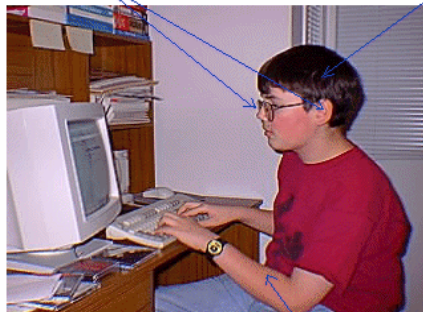


Human Perception, Cognition and Action (2)

Matthias Rauterberg
GOOGLE: rauterberg
2005

The cognitive science view

Perceptual Processor Cognitive Processor



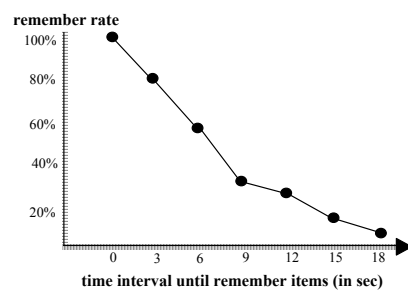
Motor Processor

Short Term Memory (STM)

- ❖ **Chunking**
 - limit of 7 +/- 2 chunks
- ❖ **Assisted by auditory rehearsal**
 - repeated exposure
- ❖ **Primacy and recency effects**
 - first things remembered best
 - most recent things more accessible
- ❖ **STM limits our ability to process task-related information**

Reference: S. Harkus (2003) [Seven, plus or minus two. What's the relevance for web design?](#)

Limits of the Working Memory

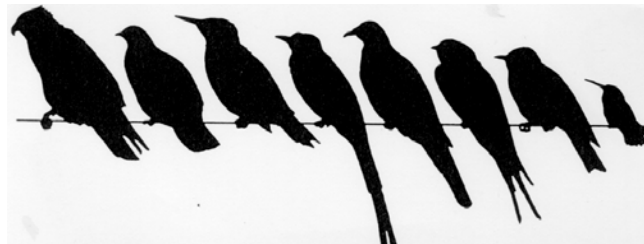


- working memory
 - remember time < 5 sec
 - about 5-9 chunks
 - masking
 - interferences
- long-term memory
 - no capacity limits

Long Term Memory (LTM)

- ❖ **No known Capacity**
 - no one knows how we forget
- ❖ **Storage by Elaboration**
 - relate incoming knowledge to existing knowledge
- ❖ **Proactive/Retroactive interference**
 - old knowledge interferes with learning new
 - new knowledge interferes with recalling old
- ❖ **LTM is used in the understanding and performance of tasks**

The Perceptual Prototype



- Which shape represents the most typical bird?

Perceptual Styles (1)

- What is this?



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Perceptual Styles (2)

- The continent Africa can be perceived without problems if the figure is rotated 90grad right

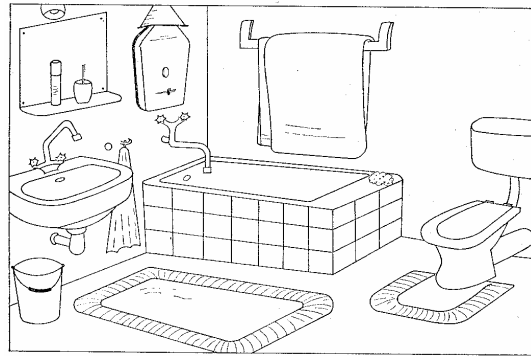


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The "normal" order in the world (1)



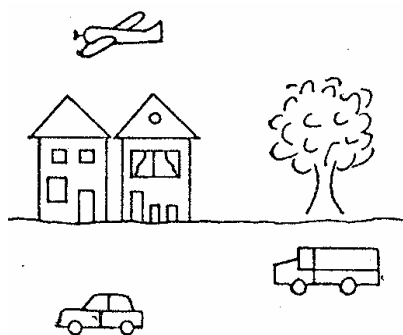
- There is no problem to perceive a bath room, based on our daily life experiences

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The "normal" order in the world (2)



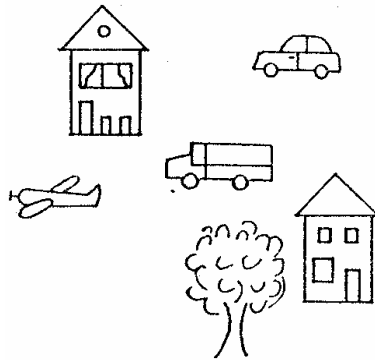
- All objects in the picture are shown at that place of their normal appearance

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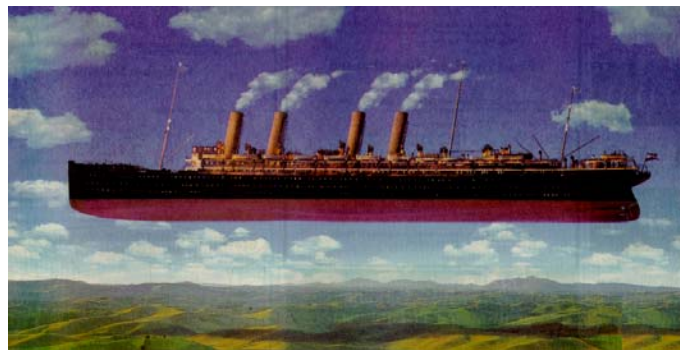
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The “normal” order in the world (3)



- All objects in the picture are shown in a random order
- these kinds of pictures are difficult to interpret

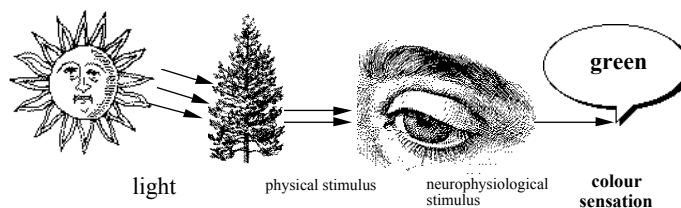
The “normal” order in the world (4)



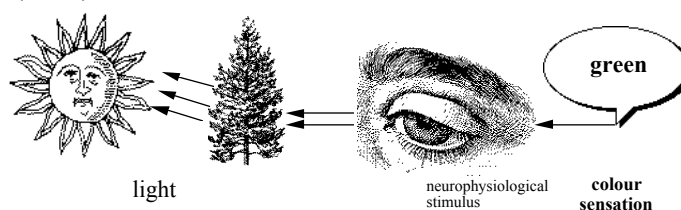
- To break through the “normal” order in the world can be used to control attention via attraction

Theories of Perception (1)

Representational Approach



(Pure) Constructivism

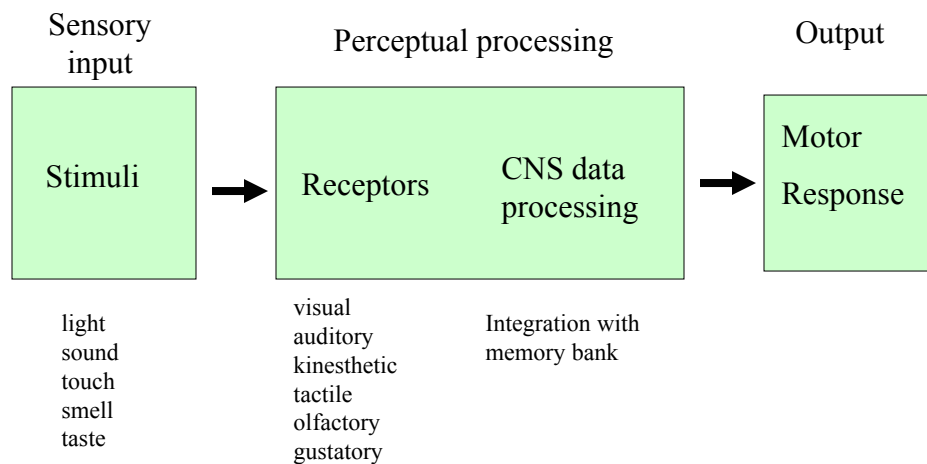


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General Information Processing Model (perceptual motor)

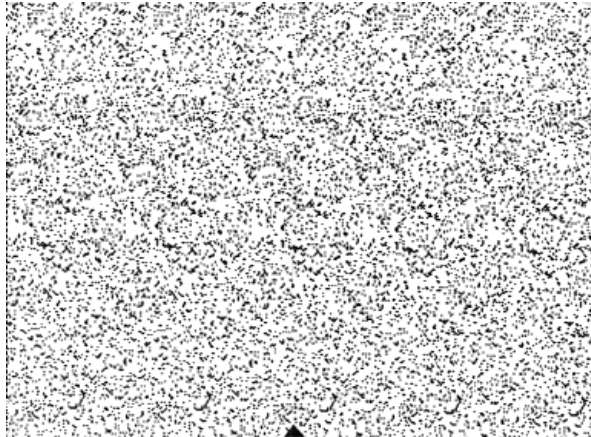


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What is this?



Answer: a "magic eye"!

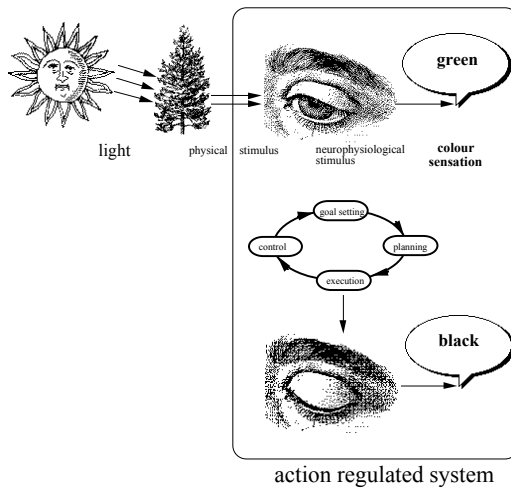
You have to hold it in front of your face (ca. 20 cm) and look "through" this picture at a virtual horizon; if you do it properly you will get a stereoscopic image of three arrows pointing downwards.

The point of this image is to know how to handle it!

This is a clear example of the strong relationship between perception and action.

Theories of Perception (2)

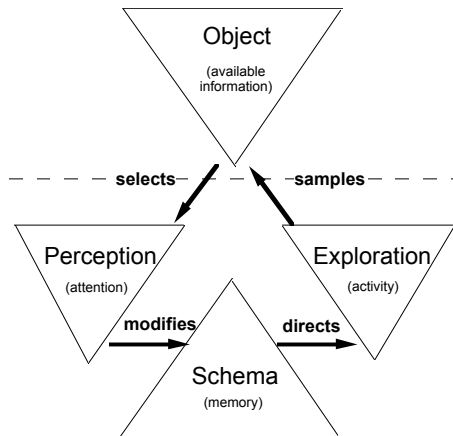
Interactionistic Approach



The Perceptual Cycle

[U. Neisser: Cognition and Reality, 1976]

[See discussion](#)

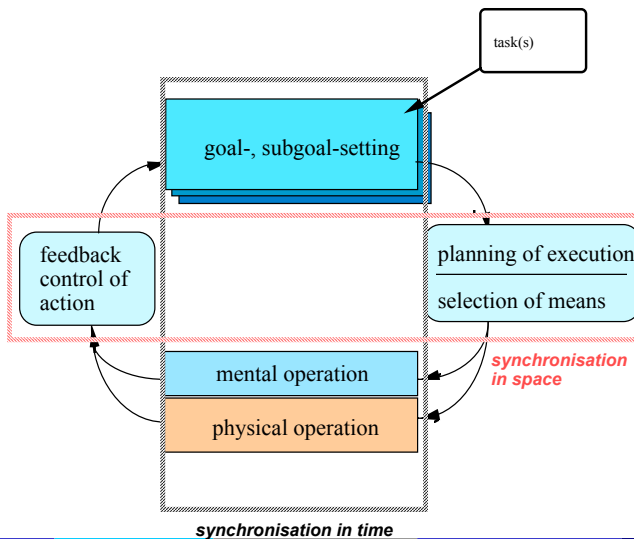


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the complete action cycle



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Fitts' Law

$$T = k \log_2(D/S + 0.5), k \sim 100 \text{ msec.}$$

T = time to move the hand to a target

D = distance between hand and target

S = size of target

Fitts' Law is a model to account for the time it takes to point at something, based on the size and distance of the target object. Fitts' Law and variations of it are used to model the time it takes to use a mouse and other input devices to click on objects on a screen.

Broadly, Fitts' Law can be applied by designers to suggest moving target buttons closer and making them larger for extremely commonly used buttons. In detail, applying the formula can be extremely useful for exact design of time-critical applications.

Attention

- **Limited** - individuals can only attend to one thing at a time, and capacity can be exceeded.
- **Serial** - individuals attend to one thing, then another.
- In terms of successful motor skill performance:
 - Alertness and preparation
 - Related to limited capacity
 - Selective attention

Alertness

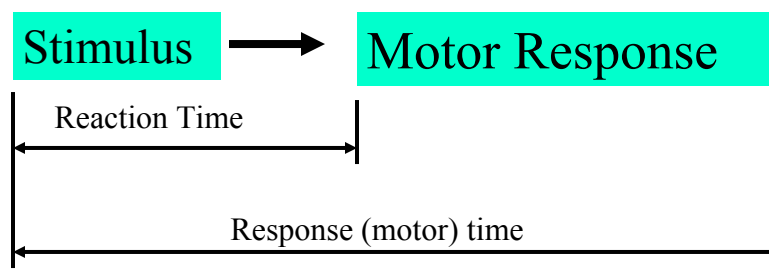
- Successful movement requires alertness and preparation.
- In a 'race start', what are you alert to?
- Research determines alertness through reaction time (RT):
 - the interval of time between *stimulus* and *initiation* of a response.

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Reaction Time (RT)



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Alertness



- Reaction time includes:
 - attention (alertness) to the stimulus
 - motor system preparation
 - reception and transmission of the stimulus
 - interpretation of the information
 - organization of a motor program for the response

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Alertness

- Development:
 - Improves (decreased reaction times) into 20 years
 - Stable until ca. 60 years
- Other factors:
 - preparation for rapid movement depends on complexity of the movement.
 - Anticipation improves RT performance.

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Divided Attention

- Individuals have limitations in the ability to take in information.
 - Attention needs to be given for successful motor performance.
 - Depending how much attention this requires, may cause interference with additional activities.
 - Interference can result in:
 - loss of speed or quality in one activity
 - both activities could be affected
 - second activity could be ignored

Divided Attention

- Young children attend to dual tasks equally
- Older children identify and perform primary task better
- The ability to do multiple tasks improves with age
 - **Automation** - with practice, less attention is taken up, freeing some attention for other tasks.
 - **Attention skills** - strategies for freeing up attention.

- As you are reading this paragraph I'll be talking and saying people's names in this class. If I say your name you'll probably stop reading and look at me instead of paying attention to what you're reading. This is known as the "Cocktail Party Phenomenon". Even though you are paying attention to the person in front of you, if your name is spoken anywhere close by, you'll attend to that instead.

Selective Attention

- Similar to visual figure-ground perception.
 - Picking the right thing out of the background
 - Can involve several senses
- What sensory information is Tony getting during a tennis game?
- What is he paying attention to?

Selective Attention

- 3 stages of selective attention:
 - 1. **Over-exclusive** mode (2-5 years old) - pay exclusive attention to one stimulus. Also more easily distracted.
 - 2. **Over-inclusive** mode (6-11 years old) - pay attention to more stimuli, some irrelevant.
 - 3. **Selective** - capable of attending to relevant stimuli.

Selective Attention

- Under age 12, children will rely more on auditory rather than visual if both are present.
- Age differences in attention are generally experience related.
 - Adolescents and adults have more experience for attending to relevant stimuli.
- Children can be taught to resist irrelevant cues.

Applying Psychology to Design: Memory

- ❖ **Use existing knowledge where possible**
 - assist learning by using metaphor
- ❖ **Use recognition over recall**
 - e.g. menu items
- ❖ **Don't overload short term memory**
 - limit the need to remember information between screens, by maintaining an external memory, e.g. of current settings
- ❖ **Design for consistency to avoid interference**
 - retroactive and proactive

Applying Psychology to Design: Sensation & Perception

- ❖ **Make use of human hardware**
 - e.g. colour vision
- ❖ **Use a variety of modalities**
 - e.g. visual and audio
- ❖ **Compensate for difficult tasks**
 - e.g. pop-up menus to avoid eye movement
- ❖ **Avoid anomalies**
 - e.g. unwanted after effects

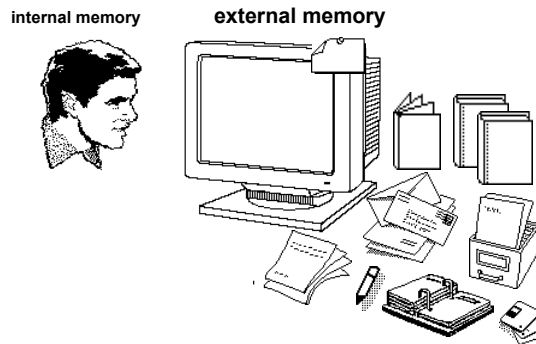
*Applying Psychology to Design:
Attention & Performance*

- ❖ **Attention acts like a filter for information**
 - can be selective, e.g. driving/car radio
- ❖ **Design to match performance**
 - response
 - speed/accuracy, e.g. Fitt's Law
- ❖ **Design for learning**
 - with practice, tasks become automatic
- ❖ **Design for error**
 - fatigue
 - action slips

Knowledge in the World and in the Head

Property	Knowledge in the World	Knowledge in the Head
Retrievability:	Retrievability whenever visible or audible or tangible.	Not readily retrievable. Requires memory search or reminding.
Learning:	Learning not required. Interpretation substitutes for learning.	Requires learning, which can be considerable.
Efficiency of use:	Tends to be slowed up by the need to find and interpret the external information.	Can be very efficient.
Ease of use at first encounter:	High.	Low.
Aesthetics:	Can be unaesthetic and inelegant, especially if there is a need to maintain a lot of information.	Nothing need be perceivable, which gives more freedom to the designer and can lead to better aesthetics.

The Difference between Internal and External Memory



- the mental model of the user about the external world is always incomplete
- all necessary information which is not in the internal memory must be provided by the environment (the “external memory”)

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- R.Sekuler & R.Blake 1994
'Perception', 3rd ed.
a comprehensive textbook covering a wide range of topics in perception (including non-visual) with nice examples and helpful physiological background
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a thorough introduction to the fundamental principles of visual perception with many physiological and comparative aspects
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'The Senses', Cambr. Univ. Press
a good introduction (but not the most recent) to psychophysics with valuable references to original research

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