

Questions?

- Project #1
- Correction about last lecture

The diagram illustrates the flow of information through the human memory system. At the top, a box labeled "LONG-TERM MEMORY" contains the following parameters:

- $\delta_{LTM} = \infty$
- $\mu_{LTM} = \infty$
- $\kappa_{LTM} = \text{Semantic}$

Below this is a box labeled "WORKING MEMORY" which is divided into two columns: "VISUAL IMAGE STORE" and "AUDITORY IMAGE STORE".

VISUAL IMAGE STORE	AUDITORY IMAGE STORE
$\delta_{VIS} = 200 \text{ [70~1000] msec}$	$\delta_{AIS} = 1500 \text{ [900~3500] msec}$
$\mu_{VIS} = 17 \text{ [7~17] letters}$	$\mu_{AIS} = 5 \text{ [4.4~6.2] letters}$
$\kappa_{VIS} = \text{Physical}$	$\kappa_{AIS} = \text{Physical}$

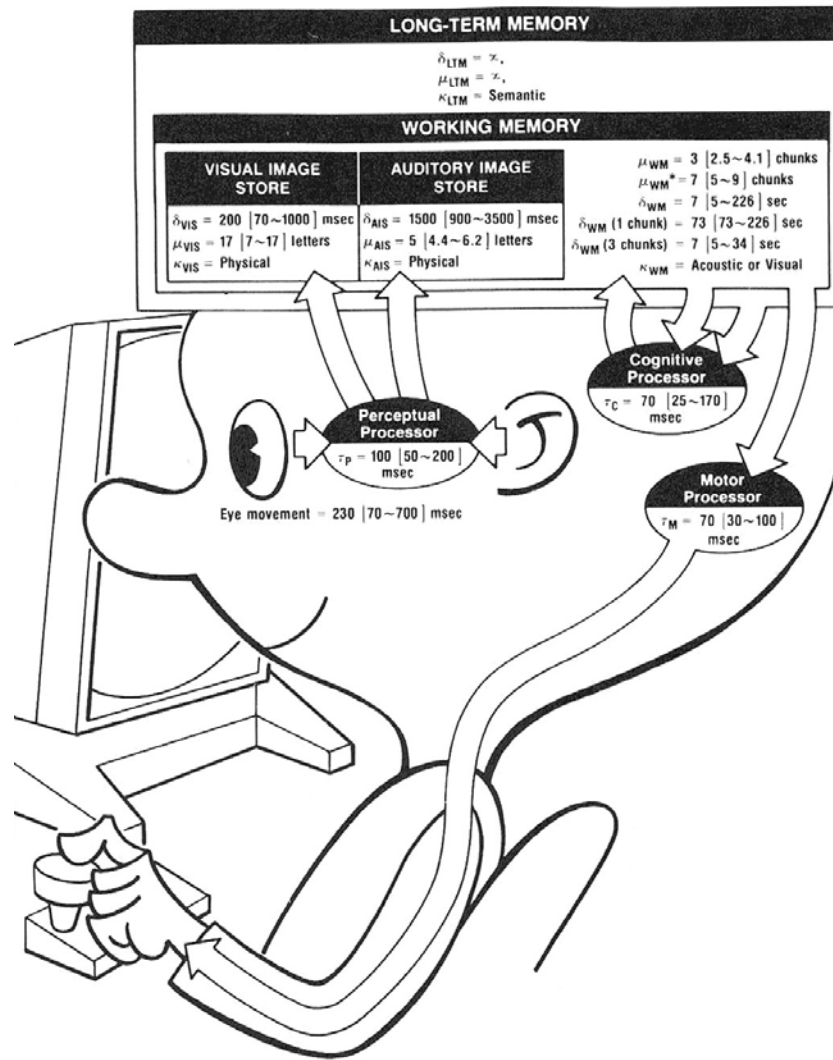
To the right of the Working Memory box, additional parameters are listed:

- $\mu_{WM} = 3 \text{ [2.5~4.1] chunks}$
- $\mu_{WM}^* = 7 \text{ [5~9] chunks}$
- $\delta_{WM} = 7 \text{ [5~226] sec}$
- $\delta_{WM} \text{ (1 chunk)} = 73 \text{ [73~226] sec}$
- $\delta_{WM} \text{ (3 chunks)} = 7 \text{ [5~34] sec}$
- $\kappa_{WM} = \text{Acoustic or Visual}$

Below the Working Memory box, the flow of information is depicted through several processors:

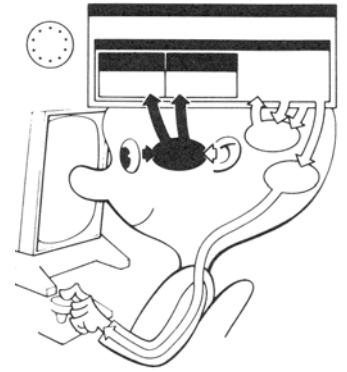
- Perceptual Processor:** Receives input from the Visual and Auditory Image Stores. Its parameters are $\tau_P = 100 \text{ [50~200] msec}$. It is connected to the eye and ear icons.
- Cognitive Processor:** Receives input from the Perceptual Processor and Working Memory. Its parameters are $\tau_C = 70 \text{ [25~170] msec}$.
- Motor Processor:** Receives input from the Cognitive Processor and Working Memory. Its parameters are $\tau_M = 70 \text{ [30~100] msec}$.

At the bottom, a hand is shown typing on a keyboard, with an arrow indicating the output of the Motor Processor. The diagram also includes an illustration of a person sitting at a desk with a computer monitor, with arrows showing the flow of information between the external world and the internal memory system.



Perceptual Processor

- Physical store from our senses: here sight
- Decoded for transfer to working memory
 - Progressive
 - *Example: 10ms/letter*
 - Selective
 - *Spatial*
 - *Pre-attentive: color, direction...*
- Capacity
 - Example: 17 letters



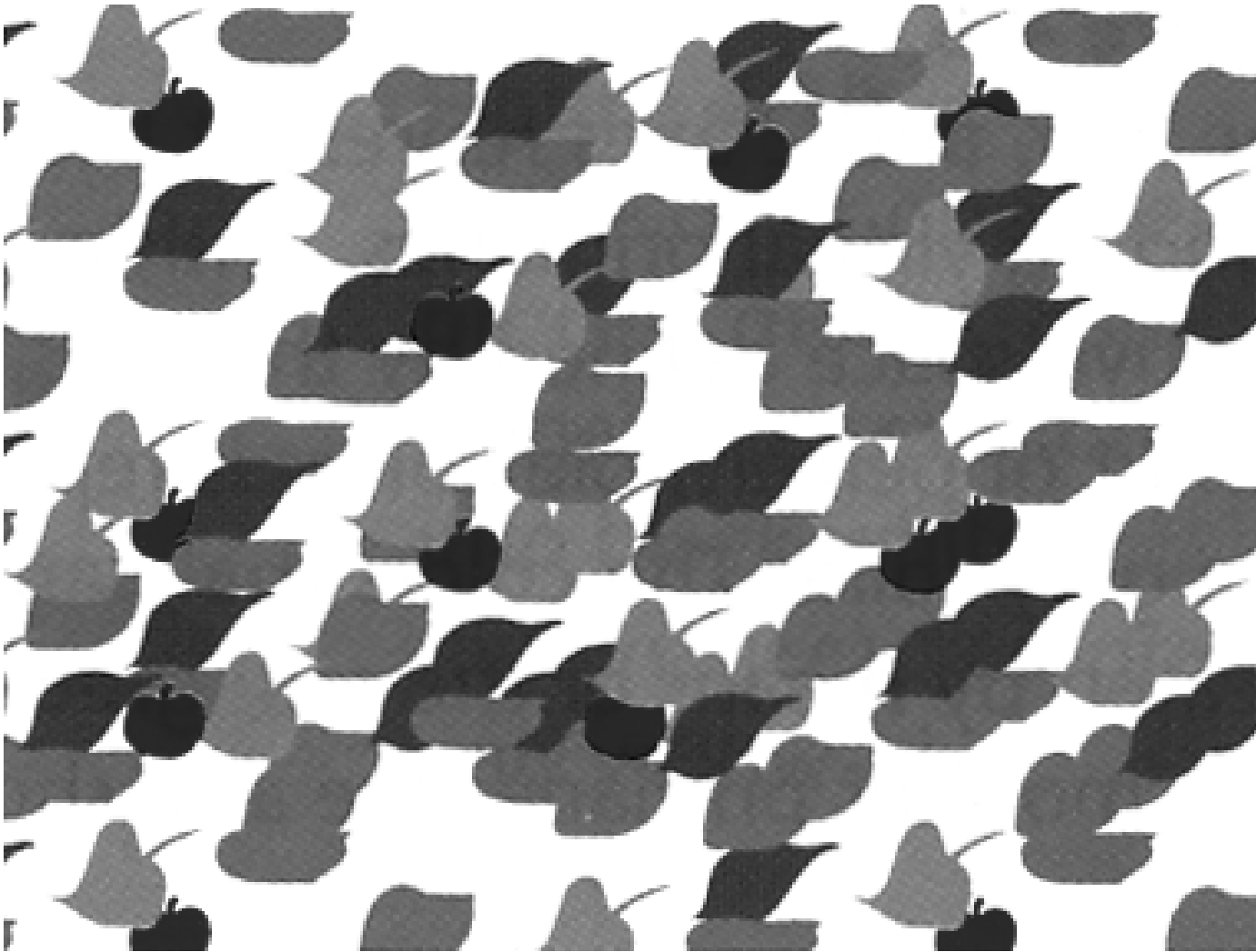
Pre-attentive perception: How many 3s?

85689726984689762689764358922659865986554897689269898
02462996874026557627986789045679232769285460986772098
90834579802790759047098279085790847729087590827908754
98709856749068975786259845690243790472190790709811450
85689726984689762689764458922659865986554897689269898

Pre-attentive perception: How many 3s?

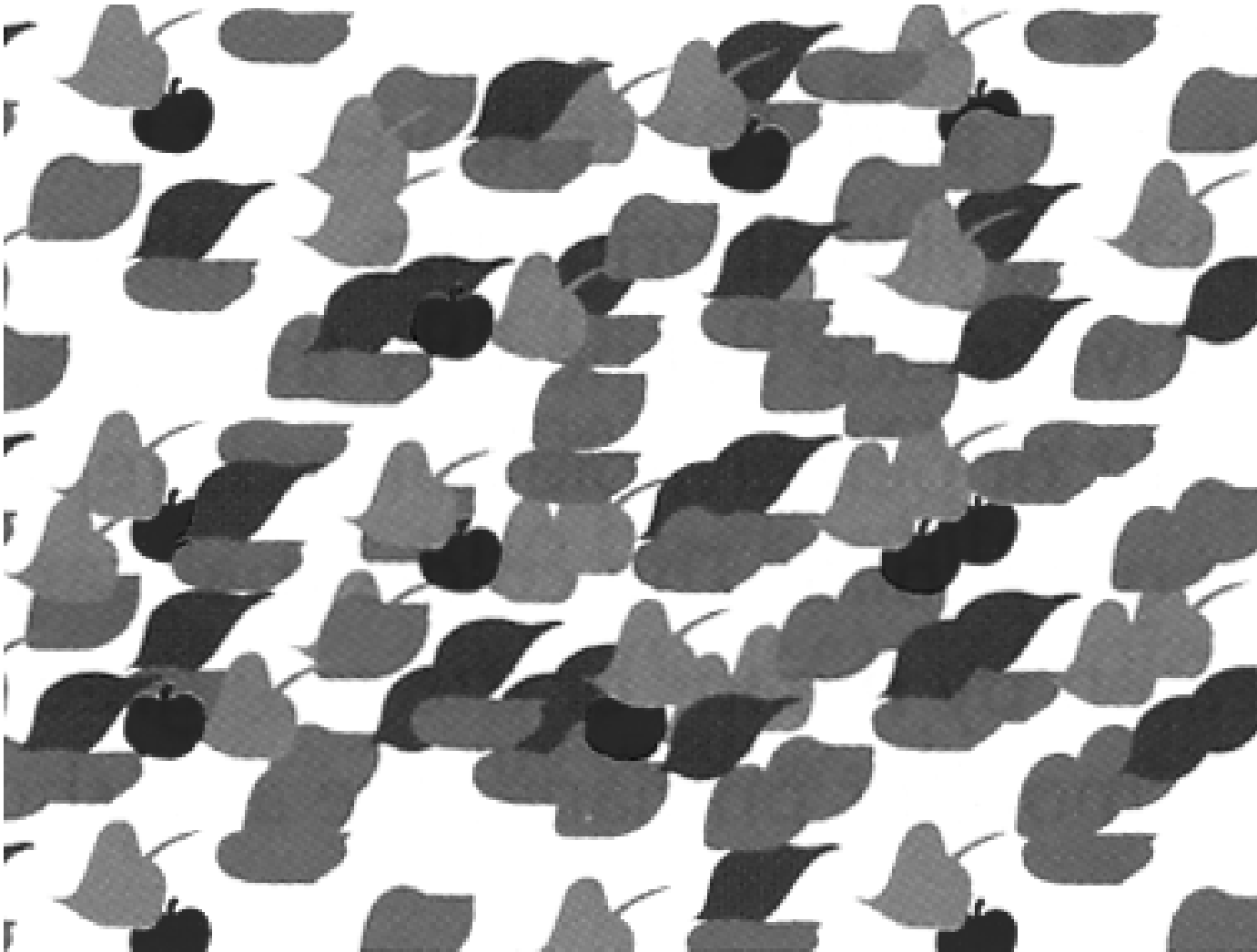
85689726984689762689764**3**58922659865986554897689269898
024629968740265576279867890456792**3**2769285460986772098
908**3**4579802790759047098279085790847729087590827908754
9870985674906897578625984569024**3**790472190790709811450
85689726984689762689764458922659865986554897689269898

Where are the cherries?



From Information Visualization, C. Ware

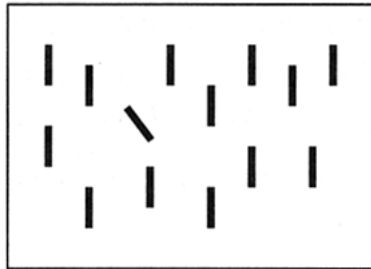
Where are the cherries?



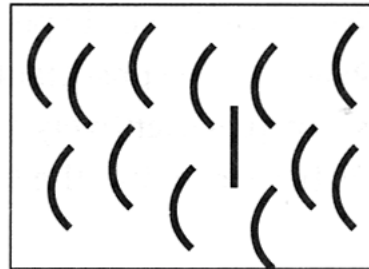
From Information Visualization, C. Ware

Other examples of pre-attentive variables

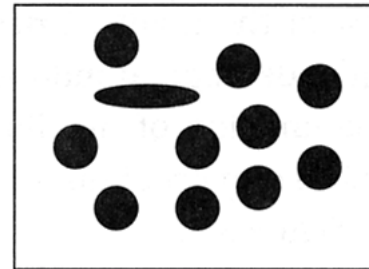
Orientation



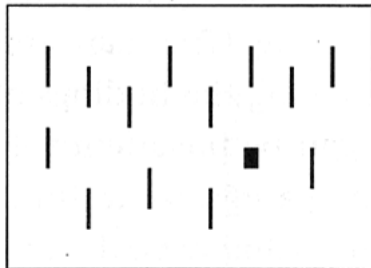
Curved/straight



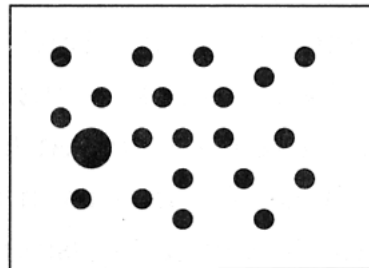
Shape



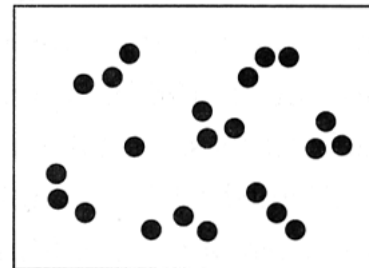
Shape



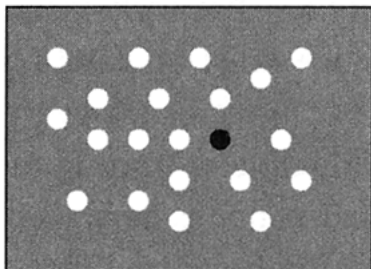
Size



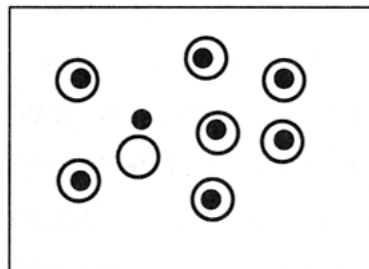
Number



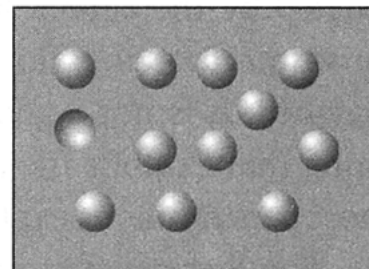
Gray/value



Enclosure

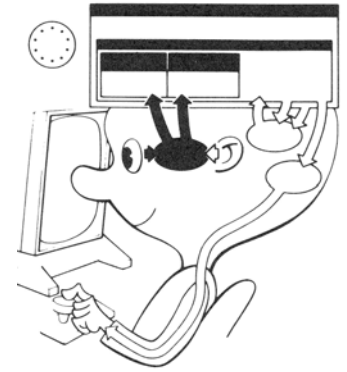


Convexity/concavity

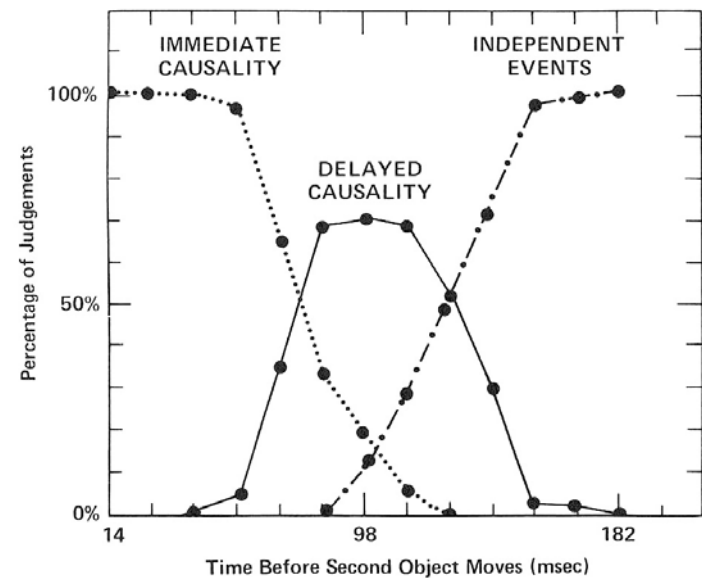
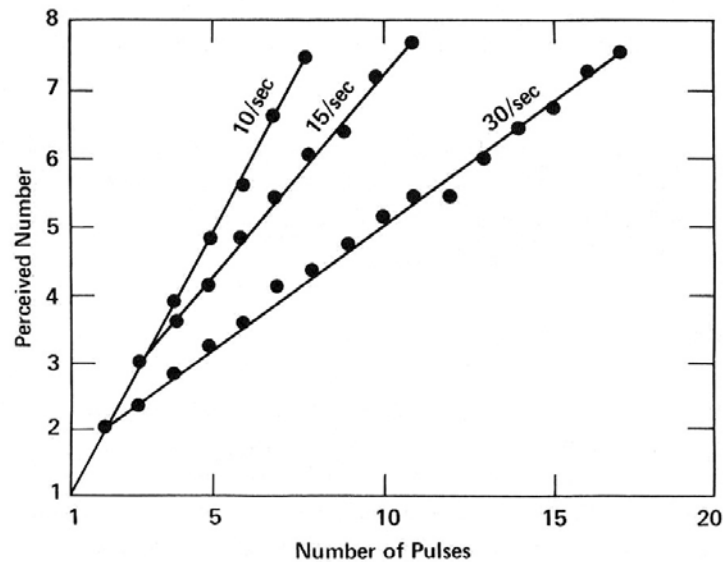


From Information Visualization, C. Ware

Perceptual Processor

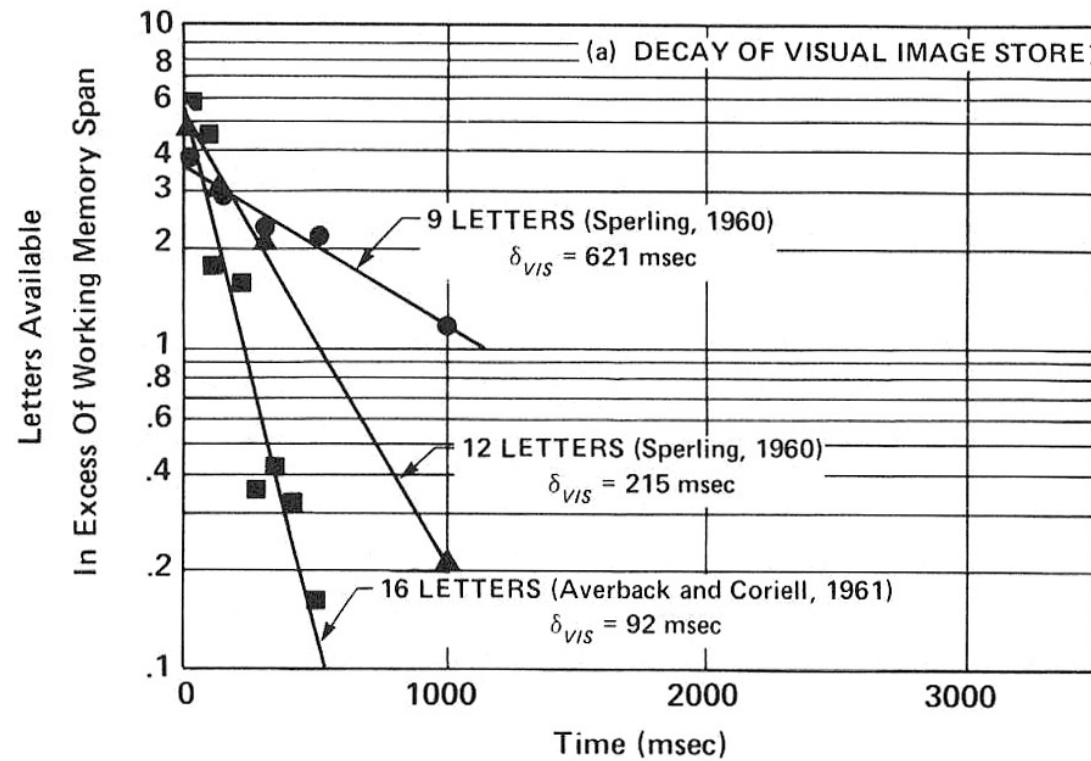
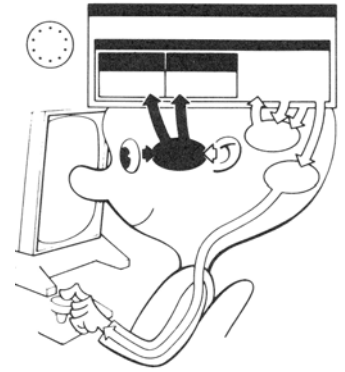


- Cycle time
 - Quantum experience: 100ms
 - *Percept fusion*
 - *Causality*

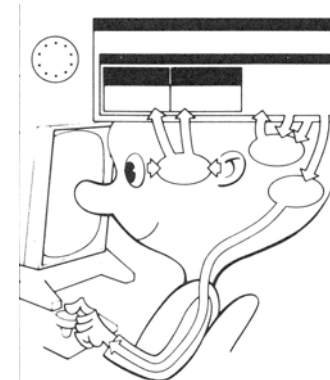


Perceptual Processor

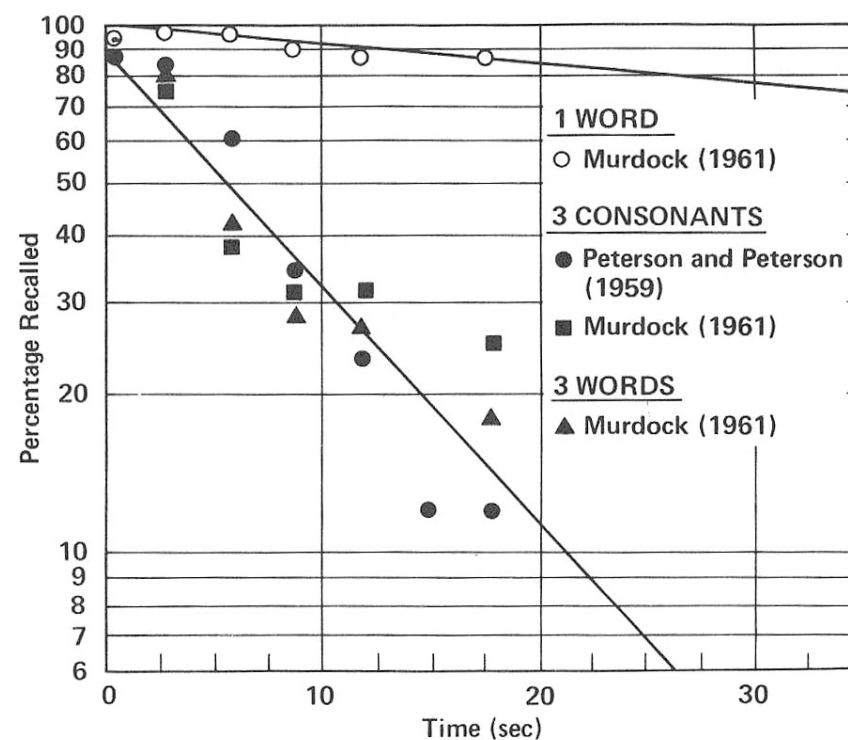
- Decay: 200ms



Working Memory

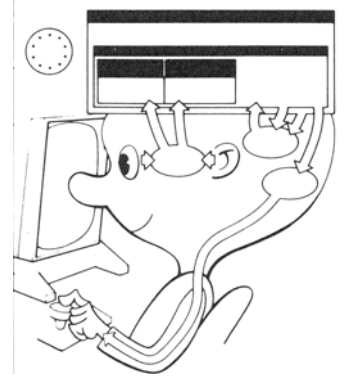


- Access in chunks
 - Task dependent construct
 - 7 ± 2 (Miller)
- Decay
 - Content dependant
 - Limit attention span

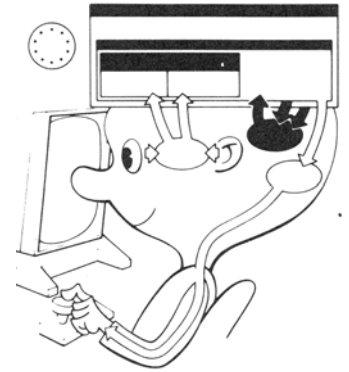


Long term memory

- Very large capacity
 - Semantic encoding
- Associative access
 - Fast read: 70ms
 - Expensive write: 10s
 - *Several Rehearsal and/or recall,*
- Context at the time of acquisition key for retrieval
- Noisy



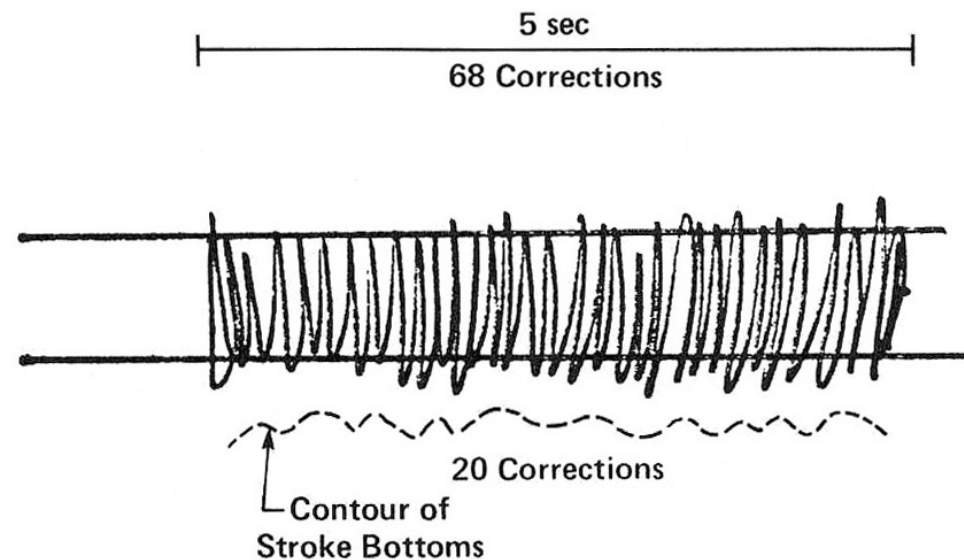
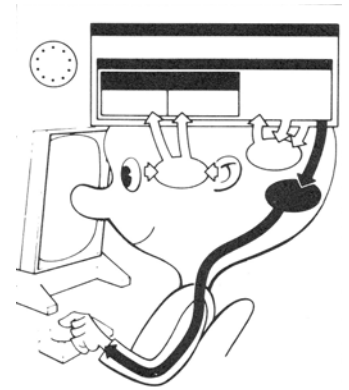
Cognitive Processor



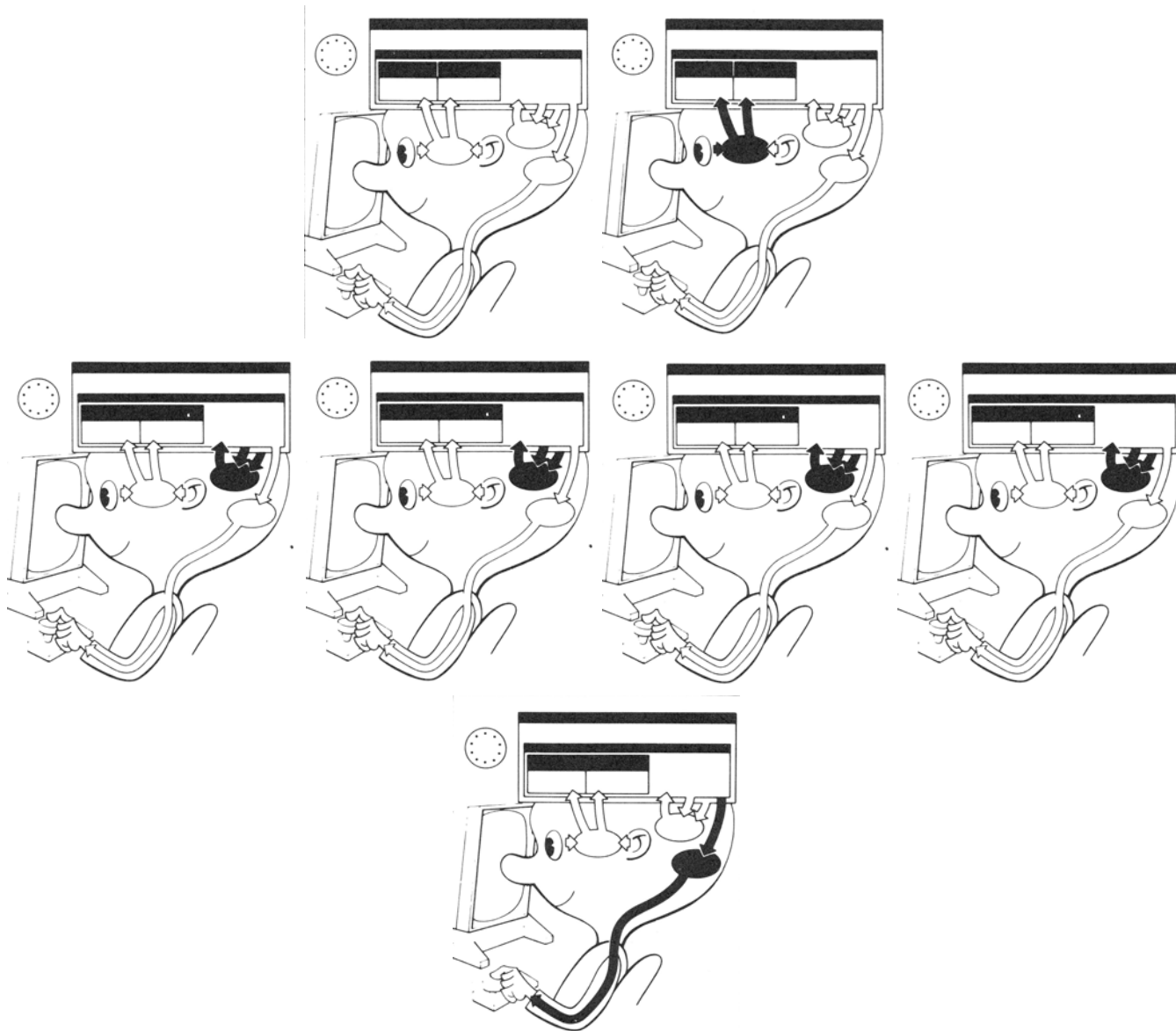
- Cycle time: 70ms
 - Can be modulated
- Typical matching time
 - Digits: 33ms
 - Colors: 38ms
 - Geometry: 50ms...
- Fundamentally serial
 - One locus of attention at a time
 - *Eastern 401, December 1972*
 - Crew focused on checking the landing gear indicator bulb,
 - Meanwhile the aircraft is losing altitude (horn, warning indicator...),
 - Aircraft crashed in the Everglades
 - see “The Human Interface” by Raskin, p25
 - *But what about driving and talking?*

Motor Processor

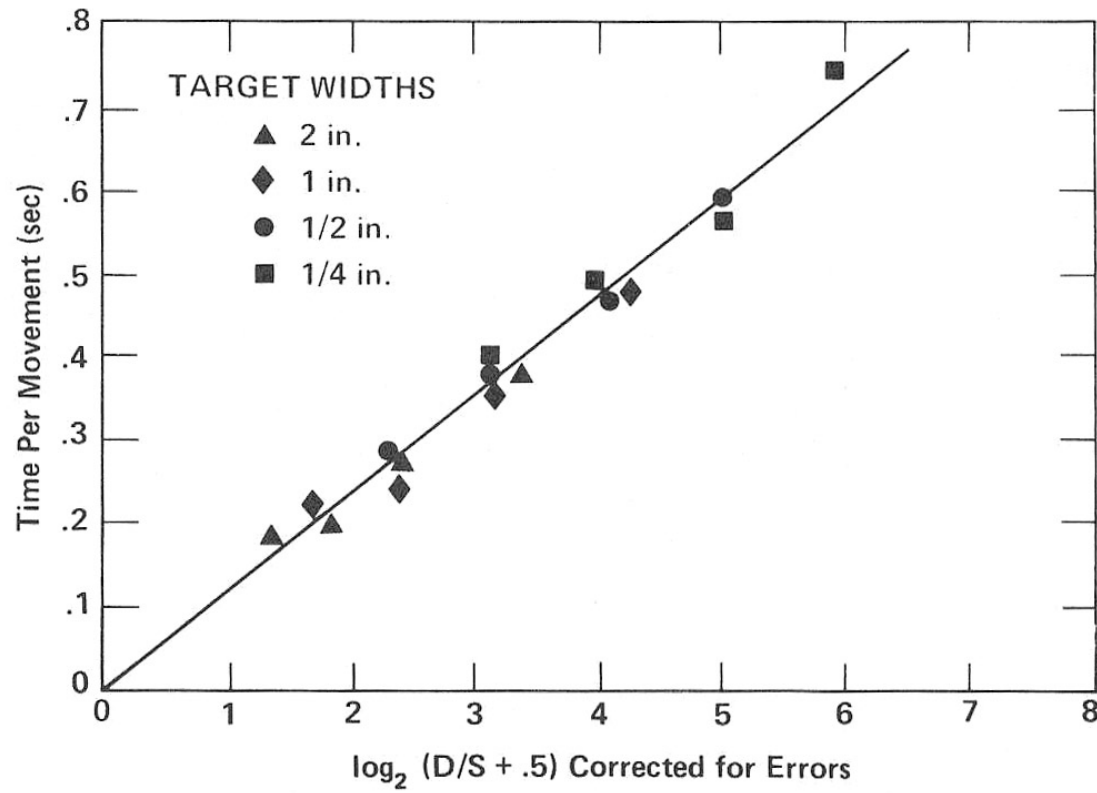
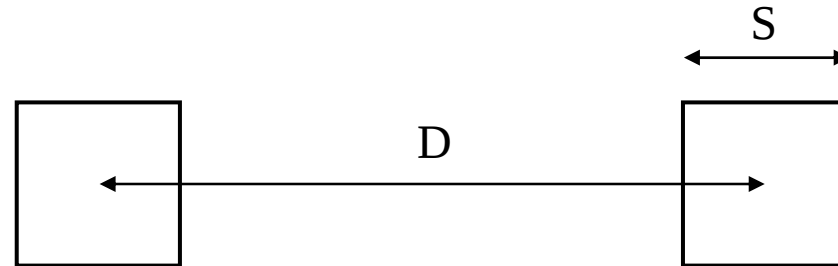
- Receive input from the cognitive processor
- Execute motor programs
 - Pianist: up to 16 finger movements per second
 - Point of no-return for muscle action



Put it together: Are A and B letters?

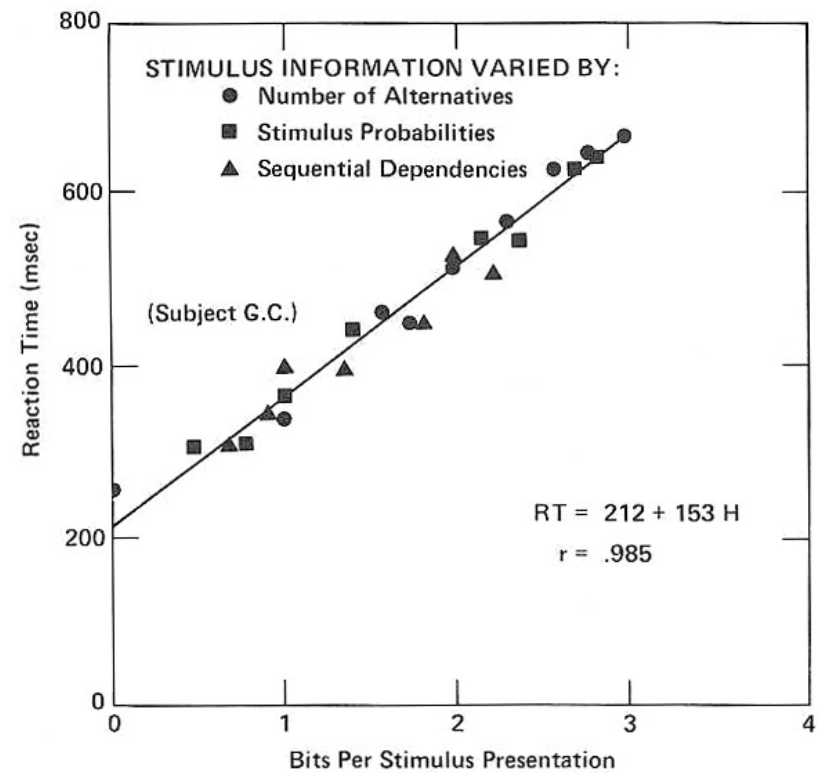
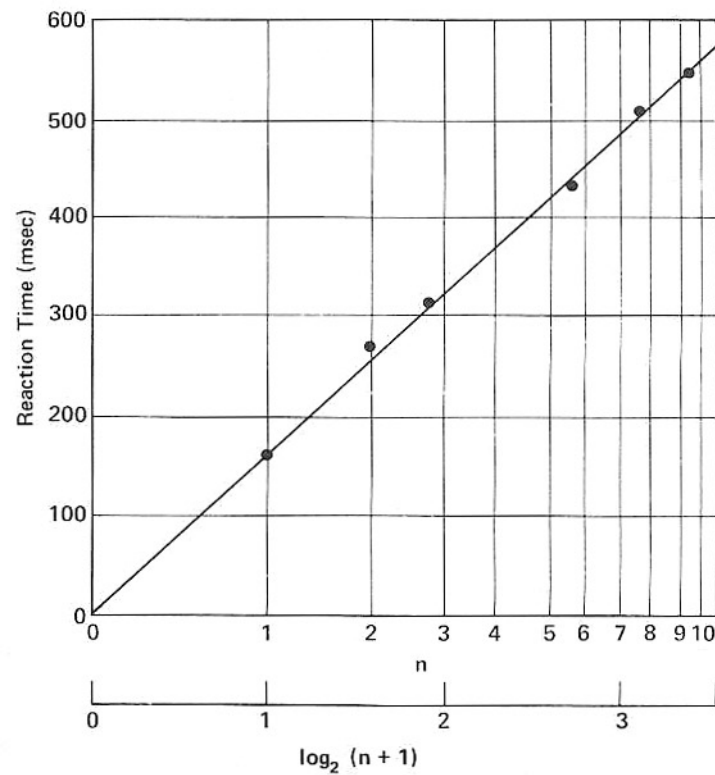


Put it together: Fitts' law (tapping task)



Hick's law

- Cost of taking a decision



Scope and Caveats

- Only a model
- Focus on low level phenomenon
 - Can be dwarfed by other considerations
 - *Learning*,
 - *Compatibility*
- Questions?