Psychology 101

Action – Perception – Cognition

Michel Beaudouin-Lafon
Université Paris-Saclay
mbl@lisn.fr

Action-perception coupling

« Classical » psychology (cognitivist approach)

- Perception <=> Cognition <=> Action

Coupling between action and perception

- Action for perception
  - Move head to perceive depth
  - Manipulate object to perceive its shape
- Perception for action
  - Adjust arm and hand motion to grasp an object

Ecological theory of perception - J.J. Gibson

Co-evolution between the animal and its environment

Direct perception

« Information pick up »

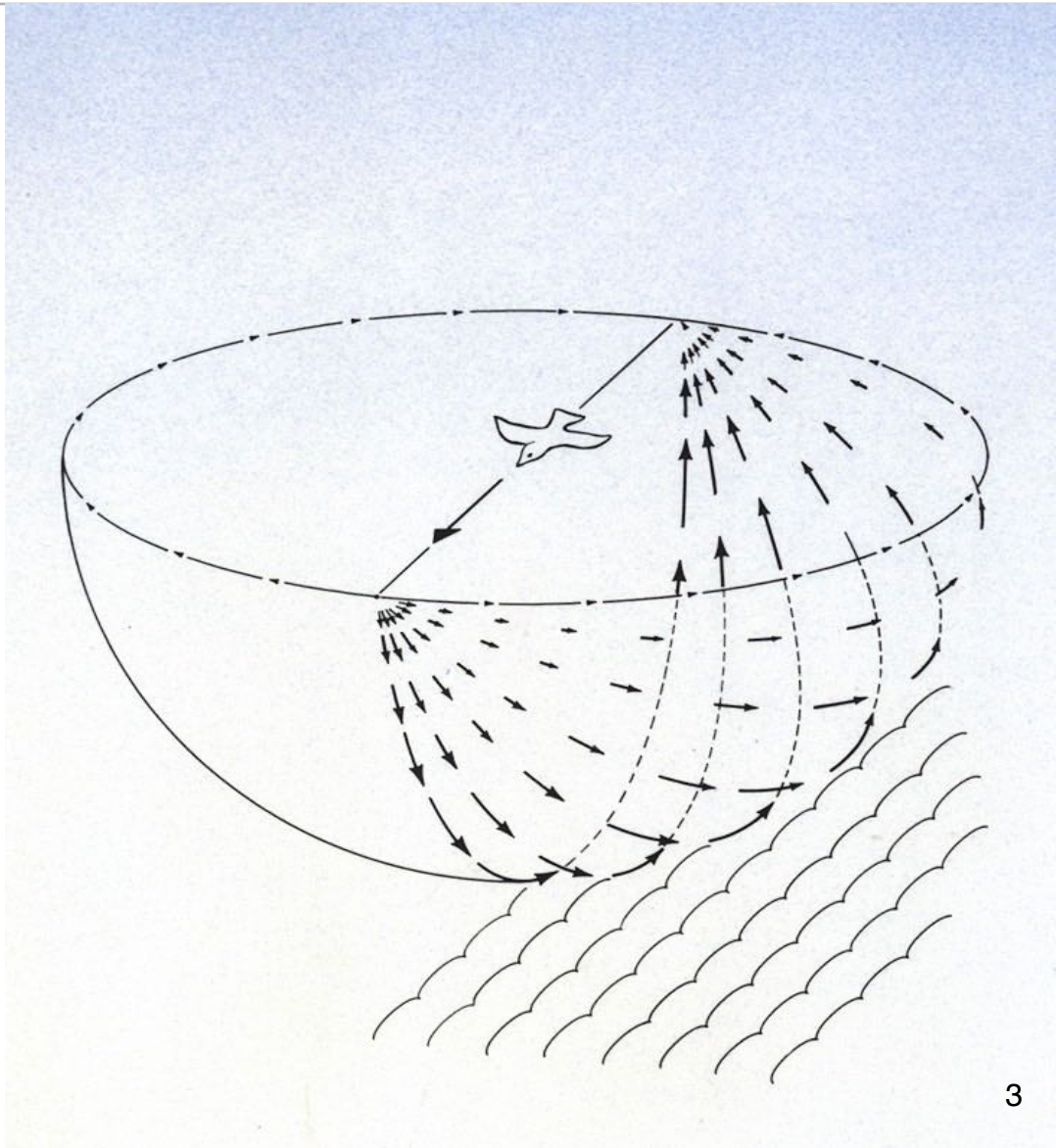
Visual perception

Perception of optical flow

Extract invariants

Example :

direction of motion =
fixed point in the optical flow



Visual channel: Sight

Visual field is about 180º

Focus of attention

- Visual acuity: 0.04mm at 50cm

Peripheral perception

- Less sensitive to colors,
  More sensitive to motion

Perception of color, motion, depth

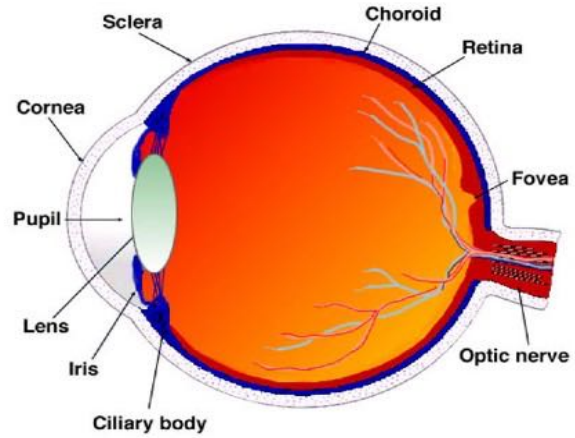
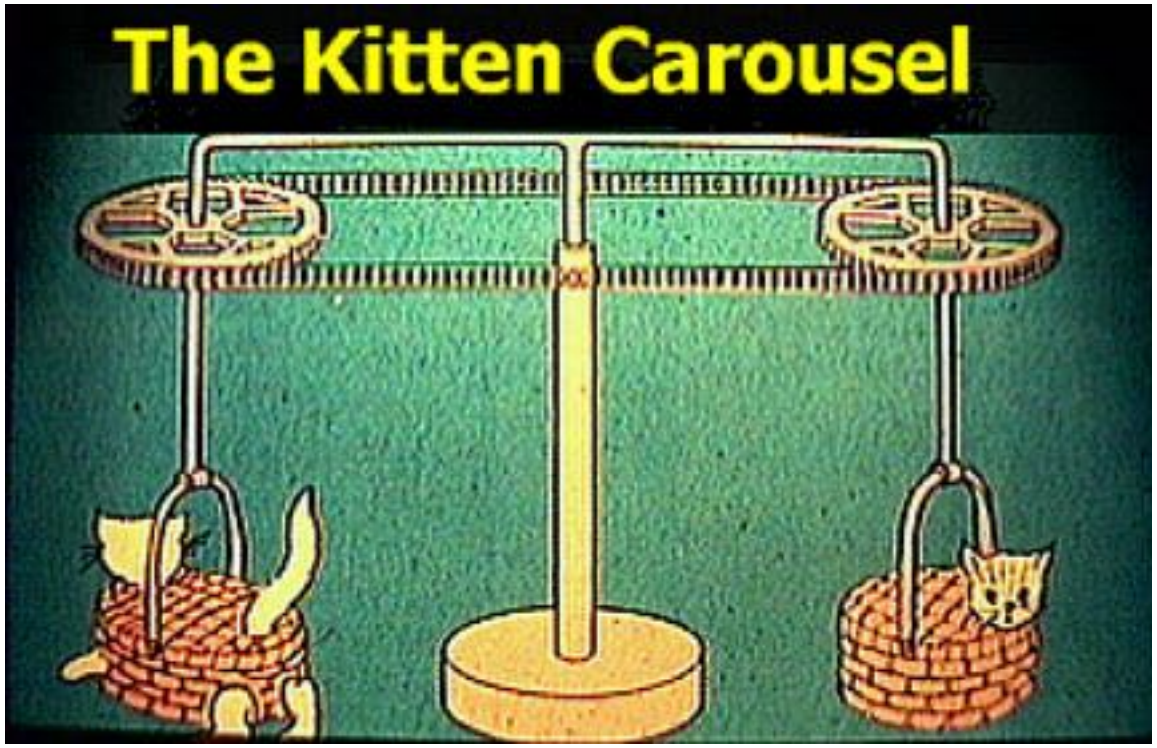


Fig. 6. Vertical sagittal section of the adult human eye.

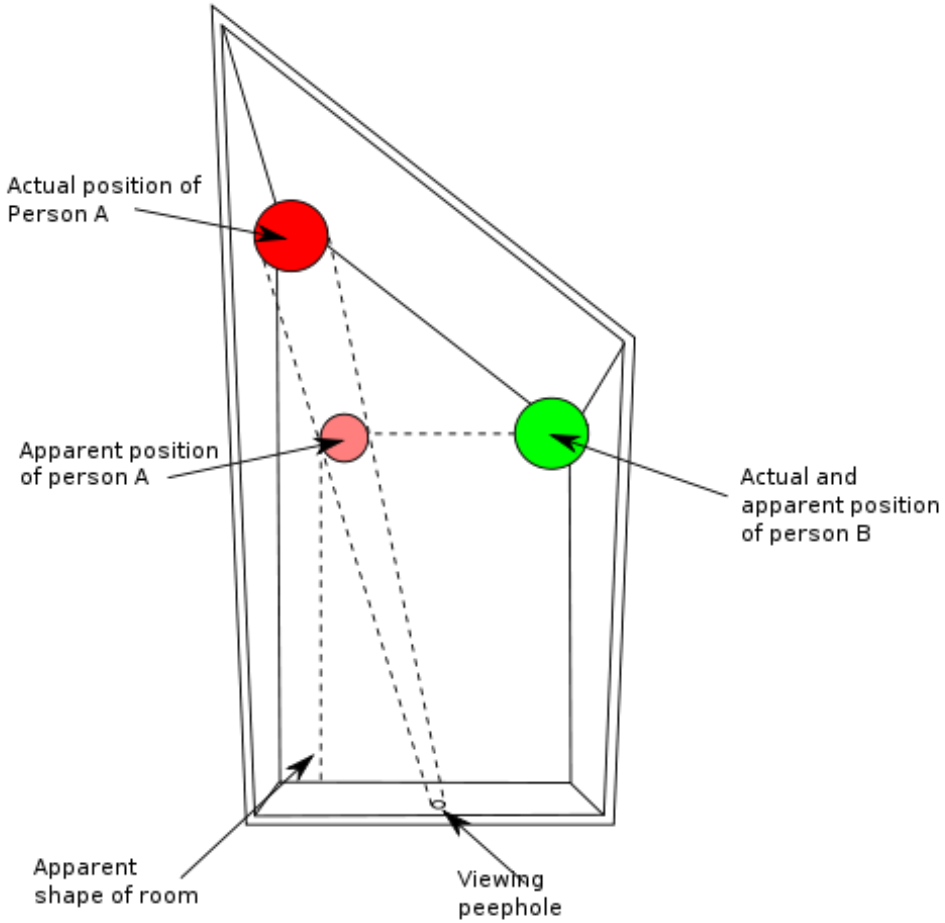
Held & Hein (1963) Kitten Carousel

The role of experience in perceptual-motor devlopment



Self-produced movement and concurrent visual feedback
are essential for the development of visually guided behavior

Depth illusion: Ames room



The Monkey Business Illusion

Watch this video:

https://www.youtube.com/watch?v=IGQmdoK_ZfY

The Monkey Business Illusion

Daniel J. Simons

Change blindness

We do not always notice changes in visual stimuli,
even when the change is dramatic

Attention is selective: notifications can go unnoticed

Change blindness

We do not always notice changes in visual stimuli,
even when the change is dramatic

Attention is selective: notifications can go unnoticed

Change blindness

We do not always notice changes in visual stimuli,
even when the change is dramatic

Attention is selective: notifications can go unnoticed

Auditory channel: Hearing

Very large sensitivity range

Hearing without listening

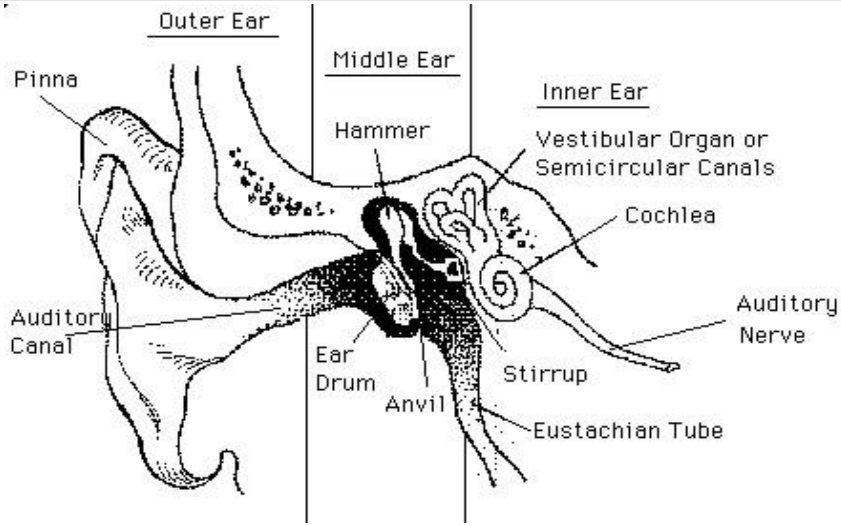
- « Cocktail-party » effect

Masking effects

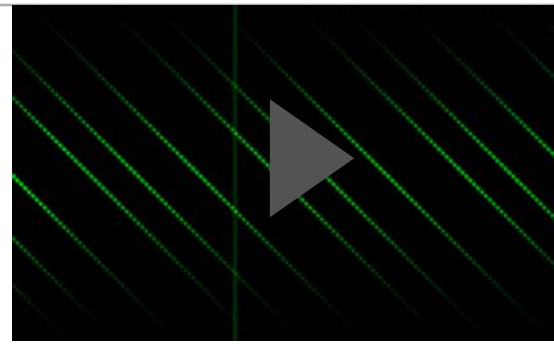
- Distance between sources
- Distance between peak frequences

Localizing a source

- Correlation with visual localisation

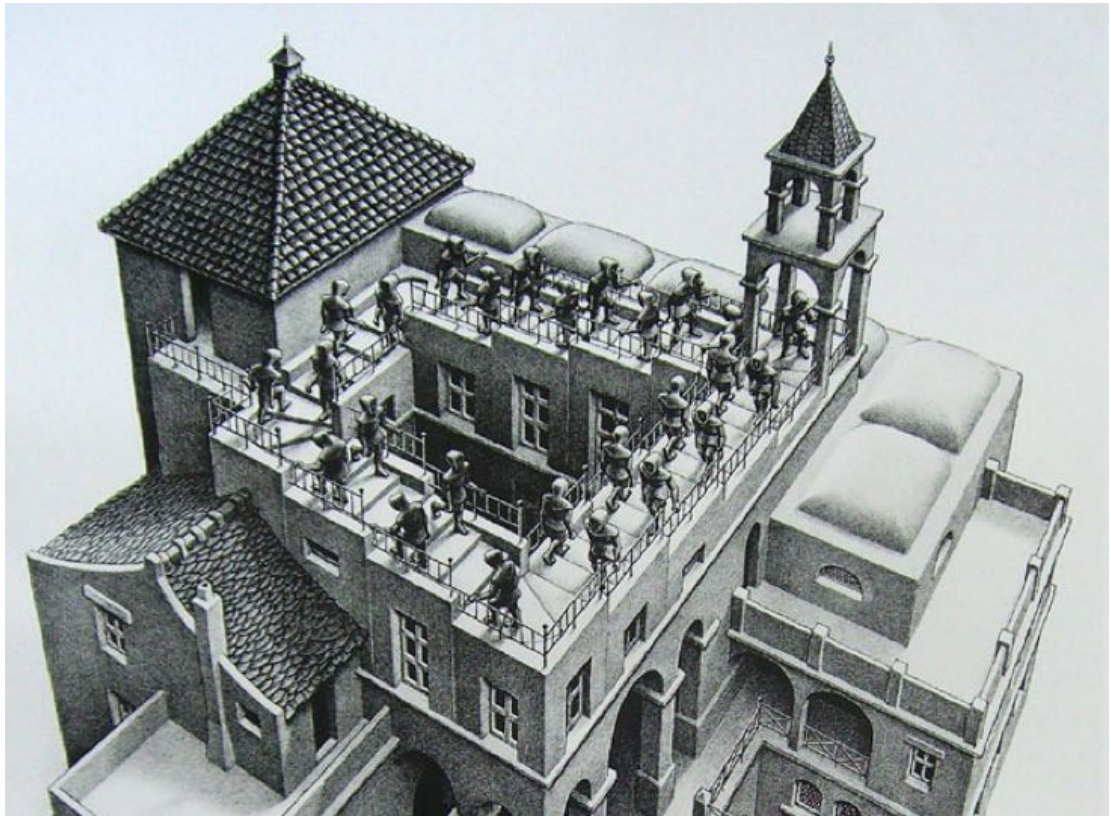


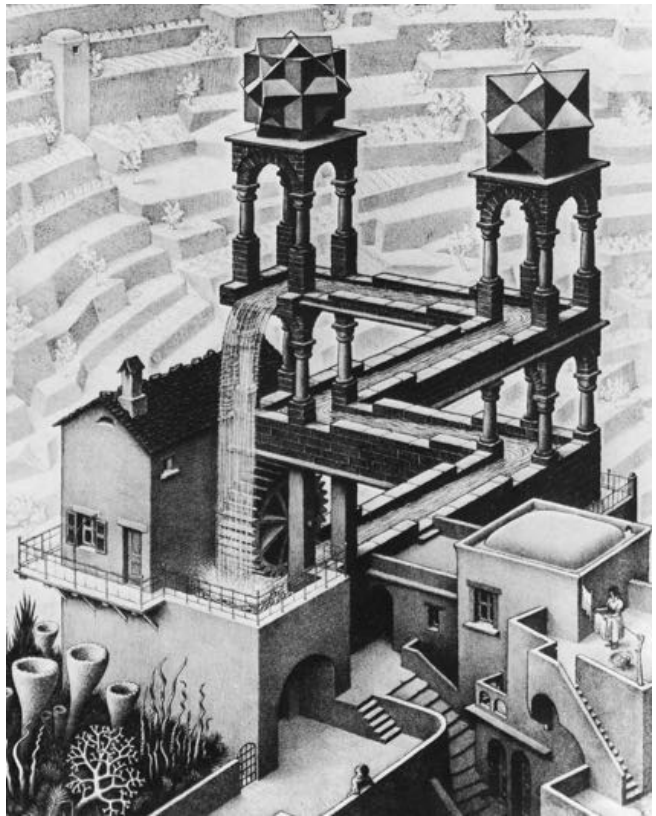
Auditory illusion: Sheppard-Risset tones



A sound that (seems to) always go down

Audio equivalent to Escher's stairs or fountain



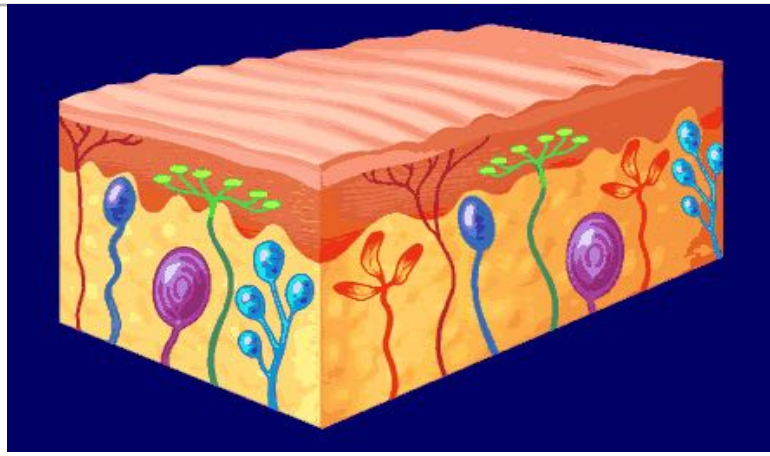


Haptic channel: TPK

Touch: 6 types of receptors

Heat, Cold, Pain

Pressure, Vibration, Texture



Haptic channel: TPK

Touch

Proprioception

Configuration of one's body in space,
used to perceive, e.g., the shape of an object

Haptic channel: TPK

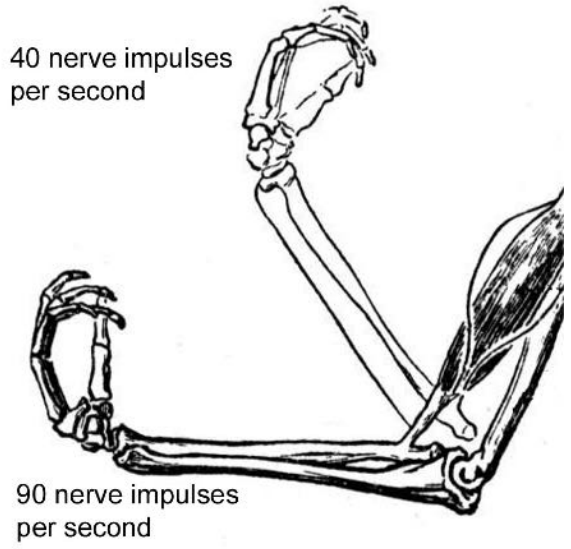
Touch

Proprioception

Kinesthesia

Tension of one's muscles,

used to assess the weight or resistance of an object



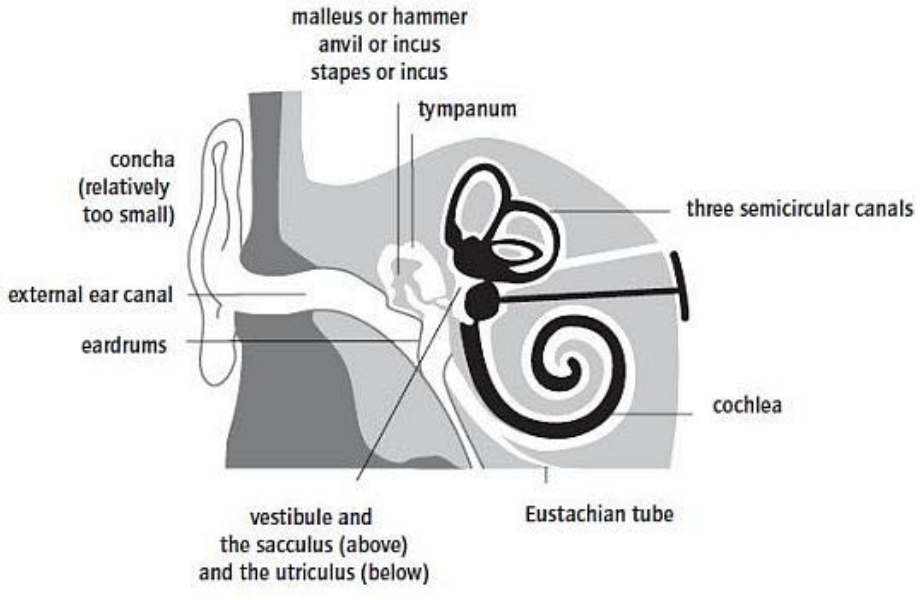
Vestibular sense

Sense of balance: relative orientation in space

Located in the inner ear

Multimodal perception: visual, kinesthetic, vestibular

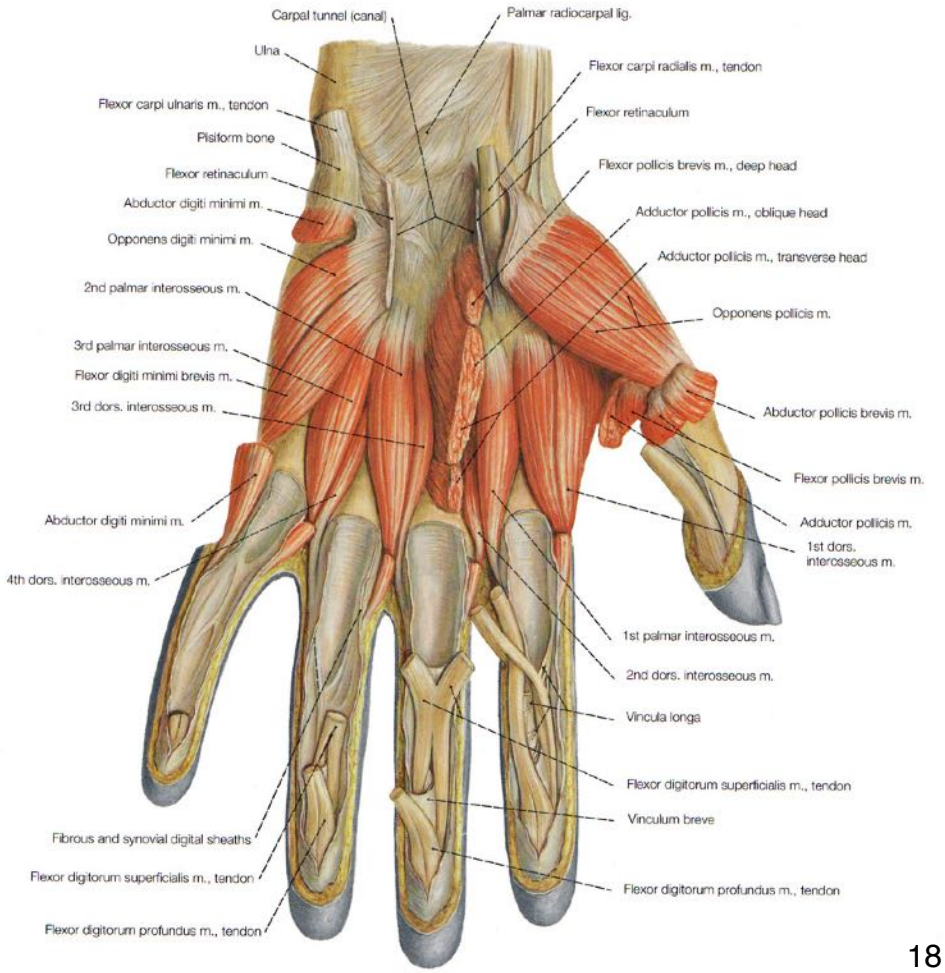
Discrepancies cause



Motor system

Control body movements

- Locomotion
- Physical action
- Gesturing, hand movements
- Voice

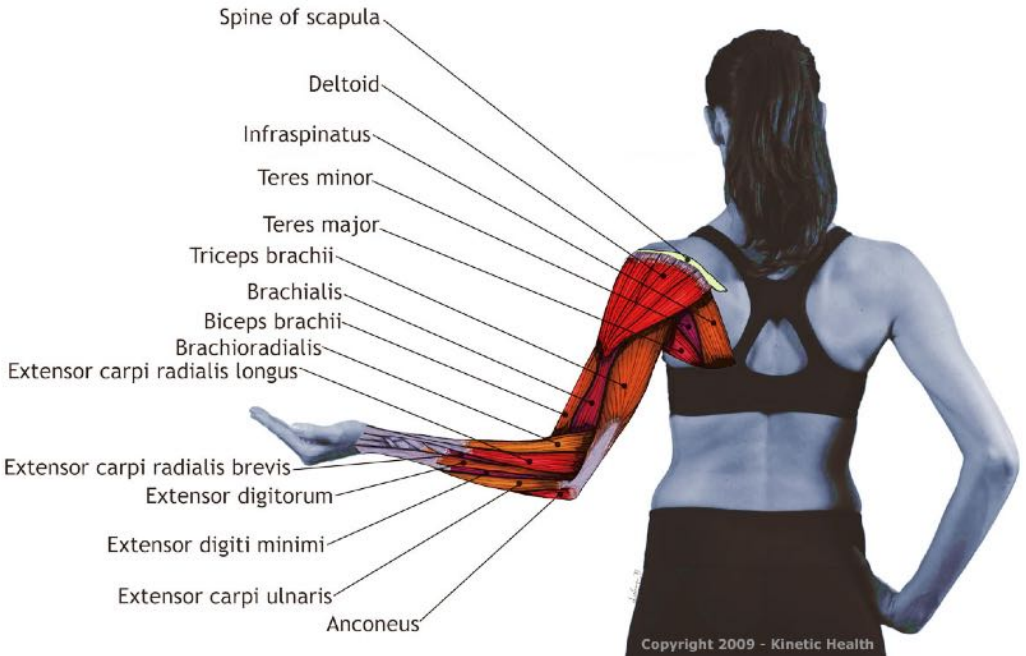


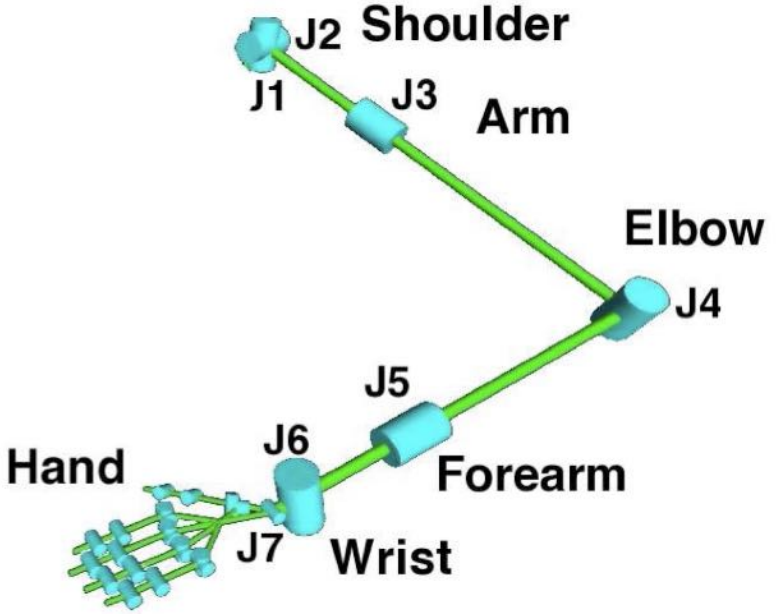
Motor system

Control body movements

Kinematic chain: articulated arrangement of the limbs

to combine large amplitude and precise movements





Motor system

Control body movements

Kinematic chain

Bi-manual control (Yves Guiard)

- Non dominant hand: sets the context
- Dominant hand: acts within that context

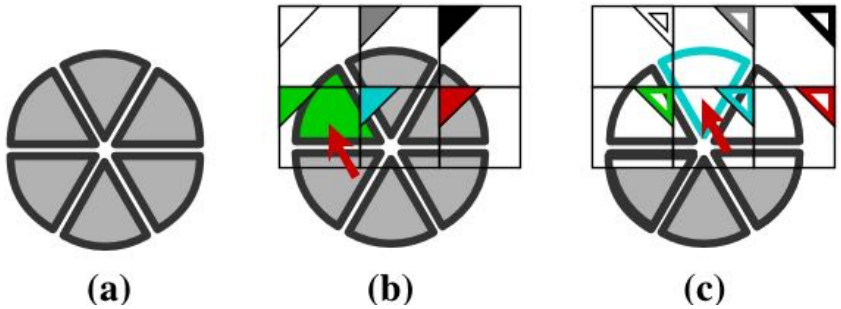
Motor system

Control body movements

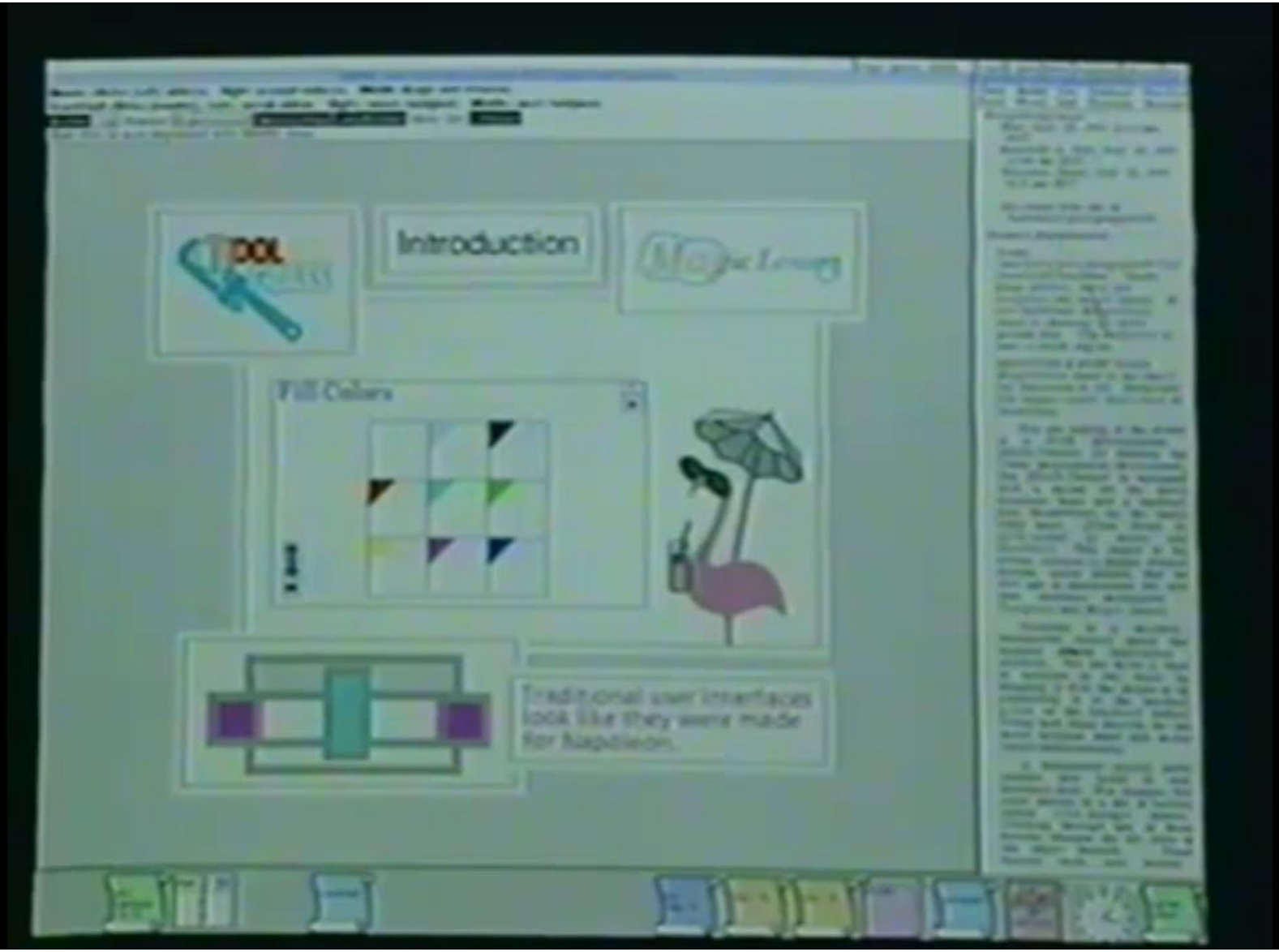
Kinematic chain

Bi-manual control (Yves Guiard)

Application to a drawing interface: Toolglasses



Toolglasses and Magic Lenses,
Bier et al., SIGGRAPH 1993


Introduction
Fill Colors
Traditional user interfaces look like they were made for Napoleon.

Motor system

Controlling a gesture: target pointing

Fitts' law

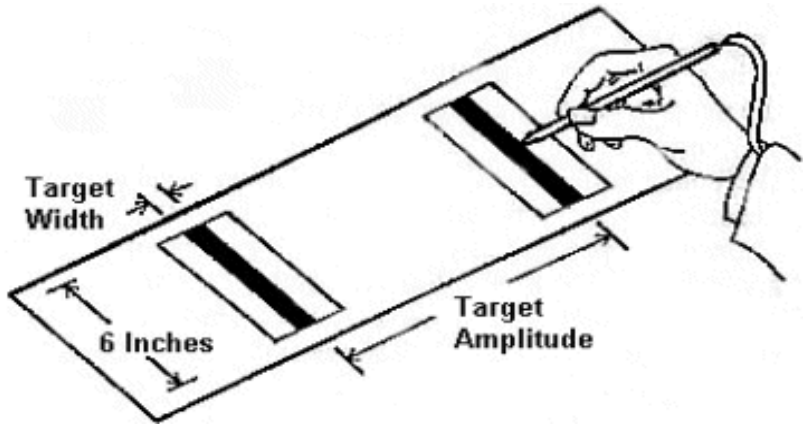
$MT = a + b \log(1 + D/W)$

MT, movement time

D, distance to target

W, width of target

a, *b*, empirically determined constants



Scale invariant:

pointing a target twice as large at a distance twice as long takes the same time

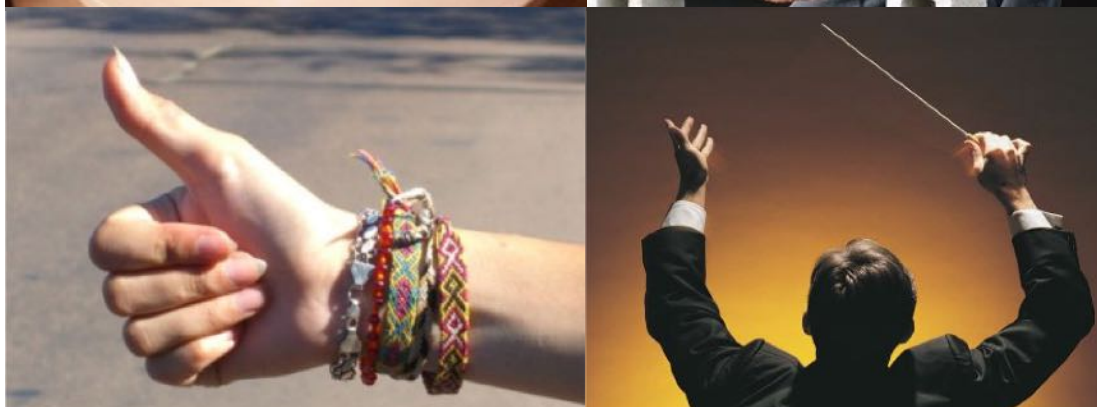
Functions of the gestural channel (Claude Cadoz)

Epistemic:
acquire information

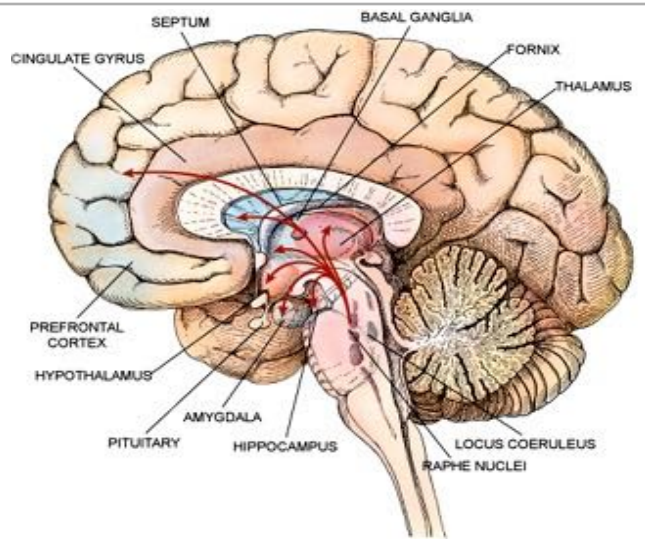
Ergotic:
transform through physical action

Semiotic:
emit information



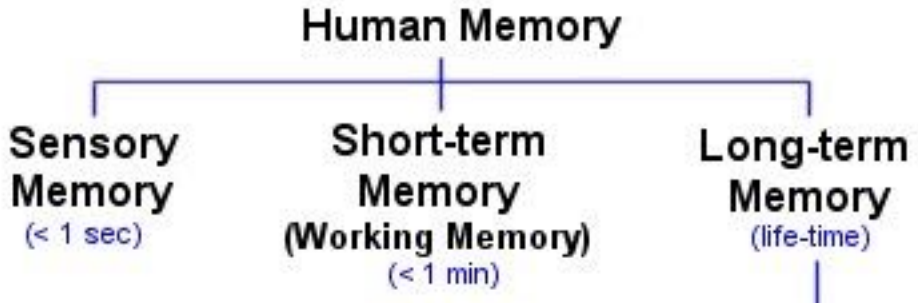


Memory and learning



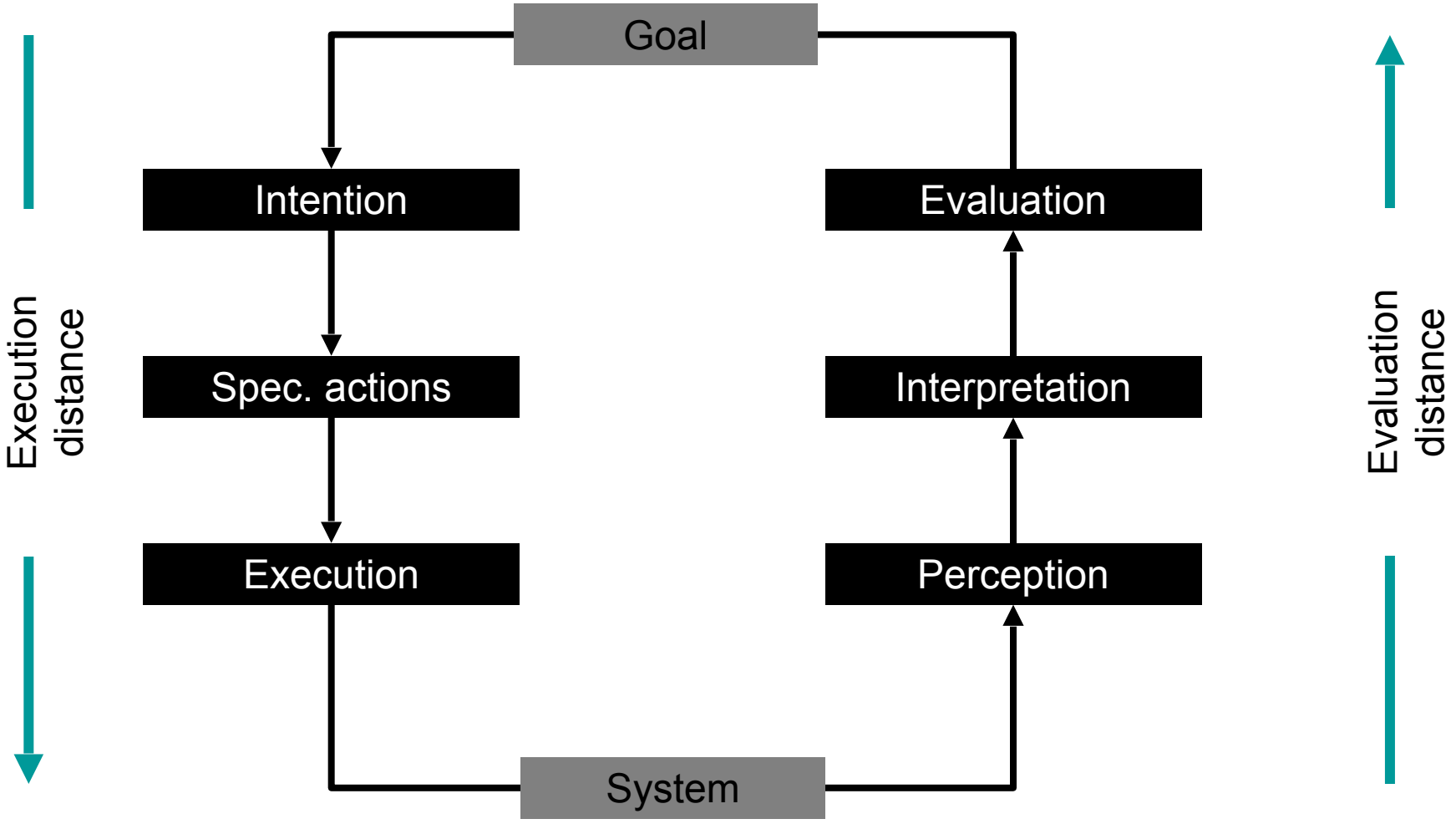
- Short-term memory
  - Working memory
  - Low capacity (7 ± 2)
  - Short-lived (10-30s)
- Long-term memory
  - Infinite capacity
  - Unlimited duration
  - Associative access
- Repetition reinforces memory and learning

Different types of memory



http://www.human-memory.net/types.html

Seven stages of action - Don Norman



Plans and Situated Action (Suchman)

Humans do not always act according to a pre-made plan

Action is *situated*

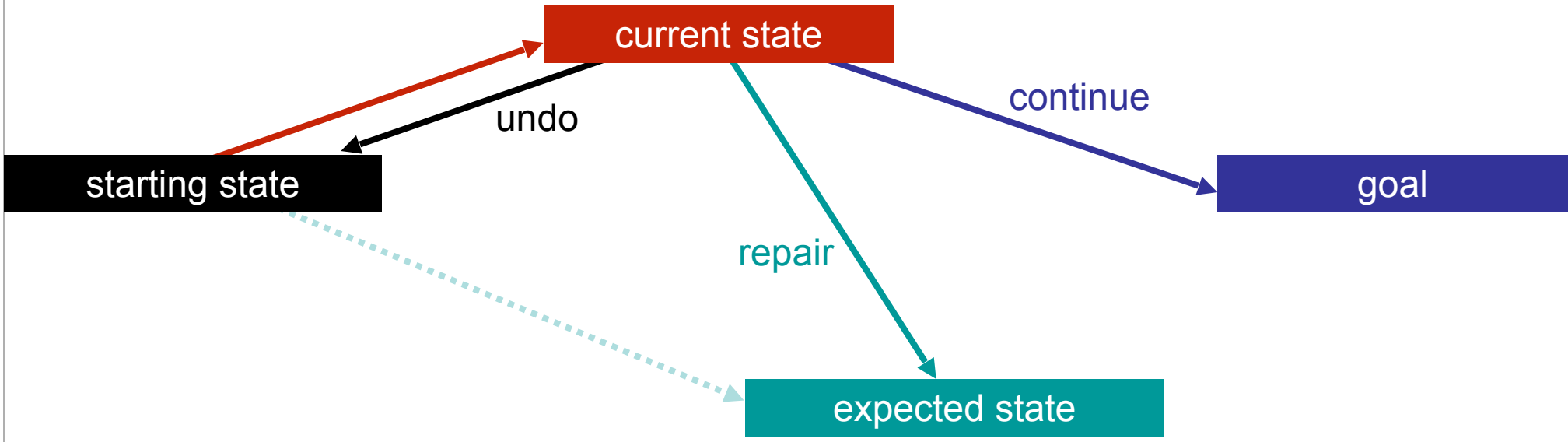
The plan is revised / adapted according to the local situation

Example: empty printer

- add paper
- print to another printer
- give up printing

Problem solving

Strategies in case of error



Mental models

Mental representations that help us reason and solve problems

Cognitive Biases

Systematic pattern of deviation from the norm or from rational judgement

Work by Tversky and Kahneman that challenges the "rational choice theory" in social and economic behavior

Example :

Do you prefer 150€ now or 180€ in 1 month?

Do you prefer 150€ in a year or 180€ in 13 months?

Wikipedia has a list of 185 cognitive biases!

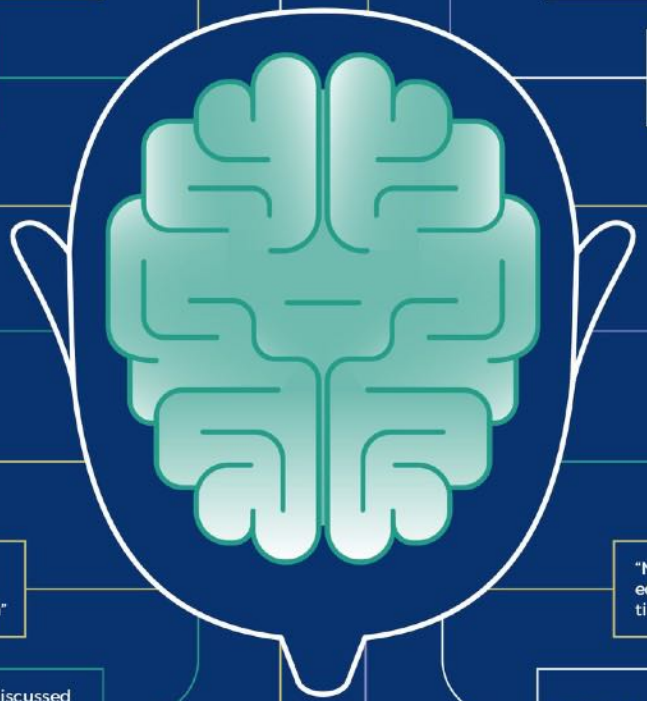
Cognitive bias

● Social ● Financial ● Failure to estimate ● Short-termism

When it comes to assessing risk, humans often fail to make rational decisions because our brains take mental shortcuts that prevent us making the correct choice. Since the 1960s behavioural scientists and psychologists have been researching these failings, and have identified and labelled dozens of them. Here are some that can cause havoc when it comes to assessing risks in business

ORIGIN

The notion of cognitive biases was first introduced by psychologists Amos Tversky and Daniel Kahneman in the early-1970s. Their research paper, 'Judgment Under Uncertainty: Heuristics and Biases', in the Science journal has provided the basis of almost all current theories of decision-making and heuristics. Professor Kahneman was awarded a Nobel Prize in 2002 after further developing the ideas and applying them to economics.



ANCHORING EFFECT
Relying too much on the initial piece of information offered when making decisions

"The first test seemed OK. Do we need to look any more?"

AVAILABILITY HEURISTIC
Overestimating the importance and likelihood of events given the greater availability of information

"I saw something very similar to this on LinkedIn. We need to take it seriously"

BANDWAGON EFFECT
Uptake of beliefs and ideas increases the more that they have already been adopted by others

"The whole department knows there's no problem here"

BELIEF BIAS
Basing the strength of an argument on the believability or plausibility of the conclusion

"I didn't quite follow your argument but the conclusion seems about right"

BLIND SPOT BIAS
Viewing oneself as less biased than others

"Let's ignore Sarah's views on this one. She's biased"

CLUSTERING ILLUSION
Erroneously overestimating the importance of small clusters or patterns in large data

"This is the second week in a row that this has happened. There must be a problem"

CONFIRMATION BIAS
Focusing on information that only confirms existing preconceptions

"We did loads of simulations. Most of them showed there's no problem"

COURTESY BIAS
Giving an opinion/conclusion that is viewed as more socially acceptable so as to avoid causing offence/controversy

"The last time we discussed this the meeting lasted for hours. Let's move on"

ENDOWMENT EFFECT
The tendency for people to ascribe more value to things merely because they already own/have them

"I know it will cost a fortune to fix but it cost us £15,000. We can't just throw it away."

"The conveyor belt broke three times last month. It's pretty unlikely it'll happen again."

GAMBLER'S FALLACY
Believing that future probabilities are altered by past events, when in fact they are unchanged

"Let's just get the deal done ASAP"

HYPERBOLIC DISCOUNTING
Preferring a smaller, sooner payoff over a larger, later reward

"This worked fine in the factory in the Korea, it should work fine here"

ILLUSION OF VALIDITY
Overestimating our ability to make accurate predictions, especially when data appears to tell a coherent "story"

"Looks like we've run out of time to discuss this"

OSTRICH EFFECT
Avoiding negative financial information by pretending it doesn't exist

"We made a good call on that one"

POST-PURCHASE RATIONALISATION
Tendency to retroactively ascribe positive attributes to an option one has selected

"Our competitors are only doing well because their products are cheap"

REACTIVE DEVALUATION
Devaluing an idea because it originated from an adversary or opponent

"Now we've got the new equipment we can cut the time spent on maintenance"

RISK COMPENSATION
Taking bigger risks when perceived safety increases; being more careful when perceived risks increases

"If it ain't broke - don't fix it"

STATUS QUO BIAS
Preferring the current state of affairs over change

"Dave from tech is worried - but frankly the tech team are always pessimists"

STEREOTYPING
Assuming a person has characteristics because they are a member of a group

RACONTEUR

https://medium.com/better-humans/cognitive-bias-cheat-sheet-55a472476b18

Cognitive Biases

Problems that biases help us address :

Too much information: we need to filter it

Examples: Confirmation bias, Anchoring

Not enough meaning: we like to fill in missing pieces

Examples : Anecdotal fallacy, Halo effect

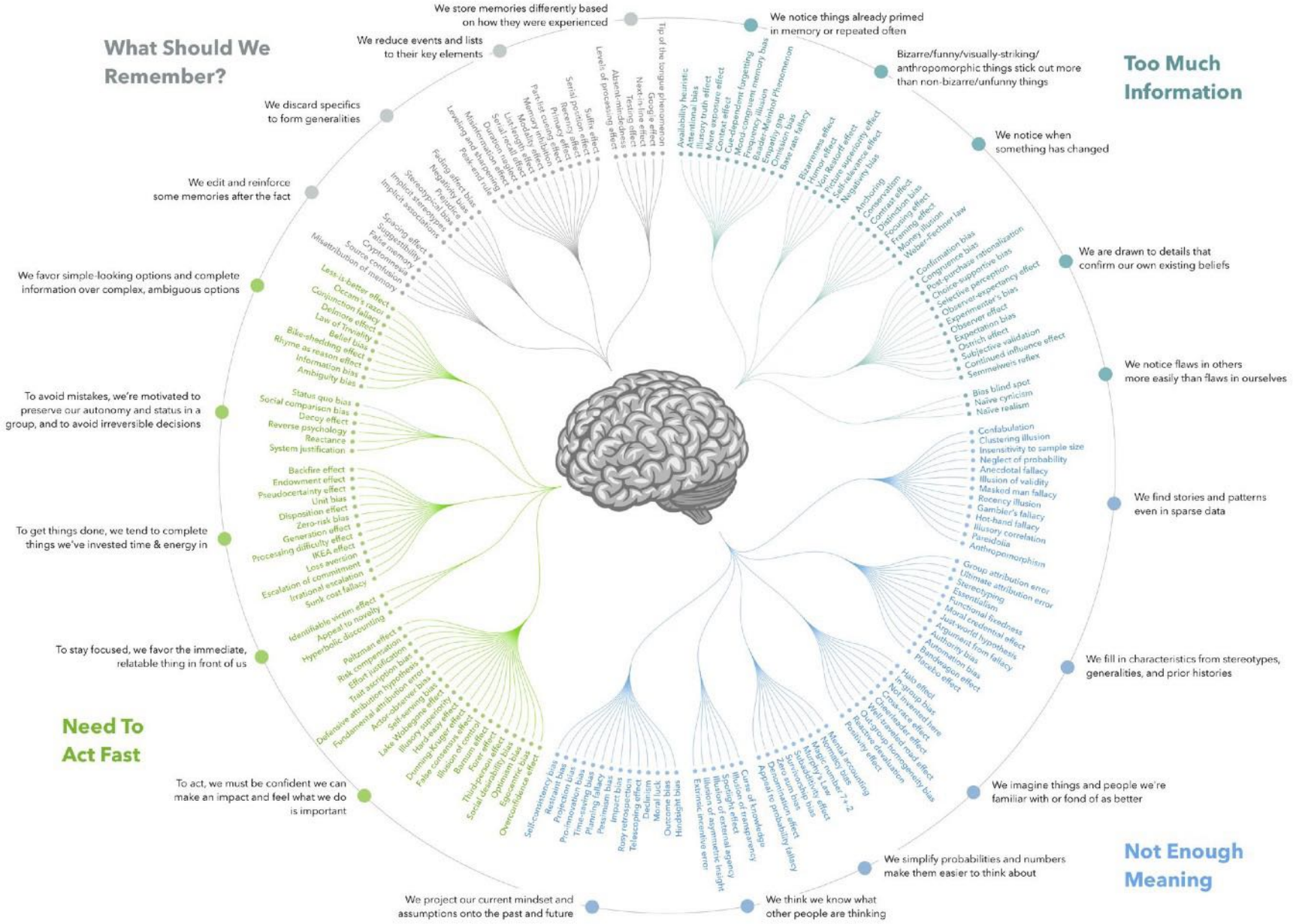
Not enough time: we need to act fast

Examples : Egocentric bias, IKEA effect

Too many things to remember:
we need to compress / omit information

Examples : Primacy / recency effects, Implicit stereotype

COGNITIVE BIAS CODEX, 2016



ALGORITHMIC LAYOUT + DESIGN BY JM3 · JOHN MANOOGIAN III // CONCEPT + METICULOUS CATEGORIZATION BY BUSTER BENSON // DEEP RESEARCH BY WIKIPEDIANS FAR + WIDE

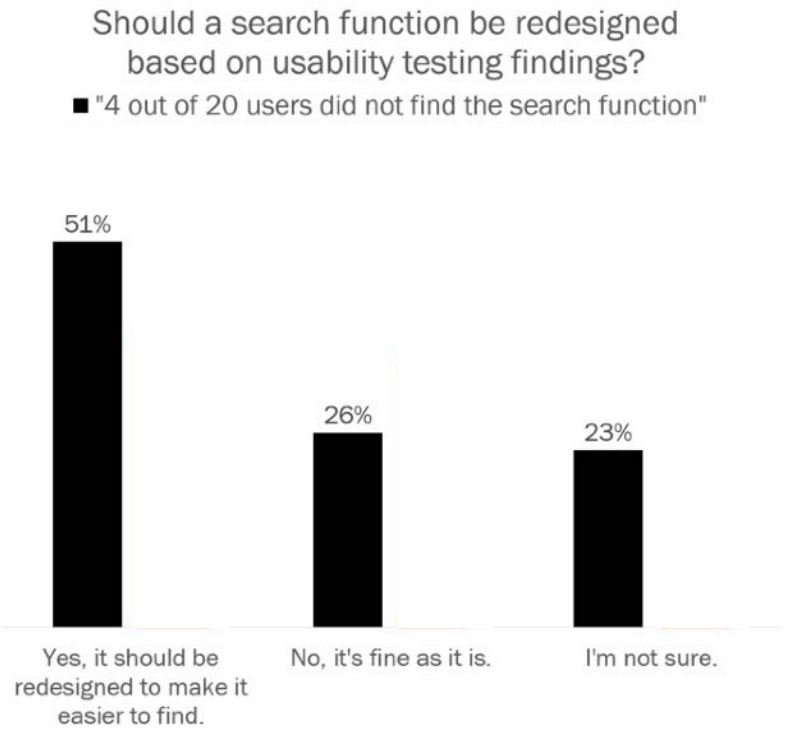
Cognitive Biases and HCI

Cognitive biases affect the design process

Confirmation bias: choose designs that support existing beliefs

Framing bias: presentation of results affect choice

"4 out of 20 users could not find the search function"



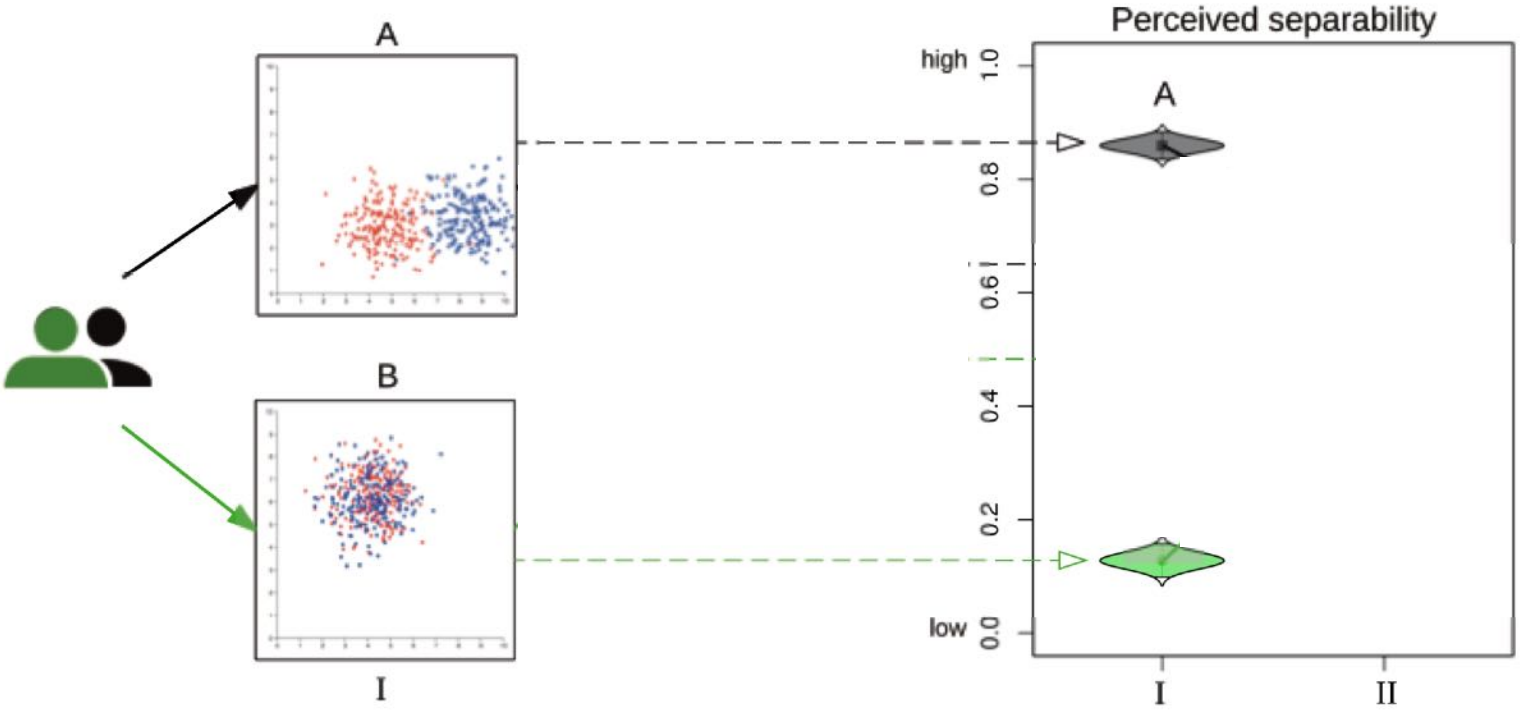
https://www.nngroup.com/articles/decision-framing-cognitive-bias-ux-pros/

Cognitive Biases and HCI

Cognitive biases affect users' behavior

Confirmation bias: users focus on online reviews that support their pre-existing opinion of the product

Anchoring: decision depends on initial piece of information



https://homepage.univie.ac.at/michael.sedlmair/papers/calero-valdez2017priming.pdf