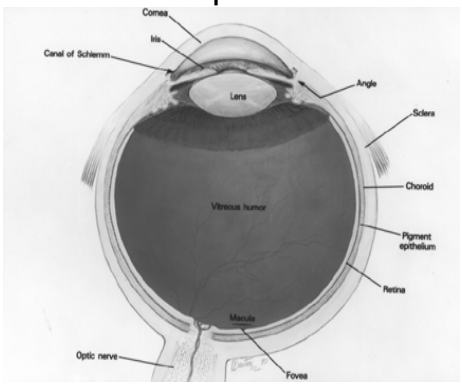
Chapter 3 – Perception & Pattern Recognition

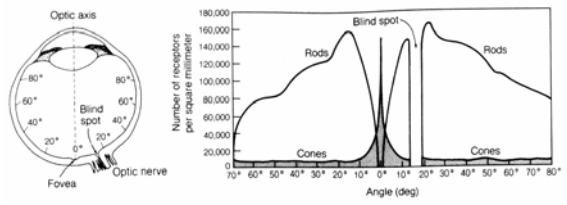
Input



Photoreceptors

- Cones – Colour sensitive
  - Red
  - Green
  - Blue
- Rods – Luminance sensitive
  - achromatic (white-black)

Distribution of Photoreceptors



Colour Blindness (%)

	Males	Females
Anomalous Trichromacy	6.3	0.37
• Protanomaly (L-cone defect)	1.30	.02
• Deuteranomaly (M-cone defect)	5.00	.35
• Tritanomaly (S-cone defect)	0.0001	0.0001
Dichromacy	2.4	0.03
• Protanopia (L-cone absent)	1.30	.02
• Deuteranopia (M-cone absent)	1.20	.01
• Tritanopia (S-cone absent)	0.001	0.03
Rod Monochromacy (no cones)	0.00001	0.00001

Refining the input

- Photoreceptors -> Bipolar Cells
- Bipolar Cells -> Ganglion Cells
- Ganglion Cells -> Visual Cortex

Refining the input

- Photoreceptors -> Bipolar Cells
- Bipolar Cells -> Ganglion Cells
- Ganglion Cells -> Visual Cortex
  - Opponent process
    - Red-green
    - Blue-yellow
    - White-Black

Sensation vs. Perception

- Sensation: the reception of stimulation from the environment and the initial encoding of that stimulation into the nervous system
- Perception: the process of interpreting and understanding sensory information

Saccades and Fixations

- ***Saccade***: the quick movement of the eyes from one location to another
- saccades vary in duration (in part as a function of length) but often take about 25-100 msec
- ***Fixation***: the brief period when the eyes stop moving and process the visual scene
- fixations also vary in duration (e.g., in reading) but typically last 200 msec or less

George Sperling (1960)

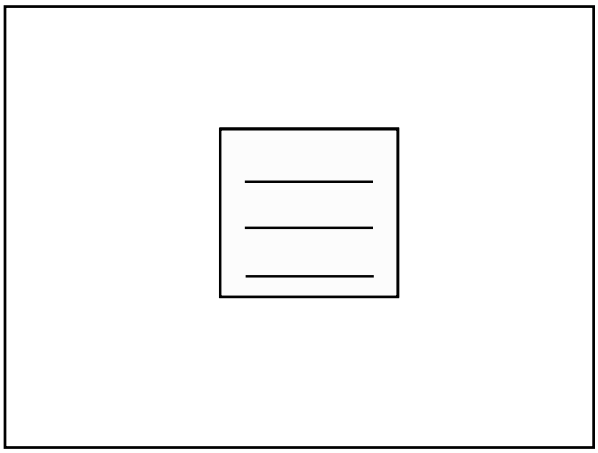
- his Ph.D. dissertation
- challenged the concept of limited perceptual span
- introduced the concept of iconic memory as a sensory store

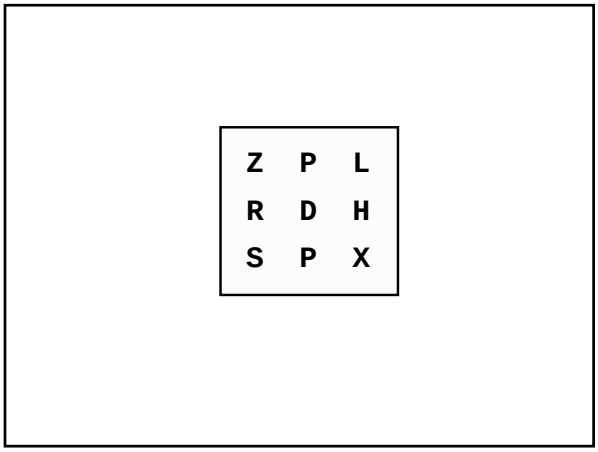
The Apparatus

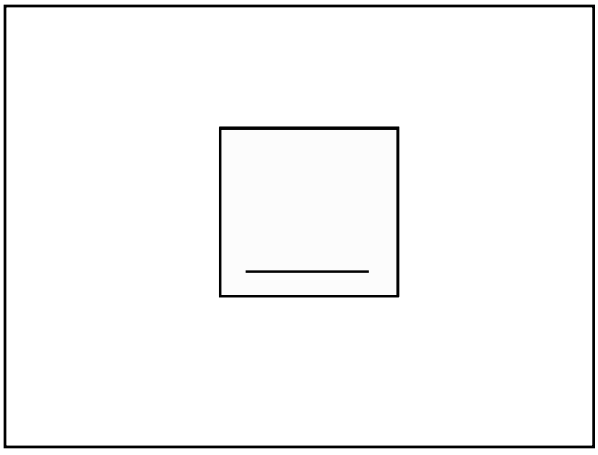
- tachistoscope (T-scope) developed by Cattell (1895)
- *takhistos* (most swift) + *scopein* (to see)
- permits brief display and rapid switch between displays

Sperling (1960)

- he replicated the standard perceptual span limitation of 4.5 items, as long as the display was less than an eye fixation (10-200 msec)
- his subjects reported two “introspections”:
  - They claimed that they had actually *seen* the *whole* array, but “forgot” it while reporting
  - They claimed that the array seemed to *fade* but was available to examine mentally even *after* it went off the screen




Z P L
R D H
S P X

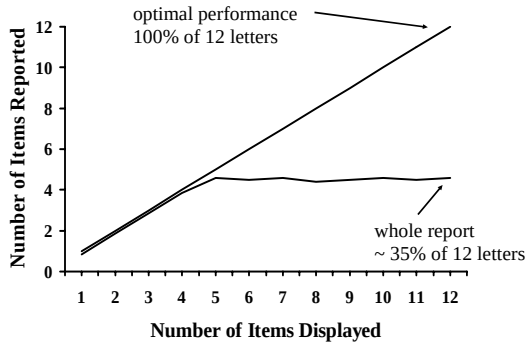


W	T	Q
F	N	C
B	G	L

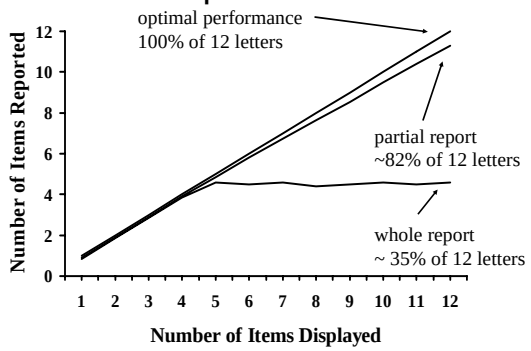
Exp. 1: Partial Report

- ***whole report*** = trying to report everything that was presented (i.e., perceptual span)
- ***partial report*** = trying to report only that portion of the display that is cued
- Sperling used 50-msec displays followed by tone cues
- Key question:
  Would 3 X partial report = whole report?

Exp. 1 Data



Exp. 1 Data

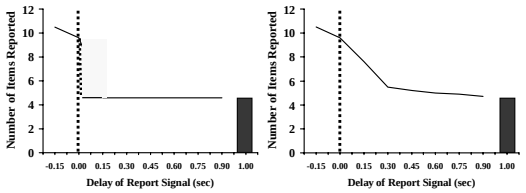


Exp. 2

- only one array size (3 X 4)
- only partial report
- variable delay before the partial report signal

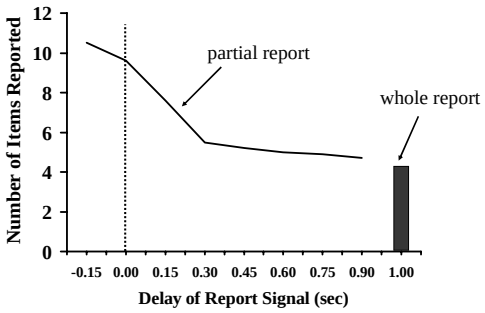
- logic:
  - if there is no icon, then any delay should eliminate partial report advantage
  - if there is an icon, the partial report advantage should decrease as that icon fades over time

Exp. 2: Predictions



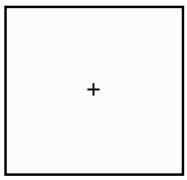
No Icon Icon

Exp. 2 Data

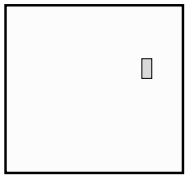


Averbach & Coriell (1961)

- cued only one location to reduce memory demands even more (*ultimate* partial report!)
- replicated Sperling's results using bar marker as cue



T	F	L
B	V	Q
K	S	D



Averbach & Coriell (1961)

- cued only one location to reduce memory demands even more (*ultimate* partial report!)
- replicated Sperling's results using bar marker as cue
- but when they used a circle as the cue…

Conclusions

- a lot is perceived in a single fixation
- perceptual span is not a good measure of what is perceived
- an iconic image persists after the display disappears
- this image, or “icon,” decays and is lost very rapidly

Sperling (1960) Exp. 3

- ***Question***: What is the format of representation in iconic memory?
- mix letters and digits
- 3 kinds of report:
  - whole
  - partial – spatial (row)
  - partial – categorical (type)

Exp. 3: Data

- partial spatial report (as in earlier experiments) was better than whole report
- partial categorical was no better than whole report
- ***Conclusion***: all of the information in iconic store is very visual and quite unprocessed as to meaning = raw, sensory information

Template Theories

- ***Template***: a pattern treated as an unanalyzed whole
- e.g., numbers on cheques; universal bar codes

- problems:
  - complexity
  - pattern differences
  - multiple interpretations

Feature Theories

- ***Feature***: a separable element of a pattern
- a feature theory aims to describe a pattern by listing the elements of that pattern
- ties well to concept identification

- an example—letter recognition as done by Selfridge's (1959) Pandemonium model

Letter Recognition by Features

A B C D E F G H I J K L M

N O P Q R S T U V W X Y Z

1. Is there a CURVED line?

Curved Line? No!

A E F H I K L M

N T V W X Y Z

2. Is there a DIAGONAL line?

YES NO

Diagonal Line? Yes!

A K M

N V W X Y Z

3. Are there TWO DIAGONAL lines?

YES NO

Two Diagonal Lines? Yes!

A K M

V X Y

4. Is there a HORIZONTAL line?

YES NO

Horizontal Line? Yes!

A

We have a winner in 4 questions!!

Letter Recognition by Features

A B C D E F G H I J K L M

N O P Q R S T U V W X Y Z

1. Is there a CURVED line?

YES NO

Curved Line? Yes!

B C D G J

O P Q R S U

2. Is there a STRAIGHT line?

YES NO

Straight Line? Yes!

B D G J

P R

3. Is there a CLOSED PART?

Closed Part? Yes!

B D

P R

4. Is there a DIAGONAL line?

Diagonal? Yes!

R

We have a WINNER in 4 questions!!

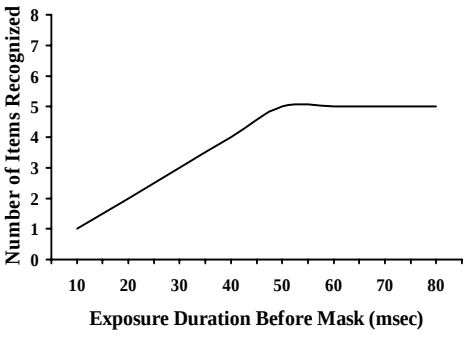
Sperling (1963)

- ***Question***: How quickly does pattern recognition copy information from sensory store to working memory?
- manipulate exposure duration of array from 5 msec to 200 msec
- but there was a problem….

Problem & Solution

- ***Problem***: Question assumes you can only extract information during actual display, but we already know that isn't true because of the icon
- ***Solution***: Use a mask to wipe out the icon so pattern recognition can only occur during the display

Sperling (1963): Data



Sperling's Conclusions

- we can pattern recognize about 1 letter in every 10 msec, up to a maximum of 5
- why can't pattern recognition keep going?
  - limit on working memory capacity (load)
  - pattern recognition works in bursts (cycling)

Summary

- representation in sensory store is in terms of raw, sensory, uninterpreted information
- sensory store has a very large capacity, contrary to what the perceptual span suggests
- the duration of information in sensory store is very brief—1/4 to 1 sec (iconic), or 1 to 4 sec (echoic)—with forgetting via rapid decay
- transfer to Working Memory occurs via pattern recognition, presumably using feature analysis

Bottom-up vs Top-down

- [bottom = sensory input; top = knowledge]
- ***Bottom-up***: processing begins with the sensory input and ends with its representation. The outcome of a lower step is never affected by a higher step in the process
- ***Top-down***: the output of a lower step is influenced by a higher one