Attention

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1. Introduction
   A. The bottleneck in information processing

Numerous Sensory Inputs

attended

2. I. Introduction (cont)
   B. Demonstration

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

A. Early selection:

Input #1: Perceptual Pattern Control Processes
Input #2: Filter Recognition e.g., memory response organization etc.

B. Late Selection

Input #1: Pattern Output Control Processes
Input #2: Recognition Filter e.g., memory response organization etc.

III. Broadbent’s Filter Model

A. Properties:

1) Early selection
2) Selection (filtering) is based on physical properties of the stimulus (e.g., pitch, loudness, etc...).
3) Attention is directed to information that passes the filter or to physically salient information that leads to a shift in attention.
4) Only one input channel can be processed at a time.
5) It takes time to shift attention.
III. Broadbent’s Model

B. Physical Analogy

Input #1  Input #2

Sensory processes (wide)

Limited capacity perceptual channel (narrow)

Hinged flap (filter)

output in condition 1: 1, 2, 3, 4, 5, 6
output in condition 2: 1, 3, 5, 2, 4, 6

III. Broadbent (cont)

C. Supporting Evidence:

Broadbent (1954): split span experiment

Stimulus presentation

<table>
<thead>
<tr>
<th>ear #1</th>
<th>ear #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

Responses

condition 1: recall by ear: “743-826”
condition 2: recall in order: “78, 42, 36”

III. Broadbent (cont)

C. Split Span Experiment (cont):

Results:

Condition 1: 65% correct
Condition 2: 20% correct
Further tests of Broadbent’s model

1) Moray’s (1959) & Cherry’s (1953) shadowing experiments
   a) Demonstration of the “cocktail party” phenomenon
   b) Information not retained from unshadowed ear
      any of the words spoken
      any numbers spoken
   c) Information retained from the unshadowed ear
      male vs. female voice
      speech vs. noise
   But, participant’s name was detected by 33% of participants

2. cocktail party and working memory (WM) capacity
   Low WM: 65%  High WM: 20%
   Thus, attention is related to capacity.
   Low WM capacity associated with ADHD,
   providing a model for why ADHD have trouble
   staying on task.

3. Counting Voices at a “cocktail party.” (Kawashima)
   Proportion of correct responses as a function of sample length
   (seconds). Error bars show 95% CI.
3. Voice familiarity and the cocktail party
Johnsrude et al. (2013)

Fig. 2. Percentage of correct responses as a function of target-to-masker ratio and condition.

Summary evaluation of Broadbent’s Model

What he got right
1. We are limited in the number of things we can attend to.
2. Salient physical features can direct attention

What he got wrong
1. Meaningful content can direct attention
2. Attention is related to memory capacity
3. Familiarity influences stimulus selection

IV. Treisman’s Attenuation Model

A. Properties:
1) Early selection
2) Selection (attenuation) is based on physical properties of the stimulus (e.g., pitch, loudness, etc...).
3) Attention is directed toward information that reaches a threshold of recognition.
4) Several inputs can be processed at a time.
IV. Treisman’s Attenuation Model

B. Diagram of the model:

Thresholds of Recognition

<table>
<thead>
<tr>
<th>High Frequency Words</th>
<th>Low Frequency Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>(low thresholds)</td>
<td>(high thresholds)</td>
</tr>
<tr>
<td>e_fo_t</td>
<td>d_r_ss</td>
</tr>
<tr>
<td>s_ro_g</td>
<td>s_e_e</td>
</tr>
<tr>
<td>h_r_e</td>
<td>h_r_e</td>
</tr>
</tbody>
</table>

IV. Treisman’s Model (cont)

Supporting Evidence (Treisman, 1960)

Ear #1 The body was buried on Moll Leg Island beside the ahead listen arm somebody North Carolina.

Ear #2 We point veiled their many wife he tussles last other grave and a cross put at its head.

female/male
V. Deutsch-Norman Model
(Deutsch & Deutsch, 1963; Norman, 1968)

A. Properties:
1) Late selection: i.e., all stimuli are processed to stimulus recognition.
2) Selection (pertinence) is based on the importance of the recognized item.
3) Memory processes (e.g., rehearsal) are devoted to selected inputs.

V. Norman’s Model

B. Diagram of the model:

C. Real life nature of the issue:
F A 18 Hornet
An F/A-18C taking off from USS Kitty Hawk
2.7.1.6 Landing Gear Warning Light and Warning Tone  The landing gear warning light is a red light located behind the LGD GEAR handle. The landing gear warning light and warning tone function between LGD GEAR handle position and actual gear position, to warn of a glazing link failure, and to provide a "whistle warning." 

A steady warning light comes on whenever the landing gear in in transit and remains on until all three gear are down and locked (LGD GEAR handle UP) or all gear are closed and locked (LGD GEAR handle UP); if the landing gear is retracted, the landing gear warning light remains on. The warning tone is activated for 10 seconds to allow for normal landing gear extension and retraction. If the warning light remains on for 10 seconds, the warning tone is annunciated to provide an aural indication of stuck landing gear position.

If a left or right glazing link failure occurs with the landing gear down and locked (glazing link previously stuck out properly retracted), the landing gear warning light will come on immediately accompanied by the warning tone.

Lastly, when the LGD GEAR handle is UP, a flashing warning light accompanied by the warning tone will be activated when approached to below 250 KIAS, altitude is less than 2,000 ft, and rate of descent is greater than 500 fpm. This "whistle warning" is provided as a reversion to the position of the
VI. Resolution

A. Treisman & Geffen (1967)

Task 1: shadow message in one ear.
Task 2: subjects asked to tap pencil when they heard the target word “green.”

Results:
tapping to “green” in shadowed ear: 87%
tapping to “green” in the other ear: 8%

VIII. Resource Allocation

Capacity Theories of Attention

A. Dual task performance:
simple multiplication
tapping

VII. Resource Allocation

Models:

### c. Automatic vs. controlled processes.

*(Shiffrin & Schneider, 1977)*

<table>
<thead>
<tr>
<th>Automatic Processes</th>
<th>Controlled Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not require attentional resources</td>
<td>Require resources</td>
</tr>
<tr>
<td>Occur without intention</td>
<td>Require conscious intention</td>
</tr>
<tr>
<td>Not available for conscious inspection</td>
<td>Conscious activities</td>
</tr>
<tr>
<td>Well practiced responses</td>
<td>Not well practiced</td>
</tr>
<tr>
<td>Fast</td>
<td>Slow</td>
</tr>
</tbody>
</table>

**Examples:**
- Freeway driving
- Recognition of frequent words
- Driving in an unfamiliar city
- Recognition of rare words

### Example of automatic processing

**Stroop (1935) effect**

- Blue
- Yellow
- Green
- Red

### Stroop Continued

- Blue
- Red
- Green
- Yellow
- Blue
- Green
D. Resource Allocation: Inattentional Blindness

Demonstration: [http://www.youtube.com/watch?v=vJG698U2Mvo](http://www.youtube.com/watch?v=vJG698U2Mvo)  
[https://www.youtube.com/watch?v=1D07neiB7HI](https://www.youtube.com/watch?v=1D07neiB7HI)

Simons and Chabris (1999):
- Detection of Unexpected Event
  - Easy 64% (counting passes by one team)
  - Hard 45% (counting passes by both teams)

Inattentional blindness related to resource allocation.

D. Resource Allocation: Cell Phones

Cell phone use may be a controlled process, requiring attention, leading to a reduction in resources to devote to driving.

Many states are passing laws limiting cell phone use while driving.

Simple RT while talking

An example of slowed reaction time in a divided attention task:

Field Studies (e.g., Redelmeier & Tibshirani (1997)
- cell phone use associated with a 4-fold increase in accidents
- no reduction in accidents for those who used hands-free phones.

Strayer & Johnston (2001) Simulated driving study
Dual Tasks:
1) Simulated driving:
   a) use a joystick and a computer to keep the cursor aligned with a moving target.
   b) press a "stop" button when the cursor turned red.
2) Distraction: (3 conditions)
   a) converse with a confederate on hand held phone
   b) converse with a hands free phone
   c) listen to a radio broadcast of their choice

Results:
1. No difference in results in the hand-held versus the hands-free conditions.
Results:

2. Cell Phone use increased the likelihood of "missing" the "stop" signal.

![Graph showing probability of missing the stop signal with and without cell phone use.]

Results:

3. Cell Phone use slowed reaction time to the "stop" signal.

![Graph showing mean reaction time with and without cell phone use.]

Testing driving in a simulator (Ford Crown Victoria).

Exp. 1: tested ability of cell phone users to respond to a vehicle braking in front of them.
40 participants drove 40 miles:
  - control: not talking on cell phones
  - exp: talking on “hands-free” phones
In heavy traffic, 3 cell phone users rear-ended the vehicle in front of them. None of them did so in the control condition.

Driving Impairs Talking

  - driving simulator
  - listened to, and retold stories either while driving or while “parked”

Becic et al (2010) results:
IX. Conclusion on Attention & Resource Allocation

1) Partial selection occurs early in the information processing stream.
2) Selection is not the result of action of a simple physical filter.
3) The selection process is sensitive to the past experiences (thresholds) of the person and the context of the recognition task.
4) Performance of multiple tasks is a complex process of allocating limited resources and performance of some operations that are automatic and thus do not require resources.