

ATTENTION

Most slides in this presentation were developed by Rowan professor Mark Hale. Professor Hale is a Cognitive Psychologist and Human Factors Specialist and very gratefully contributed his material to this course in HCI

THOUGHTS

We are bombarded by stimuli.

If we paid close attention to everything, we would go mad!`



ATTENTION

- What is attention? Take a moment to think about a suitable definition for attention.
- What does it mean to “pay” attention and what does that imply?
- Attention is very much like a “cognitive bill” for awareness.
- Attention is a resource that is limited!
- You continue to be aware and alert of stimuli in your environment until you can no longer pay attention to portions of it!
- Some opening thoughts on attention:
 - We often talk about attention as being analogous to a spotlight... but that is not completely accurate.
 - Have you ever tried to read/study while others around you had loud conversations?
 - Can you attend to two separate conversations at a party?

ATTENTION

■ Visual

- Look around you and try to take in as many visual objects as possible. Make sure you note as many characteristics as possible (shape, size, location, and color...etc.).

■ Auditory

- Now at the same time try to notice every sound in your environment, such as the hum of your computer, the noise of a clock ticking, or a distant automobile.

■ Touch

- Try to maintain all these visual and auditory stimuli, but also notice your skin senses. Can you feel the pressure that your watch creates on your wrist, and can you sense a slight itch or a subtle pain?

■ Smell

- If you somehow manage to pay simultaneous attention to your vision, hearing, and skin senses, try expanding your attention to include smell and taste. You'll easily discover that you cannot attend to everything at once.

We seldom give much thought to our attention.

Instead, attention just “happens,” and it seems as natural to us as breathing.

ATTENTION

- Attention is a concentration of mental activity that allows you to take in a limited portion of the vast stream of information available from both your sensory world and your memory.
- Meanwhile the unattended items lose out, and they are not processed in detail.
- Attention has always been a central topic in cognitive psychology, from the beginning of the cognitive revolution and continuing to the present.
- Attention tasks use both top-down and bottom-up processing.
- We will concentrate our mental activity because an interesting stimulus in the environment (bottom up) has captured our attention (when top down begins).
- Examples:
 - Something in our environment moves causing us to pay attention to it. (Bottom up)
 - We scan a crowded room for a friend. (Top down)

LEVELS OF PROCESSING IN ATTENTION

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Schneider and Shiffrin (*see readings*) suggest 2 levels of processing related to attention:

■ Automatic Processing

- Used on easy tasks with highly familiar (practiced) material. Performed in parallel.
 - Think of the process of using the breaks in your car.

■ Controlled Processing

- Necessary on difficult tasks or those involving unfamiliar material and is performed in a serial fashion.

Automatic Processing

Requires little or no attention

Occurs without conscious awareness

Interferes very little with other cognitive activities

Occur fast and seemingly all at once (in parallel)

Seems effortless

Controlled Processing

Requires attention

Conscious effort expended

Interferes with other cognitive activities

Occur slowly, often in a serial, step-by-step fashion

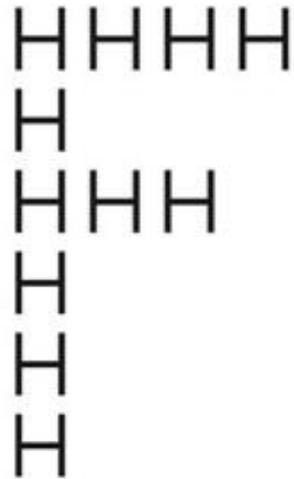
Effortful

GLOBAL VS. LOCAL PROCESSING

- **Local Processing**
 - Purposeful focusing of attention on the fine details of the stimulus.
- **Global Processing**
 - People tend to automatically process global features.

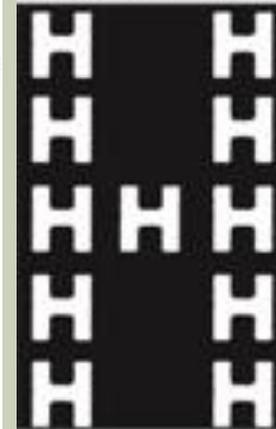
GLOBAL VS. LOCAL PROCESSING

This illustrates that **Global Features have Precedence over Local Features**, Biasing us to See the “Forest Before the Trees” in an Illustration. In this Example, the larger “F” is seen before the Constituent “H”s that Compose It.



People take longer to identify local features when they are incongruent with global features!

Congruent



Incongruent



SACCADIC EYE MOVEMENTS & READING

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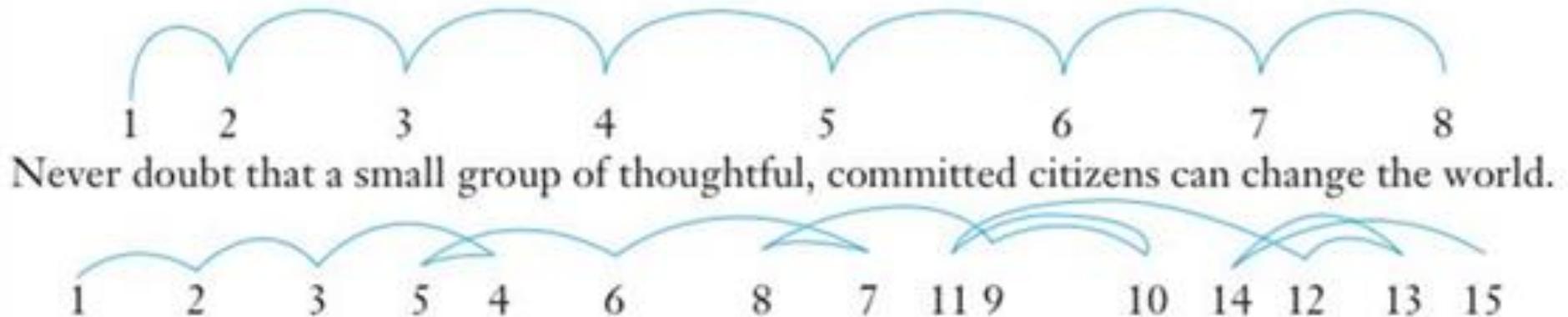
- Our eye movements provide important information about the way our minds operate when we perform a number of everyday cognitive tasks.
- Researchers have studied how our eyes move when we are looking at a scene, when we are driving, or when we do a host of complex tasks.
- Saccadic Eye Movement
 - Your eyes make a series of little jumps or **saccades** as they move across the page (or the visual scene).
 - The purpose of a saccadic eye movement is to bring the center of the retina into position over the words you want to read.
 - Why is it important to bring this stimulus information to the center of the eye? (in all tasks, reading, or otherwise!)
 - A very small region in the center of the retina, known as the fovea, has the highest acuity of retinal regions.
 - Cones, the visual receptor cells responsible for color vision, are centrally located.
 - When you read, each saccade moves your eye forward by about 7 to 9 letters.
 - Researchers have estimated that people make between 150,000 and 200,000 saccadic movements every day!

EYE MOVEMENTS & READING

Good and poor readers differ with respect to the size of the saccadic movement, the number of regressions, and the duration of the fixation pause.

FIGURE 3.1

Eye Movement Patterns and Fixations for a Good Reader (top numbers) and a Poor Reader (bottom numbers).



*Note that fixation duration is NOT represented in this graphic. 12

SACCADIC EYE MOVEMENTS & INFORMATION PROCESSING

- We do not process much information during these saccadic eye movements.
- Therefore **in between saccades** we must have **fixations** that occur which allow us to process the information.
- During each fixation, your visual system pauses for about 50 to 500 milliseconds in order to acquire information that is useful for reading.
- You perceive a smooth, continuous view of the material you are processing, even though your eyes are actually alternating between jumps and pauses.
 - How?

PERCEPTUAL SCAN

- **Perceptual Span**
 - Refers to the number of letters and spaces that we perceive during a fixation.
 - Researchers have found large individual differences in the size of the perceptual span.
 - In English this perceptual span normally includes letters lying about 4 positions to the left and about 15 positions to the right of the letter you are directly looking at.
 - Notice that the perceptual span is definitely lopsided.
 - Why?

EYE MOVEMENTS & READING

*Important
Considerations
for Design!*

- Facts regarding saccadic eye movement:
 - When the eye jumps forward it rarely moves to a blank space between sentences or between words.
 - **The eye usually jumps past short words, common words, and words that are highly predictable in a sentence.** *We will see this again in the text "Don't Make Me Think!"*
 - In contrast, the size of the saccadic movement is small if the next word in a sentence is unusual or misspelled.
 - We also make regressions, moving backwards, when we misinterpret a word or sentence what we have read.

EYE MOVEMENTS AS A FUNCTION OF READING ABILITY

- Good readers differ from poor readers with respect to their saccadic eye movements.
 - The good reader makes larger jumps and is also less likely to make regressions.
 - The good reader fixates (pauses) for a shorter time before the next saccadic movement.
 - A typical good reader might pause for $\frac{1}{5}$ second each time, whereas a poor reader might pause for $\frac{1}{2}$ second.

THEORIES OF ATTENTION

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■ Bottleneck Theories of Attention

- The earliest approaches to attention emphasized the extremely limited amount of information that we can attend to at one time.
- A common metaphor used is that of a bottleneck.
 - Also called “filter theories”
- This metaphor was especially appealing because it matches our introspections about attention.
 - The narrow neck of a bottle restricts the flow into or out of the bottle.
- Researchers proposed many variations on bottleneck theories, and many aspects of these early theories still hold true in contemporary research.

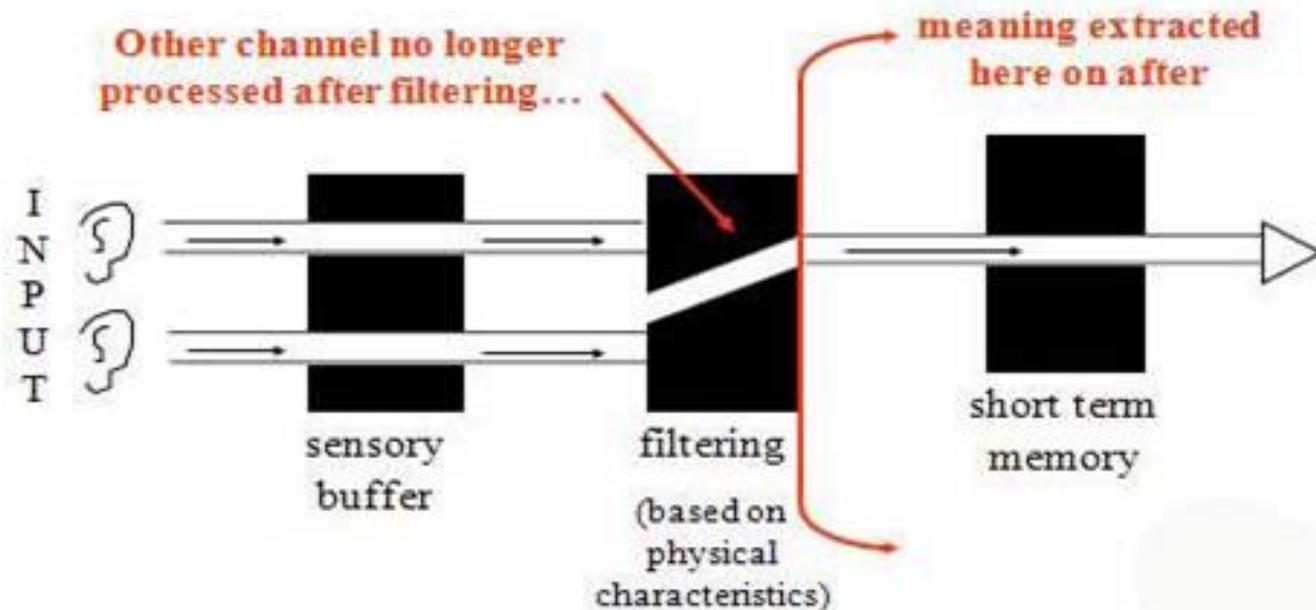
BROADBENT'S MODEL OF SELECTIVE ATTENTION

An example of an “early selection filter” theory. Note that information must be filtered/selected to extract meaning from it!

All information that was not selected/filtered was **LOST**.

There were other “selection filter” theories that evolved that had the filter “later” in the process and/or multiple filtering stages.

Broadbent's Filter Model of selective attention

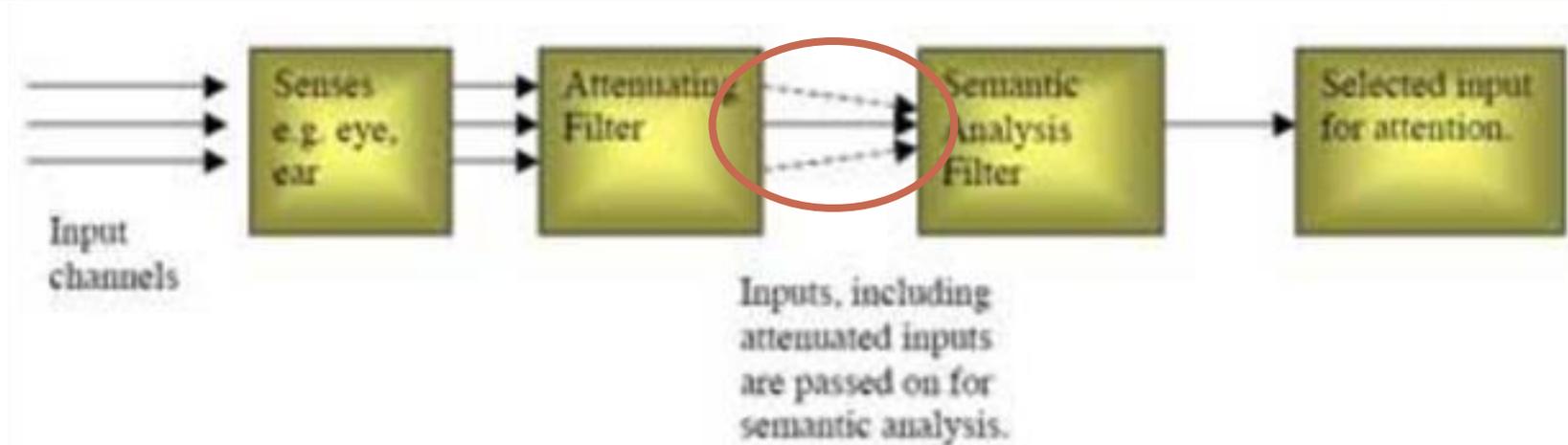


THEORIES OF ATTENTION: TREISMAN'S ATTENUATION MODEL

■ Treisman's Attenuation Model

- An attractive alternative to Broadbent's model because it included the idea that attentional filtering was not serial.
 - Not all information was lost at the point Broadbent claimed!
- Instead Treisman believed that information was lost progressively as it moved through the stages (filters).
 - Also called the "leaky filter model"
- ** There still is an attentional bottleneck (selection filter) in this model. However, there were multiple filters and more options for information to get through.

THEORIES OF ATTENTION: TREISMAN'S ATTENUATION MODEL



- Treisman proposed that the first filter was simply to attenuate (reduce) the overwhelming amount of stimulus information coming in.
- Notice the dashed lines in Treisman's Attenuation Model.
- This implies that some of the attenuated (reduced) information still reaches semantic analysis, albeit in a more fragmentary state.

THEORIES OF ATTENTION: TREISMAN'S ATTENUATION MODEL

- Even though this information is reduced it could still be selected if deemed interesting or important.
- The result of selecting previously attenuated (reduced) stimulus information is what we would call focusing attention.
- Think of an example where you first notice the faint beeping of an alarm clock in the distance.
 - You may not have even noticed it until the 10th beep for example!
- At that moment, it is unlikely that you could entirely localize it (i.e. determine its location) because you haven't been fully attending to it!
- Think of how different the situation would be if the sound was an air horn instead!

THEORIES OF ATTENTION: EVALUATING THESE BOTTLENECK THEORIES

- Researchers rejected the bottleneck theories because those theories underestimate the flexibility of human attention and are far too simple.
- Current neuroscience research demonstrates that information is not lost at just one phase of the attention process, as many bottleneck theories suggest.
- Instead, information is lost throughout many phases of attention, from the beginning through later processing.

THEORIES OF ATTENTION

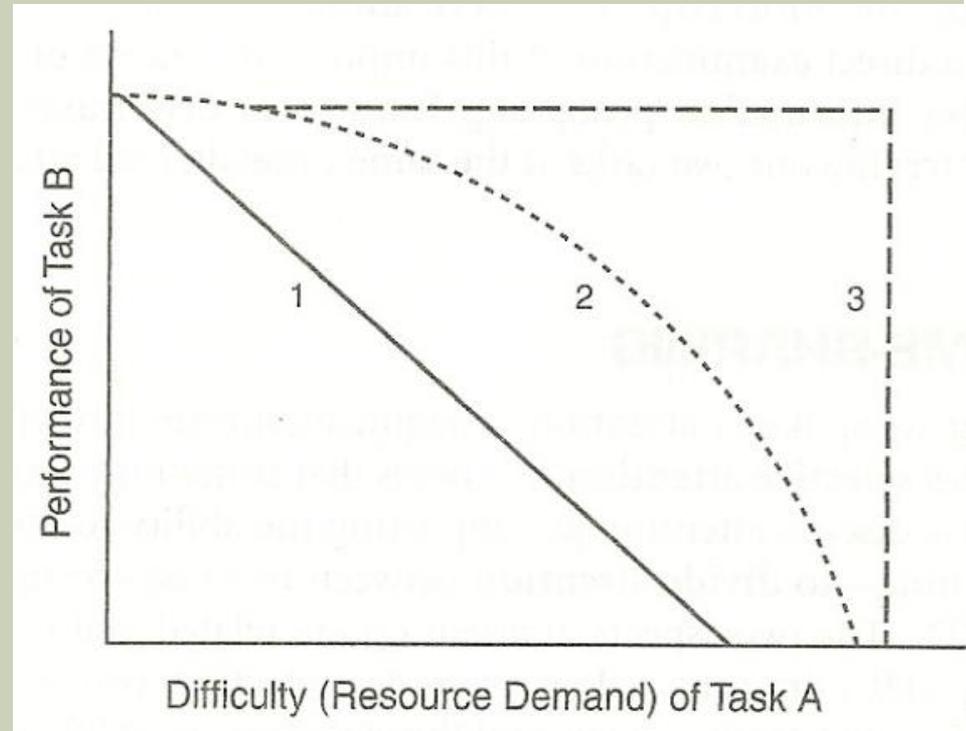
(SEE CHAPTER 6 OF *AN INTRODUCTION TO HUMAN FACTORS ENGINEERING*)

There are many other models to talk about in between traditional bottleneck theories and our primary model called Feature Integration Theory.

- Kahneman's resource models
- Selfridge's Pandemonium Model
- **Wickens's Multiple Resource Theory**
(*technically a model of working memory*)

"The relationship between single-task difficulty and dual-task divided attention decrements is the fundamental feature of **resource theory**. Scarce mental resources are shared by tasks, and more difficult tasks leave fewer resources for concurrent tasks, whose performance declines as a result."

- **Automaticity** – A task is said to be automated if it can be accomplished "automatically" without much conscious thought. Examples of highly automated tasks are signing ones name or filling in a login screen.



Relation between performance of one task (B) and the difficulty of a second task (A) carried out concurrently, as cognitive resources are shared between them. Lines 1, 2 and 3 represent versions of task B that are progressively more automatized. At high levels of automaticity (line 3), perfect performance of task B can still be attained even when task A is quite difficult.

THEORIES OF ATTENTION: FEATURE INTEGRATION THEORY

- According to Feature Integration Theory, perception of objects is divided into two stages:
 1. Pre-Attentive Stage
 2. Focused Attention Stage
- Pre-Attentive Stage
 - The first stage in perception is so named because it happens automatically, without effort or attention.
 - In this stage, an object's elementary component features are analyzed independently (color, texture, shapes, etc).
 - In other words, we may perceive “red” and a “square” but not a “red square.”
 - We are unaware of the breakdown of an object into its more elementary features because this analysis happens prior to our conscious awareness (focused attention).
 - This is when we look at a scene using distributed attention, with all parts of the scene processed at the same time.
- Focused Attention Stage
 - During this 2nd stage of attention features are recombined to form whole objects.
 - Focused attention is much more effortful - but provides much more meaning.