Vigilance, Focused Attention, and Divided Attention

Lesson III: Attention
module 13

What is attention?

- Humans don’t process all incoming sensory stimulation that is available
- Human information processing starts very early by seeking out, focusing, and selecting particular aspects of the available information
- Attention is the mechanism by which we restrict information processing to only a small fraction of the possible amount of information
- Attention includes both conscious processes and unconscious processes
- Often cognitive processes (such as object identification) are the end result of unconscious processing (visual grouping processes)

Different views on attention

- Vigilance and signal detection
  - Waiting for one’s luggage at the airport...
- Selective attention
  - Listening to a conversation at a party...
- Divided attention
  - Listening to a second conversation while still pretending to be engaged in the first one...
- Search
  - Searching for one’s car in the parking lot...
Vigilance refers to the ability to attend to a situation for an extended period of time. The goal usually is the detection of "something" (more technically "a sensory event" or "signal")

- **Human performance**
  - Performance decreases with increasing time
  - Decrease can be due to:
    - Loss of sensitivity (sensory adaptation)
    - Drifting attention (sometimes due to habituation)
    - Criterion changes (see signal detection theory)

- **Problem of fatigue**
  - Availability of frequent rest periods important

**Why is vigilance important? Plant operator**

**Why is this important? This is a classic example of signal detection...**
Perception can be viewed as decision making under uncertainty.

- "Is that smoke over there, or just a cloud...?"

What we “decide” to perceive is based partially on the following:

- The strength of the perceptual event (signal)
- The amount of background events (noise)
- A subjective threshold of the relative strength of signal to noise (criterion)
- The benefits of detecting a signal vs. the costs of not detecting it or falsely detecting it
- Expectancies (base rates - how likely is this?)
- Selective attention

Correct vs. false responses in SDT

<table>
<thead>
<tr>
<th>real world</th>
<th>signal present</th>
<th>signal absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>observers reaction</td>
<td>report signal “hit”</td>
<td>report no signal “miss”</td>
</tr>
<tr>
<td>person is guilty</td>
<td>hit</td>
<td>$1,000</td>
</tr>
<tr>
<td>person is not guilty</td>
<td>false alarm</td>
<td>$500</td>
</tr>
</tbody>
</table>

Correct vs. false responses in SDT

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<th>signal absent</th>
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<tr>
<td>observers reaction</td>
<td>report signal “guilty!”</td>
<td>report no signal “not guilty”</td>
</tr>
<tr>
<td>person is guilty</td>
<td>hit</td>
<td>good</td>
</tr>
<tr>
<td>person is not guilty</td>
<td>false alarm</td>
<td>very bad</td>
</tr>
<tr>
<td>person is not guilty</td>
<td>correct rejection</td>
<td>good</td>
</tr>
</tbody>
</table>
Selective attention: A fitting description

William James (1890)

[Attention] is the taking possession of the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thoughts.

... It implies withdrawal from some things in order to deal effectively with others.

Dichotic listening and shadowing procedures

An example for selective attention

People can attend selectively to particular events or objects

Cherry was the first to systematically investigate how humans attend to one of two simultaneous acoustical events

His studies showed that...
- Participants knew little about the content, language, well-formedness, etc. of the unattended message
- Did notice gross features of the speakers (male / female, differences in tone of voice)

We will revisit this phenomenon again in the next modules
Divided attention

- People can perform more than one task at a time (multi-tasking)
  - Driving and reading billboards
  - Walking and chatting with a friend
  - Listening to a web-lecture and watching tv
    (we will see soon how well this might work;-)
- Attentional resources can be allocated to different tasks depending on the processing needs
  - When driving on an icy road, the driver doesn’t read the billboards any more
- Attentional resources are limited
  - Tasks demand different amounts of attention

Controlled vs. automatic processing

- Cognitive processes can be differentiated based on the amount of cognitive control they require
  - Tying shoe laces vs. imagining to walk home
  - Routine tasks vs. solving new problems
  - Continuum: total control to totally automatic
- Learning, automatization, proceduralization
  - Most tasks require less control after practice
  - Separate steps are integrated into one
  - Information is processed in larger units
  - Less step-by-step verification

Controlled vs. automatic processing

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Controlled</th>
<th>Automatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effort</td>
<td>Intentional</td>
<td>No effort</td>
</tr>
<tr>
<td>Conscious</td>
<td>Fully available</td>
<td>Usually not</td>
</tr>
<tr>
<td>Resources req.</td>
<td>Large demand</td>
<td>Negligible</td>
</tr>
<tr>
<td>Type of processing</td>
<td>Serially</td>
<td>Parallel</td>
</tr>
<tr>
<td>Speed</td>
<td>Slow</td>
<td>Fast</td>
</tr>
<tr>
<td>Flexibility</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Level of processing</td>
<td>High (analysis)</td>
<td>Low</td>
</tr>
<tr>
<td>Difficulty</td>
<td>Variable</td>
<td>Variable</td>
</tr>
</tbody>
</table>
The cognitive system has limited resources
- One general resource
- Multiple (modality-)specific resources

Attentional processes require resources
- Each process uses up part of the resources
- Processes compete for resources
- Automatization reduces the amount of resources needed to perform the task

Divided attention
- Multiple attention demanding processes can be active at the same time as long as they don’t require all of the resources

Examples of automatization

Divided attention: Dual tasks
(Spelke, Hirst & Neisser, 1976)
- Practicing reading for comprehension and writing down dictated words
- Practice both tasks 5 days a week (85 sessions)

Performance
- In line with expectations, participants were much worse at performing both tasks simultaneously than in isolation
- After enough practice, this difference vanished
- Even when semantic categorization was required for dictated words, performance bounced back to normal performance in the dual task

The risks of automatization: Classification of slips (James Reason, 1990)

- Capture error: automatic process takes over even though a deviation was planned
- Omission/perseveration: because of an interruption steps are missed or repeated
- Data-driven errors: Sensory information initiates / modifies the planned action
- Loss-of-activation error: After the initiation of an action important information is lost (what am I doing?)