

# Cognition

**Human-Computer Interaction Lecture** 

Slides adapted from hci-lecture.org (A. Schmidt, N. Henze, K. Wolf, V. Schwind), Image from: pixabay.com



## **Learning Goals**

- Understand ...
  - > cognitive models and processes in HCI
  - > mental processing is considered as a ressource in HCI
  - low and high cognitive processes in HCI
- Be able to explain ...
  - > Basic cognitive processes and models in HCI
  - > Differences between perception and cognition

## **Perception vs Cognition**

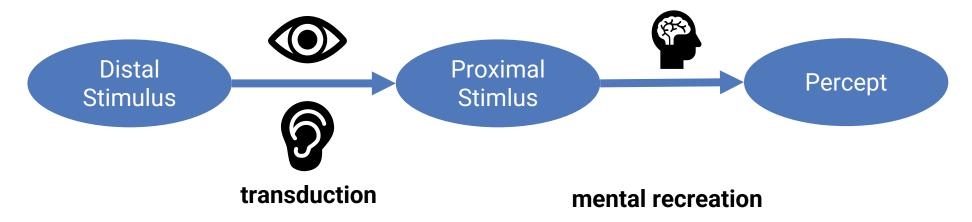
- Perception: sensors and signal processing through senses (perceptual channels)
  - Only passive impressions of cues
  - > Signal processing of body-related cues
  - Filtering
  - > Sensor "systems" (e.g., vestibular, flavor, balance)
- Cognition: "understanding" perceptual cues and mental processing in the brain
  - > There are low- and high-level processes (bottom-up and top-down)
  - > Can include active motor control (actions)
  - Includes logics, emotions, thinking, and learning
  - Decision making (consciously and unconsciously!)

## **Bottom-Up vs Top-Down Cognition**

- Bottom-up: usually refers to start of stimulus processing
  - > Perception starts at the sensory input, the stimulus
- Top-down: processing originating in the brain, possibly other signals modulating bottom-up
  - > Perception could start with the brain
  - Usually, higher order cognitive processes
  - Internal goals, prior knowledge, etc. influencing information processing
    - > Pain, language, picture blobs (what do you see?), etc.
    - Flower looks beautiful vs. specifically looking for a flower

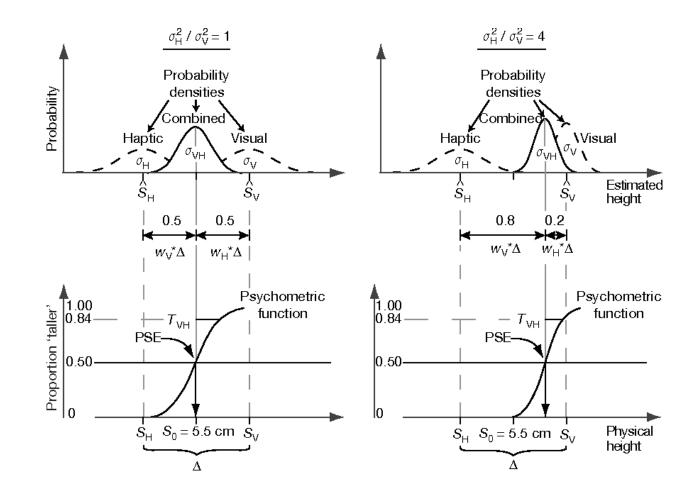
#### **Mental Recreation**

- A bottom-up process of perception begins with an object in the real world distal stimulus
- Sensory organs transform the input energy into neural activity a process called transduction the neural state of the object is the proximal stimulus
- The proximal stimulus is being transmitted to the brain and cognitively processed.
   The result is a mental recreation of the distal stimulus the percept.



## **Multi-Sensory Integration**

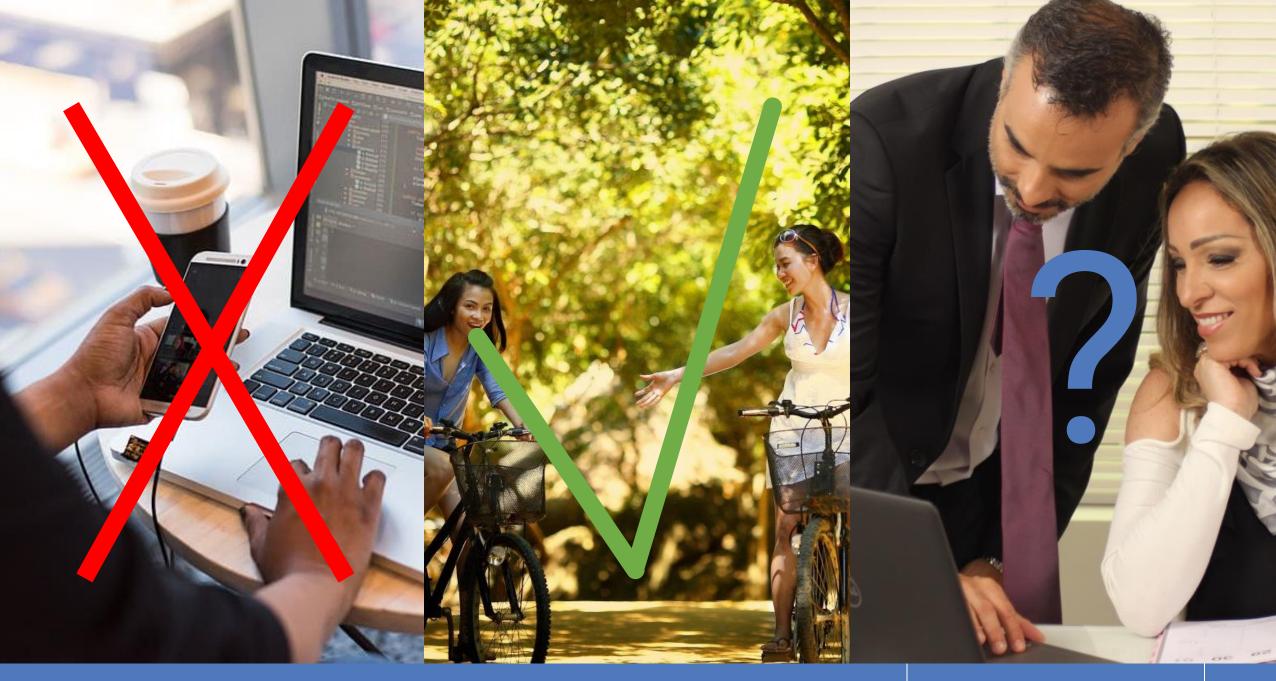
- Senses are being integrated into a percept
- A sense can dominate a perception when they provide the more reliable information and a reduced variance than other senses
- The nervous system combines information in a fashion that is similar to a maximum-likelihood integrator and can be predicted using regular statistics



Ernst, M. O., & Banks, M. S. (2002). Humans integrate visual and haptic information in a statistically optimal fashion. *Nature*, 415(6870), 429-433.

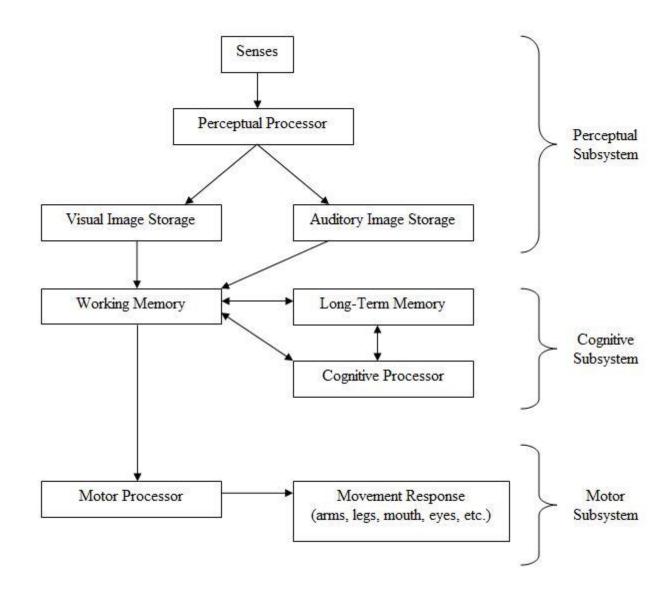
#### **Sensor Fusion**

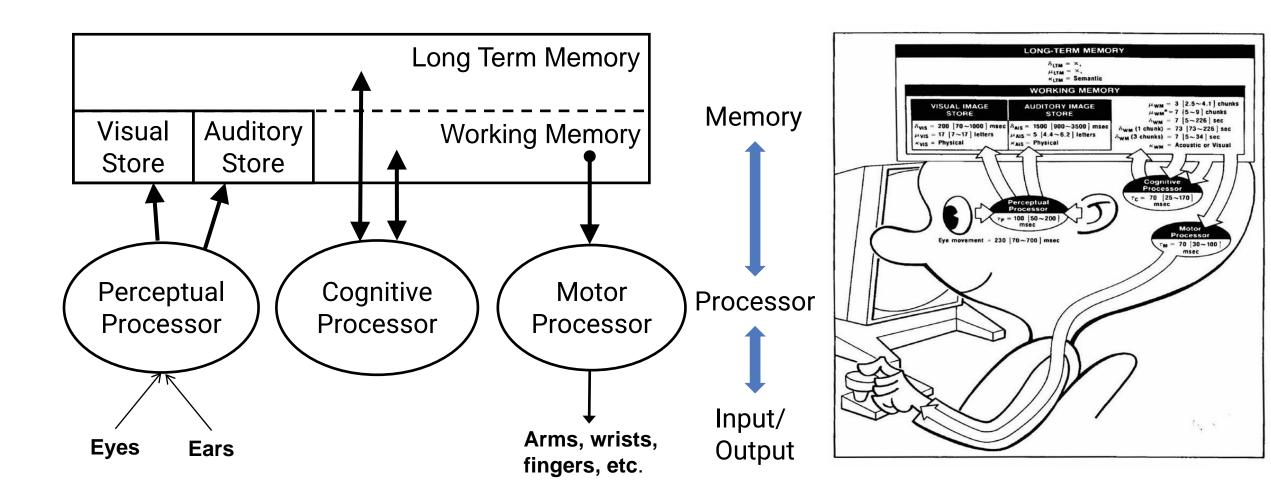
- Sensor fusion is a bottom-up process of combining sensory data or data derived from disparate sources such that the resulting information has less uncertainty than would be possible when these sources were used individually.
- Humans (and computer systems) and can fuse data to unified percepts
  - > e.g., stereoscopic vision (calculation of depth information by combining two-dimensional images from two point of views with slightly different viewpoints)
- Sensory fusion is a low-level cognitive process based on perception that is composed of individual channels – but no perception can never clearly be seperated from others as long as the process is involved



#### **Model Human Processor**

- Very simple "model" of a human interacting with a computer
- Describes three sub-systems
  - > Perceptual system
    - input: cues from the real world
  - Motor system
    - output: manipulate the real world
  - Cognitive system
    - connection between input and output,
       basic processing and memory
    - > low and high-level cognitive processes





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- Breaks down activities into the following sub-steps:
  - 1. Identify main application: a working prototype, simulation, step by step walk-through,...
  - 2. Clearly identify the specific task and method to accomplish that task
  - 3. For each step identify sub-levels of a basic process
  - 4. Convert into pseudo code (writing out methods for each step)
  - 5. List all assumptions (will be helpful as multiple iterations are completed)
  - 6. Determine time of each operation (based on the table below)
  - 7. Determine if operation times should be adjusted (slower for elderly, disability, etc.)
  - 8. Sum up execution times
  - Iterate when needed and check with prototyping if possible

Parameter	Mean	Range
Eye movement time	230 ms	70-700 ms
Decay half-life of visual image storage	200 ms	90-1000 ms
Visual Capacity	17 letters	7-17 letters
Decay half-life of auditory storage	1500 ms	90-3500 ms
<b>Auditory Capacity</b>	5 letters	4.4-6.2 letters
Perceptual processor cycle time	100 ms	50-200 ms
Cognitive processor cycle time	70 ms	25-170 ms
Motor processor cycle time	70 ms	30-100 ms
Effective working memory capacity	7 chunks	5-9 chunks
Pure working memory capacity	3 chunks	2.5-4.2 chunks
Decay half-life of working memory	7 sec	5-226 sec
Decay half-life of 1 chunk working memory	73 sec	73-226 sec
Decay half-life of 3 chunks working memory	7 sec	5-34 sec

## Response Times

- Time taken to respond to stimulus:
  - > reaction time + movement time + system time
- Movement time dependent on age, fitness etc.
- Reaction time dependent on stimulus type:
  - > visual ~ 200 ms
  - > auditory ~ 150 ms
- Interesting for game programming



Images and more on experiments on visual reaction times from David B. Fankhauser: http://biology.clc.uc.edu/fankhauser/Labs/Anatomy\_ &\_Physiology/A&P202/Nervous\_System\_Physiology/ Visual Reaction.htm

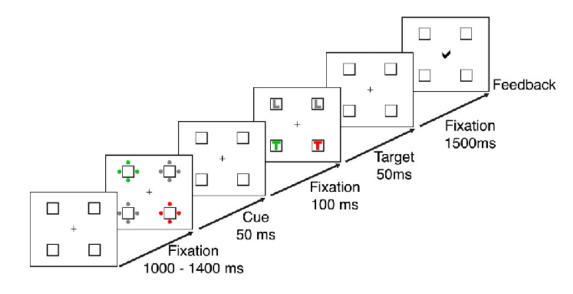
- Reaction/processing time, example:
  - > Perception (stimulus); typical time: TP ~ 100ms
  - > Simple decision; typical time: TC ~ 70ms
  - Minimal motion; typical time: TM ~ 70ms
     (example for complex motor action see later: Fitts' law, KLM)
- Overall time for operation where there is a sequential processing
  - > pressing a button when a light comes on is about 240ms: T = TP + TC + TM
  - Matching a symbol and then pressing one of two buttons is about 310ms (2TC because there is comparison and decision): T = TP + 2TC + TM
- But cognitive processes can run in parallel: (e.g., phoning while writing, talking while driving, ...)



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## **Contingent Capture**

- Top-down & bottom-up processes can interact
- Top-down goal:
  - "Search for red T signs"
- Bottom-up:
  - Only the red circles outside the box will capture attention (bottom-up) because of your top-down goal (where is the red T)
- When searching for a target item, irrelevant items that possess the target-defining characteristic capture more attention than items not possessing that feature



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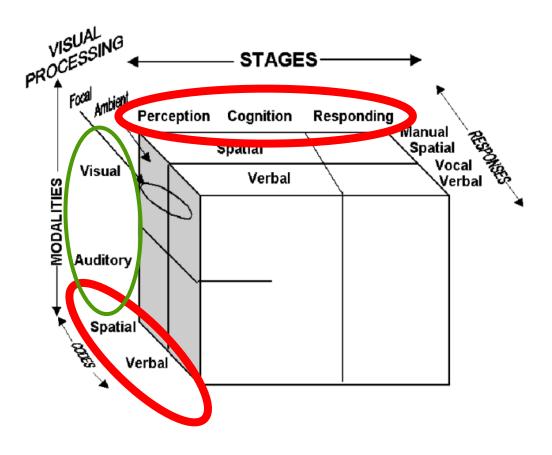
Laube, Inga & Matthews, Natasha & Dean, Angela & O'Connell, Redmond & Mattingley, Jason & Bellgrove, Mark. (2017). Scopolamine Reduces Electrophysiological Indices of Distractor Suppression: Evidence from a Contingent Capture Task. Frontiers in Neural Circuits. 11. 10.3389/fncir.2017.00099.

## **Multiple Resource Theory**

- Instead of one "pool" of resources, there are several different capacities of resources:
  - Modalities: visual, auditory
  - Information code: spatial, verbal
  - > Responses: manual, spatial, vocal, verbal
  - > Stages of processing: early (perception/cognition) or late (responding)
- Tasks using same resources interfere each other
- Tasks using different resources can be done "simultaneously"

## Model of Multiple Ressources

- Why driving and talking do not interfere:
  - Driving (eye-hand): visual processing of spatial information
  - Talking (ear-cognition-mouth): verbal processing of auditive information
  - Talking (ear-cognition-mouth) and driving maneuvers hinder, e.g., overtaking (eyecognition-hand)
- Tasks that use different stages are easier to accomplish than tasks that require "more" of the same stage
  - Example: Listening to 2 conversations vs.
     Looking for a photo during a conversation

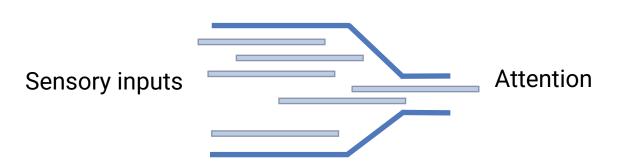


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Wickens, Christopher D. "The structure of attentional resources." Attention and performance VIII 8 (1980): 239-257.

### **Broadbent's Filter Model of Attention**

- Attention is the cognitive process of selectively concentrating on a sub-set of stimuli while ignoring other perceivable stimuli
- Stimuli are processed initially based using a selective filter based on different physical properties including
  - Color
  - > Form
  - Motion (orientation response / reflex)
  - > Pitch
  - > Loudness
  - > Direction (Cocktail Party Effect)

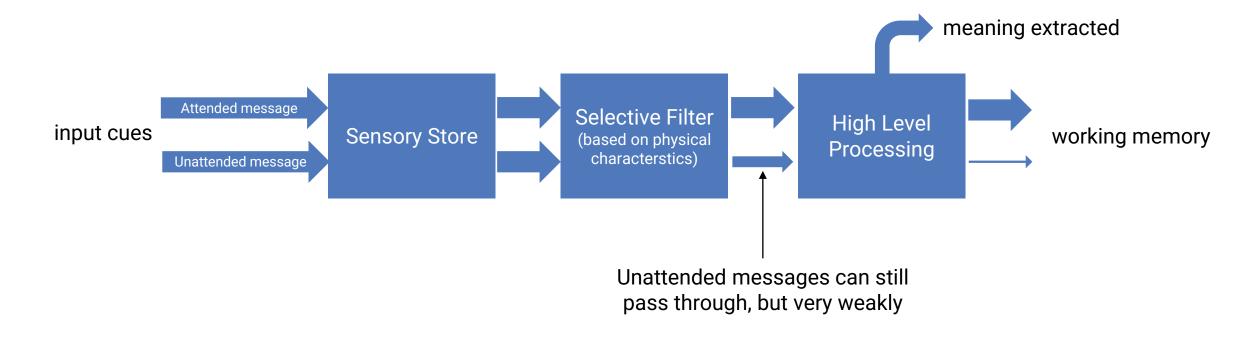


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Broadbent, D. E. (1957). A mechanical model for human attention and immediate memory. Psychological review, 64(3), 205.

#### **Broadbent's Filter Model of Attention**

Filters message before incoming information is analyzed for meaning



Lindsay, P.H. and Norman, D.A. (1977). Human Information Processing: An Introduction to Psychology, 2nd edition. New York: Academic Press. Source (text, image): <a href="http://web.cs.dal.ca/~jamie/teach/NickGibbins/psych.html">http://web.cs.dal.ca/~jamie/teach/NickGibbins/psych.html</a> M. Eysenck, M. Keane: Cognitive Psychology. Psychology Press, Hove (UK), 2000.

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#### The Filter Bottleneck

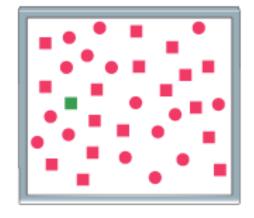
#### The filter

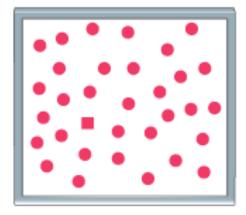
- > Only "relevant" stimuli are accepted
- Others are filtered

#### The bottleneck

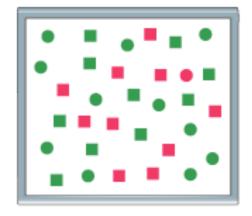
- > Attention as a limited resource
- The capacity is limited
- Only certain parts "fit through"
- Coding can widen the bottleneck

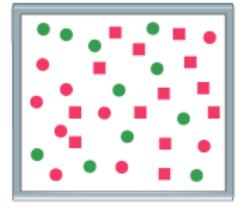
#### (a) Feature search



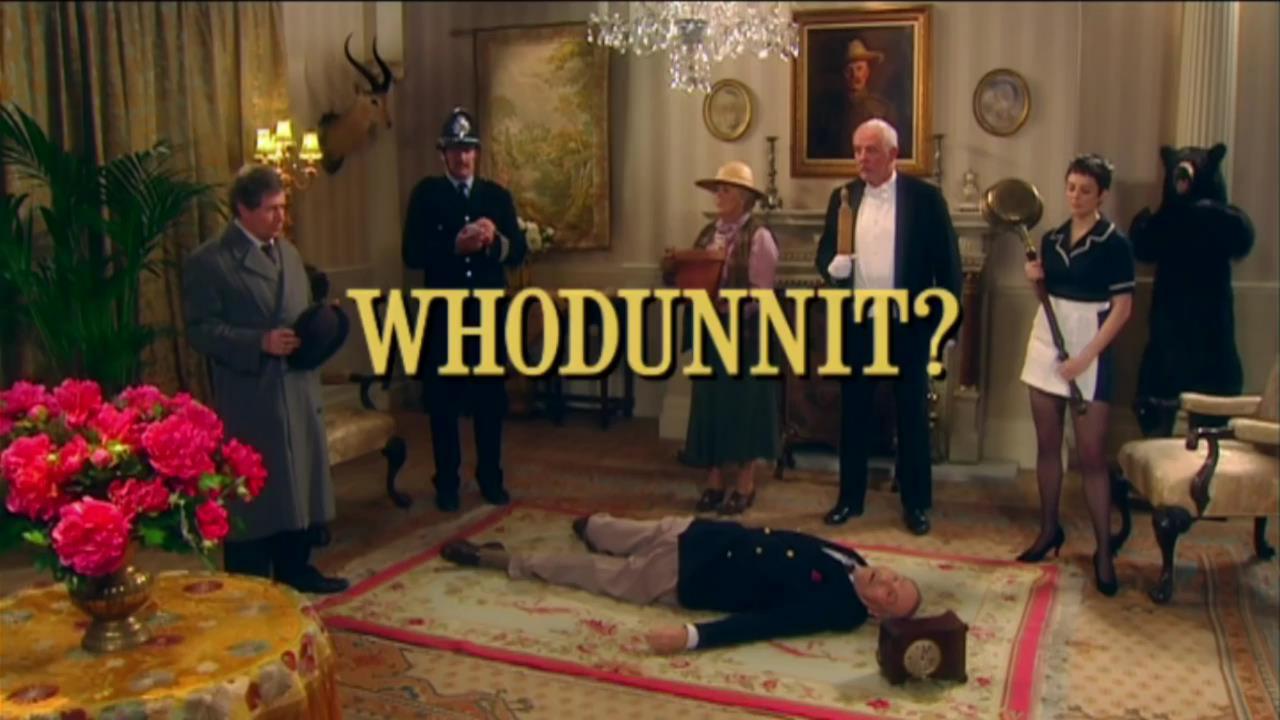


(b) Conjunction search



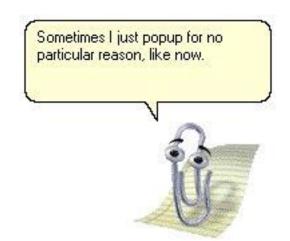


# Are you smarter than a chimp?



#### **Attention**

- Exogenous (bottom-up)
  - control of attention due to salient (conspicuous) stimulus features, involuntary
  - > Example: A friend in a crowd beckons to you
- Endogenous (top-down)
  - controlling attention through needs / goals, task, motivation, "will", "consciousness"
  - > Example: You are looking for the crowd for a friend

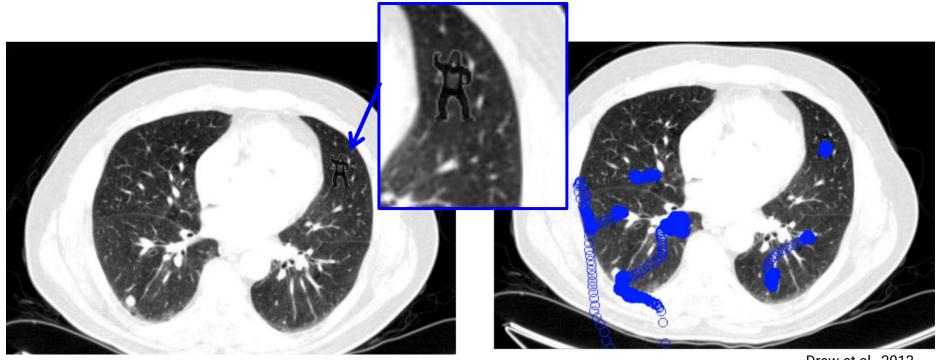




https://www.nngroup.com/articles/f-shaped-pattern-reading-web-content/

## **Focusing Problems**

- 50% of knots discovered
- 83% overlook the gorilla



Drew et al., 2013 Drew, T., Võ, M. L. H., & Wolfe, J. M. (2013). The invisible gorilla strikes again: Sustained inattentional blindness in expert observers. *Psychological science*, 24(9), 1848-1853.

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# **Consequences of Focusing Problems**



http://www.bussgeldkatalog.de/handy/





http://www.focus.de/gesundheit/ticker/autof ahrt-gefahr-auch-beim-telefonieren-mitfreisprecheinrichtung\_aid\_372760.html

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## Interruptions of Selective Attention

- Representation of the environment is not as detailed as we may feel
  - > Selective (especially serial) attention is necessary to perceive details at all
- Attention can be interrupted by:
  - > blinks
  - > saccades
  - > look away
  - reloading
  - > scrolling
  - > change of screen orientation (smartphone)

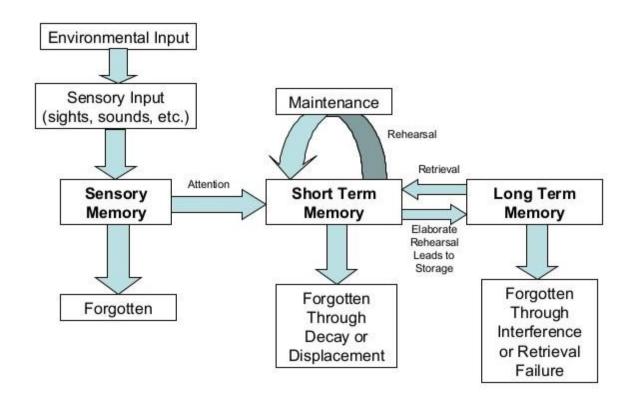


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#### **Multi-Store Model**

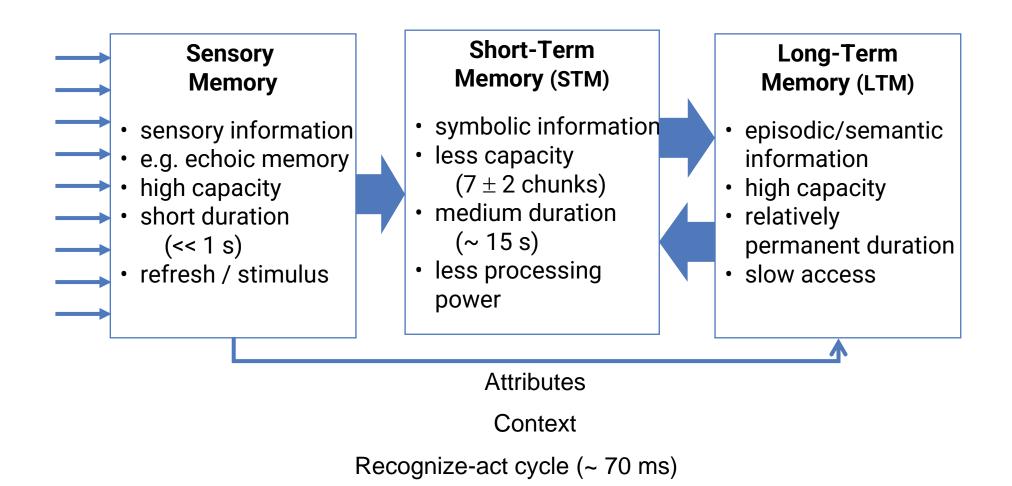
- Involves encoding and recalling knowledge and acting appropriately
- We don't remember everything involves filtering and processing
- Context is important in affecting our memory
- Recognition outperforms recalling
  - The rise of the GUI over command-based interfaces
  - Better at remembering images than words (icons are better than names)



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Image Source https://en.wikipedia.org/wiki/Information\_processing adapted by Dkahng from Atkinson, R.C. and Shiffrin, R.M. (1968). 'Human memory: A Proposed System and its Control Processes'

## **Multi-Store Model**



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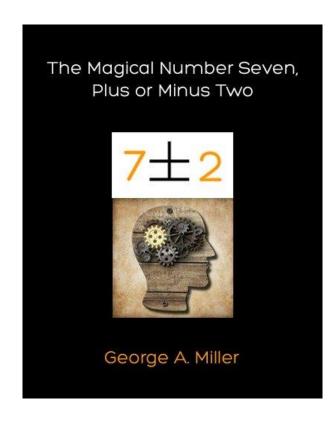
## Chunking



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## **Short-Term Memory (STM)**

- Temporary storage of information to be manipulated
  - Capacity 7 ± 2 chunks (Miller, 1956)
  - Chunks: words, numbers, pictures ...
- Many designers base their interaction design on policies such as
  - > Present only 7 options on a menu
  - Display only 7 icons on a bar tool
  - > 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
  - → Not necessary to limit the presented information

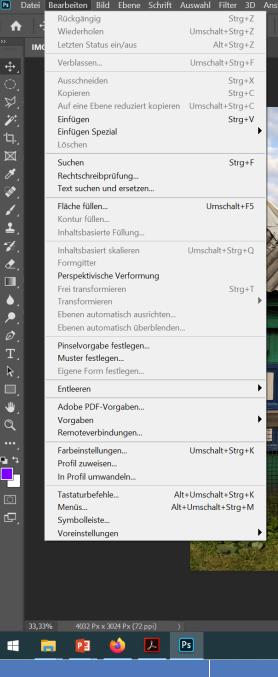


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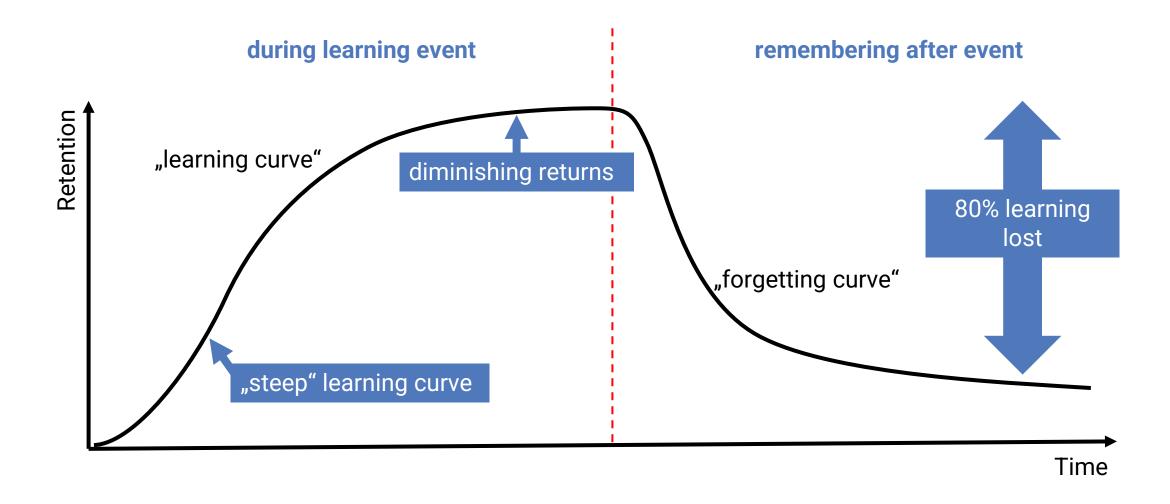
## Problems with the classic '7±2'

- In real-world tasks people are capable of storing ~4 chunks or pieces of information in short-term memory [1].
- It's about scanning or recalling?
  - People can scan/read lists of bullets, tabs, menu items in a certain order
- Do not overload the STM
  - Use known symbols
  - Notes, menus, lists (WYSIWYG)
  - Grouping, chunks (complex super symbols)
  - > Short, closed actions

[1] Cowan N. What are the differences between long-term, short-term, and working memory? Prog Brain Res. 2008;169:323-338. doi:10.1016/S0079-6123(07)00020-9



## **Typical Learning and Forgetting Curves**



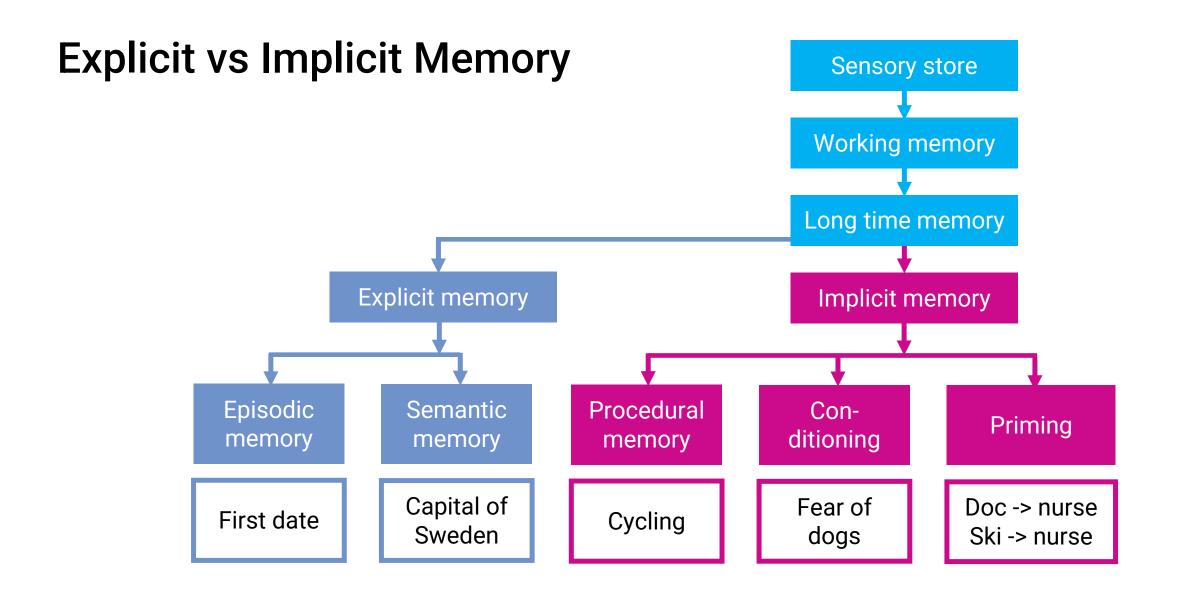
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## Supporting Short-Term Memory (STM)

- Supporting STM is essential for supporting learning curves
  - 1. **Mnemotechnics**: loci method, phrases, acronyms
    - > e.g., "ROY G BIV": an acronym that represents the first letter of each color of the rainbow—red, orange, yellow, green, blue, indigo, violet
    - > e.g., "My Very Excellent Mother Just Served Us Noodles": Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune
  - 2. **Spaced Repetition**: several lessons distributed over time are more effective than a long learning session
  - 3. **Repetition**: the longer/more often you repeat something, the better the training

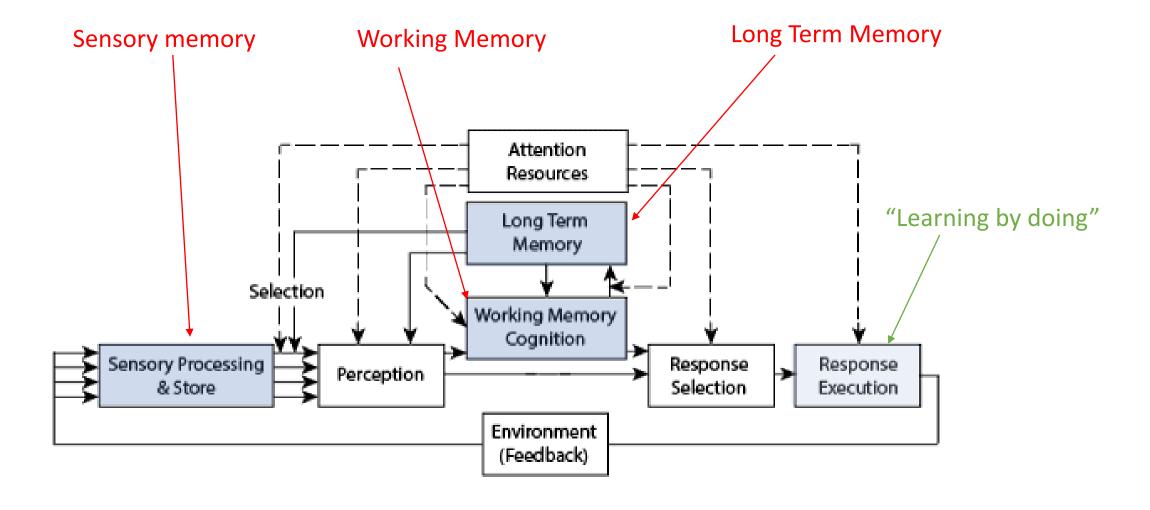
## Long-Term Memory (LTM)

- Repository for all our knowledge
  - > slow access ~ 1/10 second
  - > slow decay, if any
  - > huge or unlimited capacity
- Two types of LTM
  - > episodic LTM: serial memory of events
  - > **semantic LTM**: structured memory of facts, concepts, skills
    - → semantic LTM derived from episodic LTM



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## **Model of Working Memory Cognition**



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## **Memory**

- Memory is a limited ressource
  - > Use familiar symbols
  - > Minimize Time to Keep Something (WYSIWYG)
  - > Reduce complexity, chunking
  - > Minimize distraction
- Improve the encoding and retrieval from the long-term memory
  - Repeat important concepts distributed over time, short and closed actions
  - > Structuring the information promotes learning (group, chunk)
  - Connect to the known
  - Recall important processes via Recognition instead of recall (for example, selection instead of input)

### Random Observations about Memory

- We don't remember everything
  - → also 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 the GUI over command-based interfaces
- Better at remembering images than words
  - > The use of icons rather than names
- We remember stuff years ago but not the color of base floor in the entrance hall



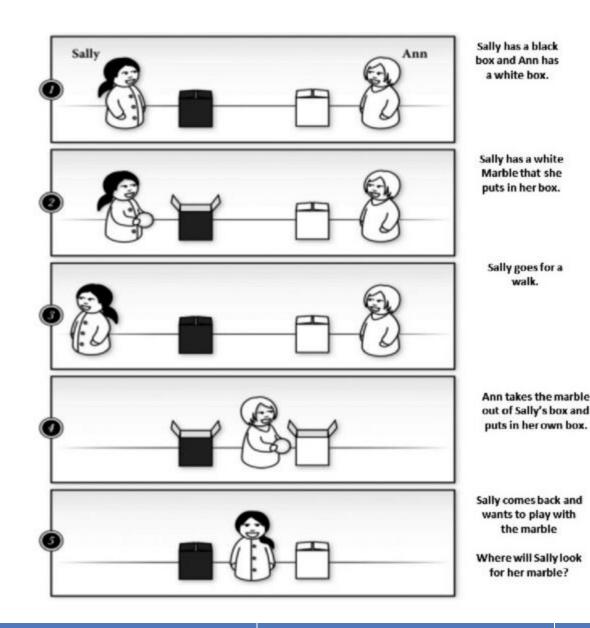


### Perspective-Taking

- Understanding a concept from an alternative point of view
- There are two types of perspective-taking:
  - > Perceptual: what another person is experiencing through their senses
  - > Conceptual: take on the viewpoint of another person's thoughts and attitudes
- When adopting perspectives, persons can use low-effort (automatic processes) and high-effort (mental demanding) strategies:
  - > Low-effort: <u>stereotyping</u>, social projection,...
  - > High-effort: anchoring, adjustment heuristic,...

## Theory of Mind

- Generally, describes the ability to understand other people by ascribing mental states to them
  - Understanding = analyzing, judging, and inferring others' behaviors
  - Include beliefs, desires, intentions and emotions
- Deficits can occur in people with mental disorders (autism, schizophrenia, ...)
  - A "byproduct" of a broader hypercognitive ability of the human mind to register, monitor, and represent its own functioning



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## Stereotyping

- Stereotyping is the generalization of objects or people using mental categorical clusters of perceived entities
- The cognitive process simplifies and systematizes information
- Stereotyping can be
  - implicit (fast, subconscious: no control and awareness)
  - > explicit (slow, conscious: conscious awareness of a stereotype)
- Implicit and explicit stereotypical biases can be measured (Implicit association tests (IATs), questionnaires...)
- Attempts to offset bias often, due to underestimating or overestimating the amount of bias being created by the stereotype
- Prejudice is the affective component of stereotyping

#### **Stereotype Content Model**

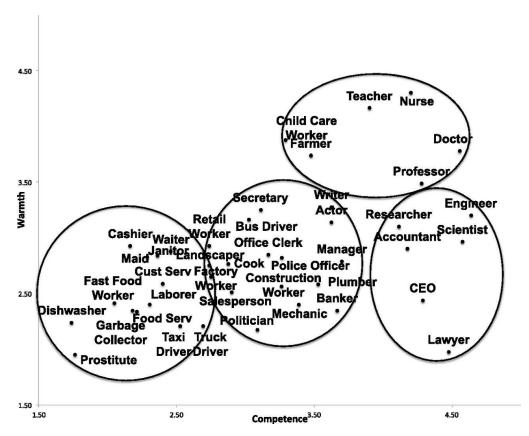
- Stereotype content refers to the attributes that people think characterize a group.
- Vary along two dimensions:
  - warmth (groups that do not compete with same pool of resources)
  - competence (groups that are economically or educationally successful)
- The model differentiated between in- and outgroup stereotypes
- Intergroup emotions and stereotypes predict distinct behaviors, which can be active, passive, facilitative, and harmful

		Competence				
		Low	High			
Warmth	High	Paternalistic stereotype low status, not competitive (e.g., housewives, elderly people, disabled people)	Admiration high status, not competitive (e.g., ingroup, close allies)			
	Low	Contemptuous stereotype  low status, competitive  (e.g., welfare recipients, poor people)	Envious stereotype high status, competitive (e.g., Asians, Jews, rich people feminists)			

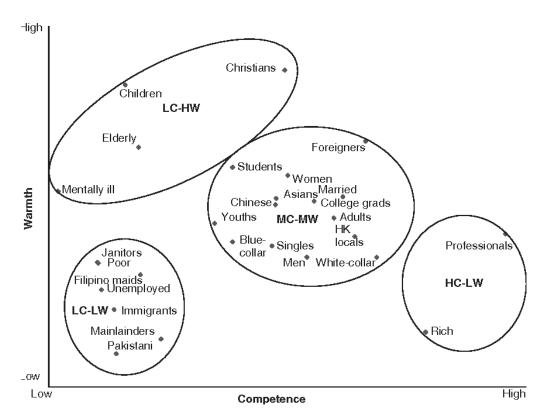
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Fiske, Susan, et al. "A model of (often mixed) stereotype content: competence and warmth respectively follow from perceived status and competition." Journal of personality and social psychology (2002)

## Stereotyping



Susan T. Fiske, Cydney Dupree. Gaining audiences' trust and respect about science Proceedings of the National Academy of Sciences Sep 2014, 111 (Supplement 4) 13593-13597; DOI: 10.1073/pnas.1317505111

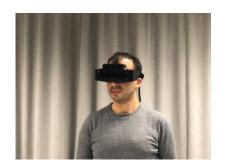


Amy J. C. Cuddy, S. Fiske, P. Glick Warmth and Competence As Universal Dimensions of Social Perception: The Stereotype Content Model and the BIAS Map



# **Stereotypical Perception of Devices**









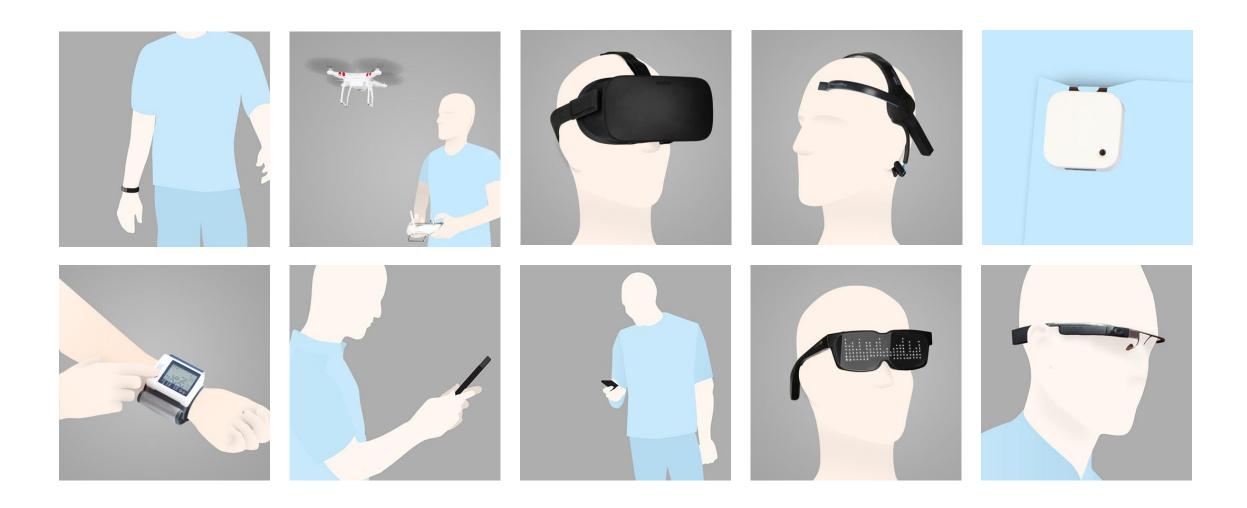






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# **Stereotypical Perception of Mobile Devices**



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#### Homeless people



A person without a home (temporarily).

#### Blood pressure monitor

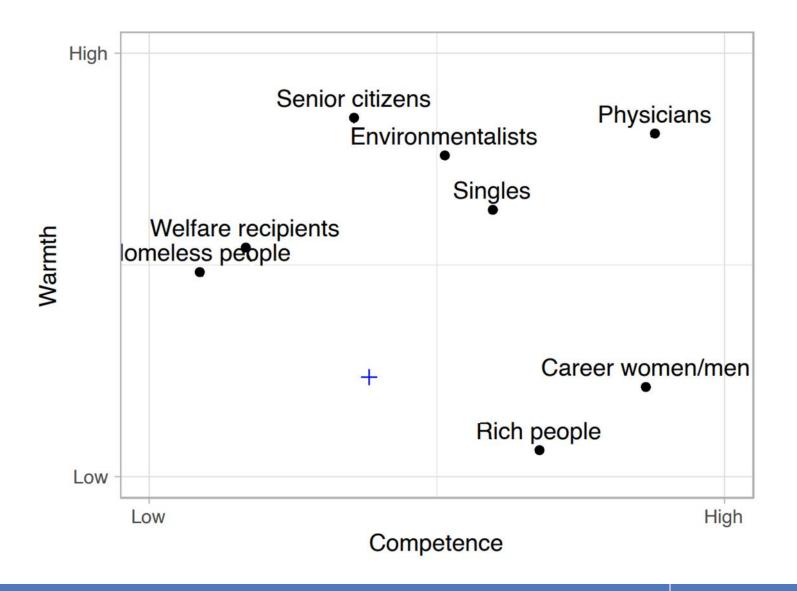


Measures blood pressure at the wrist.

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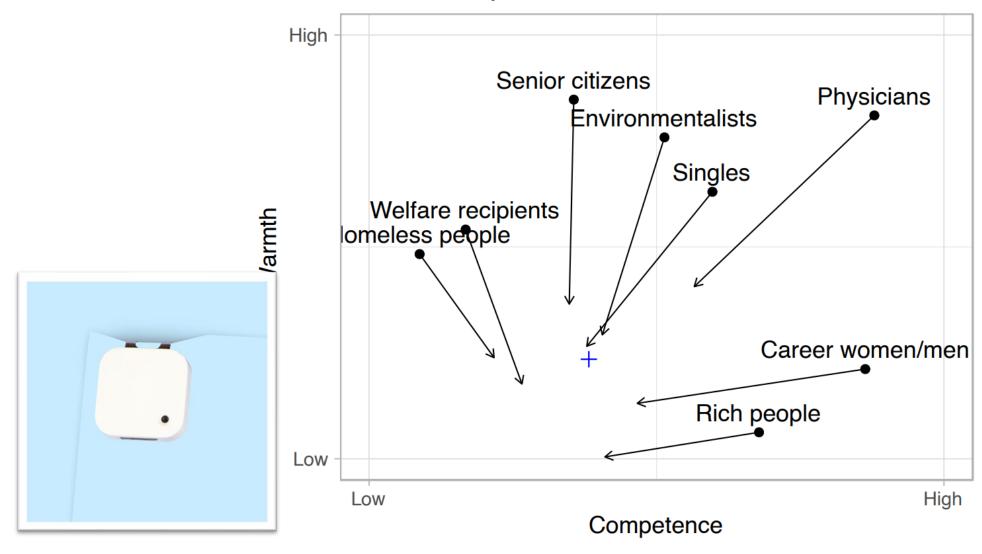
#### As viewed by society, how . . . are homeless people with Blood pressure monitors?

	not at all				extremely
	1	2	3	4	5
competent				•	
tolerant			•		
confident				•	
warm			•		
independent		•			
good-natured		•			
competitive			•		
sincere		•			
intelligent			•		



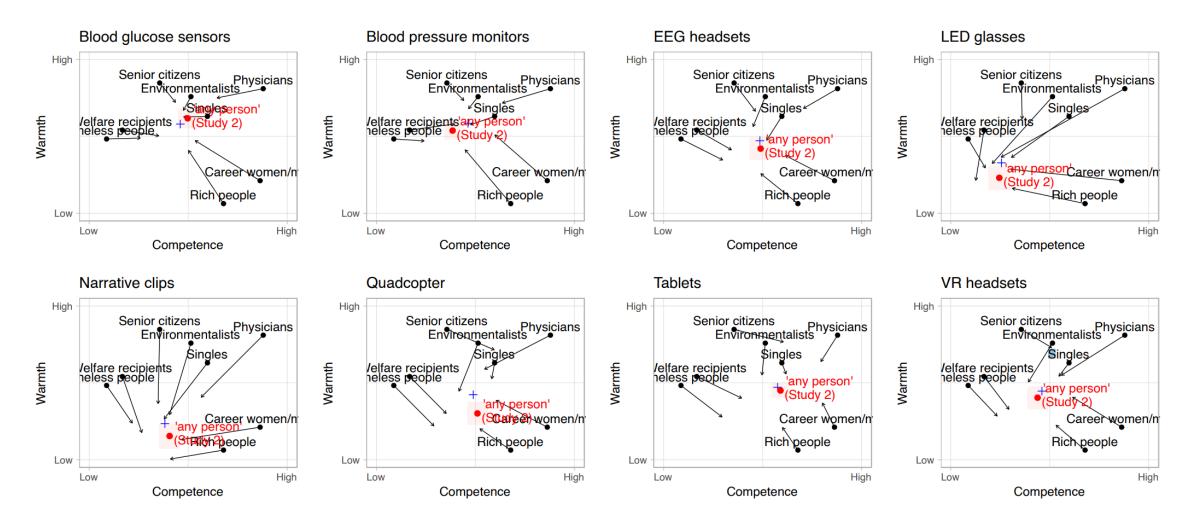
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#### Narrative clips



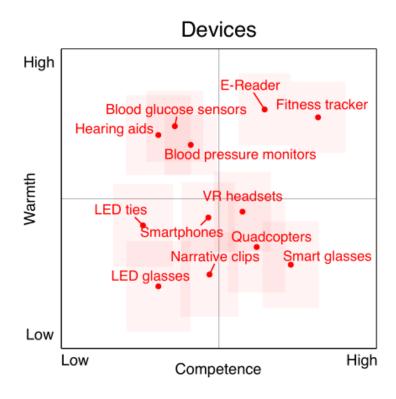
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#### Stereotypical Perception of Mobile Devices



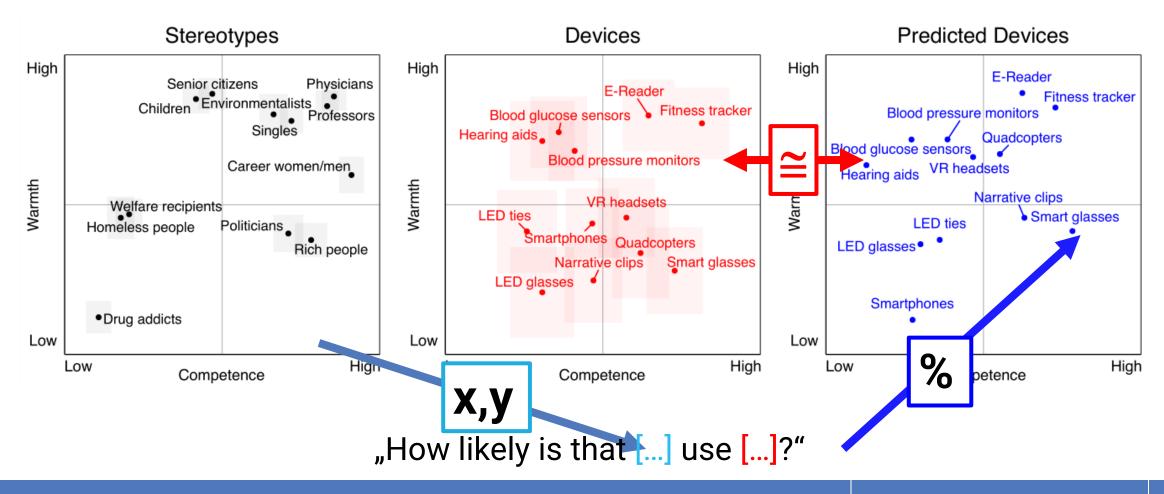
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### Stereotypical Perception of Mobile Devices



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## Anticipated Stereotypes Affect Social Perceptiojn



#### **Anchoring and Biases**

- Each individual's decisions are influenced by a particular reference point (the anchor)
  - > e.g., one is more likely to purchase a car if it is placed alongside a more expensive model
- First and last end "anchors" along a continuum are often being used to compare other entities (e.g., gender, race,...)
- Group bias: groups come to a more biased decision relative to individuals (group communication is the bias, culmination of anchors)
- Anchor measure:
  - "Would you be willing to spend ... for animals after suffering from an oil spill?"
    - → "\$5" → answer: \$20
    - → "\$400" → answer: \$143
    - $\rightarrow$  (143 20) / (400 5) = 0.31 "anchor index"

#### **Anchoring and Biases**

- Any stimulus influences a response to a subsequent stimulus, even without conscious guidance or intention
  - > e.g., the word NURSE is recognized more quickly following the word DOCTOR than following the word BREAD
- Can be measured:
  - Implicit association tests (IATs): gender bias, race bias,...
  - > Lexical decision tasks (LDTs): decisions based on words...
  - > Word stem completion tasks (WSC): verbal training of speech

> ...

### More Biases in Cognition

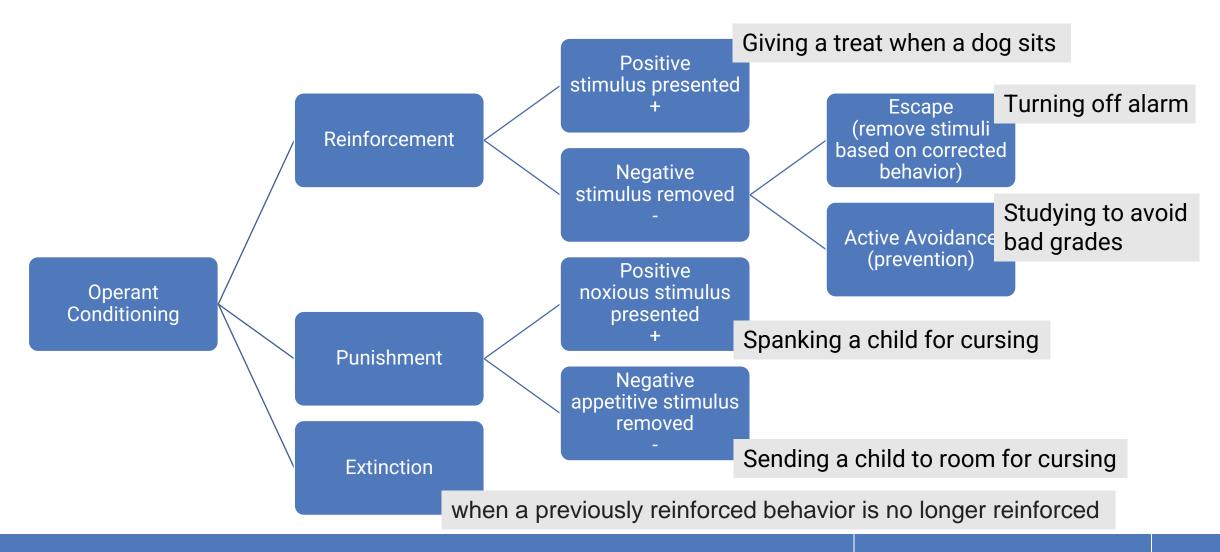
- Fundamental attribution error: to over-emphasize personality-based explanations
- Implicit bias: to attribute positive or negative qualities to a group of individuals
- Priming bias: to be influenced by the first presentation of an issue
- Confirmation bias: to search for or interpret information in a way that confirms one's preconceptions
- Affinity bias: to be favorably biased toward people most like ourselves
- Self-serving bias: to claim more responsibility for successes than for failures
- Framing: to narrow the description of a situation in order to guide to a selected conclusion
- Hindsight bias: to view past events as being predictable
- **Embodied cognition**: the selectivity in attention and perception based on the biological state of the body
- Anchoring bias: inability of people to make appropriate adjustments from a starting point
- Status quo bias: to hold to the current situation rather than an alternative situation, to avoid risk and los
- Overconfidence effect: to overly trust one's own capability to make correct decisions (Dunning-Kruger effect)

More biases: https://en.wikipedia.org/wiki/List\_of\_cognitive\_biases

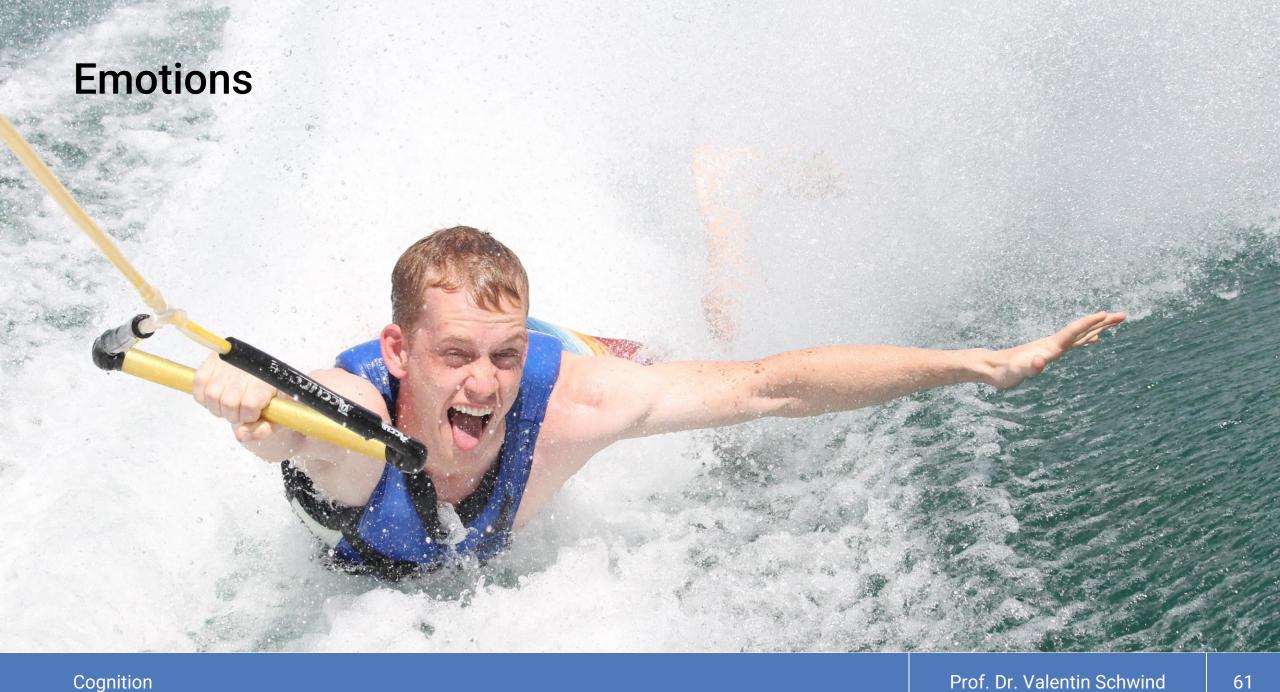
#### Types and Factors of Motivation

- "the wilful desire to direct one's behavior toward goal" (Middlesmist and Hitt, 1981)
- Bases on needs (food, water, sleep, reproduction,...) and motives (freedom, security, recognitions, self-actualization,...)
- Goal directed behavior
  - > related to satisfaction and fear
  - > can be positive (higher pay) and negative (lower pay)
- One of the most complex of high-leveled processes in cognition

## Rewards and Punishment: Operant Conditioning

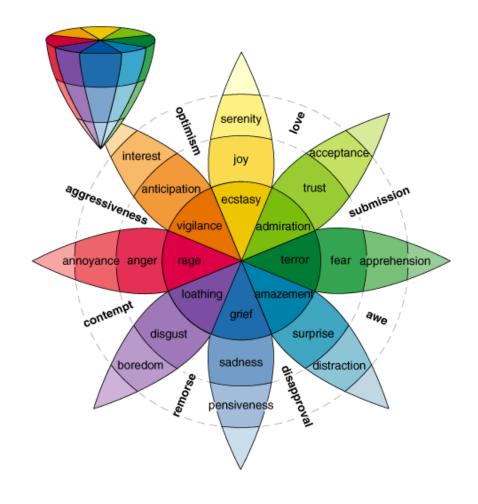


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#### **Nature of Emotions**

stimulus event	cognition	feeling state	overt behavior	effect safety	
threat	"danger"	fear	escape		
obstacle	"enemy"	anger	attack	destroy obstacle	
gain of valued object	"possess"	joy	retain or repeat	gain resources	
loss of valued object	"abandonment"	sadness	cry	reattach to lost object	
member of one's group	"friend"	acceptance	groom	mutual support	
unpalatable object	"poison"	disgust	vomit	eject poison	
new territory	"examine"	expectation	map	knowledge of territory	
unexpected event	"what is it?"	surprise	stop	gain time to orient	



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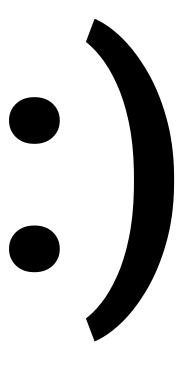
Plutchik, Robert. "The Nature of Emotions Human emotions have deep evolutionary roots, a fact that may explain their complexity and provide tools for clinical practice." *American Scientist* 89.4 (2001): 344-350. <a href="http://www.fractal.org/Bewustzijns-Besturings-Model/Nature-of-emotions.htm">http://www.fractal.org/Bewustzijns-Besturings-Model/Nature-of-emotions.htm</a>

# **Facial and Body**



Schindler et al. (2008) Recognizing emotions expressed by body pose: A biologically inspired neural model Image Source https://upload.wikimedia.org/wikipedia/commons/4/4d/Universal\_emotions7.JPG by Icerko Lýdia

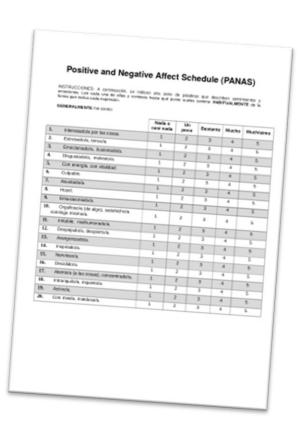
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#### **Affect**

- The emotional response to a physical stimuli is called affect
- "Temporary emotional excitement or "emotional phenomenon" triggered by external events or internal psychic processes"
- Affect influences how we react to situations
  - > Positive: creative problem solving
  - > Negative: narrow mindsets
- "Harder to do easy tasks; positive impact can make it easier to do difficult tasks" (Donald Norman)
- Can be measured: Positive and Negative Affect (PANAS)



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#### **Emotions and...**

#### Performance

> Positive affect induces flexibility and efficiency of problem solving

#### Attention

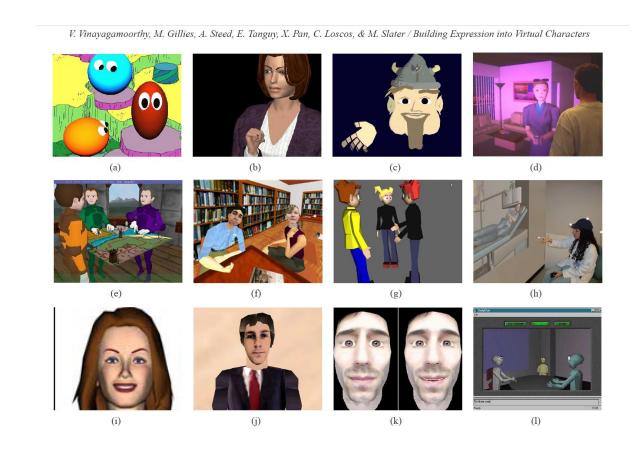
> People tend to pay more attention to thoughts and stimuli that have some relevance to their current mood state

#### Memory

Emotional stimuli (especially negative events) are better remembered than neutral events

#### **Communication of Emotions**

- Verbal
  - > Speech
- Non-verbal
  - Gesture & Mimics
- Content
  - > The lecture is canceled today. :(
  - > The lecture is canceled today. :)
  - > The lecture is canceled today.;)



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Vinayagamoorthy, Vinoba, Marco Gillies, Anthony Steed, Emmanuel Tanguy, Xueni Pan, Celine Loscos, and Mel Slater. "Building expression into virtual characters." (2006). <a href="http://eprints.gold.ac.uk/398/1/expressivevirtualcharacters.pdf">http://eprints.gold.ac.uk/398/1/expressivevirtualcharacters.pdf</a>

## **Empathy**

- The capacity to understand what another person is experiencing
- Measures of empathy show that mirror neurons are activated during arousal of sympathetic responses
- Three types of empathy are known:
  - > Affective empathy (being affected by another's emotional or arousal state)
  - Cognitive empathy (the capacity to understand another's perspective or mental state)
  - Somatic empathy (an immediae physical reaction, based on mirror neuron responses)

#### **Face Perception**

- Understand each other's identity, thoughts, anticipate their actions, recognize their emotions, build connections, and communicate
- Involves three independent sub-processes
  - Feature-by-feature analysis (perceiving simple physical aspects: age, gender, basic expression)
  - Shaping a structural model of the face (memory, 3D perception)
  - 3. Structural encoding of faces into "recognition units" to identify a person from semantics
- → Important for virtual humans and human-like robots

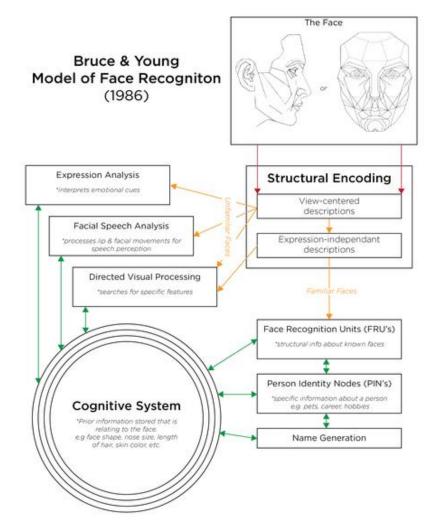
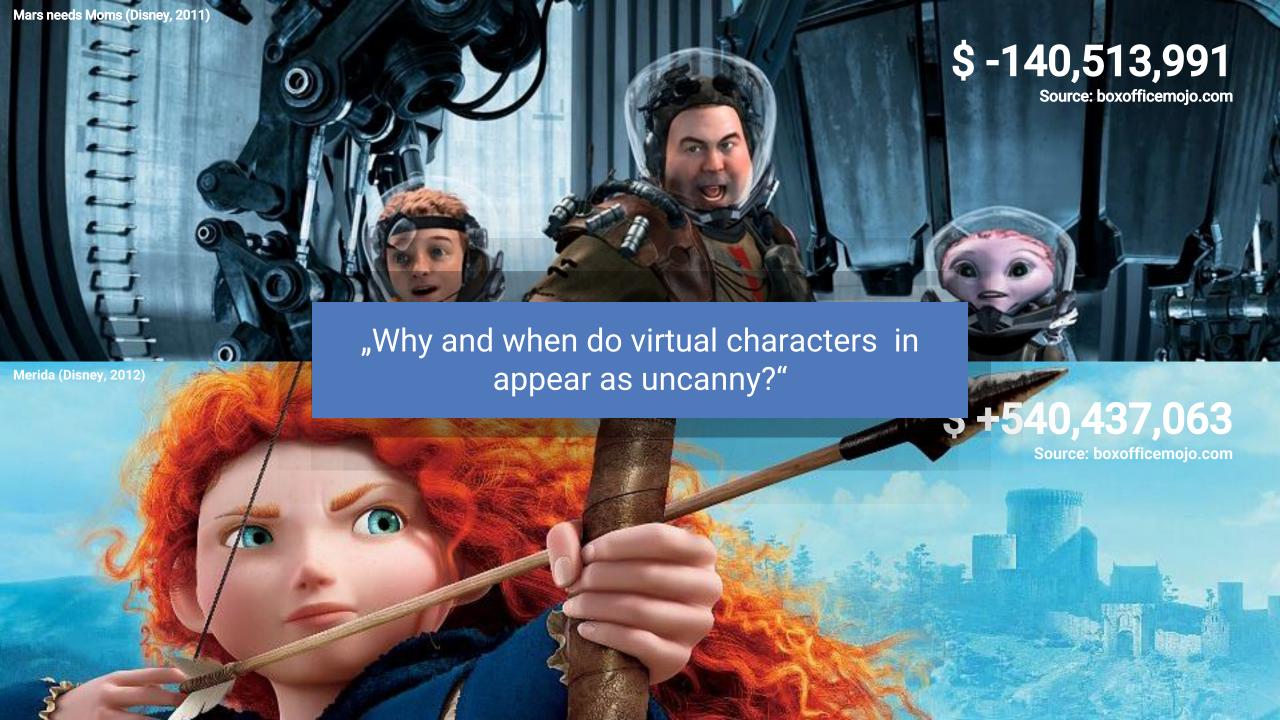
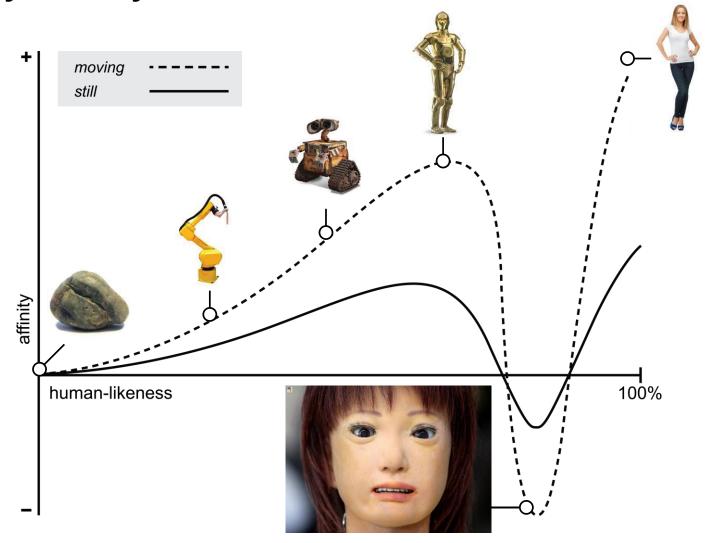


Image from: Bruce & Young Model of Face Recognition-1986, Wikipedia.org



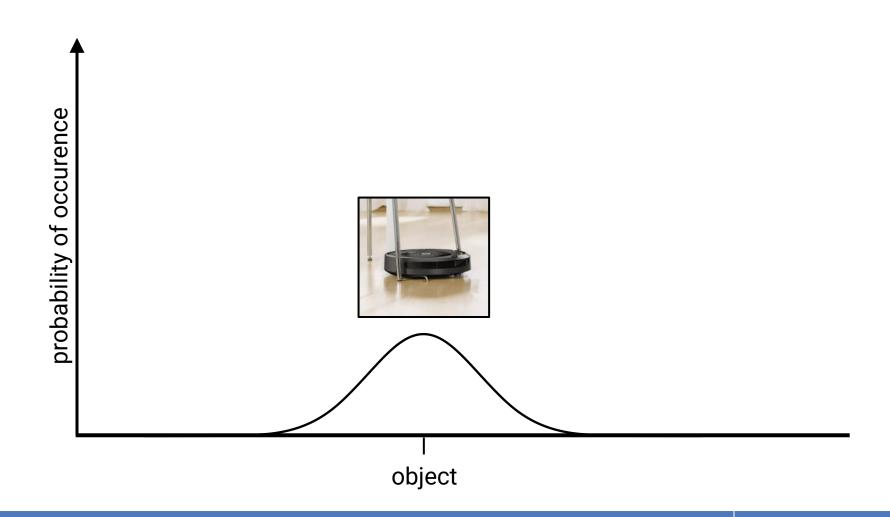


# The Uncanny Valley



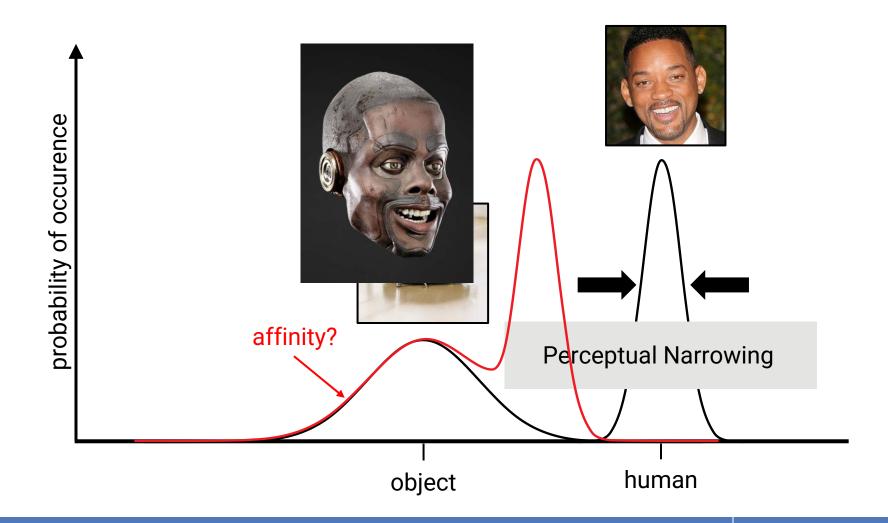
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# **Perceptual Narrowing**



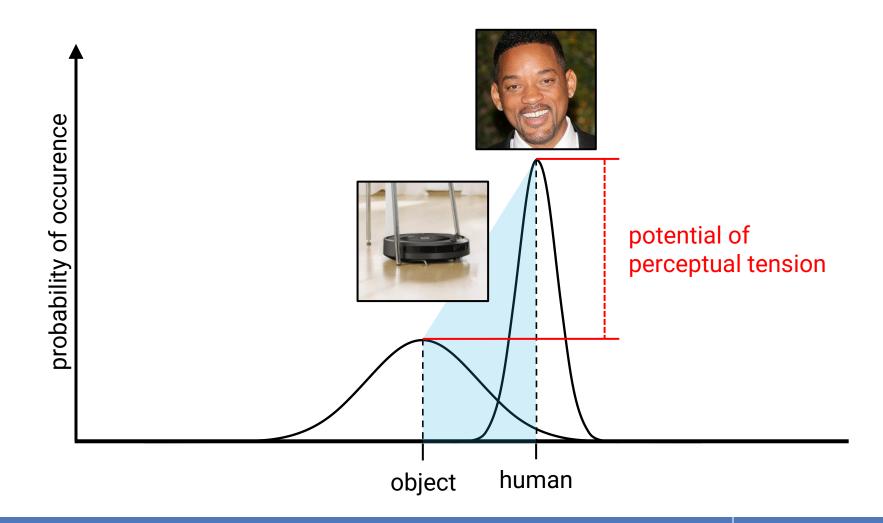
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## **Perceptual Narrowing**



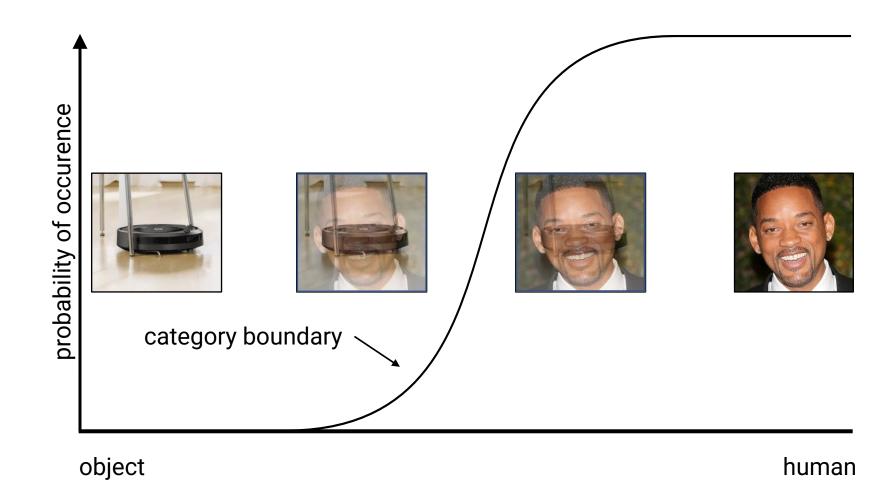
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# **Perceptual Tension**



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## **Category Boundaries**



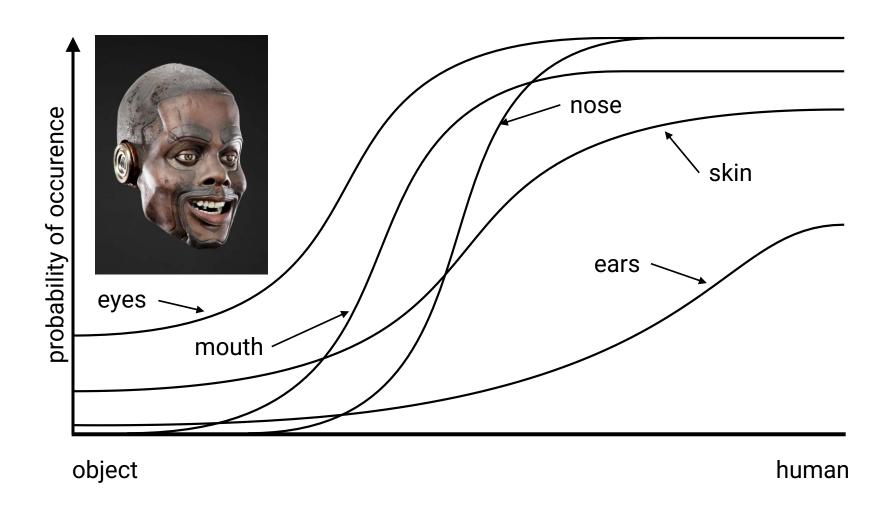
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#### **Thatcher Effect**



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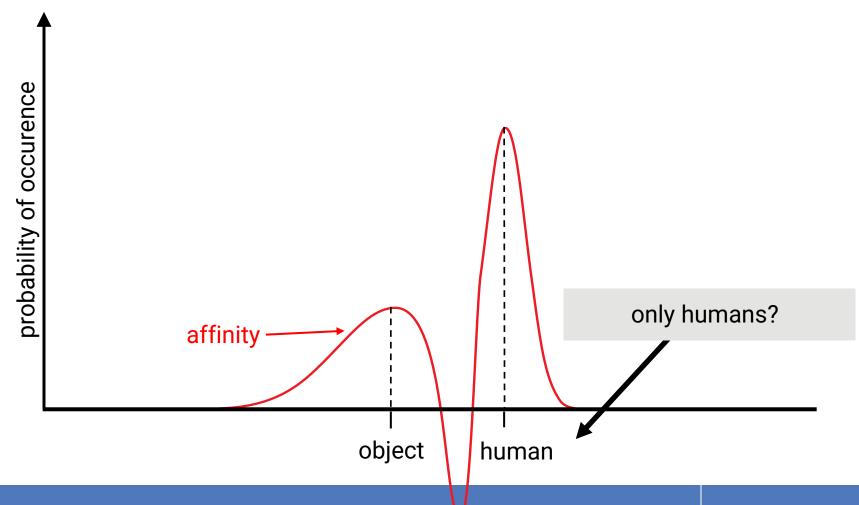
## **Conflicting Category Boundaries**



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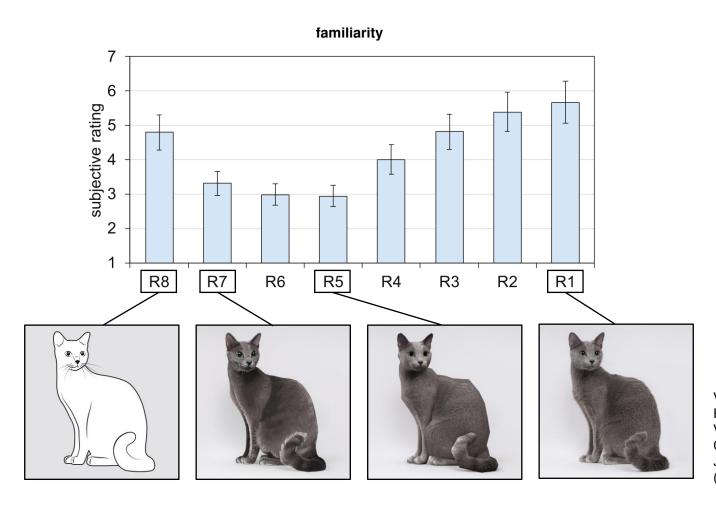


## **Uncanny Valley of Animals**



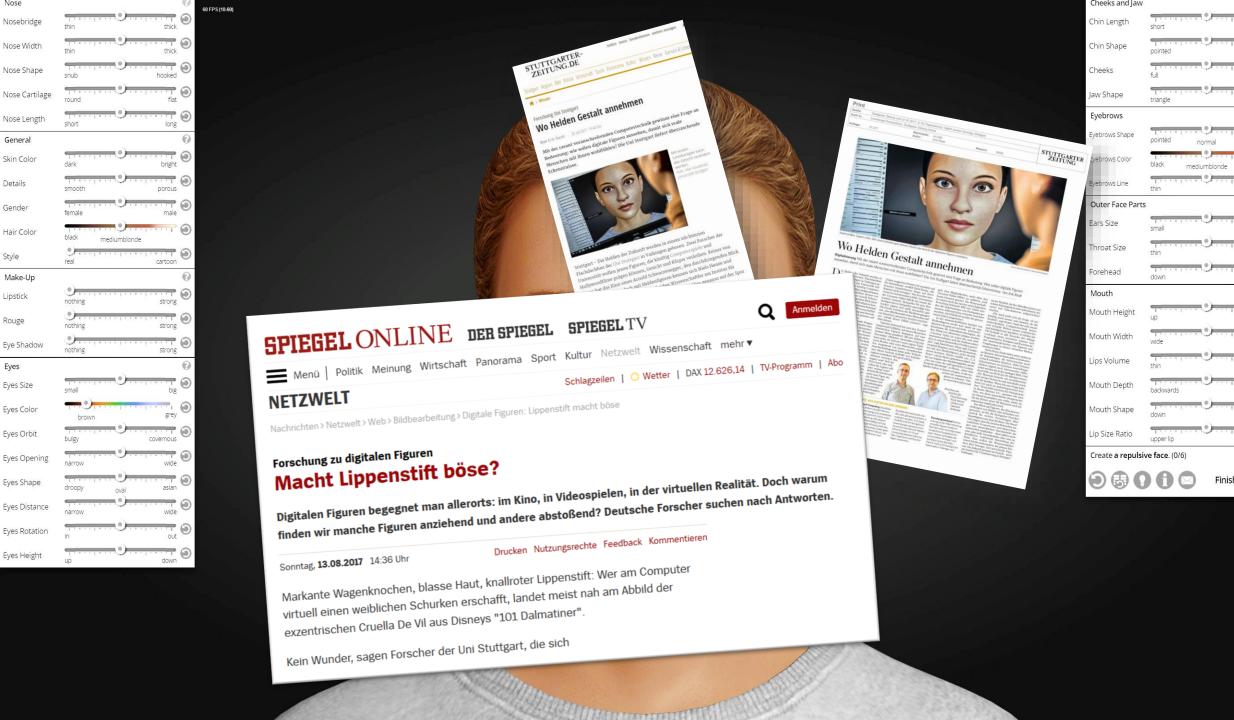
Cognition

### **Uncanny Valley of Animals**



V. Schwind, K. Leicht, S. Jäger, K. Wolf, N. Henze. "Is there an Uncanny Valley of Virtual Animals? A Quantitative and Qualitative Investigation." In International Journal of Human-Computer Studies 111 (2018)

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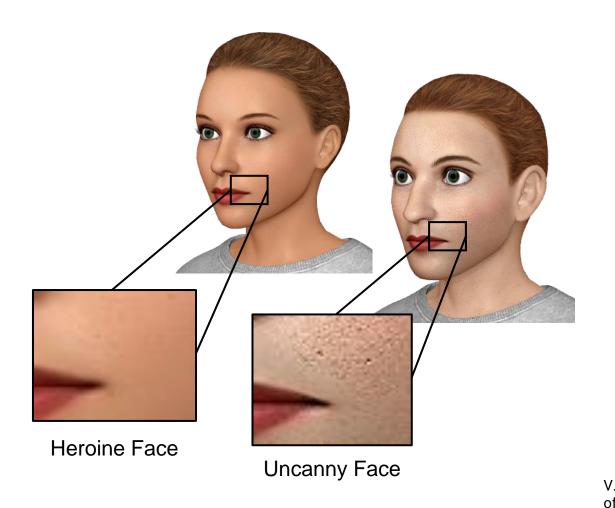
## **Stereotypical Faces**

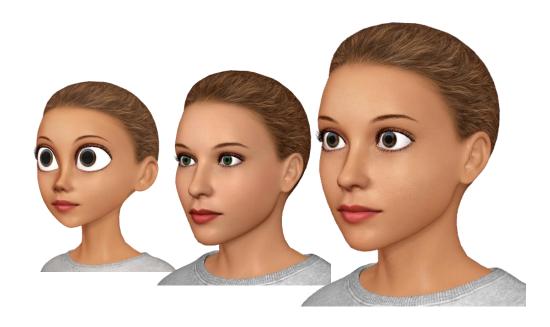


V. Schwind, Katrin Wolf, Niels Henze, and Oliver Korn. 2015. Determining the Characteristics of Preferred Virtual Faces Using an Avatar Generator. In Proc. CHI PLAY '15

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### **Uncanny Facial Realism**

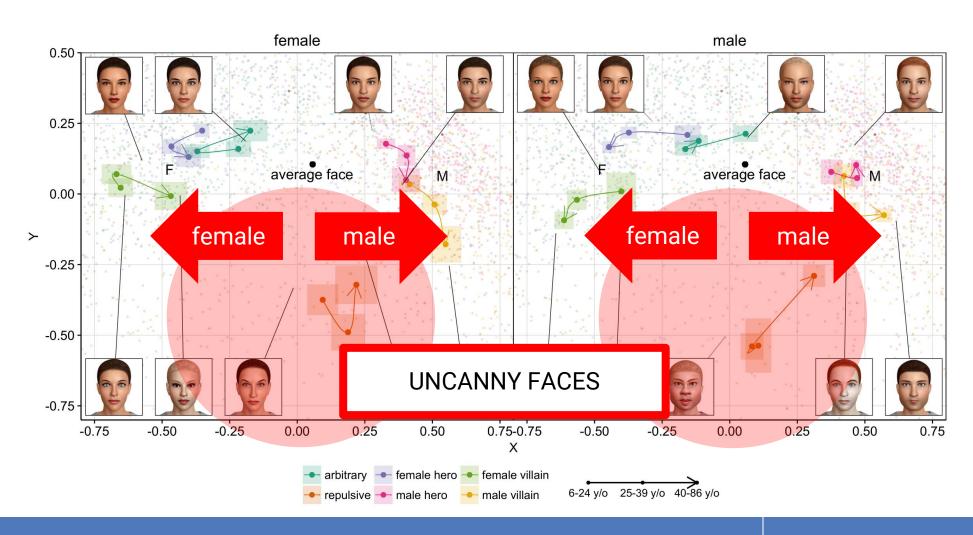




V. Schwind, Katrin Wolf, Niels Henze, and Oliver Korn. 2015. Determining the Characteristics of Preferred Virtual Faces Using an Avatar Generator. In Proc. *CHI PLAY '15* 

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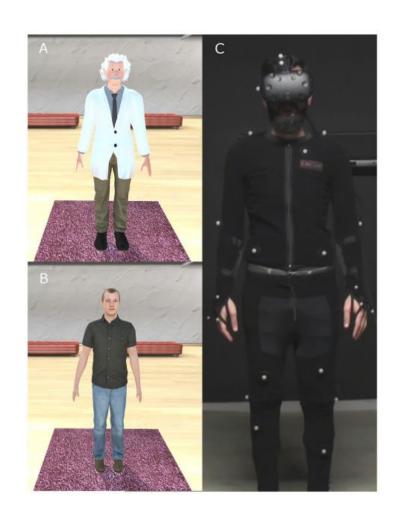
### Age and Gender-Related Differences

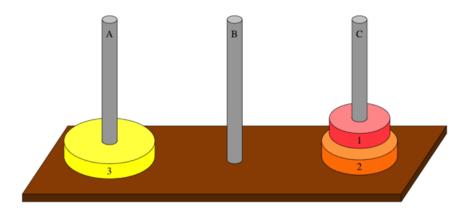


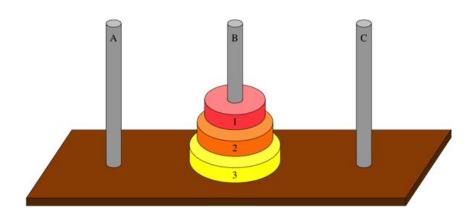
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### Virtually being Einstein improves cognitive performance







[4] Banakou, D., Kishore, S., & Slater, M. (2018). Virtually being Einstein results in an improvement in cognitive task performance and a decrease in age bias. *Frontiers in Psychology*,9
[5] Image taken from https://www.khanacademy.org/computing/computer-science/algorithms/towers-of-hanoi/a/towers-of-hanoi-continued

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### **Summary**

- All cognitive processes demand mental ressources
  - > Processes require filtering
  - > Automatic processes are fast but suffer from biases
  - > Concious processes require conciscious thinking and learning
- Cognition distinguishes between
  - > low- (perceptual-driven) and high-level (mentally-driven) processes
  - > bottom-up (unconscious) and top-down (conscious) processes
- Cognitive processes
  - > can interfere
  - can be supported