

# Cognitive Psychology

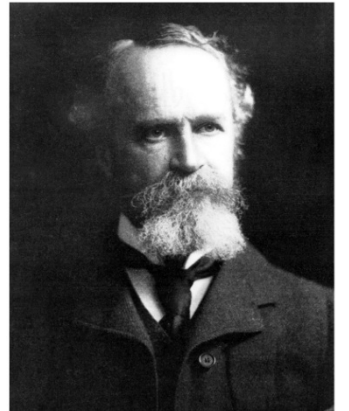
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## Lecture 4: Attention

# What is attention?

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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. Focalization, concentration of consciousness are its essence. 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, scatterbrain state. (James, 1890)*



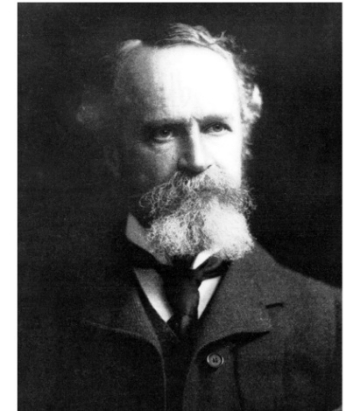
# What is attention?

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Attention can be voluntarily controlled; we can decide where (or at what) to direct our attention.



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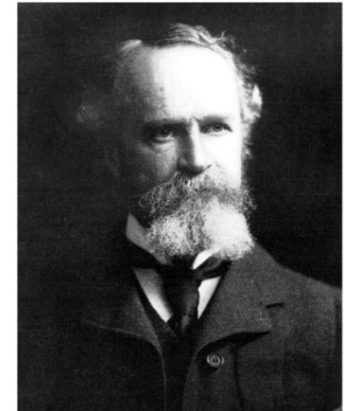
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Attention is selective, we choose among several alternatives where to attend



# What is attention?

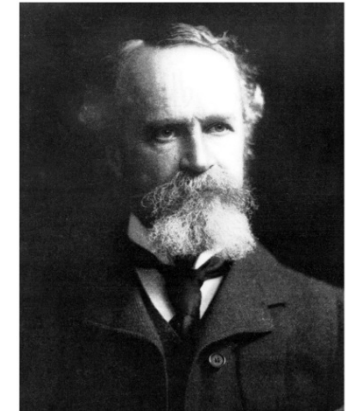
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Attention is selective, we choose among several alternatives where to attend



Attention has limited capacity

# What is attention?

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- Attention is the cognitive process of selectively concentrating on one aspect of the external or internal environment while ignoring other aspects.
- Attention is limited in capacity
  - Resource-demanding / we can't attend to everything
- Attention can be voluntarily controlled
  - Internal thoughts and goals can direct attention (top-down)
  - External stimuli can also “capture” our attention (bottom-up)

# Why is attention important?

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We need attention to deal with the huge amount of sensory information...





# Why is attention important?

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But we have physiological limitations in our ability to process it





# Why is attention important?

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- Attention allows us to give priority unexpected, the new, and important information
- Attention allows efficient filtering and exploration of information

# Why is attention important?

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## Attention in Perception

- If we look around us we experience an amazing richness of detail.
- But we do not notice the detail of objects unless attention is directed to them.

## Demonstration: Without looking!

- What color shirt is the person behind you wearing?
- On your mobile phone, what's the bottom right item?
- Which way is Lincoln facing on the penny?

# Why is attention important?

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- Change blindness
  - “Flicker paradigm” (Rensinck et al., 1997)
- Even big changes to a picture take a while to notice

# Change Blindness – Flicker paradigm

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## Change blindness – Flicker paradigm

- Explanation
  - The “bottom-up” perceptual processing is optimized towards continuous input.
  - In continuous input, changes are easily detected (usually changes are due to motion). Motion is highly salient and pulls our attention towards it.
  - The brief blank screen between the two pictures disrupt the basic bottom-up processing. No continuous motion can be detected.
  - Changes have to be searched for by deliberate attentional „top-down“ control, searching location by location...

# Change Blindness

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- Ok... but does that happen in real-life?
  - <https://www.youtube.com/watch?v=FWsXSQsspiQ&feature=youtu.be>

# Real-world applications

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The influence of attention on perception has implications

- Eye witness testimony
  - Witnesses may miss changes in the identity of the suspect.
- Driving a car in traffic
  - Texting while driving
- Human Machine Interaction
  - Missing of important signals
  - E.g. radar operators



# Models of attention

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- Attention allows us to focus on a particular stimulus while at the same time disregarding other stimuli.
- Key research questions
  - Which stimuli do we attend to?
  - At which level of processing do we decide what to attend to?
  - What happens to the stimuli that are not attended?



# What stimuli do we attend to?

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- Attention can be controlled or automatic
- Top-down processes can guide attention
  - knowledge, goals, expectations
- Bottom-up processes can also guide attention
  - Salient stimuli can “capture” attention
- Importantly, top-down and bottom-up processes often interact

# What stimuli do we attend to?

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## Controlled Attention

- Slow
- Effortful
- Prepared
- Voluntary
- Flexible

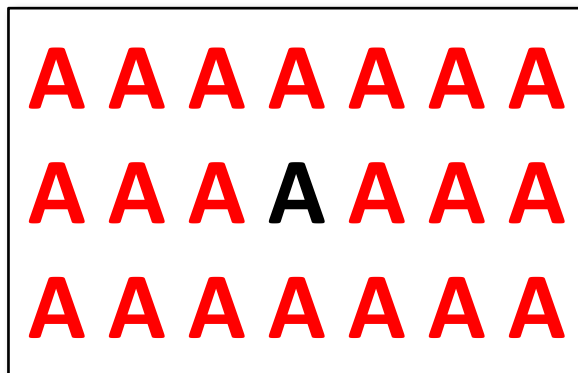
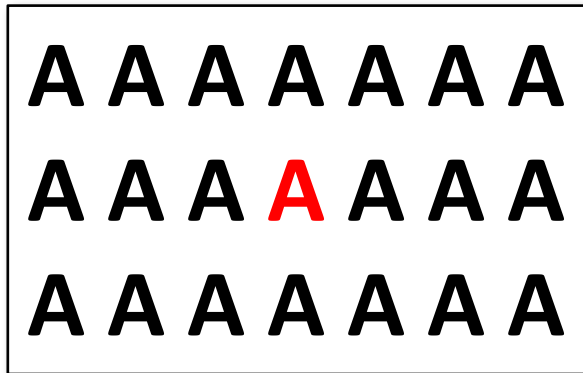
## Automatic Attention

- Fast
- Effortless
- Involuntary
- Rigid

# What stimuli do we attend to?

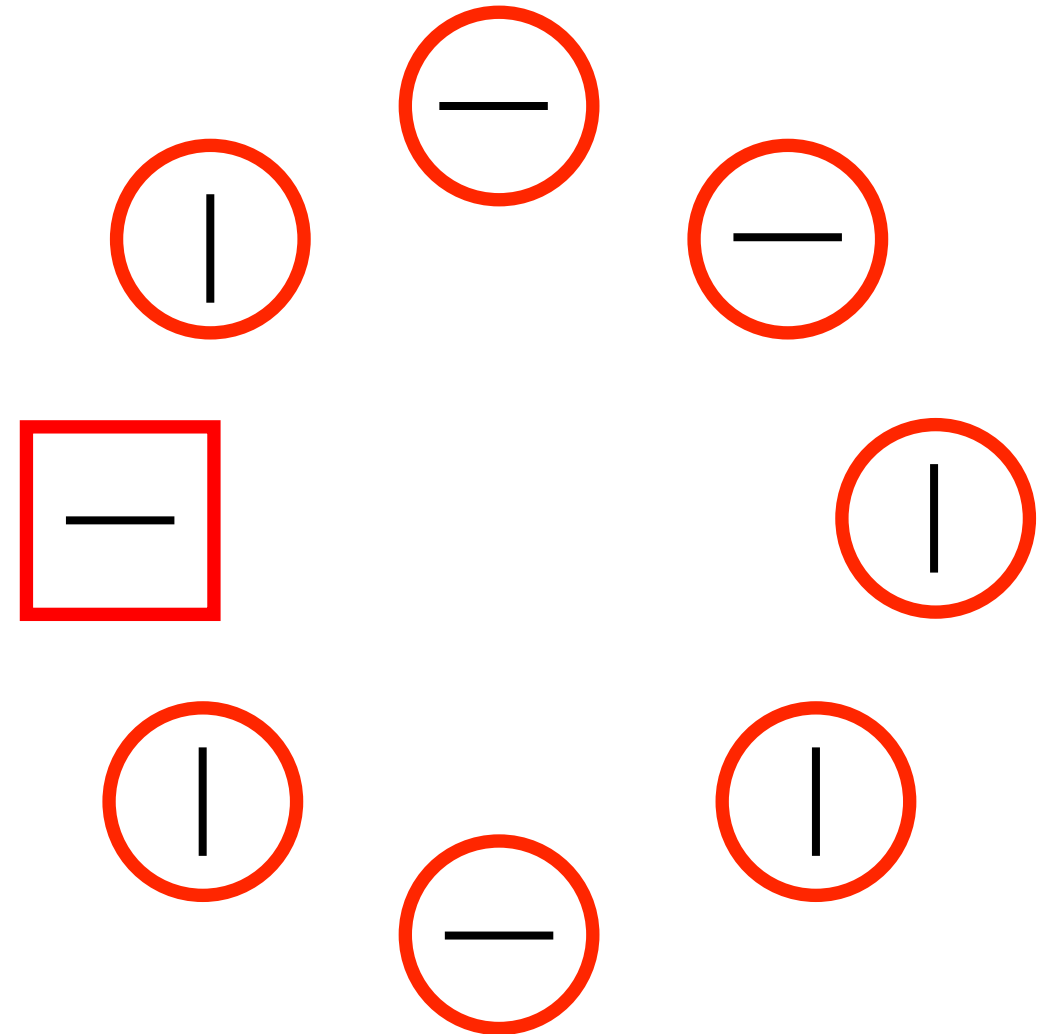
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- Some stimuli are attended to automatically because they are salient
- They capture our attention

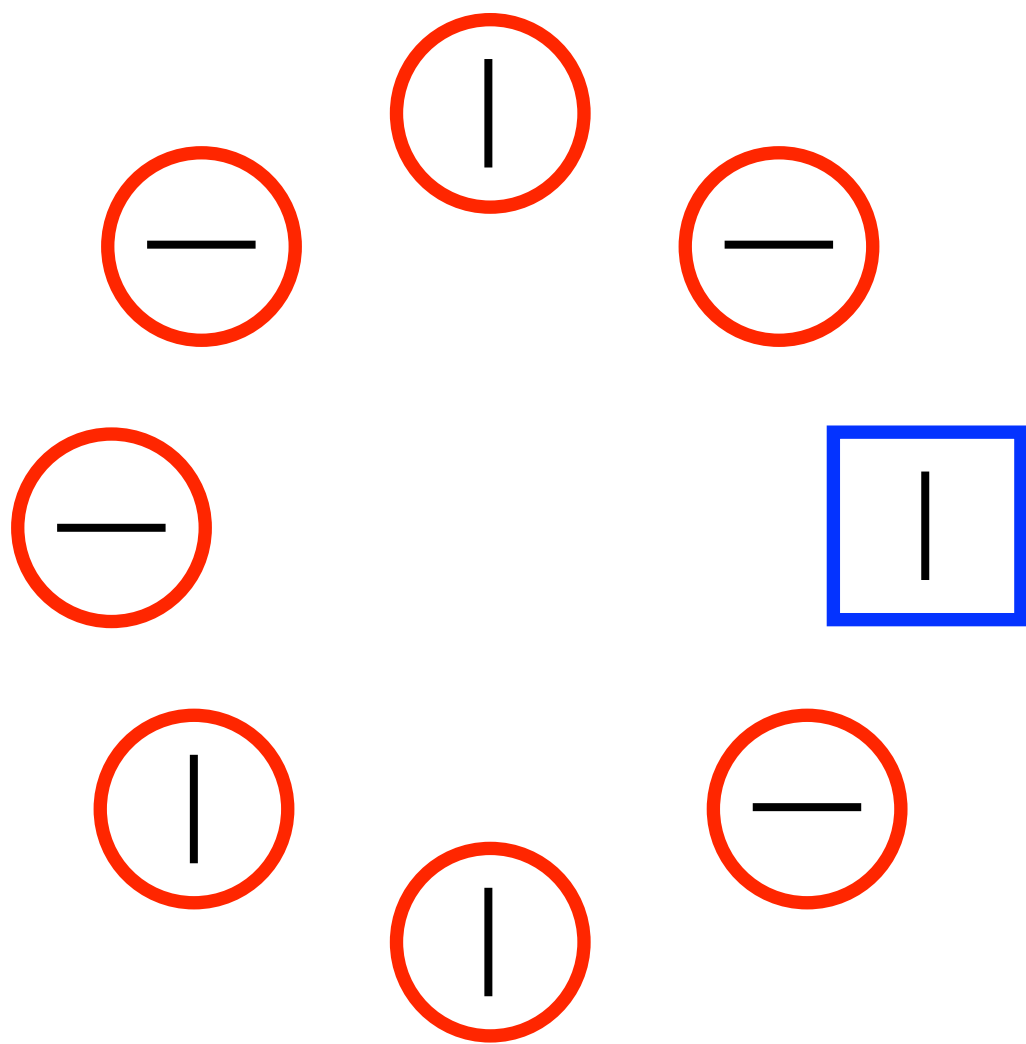


# E.g., Attention Capture

- Your task is to find the “odd” shape and indicate whether the line is vertical or horizontal

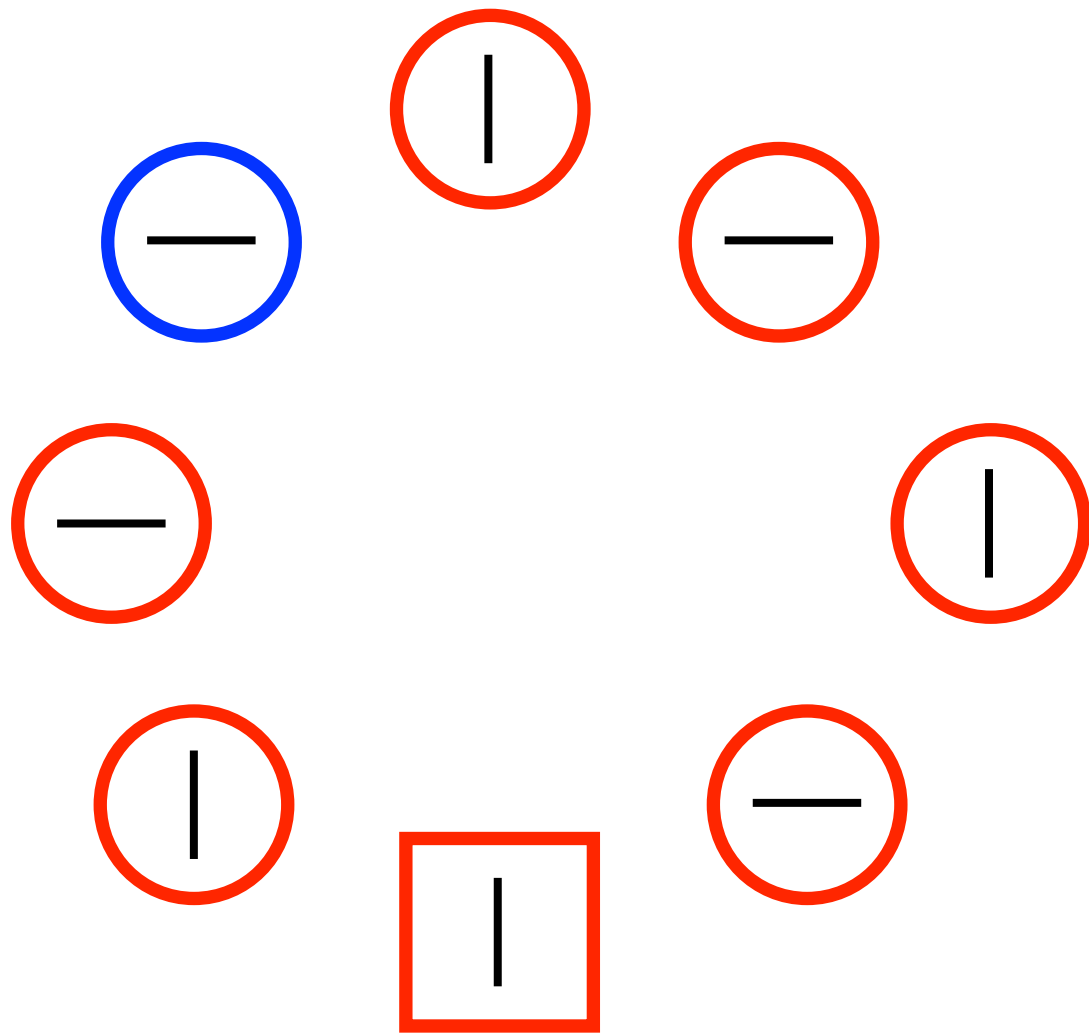








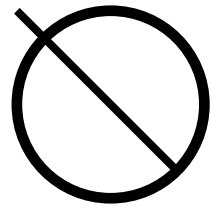




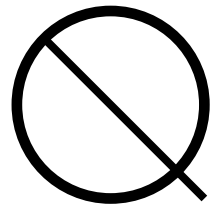
# E.g., Visual Search

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Targets

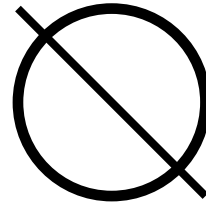


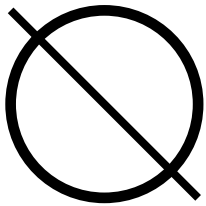
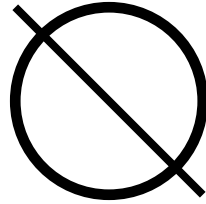
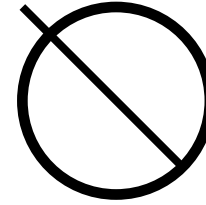
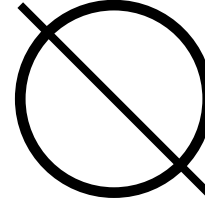
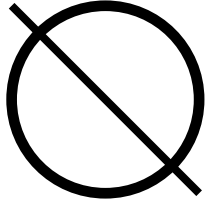
Say Up

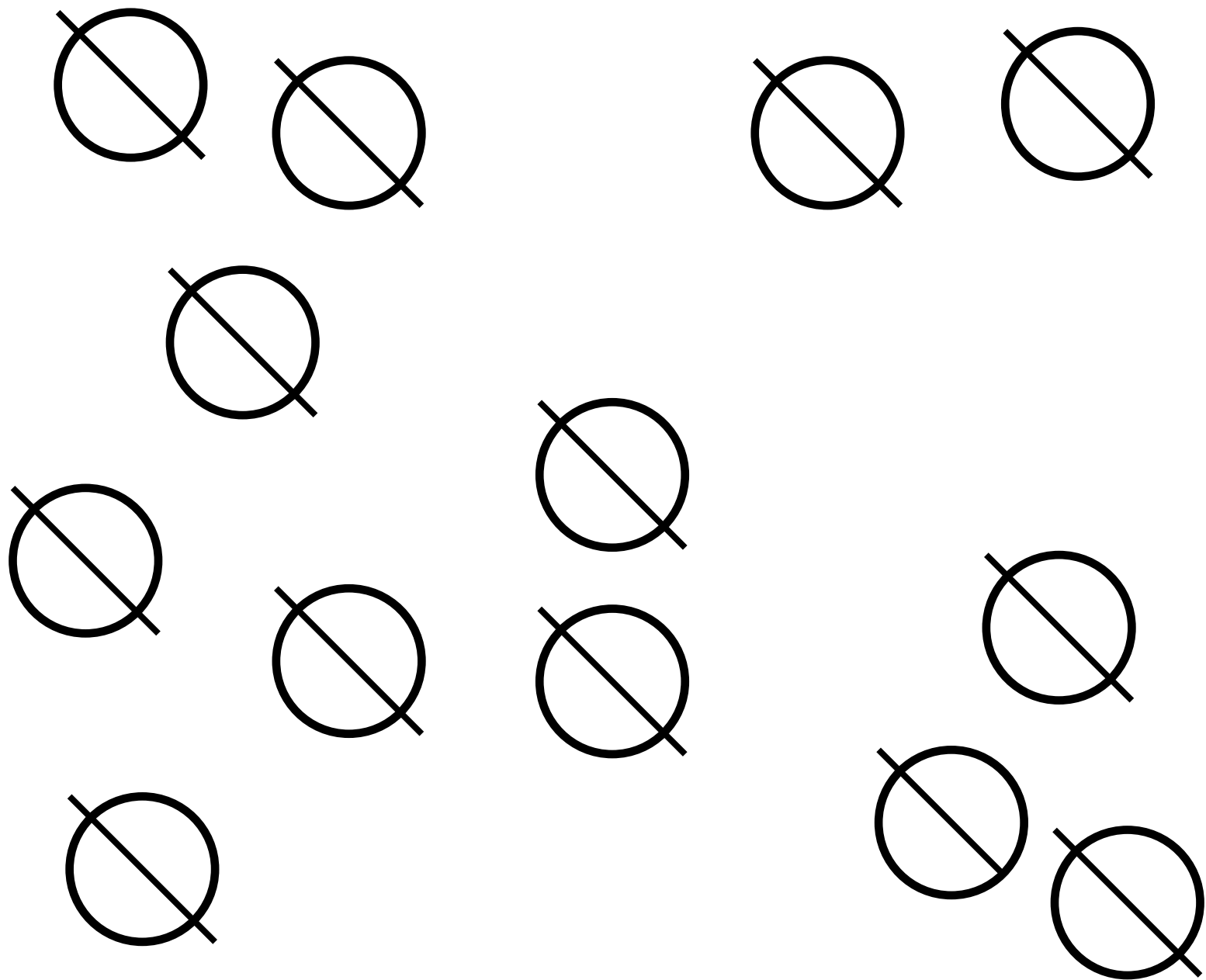


Say Down

Distractors

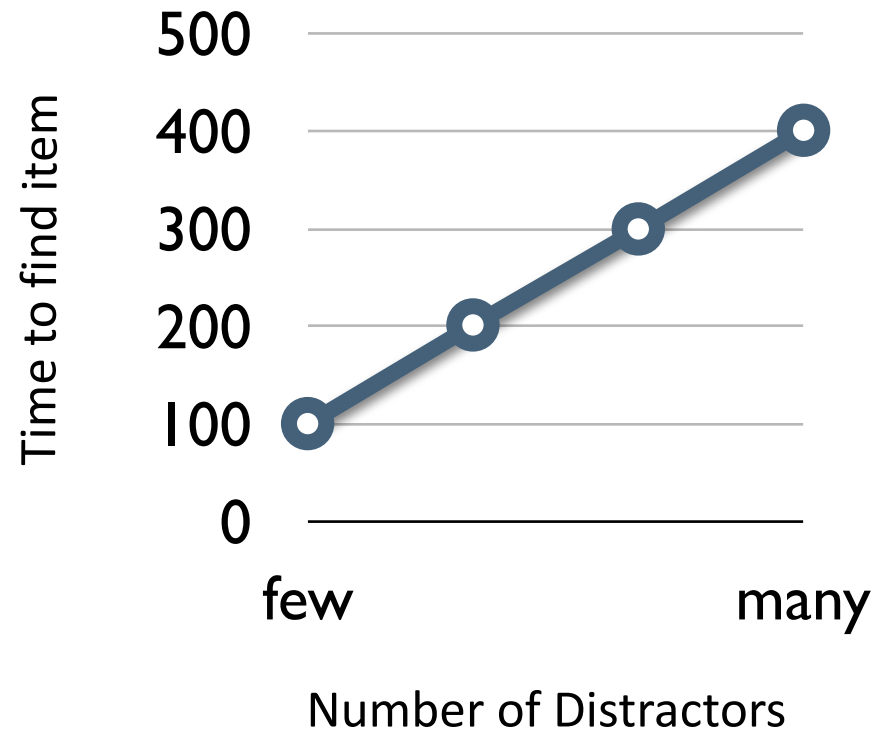


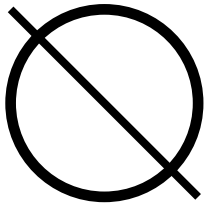
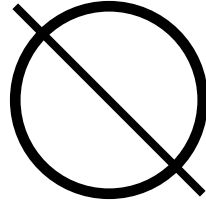
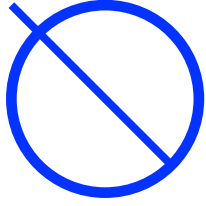
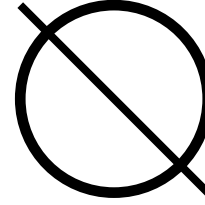
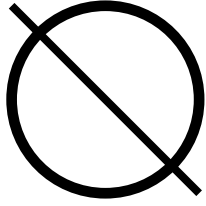


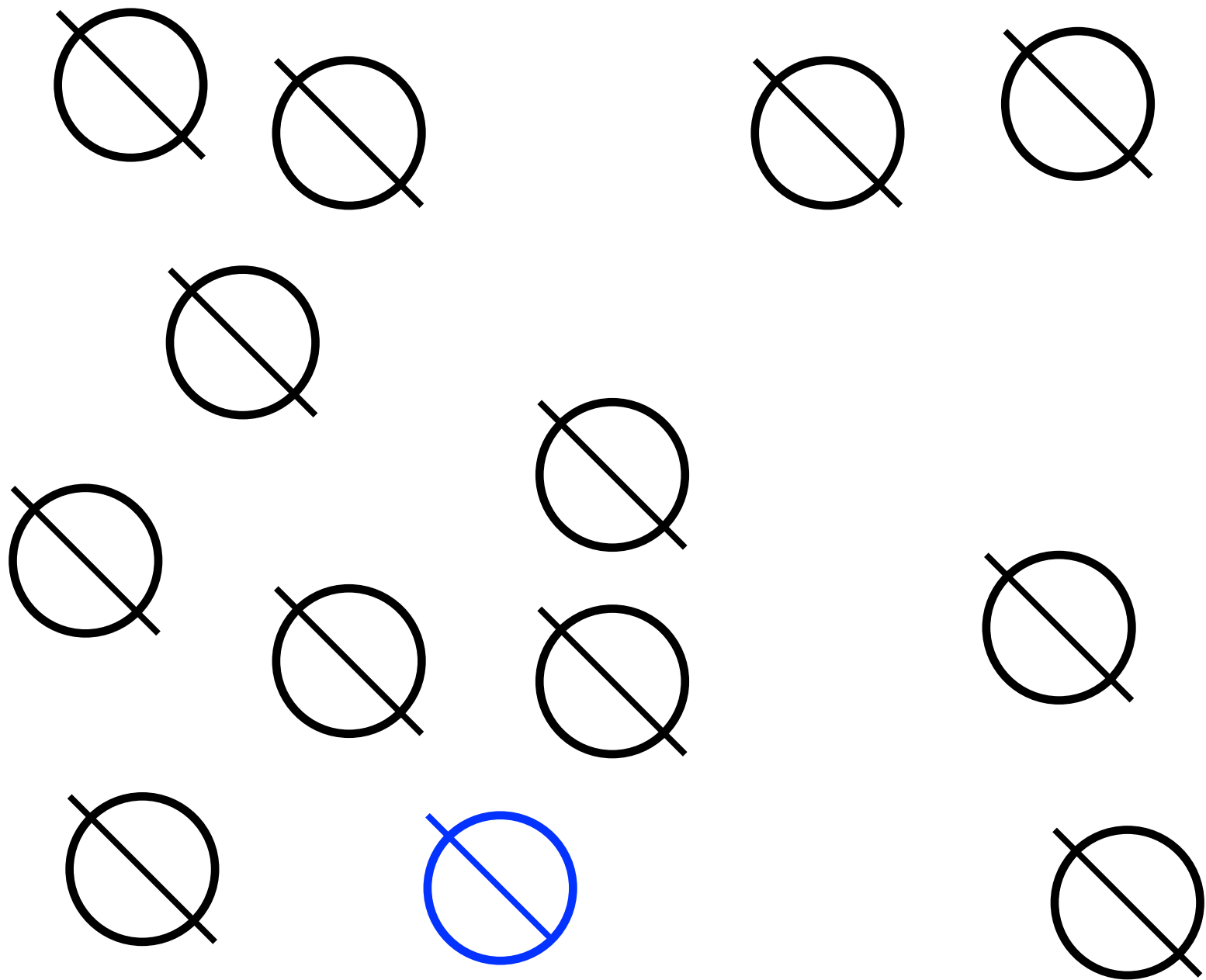


# Set Size effects

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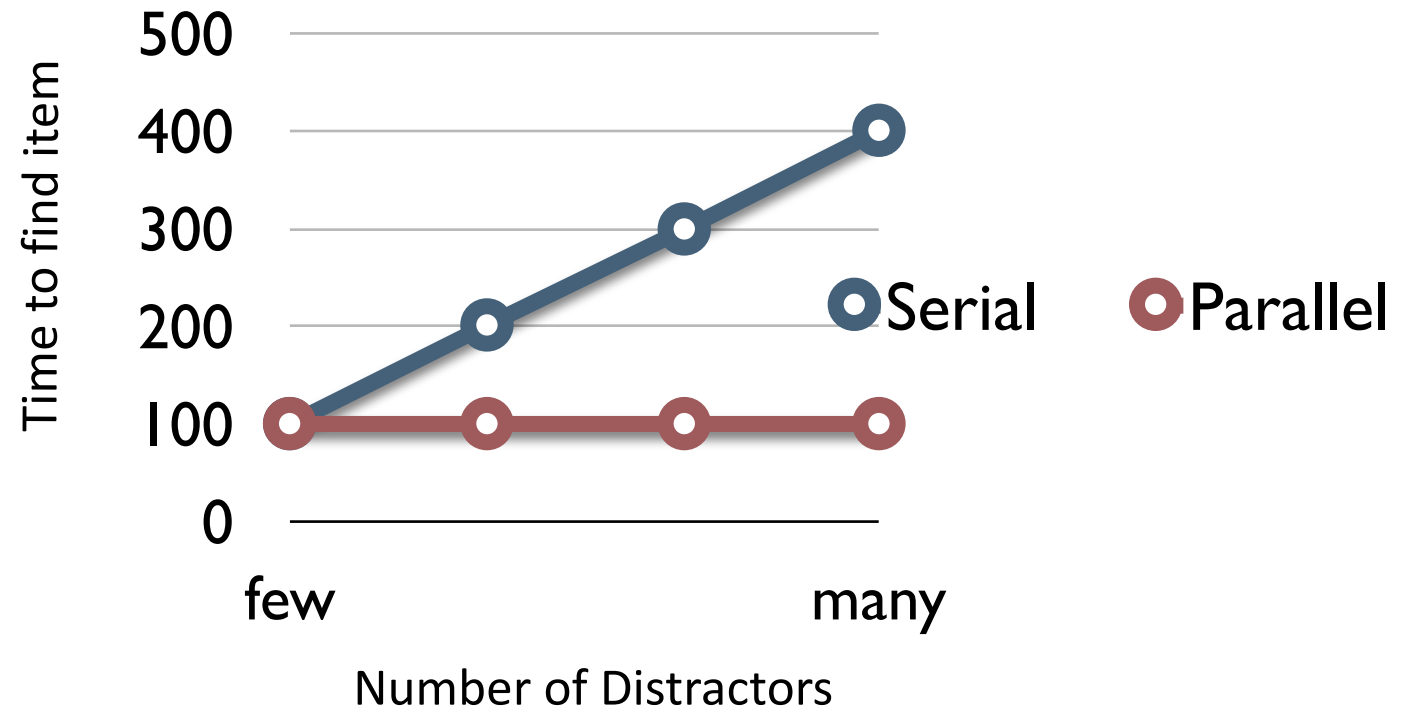






# Pop-out effects

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# E.g., The Stroop effect

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red  
blue  
green  
yellow  
blue  
red  
green  
red  
blue

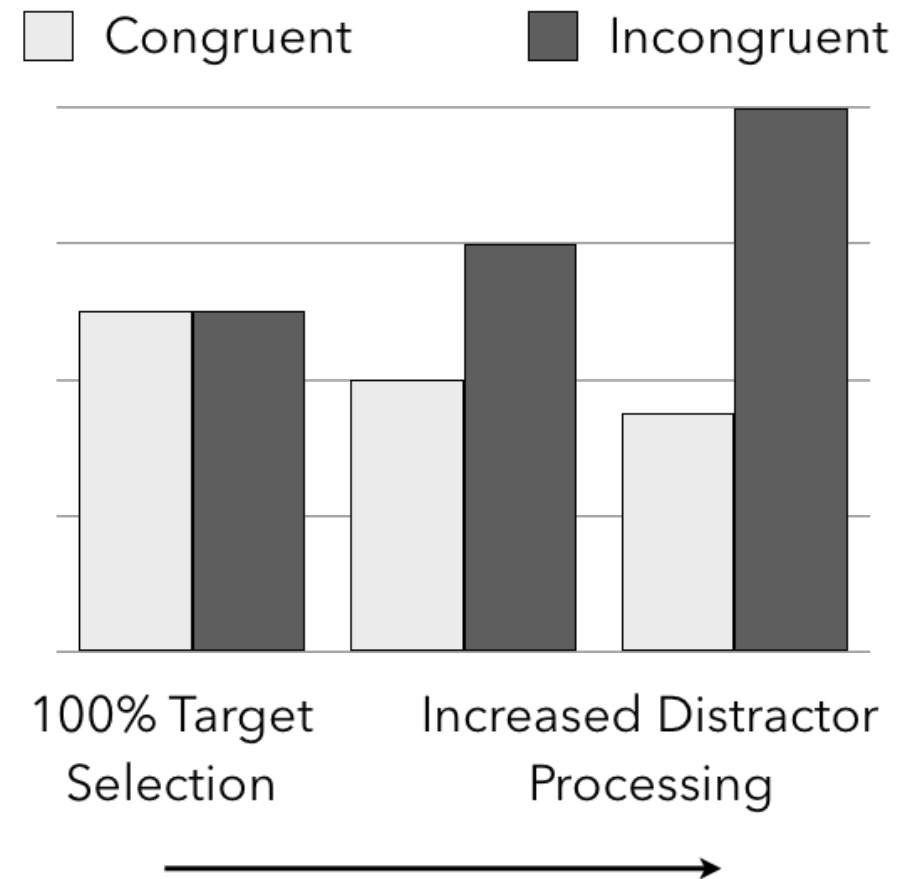
red  
blue  
green  
yellow  
blue  
red  
green  
yellow  
blue

# E.g., The Stroop effect

- Measuring attentional selection

RED  
Congruent

BLUE  
Incongruent



# E.g., The Stroop effect

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- Top-down and bottom-up interact
- Voluntary strategies

75% Congruent  
High PC

Strategy:  
**Increase**  
**Word-**  
**Reading**  
(usually  
helps)

red  
blue  
green  
yellow  
blue  
red  
green  
red  
blue

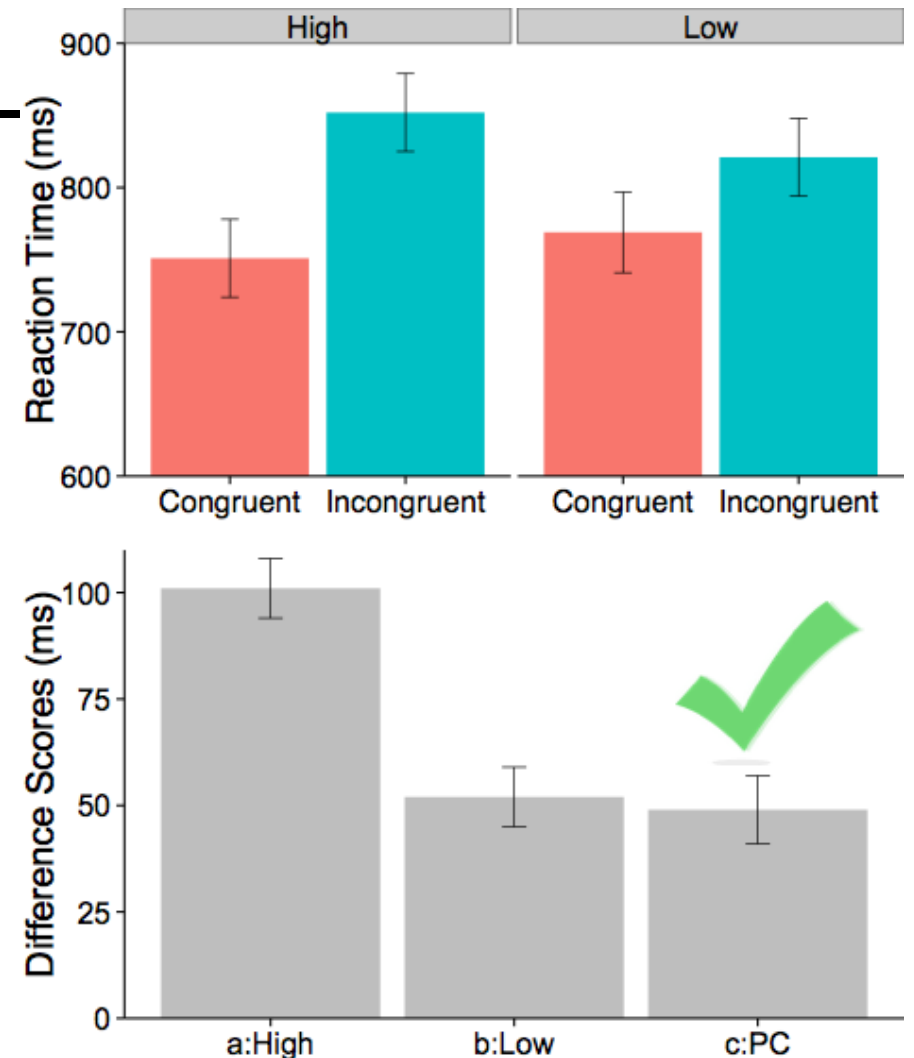
25% Congruent  
Low PC

Strategy:  
**Decrease**  
**Word-**  
**Reading**  
(usually  
hurts)

red  
blue  
green  
red  
yellow  
blue  
blue  
red  
green  
red  
blue

# E.g., The Stroop effect

- Voluntary strategies change how much you ignore the word
- You can become better at ignoring if you expect that upcoming trials will be incongruent



# Controlled versus automatic

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Like perception, how we attend changes with experience, knowledge, and expectations

Even attentional capture by salient stimuli, which seems purely bottom-up can be influenced by our goals, experience, and expectations

# Key questions

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- ~~Which stimuli do we attend to?~~
- At which level of processing do we decide what to attend to?
- What happens to the stimuli that are not attended?



# Models of attention

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- In a party, you have no problem concentrating on your conversation despite all other conversations
- You also have little difficulty switching your focus from one conversation to another



# Models of attention

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- Cherry (1953)
- Dichotic listening paradigm
  - A different message is played to each ear.
  - When voices had the same physical properties, participants could not separate the messages using meaning only.

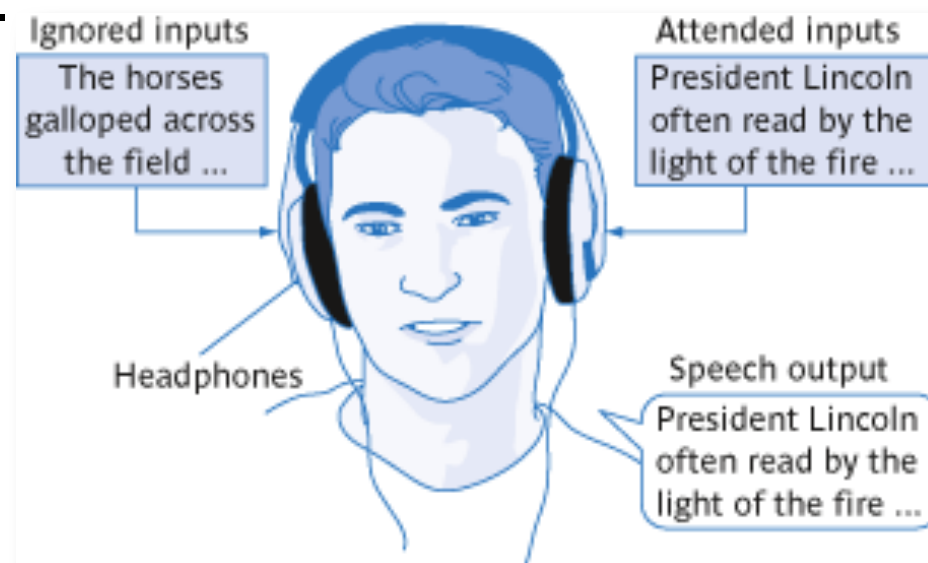


# Models of attention

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## How much is retained from the unattended message?

- Shadowing task
  - A different message is played to each ear.
  - Overtly repeat message played to one ear.

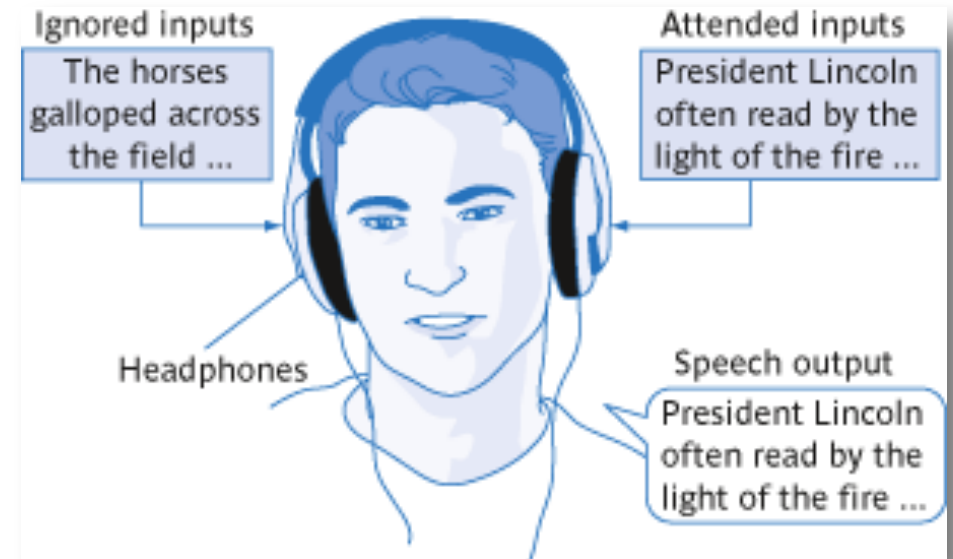


# Models of attention

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## How much is retained from the unattended message?

- Shadowing task
- Overt repetition requires strong focusing of attention on the attended input.
- Consequently, no attention on the ignored input.
- Was anything of the ignored remembered or recognized?



# Models of attention

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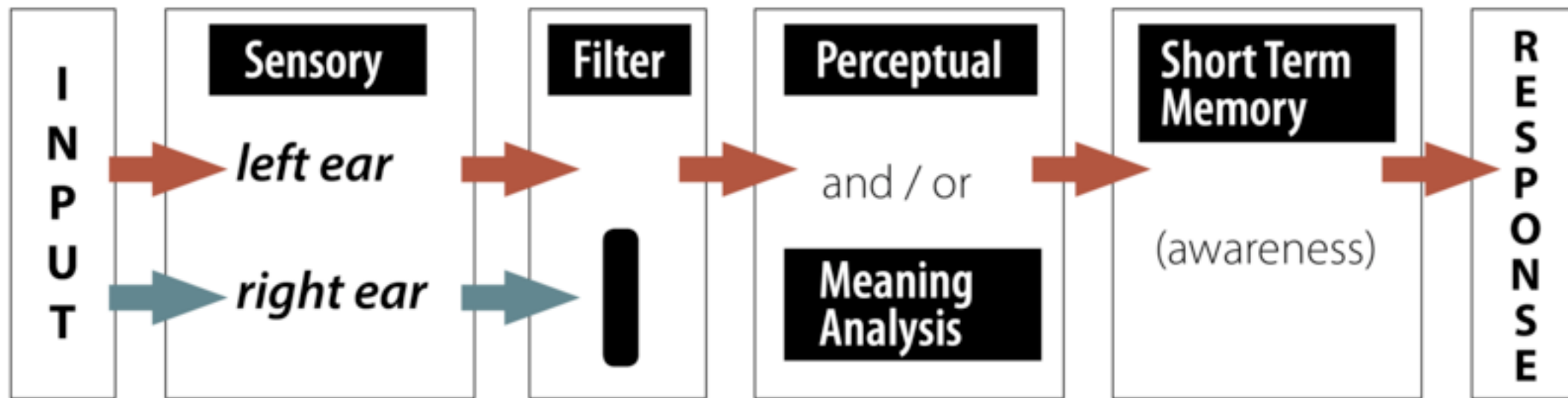
## **How much is retained from the unattended message?**

- Mostly physical properties (e.g. tonality) were noticed
- Virtually no noticing of
  - Meaning of the message
  - Change in language (English to German)
  - Change in gender (male to female)
  - Message in reverse speech
- It seems that unattended messages are filtered very early in the sensory processing, because virtually no “higher-level” information is retained.

# Early selection models

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- Broadbent's filter model
  - Filters before analysis for meaning





# Cocktail Party Effect

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- However...
- How would you hear your name if it was filtered out?
  - Moray (1959)
- Broadbent model is not able to account for this effect

Whatever! Jack is a big loser.



# Attenuator model

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- Treisman, 1964
- Is based on Broadbent's filter model
- Different mechanism for filtering:
  - Not by an all-or-nothing filter (Broadbent)
  - But by a gradual working "attenuator"

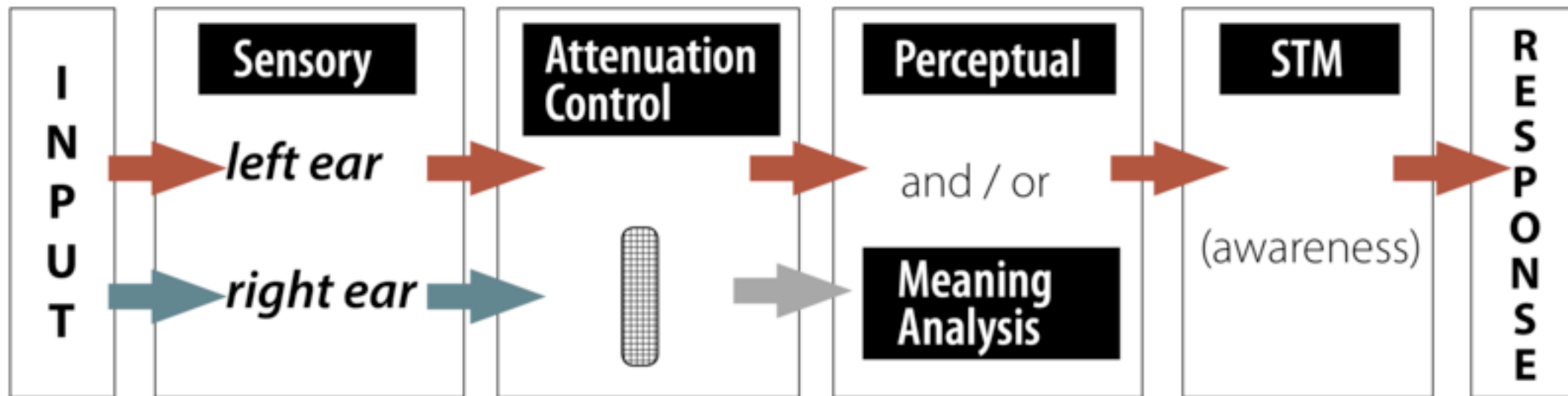


Anne Treisman (with her husband, Daniel Kahneman, Psychologist and 2002 Nobel Prize Winner)



# Attenuator Model

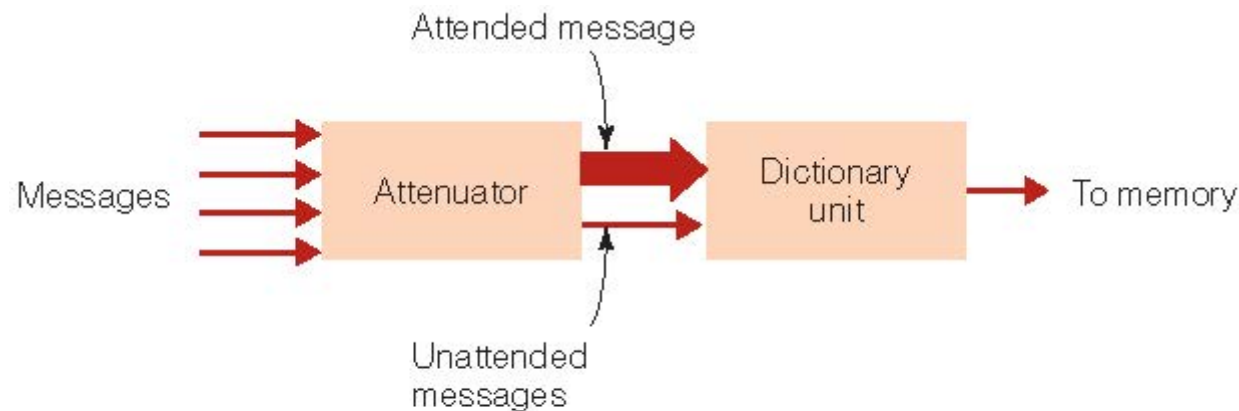
- Information is not blocked completely, but is weakened or attenuated



# Attenuator model

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- Intermediate-selection model
  - Attended message can be separated from unattended message early in the information-processing system
  - Selection can also occur later

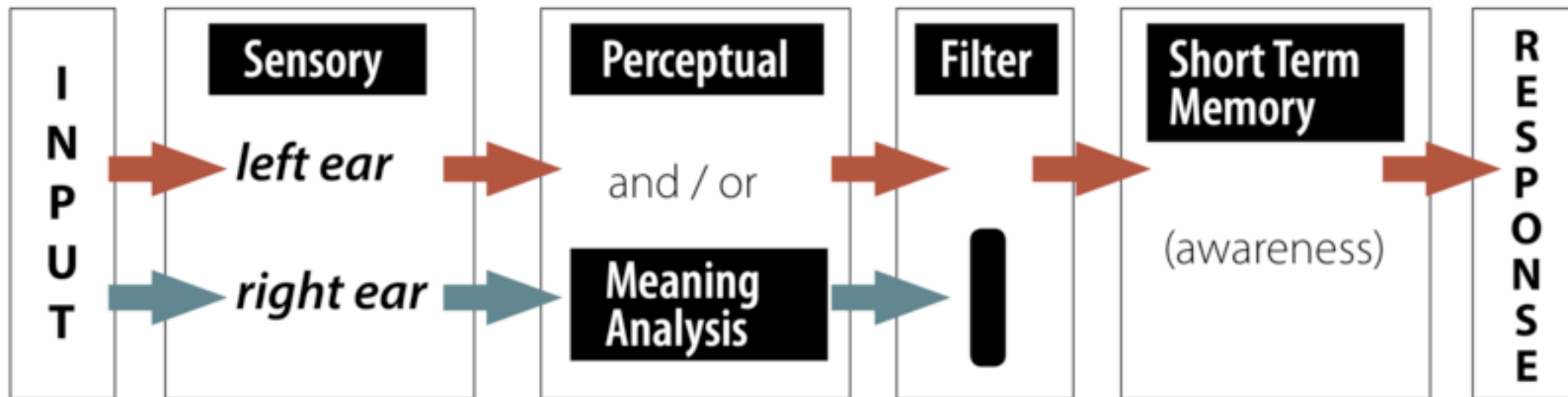


**Figure 4.5** Flow diagram for Treisman's attenuation model of selective attention. © Cengage Learning

# Late-selection models

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- Selection of stimuli for final processing does not occur until after information has been analyzed for meaning



# Late-selection models

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This model suggests that even "ignored" stimuli are processed fully

- McKay (1973)
  - In attending ear, participants heard ambiguous sentences
    - "They were throwing stones at the bank."
  - In unattended ear, participants heard either
    - "river"
    - "money"

# Late-selection models

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- McKay (1973)
  - In test, participants had to choose which was closest to the meaning of attended to message:
    - They threw stones toward the side of the river yesterday
    - They threw stones at the savings and loan association yesterday
  - The meaning of the biasing word affected participants' choice
  - Participants were unaware of the presentation of the biasing words
- Also, some evidence for “subliminal priming”
  - (Dehaene et al., 1998)

# Late-selection models

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- Late-selection models (Deutsch & Deutsch, 1963; Norman 1968)
  - All information is fully analyzed for meaning.
- Then, based on physical properties and meaning, selection by a filter takes place.
- Evaluation
  - Advantage: Since all information is processed, it is unlikely that important information is missed.
  - Disadvantage: Very resource demanding.

# Models of attention

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- Which model is correct?
  - Maybe both?
- Maybe sometimes selection is early, and sometimes late?
  - But what determines whether selection is early or late?

# Perceptual Load

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- Theory of perceptual load (Lavie; 1995, 2000)
  - “load theory”

## **Difficult tasks**

- E.g., find a specific book among other books
- Require a lot of attentional resources
- Selection is early to make resources available

## **Easy tasks**

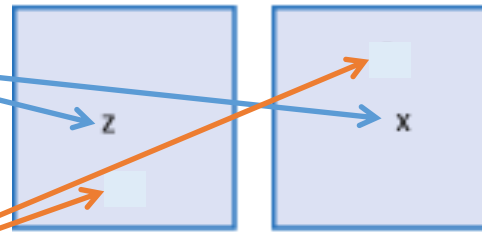
- E.g., find a DVD among books
- Require only little attentional resources
- Selection is late since resources are available



Two choice response task. Target letters:

- “x” – left finger
- “z” – right finger

Low load – set size 1



Distractor letters:

- “X”, “Z”, or any other letter.
- Task irrelevant. Is to be ignored.

Low load:

- Only one potential target letter.
- Easy task.

High load:

- Find target letter among 5 other letters.
- Difficult task.

Two choice response task. Target letters:

- “x” – left finger
- “z” – right finger

Distractor letters:

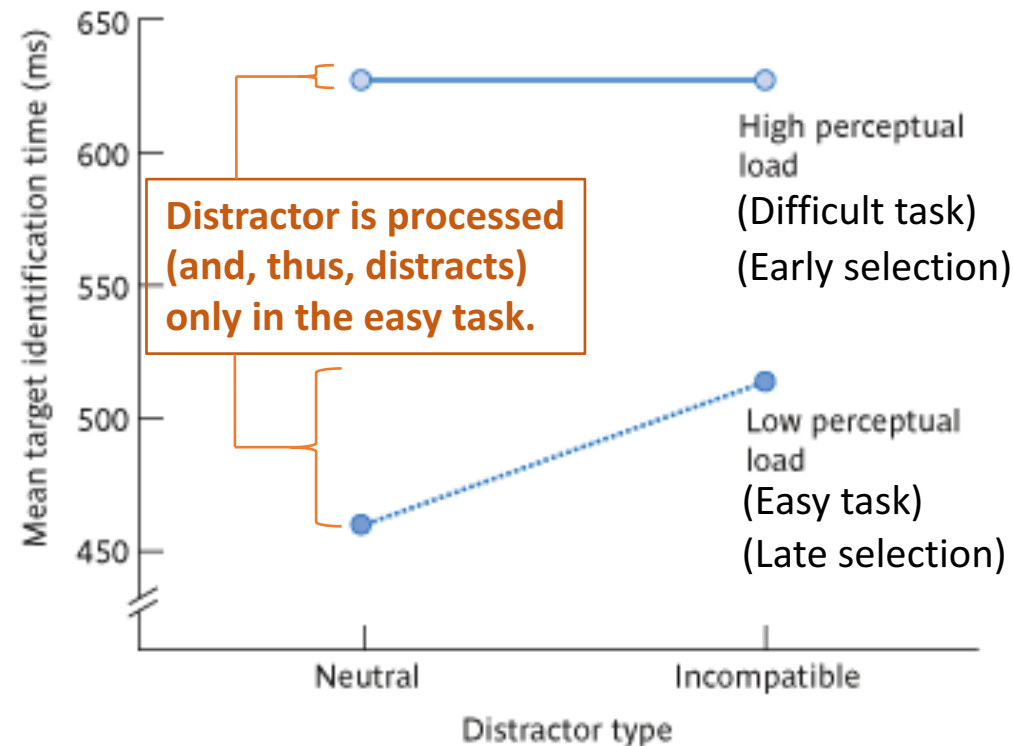
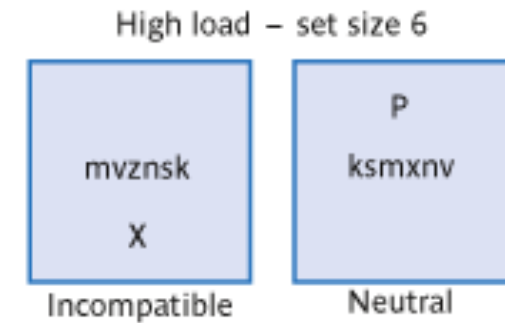
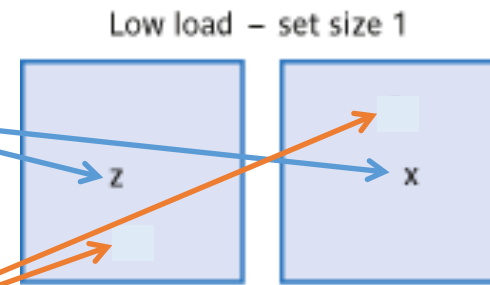
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Low load:

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# Take-home messages

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  - Resource-demanding / we can't attend to everything
- Attention can be voluntarily controlled
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  - External stimuli can also “capture” our attention (bottom-up)

# Take-home messages

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- Early selection model (Broadbent, 1958)
  - Unattended information is filtered out completely early in processing
- Attenuator model (Treisman, 1964)
  - Unattended information is attenuated early in processing
- Late-selection model (Deutsch & Deutsch, 1963)
  - All information is processed, it is filtered out only late in processing
- Theory of perceptual load (Lavie, 1995)
  - Selection is early in difficult task, and late in easy tasks