Human-Computer Interaction

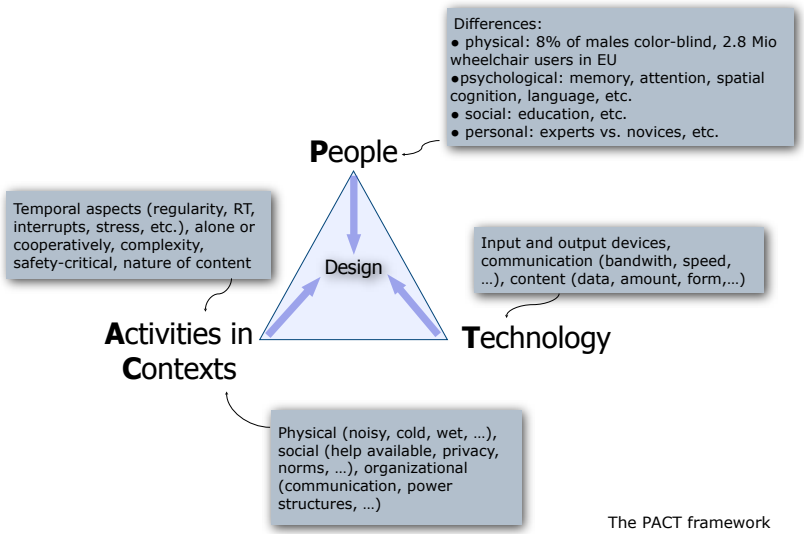
2. Termin: The human user - perception

Human-Computer Interaction

...aims at increasing the quality and efficiency of tasks that involve the human and the computer by improving the interaction between them

...is concerned with the design, evaluation and implementation of interactive systems for human use

...involves research on the human, the technology, the interaction, and the task context



The PACT framework (*Benyon et al.*)

Now...

focus on the human user

Recommended readings:

- Dix et al.: "Human-Computer Interaction", Kap. 1, S. 12-26
- Matlin & Foley: "Sensation and Perception" (3rd ed.), Allyn & Bacon, 1992.
- Reed: „Cognition" (5th ed.), Wadsworth, 2000, Kap. 1-5
- Benyon et al.: „Designing Interactive Systems", 2005, Kap. 5, 15, 16

Human-centred view

In HCI the human processes information...

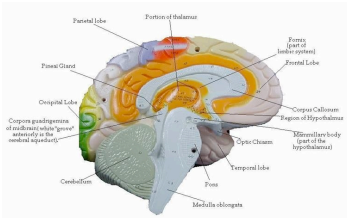
Motor-physically
pressing buttons, moving mouse, adjusting levers, haptic feedback, etc.

Perceptually
see information on display, hear audio feedback, feel touch feedback, etc.

Conceptually
try to understand system from the feedback provided, plan what should be done next

Human-centred view

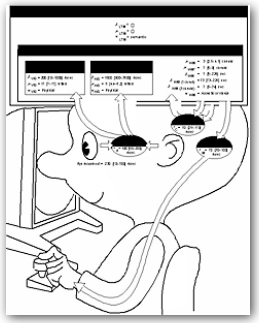
Cognitve Science and Cognitive Psychology approach



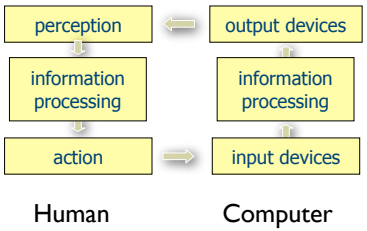
Human as information processor

- modules: specialized areas with distinctive functions
- input/output: visual, auditory, haptic, movement, force
- memories: sensory, short-term, long-term, working
- processes: reasoning, problem-solving, skills and routines, experiences, errors
- regulated and influenced by emotions

Psychology of HCI (Card, Moran & Newell; 1983)



Two information processors coupled in goal-directed action.



Human Information Processor

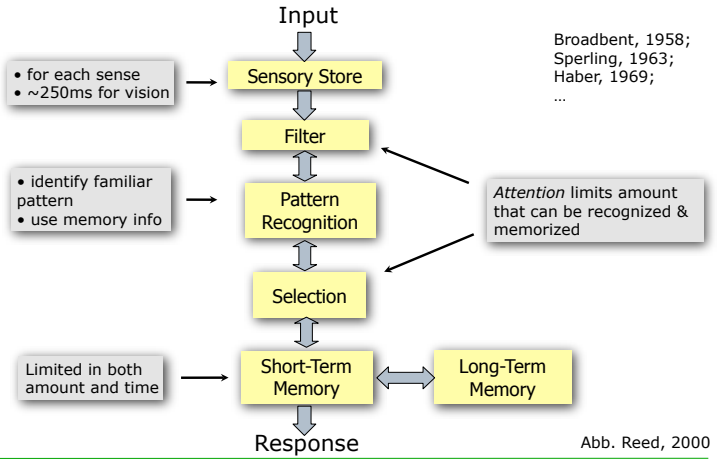
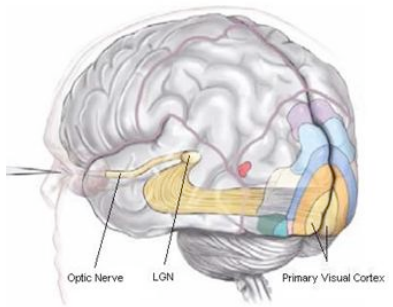


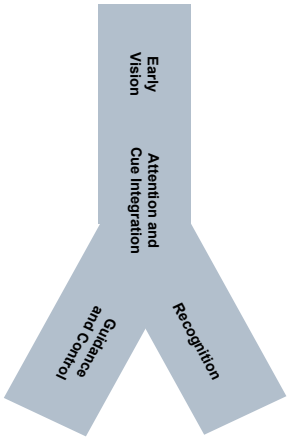
Abb. Reed, 2000

Perception

Visual perception

1. Physical reception of stimuli
   - Light sensation by optical appartus of the eye
   - Transformation into neural impulses in photo receptors of the retina
2. Processing & interpretation
   - starts right in the retina
   - Further processing and interpretation in brain structures (hierarchical visual cortex)





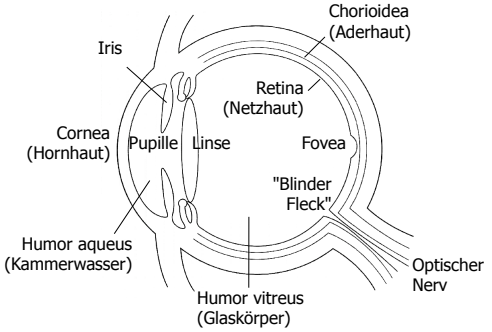
Preattentive vision
- image-like "maps" for depth, color, texture, contrast, and motion
- Parallel processing
- Perceptual learning

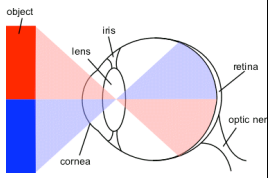
"Middle Vision"
- Serial processing within a focus of attention
- Cue integration
- Figure and ground segmentation

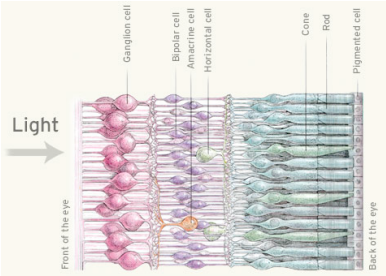
Recognition
- Generates judgements ("names")
- Invariances with respect to position, pose, illumination, etc
- Learning of categories

Guidance and Control
- Eye-hand coordination
- Body posture
- Movement control and stabilization

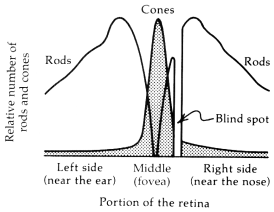
Human eye







	Cones	Rods
Function	Color sight	Black-white sight
Number	7 Millions	125 Millions
Distribution	everywhere, conentrated at Fovea	not at Fovea
Lighting conds.	well illuminated	dark
Resolution	very good	weak
Sensitivity	weak	very good



- Rods dominate peripheral vision
- details better seen in foveal region
- more sensitive with peripheral vision
- visual system compensates blind spot

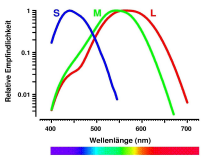
Blind spot

Cover your left eye, look directly at the dot from some distance, move towards it. At some point the cross will disappear!
To check, cover your right eye and do the same - no blind spot! That's because your left eye's blind spot is to the left of the dot.

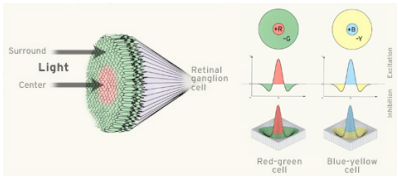
Color vision

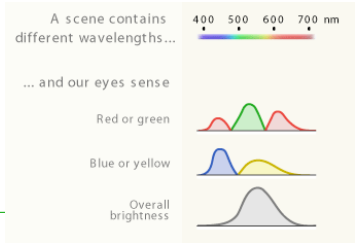
Receptors

- Three cone types with preferred wave lengths
  - S: blue, M: green-yellow, L: yellow-red
- Humans can distinguish 150 colors, with varying saturation and brightness ca. 7 Mio colors
- More M and L receptors in fovea than S type (bad color perception)



Ganglion cells





Depth perception

Visual angle depends on size & distance of stimulus

But different objects at different distances are perceived as being of same size

→ brain needs to take depth information into account

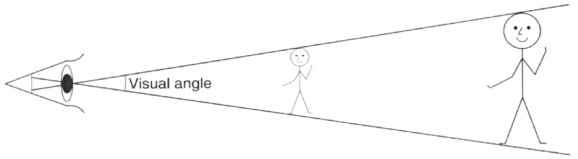


Abb.: Dix et al., 1998

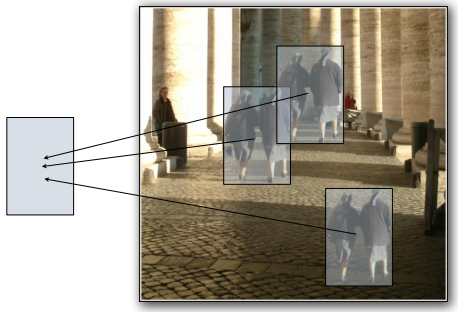
Depth perception

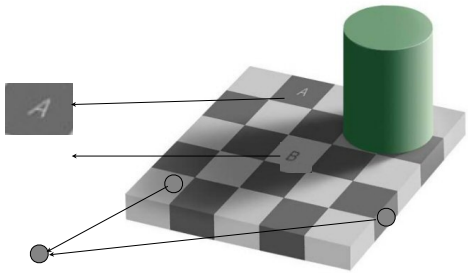
Primary depth cues

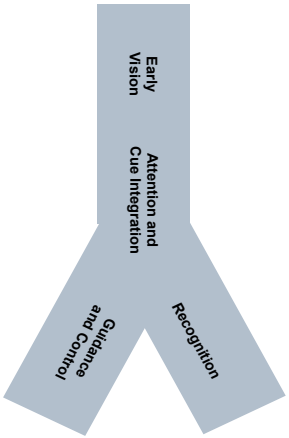
- difference of left-/right-eye images (close-up range)
- process of combining these images
- process of shaping the lens to create sharp image
- inward movement of eyes to focus (2-7m)

Secondary depth cues

- Light & shade
- Linear perspective
- Height over horizontal plane
- Motion parallax (how images of things vary when moving)
- Overlap & occlusion
- Relative size: small objects tend to be further away
- Texture gradient







Preattentive vision

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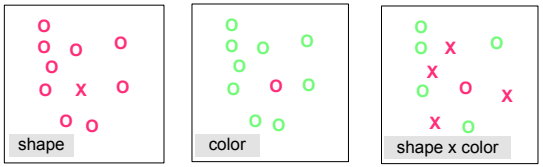
Attentive vs. Preattentive Vision

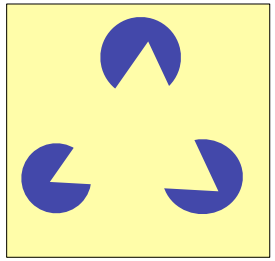


Find deviating element ("odd man out")!

- One feature dimension: Parallel search, time is independent of number of distractors
- Conjunctions of feature dimensions: Serial search, time covaries with number of distractors

Feature integration theory (Treisman & Gelade, Cogn. Psychol 1980): Binding of feature maps by focus of attention

Integration and Organization



Kanizsa triangle:

Subjective contours are perceived at the boundary between the triangle (figure) and the background.

„Gestalt laws"

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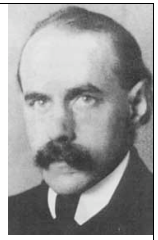

(Max Wertheimer)

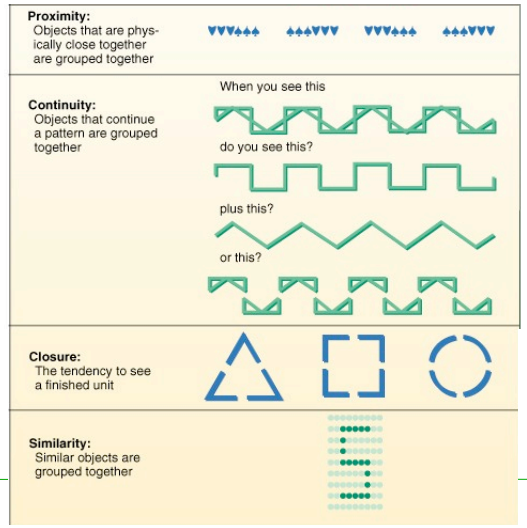
The brain strives to make visual impressions clearer, simpler, better understandable

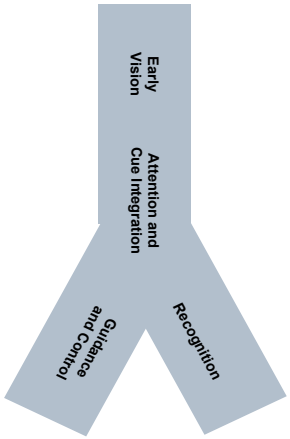
Gestalt psychology assumes „Prägnanz" to be a basic principle of perception, such that more concise forms provide better conditions for perception and memory

Gestalt qualities are given, if some structure is recognizable that eases perception

- the more difficult the order, i.e. the harder to group elemens together, the more reduced the Gestalt and perceptive qualities

Gestalt principles (examples)





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Form recognition

Comparison with patterns stored in LTM, but processed & stored in terms of what?
- Templates (Philipps, 1974)
- Features (Gibson, 1969; Egeland, 1975; …)
- Features + structure (Marr, 1978; Biederman, 1987)

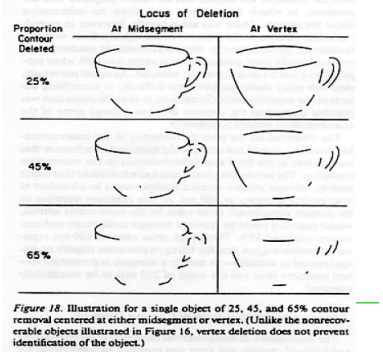


Figure 18. Illustration for a single object of 25, 45, and 65% contour removal centered at either midsegment or vertex. (Unlike the nonrecoverable objects illustrated in Figure 16, vertex deletion does not prevent identification of the object.)

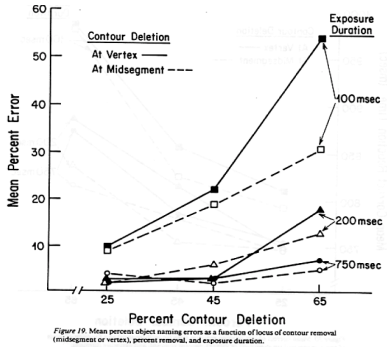


Figure 19. Mean percent object naming errors as a function of locus of contour removal (midsegment or vertex), percent removal, and exposure duration.

Visual context

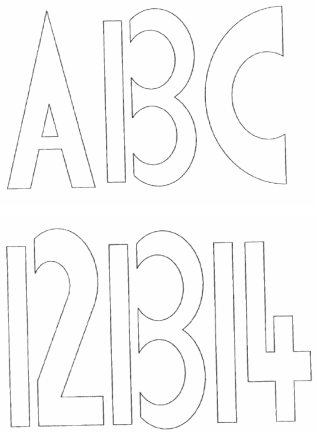


Abb.: Dix et al., 1998

Reading - applied pattern recognition

Not a sequential process!
- Saccades & fixations, perception occurs during fixations
- Words are patterns too, can be recognized as quickly as letters
- Recognition on three interacting levels in parallel: features, letters, words (McClelland & Rumelhardt, 1981; Massaro & Cohen, 1991)

Word superiority effect (Reicher, 1969):
- Stimulus: 1 letter, 4-letter word, 4-letter non-word
- Which of 2 alternative characters was at a certain pos.? Most accuracte in word condition!

Speed ~ 250 words per minute
- Dark characters on light backround easier to read
- But negative contrast improves reading from screen

Reading

Both bottom-up and top-down, guided by context and expectation

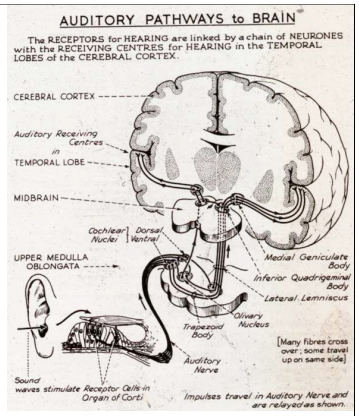
"Luat enier sidtue an eienr elgnhcsien uvrsnäiett, ist es eagl in wcheler rhnfgeeloie die bstuchbaen in eniem wrot snid. das eniizg whictgie ist, dsas der etrse und der lztete bstuchbae am rtigeichn paltz snid. der rset knan tatol deiuranchnedr sien und man knan es ienrmomch onhe porbelm lseen. das legit daarn, dsas wir nhcit jeedn bstuchbaen aeilln lseen, srednon das wrot als gzanes."

The quick brown

fox jumps over the

the lazy dog.

Auditory perception



Auditory Pathways and Hypothesized Functions

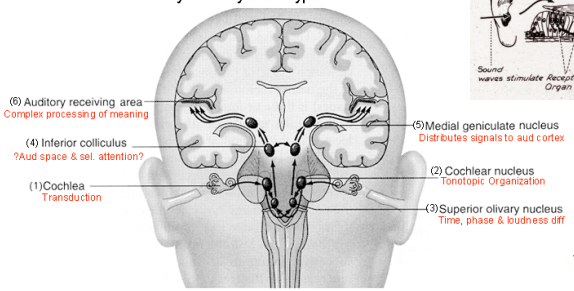
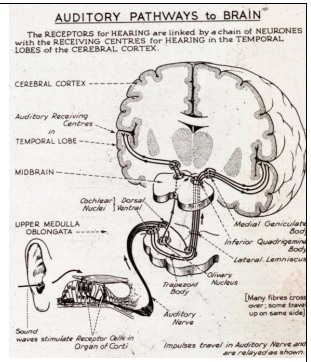


Figure 10.24

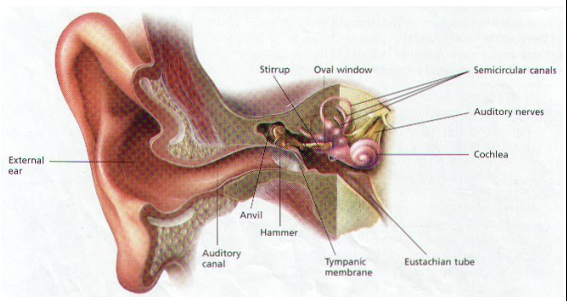
Auditory perception



1. **Transduction**
   - translates sound waves into neural impulses
2. **Auditory grouping**
   - segregation & integration of sound streams
3. **Scene analysis & organisation**
   - extraction of perceptual properties
4. **Interpretation**
   - experience of the auditory environment

(McAdams & Bigand, 1993)

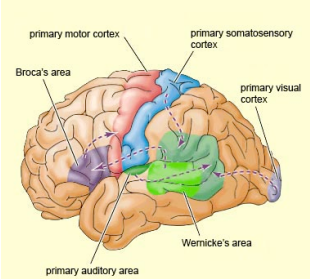
Human ear



Transduction

- Sound wave travels through ear canal
- Transformation of ear drum vibrations into bone movements (ossicls) and amplification
- Transmission into cochlea (inner ear), filled with liquid
- Delicate hair cells bend and cause neural impulses

Auditory processing



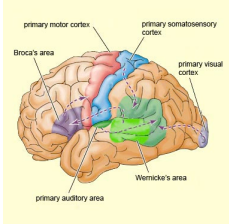
Features processed:

- Loudness (= amplitude)
  - Whisper (15 dB), conversation (60), car horn (110), rock concert (120+)
- Frequency (= pitch)
  - Human hearing range: 20 Hz - 15.000 Hz
- Timbre (type or quality of sound)

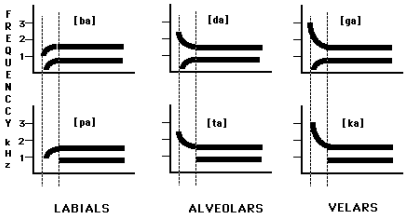
Final perception created in auditory cortex!

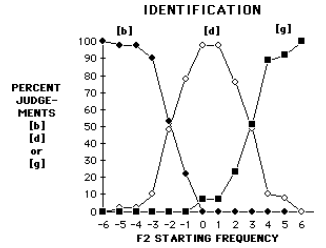
- Directed hearing from temporal and intensity differences at the two ears
- Filtering of background noise („cocktail party effect")
- Impression of non-existent sounds (tinitus)

Categorical perception

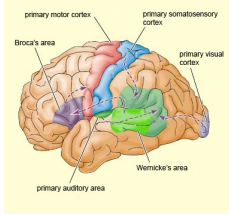


When hearing similar sounds (ba, da, ga), that differ slightly in starting frequency of an harmonic (2nd formant F2), speakers seem to discriminate between learned categories



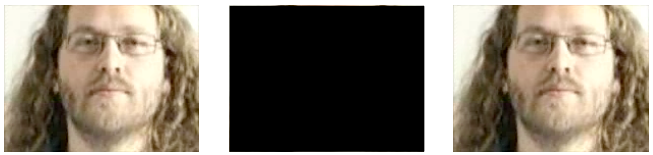


Audio-visual perception

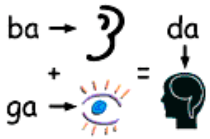


Audio-visual integration in dedicated brain areas

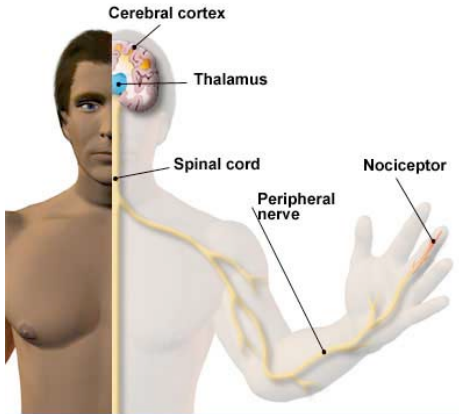
Example: What does the person say?



„McGurk-Effect"



Touch perception



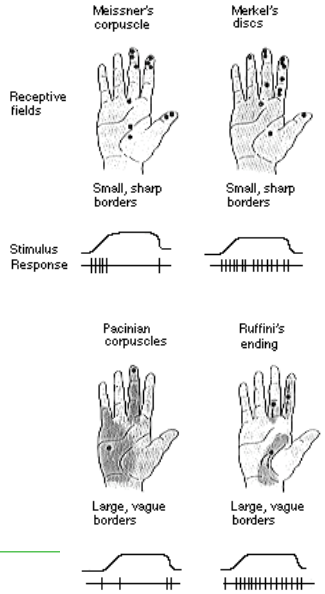
Touch reception

Receptors underneath the skin, in muscles and joints

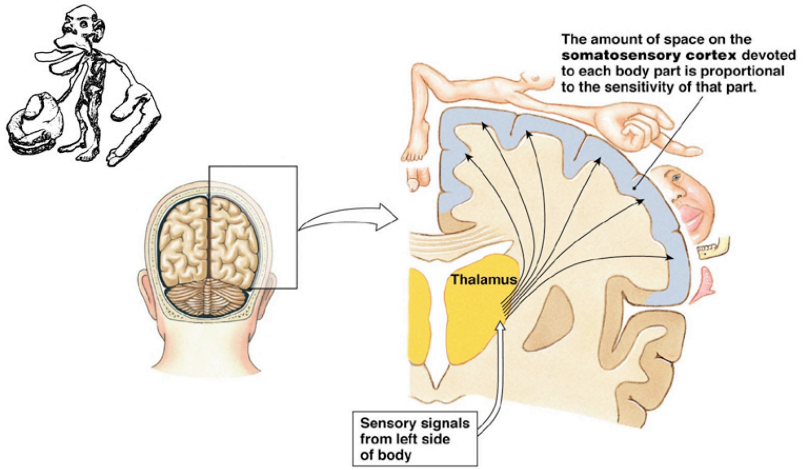
- ~2qm receptive skin surface, but not equally distributed

Three types of skin receptors

- thermoreceptors: heat and cold
- nocireceptors: pressure, heat, pain
- mechanoreceptors: respond differently to pressure, for different skin areas, in females vs. males



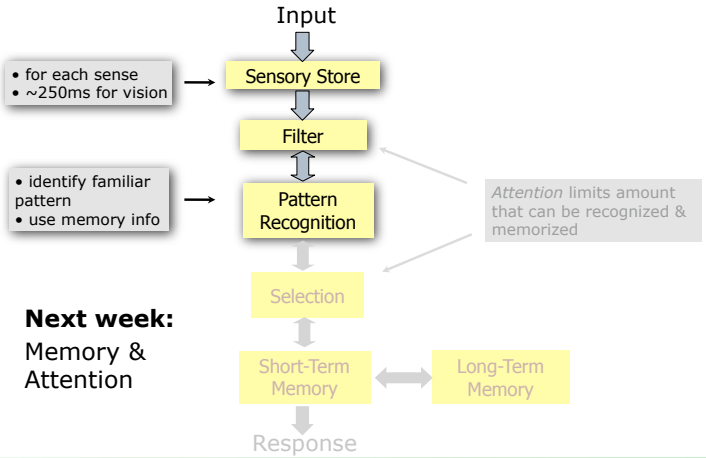
Touch processing



Cross section of the right cerebral hemisphere and sensory areas of the cerebral cortex

Fig. 10-10

Human Information Processing



Next week:
Memory & Attention