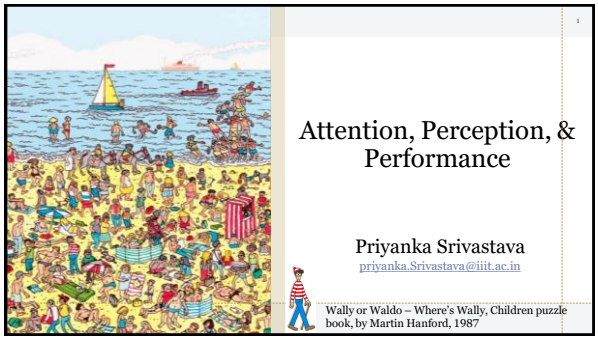
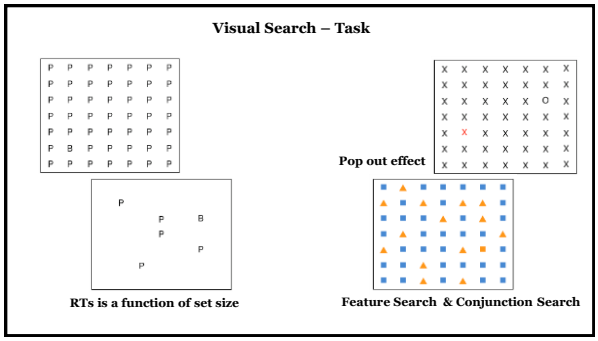



1

Where's Wally in Real Time !

The real complex conjunctive search

2

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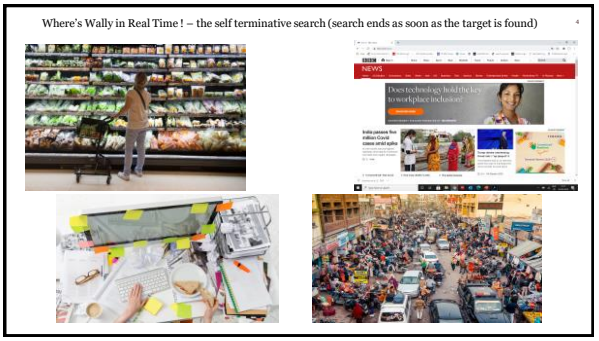


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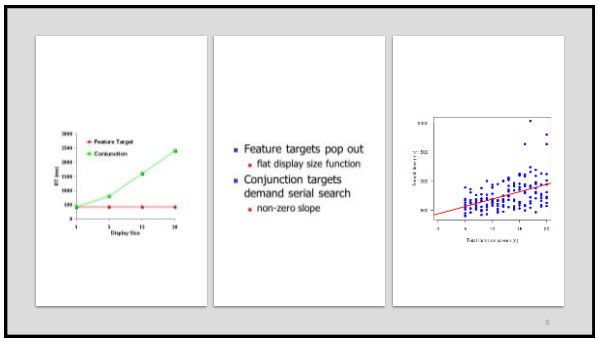


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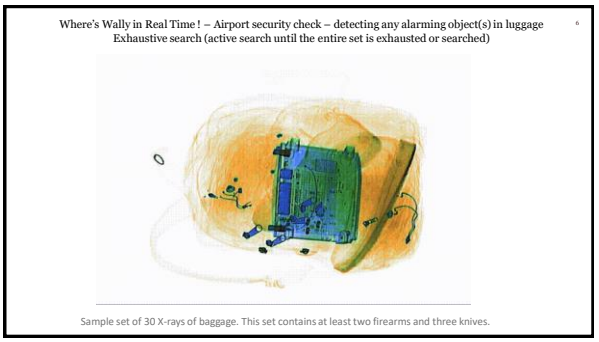
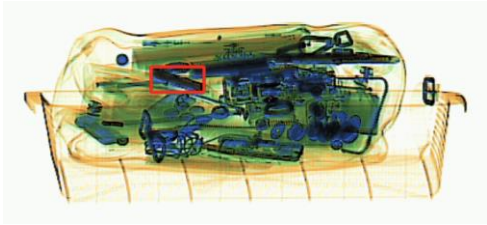



6

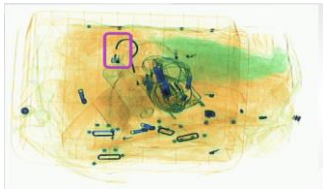
Where's Wally in Real Time ! – Airport security check – detecting any alarming object(s) in luggage
Exhaustive search (active search until the entire set is exhausted or searched)



The "side view" of a very cluttered bag with several dense metallic objects that appear as black or dark blue, including coins, a buckle, a tablet. The tray and bag, low-density and made of organic material, appear as a faint orange. A pocket knife is shown in the red box, which would be very difficult to spot with only a "top" view.

7

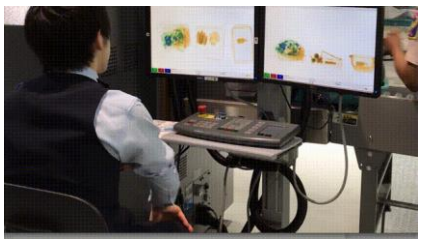
Where's Wally in Real Time ! – Airport security check – detecting any alarming object(s) in luggage
Exhaustive search (active search until the entire set is exhausted or searched)



Some items can blend in much more easily with their surroundings. Pictured is a bag containing a lighter. In Japanese airports, passengers are not allowed to carry more than one lighter onto a plane

8

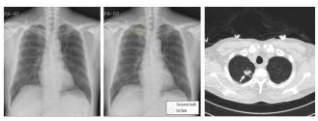
Where's Wally in Real Time ! – Airport security check – detecting any alarming object(s) in luggage



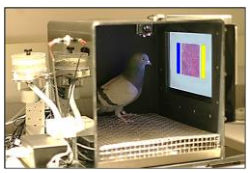
An X-ray security operator screening passengers

9

Where's Wally in Real Time ! – Radiologist reading images – detecting and annotating the anomaly



Radiologist screening image for cancer detection in simple versus conjunctive search problem.



Pigeons (*Columba livia*) as Trainable Observers of Pathology and Radiology Breast Cancer Images

Abstract

10

# Overview

- What is attention? Why it is important?
- What directs our attention? How we decide what to attend?
- Where does attention exist in information processing stream? From perception-to-action loop.
- What happens when we don't attend? Is attention always necessary?
- How it influence perception and other cognitive processing?
- How attention enables multi-tasking?
- How attention disorder impacts everyday behaviour?

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**Let's watch a video**

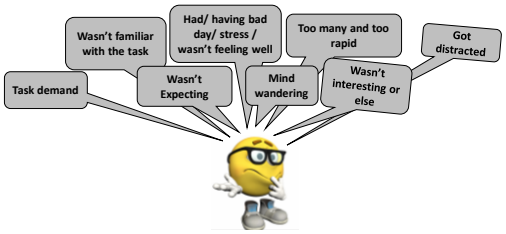
**IN FOLLOWING VIDEO – COUNT HOW MANY TIMES PLAYERS WEARING WHITE T-SHIRT PASS THE BALL**

13

14

14

**Wondering how did you FAIL to Notice Gorilla or the other changes?**




**Task demand, Cognitive Load,** but Stress, Fatigue, Motivation, Interest, Knowledge, Belief, Emotion, and Feeling also modulates the filter and central attention

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Millions of items . . . are present to my senses which never properly enter my experience. Why? Because they have no interest for me. My experience is what I agree to attend to. . . . Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. . . . It implies withdrawal from some things in order to deal effectively with others.

William James (1842 -1910)
The first prof. of Psychology at Harvard
Book, Principles of Psychology, 1890

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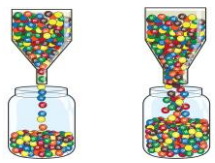
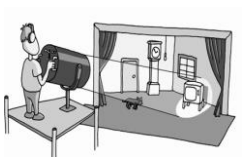
**What is Attention?** Selection, Filter, and Focus



**Selection and Bottleneck - GATEKEEPER**



**Selective Focus - SPOTLIGHT**

Enable **focus** on **relevant information selectively while ignoring irrelevant information**

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**What is Attention?** Shifting, Alternating, and Dividing – Dual Task

**Central Attention / Resource**

- Enable dividing your attention to more than one task - multi-tasking / dual task
- We have multiple resources to juggle between tasks
- The efficiency of juggling between task depends on practice, task complexity, stimulus features, task demand, sharing of stimulus features / actions between two tasks

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## Why attention is important ? Influence Perception

- **Inattention Blindness – Failure to perceive the object that are not the focus of attention**
- **Change Blindness – failure to detect changes to the visual details of a scene**

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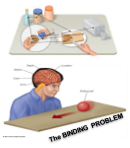
Inattention Blindness – Failure to perceive the object that are not the focus of attention

Change Blindness – failure to detect changes to the visual details of a scene

The perceptual process. The steps in this process are arranged in a circle to emphasize that the process is dynamic and continually changing.

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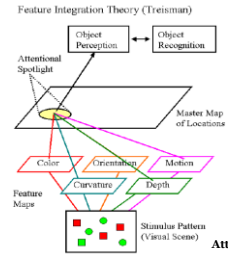
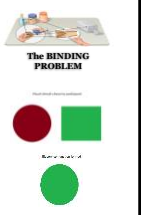
## Why attention is important ? Influence Perception

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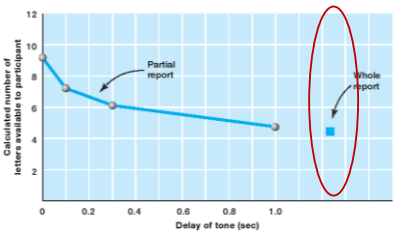
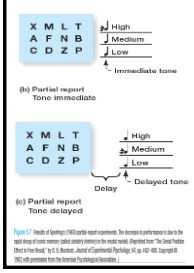
## Why attention is important ? Influence Memory

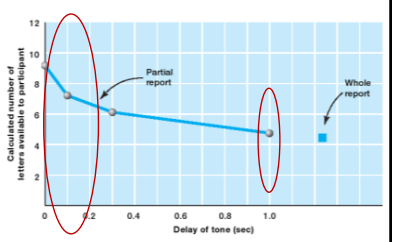




Sperling Experiment

23

## Why attention is important ? Influence Memory

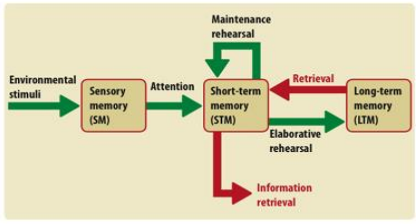



Sperling Experiment

24

## Why attention is important ? Influence Memory




Atkinson and Shiffrin, 1968

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## What directs our attention?


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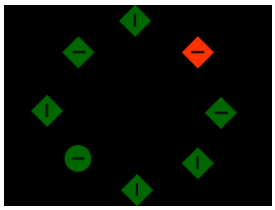
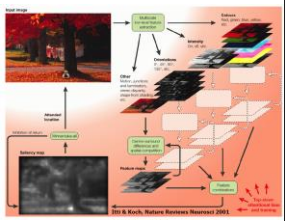
## What directs our attention ? Saliency, Saliency map



An example of attention capture: When participants were instructed to search for green circle they often looked at the orange/ red diamond first.



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## What directs our attention ? Knowledge / Schema


There was a main effect of semantic consistency, $F(1,23) = 6.36$, $p < .05$, in that semantically inconsistent objects were fixated for a longer amount of time than objects that were consistent with the semantics of the scene. In addition, we observed a strong effect of the syntactic manipulation, $F(1,23) = 42.43$, $p < .01$, with floating objects looked at longer than objects resting on surfaces. The interaction failed to reach significance, $F(1,23) = 1.94$, $p > .05$.

Similar to the total fixation duration, we observed main effects for both the semantic, $F(1,23) = 7.07$, $p = .01$, and the syntactic manipulation, $F(1,23) = 29.91$, $p < .01$, while the interaction was not significant, $F < 1$. Semantically inconsistent as well as floating objects led to a greater number of fixations than semantically consistent objects or objects resting on a surface.

*Vo and Henderson, 2009*

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## What directs our attention ? Goal / Task demand

Ilya Repin, *An Unexpected, Visitor*, (1884)

- Participants were asked to look at the painting with different questions in mind.
- The same painting was viewed differently, when asked to attend to different components of the painting.

Yarbus, 1967

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## What directs our attention ? Goal / Task demand

Free Examination

Ages of the People

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## What directs our attention ? Goal / Task demand

Clothes they are wearing

Activity prior to the visitor

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## What directs our attention ? ACTIVITY 1 – Visual Search in real time

**i.** searching for a friend in a crowded place, where the crowd feature profile matches *versus* not matches with your friend

**ii.** a conference attendee, who is not very familiar to you, in a crowded place where the crowd feature profile matches *versus* not matches with the attendee

**iii.** Compare the aforementioned comparisons with the varying set-size of the crowd.

Describe the visual search strategies that will be utilized during the search.

*Hint-keywords: serial, parallel, singleton, conjunctive, pop-out, set-size, bottom-up and top-down information.*

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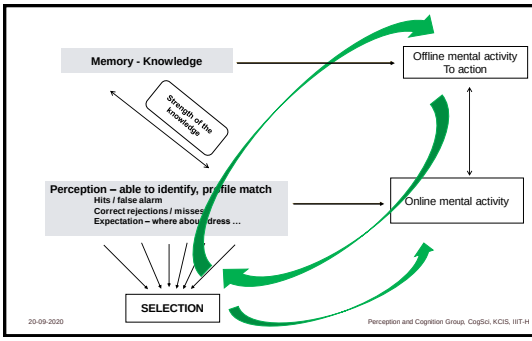
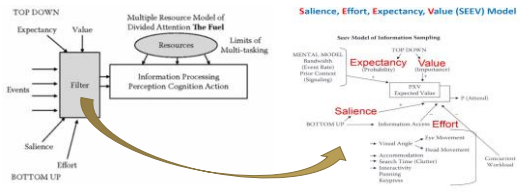



33

## What directs our attention ? SEEV model of selective attn.




Attention helps prioritizing between competing stimuli, using top-down and bottom-up processes.

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## Where Attention is Located in Information Processing Stream?

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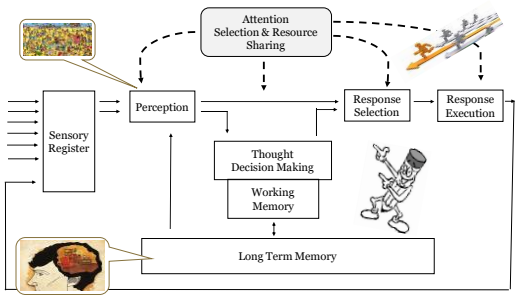
## Loci of selection / where attention takes place?

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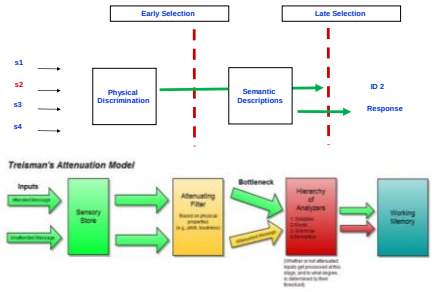
## Loci of selection / where attention takes place?



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## Loci of selection / where attention takes place?


Dichotic listening task *(Cherry , 1953)*

- Unattended stream – male/female voice, Loudness, strongly emotional words, taboo words
- No meaningful recall of the unattended channel
- Showed Early Selection

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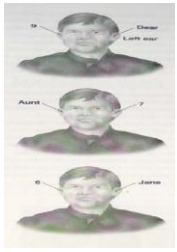
## Loci of selection / where attention takes place?






*Gray and Wedderburn, 1960*

**Dichotic listening *(McKay, 1973)***

- **Attended stream:** Ambiguous sentence "They were throwing stones at the bank."
- **Unattended stream:** Biasing word "River" or "Money"

**The biasing word had an effect!**
If "money", the ambiguous sentence was more likely interpreted as financial institution

**Sentences to recognize :**

- They threw stones toward the side of the river yesterday
- They threw stones at the savings and loan association yesterday
- **Supporting late selection view**

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## Loci of selection / where attention takes place?



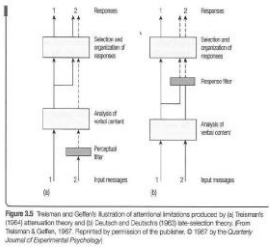


Figure 3.5 Treisman and Geffen's illustration of attentional limitations produced by (a) Treisman's (1964) attenuation theory and (b) Deutsch and Deutsch's (1963) late-selection theory. (From Treisman & Geffen, 1967. Reprinted by permission of the publisher. © 1967 by the Quarterly Journal of Experimental Psychology)

- **How much unattended information is processed?**
- **How much information is processed before attention?**
- **Early refers to physical filtering whereas late selection model refers to semantic filtering**
- **Both are "all or none" processing**
- **Triesman suggests about attenuation and function as per the task/ stimuli demands – flexible system**

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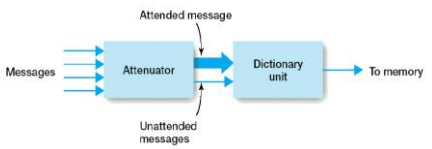
## Triesman's Attenuation model of selection



Cocktail party phenomenon

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## Where attention takes place?

- How the system decides "where and when" to filter ? Or How the system decides for early or late selection ?
- Does the system differ across expertise?

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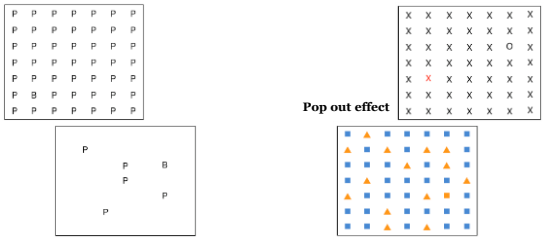
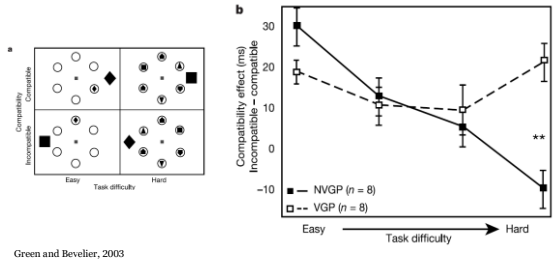
## Visual Search – Task




43

## How system decides for early or late selection ? Does the system differ across expertise?




Green and Bevelier, 2003

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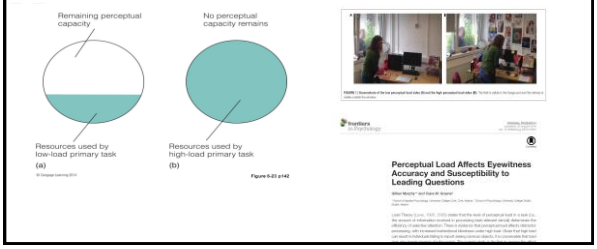
**Perceptual Load -** "the amount of information involved in the processing of the task stimuli"

(Macdonald and Lavie, 2011, p1780)

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## Perceptual Load

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**TABLE 1 | List of critical questions used in the regular, leading, and follow-up questionnaires in experiment 1A and 1B.**

| | Regular | Leading | Follow-up |
|---|---|---|---|
| Q1 | What did the thief take? | – | |
| Q2 | Did you notice any unusual objects on the desk? | – | |
| Q3 | Did you notice any unusual objects on the windowsill? | – | |
| Q4 | Thief line-up | | |
| Q5 | Witness line-up | | |
| Q6 | How confident are you that your memory for the event is accurate? (1–10) | – | F1. How confident are you that your memory for the event is accurate? (1–10) |
| Q7 | Did you see a stapler on the desk? | Did you see the stapler on the desk? | F2. Did you see a stapler on the desk? |
| Q8 | How long did the thief spend in the room? e.g., 5, 10, 15 s | How long did the thief spend in the room? e.g., 1, 2, 3 min | F3. How long did the thief spend in the room? |
| Q9 | Was the thief wearing a watch? | Did the thief check the time on the watch they were wearing? | F4. Was the thief wearing a watch? |
| Q10 | Did the thief look in the drawers? | Did the thief look in the drawers before or after taking the objects? | F5. Did the thief look in the drawers? |

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## Perceptual Load

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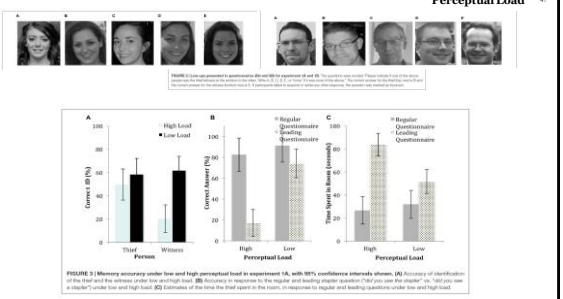


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## Perceptual Load

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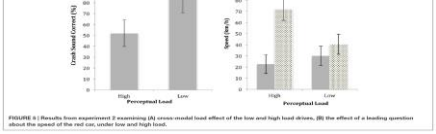
| Regular | Leading |
|---|---|
| Q1 Were there traffic lights above the intersection? | – |
| Q2 What was the vehicle to the right of the intersection? | – |
| Q3 Did you hear a car braking before or after the noise of the crash? | – |
| Q4 How confident are you that your memory for the event is accurate? (1–10) | – |
| Q5 How fast was the red car going when it made contact with the jeep? | How fast was the red car going when it smashed into the jeep? |
| Q6 How long was the jeep behind you before it overtook you? e.g., 5, 10, 15 s | How long was the jeep behind you before it overtook you? e.g., 1, 2, 3 min |
| Q7 How fast was the jeep going when it reached the intersection? | How fast was the jeep going when it ran the stop sign and reached the intersection? |
| Q8 Did you see a stop sign for the jeep? | |

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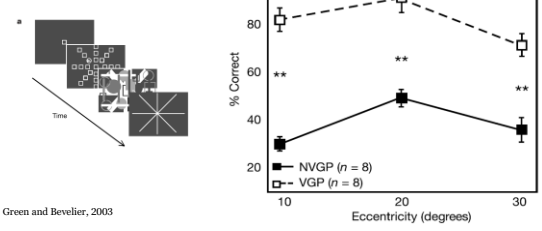
**How system decides for early or late selection ?**
**Does the system differ across expertise?**




Green and Bevelier, 2003

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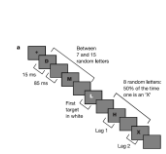
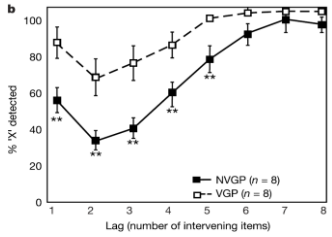
**How system decides for early or late selection ?**
**Does the system differ across expertise?**




Rapid serial visual presentation (RSVP)




Green and Bevelier, 2003

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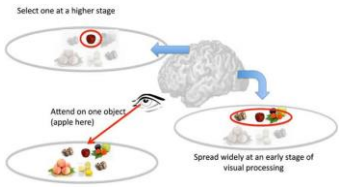
## Nature of Attention

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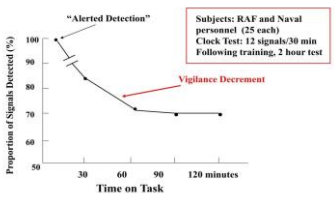
## ATTENTION IS LIMITED – spatially and temporally

**Mackworth clock test**
Vigilance – Temporal Attention - and its limitation

Results (Mackworth, 1948)

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The national transportation safety board (NTSB) final report (2014) concludes that a sleepy pilot was flying the business plane (2013). The resulting crash killed all five passengers. The NTSB concluded that "his fatigue due to acute sleep loss" contributed to the tragedy. Another factor was "his ineffective use of time between flights to obtain sleep."

The pilot lowered the landing gear on approach to the county airport. Then a system failure message came on. The pilot ignored the warning and began to land the plane. Suddenly he attempted to abort the landing by lifting off near the end of the runway. But the aircraft's left wing struck a utility pole about 63 feet above the ground. The wing was completely severed. The plane crashed nearby in a wooded area.

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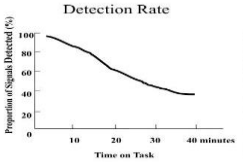
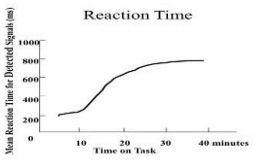
## Typical Vigilance Results

Detection Rate




- **Arousal**
- **Habituation**
- **Expectancy**
- **Attentional Resources**

Reaction Time

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## ATTENTION IS LIMITED – spatially and temporally

55

**DRIVING – spatially and temporally**


A Link Between Attentional Function, Effective Eye Movements, and Driving Ability

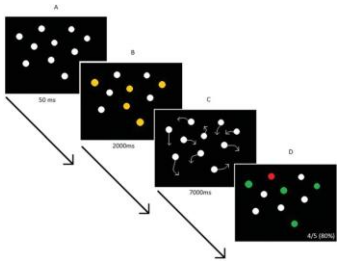
Andrew K. Mackenzie — Nottingham Trent University and University of St. Andrews
Julie M. Harris — University of St. Andrews

Screenshot images of the typical settings encountered in the (a) country highway, (b) urban area, and (c) motorway. Note the speedometer is located in the top left of the scene, with center rear-view mirror below it and passenger side mirror to the lower left. See the online article for the color version of this figure.

55

## ATTENTION IS LIMITED – spatially and temporally

56




Multiple object tracking task. Participants are presented with the stimuli (A) briefly before five dots begin to flash orange (B). All dots turn back to white and then move randomly around the scene for seven seconds (C). Motion stops and the participant must select the five dots which had flashed orange (D). In this example, the participant has correctly identified four out of a possible five targets (The final positions of the dots would not be the same as the starting positions as pictured here—this is for illustrative purposes). See the online article for the color version of this figure.

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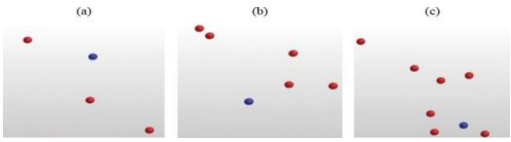
## ATTENTION IS LIMITED – spatially and temporally

57




A static representation of the multiple-object avoidance task. The task starts with three red moving circles (a), then gets increasingly more difficult such as in (b) with five circles and in (c) with seven circles. See the online article for the color version of this figure.

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## ATTENTION IS LIMITED – spatially and temporally

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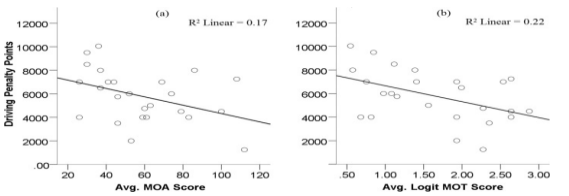
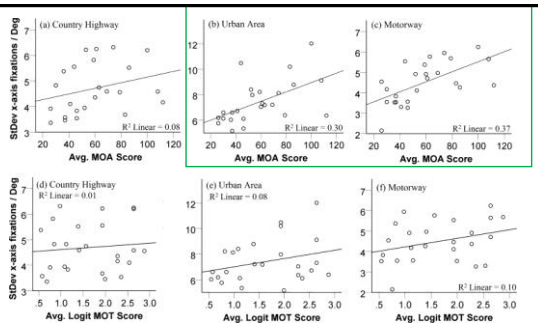


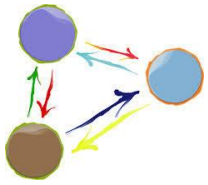

Relationship between performance in the attention tasks and driving performance. (a) Multiple object avoidance task (MOA); (b) multiple-object tracking task (MOT).

59




60

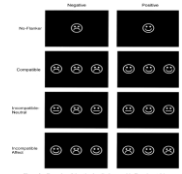
**How it interacts with other Cognitive processing?**



61

**What is the scope of attention?**
**Scope of Attn. & Emotional Stimuli**

**Flanker paradigm**



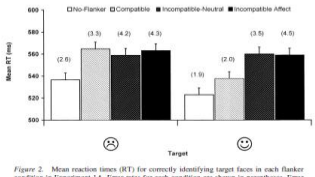



*Figure 2.* Mean reaction times (RT) for correctly identifying target faces in each flanker condition in Experiment 1A. Error rates for each condition are shown in parentheses. Error bars represent standard errors based on the procedure suggested by G. R. Loftus and Masson (1994) for within-subject designs.

Responses

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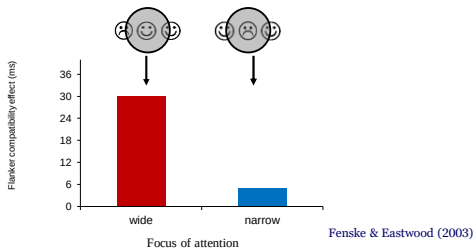
**What is the scope of attention?**
**Scope of Attn. & Emotional Stimuli**




Fenske & Eastwood (2003)

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**What is the scope of attention?**
**Scope of Attn. & Perceptual Level**

- Global cues produced benefits for both global and local targets over SOA on cued trials.
- Local cues produced benefits only for local targets.
- Scope of Attention can be contracted or expanded using hierarchical/compound stimuli

(Robertson, Egly, Lamb & Kerth 1993)

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**Perceptual Level and Emotion & Scope of Attention**

Reciprocal interaction between perceptual level and emotion

(Frederickson & Branigan, 2005)

(Srinivasan & Hanif, 2010)

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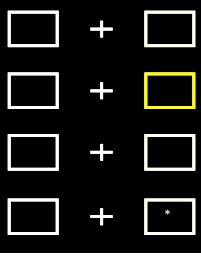
**What gets Selected?**

66

**What do we attend?**

Cueing Task: Covert and Overt Attention

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## Location-based attention


Task: Make a response as soon as you detect the target , i.e. a star

*Posner, 1980*

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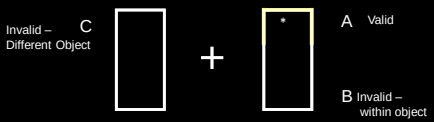
## Object-based attention




Task: Make a response as soon as you detect the target , i.e. a star

*Egly, Rafal and Driver, 1994*

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**Let's pay attention to dual or multi-task**
**How do we perform multi-task ?**

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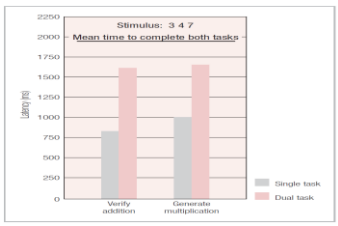
## Factors influence dual task — Task complexity




- Task 1: Judge whether the first two digits add up to the third and press a key with the right index finger if they do and another key with the left index finger if they do not.
- Task 2: Report verbally the product of the first and third numbers. In this case, the answer is 21, because 3 × 7 = 21.

FIGURE 3.21 The results of an experiment by Byrne and Anderson to see whether people can overlap two tasks. The bars show the response times required to solve two problems—one of addition and one of multiplication—when done by themselves and when done together. The results indicate that the participants were not able to overlap the addition and multiplication computations. (From Byrne & Anderson, 2001. Reprinted by permission of the publisher. © 2001 by *Psychological Review*.)

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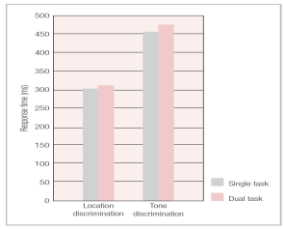
## Factors influence dual task — Task complexity




- Task 1: Press a left, middle, or right key according to whether the letter occurred on the left, in the middle, or the right.
- Task 2: Report "One," "two," or "three" according to whether the tone was low, middle, or high in frequency.

FIGURE 3.22 The results of an experiment by Schumacher et al., 2001, to see whether people can overlap two tasks—a simple location discrimination task and a tone discrimination task—when done by themselves and when done together. The results indicate that unaffected by the requirement to do the two tasks at once, because almost the same times were obtained when they were done by themselves and when done together. (From Schumacher et al., 2001. Reprinted by permission of the publisher. © 2001 by *Psychological Science*.)

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## How resource sharing occurs?

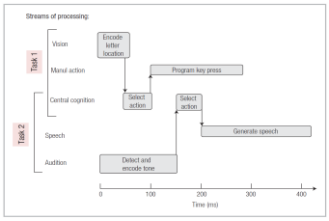


FIGURE 3.23 An analysis of the timing of events in five streams of processing during execution of the dual task in the Schumacher et al. (2001) experiment: (1) vision, (2) manual action, (3) central cognition, (4) speech, and (5) audition.

- The figure shows the time and task sharing while performing dual tasks.
- Studies have shown impairment in performance when the two tasks share their encoding, action, or central processing.

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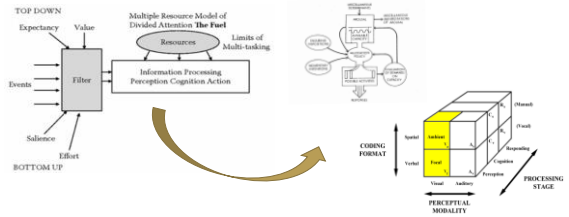
## Model of Attentional Resource

Single versus Multiple Resource Theory




Different attention resources help shifting attention/ switching attention from one task/ concept to another.

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## Automaticity & Control

| 1 control | 2 compatible | 3 incompatible |
|---|---|---|
| dog | red | red |
| chair | yellow | yellow |
| boat | green | green |
| window | blue | blue |
| block | red | red |
| fan | blue | blue |
| wheel | yellow | yellow |
| tray | green | green |
| bottle | blue | blue |
| fence | red | red |

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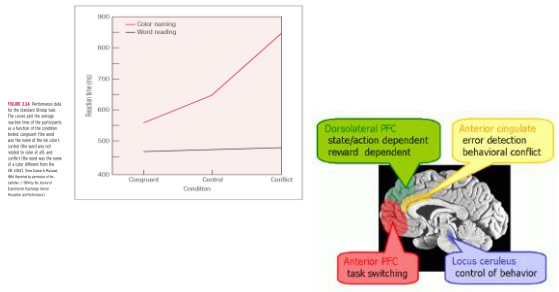


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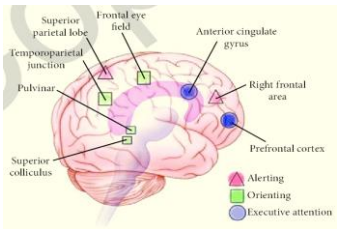
## ATTENTION as a system – Attention Networks – Posner and Peterson (1992)

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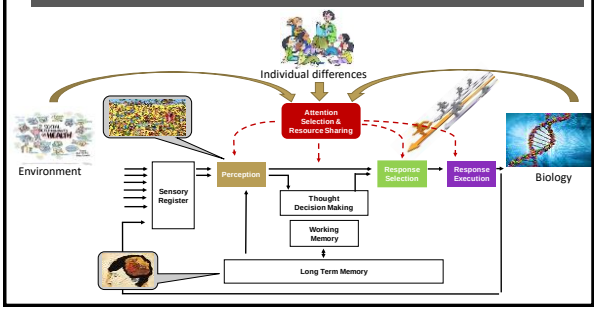
## Locus of Attention and factors that influence attention

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## ATTENTION Is Part of Everyone's Cognitive Architecture

- **Orienting Reflexes:** paying attention to important stimuli and changes in the environment.
- **Novel object –** increases the where and/or what pathway in brain as per the task demands

**However, the same objects shows decrement in brain activities when they become familiar, because it no-longer capture our attention. This is called as habituation.**

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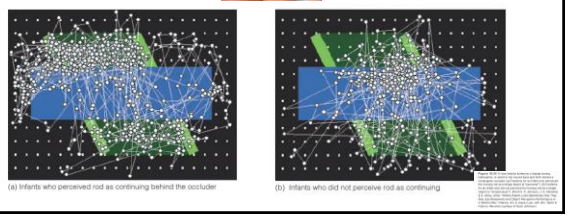
## ATTENTION Is Part of Everyone's Cognitive Architecture

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## Attention Disorder – ADHD and Hemineglect


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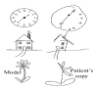
## Visual Neglect



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