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COGNITION

Kellogg Chapter 3
ATTENTION

Fundamentals of Cognitive Psychology
(Kellogg)

"Only in the last 100 years has it been realized that human cognition could be the subject of scientific study rather than philosophical speculation" (Anderson, 1995).

Fall 2013

Cognition

- The collection of mental processes and activities used in perceiving, learning, remembering, thinking, understanding, and the act of using those processes.

- The study of how people perceive, learn, remember, and think about information.

Assumptions & Foundations of Cognitive Psychology

1. Mental Processes Exist

   - Why say this? History of **Behaviorism** (struggle in the mid-50s in proving that thought and mental processes could be subject to scientific empirical research)

2. Firm Commitment to Objective Observational Methods

   - Why say this? History of **Introspection**

3. Information Processing Approach

   - Why say this? This **metatheory** (overall approach) captures the philosophy of Cognitive Psychology

Seven Themes of Cognition

- **Attention**
  - **TODAY**
- **Automatic vs. controlled processing**
  - **the study of consciousness and control. (also TODAY)**
- **Data-Driven vs. Conceptually driven processing.**
  - **processing driven by environment (data-driven) or existing knowledge (conceptually-driven)**
- **Representation**
  - **how is information represented? same memory codes or different?**
- **Implicit vs. Explicit Memory**
  - **aware vs unaware; can information for which you have no conscious awareness affect your behavior? (also TODAY)**
- **Metacognition**
  - **our own perceived awareness of our own cognitive systems and capabilities**
- **Brain**

Cognition (History)

Wilhelm Wundt (1832-1920) is regarded as the founder of psychology as a formal academic discipline. His method of inquiry was largely introspection

Hermann Helmholtz had a particular interest in the speed of neural impulses. His research was one of the first to demonstrate that it is possible to experiment on and measure a psychophysiological process. Helmholtz also developed the Young-Helmholtz theory of color vision.

Hermann Ebbinghaus (1850-1909) was determined to study higher mental processes and examine these processes neglected by Wundt. Ebbinghaus used the study of nonsense syllables to discover the fundamental laws of learning and developed the forgetting curve based on his "method of savings."

Frances Galton (1822-1911) believed in innate social worth determined human character not the environment (thus his advocacy for eugenics). He was interested in a small portion of the population, the exceptional. Galton was the first to systematically apply statistical methods to compare individuals. He invented the correlation coefficient, did substantial research about the debate of Nature vs. Nurture, and invented the free-association technique.

Edward Titchener (1867-1927) was a follower of Wundt. Titchener's view was that all consciousness was capable of being reduced to three states: sensations, which are the basic elements of perception; images, which are the pictures formed in our minds to characterize what is perceived; and affections, which are the constituents of emotions. According to his theory of meaning, core referred to raw experiences such as sensations of light, sound, touch, and smell; context consisted of associations brought on by raw experiences. Context is what gives meaning to the core. Titchener also believed that emotions are intensified feelings arising from sensations inside the body.

William James (1842-1910) wrote the first psychology textbook, Principles of Psychology. The concept of functionalism, the adaption of living persons to their environment, is expressed in James' psychology. James also contributed to the James-Lange theory (we feel an emotion because of the action in which we choose to engage; e.g., we infer we are afraid because we run).

Edward Tolman was known for "his work that centered around demonstrating that animals had both expectations and internal representations that guided their behavior." (Galotti, 1994) He believed that rats used a cognitive map in order to complete the maze instead of memorization.

Wolfgang Kohler looked at the sudden solution that followed the quiet time "insight" and concluded that it was a typical property of problem solving.

Frederick Bartlett was known for his study of memory. He placed his emphasis on studies under natural conditions. Therefore, he rejected laboratory research. He felt that past experiences helped reconstruct the material able to be retrieved. He focused on information that was remembered and "misremembered". He saw memory as an active and often inaccurate process.

Skinner, B. F. (1904-1995) is famous for his theory of operant conditioning. He believed that behaviors and language were learned through reinforcement. He believed that behavioral changes resulted from responses of the individual to environmental stimuli. He believed that the cognitive revolution was a backward, rather than a forward, step in the history of psychology.

Noam Chomsky's review of Skinner's book on language (*Verbal Behavior*) is considered the famous turning point for Cognitive psychology. Chomsky, a linguist, argued that language cannot be explained through a stimulus response process as Skinner claimed. Language is a way to express ideas, and the way that these ideas are turned into language is a cognitive process. He showed that language was much more complex than anyone previously believed and that S-R accounts could not reasonably explain the complexities. Chomsky posits two types of structures: surface and deep structures.

David Rumelhart & James McClelland argued that information processing happens simultaneously (parallel) as opposed to serially (one at a time). Their Parallel Distributed Processing (PDP) Models suggest that many simple processing units are responsible for sending excitatory and inhibitory signals to other units. By understanding these basic features, they believe that complex system can be explained. The idea that processing involves interconnected elements and the reference to neural models, makes up their Connectionist Theory. (also see Newell).

George Miller is a professor at Princeton University. He studies information processing and focuses his studies on the capacity of Short-term Memory (STM). His name is associated with the "Magic Number 7." This theory suggests that most people can remember 7 plus/minus 2 bits of information using their STM. Miller also found that recall of information is better when it is chunked together.

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William James describes **attention** as *"the taking possession by the mind, in clear and vivid form, of one out of what may seem several simultaneous possible trains of thought… Focalization [and] concentration of consciousness are of its essence"* (pp. 403-404)

This view largely describes what we refer to as "SELECTIVE ATTENTION"

Attention

- Attention is the all important but poorly understood process that can act to limit and affect our cognitive processing.
- Attention refers to the concentration and focusing of mental effort. It is:
    - Selective
    - Shiftable
    - Divisable
- It is essential to most cognitive processing but only partially under our control.
    - Is it a mechanism?
    - a pool of resources?
    - an epiphenomenon?

Attention is the means by which we actively process a limited amount of the enormous amount of information available through our senses, our stored memories, or other cognitive processes.   It includes both Conscious and Unconscious processes.

- Conscious/Unconscious
- Attended/Unattended (no longer direct linkage – some active attentional processing occurs without conscious awareness)
- Aware/Unaware
- Direct/Indirect Measures…

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Monitors our interaction with the environment

Assists linking past (memories) with present (sensations) to give continuity to our experiences

Helps us to control and plan future actions

Functions of Attention
(What does attention do?)

1) Divided attention

2) Vigilance and signal detection
    - Vigilance: fatigue decreases detection of low probability events
    - Signal detection theory (Hit *vs* miss / False alarm *vs* correct rejection)

3) Search (e.g., Target vs. distractor)
    - Feature Integration Theory (Triesman)
    - Guided Search (Wolfe)
        - parallel stage (preselection) followed by serial

4) Selective attention
    - Filter Models
    - ADHD illustrates failure to focus attention

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- Filter models assume that attention operates as a filter that blocks the processing of some stimuli and allows processing of other stimuli

- Capacity models assume the agent selects stimuli for additional processing

Filter Models (Early Selection)

- Broadbent (1958) put forward the first well-defined model of attention – a filter model with "early selection" – to account for results from SHADOWING tasks and from DICHOTIC LISTENING tasks.

- Cherry (1953) used a **shadowing task**, in which one (auditory) message was to be repeated back out aloud (i.e., "shadowed") while a second auditory message was presented to the other ear.
    - Results suggest that very little semantic information from the second ("non-attended") message is absorbed.
    - Physical changes to the to-be-unattended message were more likely to be noticed (e.g., the insertion of a pure tone, changing the sex of the speaker, changing the intensity of sound).

- Broadbent argues that the unattended auditory information receives very little processing because the message is filtered out based on perceptual characteristics.

... and then John turned rapidly toward ...

ran — house — ox — cat

and, um, John turned ...

- The Shadowing Task

- Listeners rarely noticed even when the unattended message was spoken in a foreign language, reversed speech, or words repeated 35 times.

Shadowing: Messages are presented to both ears but subject is told to attend to only one of the messages and repeat it out loud.

- By and large subjects find it easy to perform this task

- Subjects can remember what was said on the attended channel.

- Some things subjects DON'T know about the unattended channel
  - What words were spoken.
  - The topic being discussed.
  - The language of the voice.

- Some things subjects DO know about the unattended channel
  - Whether it was a human voice or just noise
  - Whether it was a male or female voice.

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Right side
M
5
3

Left side
2
T
F
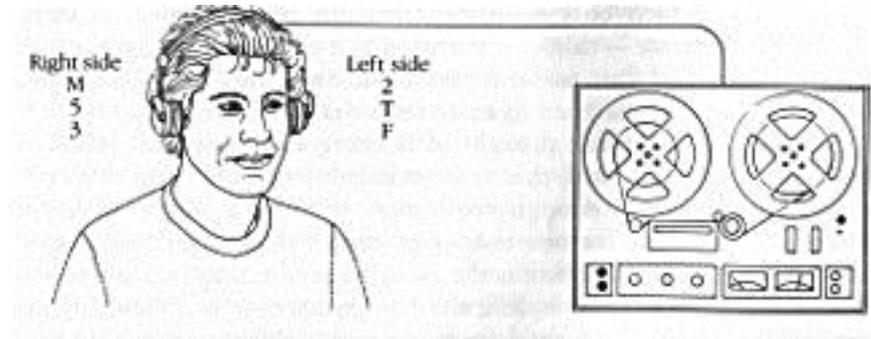
- Subjects tended to report all the information coming to one ear first then all the information coming to the other ear.

- If subjects are required to report digits in the order of arrival they did better the more time there is between presentations.

Early Selection (Broadbent)

The basic claims of the model

- **Sensory channels have an unlimited capacity**
- **There is a bottleneck allowing only one piece of information into working memory at a time.**
- **A selective filter allows in information from only one channel at a time.**
- **Information from unattended channel is completely blocked**
- **Time is required to switch from one channel to the next**

Evidence for this "early selection" Bottleneck Model

- **Explains the results of shadowing experiments.**
- **People can't repeat the message from the unattended ear (according to Broadbent) because the message was completely blocked.**
- **Broadbent (1958): Subject in dichotic listening task are presented with digits simultaneously to each ear. They are asked to report all of the numbers.**
  - **Subjects tended to report one channel, then the other.**
  - **If subjects are required to report digits in the order of arrival they do better when there is more time between presentations.**

Evidence Against "*Early Selection*" Bottleneck Models

The cocktail party effect (hearing your name)(Moray, 1959)

→ INFORMATION MUST BE PROCESSED "LATE"

(at least to a semantic level)

Contextually generated semantic errors in shadowing (Treisman, 1960)

→ INFORMATION MUST BE PROCESSED "LATE"

(at least to a semantic level)

Priming without Awareness

→ INFORMATION MUST BE PROCESSED "LATE"

(at least to a semantic level)

Galvanic Skin Response studies.

→ INFORMATION MUST BE PROCESSED "LATE"

(at least to a semantic level)

Galvanic skin response (GSR) is a measure of the electrical conductance of the skin and can be used to indicate increased emotional arousal.

- During the training phase, subjects were given a mild electric shock every time a certain word was presented.
  - **Dog, Hat, Beer, Couch ("Ow!"). Rabbit, Money, Cup, Couch ("Ow!"), Pine, ...**

- After training, hearing the word "Couch", even without the electric shock, produced a mild fear response (via *Classical Conditioning*) which could be measured by GSR.

- Later on in a shadowing task the word "Couch" was presented to the non-shadowed ear.

- Subjects showed an emotional response to the word even though they were not consciously aware of hearing it.

The Basic Claims of the Attentional Attenuation Model

- **Messages differ in terms of "subjective loudness". Paying attention means increasing subjective loudness (turning up the dial)**

- **When shadowing, messages from the shadowed ear have a higher subjective loudness than messages from the non-shadowed ear.**

- **Different concepts have different awareness thresholds – these are the subjective loudness required for that concept to be noticed.**

- **Some concepts are permanently set with a low threshold for awareness (like one's name) and others depend on context.**

Evidence supporting the attenuation model

- Your name has a permanently low threshold for activation – It will be recognized even if it is part of the "non-attended" message (cocktail party effect).

- It explains contextual errors in shadowing. Concepts related to the message in the shadowed ear temporarily have their recognition threshold lowered.

- It explains the GSR experiments because unattended messages aren't completely blocked they are just attenuated (such that the subject is not conscious of them).

Deutsch & Deutsch's *"Late Selection" model* and Norman's *Pertinence Model*

Deutsch and Deutsch suggested that both channels of information are fully processed but are quickly forgotten (unless attended to – e.g., if they hold personal pertinence to the individual).

In shadowing experiments, the participant is asked to repeat a certain message, that would create the personal significance needed for retention.

Norman elaborated on Deutsch and Deutsch's model by suggesting that selection is determined not only by the pertinence of the sensory input but also the strength of the input.

Early vs. Late Selection Models

Triesman and Broadbent posit that attention serves to determine the nature of the information that gets into Short Term Memory. They are "Early Selection" Models because they assume that attentional selection occurs <u>early</u>, <u>before information enters Short Term Memory</u>.

Late Selection Models **(Norman, 1968)** assume that all information gets into Short Term Memory but that information which isn't attended to is rapidly forgotten (within a fraction of a second). They are called Late Selection Models because the selection doesn't occur until fairly <u>late in the process, when information is already in Short Term Memory</u>.

Early Selection models treat Short Term Memory as a small box into which only a few (7 +/- 2) items can fit. Attention picks items to go into that small box.
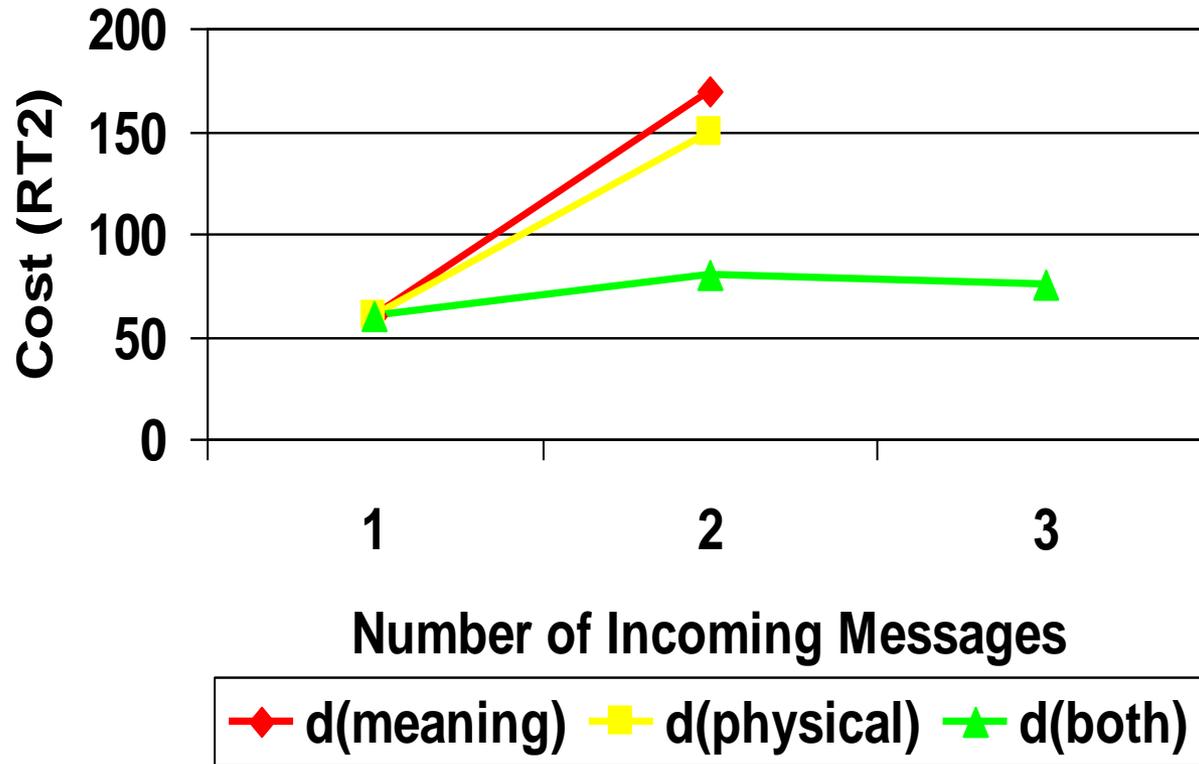
Late selection models treat Short Term Memory as large box into which many items can fit but in which items disappear quite rapidly unless they are attended to.

Filter Models of Attention
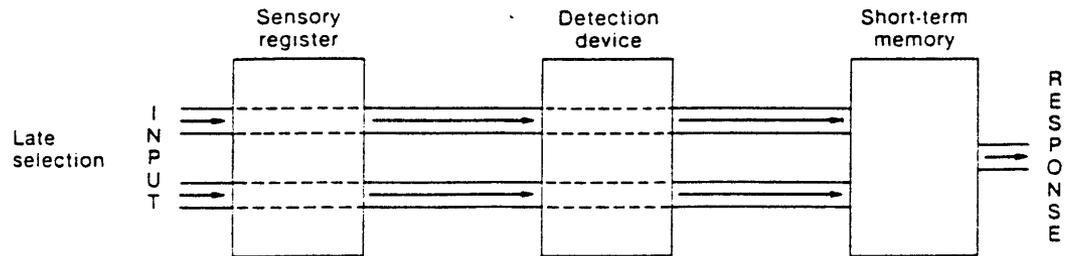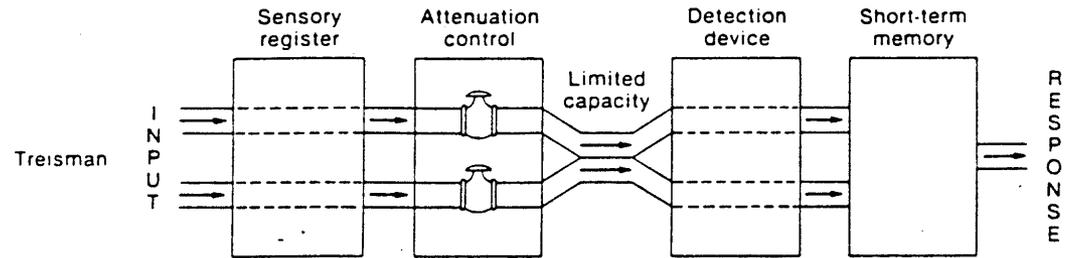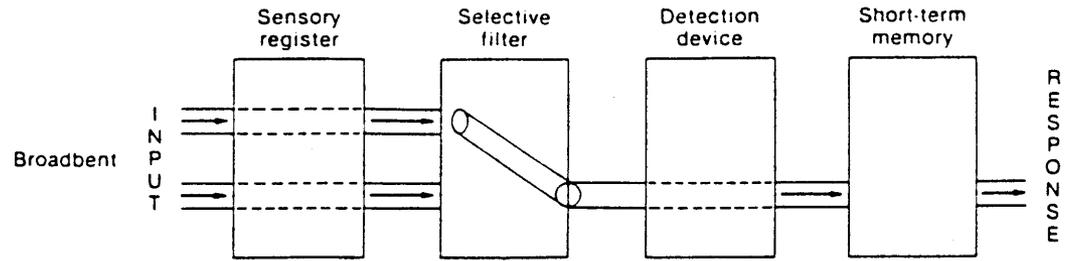
- Kahneman (1973) introduced the notion of "capacity" with "attention" as a mental resource that could be shared or distributed across multiple tasks.

- Johnston & Heinz (1978) developed the "multimode model of attention" to reflect the increasing mental costs for selection at various stages of processing

Cost on Secondary Task during
Dichotic Listening (Selection)

- Johnston & Heinz (1978) *"mulitmode model of attention"* says attention can operate at a number of different stages

- Wickens (1980) proposes a *multiple resource* model with perceptual, cognitive, and output-related domains each separated across the task-defined verbal and spatial coding required. He treats each "bin" as a separate pool of resources that a task might draw on (and/or be constrained by limitations encountered).
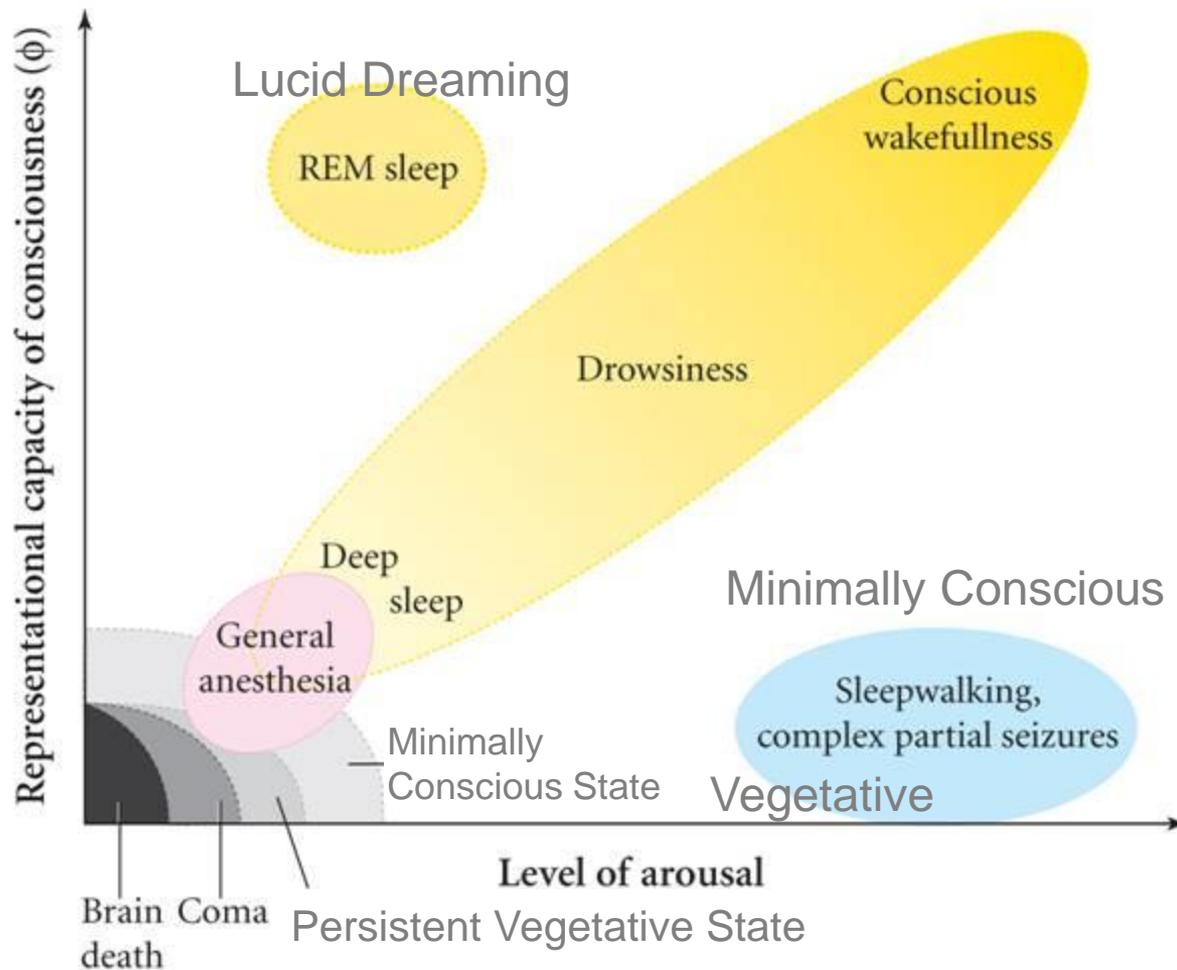
Consciousness

one's awareness of stimuli and events inside and outside of one's self;

An awareness of the sensations, thoughts, & feelings that one is attending to at a given moment;

Awareness of one's surroundings and of what's on one's mind at a given moment (per text)

Wakefulness (arousal) vs. Awareness

Wakefulness & Awareness

Wakefulness: degree of alertness (awake vs. asleep)

Awareness: monitoring of information from environment and from one's own thoughts

Vegetative State: minimal consciousness; eyes may be open but person is otherwise non-responsive

Coma: eyes are closed and person is unresponsive and unarousable

Glasgow Coma Scale

Eye opening

spontaneous	4
to speech	3
to pain	2
no reponse	1

Verbal response

alert and oriented	5
disoriented conversation	4
speaking but nonsensical	3
moans/unintelligible sounds	2
no response	1

Motor response

follows commands	6
localizes pain	5
withdraws from pain	4
decorticate flexion	3
decerebrate extension	2
no response	1

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Illustrations of "*UNCONSCIOUS*" Processing:

Subliminal Messages? – A stimulus that is presented below the threshold for awareness

- Greenwald "unconscious self-help" tapes… perceived effectiveness.
- Greenwald/Merikle "perception without awareness"???

Mere Exposure – the more often you see a stimulus, the

- more you come to like it. Form of influence w/o awareness

Priming – Tendency for a recently presented word or concept to facilitate responses in a subsequent situation. Quicker to read "doctor" after "nurse" presented than after "apple"

Prosopagnosia – inability to recognize familiar faces, although brain activity increases despite non-recognition

Blindsight – damage to visual cortex resulting in the encoding of visual info without awareness

Tip-of-the-Toungue (ToT) Phenomena – some information is present but unavailable

What constitutes "Subliminal" (below threshold) Perception?

- Limen: "limit" or threshold … subliminal… below threshold.

- Which Threshold?
  - Problem of declaring an absolute absence of conscious awareness
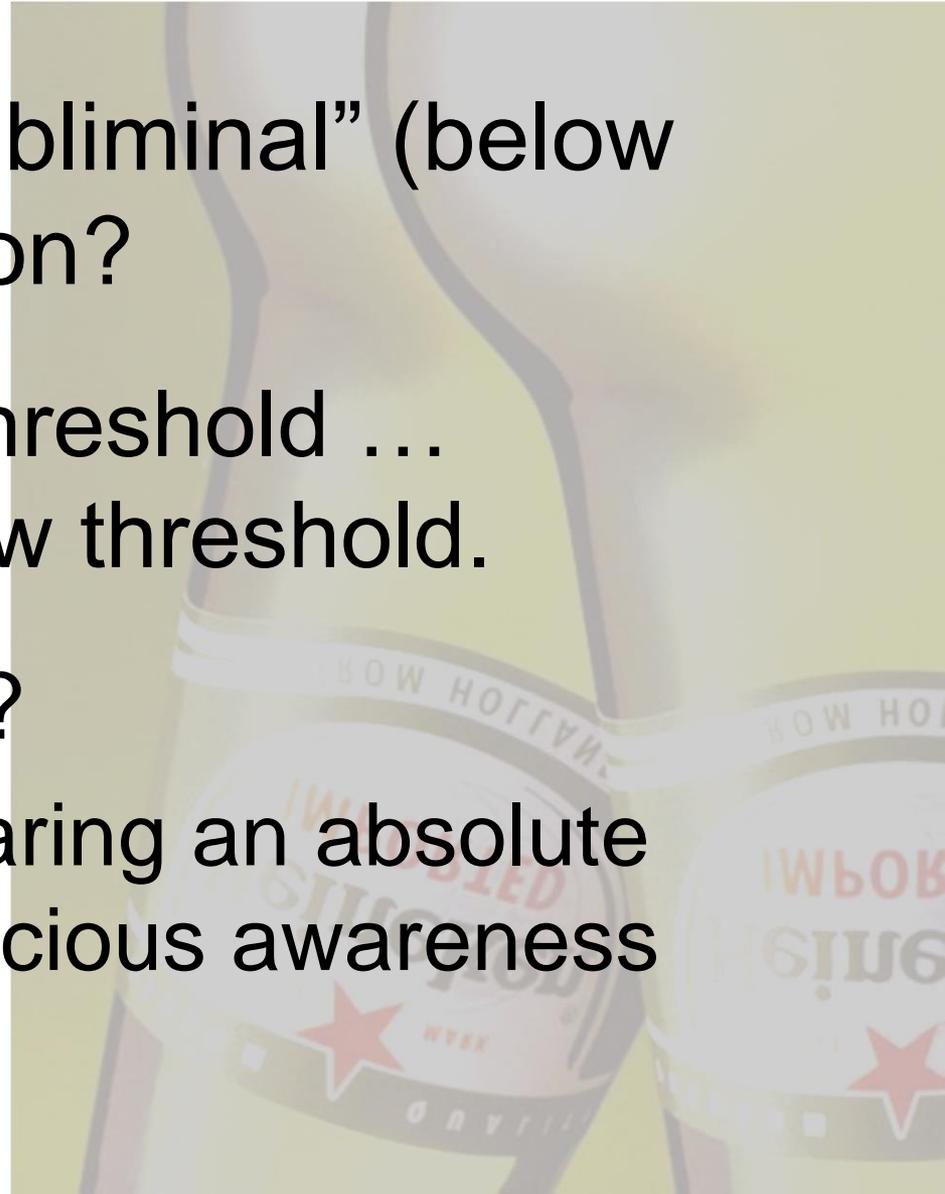
Subliminal?

Cards down the hall until "cannot identify it" subjectively; but is this truly "unconscious" despite subjective reports that there is no "conscious" experience of identification.

"nulling consciousness": required if you are to claim that all information presented is available ONLY to the unconscious (this is a MAJOR problem for "absolute threshold" of consciousness type arguments (e.g., "subliminal perception" is perception below the threshold of consciousness – and thus we should be unaware of it at ANY conscious level).

Multiple-choice versus identification

Explicit vs. Implicit
Task focused versus "other questions" (e.g., which brighter?)

Processes in opposition:
place "conscious" knowledge such that it operates in the opposite direction as the "unconscious" knowledge. For instance, when completing a STEM-COMPLETION task (e.g., D _ _ K), the instruction to include items from the previous memory list versus instructions to exclude the items from the previous memory lists.

Despite not being aware of the words that they "saw", those exposed to positive words were happier and those exposed to negative words reported being sadder. This indicates that moods can be influenced without awareness
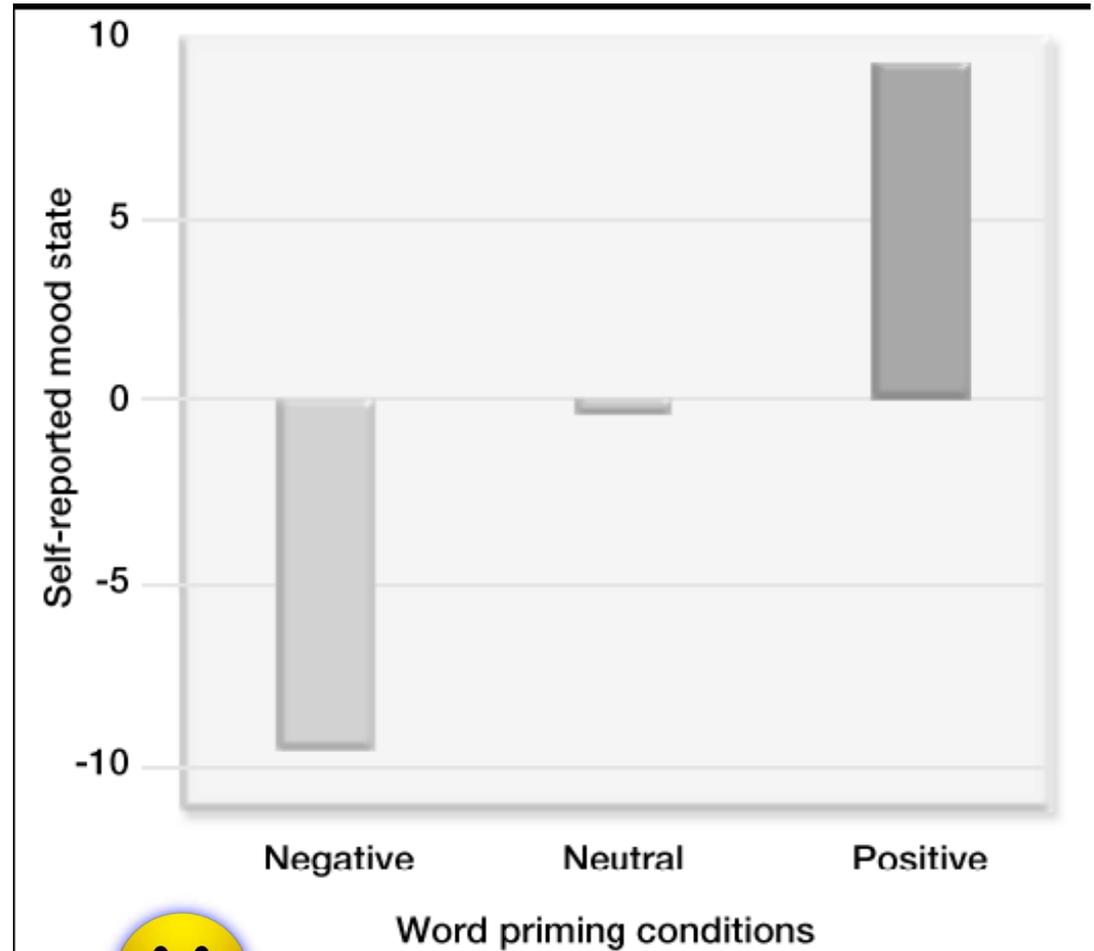
Consciousness

Attention: a state of awareness consisting of the sensations, thoughts, & feelings that one is focused on in a given moment

AWARE   UNAWARE

CONSCIOUS   UNCONSCIOUS

EXPLICIT   IMPLICIT

ATTENDED   UNATTENDED

Selective attention

- Ability to focus awareness on a single stimulus to the exclusion of other stimuli.

- Ability to focus awareness on specific features in the environment while ignoring others (text)

Dichotic listening task (analogy)

- Unable to follow/remember competing conversation

Cocktail party effect

- Ability to attend selectively to one person's speech among competing conversations but highly relevant stimuli still detected
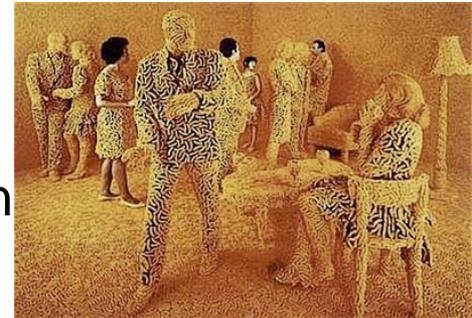
Failures of selective attention

Stroop Interference

Blue	Green	Purple
Brown	Pink	Black
White	Brown	Red
Red	Black	Gray
Orange	Gray	Green
Purple	White	Orange
Pink	Red	Pink
Green	Blue	Brown
Black	Orange	Blue
Gray	Purple	White

Read the "black words" only

In performing an experiment like this one on man attention car it house is boy critically hat important shoe that candy the old material horse that tree is pen being phone read cow by the hot subject tape for pin the stand relevant view task sky be red cohesive man and car grammatically house complete boy but hat without shoe either candy being horse so tree easy that phone full cow attention is hot not tape required pin in stand order view to sky read red it nor too difficult

When people do this type of task they do not effectively remember the red words

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What happens to unattended information?

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

Failures of Selective Attention

Ironic Processes

The harder ones tries to control a thought or behavior, the less likely one is to succeed, especially if distracted, tired, or under stress.

Examples:

1) Do not think about a white bear
2) Subjects instructed to control a pendulum moved it more than those not instructed.
3) Golfers were more likely to overshoot a putt when trying not to do so.

CONTROLLED
- With intent (only)
- Aware (Conscious)
- Attention demanding
- Slow (1 second +)
  - Characteristic of novel or unpracticed tasks with many variable features
    - Requires analysis or synthesis of information
  - Usually difficult tasks

AUTOMATIC
- without intention
- Not open to awareness
- Low attentional requirement
- Rapid
  - Characteristic of familiar and highly practiced tasks (automaticity develops with practice – e.g., Bryan & Harter, 1899 [telegraph operators])
    - Minimal analysis or synthesis of information
  - Typically fairly easy tasks

- Difference between automatic and controlled processing can be illustrated by Priming (e.g., Neely)

- Automaticity can be bad

- Airplane (de-icer "off".. yes [though should be "on" for icy conditions])

- Errors….

Mistakes: errors in choosing an objective or specifying the means to achieve the objective (intentional, controlled processes)

Slips: errors in carrying out intended actions (often involve automatic processing)

Types of slips

Capture error: failure to depart from automatic routine

Omission: interruption in routine leads to skipping one or more steps on resumption

Perseveration: repeating an already completed process

Description: correct action on the wrong object (due to internal description of intended action)

Data-Driven error: incoming sensory input overrides intended action (e.g., dialing numbers heard in the environment rather than intended phone number)

Associative-Activation error: strong associations lead to wrong automatic behavior (e.g., wrong name, "come in" to doorbell, etc.)

Loss-of-activation error: "what am I doing here after entering a room"…

Neurological Evidence (visual attention)

- Demonstrable "fine-tuning" of visual receptive fields (neural responses) occur via the thalamus (specifically the Pulvinar Thalamic Nucleus)

- Pulvinar Thalamic Nucleus: reads out new information – other areas control engage, moving, and disengage functions – failure of this system produces 'spatial neglect' (failure to move attention)

Executive Attention refers to a supervisory attentional system (based around the function of the <u>anterior cingulate gyrus [frontal lobe]</u>) that inhibits inappropriate mental representations or responses and serves to active appropriate ones.

Executive Attention is needed for: (Norman & Shallice, 1986)

- planning and making decisions;
- correcting errors;
- the required response is novel or not well-learned;
- conditions are cognitively demanding or dangerous; or,
- an automatic response must be inhibited and overcome

The Binding Problem is that features and stimuli characteristics for a single object are represented across distributed brain regions. These aspects need to be integrated into a cohesive percept. Binding requires attention. Failures of attention around binding produce INATTENTIONAL BLINDNESS (when covert attention elsewhere in the display) and the ATTENTIONAL BLINK (when attention is occupied with encoding a prior stimulus).

Feature Integration Theory (Treisman)

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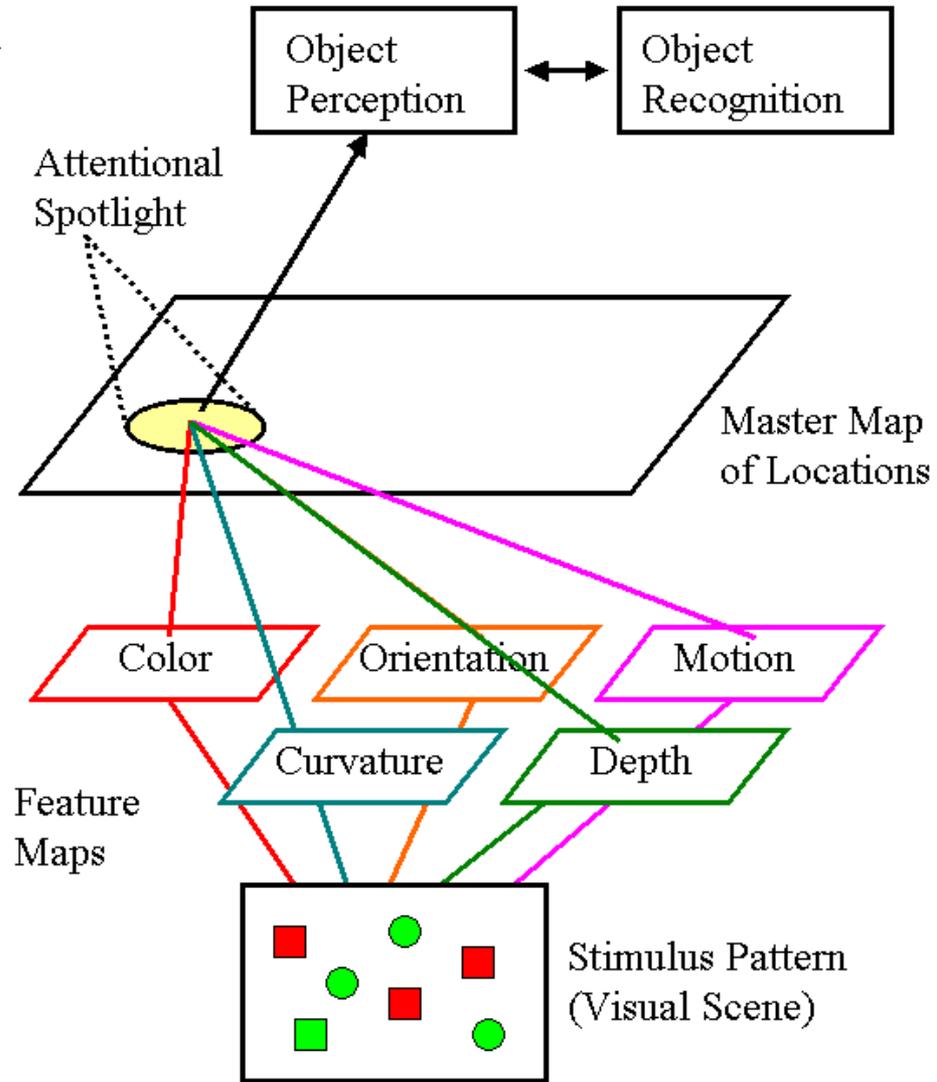
Define the binding problem, as it is described in the text.

Your assignment is to discuss the role of the binding problem as it relates to inattentional blindness leading to the attentional blink as well as the larger problem of producing coherent phenomenological percepts despite stimulus characteristics being represented in widely disparate parts of the brain (readings on consciousness and in particular the work of Baars may be pursued by the advanced student).

You must include at least one definition of what the binding problem is, at least one definition of the attentional blink, at least one definition of inattentional blindness and, based on the technical readings, provide some insight into how cognitive psychologists have endeavored to understand the binding problem.

Note that I anticipate and understand that there will be parts of the additional readings (those beyond the textbook that you will encounter in your research to best answer this question) that you will not fully understand. Obviously, I expect that you will check with a number of secondary sources (including the textbook) to help clarify the concepts underlying the binding problem. You should cite these sources (preferably in APA style) where appropriate.

"Where" versus "What" pathways
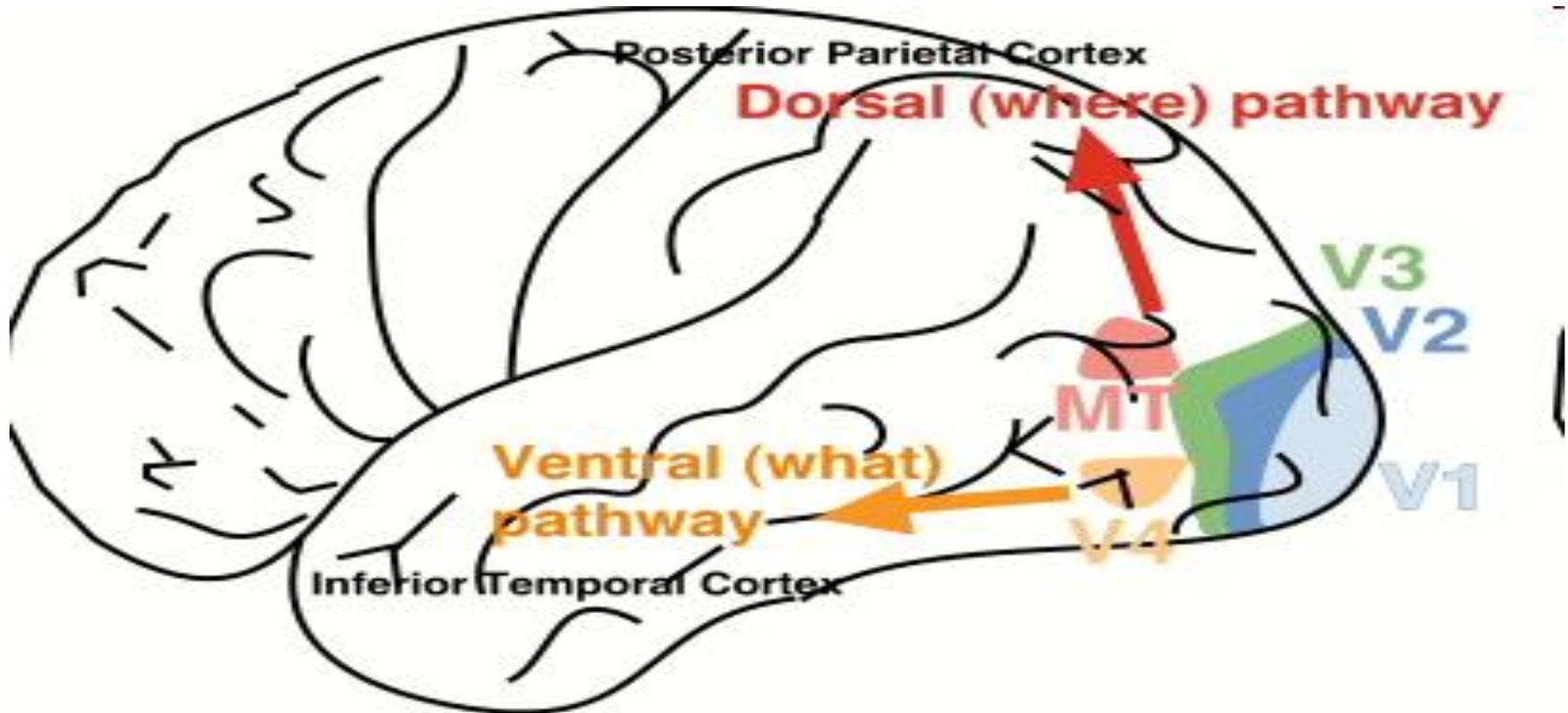
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"Everyone knows what attention is. It is the taking possession by the mind in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought...It implies withdrawal from some things in order to deal effectively with others, and is a condition which has a real opposite in the confused, dazed, scatterbrained state." (p. 403)

- **William James (1892)**

- Attention
- Selective Attention
- Divided Attention
- Shadowing
- Early Selection
- Attenuation
- Priming
- Mental Effort
- Stroop Effect
- Automatic Process
- Controlled Process

- Central Bottleneck
- Orienting
- Spatial Neglect
- Alerting
- Executive Action
- Anterior Cingulate Gyrus
- Feature Integration Theory
- Binding Problem
- Inattentional Blindness
- Attentional Blink
- Subliminal Perception

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