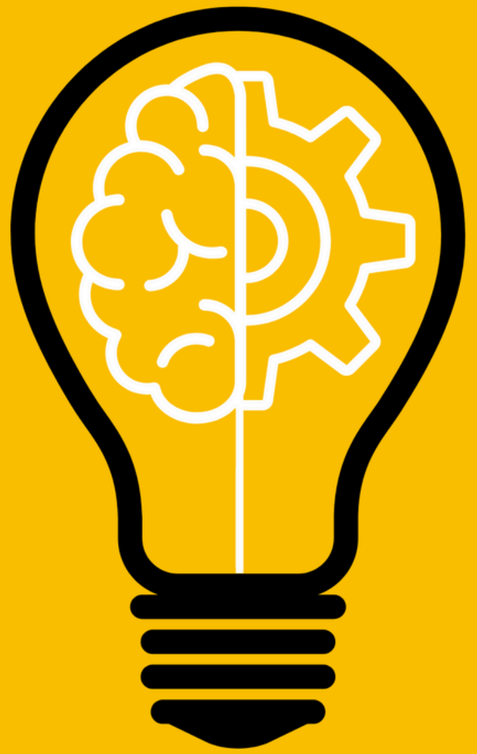
WEEK 2 - LECTURE



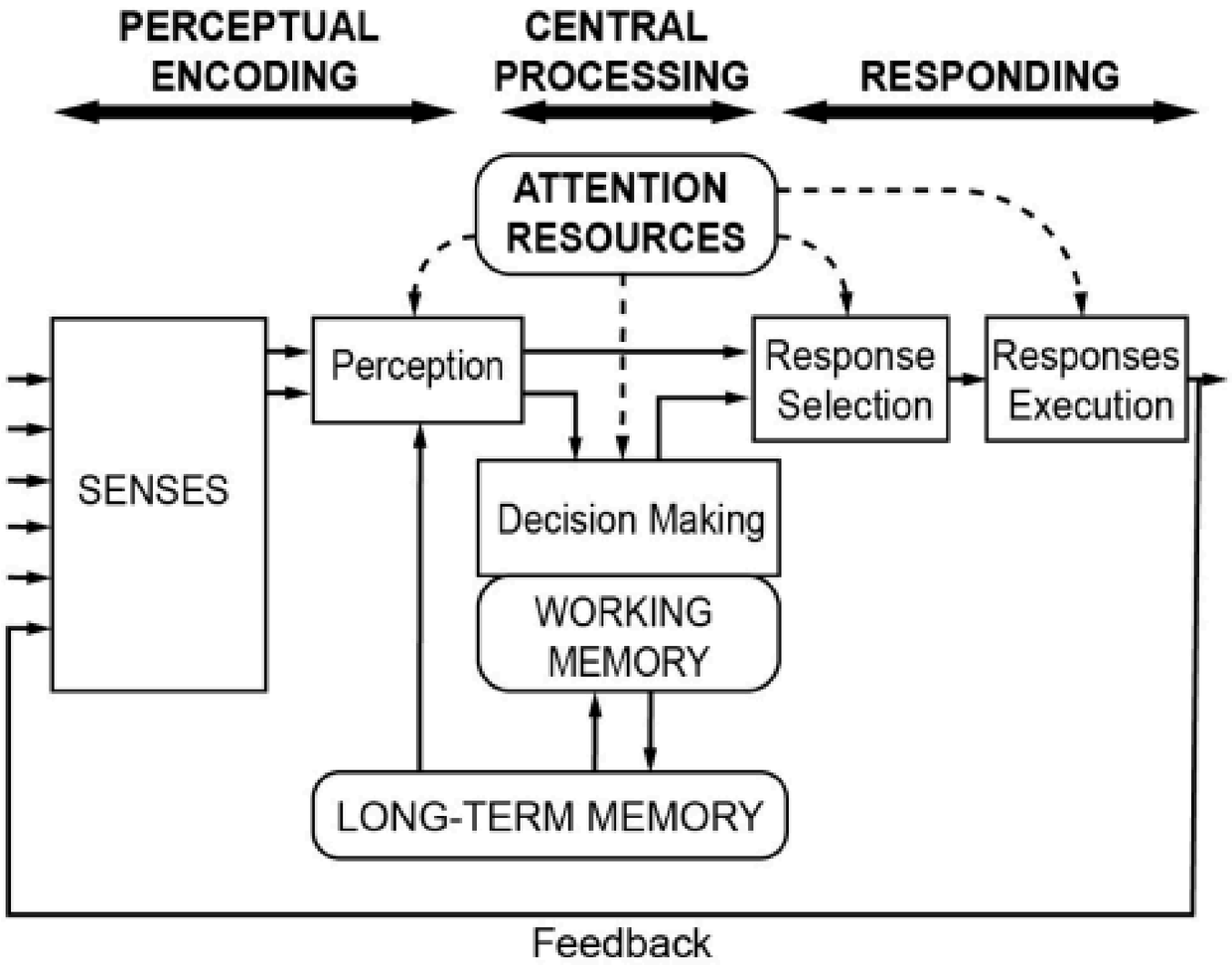
ATTENTION

Cognitive and Psychological Foundations for Product Design 2024/2025

This week

Nov 13	Lecture Week 1: Information Processing & Senses
Nov 20	Lecture Week 2: Attention
Nov 27	Lecture Week 3: Memory
Dec 4	SYNERGY / AIR WEEK
Dec 11	Lecture Week 5: Learning & Motivation
Dec 18	Lecture Week 6: Problem-Solving, Decision-Making & Reasoning
Jan 8	Lecture Week 7: Human-Computer & Human-AI Interaction
Jan 15	Lecture Week 8: Embodied Cognition
Jan 22	Lecture Week 8: Recap & Discussion
Jan 29	Exam

Human Information Processing Model

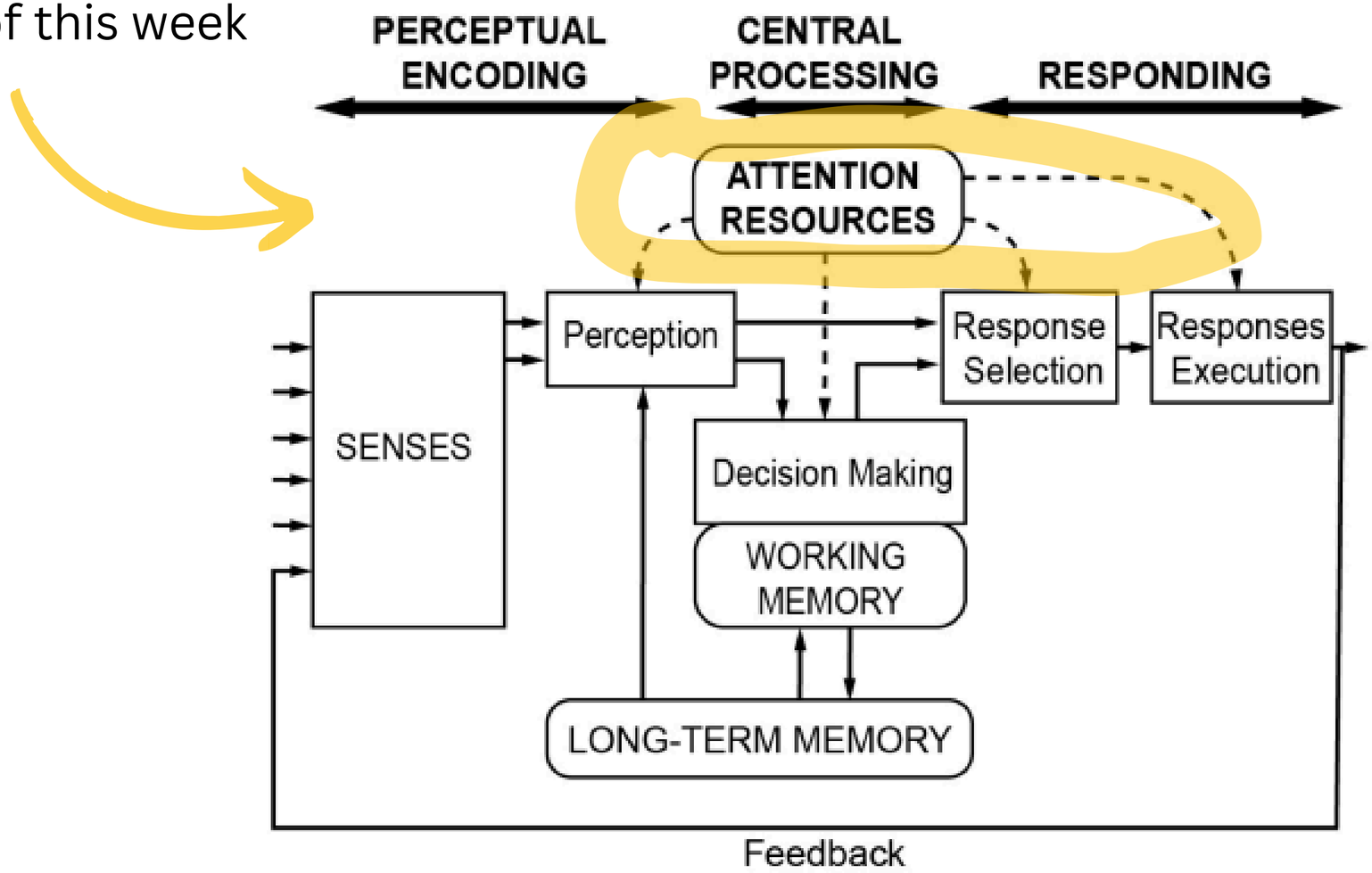


Remember this?

Designing for People: An introduction to human factors engineering. (Lee, J., Wickens, C., Liu, Y. & Boyle, L. (2017))

Human Information Processing Model

Focus of this week



Designing for People: An introduction to human factors engineering. (Lee, J., Wickens, C., Liu, Y. & Boyle, L. (2017))

1

FUNDAMENTALS

What is attention and why do we need it?

Information reception rate per sense

sensory system	bits per second
eyes	10,000,000
skin	1,000,000
ears	100,000

https://www.britannica.com/science/information-theory/Physiology

Too much information to consciously process!

attention helps us filter relevant information

What is attention and why do we need it?

Definition:

Attention is a state in which **cognitive resources are focused** on certain aspects of the environment rather than on [...] human beings do **not have an infinite capacity** to attend to everything, so focusing on certain items comes at the expense of others.

-- Dictionary of the American Psychology Association

Where we direct our attention will determine how well we perceive, remember, and act on information.

https://dictionary.apa.org/attention

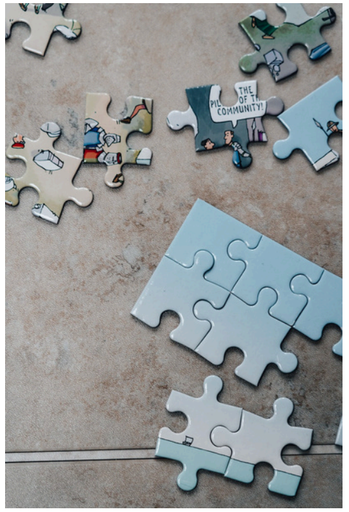
What influences attention and what types are there?

Exogenous

(bottom-up)
Attention is attracted and stimulus is hard to ignore

Endogenous

(top-down)
Attention is voluntarily directed, and irrelevant information is ignored



Designing for People: An introduction to human factors engineering. (Lee, J., Wickens, C., Liu, Y. & Boyle, L. (2017))

EXERCISE

Exogenous or Endogenous?

1. A bright flashing light from a fire alarm
2. A car horn
3. Flight number being called at the airport
4. Looking for your friend in a crowded library
5. Vibration of a smartphone
6. Large, colorful billboard
7. Assembling an IKEA shelf using the instruction manual

What influences attention and what types are there?

The selection of channels to attend is driven by four main factors:

- Salience
  - How distinctive is the stimulus from its context?
- Effort
  - How much do we need to invest?
- Expectancy
  - Where do we think we find what we are looking for?
- Value
  - What is the benefit? / What is the cost of failure?

Designing for People: An introduction to human factors engineering. (Lee, J., Wickens, C., Liu, Y. & Boyle, L. (2017))

EXERCISE

Cycling Alarm System

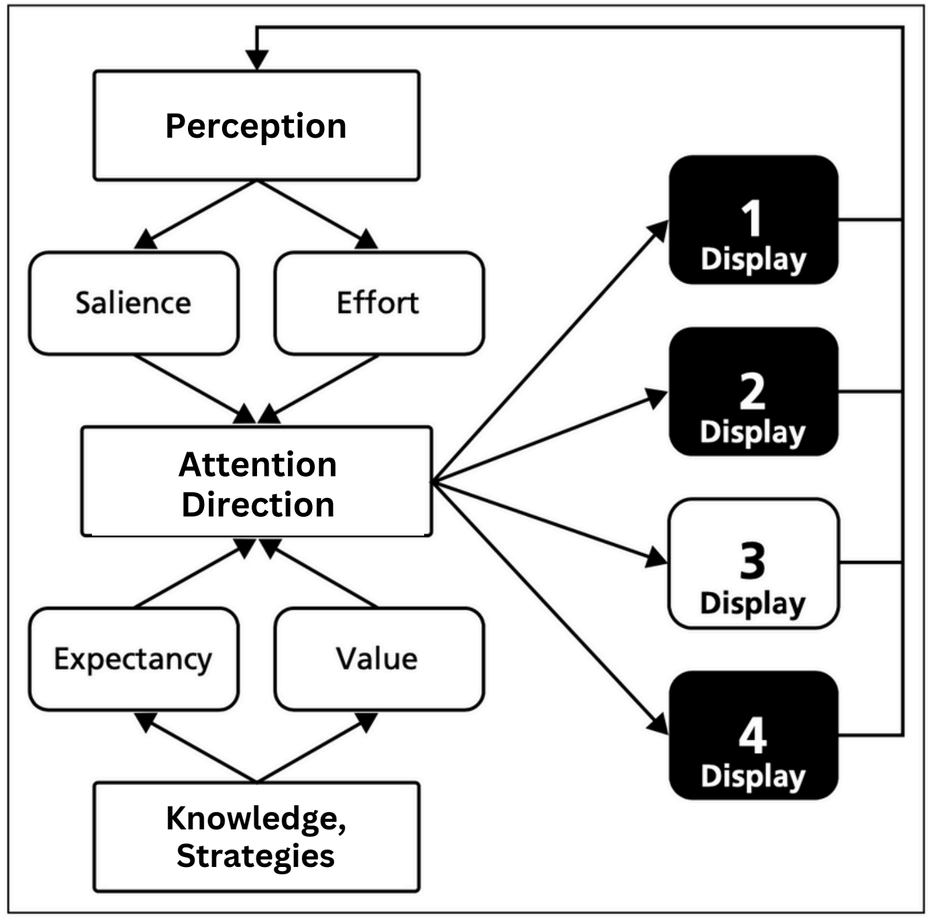
Think about the following scenario:
You are designing a new alert system for a city cycling navigation app. The system must notify cyclists of traffic signals, road hazards, and route changes

The alarm is verbal: "Red light ahead! Stop now!"

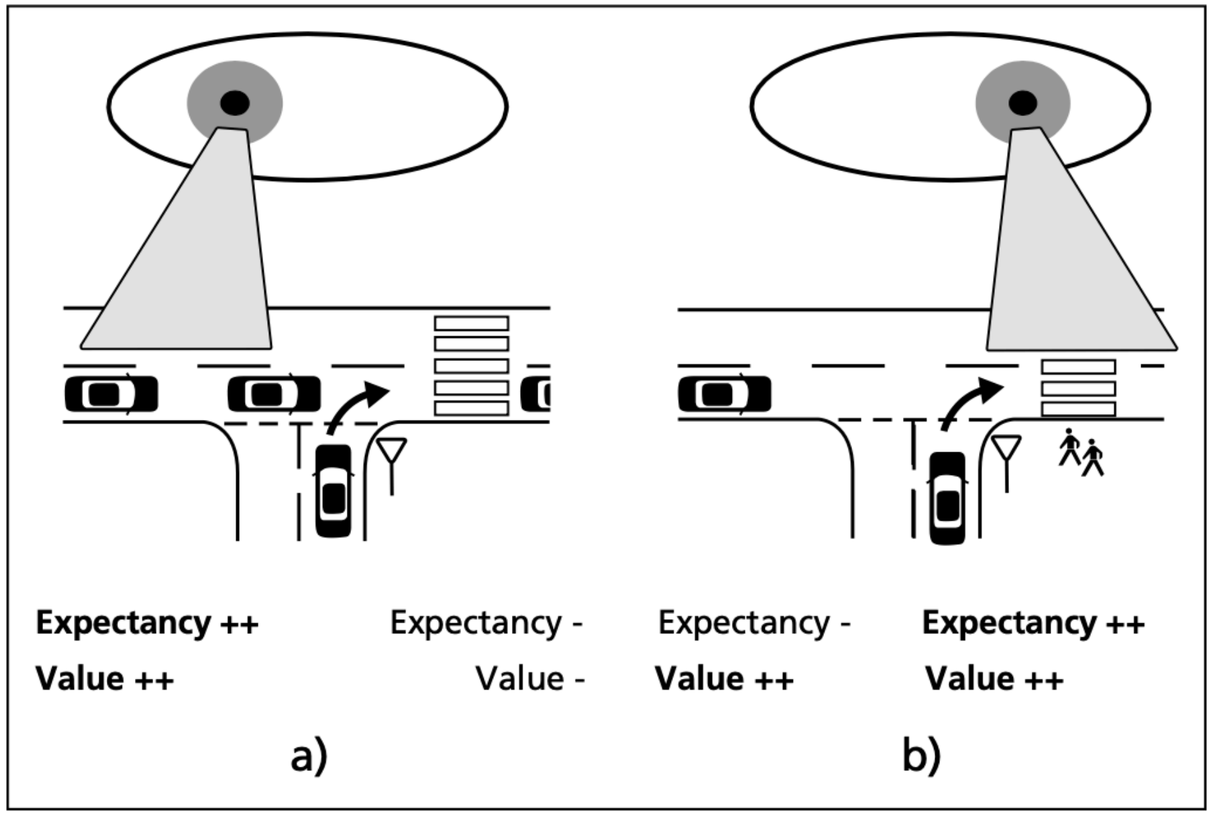
How does it score in terms of Salience, Effort, Expectancy, and Value?

Together with your neighbor
Time: 2 minutes

Attention Processing Models



Top-down vs. Bottom-up processing



Vollrath, M. (2015). Ingenieurpsychologie: Psychologische Grundlagen und Anwendungsgebiete. Kohlhammer.

How does attention relate to immersion and engagement?

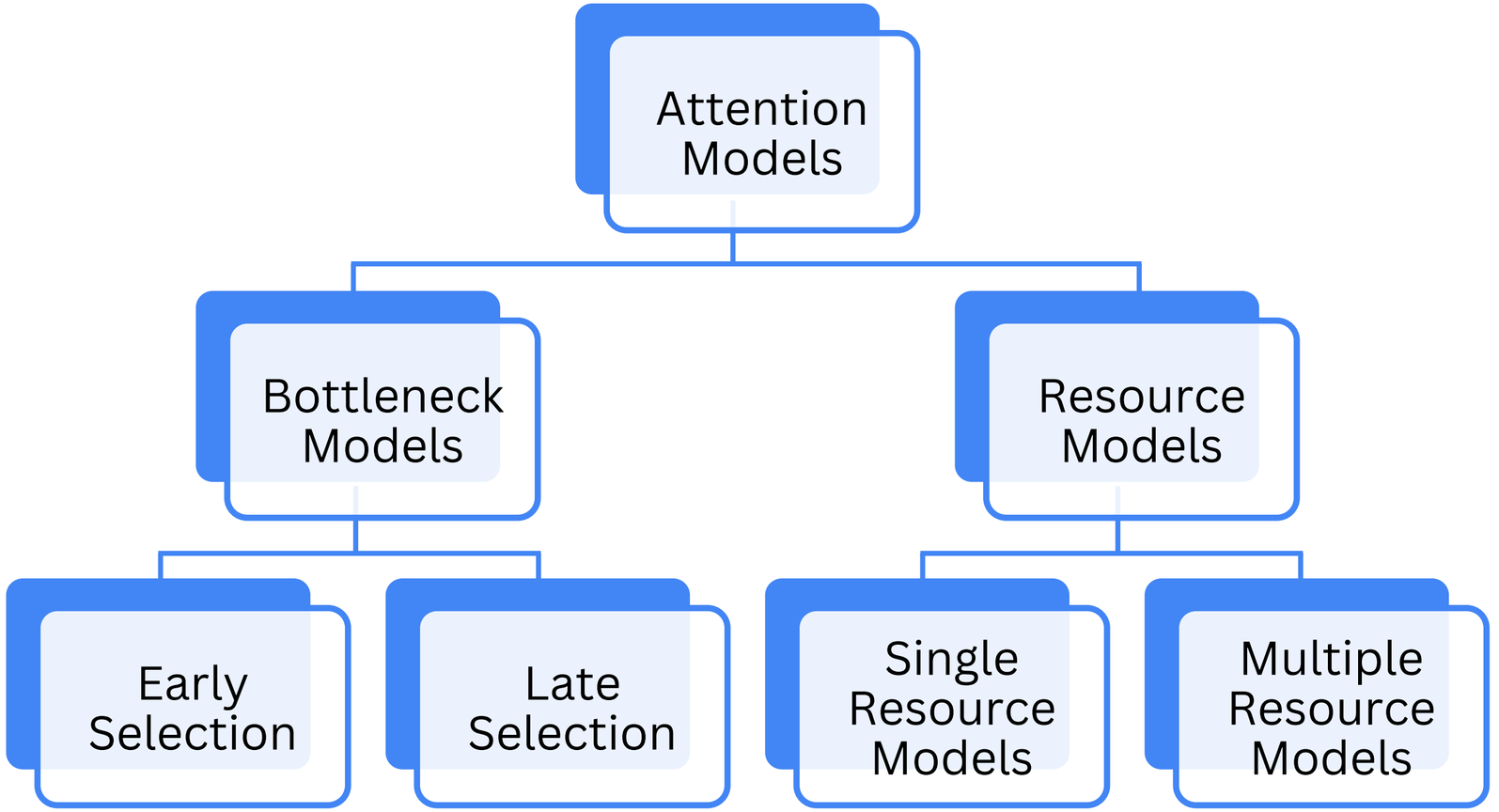
We need attention to achieve higher level cognitive states such as task engagement and immersion (e.g., in virtual reality)

- Attention is the initial step involving momentary focus on a particular stimulus.
- Immersion goes deeper, indicating a state where a person is fully absorbed in an activity, often leading to a loss of time awareness.
- Engagement encompasses a broader, sustained commitment that includes emotional and cognitive involvement, often resulting in active participation and sustained interest.

1.1 Theories & Models

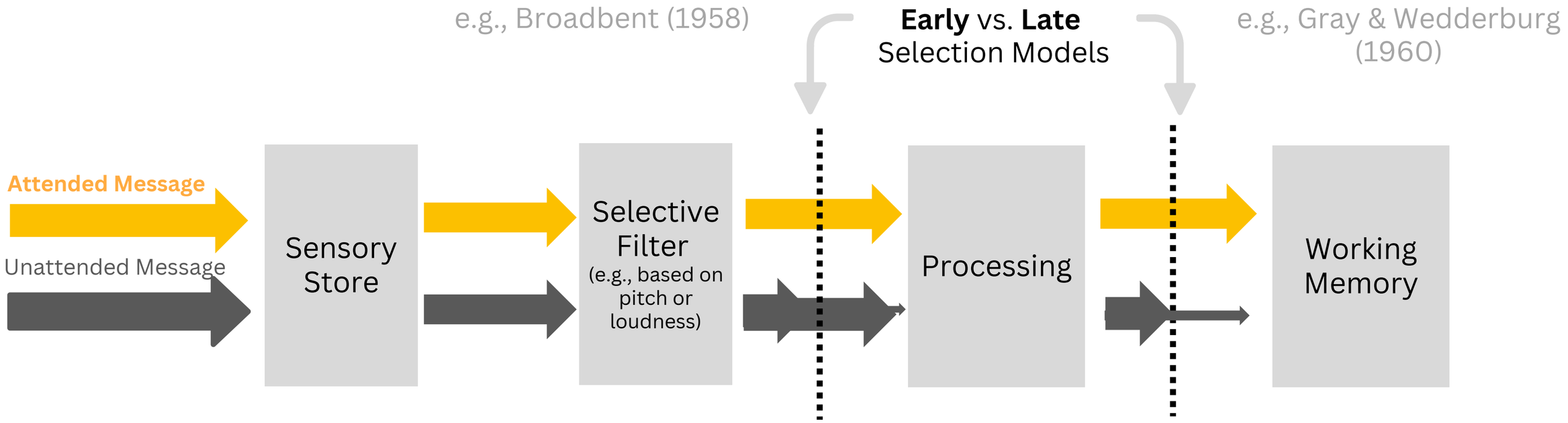
Attention Models

- Bottleneck models (early vs. late selection) vs. resource models (single resource vs. multiople resources)



Human Factors in Simple and Complex Systems (2018) Proctor & van Zandt

When is the filtering happening?



Designing for People: An introduction to human factors engineering. (Lee, J., Wickens, C., Liu, Y. & Boyle, L. (2017))

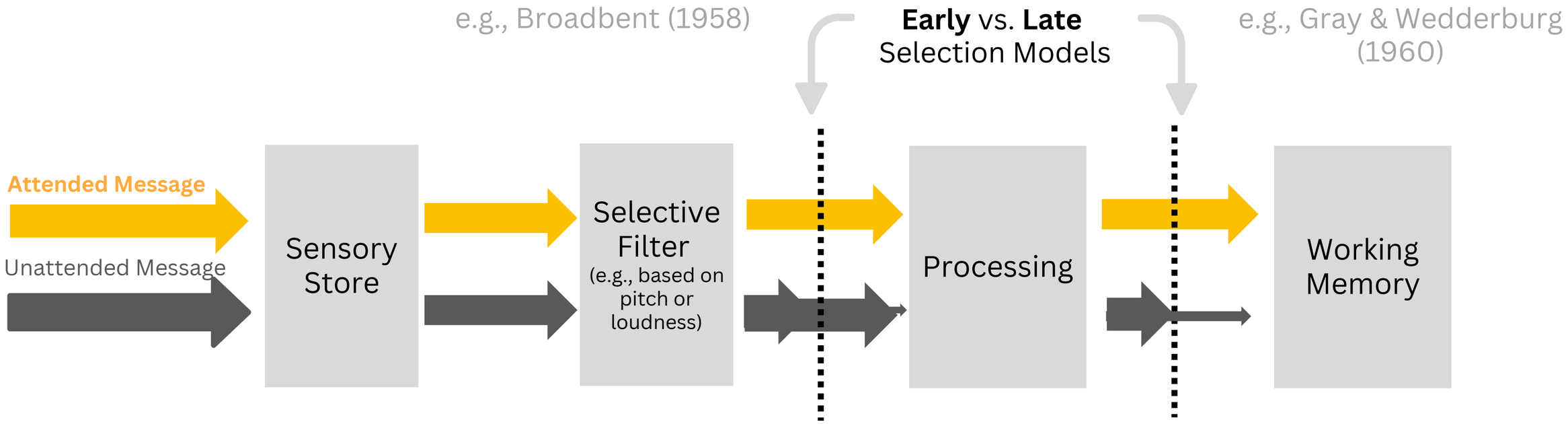
When is the filtering happening?

Example: **The Cocktail Party Phenomenon (Cherry, 1953)**:

- Selective hearing when surrounded by many different voices
- Humans are still able to hear their name when said in the crowd

Designing for People: An introduction to human factors engineering. (Lee, J., Wickens, C., Liu, Y. & Boyle, L. (2017))

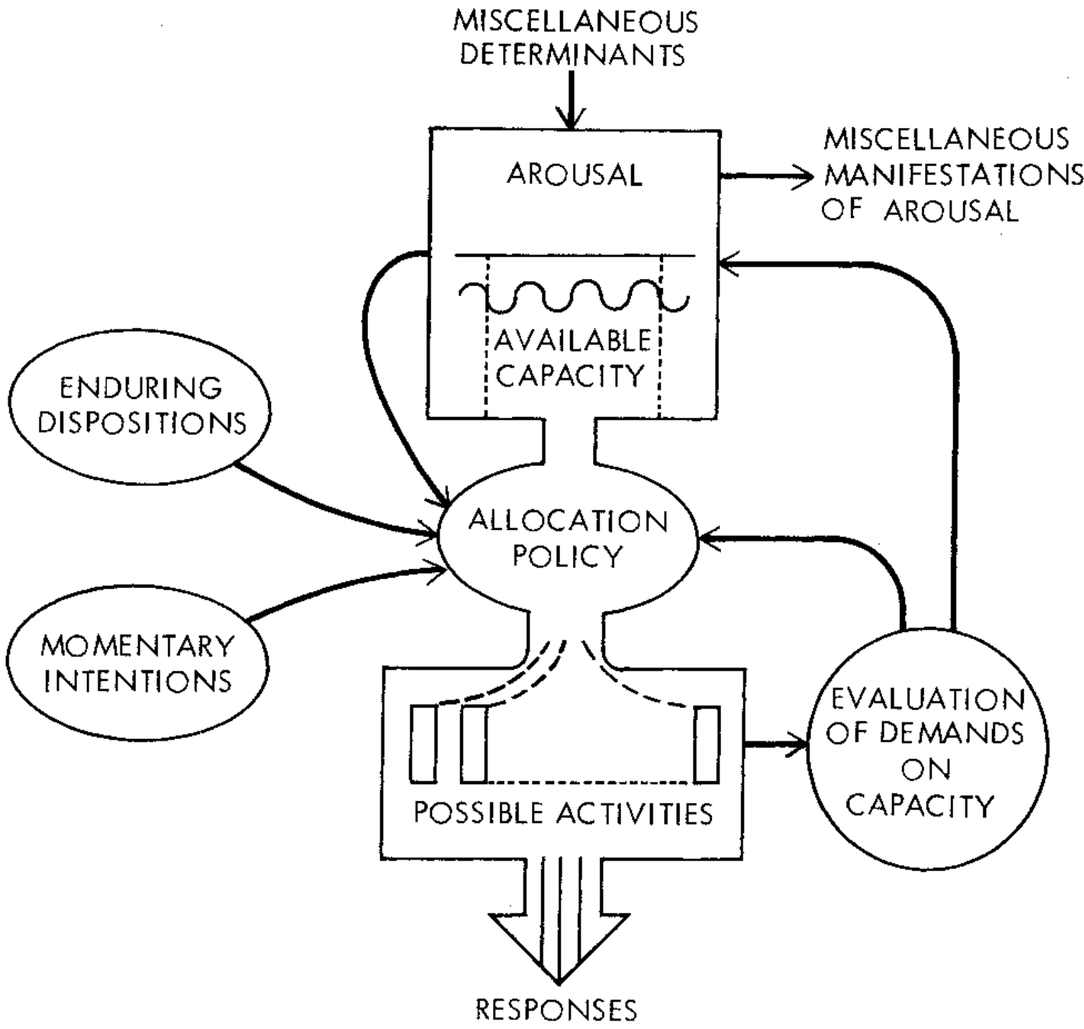
When is the filtering happening?



Designing for People: An introduction to human factors engineering. (Lee, J., Wickens, C., Liu, Y. & Boyle, L. (2017))

Single resource models

- Attention is viewed as a limited-capacity resource that can be applied to various tasks.
  - Performance suffers when this capacity is exceeded.
- Dual-task procedures measure attentional requirements, with a primary task performed as well as possible and a secondary task probing momentary attentional demands.
  - Help predict operator performance and determine the attentional demands of different tasks.
- Available attentional capacity can fluctuate with the level of arousal and task demands, explaining performance issues in both high and low-demand situations.

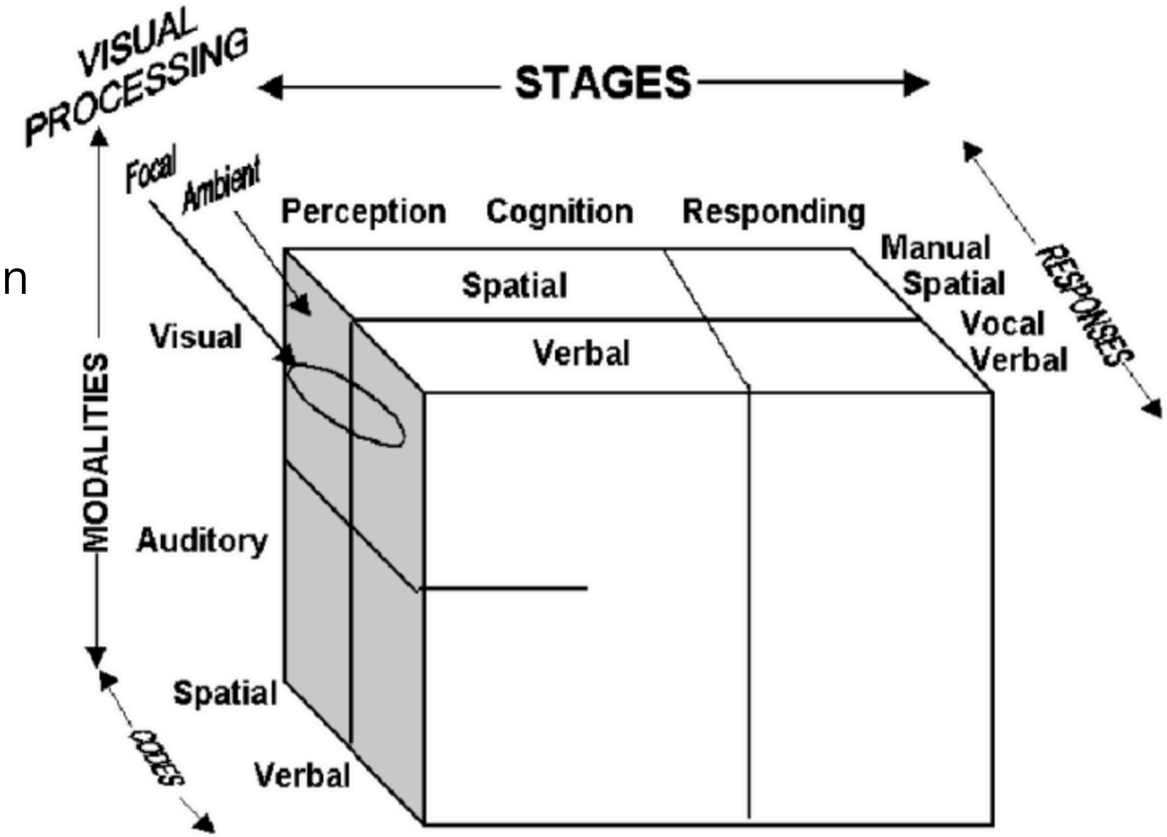


Kahneman, D. (1973). *Attention and effort* (Vol. 1063, pp. 218-226). Englewood Cliffs, NJ: Prentice-Hall.
Human Factors in Simple and Complex Systems (2018) Proctor & van Zandt

Multiple resource models

- Propose that attention is not a single pool but consists of several distinct cognitive subsystems with own limited resources.
- Tasks that draw on different resource pools can be performed more efficiently together
- Studies show improved performance on tasks utilizing different modalities

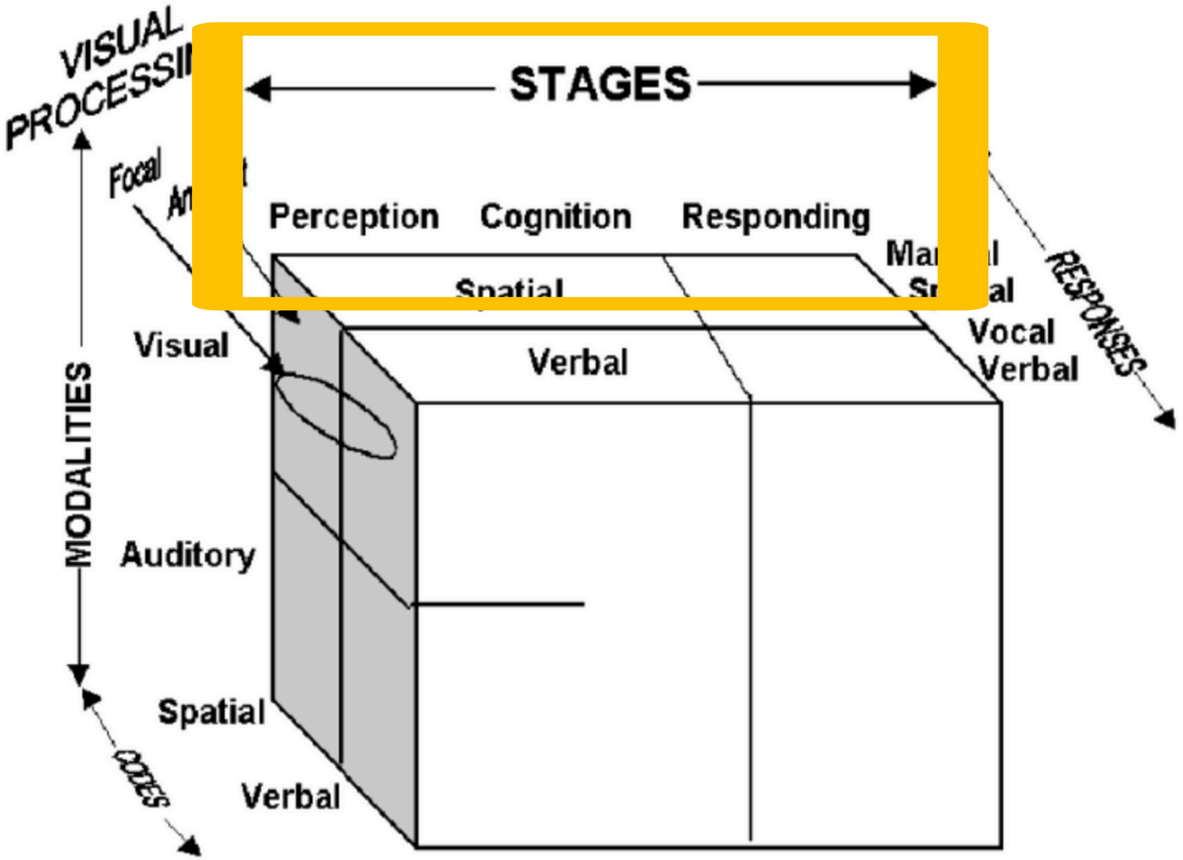
> These models help us predict multitasking performance and design systems that maximize efficiency and minimize errors by leveraging separate resource pools



Wickens, C. D. (1980). The structure of attentional resources. Attention and performance VIII, 8, 239-257.
Wickens, C. D. (2002). Multiple resources and performance prediction. Theoretical issues in ergonomics science, 3(2), 159-177

Multiple resource model

- Stages of processing



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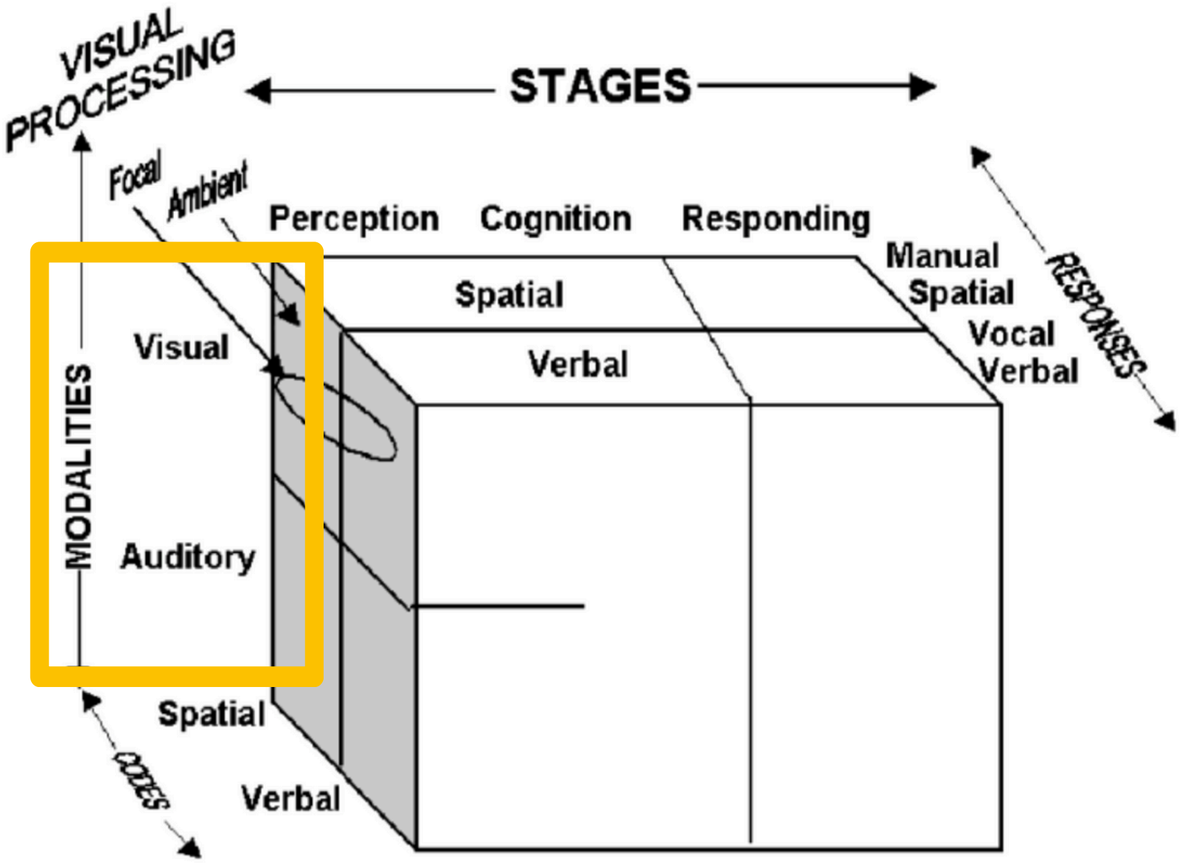
Wickens, C. D. (2002). Multiple resources and performance prediction. Theoretical issues in ergonomics science, 3(2), 159-177

Multiple resource model

- Stages of processing
- Sensory modalities



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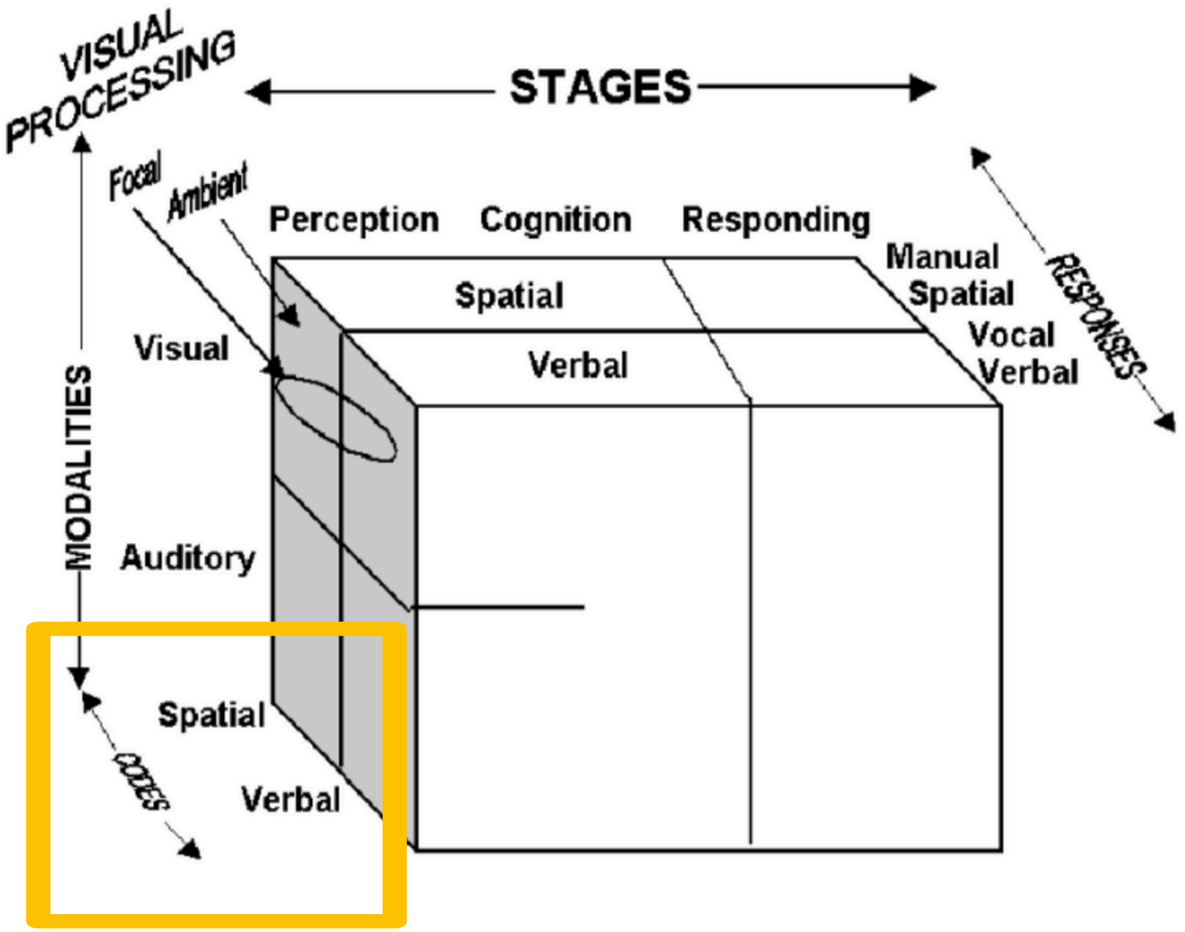
Wickens, C. D. (2002). Multiple resources and performance prediction. Theoretical issues in ergonomics science, 3(2), 159-177

Multiple resource model

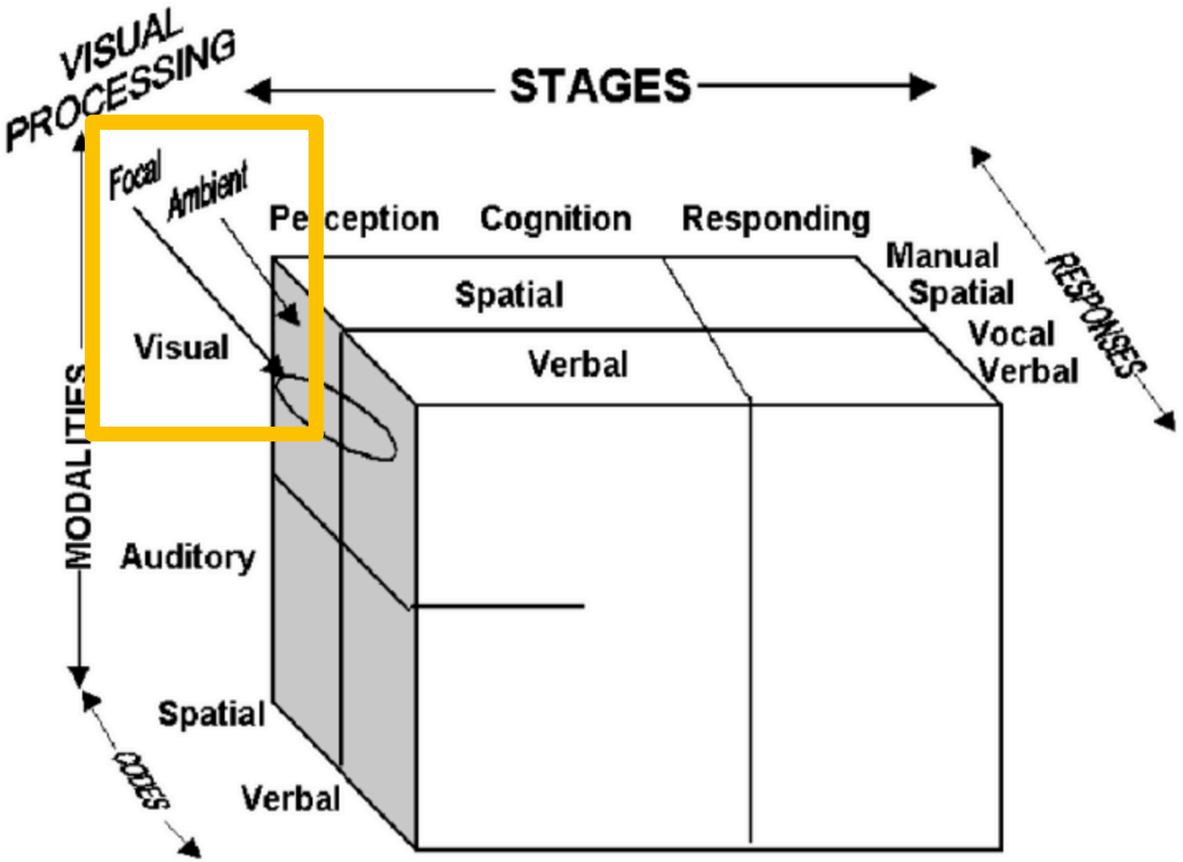
- Stages of processing
- Sensory modalities
- Codes of processing



Wickens, C. D. (1980). The structure of attentional resources. Attention and performance VIII, 8, 239-257.
Wickens, C. D. (2002). Multiple resources and performance prediction. Theoretical issues in ergonomics science, 3(2), 159-177

Multiple resource model

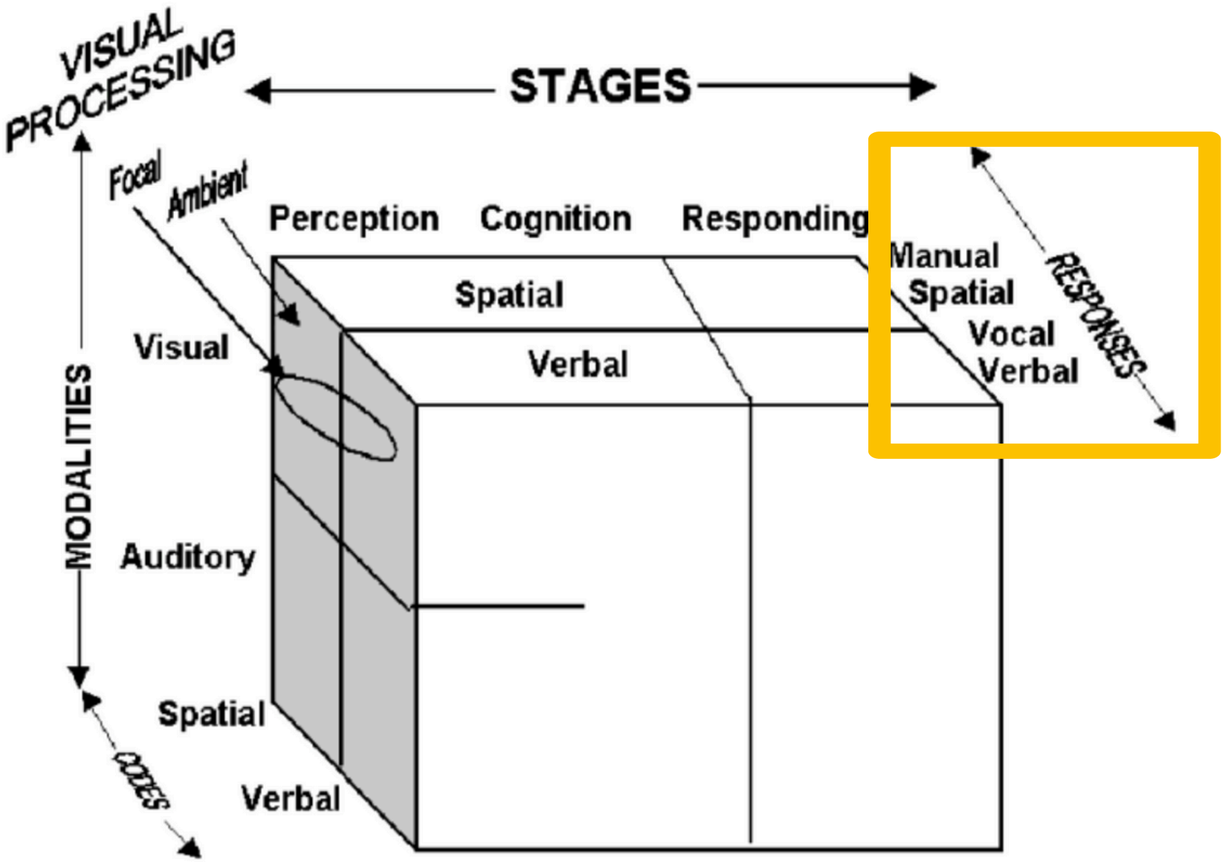
- Stages of processing
- Sensory modalities
- Codes of processing
- Visual channel



Wickens, C. D. (1980). The structure of attentional resources. Attention and performance VIII, 8, 239-257.
Wickens, C. D. (2002). Multiple resources and performance prediction. Theoretical issues in ergonomics science, 3(2), 159-177

Multiple resource model

- Stages of processing
- Sensory modalities
- Codes of processing
- Visual channel
- Responses

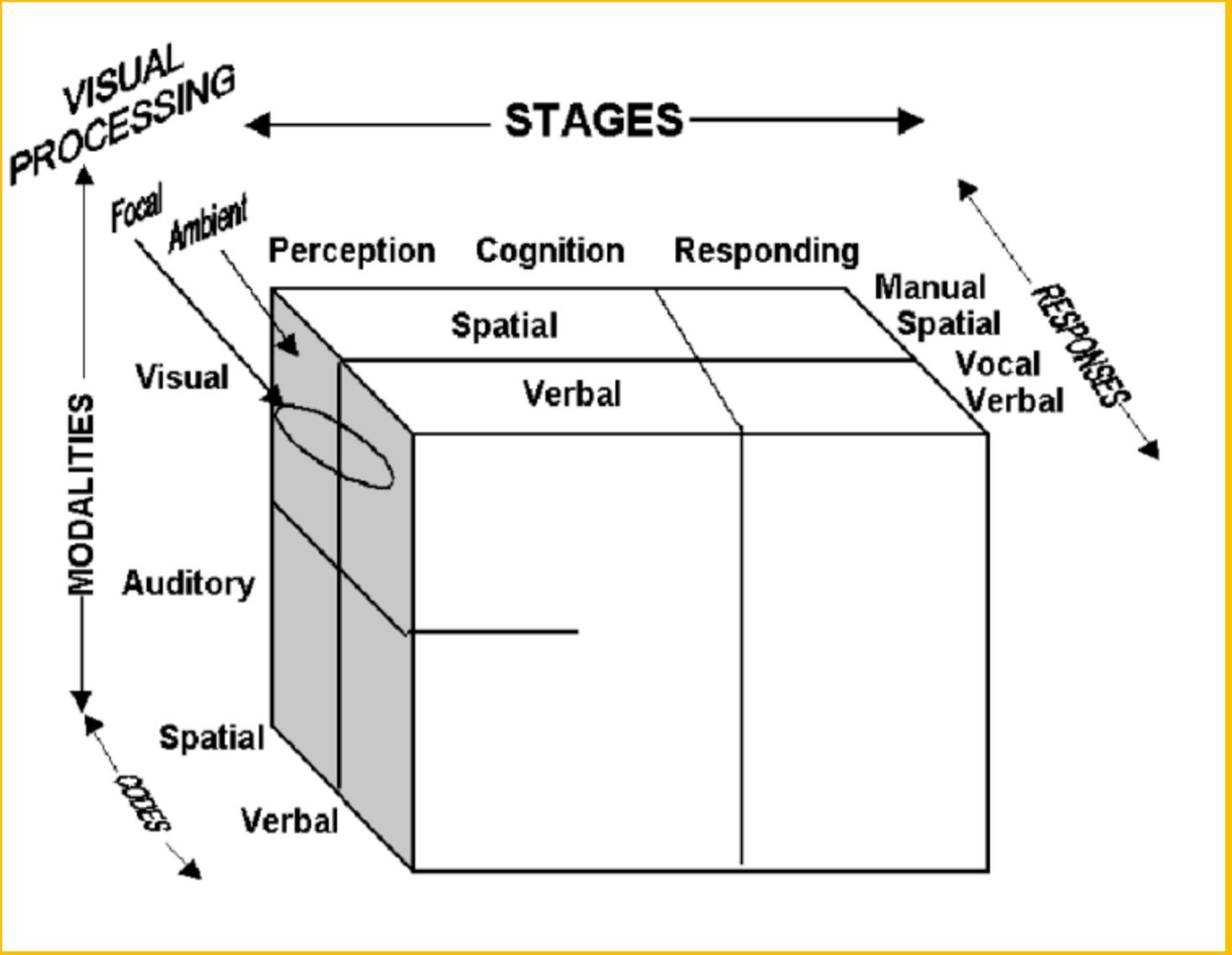


Wickens, C. D. (1980). The structure of attentional resources. Attention and performance VIII, 8, 239-257.
Wickens, C. D. (2002). Multiple resources and performance prediction. Theoretical issues in ergonomics science, 3(2), 159-177

EXERCISE

Listening to music while:

a. walking
b. writing a text
c. reverse parking



Together with your neighbor
Time: 3 minutes

1.2 Selective Attention

Selective attention vs. Divided attention

https://www.sfmic.com/wp-content/uploads/110817_blog_distracted_driver.jpg
https://img.welt.de/img/news/crop111875297/030872660-ci3x2l-w620/Hektik-hilft-nicht.jpg
https://images.unsplash.com/photo-1603638725135-928baf863eff?ixlib=rb-1.2.1&ixid=MnwxMjA3fDB8MHxzZWFyY2h8MXx8Z3BzfGVufDB8fDB8fA%3D%3D&auto=format&fit=crop&w=400&q=60
https://cdn-bpbce.nitrocdn.com/xwqhWLJHjjHutiZlCXjdARtlFXMQJqyL/assets/static/optimized/rev-52dd72e/wp-content/uploads/2019/11/multitasking-and-driving-dangers.jpg

Selective Attention - Definition

Definition:

Selective Attention is to concentrate on certain stimuli in the environment and not on others, enabling important stimuli to be distinguished from peripheral or incidental ones.

- Typically measured by instructing participants to attend to some sources of information but to ignore others at the same time and then determining their effectiveness in doing this.

-- Dictionary of the American Psychology Association

https://dictionary.apa.org/selective-attention

EVALUATION

Selective Attention - Auditory Tasks

- Selective Listening Task:
  - The target signal is presented together with the distractor signal
  - E.g., when designing an auditory icon for a busy environment (factory alarm)
  - What makes it easier:
    - When the target message is physically distinct from the distractor
    - Spatial separation (e.g., different speakers or ears)
    - Different frequencies or frequency regions

These findings are consistent with filter theory (Treisman, 1964a,b).

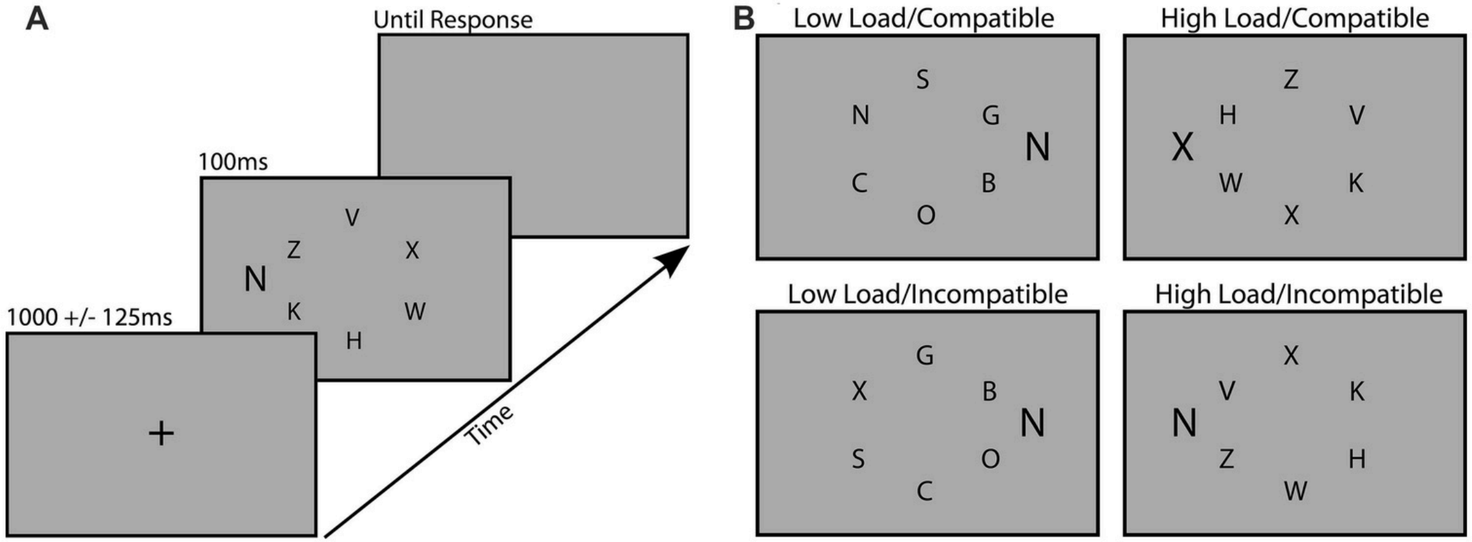
Human Factors in Simple and Complex Systems (2018) Proctor & van Zandt

Selective Attention - Visual Task

- Presenting several stimuli at once and requiring the observer to perform a task that depends on only one of them
- Example: Stroop Task

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: an integrative review. Psychological bulletin, 109(2), 163.

Visual Attention Task

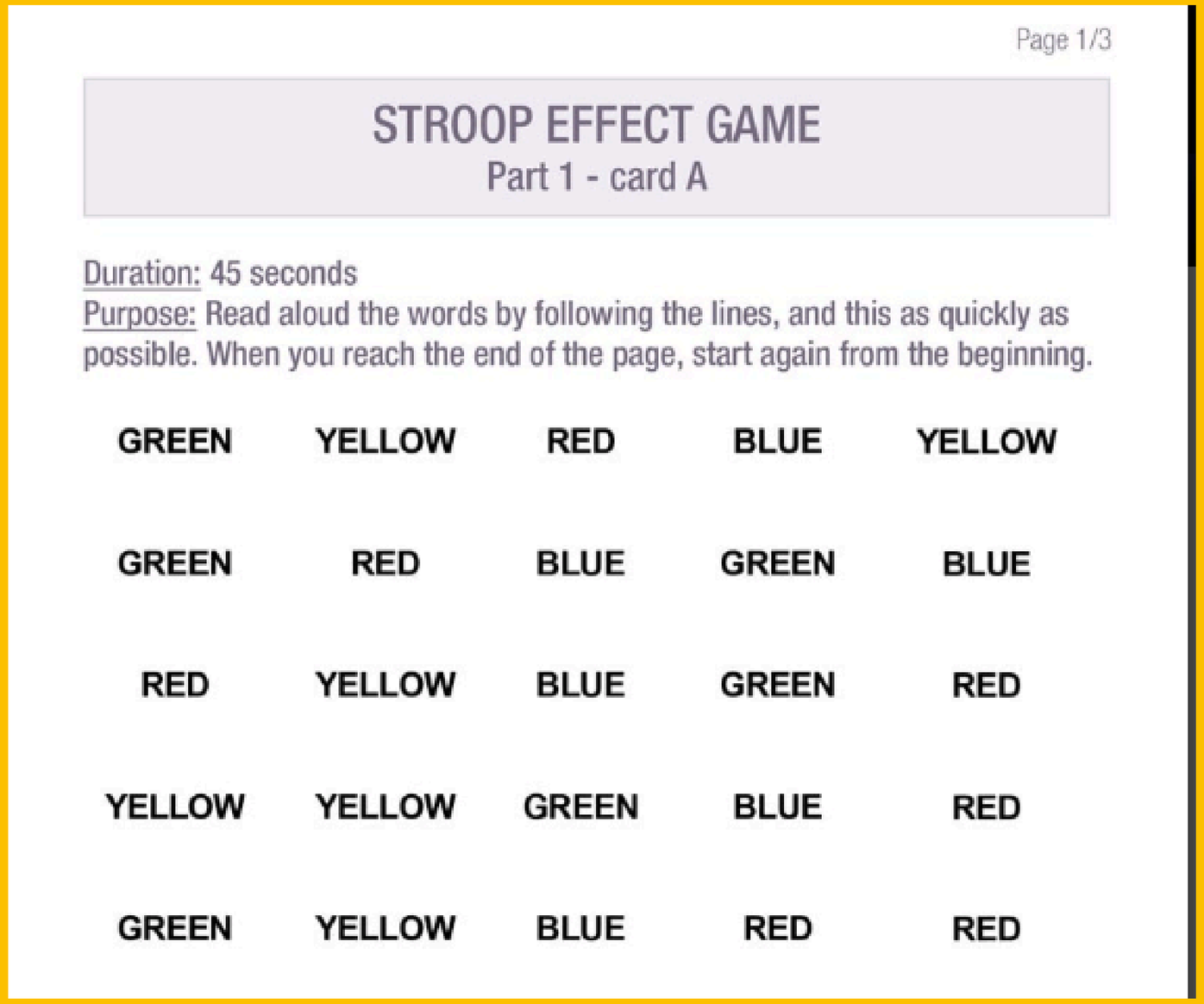


Stroop Task

Human Factors in Simple and Complex Systems (2018) Proctor & van Zandt

EXERCISE

Stroop Test:



Page 1/3

STROOP EFFECT GAME
Part 1 - card A

Duration: 45 seconds
Purpose: Read aloud the words by following the lines, and this as quickly as possible. When you reach the end of the page, start again from the beginning.

GREEN	YELLOW	RED	BLUE	YELLOW
GREEN	RED	BLUE	GREEN	BLUE
RED	YELLOW	BLUE	GREEN	RED
YELLOW	YELLOW	GREEN	BLUE	RED
GREEN	YELLOW	BLUE	RED	RED

https://www.memozor.com/memory-games-to-print/words/stroop-effect-game

EXERCISE

Stroop Test:

Page 2/3

STROOP EFFECT GAME

Part 2 - card C

Duration: 45 seconds

Purpose: Name out loud the color of each rectangle by following the lines, and this as quickly as possible. When you reach the end of the page, start again from the beginning.

https://www.memozor.com/memory-games-to-print/words/stroop-effect-game

EXERCISE

Stroop Test:

Page 3/3

STROOP EFFECT GAME
Part 3 - card B

Duration: 45 seconds
Purpose: By following the lines and as quickly as possible, name out loud the color of each word (not what the word says). When you reach the end of the page, start again from the beginning.

BLUE	YELLOW	BLUE	RED	BLUE
GREEN	YELLOW	RED	GREEN	YELLOW
GREEN	RED	GREEN	YELLOW	YELLOW
YELLOW	RED	YELLOW	GREEN	BLUE
BLUE	RED	YELLOW	YELLOW	GREEN

https://www.memozor.com/memory-games-to-print/words/stroop-effect-game

Implications for Design - Supporting selective attention

Users perform best when focusing on a single task or information stream.

Minimize distractions:

- Avoid adding unnecessary elements, such as ads or notifications, that can pull attention away from the primary task.

Attention management tools:

- Allow users to filter or snooze non-critical alerts, ensuring they can concentrate on essential tasks.

Ensure task relevance:

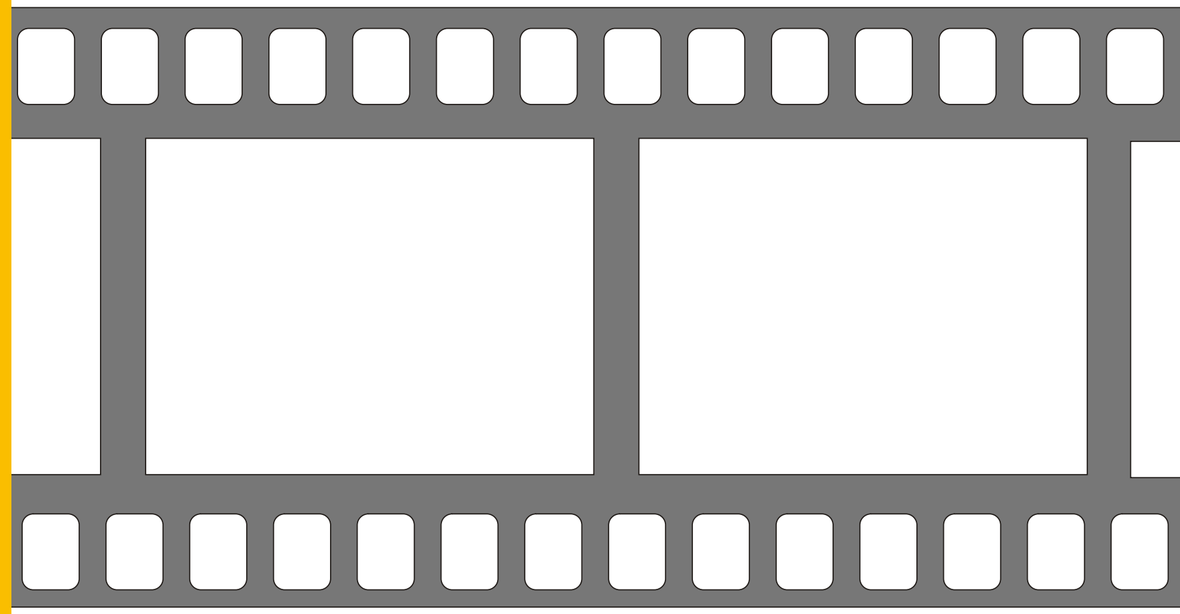
- Align the design with the user's goals by keeping the interface uncluttered and content relevant to the current task.

VIDEO

ATTENTION

ADHD

Cognitive and Psychological Foundations for Product Design 2024/2025



Check out our specialization topic video on ADHD!


coffee
break
for
10 min

1.3 Change Blindness

Change Blindness

Definition:

Change blindness is the failure to notice an obvious change in the visual array between two successive scenes.

https://dictionary.apa.org/change-blindness

Situations where change blindness occurs:

- During blinks, saccades, or other natural occlusions.
- When changes occur gradually, with no visible transient.

Real-world examples:

- Automobile accidents, eyewitness identifications, military operations, and everyday interpersonal interactions.

Explanations for change blindness:

- Attention-based: Focus diverted from the changing object.
- Memory-based: Failure to encode visual information in working memory due to irrelevance to task demands.
- Comparison failure: Inability to compare pre-change and post-change mental representations of the visual environment.

Human Factors in Simple and Complex Systems (2018) Proctor & van Zandt

The Door Study

https://youtu.be/VkrrVozZR2c?si=3GZsKmBlMCd38d5P

Based on Simons, D. J., & Levin, D. T. (1998). Failure to detect changes to people during a real-world interaction. Psychonomic Bulletin & Review, 5, 644-649. https://link.springer.com/content/pdf/10.3758/bf03208840.pdf

EXERCISE

Mitigating Change Blindness

Think of a design that mitigates change blindness to ensure users notice critical updates and changes.

Consider a UI where a critical change must be noticed (e.g., an important alert or update).

Together with your neighbor
Time: 3 minutes

EXERCISE

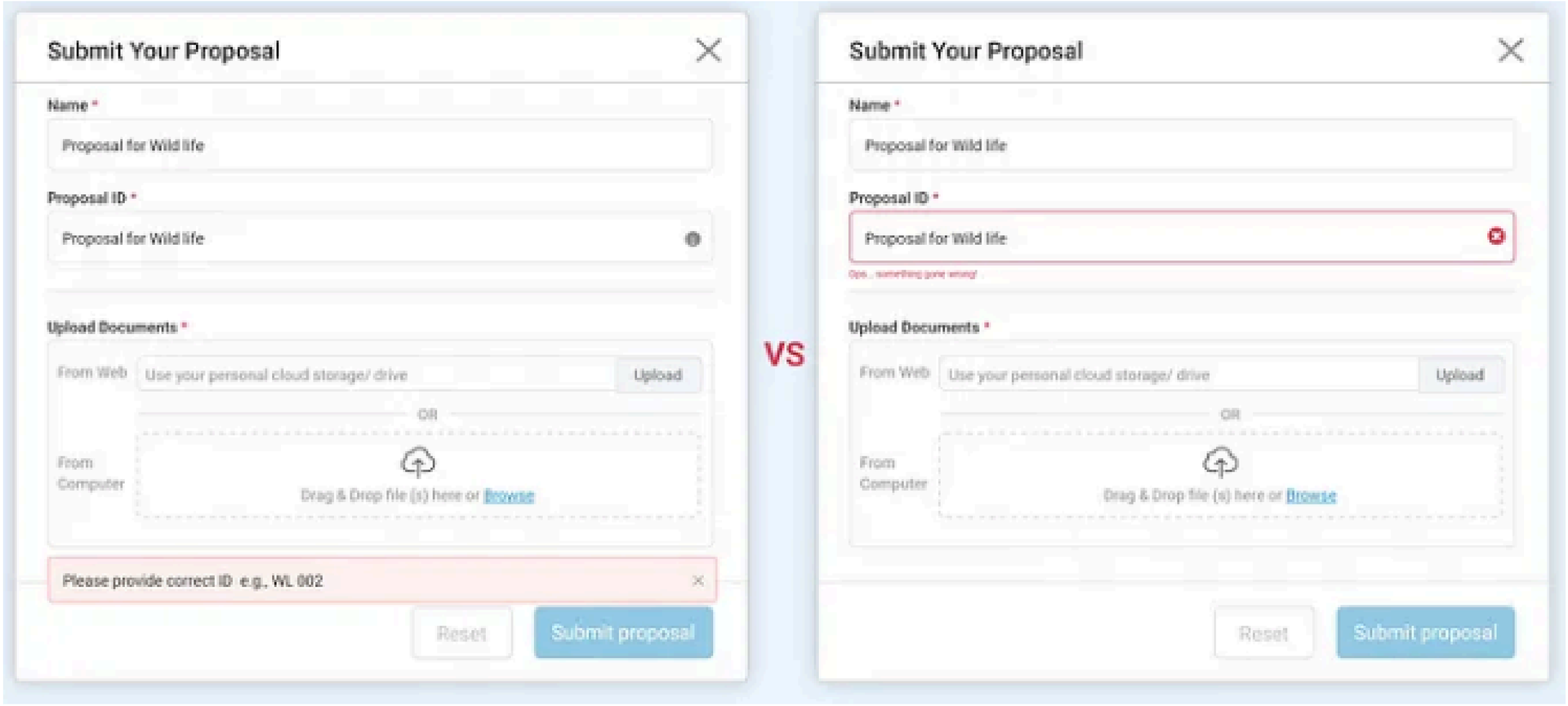
Utilizing Change Blindness

Think of a design that intentionally utilizes change blindness to streamline the user experience and avoid overwhelming the user with too many simultaneous changes.

Think of a UI where subtle changes occur in the interface that users might not notice immediately.

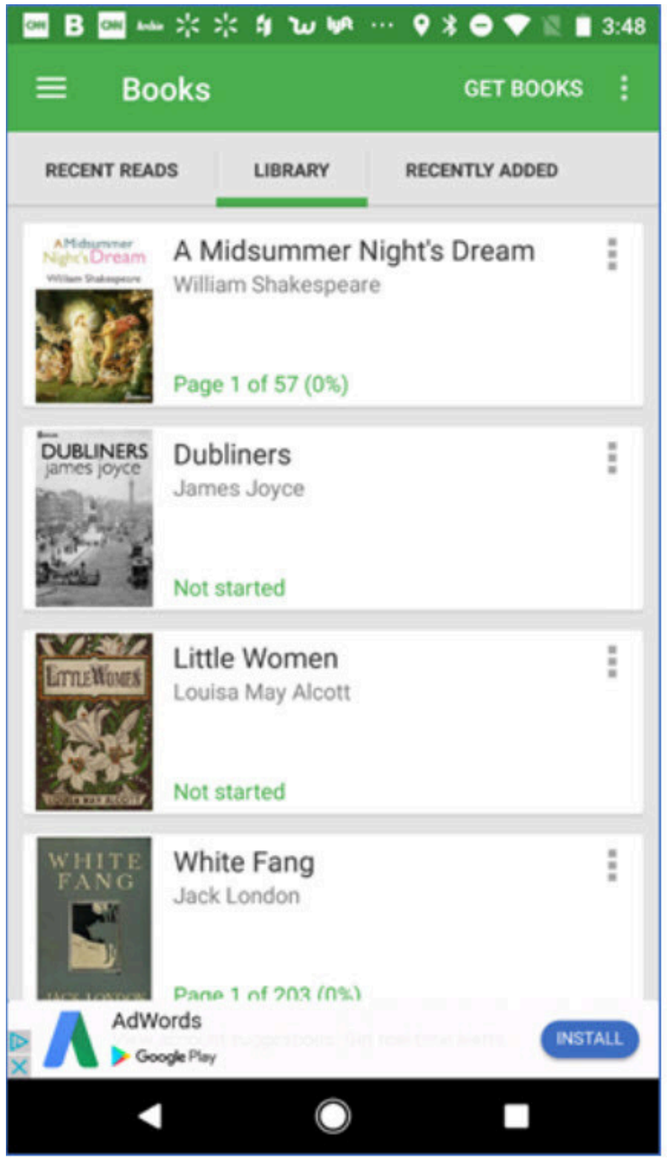
Together with your neighbor
Time: 3 minutes

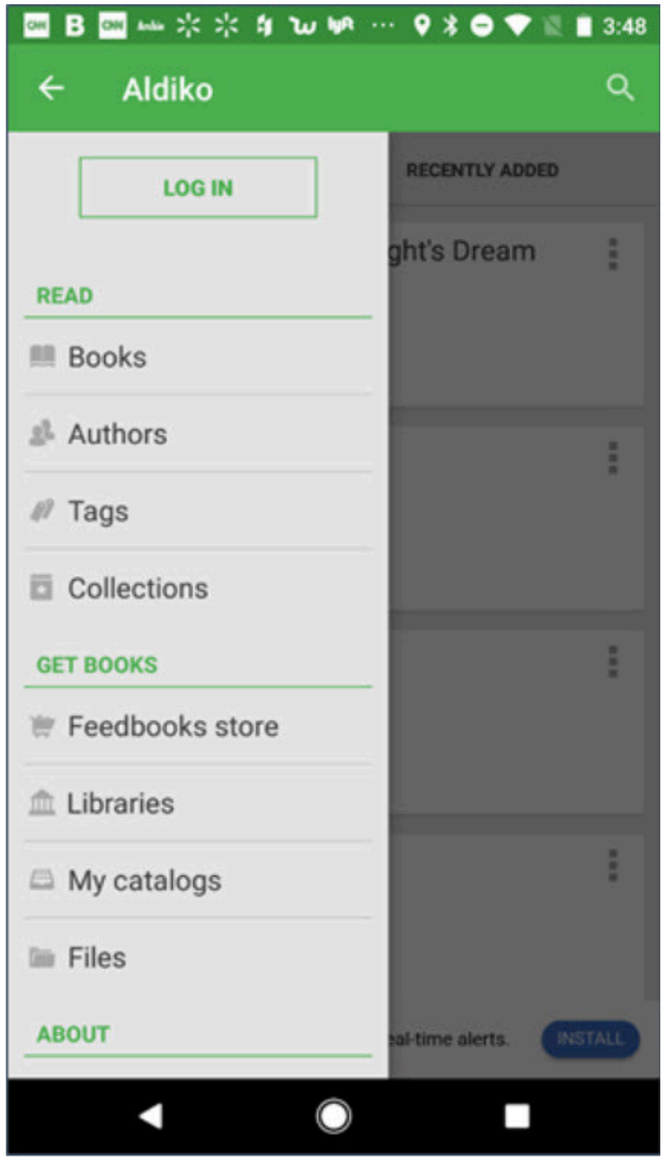
Change blindness can affect critical information such as error messages and navigation menus, leading to user confusion and task failure. Placement and contrast of content are key when designing to avoid being overlooked by users.



Example on change blindness

https://uxplanet.org/psychology-for-product-design-part-2-1696c7cc54a1





Aldiko for Android: When the menu is opened, the controls in the right top corner of the screen get replaced by a magnifier glass. The search tool will remain unnoticed because (1) people will look at the expanded menu, which will be a direct result of their action; (2) they will expect the other elements of the screen to remain unchanged (as they normally do in interactions with most UIs).

https://www.nngroup.com/articles/change-blindness-definition/

NYTimes for iPhone: As they start scrolling up, people may miss the semipersistent navigation bar that appears at the top of the screen because they are focused on the scrolling of the page. An aggravating factor is the fact that the visuals of the navigation bar are not distinctive enough from the page content.

https://www.nngroup.com/articles/change-blindness-definition/

Implications for Design - Mitigating change blindness

1. Limit the number of changes in the interface
2. Make one change at a time (not multiple like in the Aldiko app)
   --> progressive disclosure
3. Keep changes close to the focal point
4. Use visual cues such as animations to signal change
5. Make changes visually prominent

https://www.nngroup.com/articles/change-blindness-definition/
https://www.youtube.com/watch?v=5O71iuTPTTI

1.4 Inattentional Blindness

Inattentional Blindness

Definition:

Inattentional blindness is a failure to notice unexpected but perceptible stimuli in a visual scene while one's attention is focused on something else in the scene.

-- Dictionary of the American Psychology Association

Real-World Examples:

- Magic tricks: Observers fail to see sleight of hand right in front of them.
- Driving accidents: Drivers fail to see other road users due to attention focused elsewhere (In traffic psychology, this is often discussed in the context of "looked-but-failed-to-see" accidents because, in many cases, the driver has been clearly looking in the direction of the other party but yet failed to see him/her [unfortunately often cyclists] because their attention is elsewhere.

Factors Influencing Inattentional Blindness:

- Visual relationship of unexpected items to other objects in the scene.
- Meaningfulness of the unexpected item.
- Attentional set and cognitive load: Inattentional blindness is more likely for task-irrelevant stimuli and in high task-processing demand situations.

https://dictionary.apa.org/inattentional-blindness

EXERCISE

What is your attitude towards including head-up displays in cars?
Why could it be a bad idea in terms of how attention work?

https://www.youtube.com/watch?v=DCgy3askMcM&t=119s

Together with your neighbor
Time: 3 minutes

1.5 Divided Attention

Divided attention

Definition:

Divided attention means allocating attention to two or more channels of information at the same time so that two or more tasks may be performed concurrently.

It may involve the use of just one sense (e.g., hearing) or two or more senses (e.g., hearing and vision).

-- Dictionary of the American Psychology Association

https://dictionary.apa.org/divided-attention

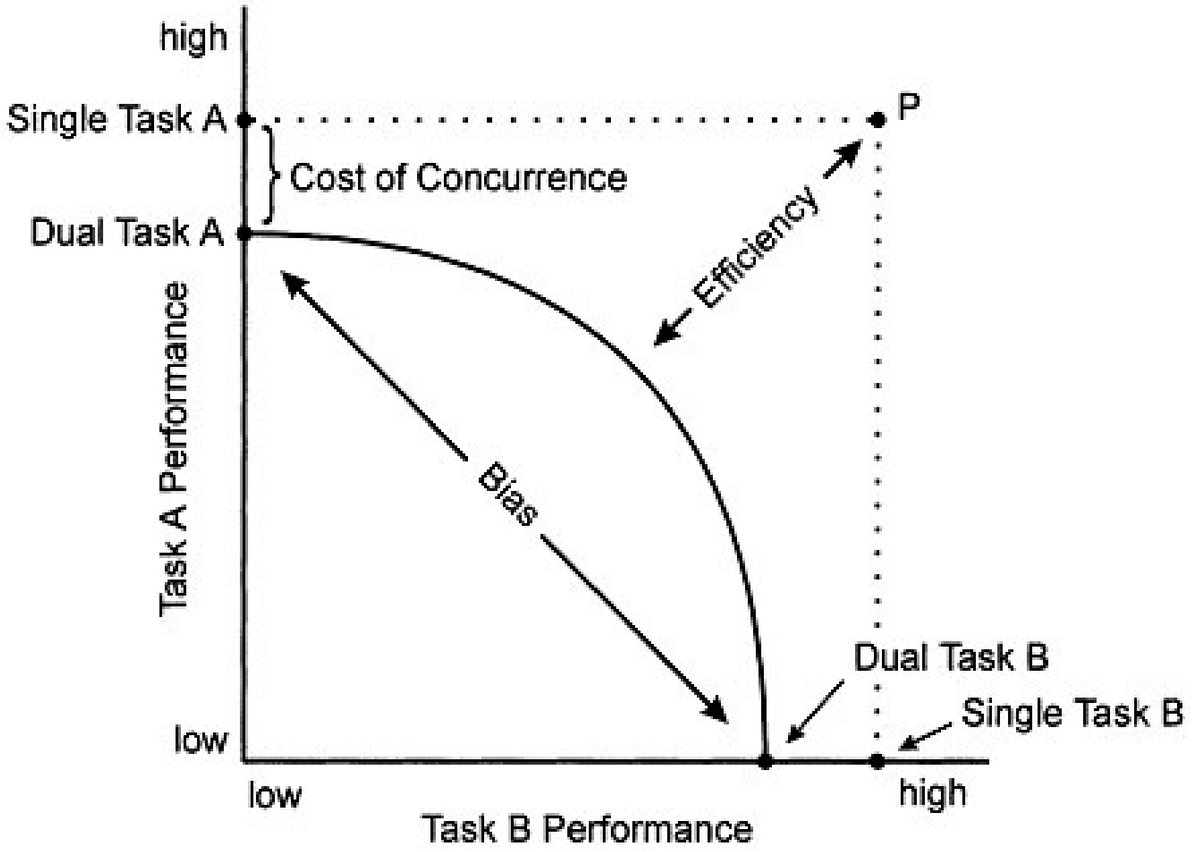
Divided attention

Task Complexity and Response

- Problems arise when multiple targets need different responses.
- The ability to respond to multiple simultaneous targets can improve with practice, but not to single-source levels.

Performance Operating Characteristic (POC) Curve

- Describes the tradeoff in dual-task performance.
- Shows efficiency in performing two tasks simultaneously.
- The closer the curve to the independence point, the more efficient the performance



Goldstein, E..B., & von Hooff, J.C. (2020). Cognitive Psychology (2nd ed.)
Human Factors in Simple and Complex Systems (2018) Proctor & van Zandt

1.6 Arousal and Vigilance

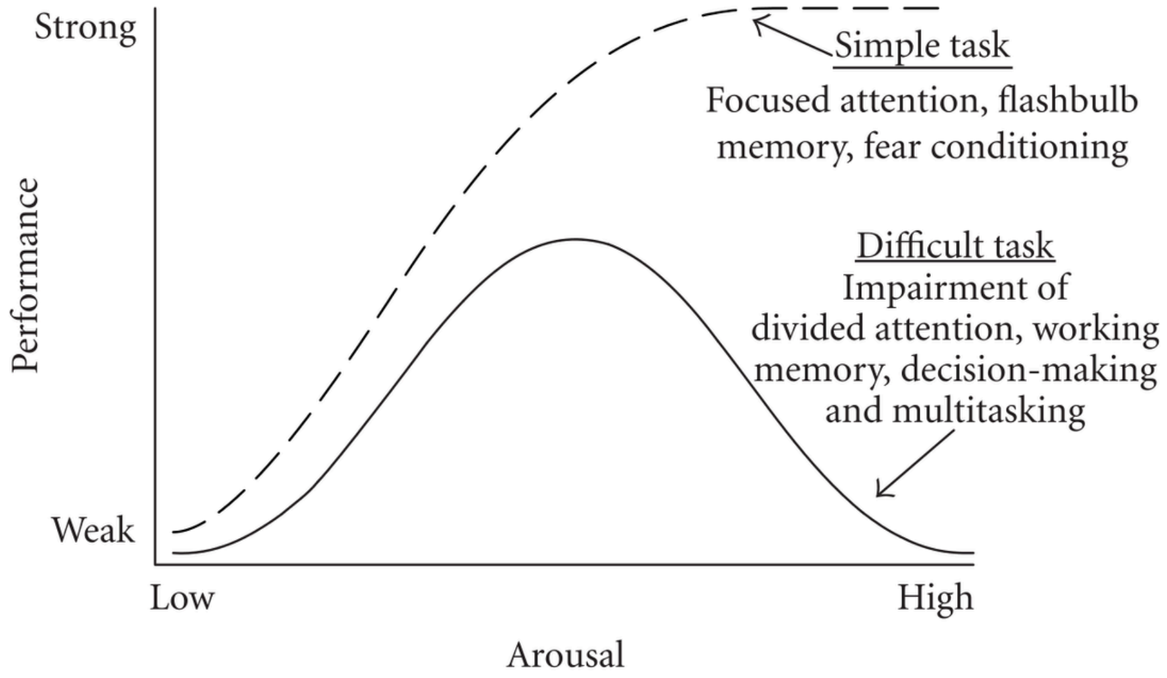
Arousal and Performance

Influence of Arousal

- Arousal affects attentional resources and task allocation.
- Yerkes-Dodson Law: Performance follows an inverted U-shaped function of arousal.
    - Optimal arousal higher for simple tasks, lower for complex tasks.

Perceptual Narrowing

- High arousal restricts attention focus (Easterbrook, 1959).
- Example: Novice SCUBA divers performing worse under high-stress conditions.
- Similar results in simulated driving tasks (Janelle, Singer, & Williams, 1999).



Yerkes-Dodson law Wikipedia
Robert Yerkes und John D. Dodson, 1908)

Goldstein, E..B., & von Hooff, J.C. (2020). Cognitive Psychology (2nd ed.)
Human Factors in Simple and Complex Systems (2018) Proctor & van Zandt

Vigilance Decrement

Definition and Importance

- Vigilance tasks: Detecting infrequent signals at unpredictable times.
- Historical context: Radar operators in WWII.
- Modern relevance: Industrial quality control, air-traffic control, etc.

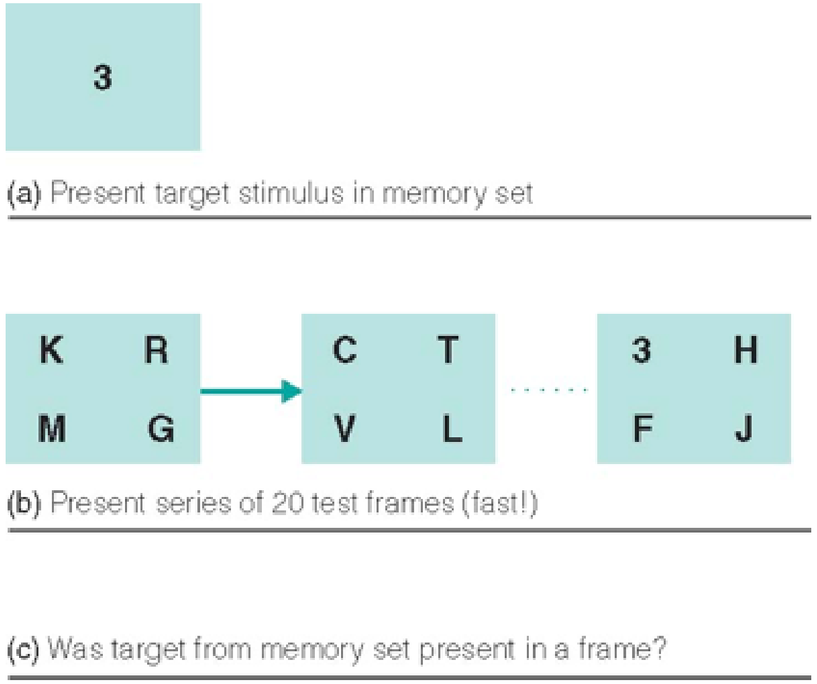
Vigilance Decrement

- Decrease in performance over time in vigilance tasks.
- Mackworth (1950): Hit rate decreases within the first 30 minutes.
  - Why: Sensitivity decrement and/or shift in response criterion.
- Varying impacts based on task type (sensory vs. cognitive discrimination).

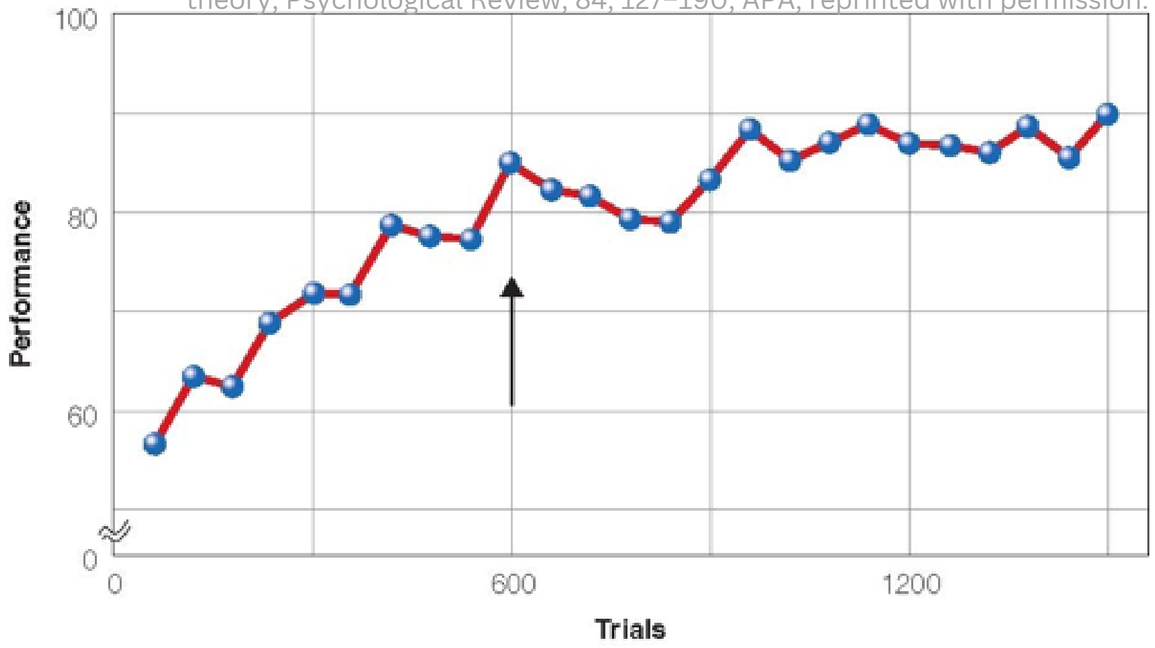
Goldstein, E..B., & von Hooff, J.C. (2020). Cognitive Psychology (2nd ed.)
Human Factors in Simple and Complex Systems (2018) Proctor & van Zandt

Divided attention can be achieved with practice

Study: asked people to hold information about the target stimulus in memory (3), then pay attention to a series of distractors
--> it took ~900 trials to reach 90%!



Originally Schneider, W. and Shiffrin, R. M. (1977). Controlled and automatic human information processing: Perceptual learning, automatic attending, and a general theory, Psychological Review, 84, 127–190, APA, reprinted with permission.



Goldstein, E..B., & von Hooff, J.C. (2020). Cognitive Psychology (2nd ed.)
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Implications for Design - Supporting divided attention

Signal prioritization:

- Clearly differentiate high-priority alerts from low-priority ones using color, size, or sound cues.

Redundant feedback:

- Use multiple modalities (e.g., visual and auditory signals) to ensure critical information is noticed, even if one channel is overloaded.

Cluster related information:

- Group relevant inputs together to reduce the cognitive effort required to monitor multiple sources.

2 MULTITASKING

Divided attention vs. Multitasking

Giving attention to two or more sources of information at the same time

- **Goal:** Monitor or respond to several inputs at the same time.
- **Example:** A nuclear power plant operator monitoring several gauges at once for potential system malfunctions.

Doing two things at the same time (often switching attention back and forth in quick succession)

- **Goal:** Completing multiple tasks, but not necessarily simultaneously (often involves task-switching).
- **Example:** Checking emails while participating in a conference call and jotting down notes.

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EXERCISE

TASK

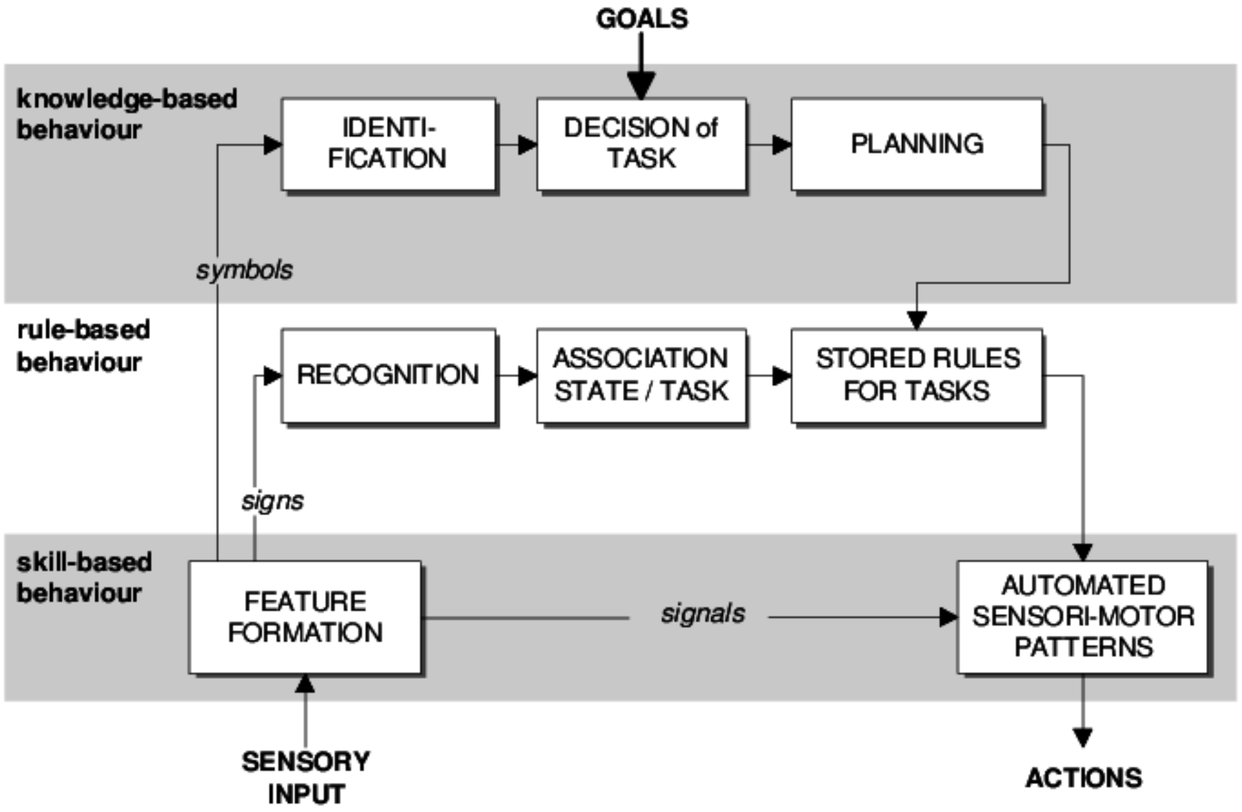
Try to rotate your right foot clockwise and your right arm counter-clockwise

ChatGPT

Multitasking and Task Proficiency

- Multitasking performance depends on the tasks and proficiency level and can become better with practice

Rasmussen's SRK model



(to be further discussion in the lecture on decision-making)

3

TEASER: WORKLOAD

Attention and Workload

Mental workload is the amount of mental work or effort necessary to perform a task in a given period. It increases when task demand increases or time decreases.

Definition by Young & Stanton (2006):
The mental workload of a task represents the level of attentional resources required to meet both objective and subjective performance criteria, which may be mediated by task demand, external support, and past experience.

Concept of workload stems directly from the unitary resource model of attention

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4 MEASUREMENTS

EVALUATION

Attention can be assessed for example via:

- Gaze Tracking
- Interaction tracking (direction)
  - Mouse
  - keyboard
  - Scrolling

- Physiological Sensing
  - Eye tracking (visual focus & pupil dilation)
  - Electroencephalography (EEG)
  - Heart rate variability (HRV)
  - Galvanic skin response (GSR)

- Think-aloud protocol (conscious focus)
- Dual Task Paradigm
- Task Performance Metrics (error rates, completion times, reaction time)

EVALUATION

Interaction Tracking

Tracking user interactions, including movements, mouse clicks, and pauses.

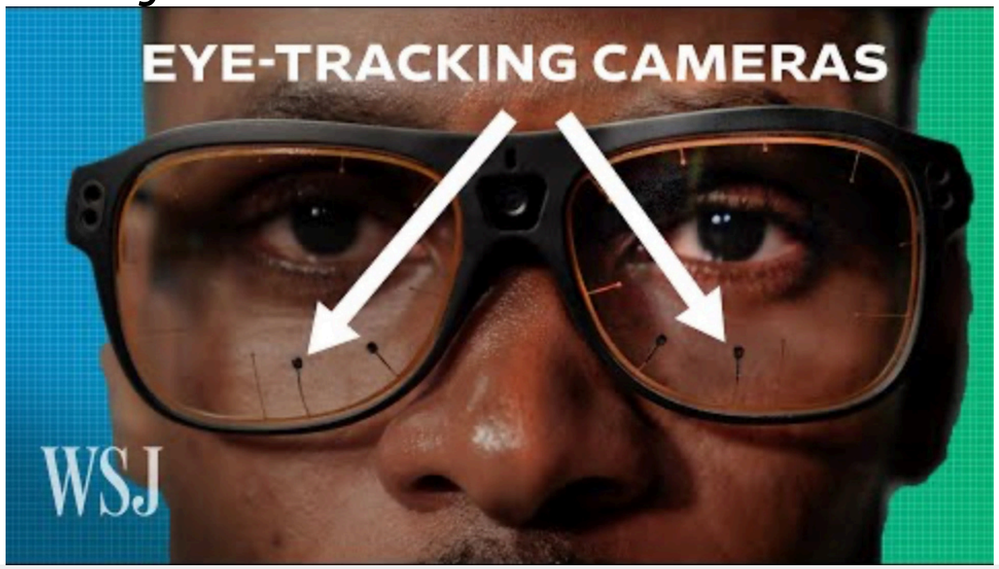
- Used to understand user behavior, attention patterns, and interaction efficiency in user interfaces
- Also ensure interactive elements (buttons, links) are large enough and within easy reach to minimize user effort.

EVALUATION

Eye Tracking

~ 2013

today



Gaze Heat Map

Images:
https://connect.tobii.com/s/article/heat-maps-and-gaze-plots?language=en_US
http://www.eyetracking- glasses.com/fileadmin/user_upload/documents/smi_etg_flyer.pdf
https://www.youtube.com/watch?v=JBz_VB26pUg

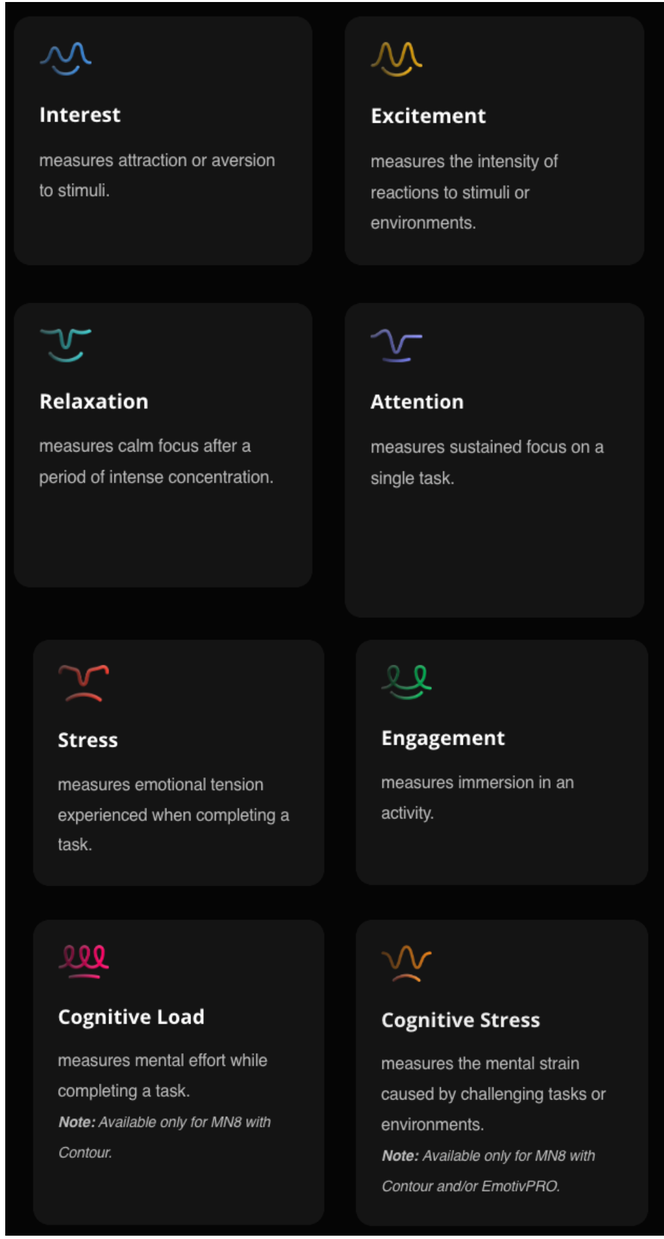
EVALUATION

EEG

- Electroencephalography
  - Can measure attention (often immersion or engagement are used as more complicated metrics)
  - Can provide information on:
    - Task switching
    - Allocation of mental resources

https://www.brainproducts.com/solutions/liveamp/

https://store.brainbit.com/products/brainbit-sdk



https://www.emotiv.com/pages/performance-metrics?srsltid=AfmBOoq8KXWNOrs0EH_X0tuU-lb-E7lSEtkVzHNya79Gr7my8r0hRnnr

EVALUATION

EEG for Visual Attention

- SSVEPs (steady-state visually evoked potentials)
- Flickering of the target object on the screen is picked up by the retina and brain and can be measured via EEG
- Can be used as a brain-computer interface (BCI) for people who can not use standard typing interfaces

https://www.youtube.com/watch?v=KCW57QDNDos
Chen, X., Wang, Y., Nakanishi, M., Gao, X., Jung, T. P., & Gao, S. (2015). High-speed spelling with a noninvasive brain–computer interface. Proceedings of the national academy of sciences, 112(44)

5

CLOSING

Teaser for next week:

Attention and memory go hand in hand!

Check out this paper in the Brightspace Wrap up section!

ELSEVIER

Interactions between attention and memory

Marvin M Chun and Nicholas B Turk-Browne

Attention and memory cannot operate without each other. In this review, we discuss two lines of recent evidence that support this interdependence. First, memory has a limited capacity, and thus attention determines what will be encoded. Division of attention during encoding prevents the formation of conscious memories, although the role of attention in formation of unconscious memories is more complex. Such memories can be encoded even when there is another concurrent task, but the stimuli that are to be encoded must be selected from among other competing stimuli. Second, memory from past experience guides what should be attended. Brain areas that are important for memory, such as the hippocampus and medial temporal lobe structures, are recruited in attention tasks, and memory directly affects frontal-parietal networks involved in spatial orienting. Thus, exploring the interactions between attention and memory can provide new insights into these fundamental topics of cognitive neuroscience.

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Current Opinion in Neurobiology 2007, **17**:177–184

This review comes from a themed issue on
Cognitive neuroscience
Edited by Keiji Tanaka and Takeo Watanabe

Available online 26th March 2007

0959-4388/$ – see front matter

DOI 10.1016/j.conb.2007.03.005

Introduction

Throughout the modern history of psychology and neuroscience, memory and attention have enjoyed center stage as fundamental processes of intellectual function. Yet most of this research has focused on these processes as separate topics. Memory studies have typically not explored the role of attentional selection and modulation of encoding, whereas attention studies commonly ignore the important role of perceptual experience and past knowledge. However, because memory has a limited capacity, it is crucial to understand which information is selected for encoding. Likewise, because attention operates in a world that is relatively stable over time, it is useful to rely on past experience to optimize selection. In fact, some aspects of attention and memory might even reflect the same processes. For example, memory retrieval might reflect a form of selective attention to internal representations [1,2•].

Classic psychologists such as William James stated long ago that 'we cannot deny that an object once attended to will remain in the memory, while one inattentively allowed to pass will leave no traces behind' [3]. More recently, leading neuroscientists such as Eric Kandel have stated that one of the most important problems for 21st century neuroscience is to understand how attention regulates the processes that stabilize experiential memories [4]. Here, we review studies from the past two years that reveal progress towards understanding the interactions between attention and memory in neural systems.

Attention at encoding

A major question in many people's minds is how to improve memory. It is safe to say that attention helps to improve memory encoding but the details of this modulation remain unresolved. Also, although it is uncontroversial that attending to or focusing on a fact or event will enhance the likelihood of later memory, it is less clear how attention modulates and enhances implicit, unconscious memories — those traces of experience that we cannot articulate or overtly declare. Innovations in brain imaging research have helped reveal these implicit memory traces in the mind. Similar methods have also helped characterize which brain states are more likely to lead to better memory encoding and retrieval.

But what does it mean to attend? In one sense, it means that processing resources are being allocated to a task. In another sense, attention involves selecting what deserves these resources, and preventing other things from receiving them. Think of this as an analogy to resource-demanding endeavors, such as exercising. Do I have the time and energy (resources) to exercise? If so, should I run around the neighborhood or swim laps (selection)? The distinction between resources and selection is useful for understanding how attention modulates memory. In behavioral research, for example, explicit memory is impaired when processing resources are divided between two tasks during encoding but not retrieval [5]. Many implicit memory tasks can be performed despite a demanding secondary task, although even in such cases the stimuli must be selectively attended [6,7].

In the following sections, we will discuss how resources and selection interact with memory encoding. We will focus on two neural measures of memory: first, explicit episodic memory, which typically correlates with increased activity in frontal and medial temporal regions

https://www.sciencedirect.com/science/article/abs/pii/S0959438807000360)

Is our attention capacity shrinking or evolving?

https://time.com/3858309/attention-spans-goldfish/

TIME

HEALTH • NEUROSCIENCE

You Now Have a Shorter Attention Span Than a Goldfish

2 MINUTE READ

BY KEVIN MCSPADDEN

MAY 14, 2015 5:09 AM EDT

The average attention span for the notoriously ill-focused goldfish is nine seconds, but according to a new study from Microsoft Corp., people now generally lose concentration after eight seconds, highlighting the affects of an increasingly digitalized lifestyle on the brain.

Researchers in Canada surveyed 2,000 participants and studied the brain activity of 112 others using electroencephalograms (EEGs). Microsoft found that since the year 2000 (or about when the mobile revolution began) the average attention span dropped from 12 seconds to eight seconds.

"Heavy multi-screeners find it difficult to filter out irrelevant stimuli — they're more easily distracted by multiple streams of media," the report read.

Reflection

Think about today's session with your neighbor and each answer one of the following questions:

It can be answering any of the following questions:

- What is your main take away from today?
- What was most surprising from this session?
- What did you find most interesting?
- What made an impact on you?

Don’t forget to finish the **WRAP UP** section of this week and complete the **QUIZ**!