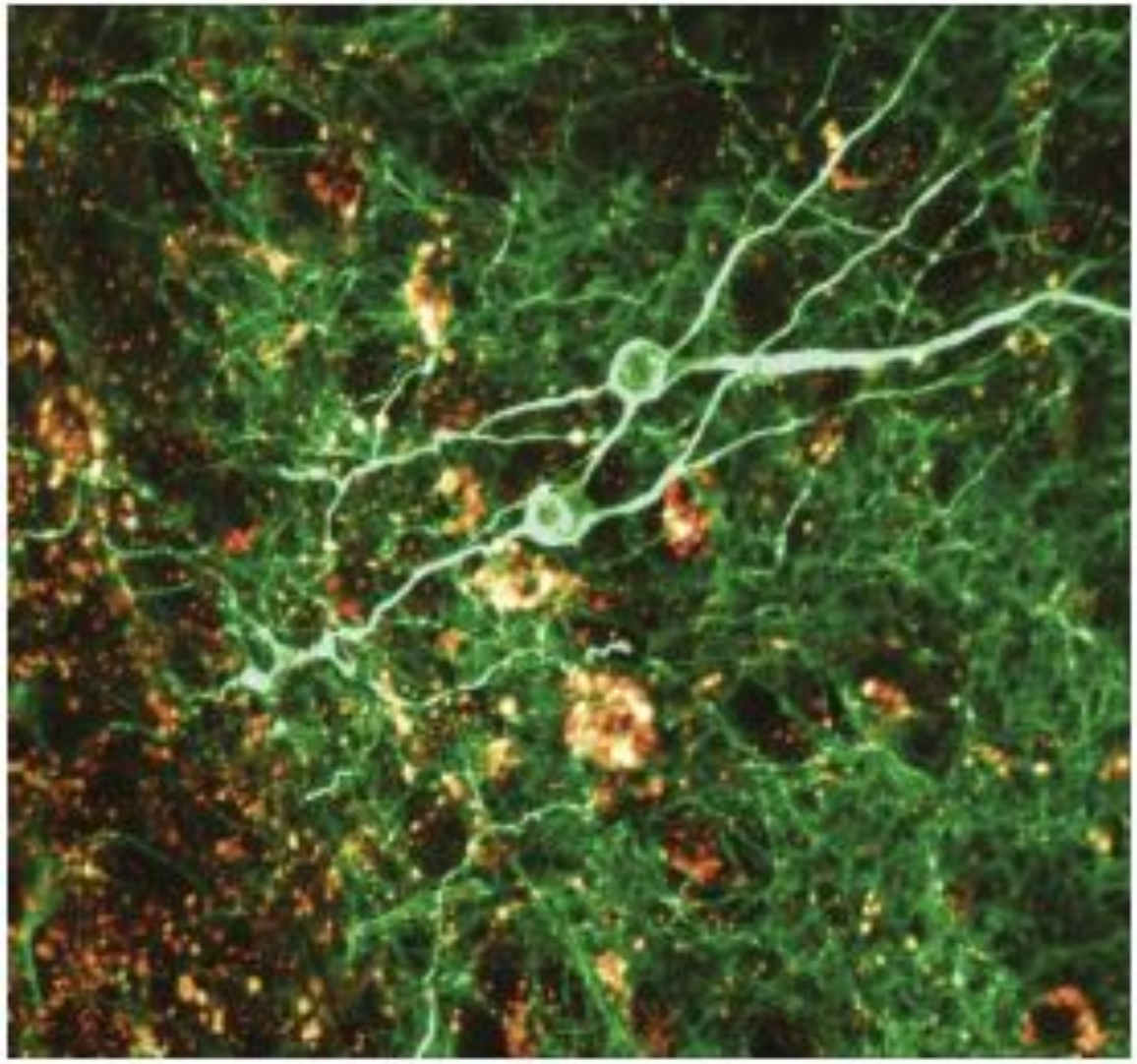
Attention

Introduction

FOOD FOR THOUGHT



Caffeine might provide more than a boost in alertness — it could also create long-lasting changes in the brain. David Blum at the University of Lille and Anne-Laurence Boutillier at the University of Strasbourg, both in France, and their colleagues fed caffeine-infused water to mice for two weeks and then extracted each rodent's hippocampus, a brain region crucial for learning and memory. **The brains of animals given caffeine had changes in gene activity in many types of brain cell, leading to a decrease in the synthesis of proteins involved in metabolism and an increase in those involved in neuronal signalling and plasticity.** Some changes persisted even after the mice had been denied caffeine for two weeks. The team also discovered that after a learning task, the animals that had received caffeine exhibited a larger boost in the activity of genes involved in processes such as memory formation than did mice that hadn't consumed caffeine. The authors say that these findings indicate that caffeine could cause long-term alterations in the brain — some of which might explain the substance's ability to enhance cognitive function.

SPOT THE PENGUIN

The Attention Problem…

- ✔ Human body is filled with sensors that detect sight sound smells and physical contact
- ✔ Billions of neurons process sensory information and deliver them to higher centers of the brain
- ✔ A large amount of information is processed at a given time

- How does the individual decide what to attend to?
- How does it comprehend meaningful information in a complex visual scene?
- How are parallel activities like driving a car and conversation coordinated?

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.*"

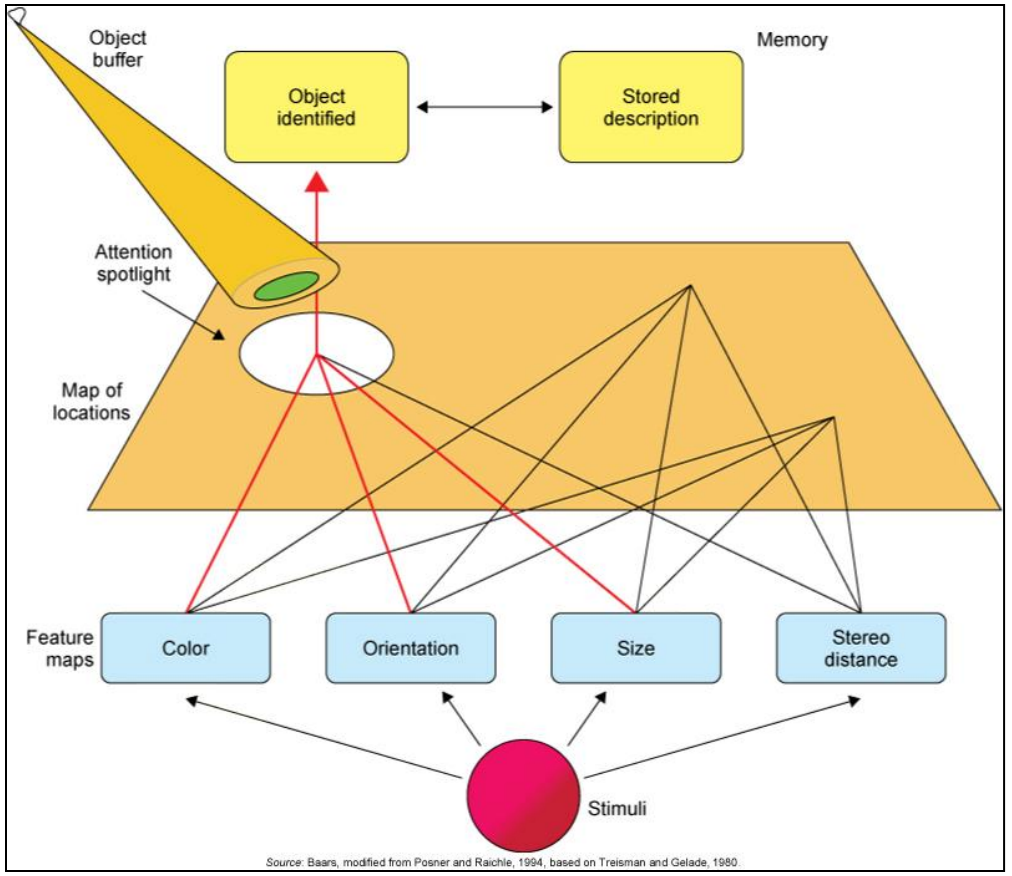
William James, 1890, Principles of Psychology

(1) People typically report that the object of their focus is at the forefront of their consciousness when they attend;
(2) the object or information upon which attention is focused typically becomes clearer and more vivid relative to other possible objects or thoughts;
(3) this process involves selection of one from multiple possible stimuli or thoughts at any given moment;
(4) when attention is intensely focused, other unrelated stimuli fall outside of conscious awareness and remain there until there is a disengagement from the primary focus of attention.

Attention

Attention and consciousness can be seen as complementary processes

Attention often is thought of by an analogy to a spotlight, moving to 'point at' and select some part of the world for conscious processing. Controlling the 'spotlight of attention' requires frontal and parietal cortex as well as subcortical regions



Attention is….

A crucial distinction is made between:

1. the mechanisms by which certain information is registered and other information is rejected, whether the latter enters conscious awareness

   (***selective*** **or** ***focused attention***)

2. some upper limit to the amount of processing that can be performed on incoming information at any one time

   (***divided attention***)

Solso's (1995)

Types of attention:

- focused,
- selective,
- directed,
- divided,
- sustained,
- effortful,
- controlled,
- automatic,
- voluntary attention

The term 'attention' has also been used for:

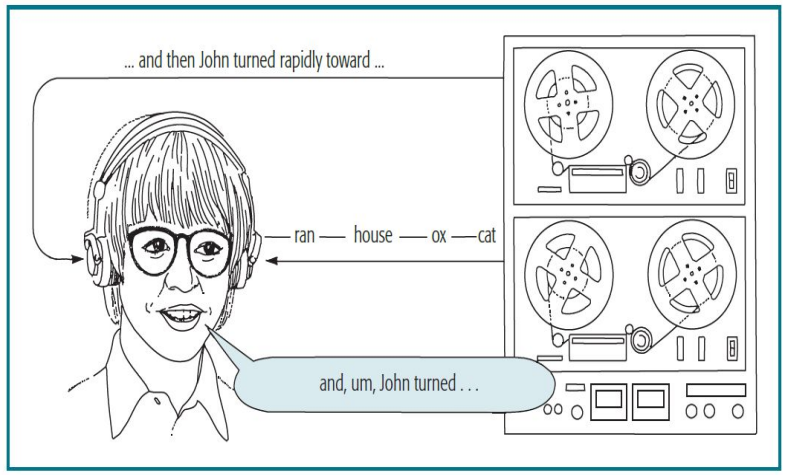
- concentration
- *vigilance*
- orientation
- executive control
- intention, and search

Ineffective attention is associated with:

- Inattention
- Fatigue
- Distractibility
- Confusion
- Impersistence
- Neglect
- discontrol

SELECTIVE (OR FOCUSED) AUDITORY ATTENTION

Participants wore headphones through which pairs of spoken prose 'messages' were presented to both ears simultaneously (*binaural listening*)



Cherry found that various physical differences affected a person's ability to select one of the messages to attend to, in particular voice intensity, the speaker's location and the speaker's gender

When these differences were controlled for in the two messages (eg: each message was spoken in an equally intense female voice), their meaning was extremely difficult to separate

In later experiments, he used dichotic listening and shadowing. While participants were able to shadow the specified message, they remembered little of the non-shadowed message

Cherry, 1953

Shadowing task – Visual

Somewhere Among hidden the in most the spectacular Rocky Mountains cognitive near abilities Central City is Colorado the an ability old to miner select hid one a message box from of another. Gold. We Although do several this hundred by people focusing have our looked attention for on it, certain they cues have such not as found type it style

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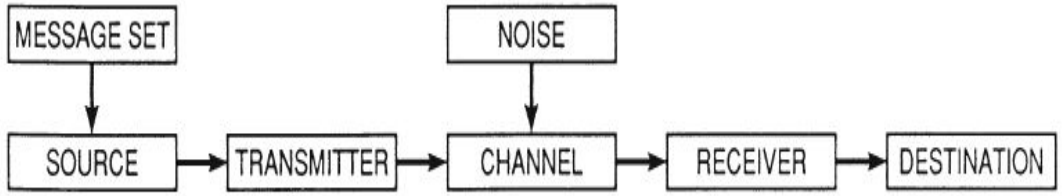
Selective attention

Broadbent used the communication system as a metaphor for relationships within the human nervous system:
the relationship between a sensory receptor and the brain
between the sensory system and memory,
between a perception and response generation

Similarity to communication systems:-

- Each of these systems consists of an information source
- a transmission channel or channels
- and a receiver
- The receiver, may function as a new transmission source

Each system may be conceptualized as a unit, and its properties may be studied by considering experimentally how different task demands effect outputs from the system, given a specific input



Shannon and Weaver's schematic of a communication system

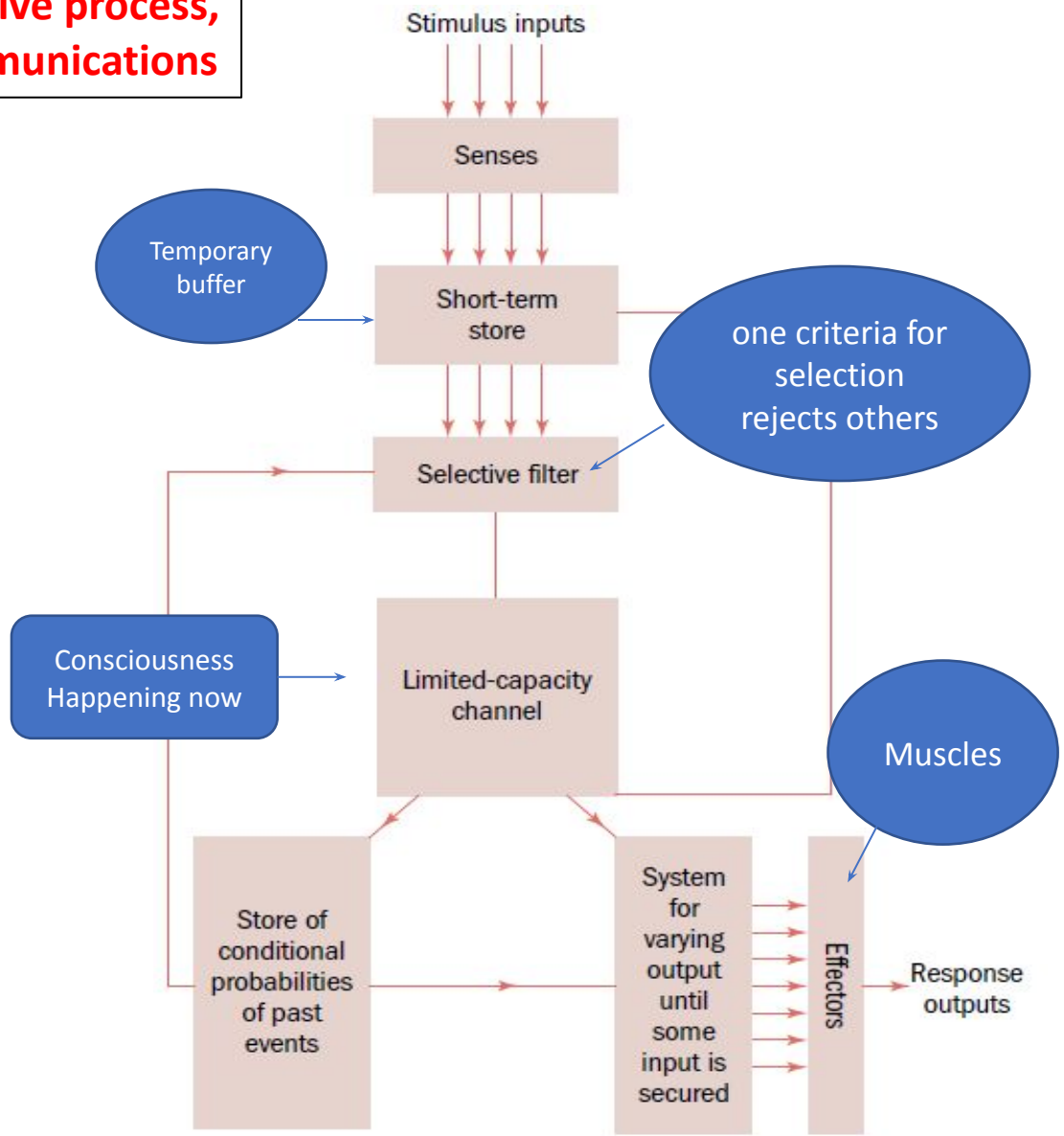
Broadbent's Selection Filter Theory 1958

Broadbent: listening is usually a selective process, particularly listening to linguistic communications

Information allowed through the filter reaches a limited-capacity channel (the filter is necessary precisely because the channel is capacity-limited)

This corresponds to the 'span of consciousness' (James, 1890) or what we experience as *happening now*

The information allowed through the filter is analyzed in that it's recognized, possibly rehearsed, and then transferred to the motor effectors (muscles), producing an appropriate response



Broadbent's split-span studies (1954)

Digits
A
B
C

Digits
E
F
G

Instructions: A few digits will be told to you. Please remember these digits

The task is to listen to the two sets of numbers and then write down as much as can be remembered

The digits can be recalled either:

1. *ear-by-ear recall*
2. *pair-by-pair recall* - chronological order of presentation

- When people are simply given a list of six digits at a rate of one every half a second, **serial recall is typically 95 per cent accurate**
- Broadbent found that the split-span procedure produced accurate recall **only 65 per cent of the time**
    - pair-by-pair recall poorer than ear-by-ear recall
    - Given a choice, people preferred ear-by-ear recall

Treisman's attenuation (or stimulus-analysis system) model

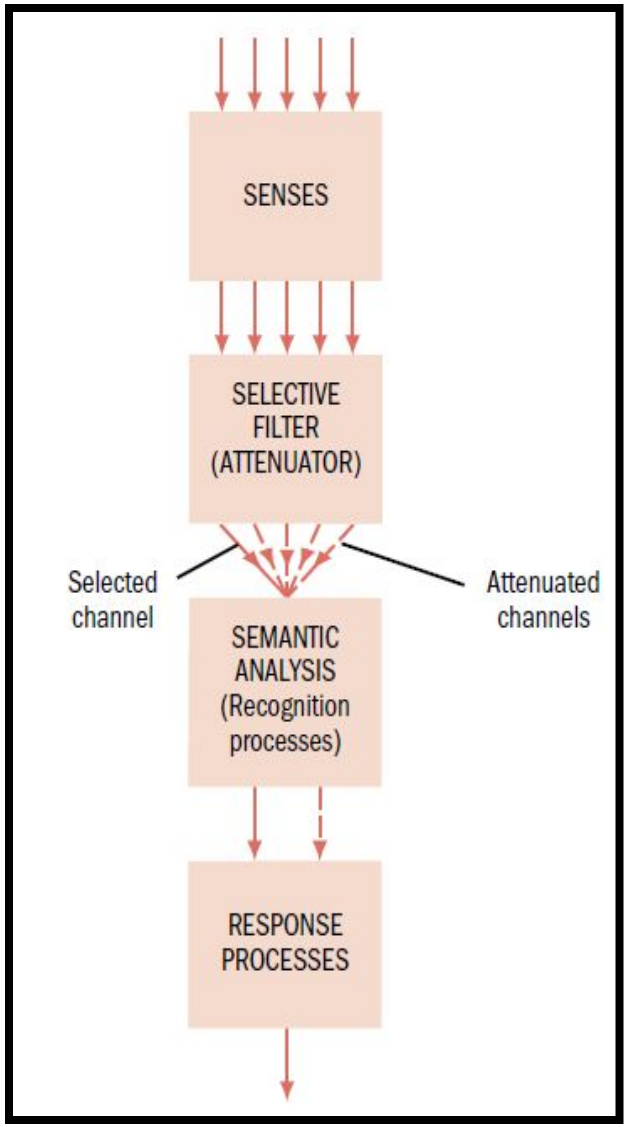
Treisman (1960, 1964) Competing information is analyzed for things other than its physical properties, including sounds, syllable patterns, grammatical structure and the information's meaning

Non-shadowed message isn't filtered out early on, but that the selective filter *attenuates* it a message that isn't selected on the basis of its physical properties wouldn't be rejected completely, but its 'volume' would be 'turned down'

Attenuation: The gradual loss of intensity

Biologically relevant and emotionally important stimuli may be 'presets' to which attention is switched, irrespective of the attenuated message's content

This accounts for our ability to switch attention to a different conversation when our name is mentioned



The late selection theory

J. A. Deutsch and D. Deutsch (1963) - all the information is processed completely without attenuation.

- Hypothesis - The capacity limitation is in the response system, not the perceptual system.

- People can perceive multiple messages but that they can say only one message at a time.

- People have some basis for selecting which message to shadow
- Ex - If they use meaning as the criterion (either according to or in contradiction to instructions), they will switch ears to follow the message. If they use the ear of origin in deciding what to attend to, they will shadow the chosen ear.

Difference between Late selection and early selection theories

- Both models assume that there is some filter or bottleneck in processing
- **Treisman's theory** - filter selects which message to attend to
- **Deutsch and Deutsch's theory** - the filter occurs after the perceptual stimulus has been analyzed for verbal content

Goal directed vs Stimulus driven attention

Stimulus driven attention

- Initially - the eyes will be drawn to large, salient objects like the towers of the temple and the stairs
- This would be an instance of stimulus-driven attention—it is not that we wanted to attend to this; but the structure/figure grabbed our attention
- When asked to search for “repair work” in the picture we have a goal and will direct our attention over the picture to find the object being described
  - In this case, I have not specified what type of repair work – so though GOAL DIRECTED ATTENTION is present, the specific image to be searched is unavailable
- When I ask you how many people are there in the picture – the search is GOAL DIRECTED and it is easier to spot

Real – world visual search: the low prevalence effect and intentional blindness

Real world example of missed information:

Drew *et al.* (2013): 24 experienced radiologists were asked to scan lung X-rays to look for tumours. Unbeknown to the radiologists, a small picture of a gorilla had been inserted into one of the slides.

A full 83 per cent of the doctors failed to notice the gorilla image because they were looking for something else (*in-attentional blindness*)

Real-world visual search often involves 'whole objects'

Example: professional searchers, such as the crews who look for survivors in storm wreckage, are looking for something they're unlikely to find as its irregular and rare

The *low prevalence effect* greatly reduces accuracy (Hout and Goldinger, 2013)

Real World Visual Search

https://www.youtube.com/watch?v=vJG698U2Mvo

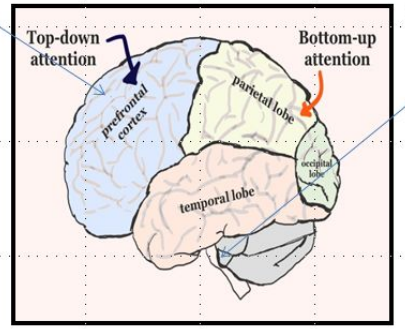
https://www.youtube.com/watch?v=UtKt8YF7dgQ

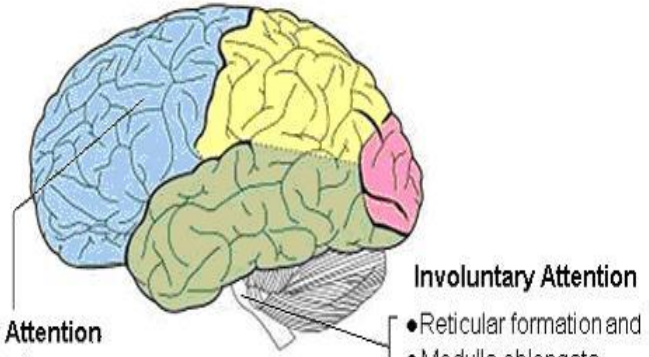
Brain and attention

Top down and Bottom up approach

Goal oriented
Responsible for seeing the bigger picture and uses to process information
Eg: studying for an exam or trying to solve a difficult problem

something around **grabs attention** (like a ping, or notification)
eg: loud noise, suddenly someone appears, phone buzzes





***Involuntary attentional capture* (IAC)** - attention is 'grabbed' beyond control

example, when we respond to an extremely loud noise or bright light (or an extremely attractive or unusual-looking person

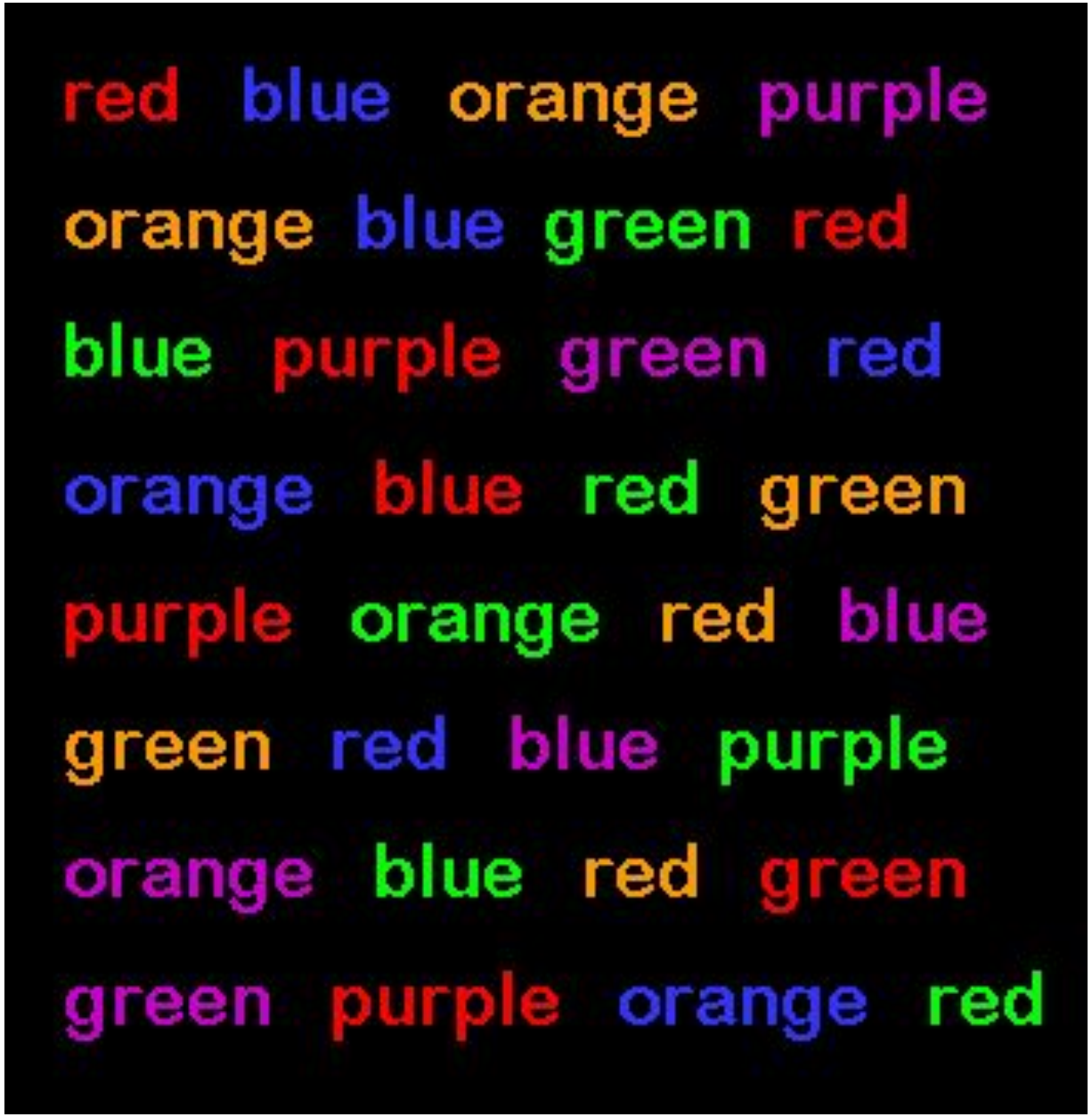
An experimental example involves presentation of a display containing three squares: when one of the squares briefly flashes (the cue) attention rapidly orients to the flash (within 1/10 of a second)

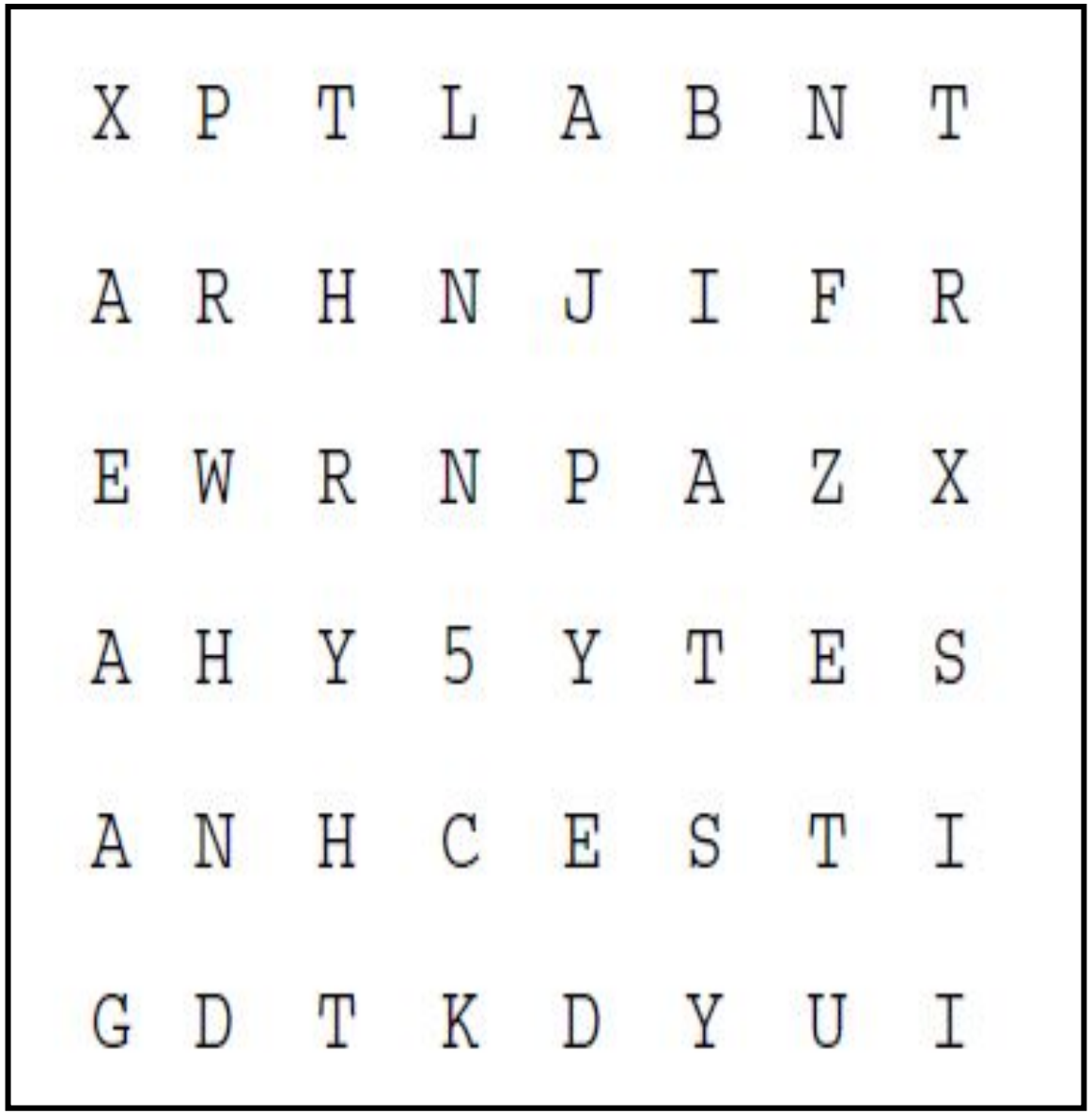
This is an *automatic process*

A demonstration of IAC is the Stroop effect

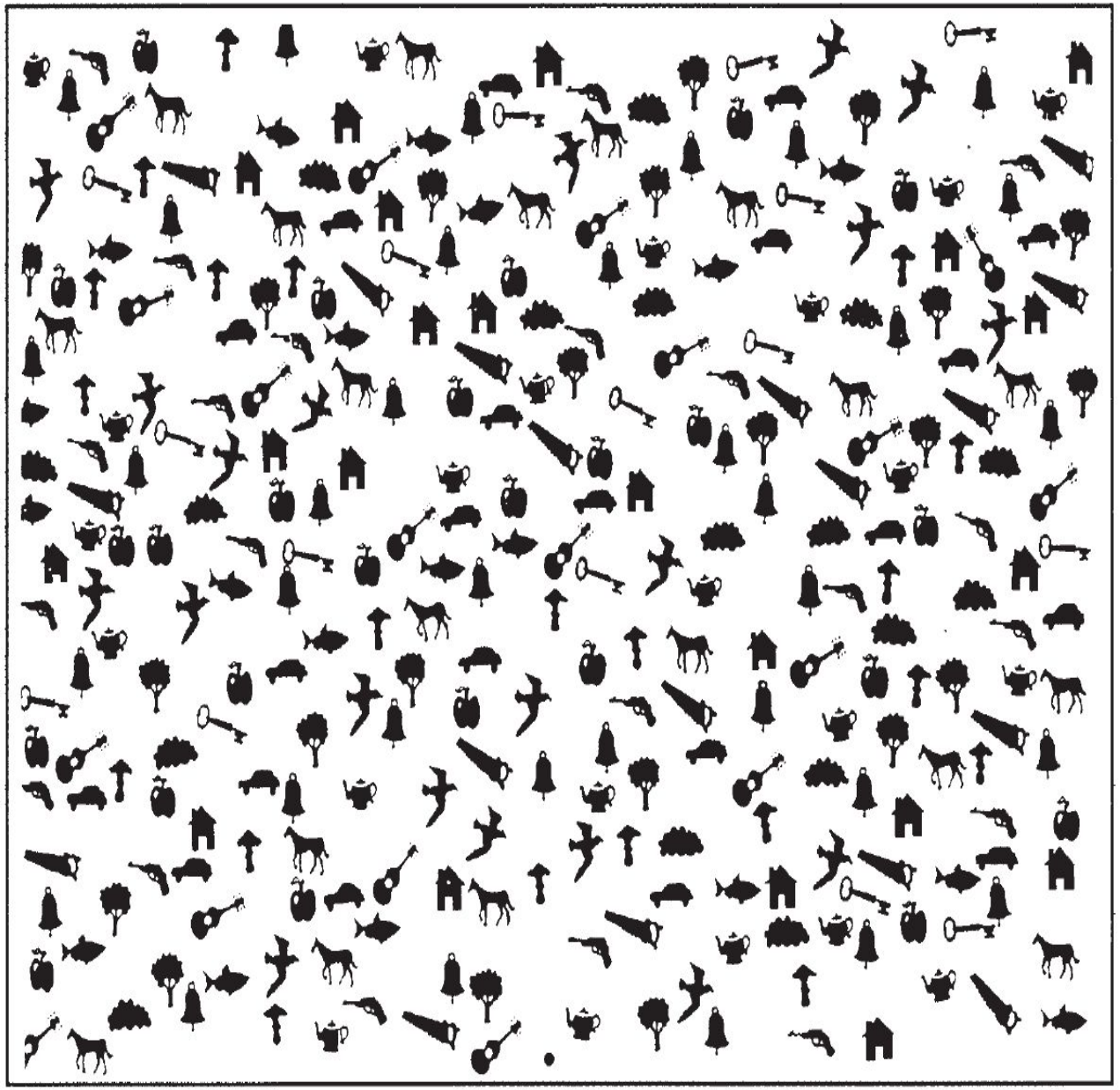
***Voluntary attentional vigilance* (VAV)** ability to consciously and deliberately focus on some particular aspect of the environment

The Stroop Effect





A visual search array: The task is to find the number five among the letters



Bell cancellation Test

How do we manage to focus on anything?

Summary of previous studies:

The act of concentration induces the brain to become blinkered to irrelevant distractions, so that it won't process them at all; the opposite view claims that we perceive everything, but the brain prioritises what's important

Lavie (1997): both views are mistaken:

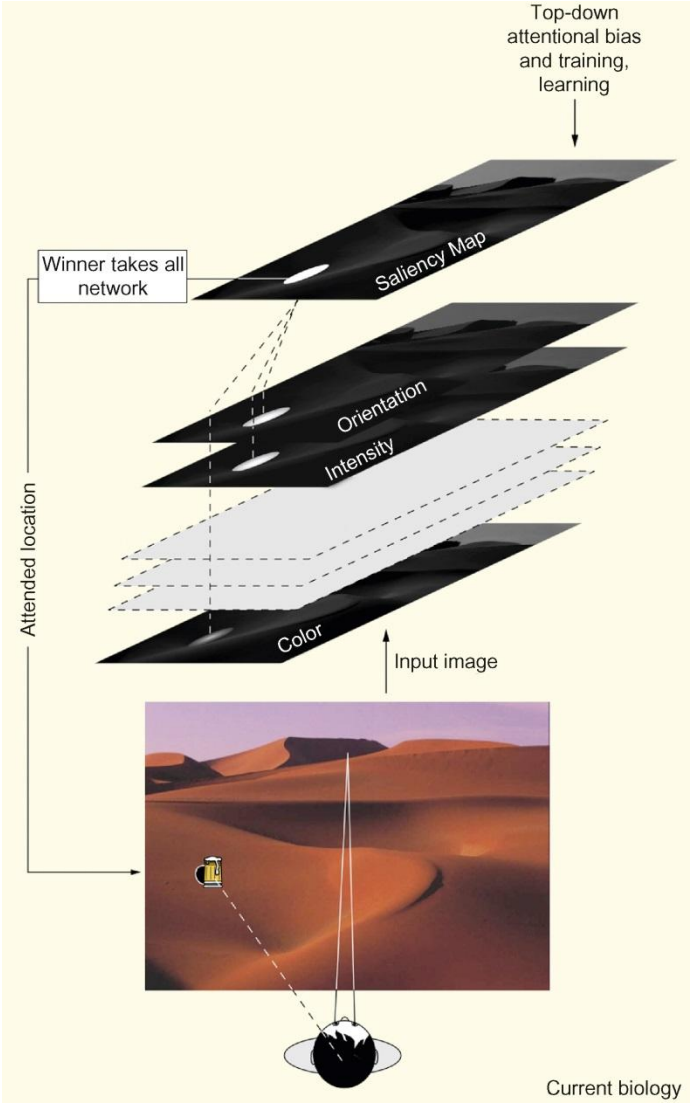
Concentrating in itself cannot screen out distractions (as in Involuntary Attentional Capture) and there's an upper limit to what our eyes can take in at any one time (Voluntary Attentional Vigilance)

Brain model for visual attention

Itti and Koch (2002) developed a useful model of attention that combines a number of important features. It shows a simplified layered concept of the visual system, with multiple topographic visual maps.

The visual maps show line orientation, stimulus intensity (contrast), color, and salience. 'Salience' is defined in terms of feature contrast in any visual map.

For example, in light-sensitive regions in the visual system, salience is the contrast between light and dark patches on the map while in motion-sensitive regions, it might be the contrast between a moving vs. stable object.

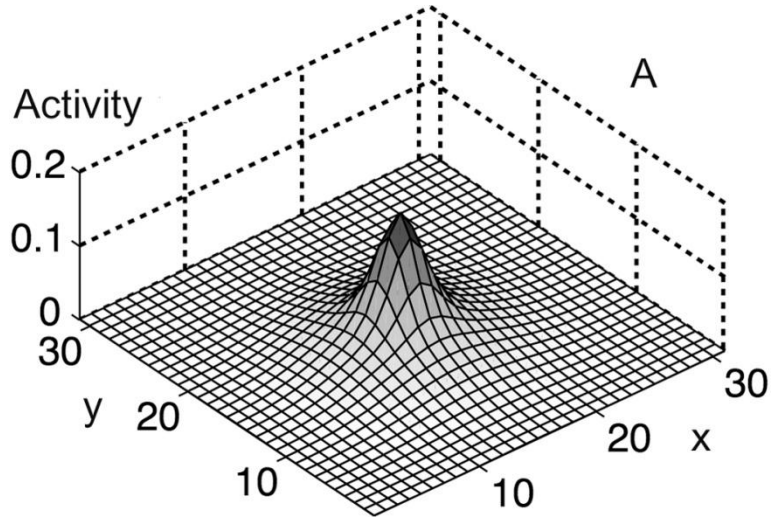


Brain model for visual attention

A combined saliency map may combine all the contrasting features of multiple visual arrays into a single overall saliency map, one that reflects the unusual, the unexpected, or noteworthy features of a visual scene.

The concept of a saliency map reflects the significance, motivational relevance, and vividness of the visual input

A 'Winner-Take-All' (WTA) computational network, proposed by Itti and Koch, *selects the most salient location* on a combined map and *inhibits competing locations*.



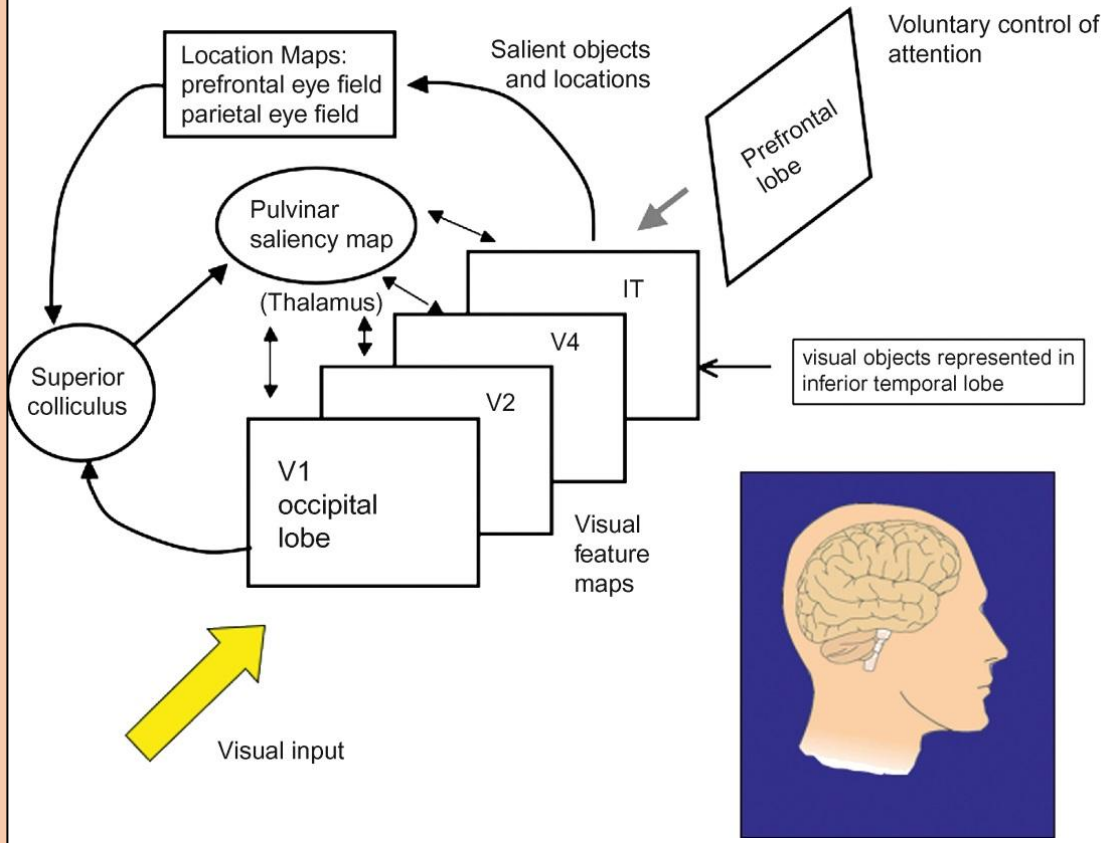
'Winner-Take-All' network

Brain model for visual attention

This brain model shows a current set of hypotheses about specific brain regions involved in voluntary attention to a visual location or stimulus.

Voluntary control of attention is attributed to the prefrontal cortex. Top-down activity descends to visual maps related to eye movements (prefrontal eye field, parietal eye field, and superior colliculus) and visuo-topical feature maps (V1, IT)

The pulvinar nucleus of the thalamus also contains a visuo-topical map and brings together saliency cues and their locations in all sensory feature maps

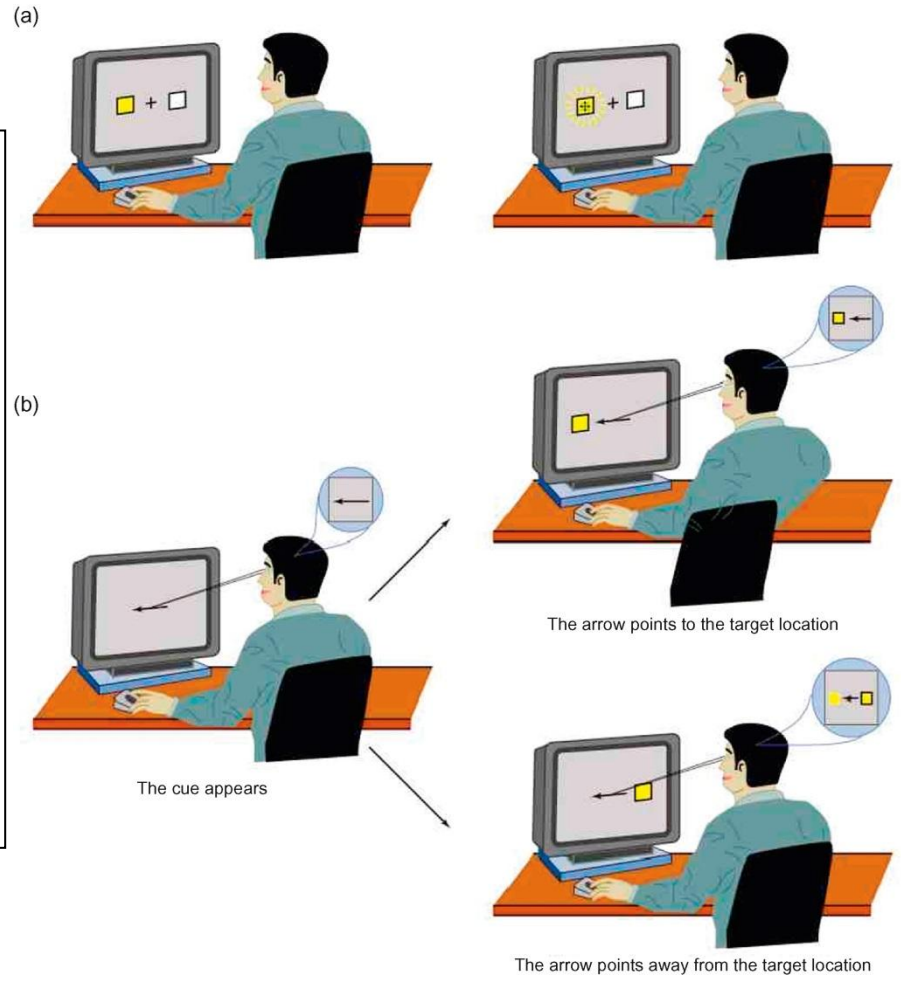


Attention enhances perception, cognition, and learning

Investigating attention: the Posner flanker task

The Posner flanker task has long been used to assess visual selective attention and its brain bases. The subject looks only at a *fixation point* in the center of the screen (a).

Directional cues such as an arrow (b) draw attention to the left or right flank (side) of the fixation point, but no eye movements are allowed. It is the subject's attention that is cued to one or the other side of the screen, not their eyes.



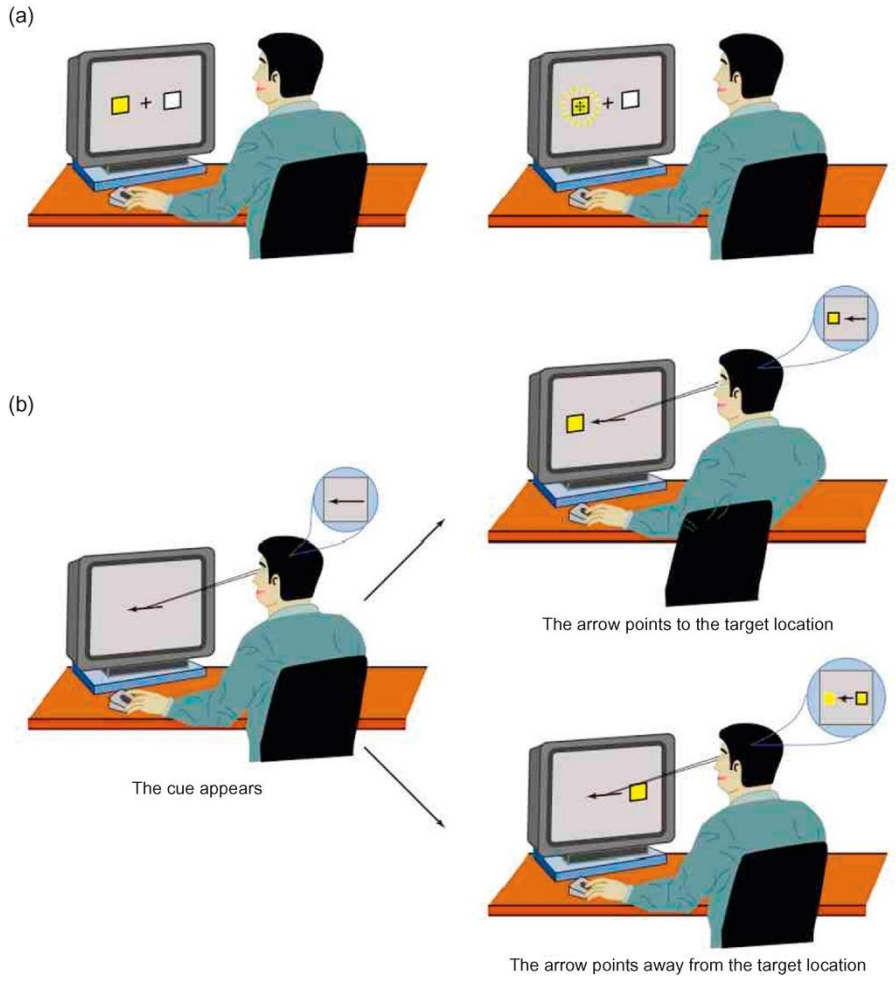
Attention enhances perception, cognition, and learning

Investigating attention: the Posner flanker task

The experimenter measures the subject's accuracy and response time across different experimental conditions to assess the effects of cuing.

A typical finding is that targets presented to the expected side have a *benefit* in shorter response time and increased accuracy, while targets presented to the unexpected (un-cued) side have a *cost* in longer response time and reduced accuracy

Thus, studies using this task have demonstrated that selective attention has both benefits and costs



Measuring Distractibility

Posner Flanker task:
https://www.psytoolkit.org/experiment-library/flanker.html

Change Blindness

Change blindness is the tendency to fail to detect changes in a stimulus array while actively exploring it. This happens when the perception of the motion that typically accompanies stimulus change is prevented or disrupted

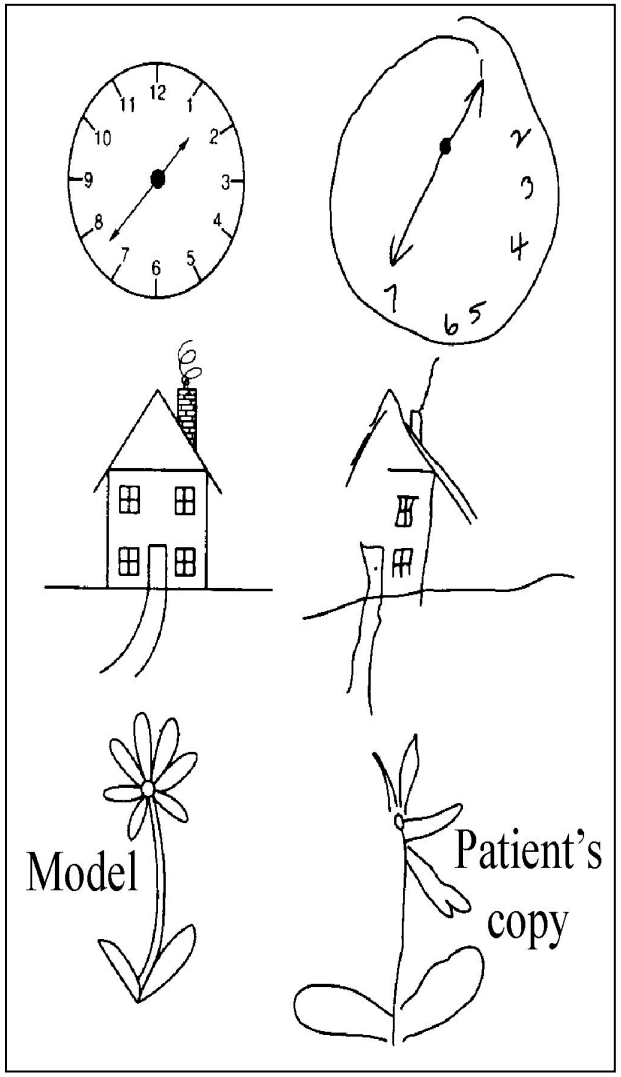
When Attention is disordered

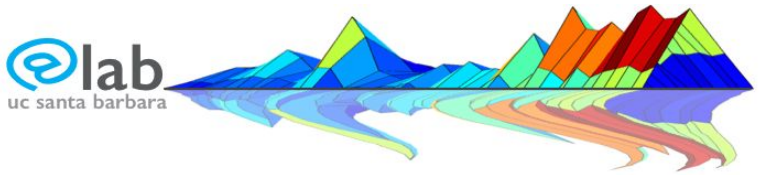
Unilateral visual neglect

People who've suffered a right-hemisphere stroke involving the parietal lobe may completely ignore stimuli occurring on the left side

Example:

They may fail to eat food from the left side of their plate, and be unaware of their body on that side. The fascinating thing about this (VN) is that these effects occur even though the pathways from the receptors to the central nervous system of for the neglected information remain intact





Welcome News People Research Publications Resources Participate

Welcome to the UCSB Attention Lab

On a moment-by-moment basis we are faced with an environment that is in a continual state of flux, changing over time and space. Coherent and adaptive behavior in this complex environment is supported by the interplay of a variety of sensory, perceptual and cognitive systems. Attention provides a powerful coping mechanism that mediates the selective processing of information that is consistent with our current behavioral goals and intentions. The purpose of the research conducted in our lab is to clarify the perceptual, cognitive, and neural mechanisms of selective attention.

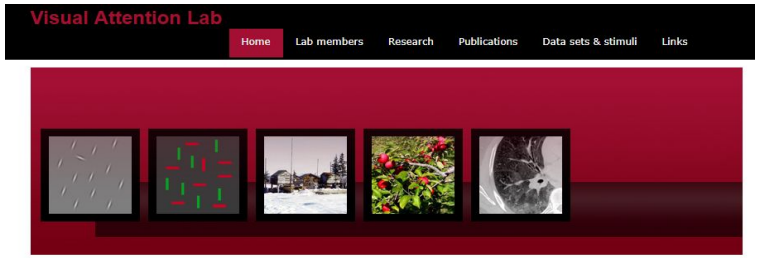
Recent News

Anne wins Richard E. Mayer Award!!

Amelia @ UG Slam and URCAII

Congrats Jelena & Sasa!

https://labs.psych.ucsb.edu/giesbrecht/barry/Attention_Lab/Welcome.html



Welcome to the Visual Attention Lab!

PI: Dr. Jeremy Wolfe

Work in the lab focuses on:

Preattentive vision - Studies of the processing of visual stimuli before they are selected by attention for further, more complete analysis.

Attentional deployment - Studies of the mechanisms by which attention selects specific items including studies of how to terminate searches without finding the target.

Post-Attentive vision - Studies of the consequences of attention. Once attention has been deployed to an item and has been removed, what are the persistent effects of that act of attention?

Real-world applications - Studies of visual search behavior in tasks such as airport security and medical screening.

Click here for a lecture by Dr. Wolfe introducing some of our research.

Contact Us

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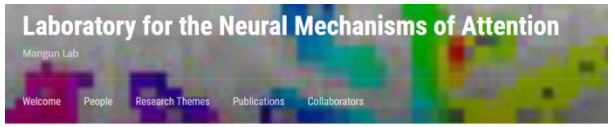
Participate

Click **here** to learn more about participating in studies at the Visual Attention Lab.

Affiliations

We are affiliated with Harvard Medical School and Brigham & Women's Hospital

http://search.bwh.harvard.edu/new/index.html

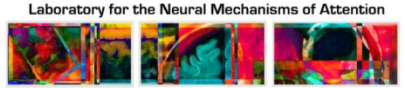


Start here

- Welcome
- People
- Research Themes
- Publications
- Collaborators

Welcome

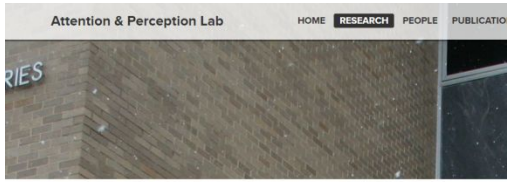
Laboratory for the Neural Mechanisms of Attention



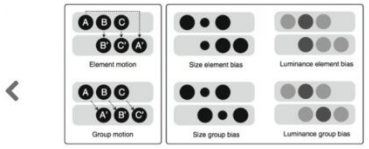
Center for Mind and Brain, University of California, Davis

Our laboratory uses a **cognitive neuroscience** approach to investigate the cognitive and neural mechanisms of voluntary and reflexive attention in humans. We bring to bear a variety of complementary tools to study attention, including behavioral and psychophysical methods, human electrophysiological measures, and functional neuroimaging. **Behavioral and psychophysical methods** permit us to analyze the properties of the human attention system and how attention influences perception and performance. Recordings of the electroencephalogram (EEG) and evoked responses known as **event-related potentials (ERPs)** permit a fine-grained view of the temporal properties of attentional control and selection. This is done by placing high density arrays of electrodes on the scalp and recording the electrical activity of populations of neurons as the human subjects participate in carefully controlled attention tasks. Finally, **functional magnetic resonance imaging (fMRI)** is used to investigate the functional brain anatomy of the attention system and where in the brain attention influences various information processing transactions during perception and action. Advanced signal processing methods, including

https://mangunlab.faculty.ucdavis.edu/



Research

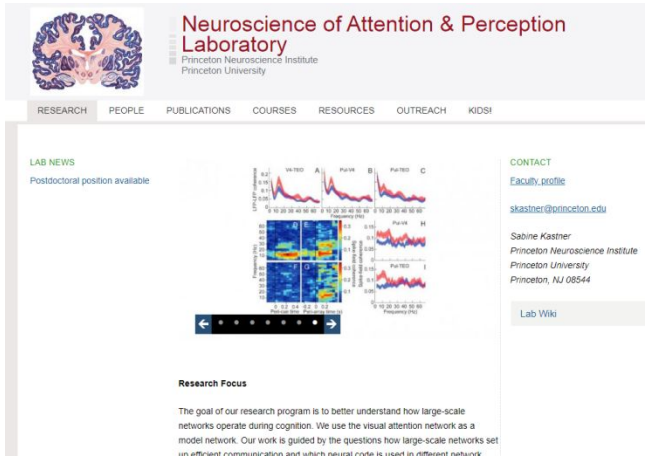


Stimuli used in Hein and Moore (2014) JEP:P

Objects and Perceptual Organization

The retinal image is just that, an image. Think of a digitized pixel map of different intensity and wavelength values at each x-y location on the retina. Although this is an oversimplification, it does characterize one of

https://psychology.uiowa.edu/iowa-attention-perception-lab/research



https://scholar.princeton.edu/napl/home