Human Computer Interaction

Chapter 3: Humans – Part 1

Prof. Dr. Björn Eskofier
Machine Learning and Data Analytics (MaD) Lab
Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)
Summer Term 2024

Overview

01 Design for Humans

02 Excurse: Physiology

03 Human processor, cognitive abilities and memory

04 Visual perception

05 Optical illusions and Gestalt laws

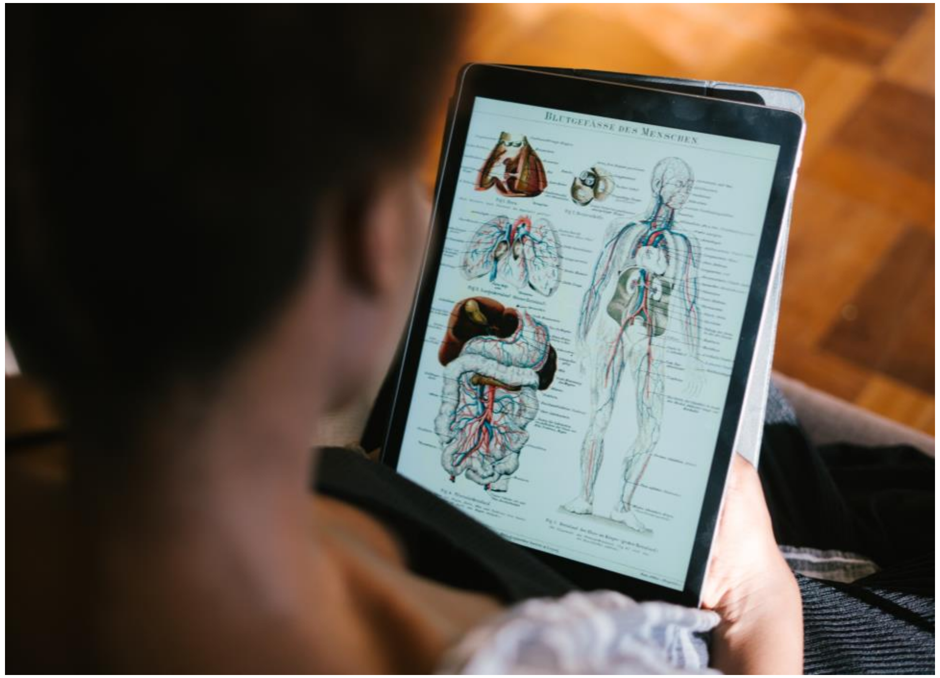
06 Stereo Vision

07 Reading

07 Hearing, Touch, Movement

08 Space and territory

09 Emotion



Design for human

What has to be considered?

Physiology does not explain everything.

Humans are very **complex**!
Even psychology only explains parts

→ Physical

Physiology (e.g., size, strength, degrees of freedom, fatigue)

→ Psychological.

Psychology (e.g., Memory, perception, cognition)

→ Emotion.

Emotions (e.g., Gender, abilities, and disabilities)

→ other stuff

Soft factors (e.g., Aesthetics, motivation, pleasure, experience)

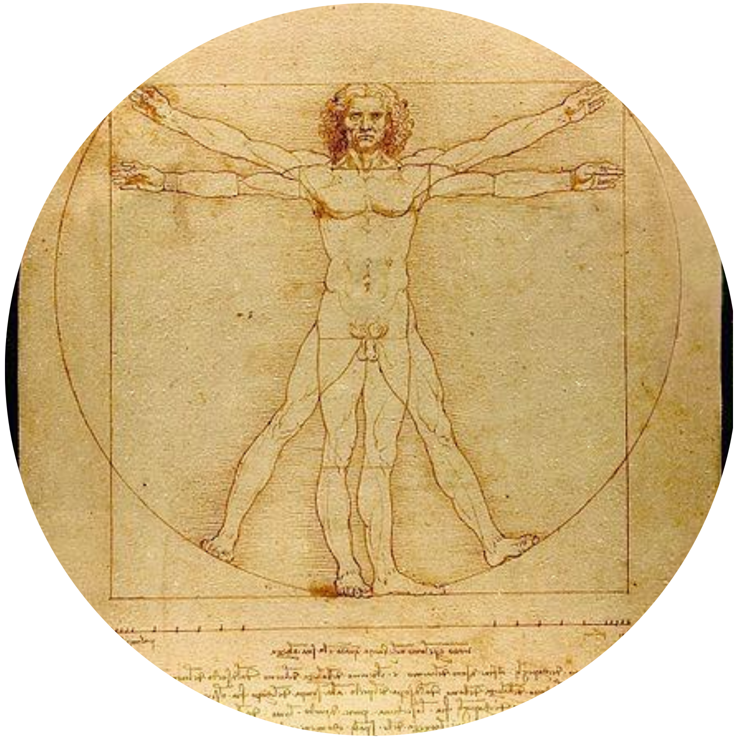
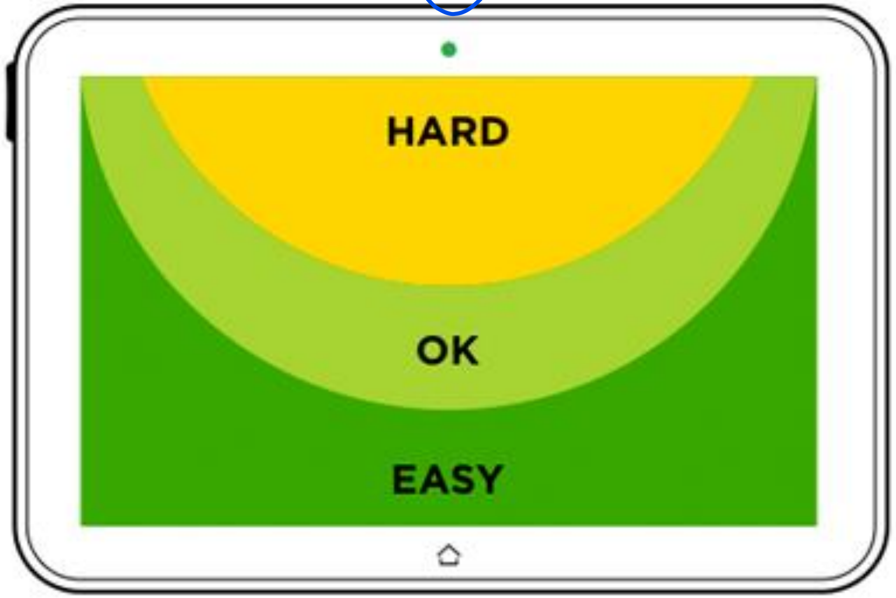


Photo by Luc Viatour drawing by Leonardo da Vinci
https://en.wikipedia.org/wiki/File:Da_Vinci_Vitruve_Luc_Viatour.jpg

What has to be considered?

Difficult to reach.

https://buildfire.com/mobile-web-design/



https://www.lukew.com/ff/entry.asp?1649

Human Abilities

Different users

Abilities of un-augmented users in general do not change a lot over time, e.g.

- Ability to cope with cognitive load
- Willingness to cope with stress
- Time one can concentrate on a particular problem

Same User.

Change over time

Abilities of one individual user changes over time

(e.g. getting old)

Same User

Abilities between individual users vary a lot

- Long term, e.g. gender, physical and intellectual abilities
- Short term, e.g. effect of stress or fatigue

long term
↳ very long.

short term
↳ Instant

General Principle : Designing for humans

The goal is to create systems and technologies that **fit humans**,

with regard to:

keep these in mind when designing.

- Physiology
- Psychology & cognitive abilities
- Emotions

Humans – Excurse: Physiology

Humans – Excurse: Physiology

1. Examples for physiological limitations

→ abilities & limitations.

On the one hand humans have a lot of abilities through their specific physiology but on the other hand also lots of examples where you have physiological limitations:

- Size of objects one can grasp — size
- Weight of objects one can lift — weight
- Reach while seated or while standing — Sit / stand Reach.
- Optical resolution of the human vision system — Optical Resolution
- Frequencies humans can hear — Hear frequencies
- Conditions people live in — Living conditions

Size of objects one can grasp

When you think about Bergkirchweih in Erlangen. You get 1l Maßkrug: For some people this is easy to grab and lift. However, there are lots of users that are actually not able to do that. The sheer size and weight of the objects makes it hard for specific groups to use it as it is supposed to.

> Not everything that could be done technically can be used / perceived by humans.

Humans – Excurse: Physiology

2. Relation to Computer Science

If we wouldn't take the human physiology and human factors in general into account, people might not be able to use a certain device or might come up with suboptimal performance.

Ways not used optimally.

Humans – Excurse: Physiology

2. Relation to Computer Science

Human physiology has also been explored in the context of computer science and HCI-related disciplines within the last decades. The possibilities and especially the limitations you just learned play an important role in the design and implementation of future interfaces. Existing devices and systems, that are intended for the interaction with a human have been widely investigated in research and industry.

One example for this is the computer keyboard as you know it. For physiology experts it is completely clear that writing in the position you have with a normal keyboard is unhealthy and ergonomic keyboards have been designed to overcome this issue. When we take a look back in history to the invention of the keyboard, we find ourselves in the time of typewriters. Due to the functional principle, the keys were placed in the layout that can still be found on almost all keyboards today.

Today, of course, this is no longer necessary from a technical point of view, but no new design has been able to establish itself apart from some isolated solutions. but no new design has been able to establish itself apart from isolated solutions. Most people are used to type with the QWERTZ keyboard even though there might be more physiological and efficient ways for typing.

Humans – Excurse: Physiology

3. Hand, Motions and DOF

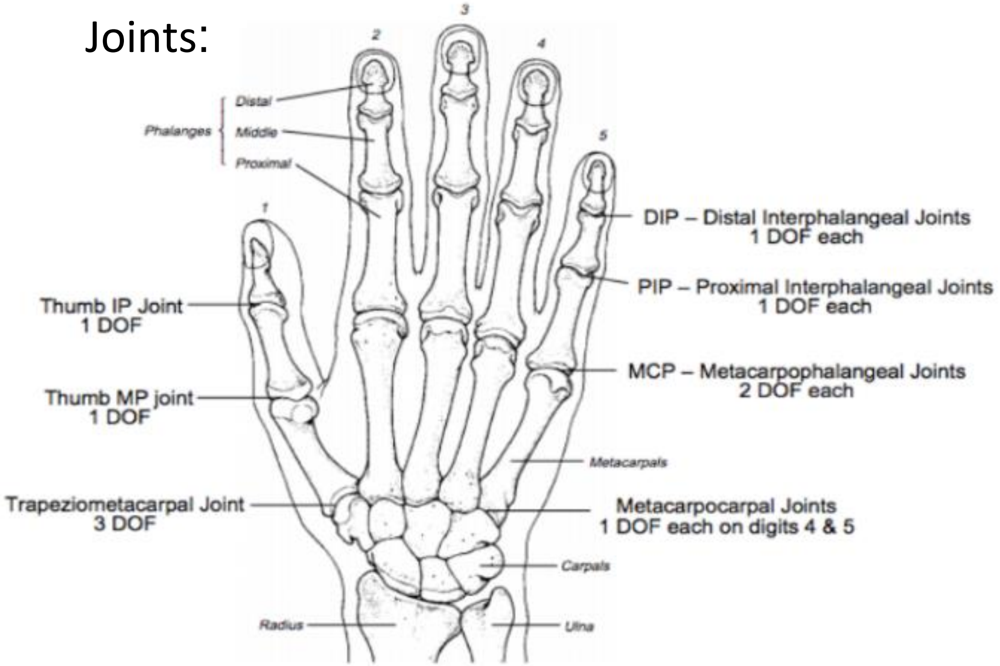
Hand Complex part.

The human hand with its numerous bones, joints and muscles is an anatomically complex part of the human body. It consists of 17 active joints that provide 23 degrees of freedom (DOF) in total.

Both easy and difficult movements are depending on the musculoskeletal system behind the hand. This defines what can and cannot be realised by us and might also be different for individual people.

Imagine you want to recreate a human hand:
What would be good design choices for it?

Joints:

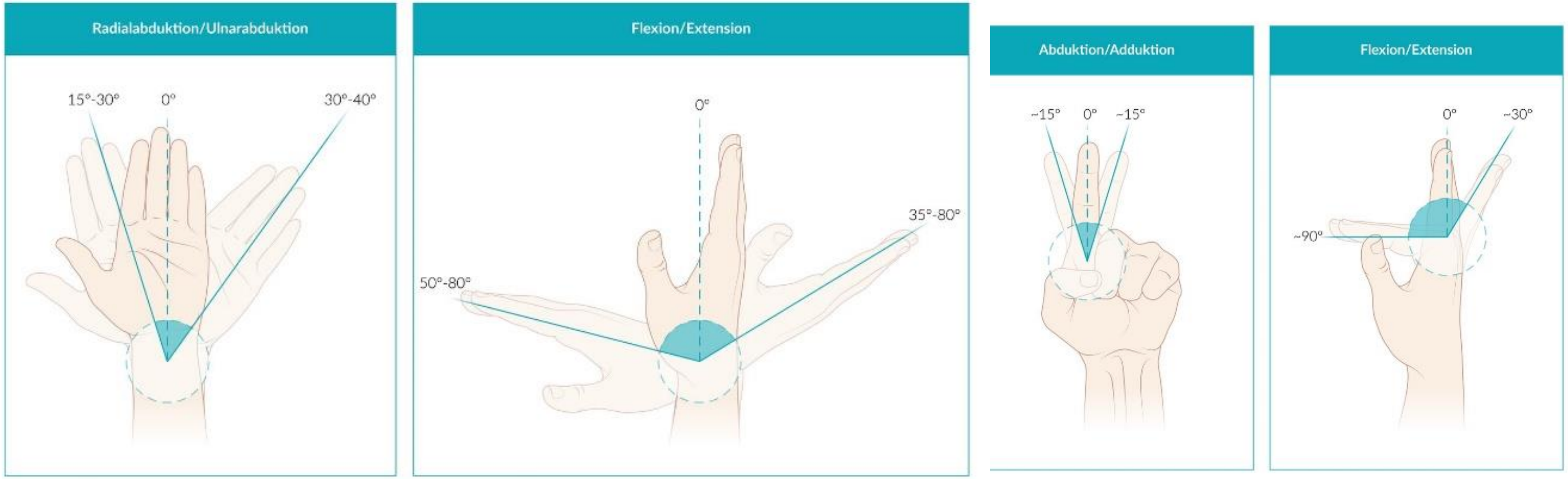


Humans – Excurse: Physiology

3. Hand, Motions and DOF

The human hand with its numerous bones, joints and muscles is an anatomically complex part of the human body. It consists of 17 active joints that provide 23 degrees of freedom (DOF) in total.

DOF:



User interface vision in 2002:

Minority Report

Humans – Excurse: Physiology

3. Gesture Input vs. Physiology

Gesture Vs Physiology.

Why HCI should care about Sci-Fi

Philipp Jordan
University of Hawaii at Manoa
Honolulu, HI 96826, USA
philippj@hawaii.edu

Brent Auernheimer, PhD
Department of Computer Science
California State University
Fresno CA 93740 USA
brent@csufresno.edu

Abstract
We consider the devices and interactions depicted in science-fiction popular media to be a legitimate topic in human-computer interaction (HCI) research, application and education. The role of movies to inspire and generate real-world technological developments is becoming understood and occasionally utilized by HCI researchers, user experience professionals, and science educators. Nevertheless, we argue to recognize and systematically explore the potential and power of popular media depictions in science fiction movies and shows as both a valuable inspiration for the HCI community and as a viable field of research for future HCI endeavors.

Author Keywords
human-computer interaction, science-fiction, technological visions, future interfaces, creativity, collective imagining, design fiction, diegetic prototypes, virtual ethnography

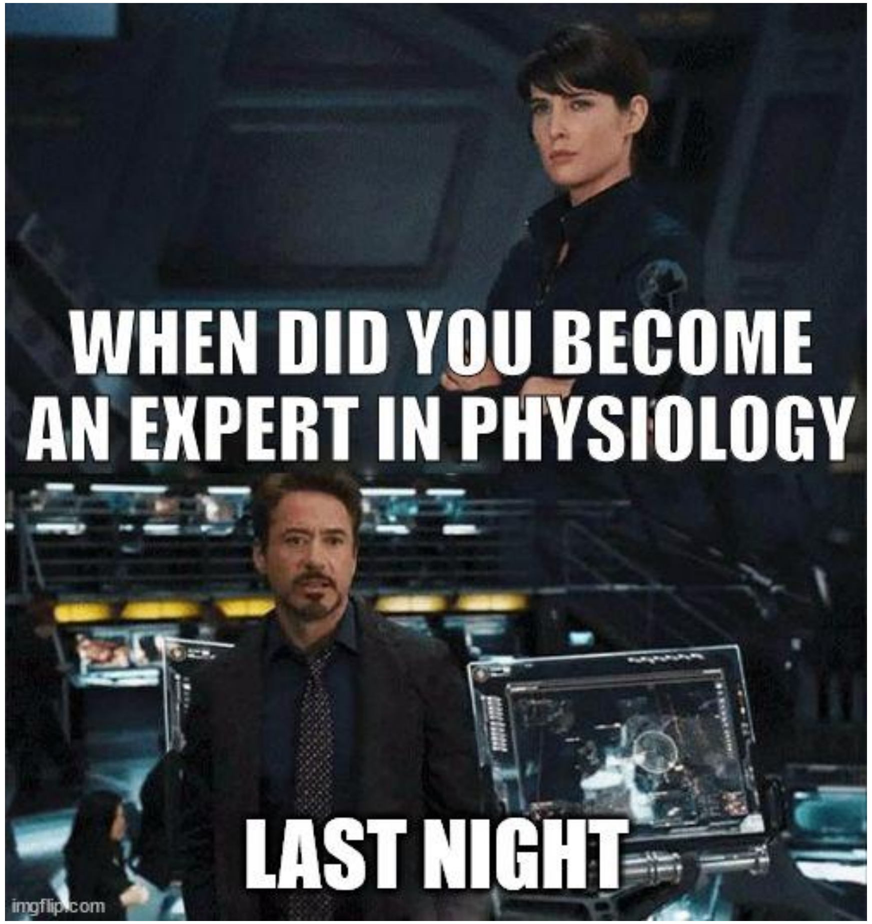
ACM Classification Keywords
H.5.m. **[Information interfaces and presentation]**: Miscellaneous.

Introduction
In January, 2016 [1] the future of personal health care will become reality with the conclusion of a five year, 10 billion dollar worth project sponsored by Qualcomm to design a "portable, wireless device in the palm of your hand that monitors and diagnoses your health conditions". One example of many, a medical tricorder was envisioned 50 years in the past in Star Trek, one of the most popular science-fiction (Sci-Fi) franchises of the 20th century.

Until recently, Sci-Fi audio-visual media and the depiction of the embedded interactions was not a serious topic in human-computer interaction (HCI) research, application or education. However, we do recognize an enduring and increasing intersection of technologies and interactions shown in modern Sci-Fi movies and shows with the themes investigated in HCI research and interaction design. Our position is to exploit the power of multimedia depiction in Sci-Fi movies and shows for HCI and interaction design researchers, professionals, consultants and educators. To achieve this, we need to consider the applicable

What do you think about this type of user interface?
- Is it feasible?
- What are advantages and disadvantages?

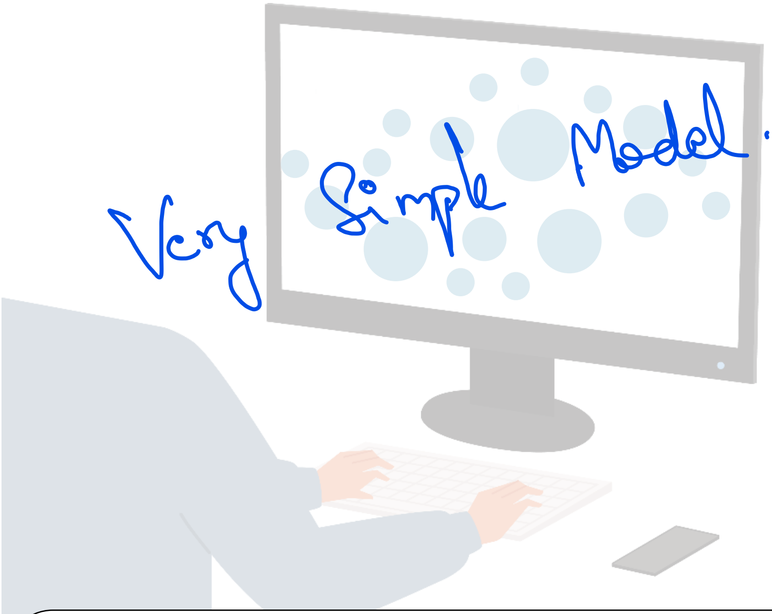
Jordan, Philipp & Auernheimer, Brent. (2015). Why HCI should care about Sci-Fi.
https://www.researchgate.net/publication/307173212_Why_HCI_should_care_about_Sci-Fi


WHEN DID YOU BECOME AN EXPERT IN PHYSIOLOGY
LAST NIGHT
imgflip.com

Human processor, cognitive abilities and memory

Model Human Processor (1)

Very Simple Model.



Very simple “model” of a **human interacting** with a computer

See Card, Moran and Newell 1983, and Dix Chapter 1

The model describes the human as **three sub-systems** 3

Perceptual system i/p
(acquire input from the real world)

Motor system Manipulate
(manipulate the real world)

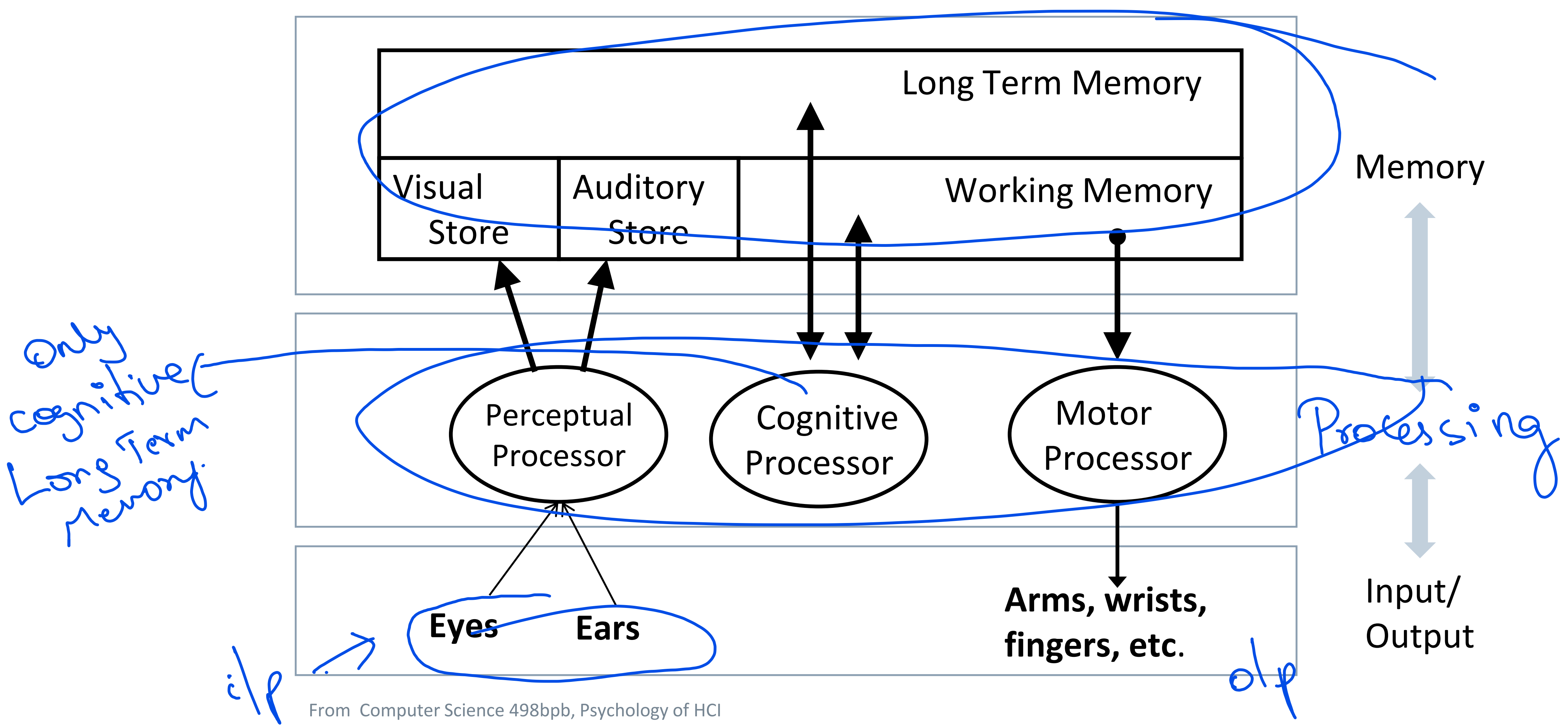
Cognitive system (Mind)
(connection between input and output, basic processing and memory)

Each subsystem includes:

- Processing
- Memory

MP

Model Human Processor (2)



From Computer Science 498bpb, Psychology of HCI

Example : Visual Processor

https://www.youtube.com/watch?v=vJG698U2Mvo&ab_channel=DanielSimons

Model Human Processor (3)

The model can explain how long certain tasks will take

Examples for Reaction/processing time:

- Perception (stimulus); typical time: TP ~ 100ms
- Simple decision; typical time: TC ~ 70ms
- Minimal motion; typical time: TM ~ 70ms

TP
Time Cognition
Time Motor

Reaction time
100 ms

Perception slower than motion, decision.

Further example for complex motor action: see Fitts' law, KLM

Model Human Processor (3)

Overall time for operation where there is a sequential processing

— Pressing a button when a light comes on ? → one by one.

- 240ms 100 + 70 + 70
- T = TP + TC +TM

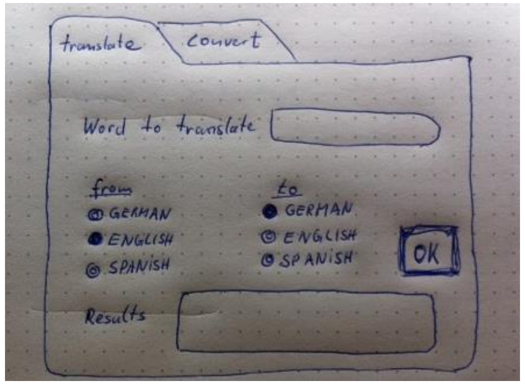
— Matching a symbol and then pressing one of the two buttons ?

- 310ms (2TC because there is comparison and decision)
- T = TP + 2TC + TM See + Compare + Decide + press

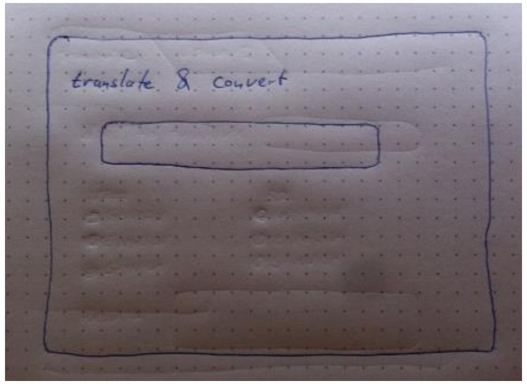
100 + 2×70 + 70

Processing can also be "parallel"

(e.g., phoning while writing, talking while driving, …)



vs.



Movement

Time taken to respond to stimulus

- Reaction time + movement time
- Movement time dependent on age, fitness etc.
- Reaction time – dependent on stimulus type:
  - Visual ~ 200ms
  - Auditory ~ 150ms
  - Pain ~ 700ms

Auditory, Visual, Pain

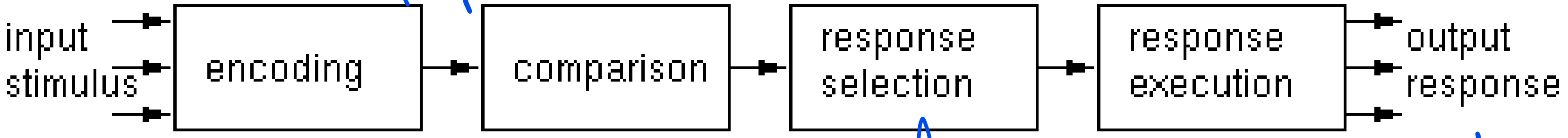
- Interesting for programming games
- $t = \sqrt{\frac{2d}{9.81\ m/s^2}}$
  - d = distance in meters
  - t = reaction time

Human Information Processing

Sequential four-stage process

Internal Representation.

Selection



Memorised Representation

Act on Stimulus.

- Encode stimulus received from the environment into an internal representation
- Compare the encoded stimulus with stored / memorised representation
- Formulate / select a response to received and encoded stimulus
- Act on the stimulus and execute the response

Lindsay, P.H. and Norman, D.A. (1977). Human Information Processing: An Introduction to Psychology, 2nd edition. New York: Academic Press.
Source (text, image): http://web.cs.dal.ca/~jamie/teach/NickGibbins/psych.html

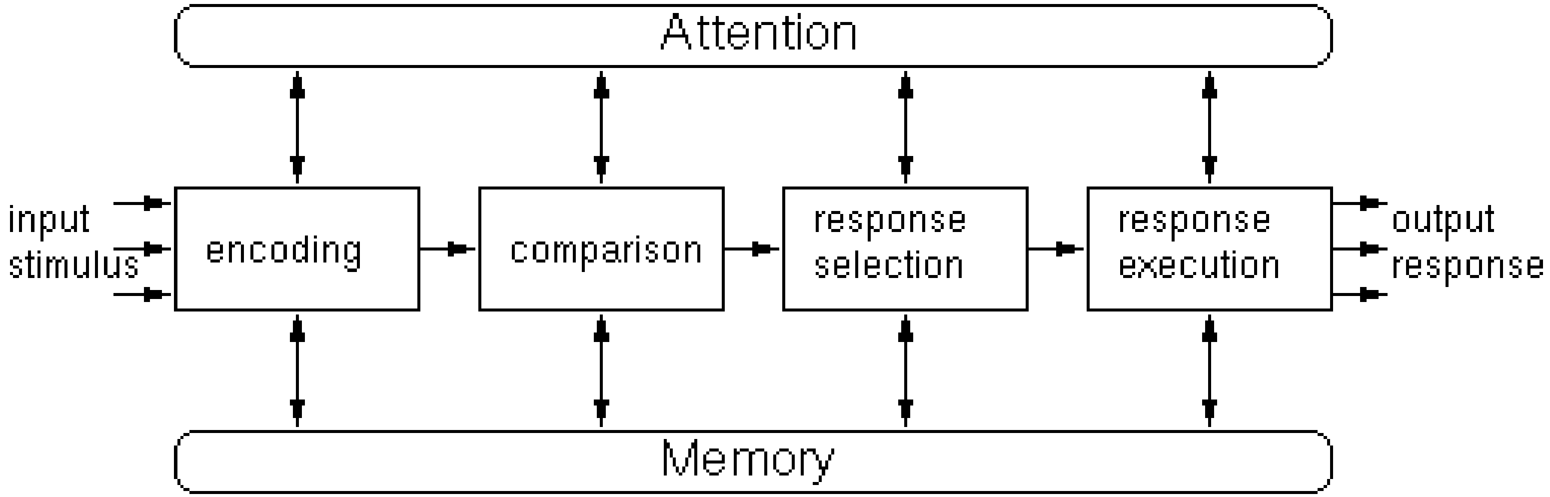
Human Information Processing

ECRsRe

Extended four-stage process

Attention and memory are relevant in all 4 stages

i/p
Stimulus



o/p
response

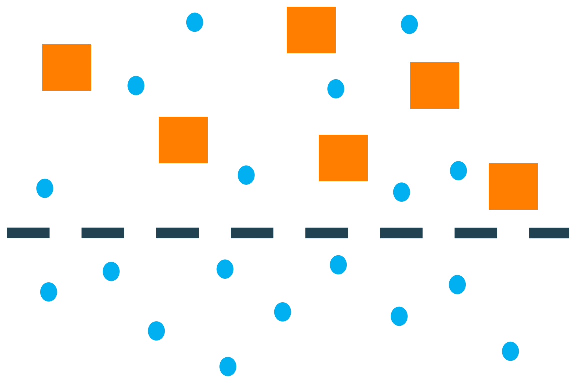
Barber, P (1988). Applied Cognitive Psychology. London: Methuen.
Source (text, image): http://web.cs.dal.ca/~jamie/teach/NickGibbins/psych.html

Excurse: Attention

Like a Filter?

- Attention acts as filter
- “Relevant” stimuli are accepted
- Others are filtered out

filtered out



Like a Bottleneck?

→ Allow few.

- Attention as a limited resource
- The capacity is limited
- Only parts “get through”
- Coding is relevant

→ coding / Encoding

Human Information Processing

See + Oral perception.

Multi-store Model.

Multi-Store Model for visual and oral perception

Sensory Memory

- sensory information
- high capacity
- short duration (<< 1 s)
- refresh / stimulus

Short-Term Memory (STM)

- symbolic information
- less capacity (7 ± 2 chunks)
- medium duration (~ 15 s)
- less processing power

less

Long-Term Memory (LTM)

- episodic/semantic information
- high capacity
- Relatively permanent duration
- slow access

meaningful.

Attributes

Context

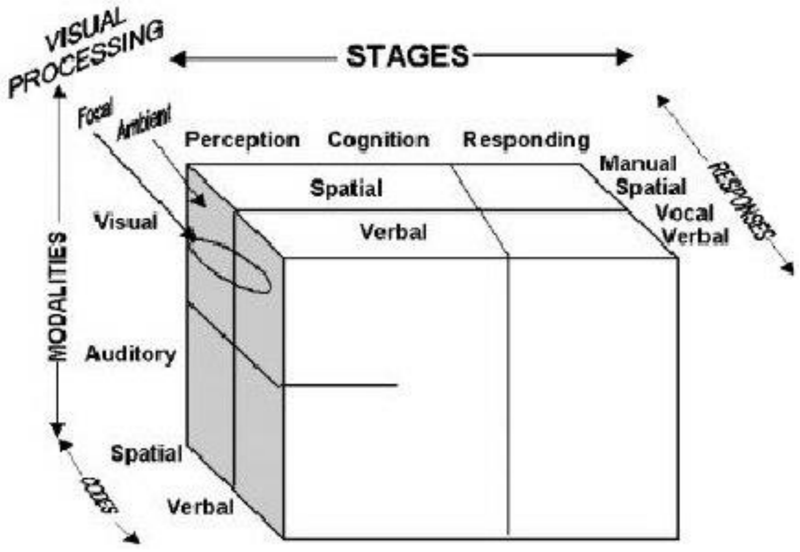
Recognize-act cycle (~ 70 ms)

Smell ? Sambar smell.???

Wickens 4 - Dimensional Multiple Resource Model

- **Four** important dimensions explain the variance in time-sharing performance
- Each dimension has **two discrete 'levels'**
- Two tasks that both demand one level of a given dimension (e.g., two tasks demanding visual perception) will **interfere** with each other more than two tasks that demand separate levels on the dimension

↳ More interference.



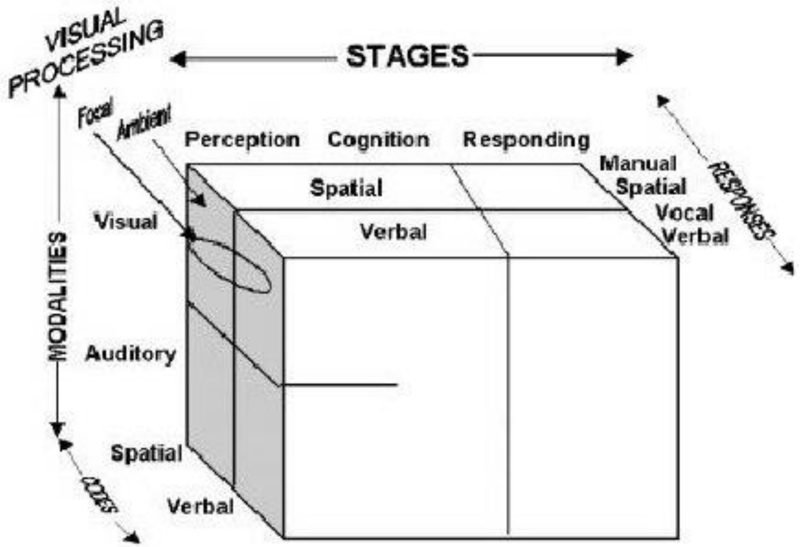
Source: Wickens, C. D.: Multiple resources and performance prediction. Theoretical Issues in Ergonomics Science. S.159–177, 2002.

Wickens 4 - Dimensional Multiple Resource Model

Four dimensions are:

- Processing stages
- Perceptual modalities
- Visual Channels
- Processing codes

P_S P_M V_C P_C



Source: Wickens, C. D.: Multiple resources and performance prediction. Theoretical Issues in Ergonomics Science. S.159–177, 2002.

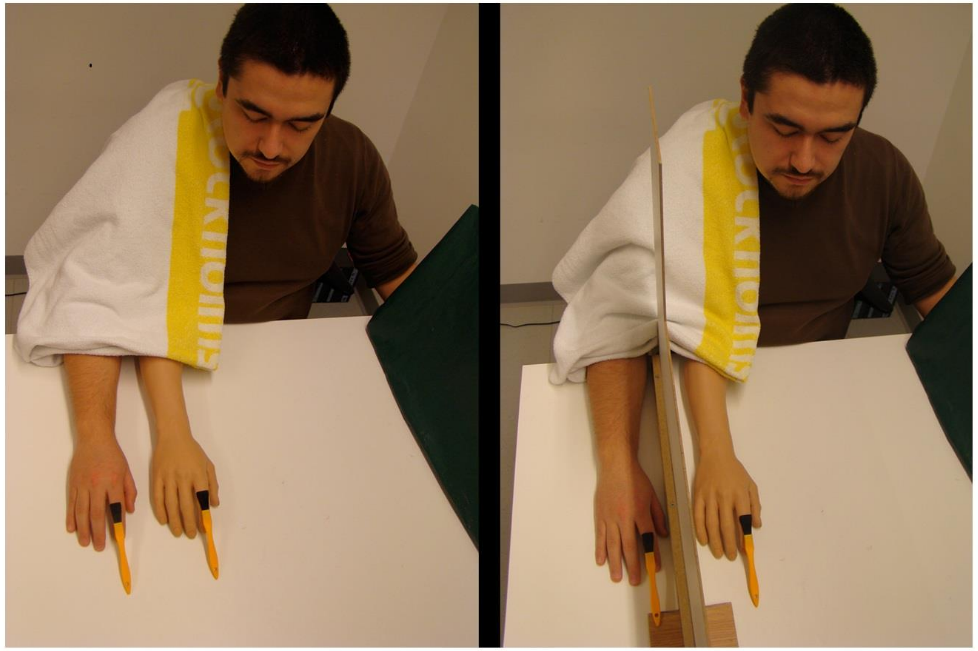
Implications:

- Tasks that use different levels are
- easier to do than tasks that require “more” of one level
- Listening to 2 conversations? → Difficult
- Searching a photo while listening? → Easy.

Rubber-Hand illusion

Visual information overwrites proprioception

Visual > proprioception.

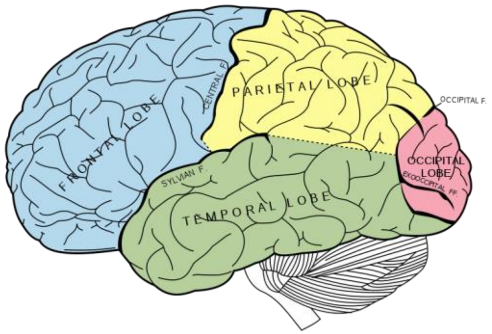


https://www.youtube.com/watch?v=sxwn1w7MJvk

Memory

Involves encoding and recalling

- Knowledge and acting appropriately
- **We don't remember everything** – involves filtering and processing
- **Context** is important in affecting our memory
- We **recognize** things much better than being able to recall things
  - The rise of GUI over command-based interfaces
- Better at **remembering images** than words
  - The use of icons rather than names



Reproduction of a lithograph plate from Gray's Anatomy by Mysid (public domain)
https://en.wikipedia.org/wiki/File:Gray728.svg

https://en.wikipedia.org/wiki/File:Luna_Park_Melbourne_scenic_railway.jpg

Short-term memory (STM)

Guideline: Do not overload and over strain your STM

- Use known symbols
- Notes, menus, lists (WYSIWYG)
- Grouping, chunks (complex super symbols)
- Short, closed actions

0110 1011 0111 1100
6B7C

www.mad.tf.fau.de
131.188.16.206

Guideline: Utilize STM properties

- Visualize attributes (icons, colors)
- Link illusion and keyword
- Minimize distraction!
- Avoid inconsistent similarity (e.g. get / set , delete / repeat)
- Reduce Complexity

same - same but different ?
Avoid.

Long-term memory (LTM)

Machine Learning Data Analytics FAU

- Context-based memory (associative links) → Associative links.
- Loss of access instead of erasing (forgetting) → there but not accessible anymore.
- Duration depends on the intensity and the quality of memorizing
- Two types of LTM
  - **Episodic** : serial memory of events → episodes ?
  - **Semantic** : structured memory of facts, concepts, skills
- The following can train your LTM:
  - Learning by **repeated practicing** → repetition
  - **Active** learning (learning by doing) → Active
  - **Rules** and **structures** increase the efficiency → Rules / structures
  - Illustrate and **visualize** words

Motivation : Decision and long-term memory

Do dogs bark?

Do dogs breathe?

Yes | No

Yes | No

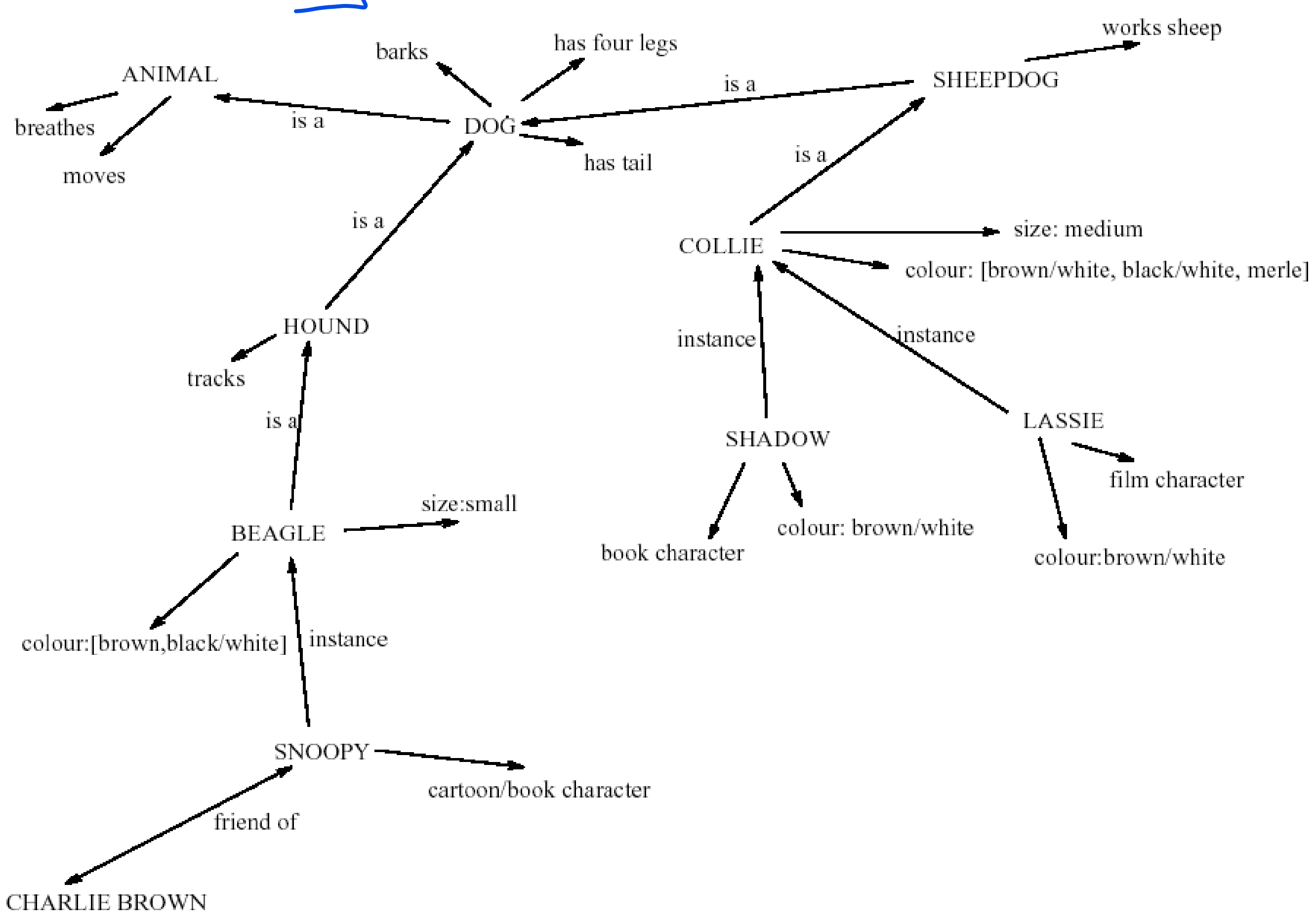
(Tree / network) structured memory of facts.

The second question takes longer to answer.

This indicates semantic coding.

Semantic coding.

LTM – semantic network



LTM – Storage of information

Rehearsal

Skep rehearsal

- Information moves from STM to LTM

Total time hypothesis

- Amount retained proportional to rehearsal time

More rehearsal time
More retained

Distribution of practice effect

learning over time.

- Optimized by spreading learning over time

Structure, meaning and familiarity

- Information easier to remember

LTM – Forgetting

Decay

- Information is lost gradually but very slowly

Interference

- New information replaces old: retroactive interference
- Old may interfere with new: proactive inhibition

retroactive – new replace old.

proactive – old interfere with new.

So may not forget at all memory is selective …

… affected by emotion – can be subconsciously ‘choose ’ to forget

Forgetting

Forgetting curve (Ebbinghaus)

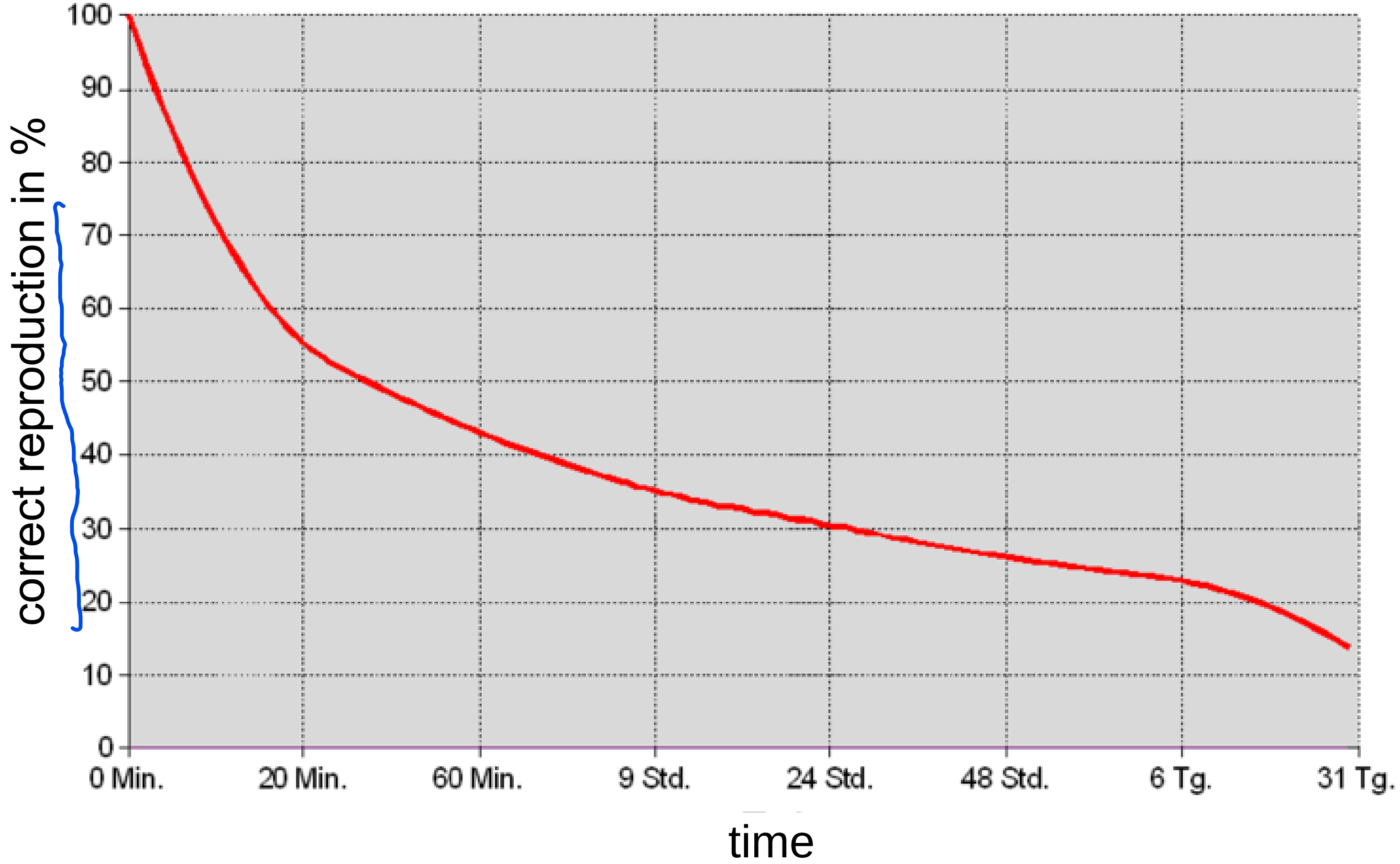


Image by Rdb (GFDL)
https://commons.wikimedia.org/wiki/File:Vergessenskurve.png

Non-linear

forget

LTM – Retrieval

Hints.

Recall

- Information reproduced from memory can be assisted by cues, e.g., categories, imagery

images,
Categories

Recall more
Complex.

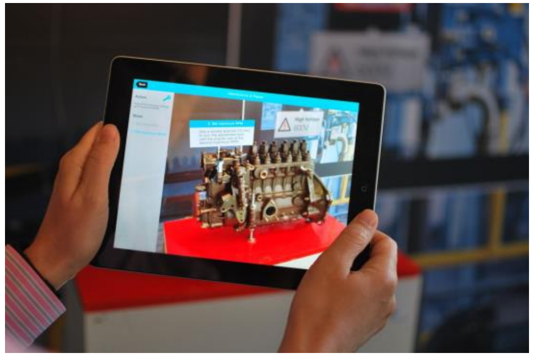
Information - cue

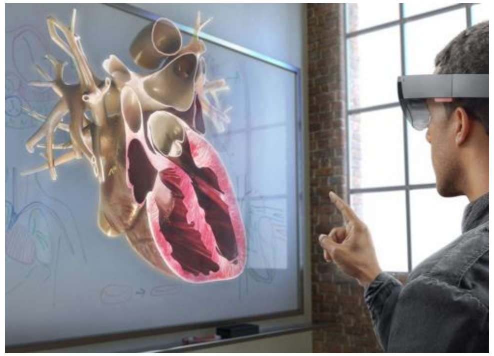
Recognition

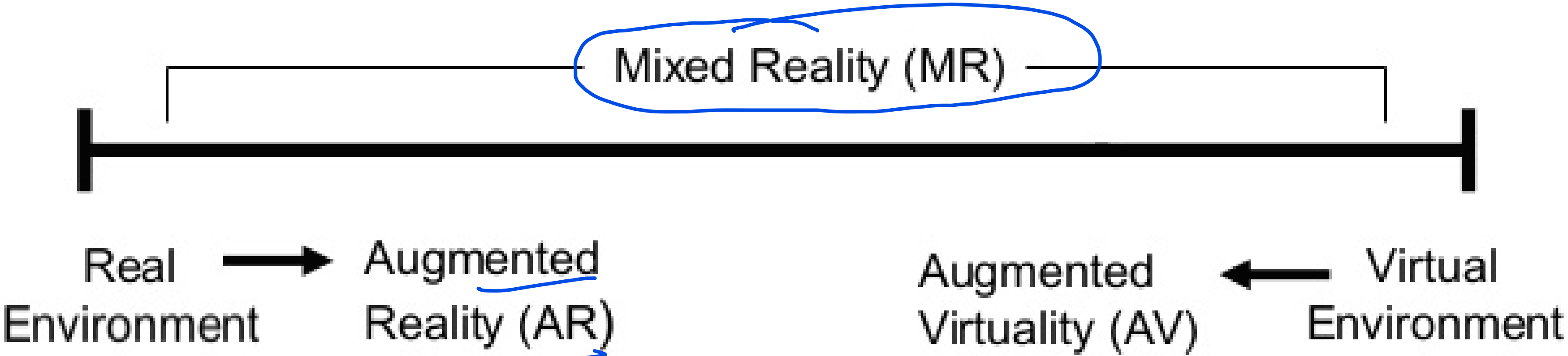
- Information gives knowledge that it has been seen before
- Less complex than recall - information is cue

Excurse: Modern Media

How does/can our learning process change?







Virtual Env.

Augmented Virtuality.

The problem with the classic '7±2'

- George Miller's theory of how much information people can remember
  (THE MAGICAL NUMBER SEVEN, PLUS OR MINUS TWO: SOME LIMITS ON OUR CAPACITY FOR PROCESSING INFORMATION, The Psychological Review, 1956, vol. 63, pp. 81-97)

- People's immediate memory capacity is very limited

7 ± 2

- In general, you can remember **5-9 chunks** – and chunks can be letters, numbers, words, sentences, images, …

Wrong application of theory

Many designers have been led to believe that this is a useful finding for interaction design

- 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

But this is wrong! Why?

- Inappropriate application of the theory
- People can scan lists of bullets, tabs, menu items till they see the one they want
- They don't have to recall them from memory having only briefly heard or seen them

Non need to recall

Coding of Information

Machine Learning Data Analytics FAU

- Visual – image of a person
- Phonological – sound of a voice
- Semantic – meaning of what a person is saying → Semantic – meaning –
- Coding in Short Term Memory – STM coding
- Sound is most efficient – Sound best.
- When users have to remember something in the application

Make it possible to code it phonological (e.g., password you can say)

Stroop effect.

Test:

- 3 groups of 6 words in different color
- Say color names of words as fast as you can
- Say done when finished
- Simple explanation: http://faculty.washington.edu/chudler/words.html
- An online version: http://faculty.washington.edu/chudler/java/ready.html

Interference:

- Strong clues in working memory → Strong clues in working memory.
- Link to different chunks in LTM → colors in LTM

Green
White
Yellow
Red
Black
Blue
White
Black
Yellow
Red
Blue

Paper
Fortune
Back
Homeland
Car
Paper
Homeland
Socker
Fortune
Back
Soccer

Blue
Green
Black
White
Red
Yellow
Red
White
White
Red
Yellow

Human Information Processing

Human Communication

- Inaccurate, full of assumptions, not complete & Short
- Structured information (forms, dialog boxes)
- Require confirmation

→ One step confirm?

Thinking / Deciding

- Either broad and flat Or narrow and deep
- Limited number of alternatives
- Avoid frequent repetitions

Visual Perception

Visual Perception

Machine Learning
Data Analytics

FAU

Visual perception is one of the most important sources of information.
Approximately 60-80% of all information is perceived visually.
We can define three terms that will clearly distinguish the processes in visual perception:

Reception

Reception describes the transformation of the stimulus (light) into electrical energy.
Cognition describes the *"Understanding"* in the brain.
Perception describes the sensors (receptors) and signal processing happening in the eyes and in brain.

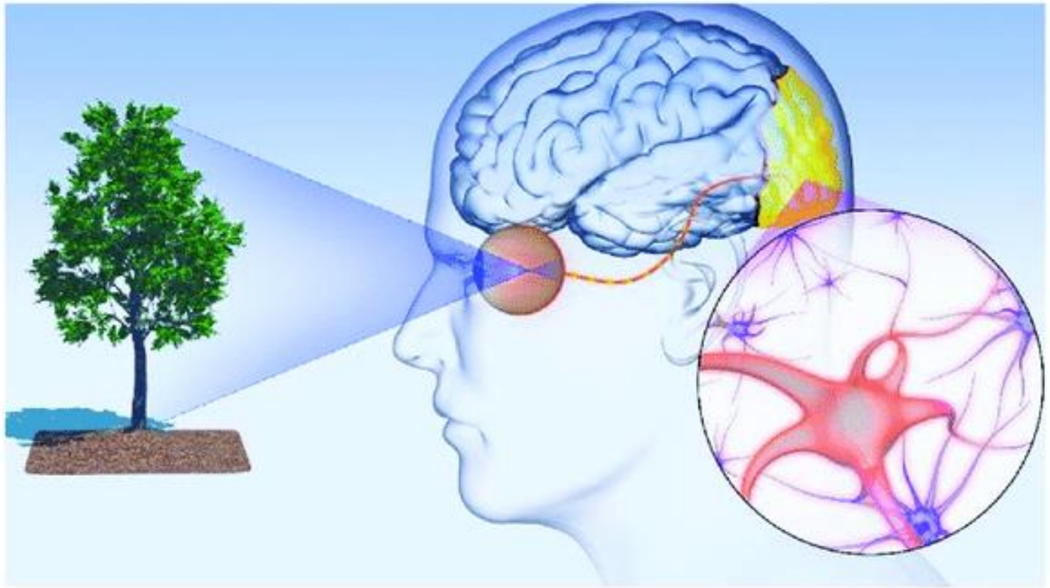
Cognition

Perception.

Sensor + signal processing →

Visual Perception

Visual perception is one of the most important sources of information.



Deng, Wei & Zhang, Xiujuan & Jia, Ruofei & Huang, Liming & Jie, Jiansheng. (2019). Organic molecular crystal-based photosynaptic devices for an artificial visual-perception system. NPG Asia Materials. 11. 77. 10.1038/s41427-019-0182-2.

Visual Perception

Sensory Organ – The Human Eye

The human eye has some very basic attributes:

- Very high dynamic range
- Bad color vision in dark conditions
- Best contrast perception in red/green
- Limited temporal resolution (reaction speed) – The human is said to be blind when moving the eyes.
- Good resolution and color in central area (macula)
- Maximum resolution and color only in the very center (fovea)

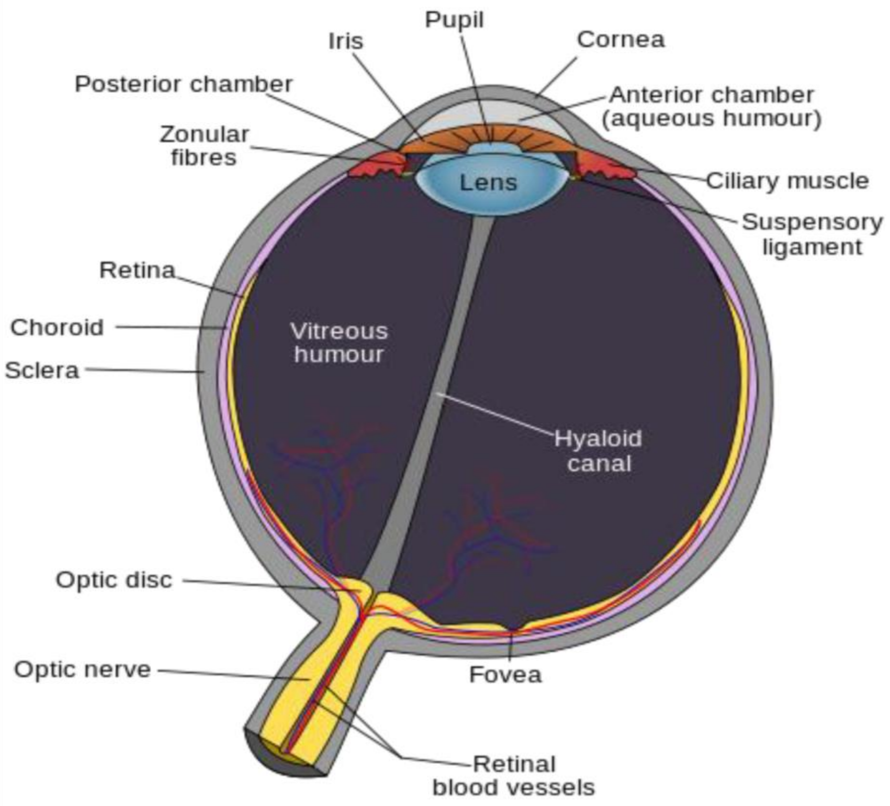
limited speed.

Macula.

fovea

Macula

fovea



Visual Perception

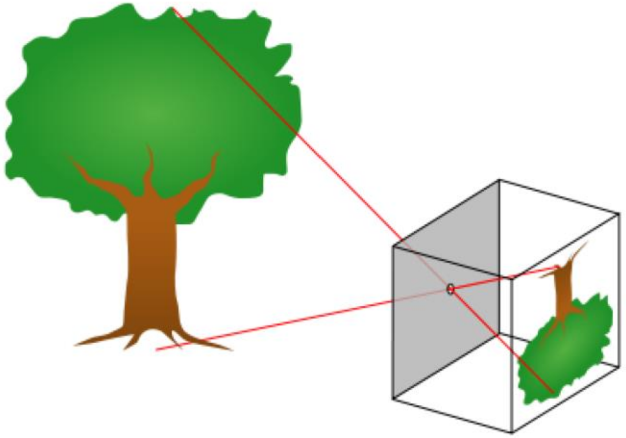
Sensory Organ – The Human Eye

The human eye has some very basic attributes:

RGBC

- Retina contains **rods** for low light vision and **cones** for color vision (they transform light into electrical energy) → Receptor for light stimuli
- Ganglion cells inside the retina are already part of the brain and detect patterns and movements
- Pinhole camera (everything we see is upside-down projected on the retina)

Ganglion - part of Brain ?



Visual Perception

Interpreting the signals

Basic and first signal interpretation:

- Size and depth
- Brightness
- Color

size, depth
brightness
Color.

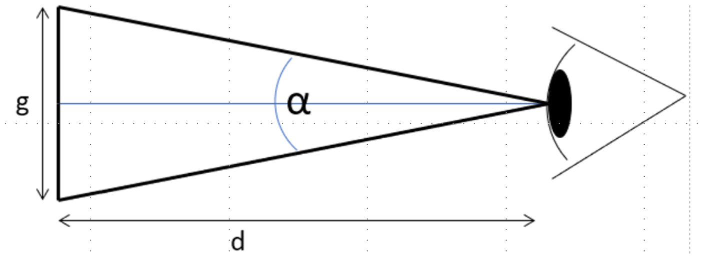
Visual Perception

Interpreting the signals - Size and depth

Visual acuity (VA) is the ability to perceive details (smallest resolvable object size *g* at given distance *d*). This ability is limited and can change over time. The better, the more precise is our interpretation of size.

Visual Acuity

$$VA = \frac{1}{arctan(\frac{g}{d}) \cdot 60}$$



$$VA = \frac{1}{Arctan\left(\frac{g}{d}\right) 60}$$

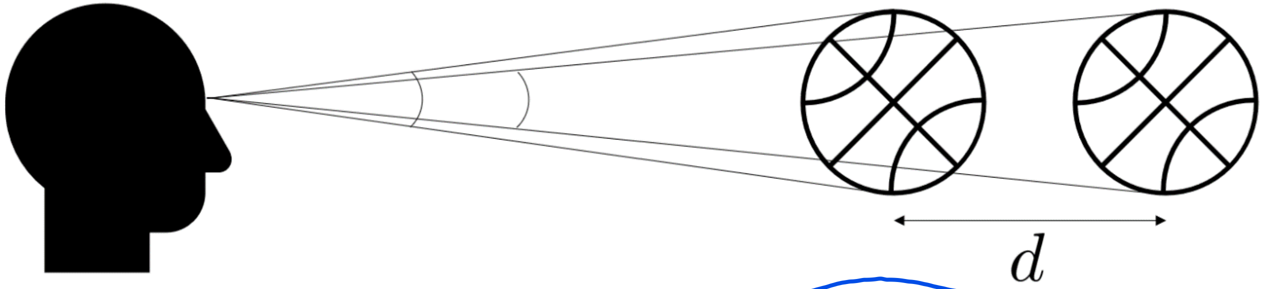
The visual angle indicates how much of our field of view an object occupies (relates to size and distance from eye). Familiar objects are perceived as constant size (despite changes in visual angle when far away).

constant size.

Visual Perception

Interpreting the signals - Size and depth

The Visual angle of an object (ball) maps onto the retina. The same object spans a different visual angle based on the distance to the eye.



-> The two balls are interpreted as having the same size.

Our depth perception mainly relies on *depth cues*.
Thereby we can distinguish two types of *cues:* **monocular and binocular depth cues**

Visual Perception

Interpreting the signals - Size and depth

Monocular depth cue (depth cues we can perceive with one eye)

Examples:

- **Accomodation** is tension of the muscles for the lens of the eyes -> change focal length, helps to correctly map the image onto the retina
- **Monocular Movement Parallax** -> by moving your head you can perceive depth
- **Retinal image size** -> when object size is known, smaller objects are perceived farther away (see above)
- **Linear perspective** -> railroad tracks that meet in infinity
- **Texture gradient** -> closer means more detailed (standing at a tree and looking up -> rough bark of the tree loses details) -> relates to visual acuity
- **Overlapping** -> closer objects block objects that are further away
- **Aerial perspective** bluish fog or hazy ???
- **Shadows** give a hint when there is only one light source

Visual Perception

Interpreting the signals - Size and depth

Binocular depth cue (depth cues we can only perceive with both eye)

Examples:

కళ్లు లోపలికి పోతాయి.

Convergence when the eyes are moving inward to focus on a close object

Monocular Movement Parallax are differences in the perspective onto a scene or object caused by the distance between the eyes (different viewing locations)

different viewing locations.

Visual Perception

Interpreting the signals - Brightness

We have a very subjective reaction to levels of light. However, our reaction is still affected by the luminance of an object. Our eyes “measure” the luminance by just noticeable differences.

Interestingly our **visual acuity increases with luminance** as does flicker (fast changes in luminance).

Acuity $\propto$ luminance. (ability to perceive details)

Rods have a **lower density at the fovea but a higher density temporal and nasal to the fovea**. Thus, they contribute more to the peripheral vision. They cannot detect color.

b/w
dark/light.

Rods
more peripheral.

Visual Perception

Interpreting the signals - Color

Our color perception is made up of:

- Hue
- Intensity
- Saturation

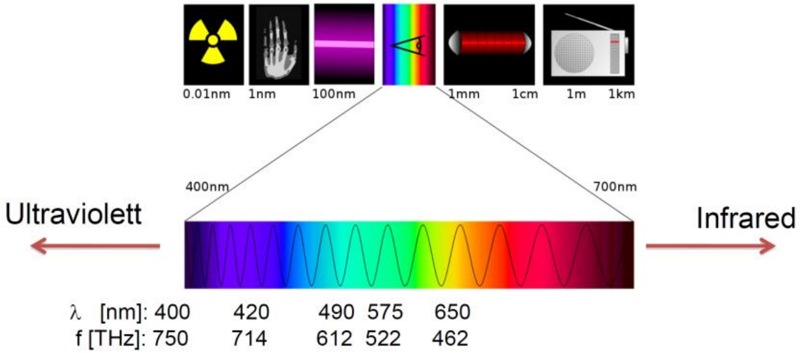
→ Ability to perceive details.

Cones are sensitive to color wavelengths, whereby the acuity to blue color is lowest.

Visual Perception

Interpreting the signals - Color

The spectrum of visible light for humans is quite small:



We only can perceive wavelengths between 400 and 700 nm. The Tristimulus theory (**trichromaticity**) describes that humans have three different cones that are differently sensitive to wavelengths λ:

trichromaticity.

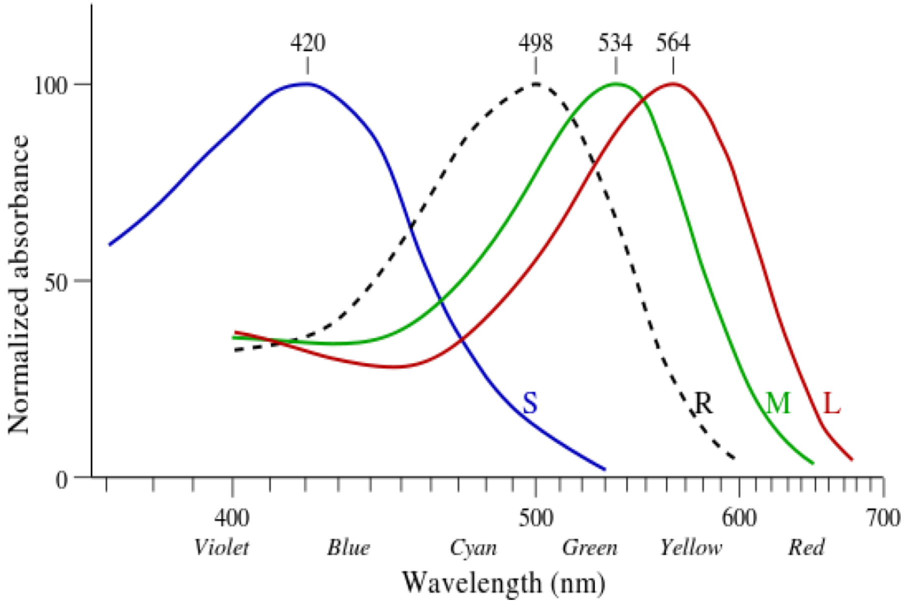
Red (Long)

Green (Medium)

Blue (Short)

Rods: Dashed line → cannot detect color, sensitive to all wavelengths

RGB reverse. BRG Red.



Bowmaker J.K. and Dartnall H.J.A., "Visual pigments of rods and cones in a human retina." J. Physiol. 298: pp501-511 (1980).

Visual Perception

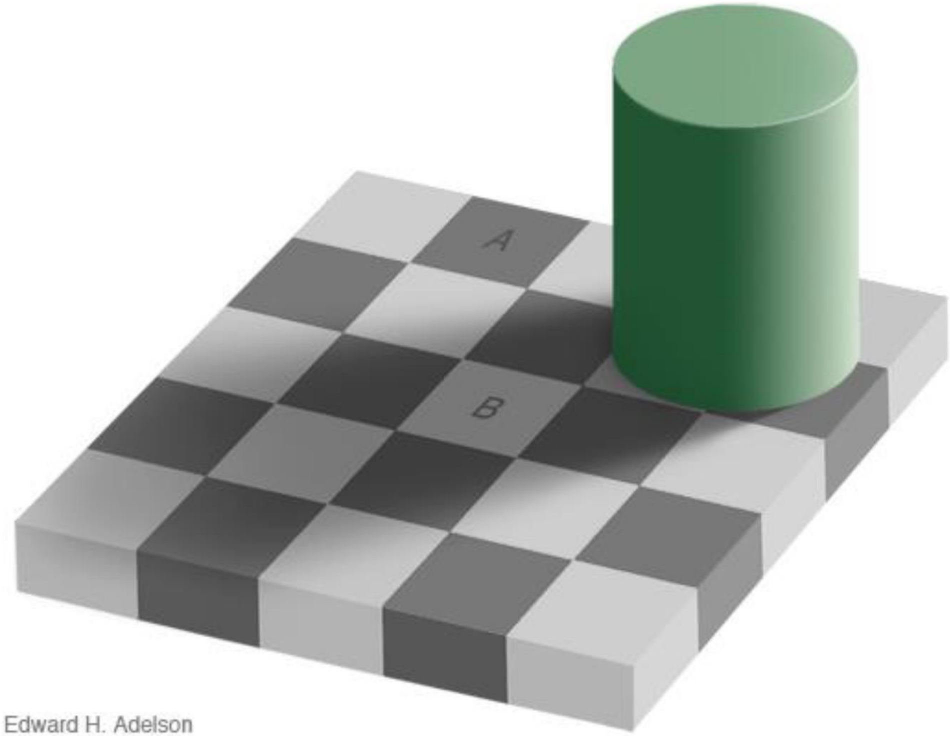
Interpreting the signals - Color

Some people cannot detect colors in general. They are color blind or cannot detect or distinguish between specific colors. Color blindness is a hereditary disease and is more prevalent in male (**8-10% males and just 1% females are color blind**). The ype of color blindness can be detected with the following images:

Visual Perception

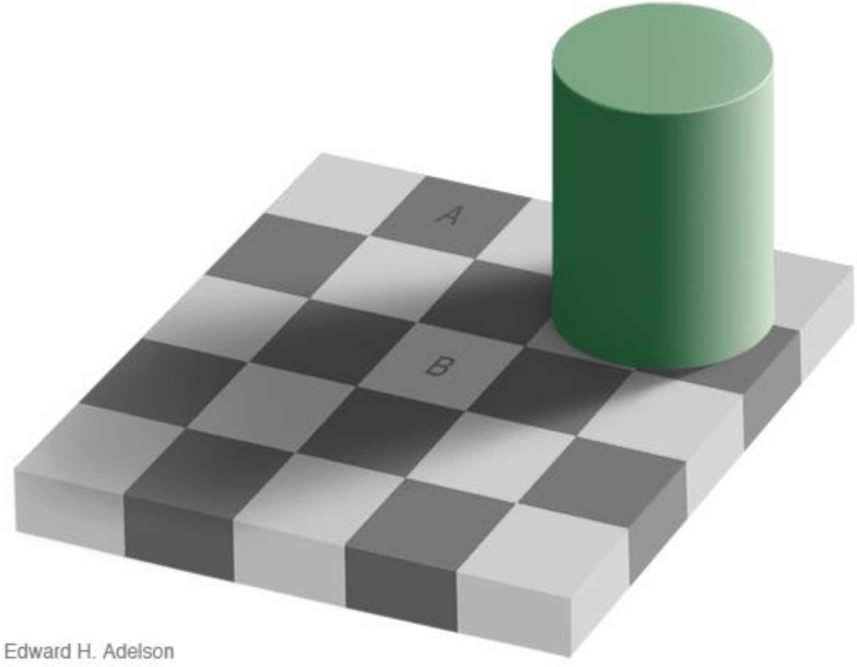
Interpreting the signals - Color

Our perception can be changed by the environment. A very good example is the *Adelson's checkerboard illusion.* This illusion makes use of a phenomenon in which the perceived brightness and color seems to play tricks on us. The brightness and color of tile *A* and *B* seem to be different. Are they different?



Edward H. Adelson

Our perception can be changed by the environment. A very good example is the *Adelson's checkerboard illusion.* This illusion makes use of a phenomenon in which the perceived brightness and color seems to play tricks on us. The brightness and color of tile *A* and *B* seem to be different. Are they different?



Tile A and B have the same Color!

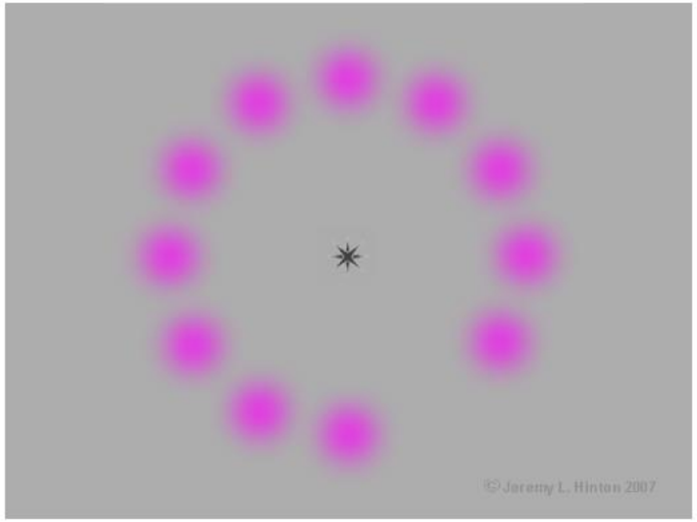
Video link:
https://www.youtube.com/watch?v=GALLMJxLvgA

Thus, using color keys can be difficult and misleading!!

Visual Perception

Interpreting the signals - Color

Another phenomenon is the afterglow of the opposite color. Following the link below, you will find an animation. You must fixate on the star in the middle. When you do that, a green dot will appear on the spots where the purple dot is missing.



Jeremy L.Hinton

https://appliedperception.wordpress.com/2015/09/22/hintons-lilac-chaser/

-> 2 Thumb rules for good designs especially for- and background colors

Visual Perception

Interpreting the signals - Color

1. Do not use opposite colors because….

Reds and Blues are on opposite ends of the color spectrum. It is hard for your eyes to focus on both.

Visual Perception

Interpreting the signals - Color

1. Lightness difference higher than 0.2 results in good contrast.

VIBGYORWB.

Optical Illusions and Gestalt Laws

Optical Illusions and Gestalt Laws

Optical Illusions

Our visual system compensates for movements and changes in luminance. The Context is used to resolve ambiguity. However, optical illusions sometimes occur due to overcompensation of our visual system.

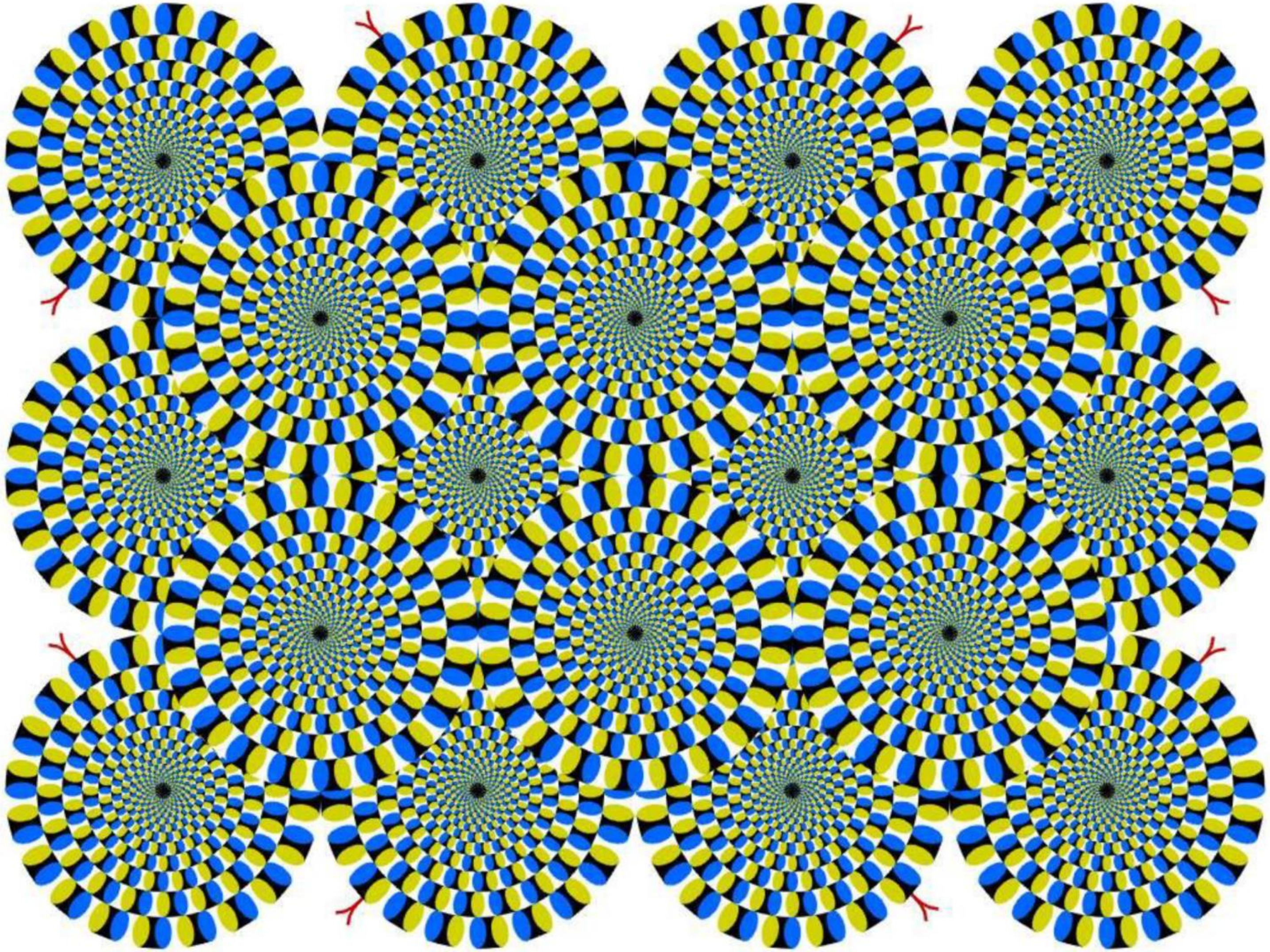
Hallucinate ?

We – for example – have a different perception in focus region and in peripheral view leading to motion artifacts. When you look at the following image in full screen you get the impression that the circles are moving although they’re not. This is caused by the difference in the focus and peripheral view.

Focus view
& peripheral view.

Optical Illusions and Gestalt Laws

Optical Illusions

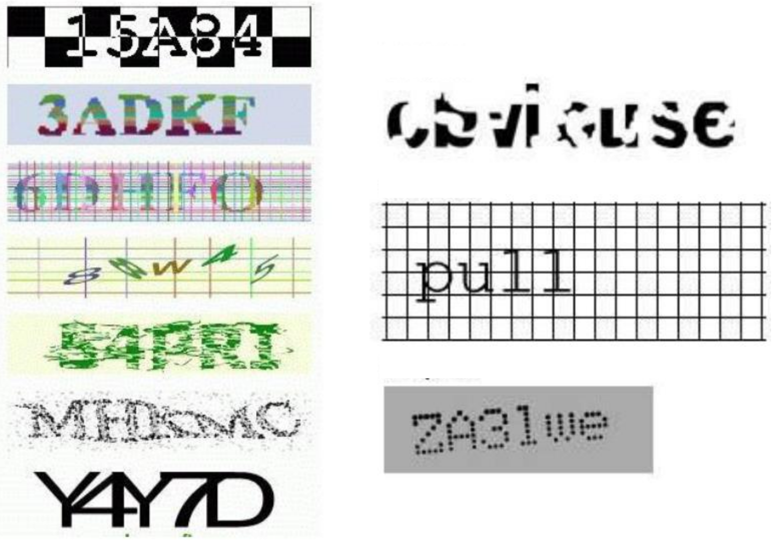


An illusion is also the Escher Waterfall. This picture shows a reality that cannot be real. The waterfall is driving a wheel and after that the water flows back “up” into the tower to again fall and drive the wheel. This is impossible.

Our visual system tries to make sense out of the visual information we get. This behavior can also be used in HCI to create a special kind of interaction that can be interesting for many different applications.
Good examples of this are the Gestalt Laws and surely all of us already got in touch with those…

Why can we decode Captchas?

What are the implications for user interface design?



For human simple to read, for computers not. Here we can make use of our behavior to make sense out of given visual information. All these Captchas follow Gestalt Laws

The left one reads “Keep Red” and “Off Line” because we tend to group closer things together. The right one reads “Keep off Red Lines”. Just by placing the words differently the perception changes.

Optical Illusions and Gestalt Laws

Gestalt Laws

Many different Gestalt Laws, but we will stick to just seven:

More than 7

- Law of Similarity
- Law of Proximity
- Law of Continuity
- Law of Closure
- Law of Pragnanz
- Law of common fate
- Law of Symmetry

There are more Gestalt Laws like *Figure and Ground* or *Smallness Area*. However, we will only cover the seven Laws above.

Optical Illusions and Gestalt Laws

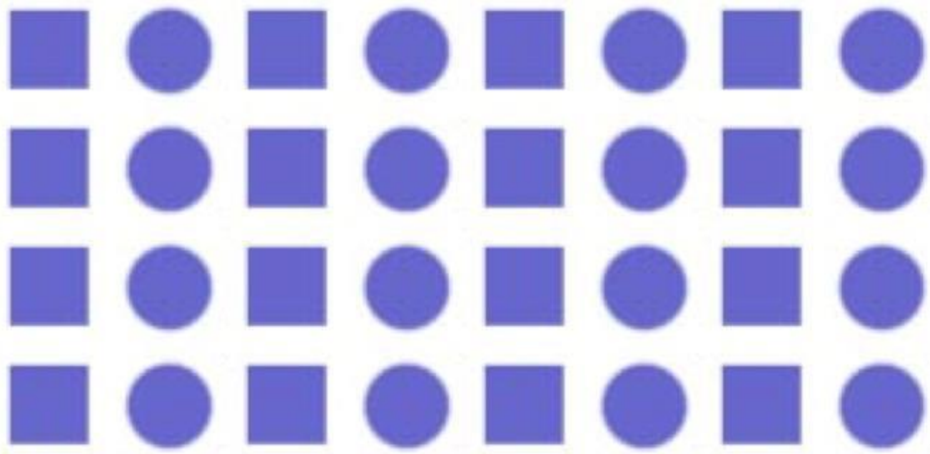
Gestalt Laws – Law of Similarity

Items that are similar tend to be grouped together.

In the image, most people see vertical columns of circles and squares.

Similar ?

Group together



Optical Illusions and Gestalt Laws

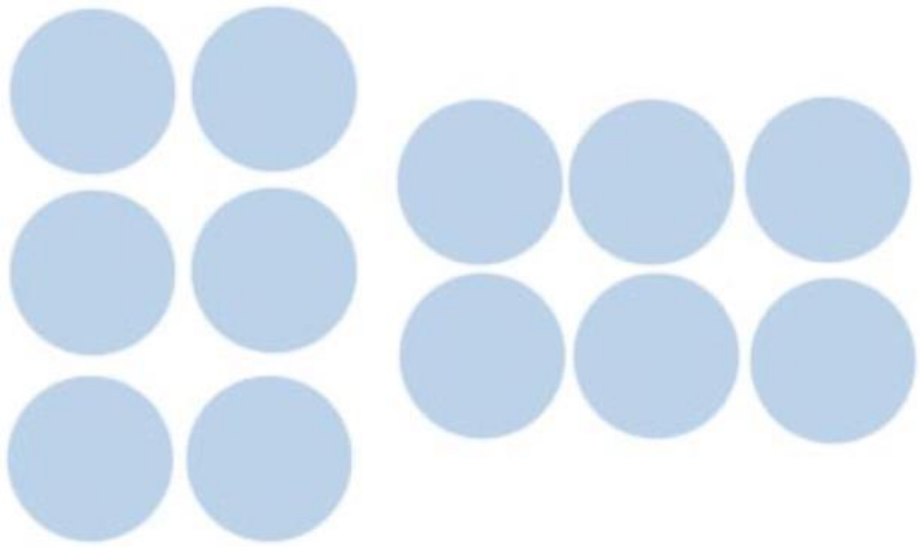
Gestalt Laws – Law of Proximity

Objects near each other tend to be grouped together.

The circles on the left appear to be grouped in vertical columns, while those on the right appear to be grouped in horizontal rows.

Close

Proximity - Group together.



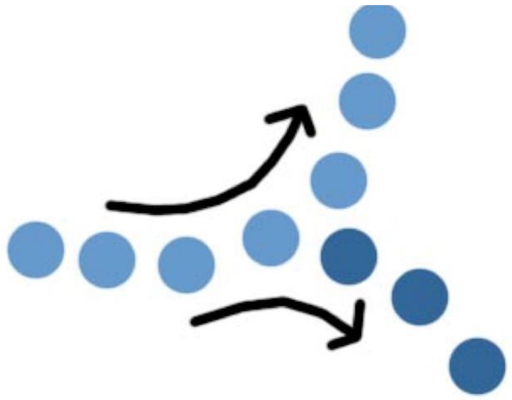
Optical Illusions and Gestalt Laws

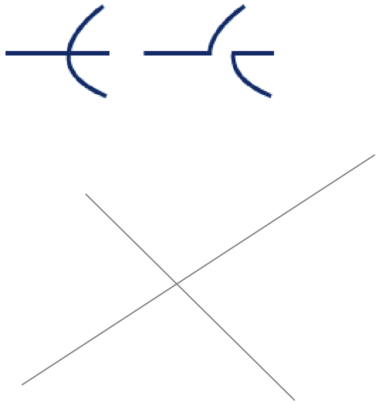
Gestalt Laws – Law of Continuity

Lines are seen as following the smoothest path.

lines ? → smoothest path.

In the left image, the top branch is seen as continuing the first segment of the line. This allows us to see things as flowing smoothly without breaking lines up into multiple parts.





Optical Illusions and Gestalt Laws

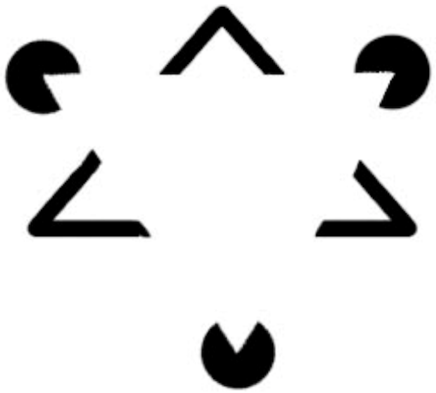
Gestalt Laws – Law of Closure

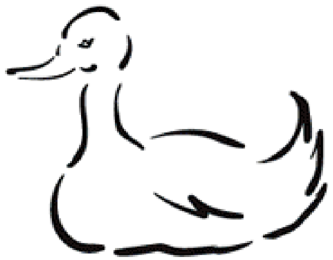
Objects grouped together are seen as a whole

Grouped together ? → whole.

We tend to ignore gaps and complete contour lines. In the left image, there are no triangles or circles, but our minds fill in the missing information to create familiar shapes and images.

Ignore Gaps
& Complete
contour lines.





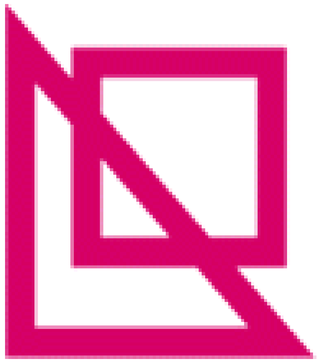
Optical Illusions and Gestalt Laws

Gestalt Laws – Law of Pragnanz (Simplicity/ good shape)

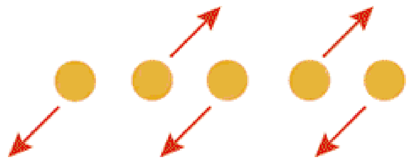
Not complex but simplest forms.

Reality is organized or reduced to the simplest form possible

E.g., we see the left image as a series of circles rather than a much more complicated shape



Elements with the same moving directions are perceived as a collective or unit.



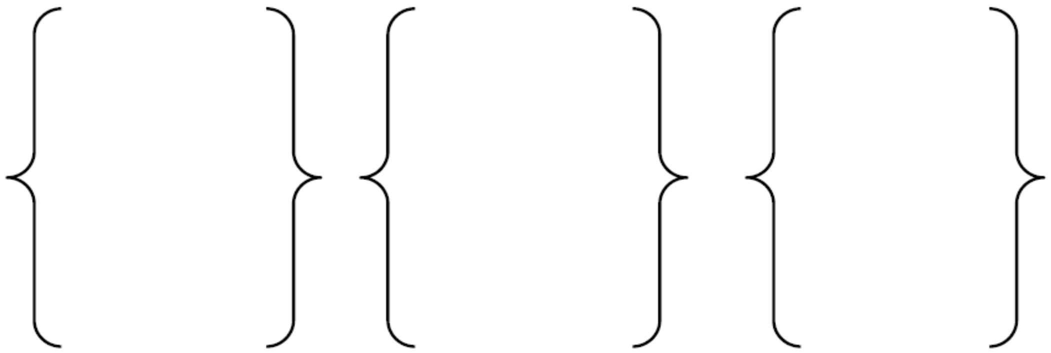
Same direction
Seen as a
collection or
unit.

Video Link:
https://www.youtube.com/watch?v=LZMaTtPHBMk

Optical Illusions and Gestalt Laws

Gestalt Laws – Law of symmetry

Symmetrical images are perceived collectively, despite their distance to each other



Symmetry ?

seen as one.

There is one interesting phenomenon in perception called the *Change Blindness*. It describes that even large changes in a scene are not noticed. Reasons for this are short distractions caused by *Mud splashes, brief flicker* or *cover boxes*

Some further explanation can be found here:
http://nivea.psycho.univ-paris5.fr/ECS/ECS-CB.html
https://www.youtube.com/watch?v=5O71iuTPTTI

Examples for change blindness:
http://nivea.psycho.univ-paris5.fr/ECS/kayakflick.gif
https://www.youtube.com/watch?v=FWVDi4aKC-M

Examples for change blindness:
http://nivea.psycho.univ-paris5.fr/ECS/kayakflick.gif
https://www.youtube.com/watch?v=FWVDi4aKC-M

Optical Illusions and Gestalt Laws

Gestalt Laws – other Illusions: Change blindness

Examples for change blindness:
http://nivea.psycho.univ-paris5.fr/ECS/kayakflick.gif
https://www.youtube.com/watch?v=FWVDi4aKC-M

Why do we need to know about all the illusions and Gestalt Laws?
->We can better guide the **Distribution of attention and perception.**

Distibution of attention and perception.

The Distribution depends on:

- Culture (cultural background)
- Custom / habit
- Perception
- Processing
- Experience

If we know how to organize elements in a scene or we know which visual phenomenon could result in an illusion that breaks attention, we can account for this and create better User Interfaces or Products in general that can be used easily.

Thank you
for your attention