ATTENTION!
(Specifically Divided and Selective Attention)
Chapter 4

Learning Objective Topics

• Selective Attention
  • Visual Tasks
  • Auditory Tasks
  • Early vs. Late Selection Models
  • Visual Search
• Divided Attention
• Attention Blindness
Controlled attention

• Deliberate, voluntary allocation of attention

• Selective attention: attend to one source, ignore other sources
  • Attention metaphor: filter

• Question we will focus on: What influences our ability to ignore irrelevant stimuli?

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Selective attention: Visual tasks

• Flanker compatibility task

• Attend to center of display, ignore sides (“flankers”)

• Instruction: say if target is present or not

  • [http://cognitivefun.net/test/6](http://cognitivefun.net/test/6)

• Press one key if A or B is in the center
• Press Another if C or D is in the center

<table>
<thead>
<tr>
<th>STIMULUS</th>
<th>FLANKERS</th>
<th>TYPICAL RESULT</th>
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<tbody>
<tr>
<td>(a) B A B</td>
<td>Compatible</td>
<td>Fastest response to target</td>
</tr>
<tr>
<td>(b) C A C</td>
<td>Incompatible</td>
<td>Slowest response to target</td>
</tr>
<tr>
<td>(c) X A X</td>
<td>Neutral</td>
<td>Intermediate response to target</td>
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(c)2011 Cognitive Learning
Participants are influenced by flankers even if told to ignore them

But only up to a certain point

Press one key when the target is N, one key when the target is X
Flanker

• Incompatible – slows response for low load
• No effect on high load
• Why does this happen?

Video-Game Experts

• Tested using flanker compatibility task
• Low load: experts’ performance is similar to non-experts
• High load: experts still had enough resources left to process distractors
  • They had slower reaction times in the incompatible condition even under the high load condition
• What does this suggest about playing video games?
Selective attention: Visual tasks

• Stroop task
  • Dual-component stimuli (color and word)
  • Instruction: say color of ink
  • Why was the classic Stroop often harder than your Stroops?
• From the Flanker and Stroop tasks:
  • What influences our ability to ignore task irrelevant stimuli?
• Real life examples: When does an automatic task interfere with intended processing?

Selective attention: Visual tasks

• Simon effect
  • Right button – red light
  • Left button – green light
  • Ignore location
  • Hypothesis? Will you be faster if button appears on left or right?
Simon Applications

- Design of Aircraft cockpits
- Industrial/Organizational Psychology

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Selective attention: Auditory tasks

• Dichotic listening
  • 2 auditory messages: 1 in each ear
  • Task: to attend to 1 ear

• Shadowing task
  • Dichotic listening
  • Task: repeat content of 1 ear

Let’s try it!

• Volunteer to be the listener
  • Shadow what you hear in the right ear
• Two readers
Cocktail Party Effect

- Processing of sound in noisy environments
  - Auditory regions of the brainstem – inferior colliculus
  - Inputs from cortex - amplify relevant information in the sound signal while inhibiting irrelevant information
- Evidence from bats and birds


What do you know about the disorder (formerly known as?) dyslexia?
Cocktail Party Effect & Dyslexia

Chandrasekaran et al., 2009:
• Measure brainstem activity
• Non-Dyslexic Children: Watched video while the syllable “da” was played
  • Syllable was either in a repetitive or unpredictable pattern
  • Repetitive syllable: more brainstem activity
  • Filter out repeated syllable and attended to video
• Dyslexic children
  • No increased brainstem for repetitive
  • Have trouble filtering out background cues
  • Trouble focusing in class
• Music training may help!

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Early selection findings

• Cherry (1953) dichotic listening findings
  • Don’t notice language or content of 2nd message
  • Do notice gender of 2nd message

Early selection findings

Broadbent (1958)

• “Split scan” method: Hear 3 pairs of digits simultaneously in right/left ear
  • After all three pairs are spoken:
    • Recall items in any order or in pairs
Early selection findings

Broadbent (1958)

- Results A: Report any order
  - Participants chose to recall digits from one ear then other – 65% accurate
- Results B: Report in pairs
  - Forced to switch – 20% accurate

Broadbent’s Filter Model of Attention

- Bottleneck model: restricts info available
  - Which part would be the bottle neck part?
- Filter selects info based on physical characteristics
- Early selection theory
How does this relate to the early selection theory?

Broadbent (1958)

• Messages are first selected based on physical characteristics (filter)

Evidence against Broadbent’s model

• Moray (1959)
• Method:
  • Shadow 1 ear
  • Name said in unattended message

• Results/Conclusion:
  • 1/3 hear name = “Cocktail party effect”
  • Name not filtered so analysis of unattended message goes beyond physical characteristics
Dear Aunt Jane Experiment (Gray & Weddeburn, 1960)

Method:
Shadow 1 ear: “dear 7 Jane” vs. “9 Aunt 6”

Results:
Ss report hearing in shadowed ear “dear Aunt Jane”

Why is the problematic for Broadbent’s theory?

Treisman (1960)

- Complete message switches to “unattended” ear
- Treisman (1960) results:
  - Attention can switch with message meaning
  - Unattended message “reduced"
Broadbent’s Model Could Not Explain

- Participant’s name gets through
  - Cocktail party phenomenon
- Participants can shadow meaningful messages that switch from one ear to another
  - Dear Aunt Jane (Gray & Weddeburn, 1960)
- Effects of practice on detecting information in unattended ear
  - You can be trained to detect in unattended ear based on the meaning of the message

Treisman’s Attenuation Theory

- Analysis beyond sensory information
- If important, boosted above threshold
- If unimportant, value is weakened ("attenuated")
Treisman's attenuation theory

- 2-stage process:
  - Attenuator: Analyzes physical characteristics and meaning
  - Dictionary unit: Decide if reached threshold for output
  - Early selection theory (b/c filter early in processing)

Norman’s Pertinence Model

- Selection based on
  - Sensory information AND
  - Pertinence
  - Highest combination gets attention
  - Continuous process
  - Late selection theory
MacKay (1973)

- Method
  - Ambiguous sentence in attended ear – one word at a time
    - “They were throwing rocks at the bank.”
  - Unattended ear – word related to one meaning (bias word)
- Result
  - Bias word influences sentence meaning
- Conclusion
  - Unconscious processing of unattended information
  - Support for late selection

Early vs. Late selection

- How much is processed before selected?

- Early: filter at physical (sensory) analysis (fig a)
- Late: filter at/after semantic analysis (fig b)
Effect of Load on Selective Attention

- High-load experiments support early selection
  - Example: Treisman’s half of messages in each ear
- Low-load experiments support late selection
  - Example: MacKay’s bank/bank study
  - Why is this low load??

High or low load task?
Early or late selection? Why?

1. A dichotic listening task in which different passages are presented to each ear and participants shadow the passage presented to the right ear.
2. A dichotic listening task in which a passage is presented to the right ear and a single word is presented intermittently to the left ear. Participants shadow the message presented to the right ear.
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Stimulus for Neisser’s (1964) visual search experiment

Where is the letter Z?

Which takes longer? Why?
Feature Search
• Allows participants to respond quickly regardless of number of distractors
• Pop-out effect
• Aka Parallel Search
Conjunctive Search

- Participants must study each item individually until the target is identified.
- Hypothesis: Search time should increase with the number of distractors
- AKA serial search

What search method is used to identify the blue-yellow-red molecule in the pictures below?

TRENDS in Cognitive Sciences
Feature Perception

- How do we perceive features as part of the same object?
- Red, Ball, Rolling

Anne Treisman’s Feature Integration Theory

- How are Treisman’s two stages shown in the visual search findings?

Selective attention

• When does selective attention occur?
• Is it different for:
  • Auditory vs. visual selective attention
  • Type of task
  • Memory load
  • Automatic or Controlled Processes

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Divided attention

• TRY to split attentional resources between 2 sources
  • Dual-task methodology
• Real-world examples
  • Musicians
  • DRIVING
• How are you capable of doing more than 1 thing at the same time?
  • 1 or more of the tasks requires fewer resources
  • Automatic processing: require little or no conscious attention
• How does automaticity develop?

Divided attention:
Tyler et al (1979)

• Question:
  • Can attention be split?
• Method:
  • 1) Anagram task (easy or hard)
  • 2) RT to tone
• Results:

• Conclusions:
  • Difficult tasks uses more resources leaving less for 2nd task, causing decrease in performance
  • Competition for limited attentional resources
Divided attention

• What are the research questions?

• What makes divided attention possible? What are the factors involved?
• How does practice affect divided attention? How does automaticity develop (for easy and hard tasks)?
• What is the application of divided attention research to real-world topics, such as driving?

Divided Attention

• How did it feel when you were learning to drive? Move from "controlled" to "automatic"?

• Schneider & Shiffrin (1977): How does processing become automatic?
Automatic Processing

- Tell me how to put on this sweater

Schneider & Shiffrin (1977)

- Question:
  - How does processing become automatic?
- Task:
  - Dual task: hold info in memory; search for target among distractors
  - Stimuli: #'s or letters
  - Measure: RT and accuracy
You will see grids of letters which may or may not have the target in them. Your task is to say if the following target is in the grids:

3

A  F

M  G
Schneider & Shiffrin (1977)

- Was it there?
- What is the attention divided between here?
- Conditions
  - Memory set size (1-4) (target stimuli)
  - Frame set size
  - Presentation time (40 to 800ms)
  - Congruency of memory set and distractors
    - Consistent-mapping vs. Varied-mapping

Shiffrin & Schneider (1977)

- Consistent mapping
  - Memory set: 7 4 9 2
  - Distractor set: K G R T
- Varied mapping
  - Memory set: M J D T
  - Distractor set: C G F M
  - Memory set (trial2): G M Y V

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Memory set size = 4
Frame size = 2
Frame time: 100ms
Shiffrin & Schneider (1977)

Consistent mapping

Set size = 1
Frame size = 4
Frame time = 100ms

Target = 8

Target = 3

Note: previous distractor becomes target

Schneider & Shiffrin (1977)

- Improvement in performance with practice in Schneider and Shiffrin's consistent mapping condition. The arrow indicates the point at which participants reported that the task had become automatic.
Shiffrin & Schneider

• Results
  • Consistent mapping:
    • Only frame duration affects accuracy
    • Automatic processing
    • Parallel search
  • Varied mapping:
    • All conditions affected accuracy
    • Controlled processing
    • Serial search

Developing automaticity
Spelke, Hirst, & Neisser (1976); Hirst, et al. (1980)

• Dual-task
  • Read stories silently
  • Copy irrelevant words being dictated

• Results
  • Week 1: handwriting illegible, reading slow
  • Week 6: better reading comprehension, poor recall of dictated words
  • Week 17: Can copy complete sentences while reading, with understanding of both

• Conclusion
  • Practice can automatize particular task or how tasks function simultaneously
  • But, alters ability only for those particular tasks!
Automatization

• How do processes become automatic?
  • More efficient through practice
• Effortful steps → integrated into single operation
  • Example: math
• Logan (1988)
  • Automatization = memory retrieval
• Is automatization always good?
  • What are some automatic errors?
  • What situations could it be harmful?

Driving and Attention

• What aspects of driving still remain “controlled” and why?
• What tasks or activities interfere more with driving ability and when?
Disadvantages of automaticity
Barshi & Healy (1993): proofreading

Task: Scan pages of multiplication problems w/ same mistakes repeated; find errors

Fixed order: problems in same order on each page -encouraged automatic processing

Varied order: problems in different order on each page

- Hard to undo automatic behaviors
- Real world examples?

Strayer & Johnston (2001)
Cell phones and driving

(a) Fraction of red lights missed
(b) Rt. time (msec)

Results: When the person was talking on the cell phone, they (a) missed more red lights, and (b) took longer to apply the brakes.
Horswill & McKenna (1999)

- Question:
  - Do attentional capacity limits negatively affect driving while talking on a cell phone?
- Method:
  - Simulated driving
  - Monitor auditory list for letter "K"
- Results:
  - Dual-task (vs. single task): worse driving performance and worse on monitoring task
- Conclusion:
  - Participants took more risks driving in dual-task condition
  - Tasks compete for same pool of attentional resources

Driving and Attention

- How do the cell phone studies in the text relate to your own driving behaviors?
- What experiences do you have with driving that might provide insights about attentional processes?
Spence & Read (2003)

- Questions:
  - Can we divide attention between eye and ear?
  - Does it depend on if sources are from same spatial location?

- Method:
  - 1) driving simulator (complex suburban rd)
  - 2) dichotic listening; repeat 1 stream after each triplet
  - IV: location of auditory stream (front or side)
  - DV: driving performance (speed, lane position)
  - DV: Accuracy of shadowing

- Results:
  - Shadow alone: 77%; w/ driving: 56%
  - Better shadowing if stream was in front rather than side while driving
  - No significant decrement in driving performance

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Instructions

- You will see 2 teams of players – one wearing white t-shirts and one wearing black t-shirts. Try to count the total number of times the team wearing white passes the ball.

- [http://www.youtube.com/watch?v=Ahg6qcg0ay4](http://www.youtube.com/watch?v=Ahg6qcg0ay4)

Simons & Chabris (1999)

- **Question**
  - Does perception depend on attention?

- **Method**
  - 75s film with surprising event
  - Ss asked if noticed anything unusual

- **Results**
  - 46% fail to report event
  - Selectively attending to white not to black objects

- **Conclusion**
  - “Inattentional blindness”
  - Conscious perception depends on attention
Simons & Chabris (1999)
“Gorillas in our midst: Sustained inattentional blindness for dynamic events”

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<tr>
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<th>Easy Task</th>
<th>Hard Task</th>
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<tbody>
<tr>
<td>White</td>
<td>58%</td>
<td>33%</td>
</tr>
<tr>
<td>Black</td>
<td>92%</td>
<td>42%</td>
</tr>
</tbody>
</table>

- Results: % notice unexpected event
- Easy: count passes
- Hard: count air vs bounce passes
- Color: team attended to

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<th>Easy Task</th>
<th>Hard Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>100%</td>
<td>83%</td>
</tr>
<tr>
<td>Black</td>
<td>58%</td>
<td>58%</td>
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<tr>
<td>Opaque</td>
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Change Blindness

- [http://www.youtube.com/watch?v=Qb-gT6vDrmU](http://www.youtube.com/watch?v=Qb-gT6vDrmU)
Simons & Levin (1998)

- Method Exp 1:
  - 15 pedestrians (20-65yrs) were approached by a person asking directions. After 15s, a door passed between them, and a new person is there afterwards. The entire interaction takes approx 2 – 5min. Two people wore different clothes, and had different voices.
- Method Exp 2:
  - Expmr’s dressed as construction workers
  - Ss all young

- Results:
  - Only 7 of 15 noticed change – 47%!
  - Ss that noticed were same age as expmtrs (20-30yrs)
  - Only 4 of 12 noticed change – 33%
- Conclusion: Inattentional blindness

Simons & Levin (1998)

- Comments regarding methodology...
- External validity: not a real world event
  - Assumption of unchanging visual world
  - Ss are not searching for a change
- Cause of effect:
  - Attention focused on task
  - Similarity of information
- Conclusions
  - We do not have a detailed visual representation of the world
Change Blindness and Inattentional Blindness

- Attention: necessary but not sufficient to detect change
  - We don’t store details & we need to attend to objects
- Are we just not efficient and accurate processors of (visual) information?
  - If you tracked every detail, your system would be overwhelmed
  - Instead visual system gets gist and you ignore the details
- What future studies could be conducted?
- What are the applications of this research?

Links

- D. Simons webpage
  - http://viscog.beckman.uiuc.edu/djs_lab/
- D. Levin webpage
- Demos
Johnston and Heinz (1978)

- Attention is flexible.
  - Selective attention can operate in multiple modes (early, middle, late).
  - But, later selection uses more of our limited attentional capacity.
- Trade-off:
  - Stage of processing VS. capacity
  - Time and accuracy
- Experiments
  - Dual-task: 1+ messages plus light detection
  - Messages differ physically or in meaning, or both
Flicker task

- This task tests how well you can detect changes when you are trying your best to find them. A photo of a scene will appear briefly and then it will be replaced by a blank screen. After a fraction of a second a changed version of the scene will appear. The original and changed images will alternate for about 10s. Try to find the change.
CogLab: Change detection
Flicker task

- 2009 Data summary:
  - N = 8
  - Averages across participants
  - Flicker
    - Acc = 61.25%
    - RT = 10,086ms
  - No Flicker
    - Acc = 92.50%
    - RT = 6,109ms
**Rensink (2002)**

- **Question**
  - Is attention necessary to detect a change?
- **Method**
  - Flicker Task
  - IV: time of blank field between original and modified image
  - IV: location of change in picture
- **Results**
  - Took time before change was detected
  - Impossible to attend to all aspects of a scene at 1 time
  - Center change detected faster than peripheral change
  - Requires fixation on 1-4 pieces at a time
- **Conclusions**
  - Change blindness: Failure to automatically notice change
  - Requires focused attention (objects or locations)


- Flicker task *variations*:
  - Exp1: extended preview of Pic1 before flicker
  - Exp2: IV blank field duration
  - Exp3: IV blank field colors (black, white, red)
  - Exp4: “splats” that do not cover change rather than full blank field
FIG. 2. Effect of extended preview (Experiment 1). Error bars indicate one standard error. Dashed lines indicate results under standard conditions; horizontal gray bars indicate their standard error. (These values taken from Rensink et al., 1997.) As is evident, no significant differences were found between the preview and standard conditions.

FIG. 3. Effect of blank field duration (Experiment 2). Error bars indicate one standard error; dotted line indicates baseline performance when no interruption is present (taken from Rensink et al., 1997). Dashed lines indicate results under standard conditions; horizontal gray bars their standard error. (a) 40 msec blank. For all types of change, a similar pattern was found. Changes were easier than in the standard condition, although not as easy as when no blanks were present. (b) 80 msec blank. This is the standard condition; data from Rensink et al. (1997). (c) 160 msec blank. When analysed in terms of number of alternations required to see the change, no significant differences were found between this and the standard condition. (d) 320 msec blank. Although not large in magnitude, decline was significant.
FIG. 5. Effect of blank field hue (Experiment 3c). Error bars indicate one standard error. Dashed lines indicate results under standard conditions; horizontal gray bars their standard error. Response patterns remained largely unaffected by field hue. However, a significant slowdown occurred for color changes in marginal interests.

FIG. 6. Effect of splats (Experiment 4). Error bars indicate one standard error; dotted line indicates baseline performance when no interruption is present (taken from Remwich et al., 1997). Responses for all types of change were not significantly different from each other. However, all responses were significantly slower than for the no-interruption conditions, and the amount of this slowdown was roughly constant under these conditions.
Rensink, O’Regan & Clark (2000)

- Change blindness with flicker paradigm findings:
  - CB occurs when attention is diverted
  - Central meaning to picture or distinct object is found faster
  - Attention is necessary to detect change
  - Attention is not SUFFICIENT to detect change
  - Need to compare 2 pictures simultaneously
  - Conclusion: Visual representations are incomplete

Levin & Simon (1997)

- Method:
  - Ss watch video with various types of changes
- Results:
  - 1 out of 10 noticed any changes
  - After told to watch for changes noticed only 25%
- Conclusions:
  - Change blindness
  - Importance of attention for perception
  - "Change blindness blindness": Lack of awareness for ability to notice changes
Simons (2000)
Current approaches to Change Blindness
5 Causes of Change Blindness