Attention and Performance Limitations

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The concept of “Attention”

- Attention became a fashionable concept
  - In the late 19th century
  - In 1958 (Broadbent’s book *Perception and Communication*)
- More recently many argued that it is too vague to be of value
- Attention is regarded:
  - As the ability to select part of the incoming stimulation for further processing
  - As synonymous with concentration or mental set.
  - As relied to search activities
  - As co-variant with arousal
- Attention is most commonly used to refer to selectivity of processing
Focused and Divided Attention

Figure 15.1
The ways in which different topics in attention are related to each other.

Auditory (e.g. shadowing; fate of unattended stimuli)
Visual (e.g. variable beam spotlight; fate of unattended stimuli)
Focused Attention

• Focused Attention:
  • Is studied by presenting people with two or more stimulus input at the same time, and instructing them to process and respond to only one.
  
  – Work on focused attention
  • Can tell us how effectively people can select certain inputs rather than others, and enables us to investigate the nature of the selection process and the fate of unattended stimuli
Divided Attention

• Divided Attention
  • Is also studied by presenting at least two stimulus inputs at the same time, but with instructions that all stimulus inputs must be attended to and responded to.

  – Studies on divided attention
    • Provide useful information about an individual’s processing limitations, and may tell us something about attentional mechanisms and their capacity
Important Limitations

• There are two important limitations in most research on attention

  1) though we can attend to either the *external environment* or the *internal environment*, most of the work on attention has been concerned only with attention to the external environment.

  2) Most studies on attention are very artificial. In the real world we generally attend to **3D dimensional** people and objects and decide what actions might be appropriate with respect of them. In laboratory the emphasis is on experiments that briefly present static **2D situations** (that are rarely encountered in our usual interactions with the environment).
Focused Auditory Attention

• The “cocktail party problem” (Cherry 1953)
  – Sex of the speaker
  – The voice intensity
  – The location of the speaker

• The fate of unattended information
  • The Broadbent’ s filter theory
  • The Treisman’ s attenuation theory
  • The Deutsch & Deutsch theory
Figure 15.2
A comparison of Broadbent’s theory (top); Treisman’s theory (middle); and Deutsch’s theory (bottom).
Focused attention

• The most reasonable account of focused attention
  • May be along the lines suggested by Treisman, with reduced or attenuated processing of sources of information outside focus attention.
  • The extent of such processing is probably flexible, being determined in part by task demands
Focused Visual Attention

- Zoom-lens Model (Eriksen 1990)
  - There is an attentional spotlight, but this spotlight has an adjustable beam so that the area covered by the beam can be increased or decreased.

![Zoom-lens Model Diagram](image.png)

*Figure 15.5* 
An indication of the stimulus display used by Juola et al. (1991).
VISUAL SEARCH
The Feature Integration Theory
(Treisman 1988 - T)

- There is a rapid initial parallel process in which the visual features of objects in the environment are processed together; this is not dependent on attention.
- There is a second, serial process in which features are combined to form objects (e.g. a large, red chair).
- The second serial process is slower than the initial parallel process, especially when several stimuli need to be processed.
- Features can be combined by focused attending to the location of the object, in which case focused attention provides the “glue” that constructs unitary objects from the available features.
- Feature combination can also be influenced by stored knowledge (e.g. bananas are usually yellow).
- In the absence of focused attention or relevant stored knowledge, features will be combined from different objects in a random fashion, producing what are known as “illusory conjunctions.”
VISUAL SEARCH
Attentional Engagement Theory (1)
(Duncan & Humphreys 1989, 1992 – D&H)

• They assume that the time taken to detect a target in a visual display depends on two major factors:
  • Search times will be slower when the similarity between the target and the non-targets is increased
  • Search times will be slower when there is reduced similarity among non-targets. Thus, the slowest search times are obtained when non-targets are dissimilar to each other, but similar to the target
VISUAL SEARCH
Attentional Engagement Theory (2)
(Duncan & Humphreys 1989, 1992 – D&H)

- There is an initial parallel stage of perceptual segmentation and analysis involving all of the visual items together.
- There is a subsequent stage of processing in which selected information is entered into visual short-term memory; this corresponds to selective attention.
- The speed of visual search depends on how easily the target item enters visual short-term memory.
- Visual items that are well matched to the description of the target item are most likely to be selected for visual short-term memory; thus, non-targets that are similar to the target slow the search process.
- Visual items that are perceptually grouped (e.g. because they are very similar) will tend to be selected (or rejected) together for visual short-term memory; thus, dissimilar non-targets cannot be rejected together and this slows the search process.
Visual Search

• The speed of visual search appears to depend on a number of factors:
  • The similarity between target and non-targets (accepted by D&H and by T)
  • The degree of similarity among non-targets (emphasized by D&H)
  • Conjunction of features (emphasized by T)

• There are indications that
  • the differences between T’s theory and D&H’s theory are becoming less as the theories are modified.
Disorders of Visual Attention

- Posner & Peterson (1990)
  - a theoretical framework within which various disorders of visual attention in brain-damaged patients can be understood.

- At least three separate abilities are involved in visual attention
  - The ability to *disengage* attention from a given visual stimulus
  - The ability to *shift* attention from one target stimulus to another
  - The ability to *engage* attention on a new visual stimulus
Divided Attention

• Two tasks are performed well together when:
  • They are dissimilar
  • When they are relatively easy
  • When they are well practiced
Automatic Processing (1)

- Practice leads to automatic processing.

- Automatic processes
  - Are fast
  - They do not reduce the capacity available for other tasks
  - There is no conscious awareness of them
  - Are unavoidable
Automatic Processing (2)

- Norman & Shallice (1986)
  - showed that there is not a single control system (as previously thought)

- There are two separate control systems
  1) A contention scheduling – which selects one of the available schemas on the basis of environmental information and current priorities
  2) A supervisory control system

- The Norman & Shallice Theory explains the fact that
  - some processes are fully automatic whereas others are only partially automatic
Automatic Processing (3)

• Logan (1988) proposed that
  • increased knowledge about what to do with different stimuli is stored away with practice,
  • automaticity occurs when this information can be retrieved very rapidly
Separate memory traces are stored away each time a stimulus is encountered and processed.

Practice with the same stimulus leads to the storage of increased information about the stimulus, and about what to do with it.

This increase in the knowledge base with practice permits rapid retrieval of relevant information when the appropriate stimulus is presented.

"Automaticity is memory retrieval: performance is automatic when it is based on a single-step direct-access retrieval of past solutions from memory" (Logan, 1988, p. 493).

In the absence of practice, responding to a stimulus requires thought and the application of rules; after prolonged practice, the appropriate response is stored in memory and can be accessed very rapidly.

These theoretical views make a strong case for automaticity.
Attention: Unitary or Multiple Systems?

• The long-lasting popularity of the view that attention is unary
  • Is that it fits well with introspective evidence.
• However this view is wrong
• Attention is closely bound up with motivation in the real world
  • But this interdependence of attention and motivation is not reflected in most theories
Limitations of most theories of attention

• New research on attention must have a new focus on
  • Segmentation of different parallel processing streams
  • Priority assignment among multiple goals
  • Co-ordination between sensory input and action: selection for action