Human-Computer Interface

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Today's Topics

- Understanding Users
- Human Perception
- Cognitive Process

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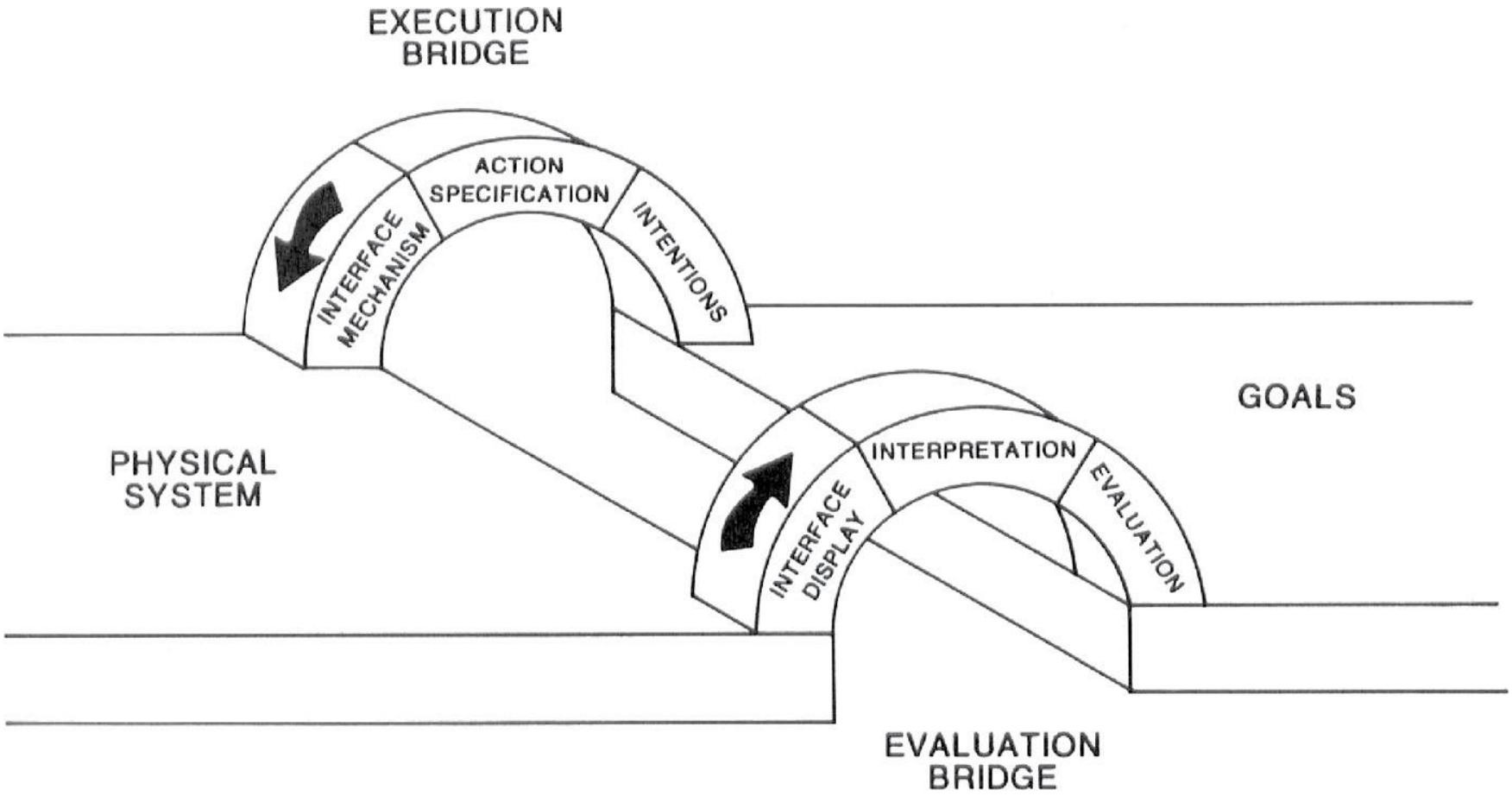
- ***Understanding Users***
- Human Perception
- Cognitive Process

Gulfs of Execution and Evaluation

- The ‘gulfs’ explicate the gaps that exist between the user and the interface
- The gulf of execution
  - The distance from the user to the physical system
- The gulf of evaluation
  - the distance from the physical system to the user

- Bridging the gulfs can reduce cognitive effort required to perform tasks

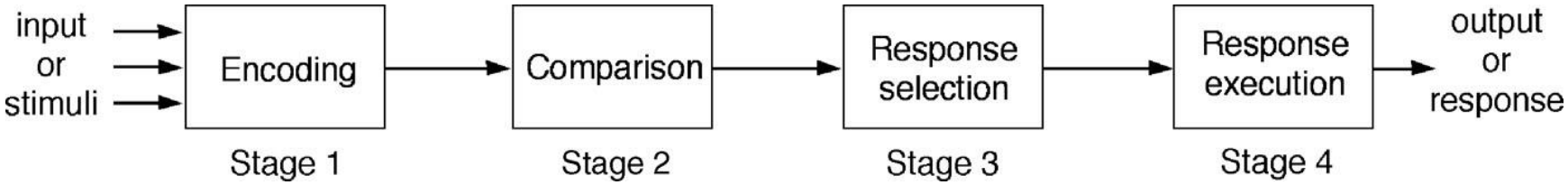
Bridging the gulfs



Norman, 1986; Hutchins *et al*, 1986

Information Processing

- Conceptualizes human performance in metaphorical terms of information processing stages

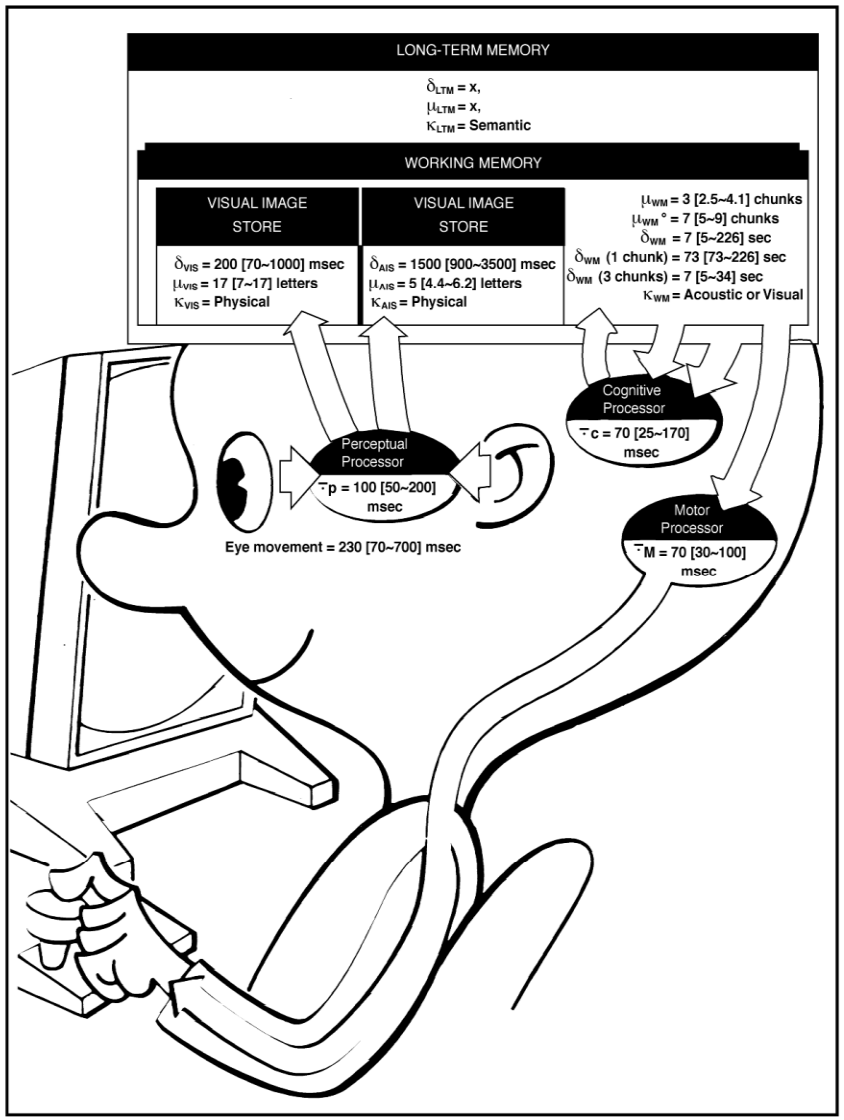


Model Human Processor

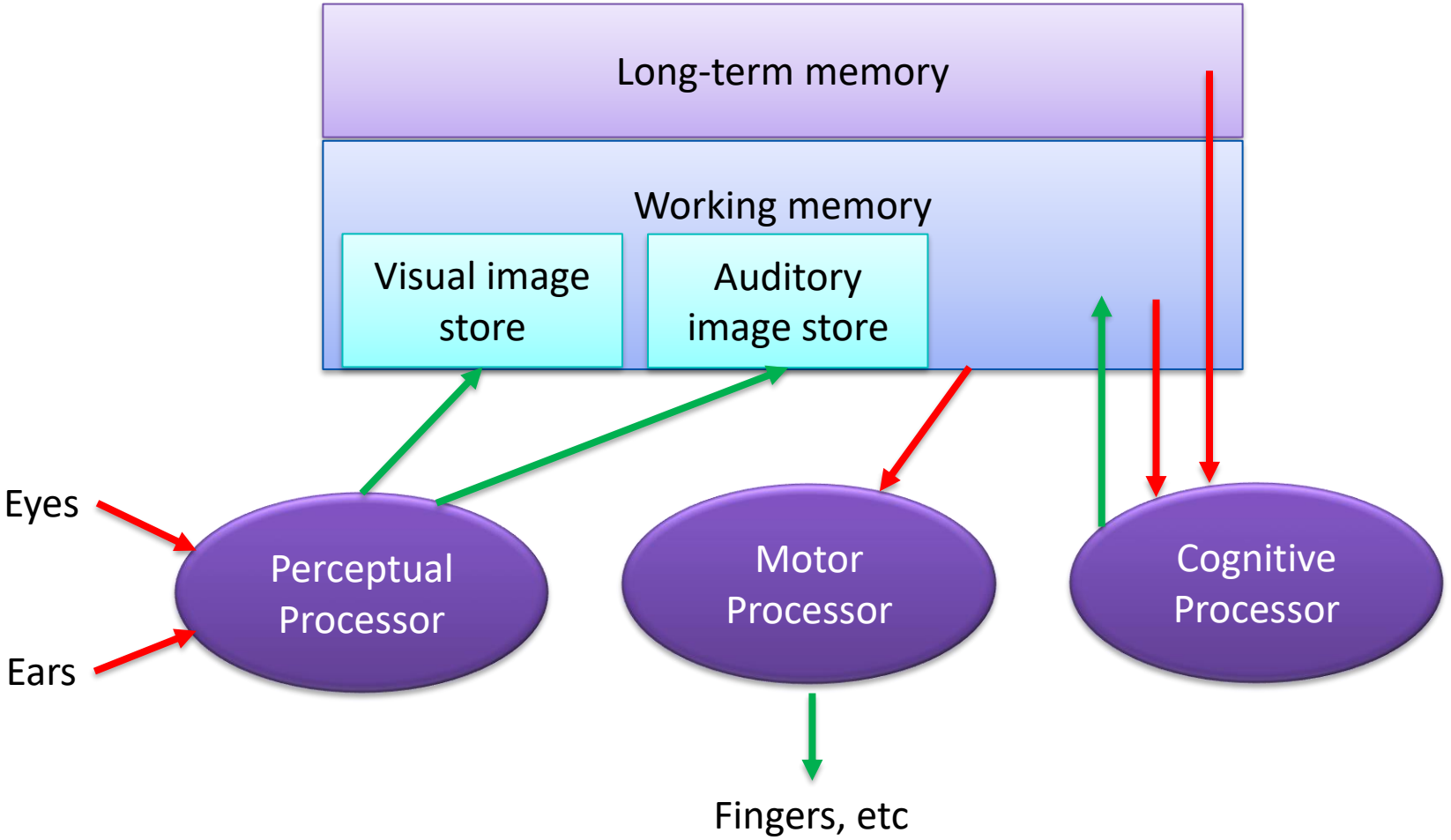
- The most famous one – Card et al, 1983

- Models the information processes of a user interacting with a computer
- Predicts which cognitive processes are involved when a user interacts with a computer
- Enables calculations to be made of how long a user will take to carry out a task

Model Human Processor



Model Human Processor



Limitations

- Based on modeling mental activities that happen exclusively inside the head

  → *external cognition*

- Do not adequately account for how people interact with computers and other devices in real world

  → *distributed cognition*

Today's Topics

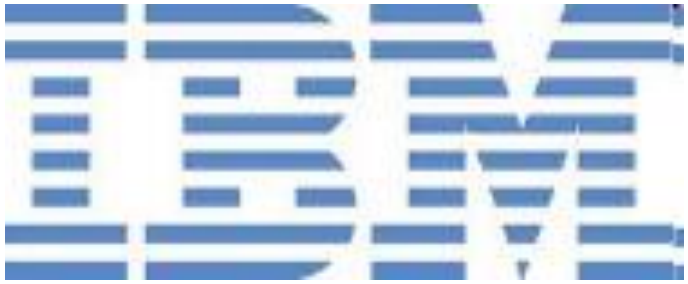
- Understanding Users
- ***Human Perception***
- Cognitive Process

Cognitive Psychology

- What psychology has to do with software development?
  - Interacting with technology is cognitive
  - Provides knowledge about what users can and cannot be expected to do
  - The way an interface is designed can greatly affect how well users can perceive, attend, learn and remember how to do their tasks

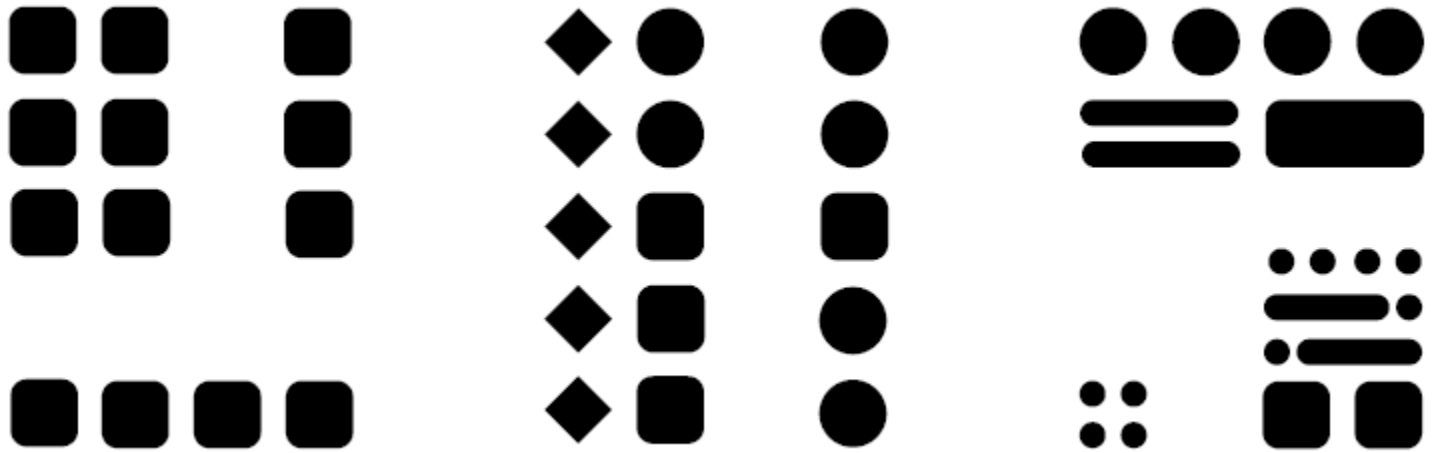
Gestalt Law (格式塔心理学)

- Gestalt
  - *noun, [guh-**shtahlt**, -**shtawlt**], (German)*
  - Configuration (完形) or Pattern (型式)
- The essence or shape of an entity's complete form (完形心理学)
  - Users tend to regard visual content as a whole
  - Laws of grouping (完整性法则)



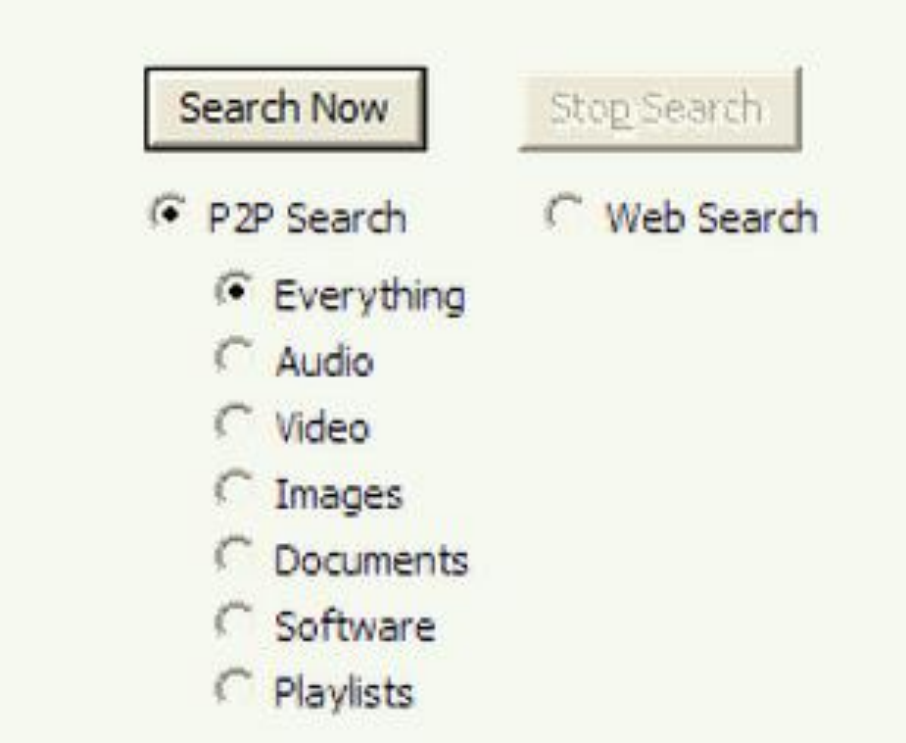
Law of Proximity (邻近性法则)

- The closer objects are to each other, the more likely they are to be perceived as a group



Law of Proximity

- Group items based on relevance

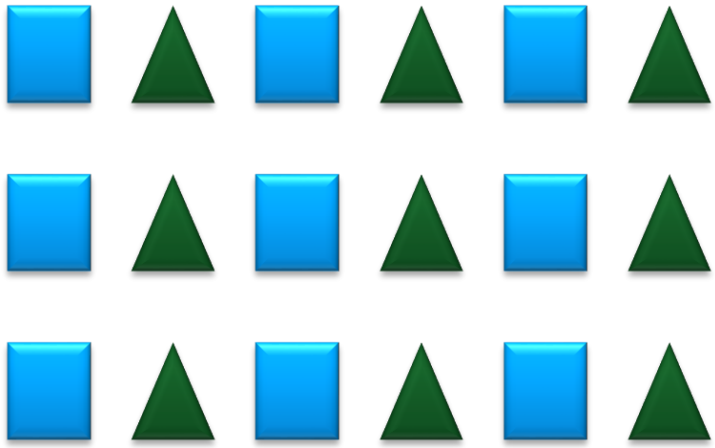


An example of the use of the law of proximity in interface design - Kazaa Media Desktop

Law of Proximity

Law of Similarity (相似性法则)

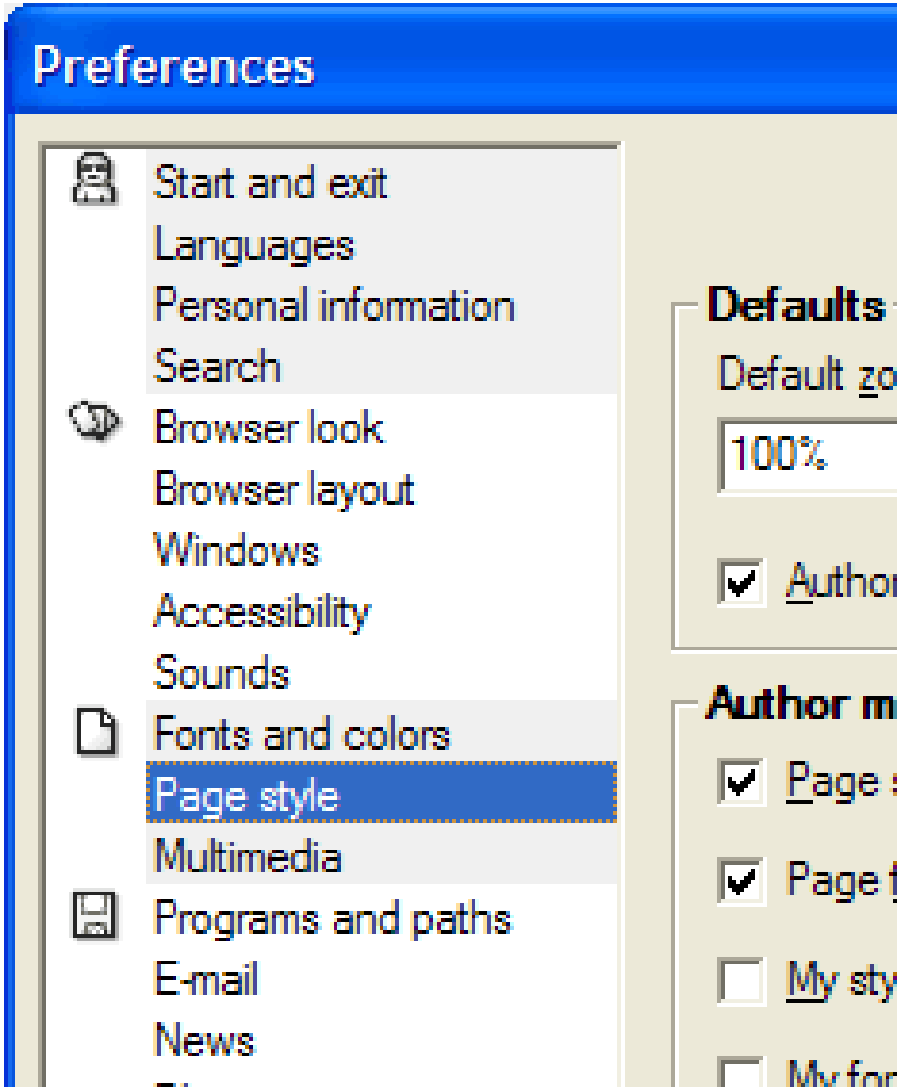
- Objects that are similar, with like components or attributes are more likely to be organised together



Objects are viewed in vertical rows because of their similar attributes.

O X X X X X X X X X
X O X X X X X X X X
X X O X X X X X X X
X X X O X X X X X X
X X X X O X X X X X
X X X X X O X X X X
X X X X X X O X X X
X X X X X X X O X X
X X X X X X X X O X
X X X X X X X X X O

Law of Similarity

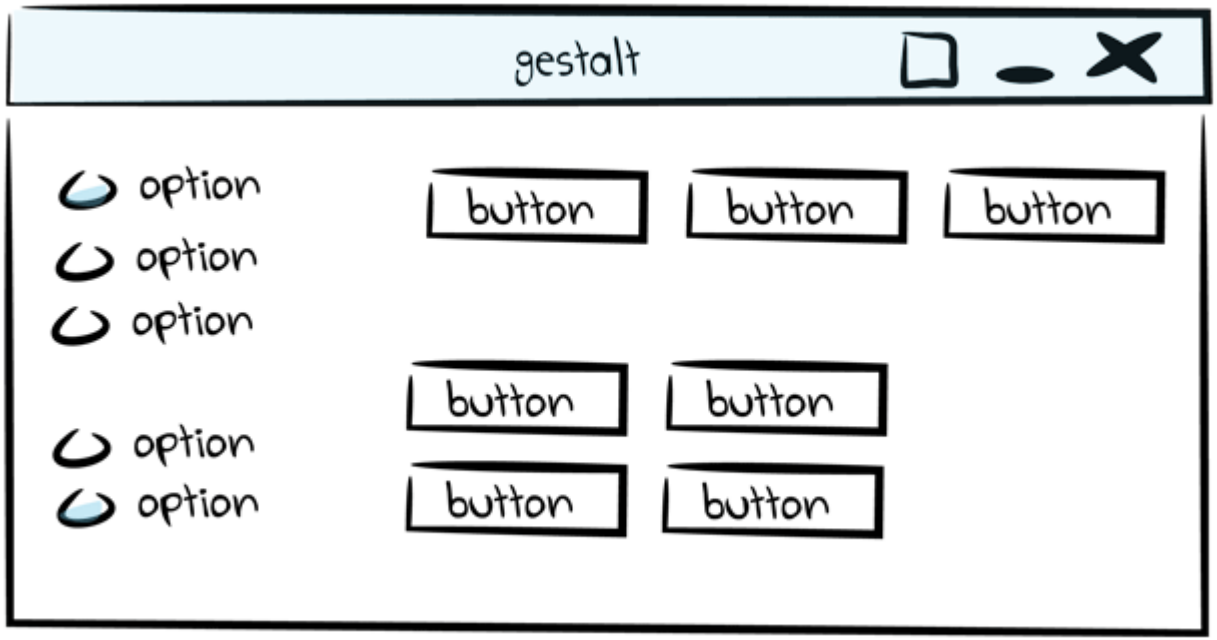


The "preferences window" of the Opera browser

Color is used to make the user group the menu items on the basis of their background color.

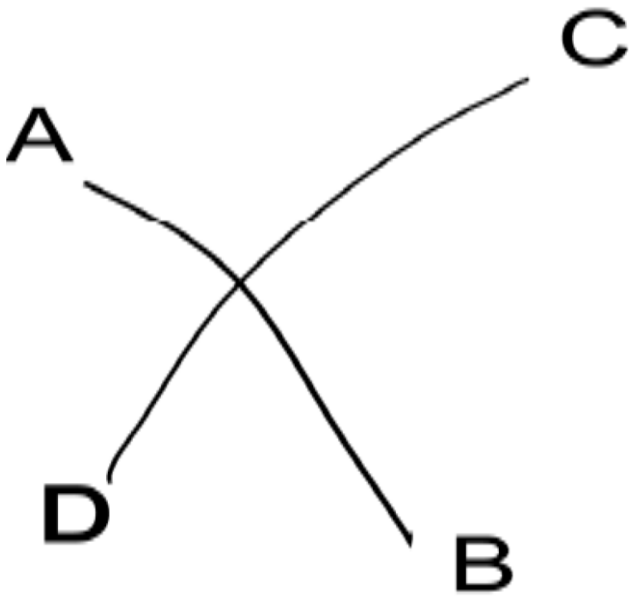
Law of Similarity

- Use same or similar designs to represent components with similar functions



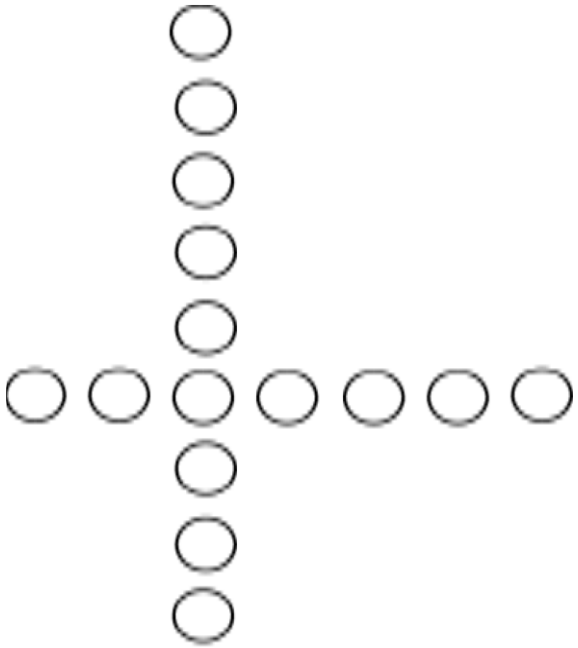
Law of Continuity (连续性法则)

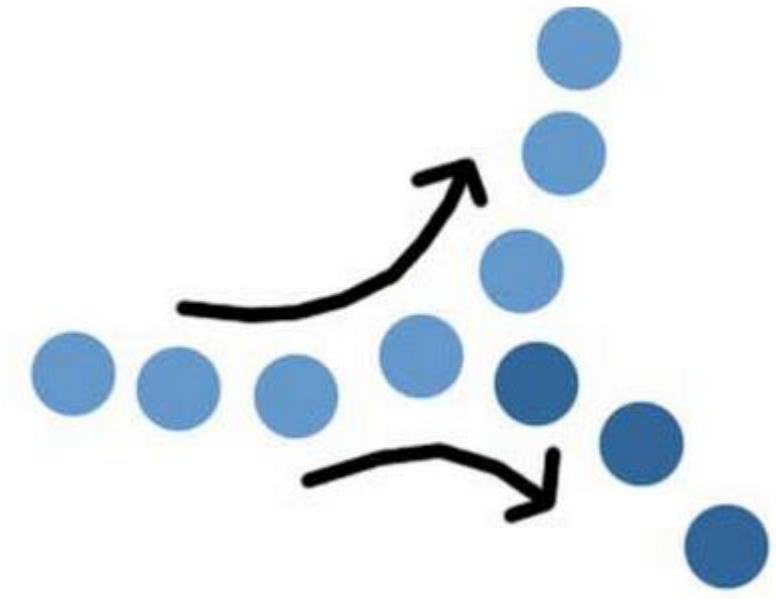
- Objects will be grouped as a whole if they are co-linear, or follow a direction



Law of Continuity

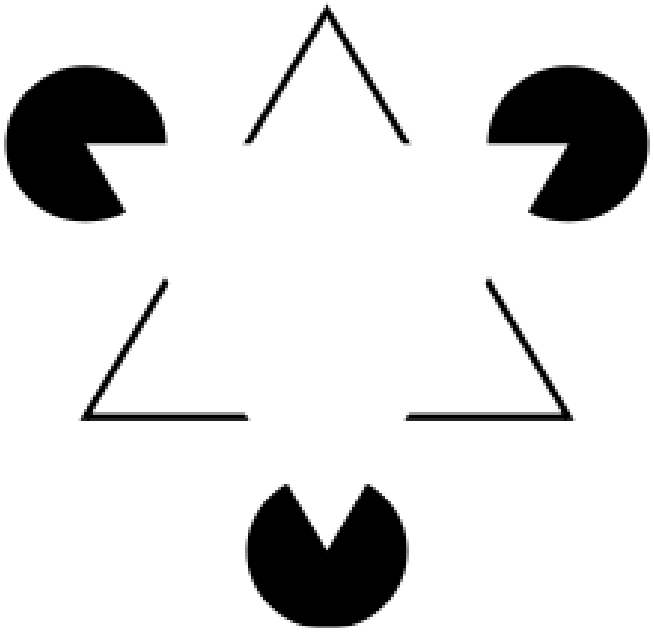
- Align relevant component
- Lines are seen following the smoothest path

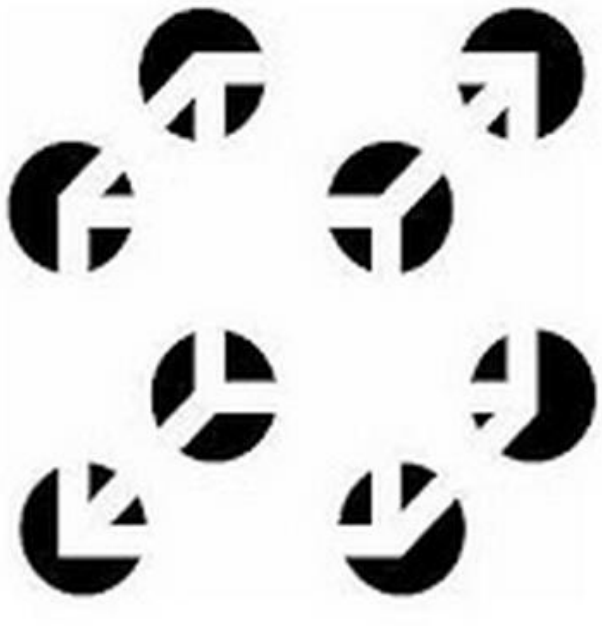




Law of Closure (闭合性法则)

- In perception there is the tendency to complete unfinished or partially obscured objects



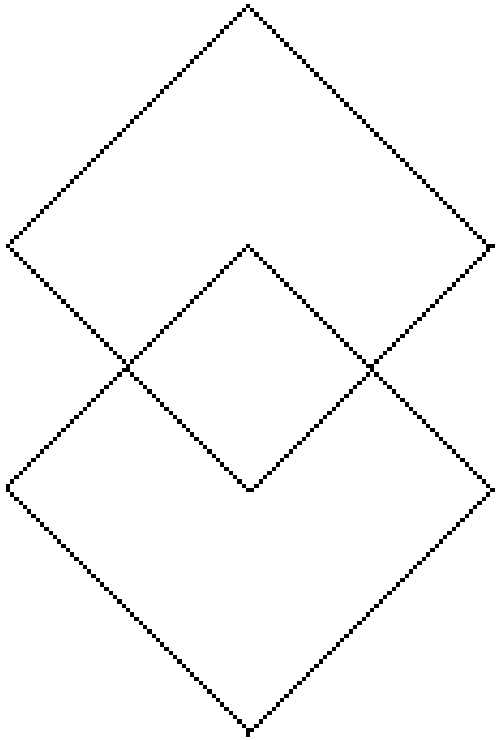


Law of Closure

Law of Symmetry (对称性法则)

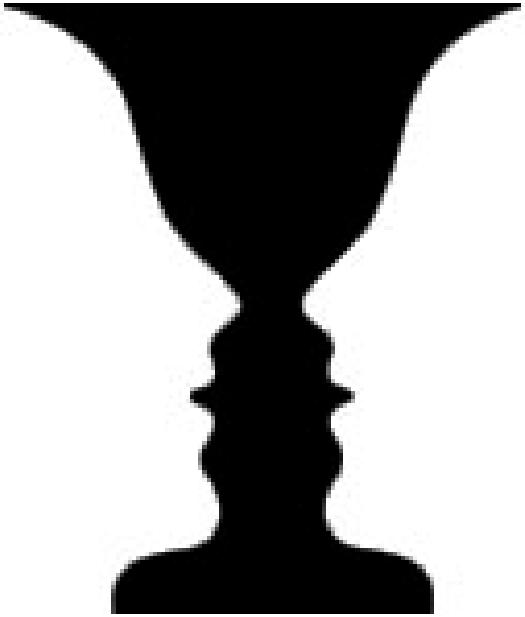
- Objects must be balanced or symmetrical to be seen as complete or whole

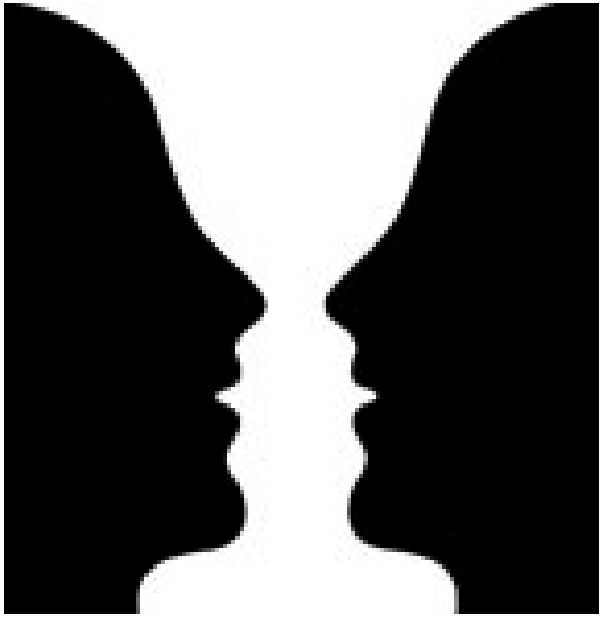
[ ][ ][ ]



Law of Figure – Ground (前景-背景法则)

- Viewers will perceive an object (figure) and a surface (ground) even in shapes are grouped together
  - This law also defines use of contrast





Law of Figure - Ground

Mac OS

Law of Figure - Ground

- you can focus on *only one* "interpretation" at a time; you cannot observe both the figure and ground at the same time, as ground will become figure when shifting the focus

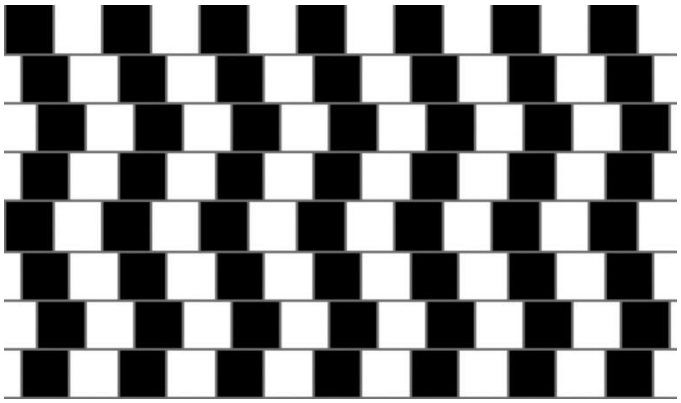
Law of Prägnanz (精练)

- Prägnanz means, in simple terms, “good form” and refers to organising shapes to simple forms
  - Figures are seen as their simple elements instead of complicated shapes

The Opposite

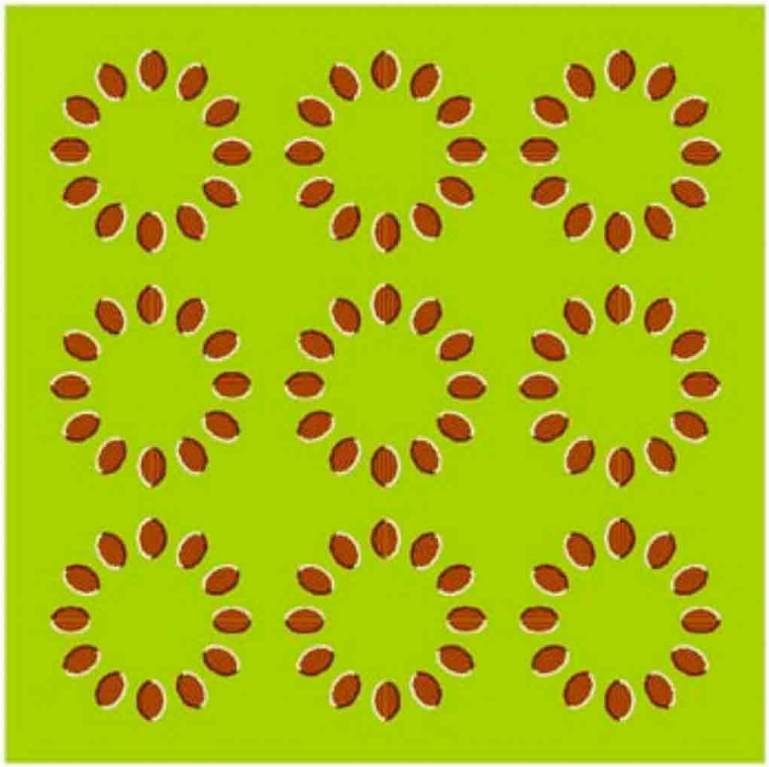
- Don't forget that just as these Gestalt laws are true when defining human perception, the opposite of each is also true
  - For example, in the diagram below, the figure on the right is *DIS*-similar to the others and therefore stands out.

Visual Illusion

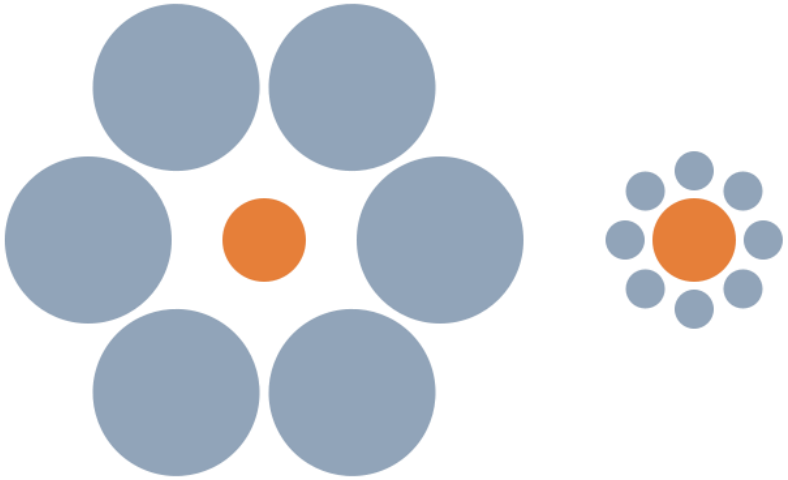


Are the horizontal lines straight or crooked?

Are the circles static or moving?



Visual Illusion



- Visual illusion is inevitable
- Context usually matters

Does Order Matter?

- *"From Cambridge University .*

  Olny srmat poelpe can raed tihs.
  I cdnuolt blveiee taht I cluod aulaclty uesdnatnrd waht I was rdanieg. The phaonmneal pweor of the hmuan mnid, aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, t he olny iprmoatnt tihng is taht the frist and lsat ltteer be in the rghit pclae. The rset can be a taotl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe. Amzanig huh? yaeh and I awlyas tghuhot slpeling was ipmorantt!"

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How about Chinese?

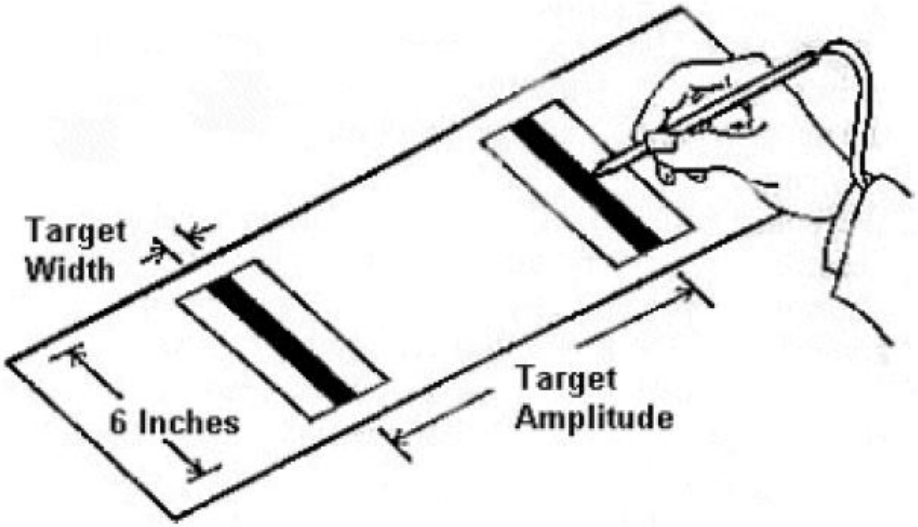
- 研表究明，汉字的序顺并不定一能影阅响读
- 比如当你看完这句话后，才发这现里的字全是都乱的

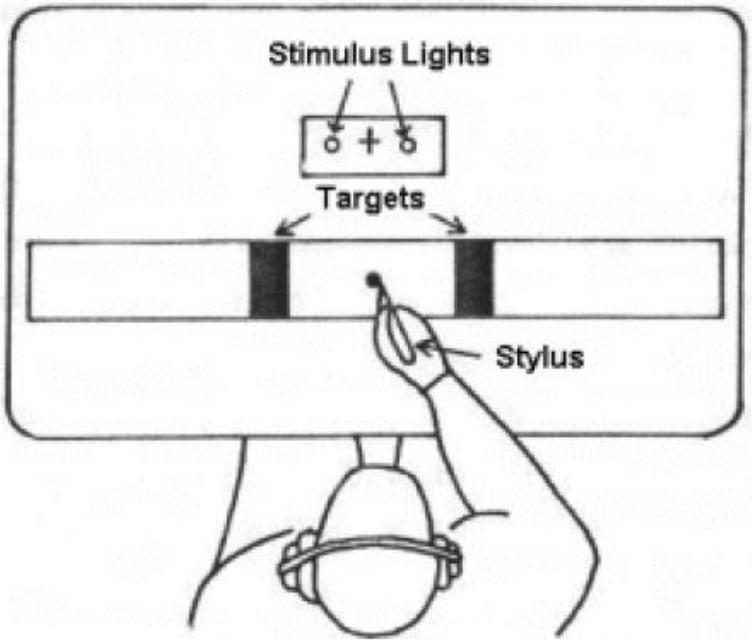
Today's Topics

- Understanding Users
- Human Perception
- ***Cognitive Process***
  - ***Movement***
  - Memory
  - Reasoning

Activity

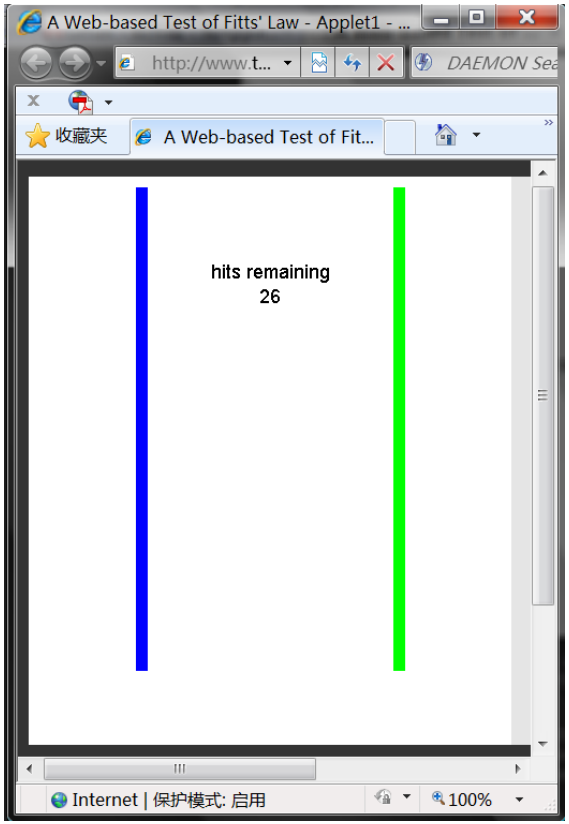
- Hit the black section iteratively
  - Try to be as precise as possible
  - Which one is easier?

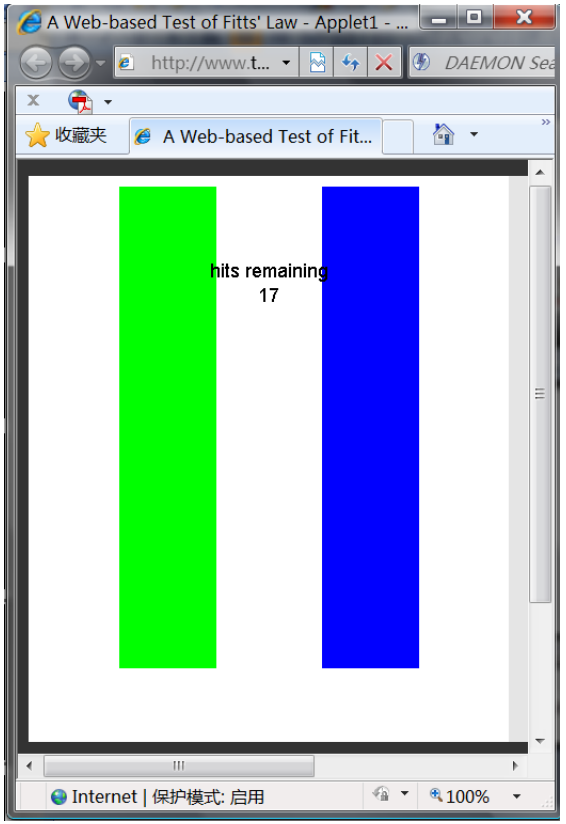




Activity

- www.tele-actor.net/fitts/



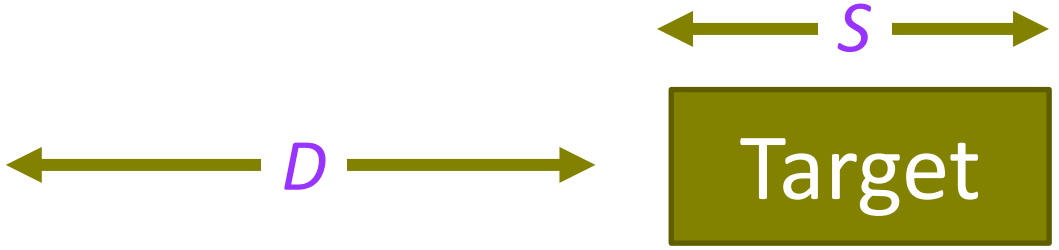


Fitt's Law

- Fitt's Law describes the time taken to hit a screen target

$$T = a + b \log_2(D/S + 1)$$

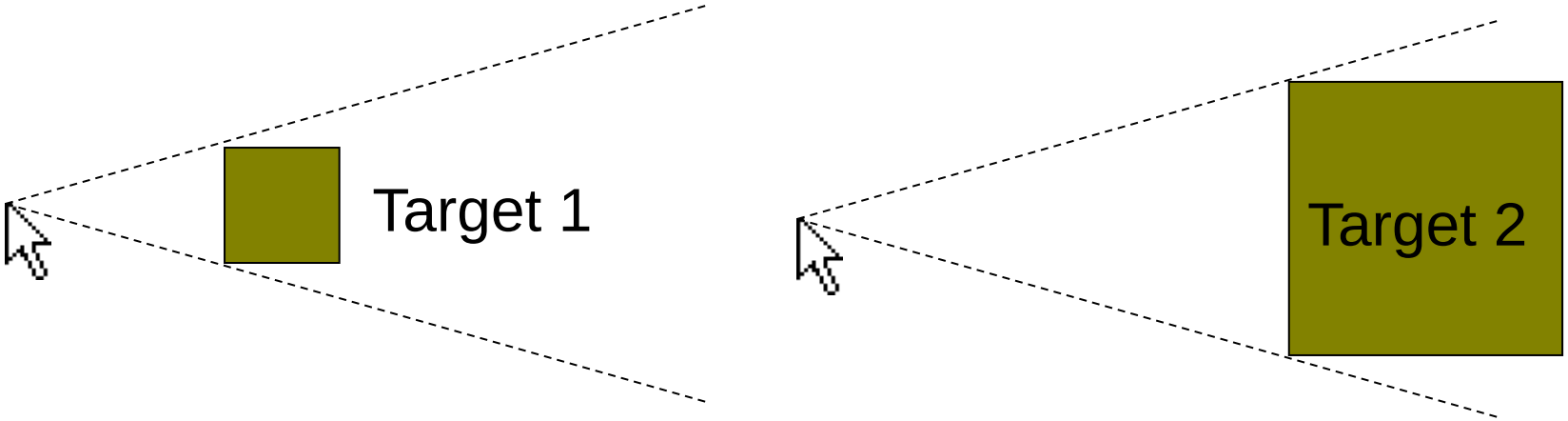
- where
  - *a* and *b* are empirically determined constants
    - a = 50, b = 150
  - *T* is movement Time
  - *D* is Distance
  - *S* is Size of target



Fitt's Law

- $T = a + b \log_2(D/S + 1)$

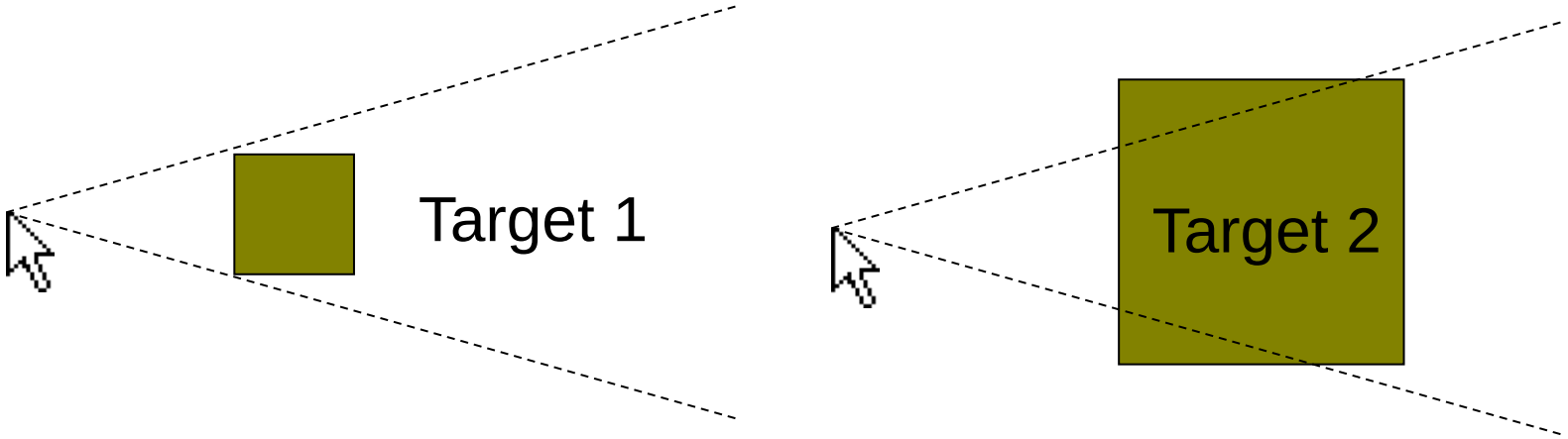
- Same D/S → same difficulty



Fitt's Law

- $T = a + b \log_2(D/S + 1)$

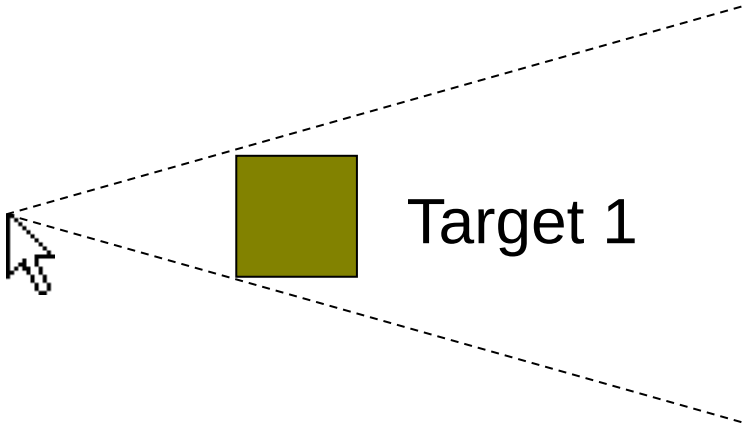
- Smaller D/S → easier

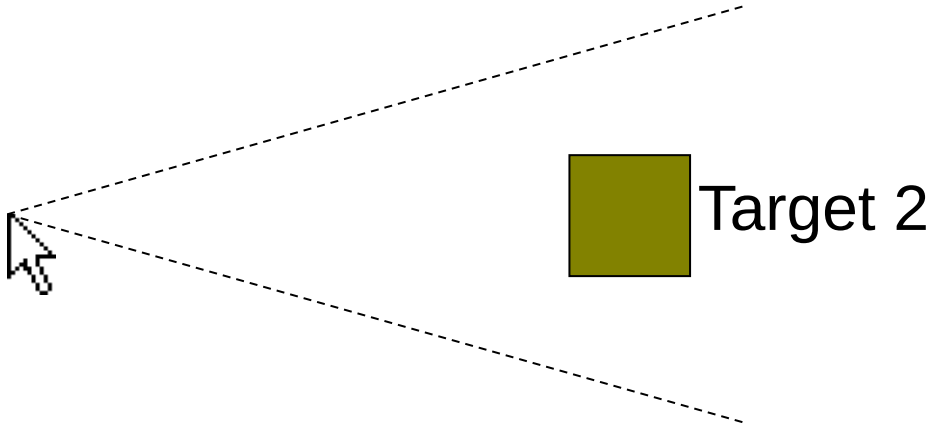


Fitt's Law

- $T = a + b \log_2(D/S + 1)$

- Larger D/S → harder





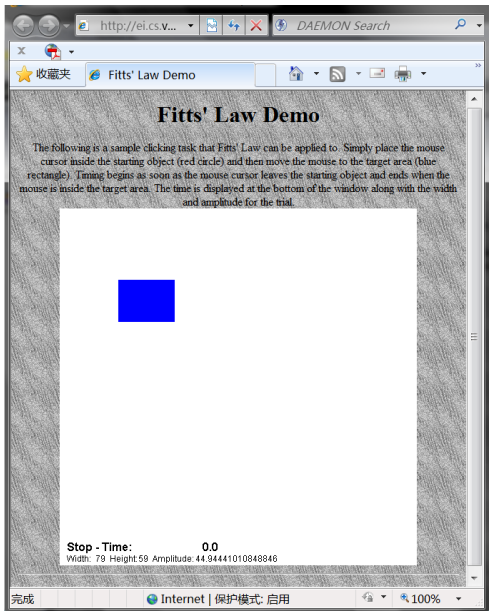
Fitt's Law

- *The further away & the smaller the object, the longer the time to locate it and point*

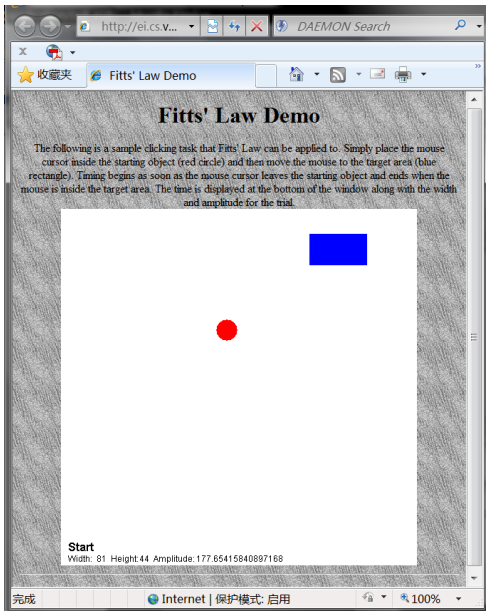
- Target
  - As large as possible
- Distances
  - As small as possible

Example

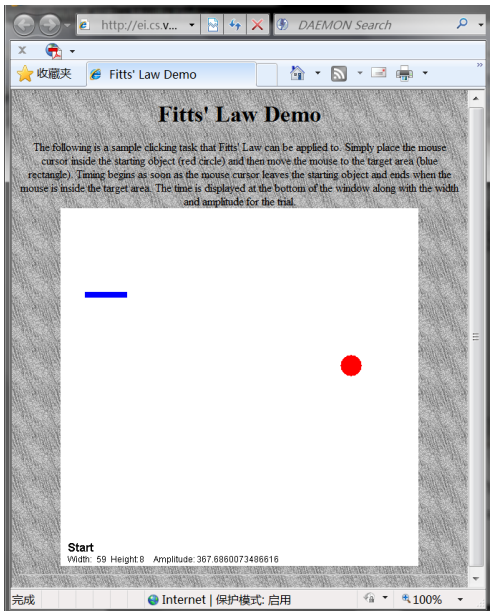
- **http://ei.cs.vt.edu/~cs5724/g1/tap.html#**



Width:79, height:59
amplitude:44.94441…
Time = 0.0s



Width:81, height:44
amplitude:177.65415…
Time = ?



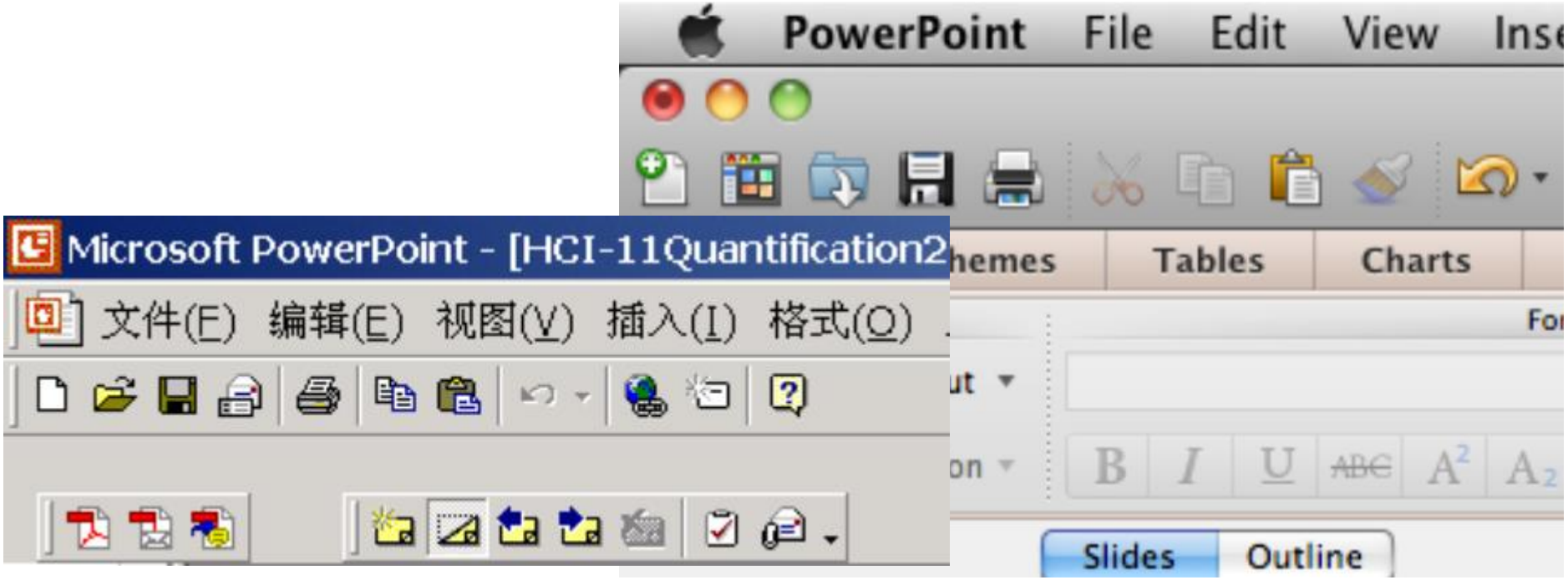
Width:59, height:8
amplitude:367.68600…
Time = ?

Design Implications

- Accelerator Vs. Brakes

Design Implications

- MacOS Vs. Windows



Mac OS： $50+150\log_2(80/50+1)=256ms$

Windows： $50+150\log_2(80/5+1)=663ms$

Apple Patent

Design Implications

- Mobile

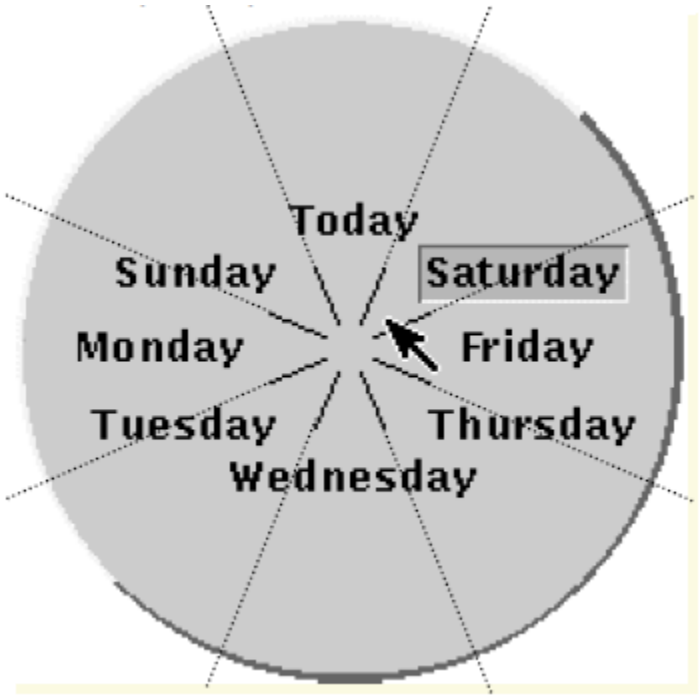
Design Implications

- MacOS “dock”
  - Amplify icons dynamically

Design Implications

- Linear menu Vs. Pie Menu

Today
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday

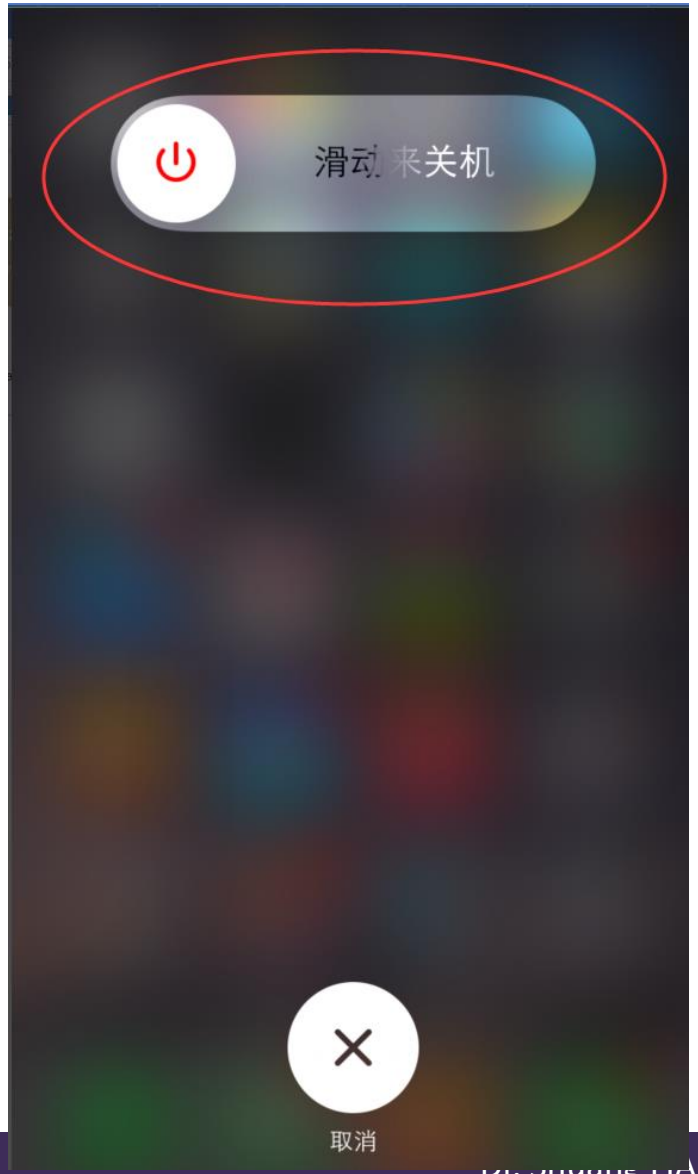


Design Implications

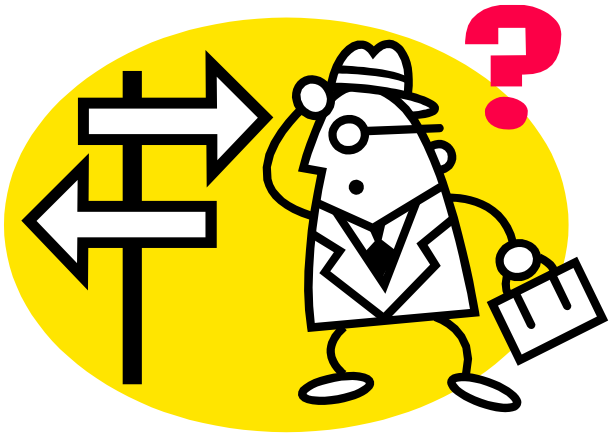
- Right-button click menu

The Opposite

- Don’t forget that just as Fizz law is useful when optimizing human operation, the opposite is also useful



Activity



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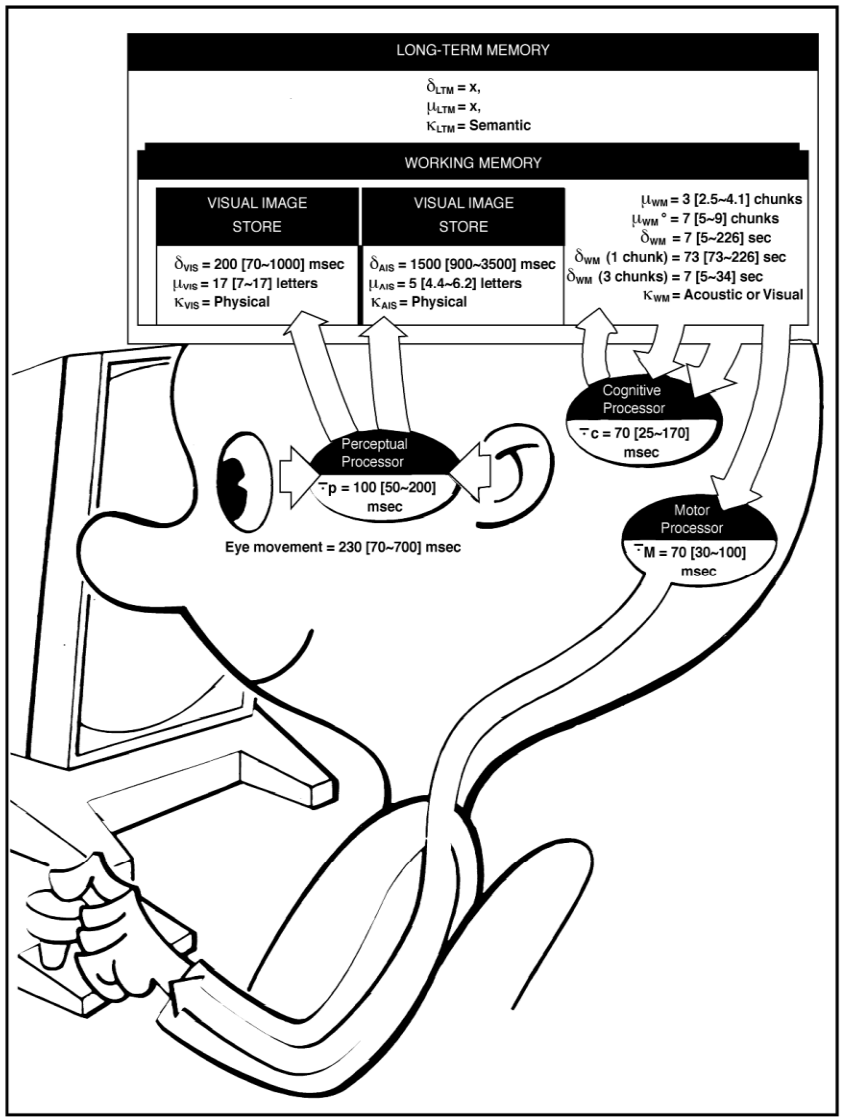
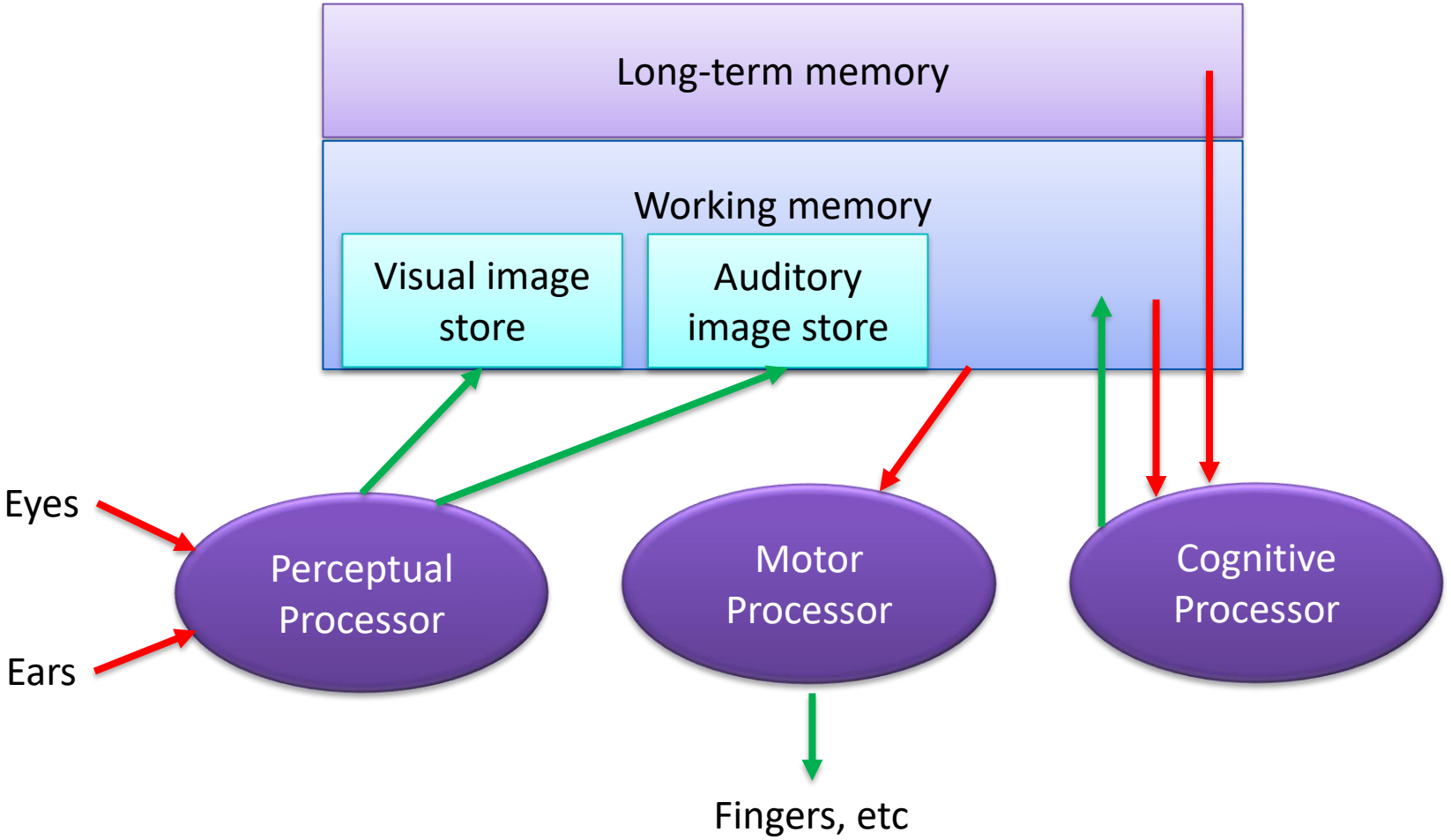
  - Movement
  - ***Memory***
  - Reasoning

Revisit: Model Human Processor



Model Human Processor



Three Types of Memory

- 1. Sensory memory
  - Focusing attention transfers to
- 2. Short term (working) memory (STM)
  - Practice/rehearsal transfers to
- 3. Long term memory (LTM)

Sensory Memory

- Short term buffers
- Duration: ~1s

- Different channels have different buffers:
  - Iconic memory for visual stimuli
  - Echoic memory for auditory stimuli
  - Haptic memory for touch

- New information overwrites old information

Sensory Memory

- Existence demonstrated in a couple of ways:
  - After images (残留图像)
  - Direction from which sound emanates and recall of question you didn't think you knew (脱口而出)

- Collects information all the time
  - Need some way to filter
  - We do this by *attention* and *focus*

Short-Term Memory (STM)

- Think about a task like *reading*:
  - Need to keep info from first of a sentence in order to get meaning
  - Meaning is what's stores, not words
  - Implies a need for temporary "working" storage
- Accessed rapidly: ~70ms
- Duration: ~30s
- Limited capacity
  - Lengths of sequences: 7 +/- 2 digits
  - Free recall of info in any order

STM Activity

- 3, 12, 6, 20, 9, 4, 0, 1, 19, 8, 98, 13, 84
- 猫, 房子, 纸, 笑, 人, 红色, 是的, 数字, 阴影, 下雨, 植物, 灯泡, 巧克力, 收音机, 一, 硬币, 直升机
- t, k, s, y, r, q, x, p, a, z, l, b, m, e

STM Activity

- Here is a sequence of numbers:
  - 8,6,2,1,6,9,5,8,5,4,9,1,5,3,5
- →
  - 86-21-6958-5491-535

- We remember best when information is “chunked”

STM Game

- The first one says
  - I bought *a fish* in the supermarket.
- The second one says
  - I bought *a fish*, and *a piece of bread* in the supermarket.
- ……

- Until somebody makes mistakes
- Remember how many items can you remember

What Some Designers Get Up to…

- Present only 7 options on a menu
- Display only 7 icons on a tool bar
- Have no more than 7 bullets in a list
- Place only 7 items on a pull down menu
- Place only 7 tabs on the top of a website page

- Is it right/wrong? Why?

Long-Term Memory (LTM)

- Stores factual information, experiential knowledge, and rules of behavior
- Huge, if not unlimited
- Slow access time (100 ms)
- Two types:
  - Episodic memory (情景记忆)
    - Our memory of events
  - Semantic memory (语义记忆)
    - Structured record of facts
- Use rehearsal to move info from short term to long term memory

LTM Processes

- Getting info into long term memory:
  - How do I *learn*?
  - Optimizations include:
    - Total time hypothesis: Amount learned is proportional to time spent learning
    - Distribution of practice effect: Learning works best if spread out
  - Learning well includes *understanding*
    - Build models of information
    - Structure, familiarity, concreteness
    - Particularly for devices

LTM Processes

- *Forgetting*
  - Decay or interference (衰退和干扰):
    - Decay:
      - Theory that over time, information degrades
      - Actually plotted logarithmic scale
    - Interference:
      - New info. Over-writes old info.
  - Now a debate about whether forgetting ever happens or if it's a retrieval problem
    - Old information breaking through
    - Tip of tongue phenomenon (提笔忘字)

LTM Processes

- *Recall* vs. *recognition*
  - Recall
    - Information is reproduced from memory
  - Recognition
    - Presentation of information cues us to fact we've seen this before
  - Should stress recognition over recall
    - Why?
    - Provide strong cues for recall if used

Today's Topics

- Understanding Users
- Human Perception
- ***Cognitive Process***
  - Movement
  - Memory
  - ***Reasoning***

Reasoning

- Deductive(推理)
  - Uses logic to derive conclusions from premises (因-果)
    - If it is Friday then she will go to work.
    - It is Friday, therefore she will go to work
- Inductive(归纳)
  - Generalizes from cases we have seen
    - Can disprove simply by producing counter-example.
    - Scientific method.
- Abductive(回溯，溯因)
  - Reasons about causes from events (果-因)
    - I pressed a button and the window closed.

Reasoning

- *Problem Solving*
  - Gestalt theory (less is more)
    - Restructuring and insight to perform productive problem solving
  - Problem space theory (初始-目标,步步引导)
    - Problem solving looks at problem space as state space and moves from initial to goal state using operators
      - Math example
  - Using analogy (已知-未知)
    - Solving novel problems involves mapping previous knowledge – analogical mapping
      - Medical example

Mid-term Presentation

- Schedule
  - Apr. 17th
- General items
  - About 5 minutes
  - Slides in English (optional)
  - Presentation in Chinese or English (Encouraged)
  - Allow multiple speakers

Mid-term Presentation

- About your project
  - Background and motivation
  - Related work
  - Your goals
  - Work plan
  - Discussion
- Team introduction
  - Division of work

Final Presentation

- Team introduction
  - Division of work
  - How about contributions?
- About your project
  - Background and motivation
  - Related work
  - Your goals
  - How you achieve the goals?
    - Conceptual design
    - Physical design
  - Demo
  - Evaluation

Thank you for your attention!