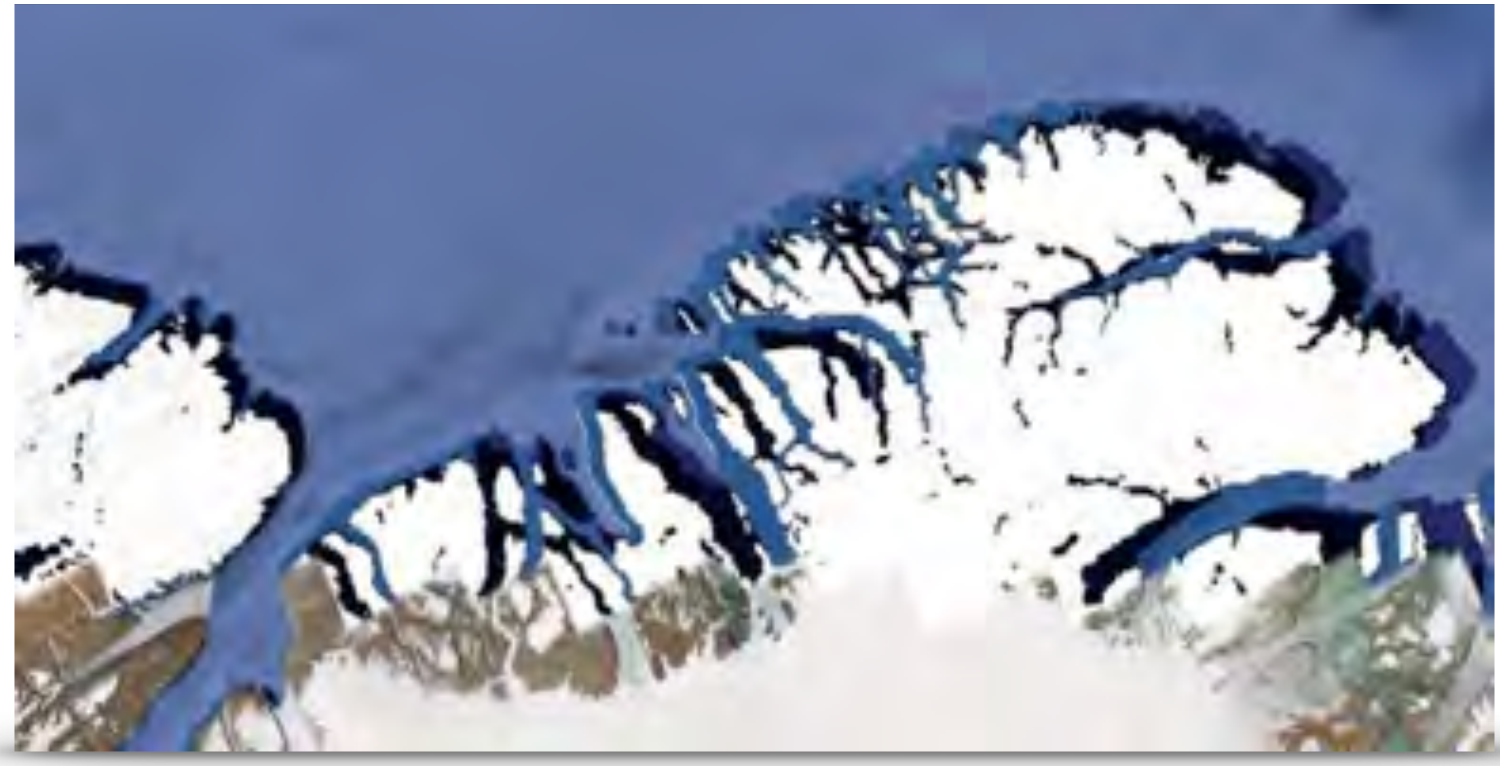
IKON 1

Prof. Dr. Frank Steinicke
Human-Computer Interaction
Fachbereich Informatik
Universität Hamburg

Bewerten

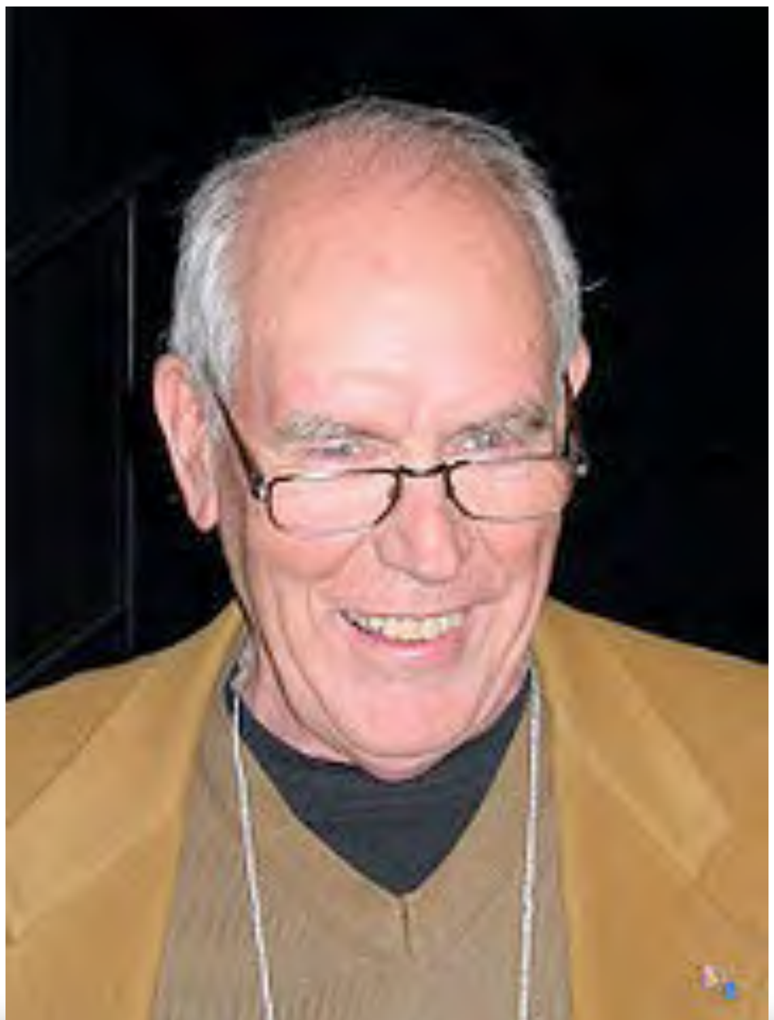
Design Challenge



Deadline: 3. November, 2016 um 8:00 Uhr

Lesen

Classic Reading



The Ultimate Display

Ivan E. Sutherland

Information Processing Techniques
Office, ARPA, OSD

We live in a physical world whose properties we have come to know well through long familiarity. We sense an involvement with this physical world which gives us the ability to predict its properties well. For example, we can predict where objects will fall, how well-known shapes look from other angles, and how much force is required to push objects against friction. We lack corresponding familiarity with the forces on charged particles, forces in non-uniform fields, the effects of nonprojective geometric transformations, and high-inertia, low friction motion. A display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world. It is a looking glass into a mathematical wonderland.

Computer displays today cover a variety of capabilities. Some have only the fundamental ability to plot dots. Displays being sold now generally have built in line-drawing capability. An ability to draw simple curves would be useful. Some available displays are able to plot very short line segments in arbitrary directions, to form characters or more complex curves. Each of these abilities has a history and a known utility.

It is equally possible for a computer to construct a picture made up of colored areas. Knowlton's movie language, BEFLIX [1], is an excellent example of how computers can produce area-filling pictures. No display available commercially today has the ability to present such area-filling pictures for direct human use. It is likely that new display equipment will have area-filling capability. We have much to learn about how to make good use of this new ability.

The most common direct computer input today is the typewriter keyboard. Typewriters are inexpensive, reliable, and produce easily transmitted signals. As more and more on-line systems are used, it is likely that many more typewriter consoles will come into use. Tomorrow's computer user will interact with a computer through a typewriter. He ought to know how to touch type.

A variety of other manual-input devices are possible. The light pen or RAND Tablet stylus serve a very useful function in pointing to displayed items and in drawing or printing For input to the computer. The possibilities for very smooth interaction with the computer through these devices is only just beginning to be exploited. RAND Corporation has in operation today a debugging tool which recognizes printed changes of register contents, and simple pointing and moving motions for format relocation. Using RAND's techniques you can change a digit printed on the screen by merely writing what you want on top of it. If you want to move the contents of one displayed register into another, merely point to the first and "drag" it over to the second. The facility with which such an interaction system lets its user interact with the computer is remarkable.

Knobs and joysticks of various kinds serve a useful function in adjusting parameters of some computation going on. For example, adjustment of the viewing angle of a perspective view is conveniently handled through a three-rotation joystick. Push buttons with lights are often useful. Syllable voice input should not be ignored.

In many cases the computer program needs to know which part of a picture the man is pointing at. The two-dimensional nature of pictures makes it impossible to order the parts of a picture by neighborhood. Converting from display coordinates to find the object pointed at is, therefore, a time-consuming process. A light pen can interrupt at the time th at the display circuits transfer the item being pointed at, thus automatically indicating its address and coordinates. Special circuits on the RAND Tablet or other position input device can make it serve the same function.

What the program actually needs to know is where in memory is the structure which the man is pointing to. In a display with its own memory, a light pen return tells where in the display file the thing pointed to is, but not necessarily where in main memory. Worse yet, the program really needs to know which sub part of which part the man is pointing to. No existing display equipment computes the depths of recursions that are needed. New displays with analog memories may well lose the pointing ability altogether.

Other Types of Display

If the task of the display is to serve as a looking-glass into the mathematical wonderland constructed in computer memory, it should serve as many senses as possible. So far as I know, no one seriously proposes computer displays of smell, or taste. Excellent audio displays exist, but unfortunately we have little ability to have the computer produce meaningful sounds. I want to describe for you a kinesthetic display.

The force required to move a joystick could be computer controlled, just as the actuation force on the controls of a Link Trainer are changed to give the feel of a real airplane. With such a display, a computer model of particles in an electric field could combine manual control of the position, of a moving charge, replete with the sensation of forces on the charge, with visual presentation of the charge's position. Quite complicated "joysticks" with force feedback capability exist. For example, the controls on the General Electric "handyman" are nothing but joysticks with nearly as many degrees of freedom as the human arm. By use of such an input/output device, we can add a force display to our sight and sound capability.

I. Sutherland: The Ultimate Display, 1965

Deadline: 27. Oktober, 2016 um 8:00 Uhr

Diskutieren

Shame or Fame?

Deadline: 27. Oktober, 2016 um 8:00 Uhr

I.E. Sutherland: Head-mounted 3D display, Fall Joint Computer Conference, 1968

arsnova.eu

Zugangsschlüssel: 71 67 90 24

Mensch-Computer-Interaktion

Menschliche Informationsverarbeitung

Prof. Dr. Frank Steinicke

Human-Computer Interaction, Universität Hamburg

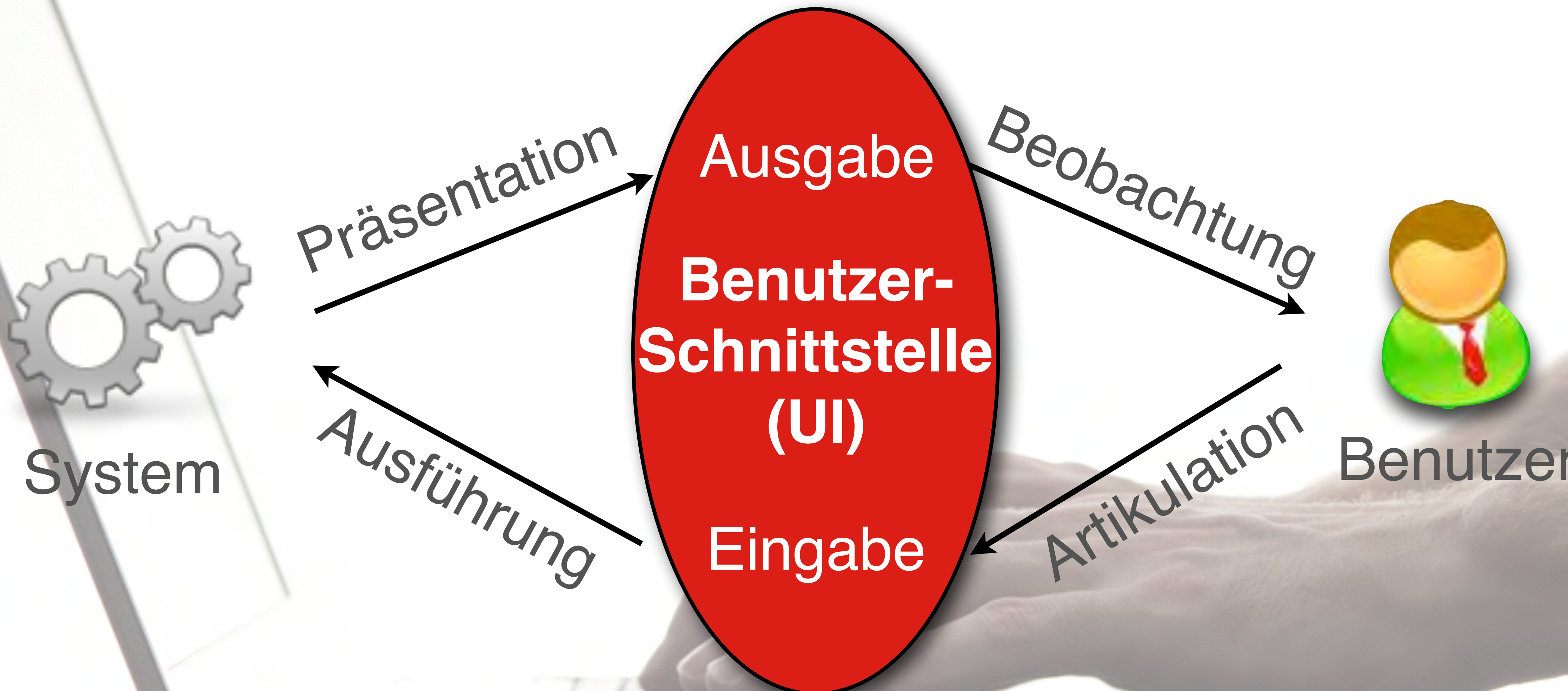
1. Hardware ➲ 2. Software ➲ 3. Benutzer

Bildnachweis: www.stockarch.com

Benutzerschnittstelle

- Interaktion mit digitalen Welt erfolgt über (**multimediale**) **Benutzerschnittstelle** (engl. ***User Interface; kurz UI***)
- Beispiele:
  - **Ausgabegeräte**, z.B. Monitor, Lautsprecher, haptische Geräte ...
  - **Eingabegeräte**, z.B. Maus, Tastatur, Sprache, Augentracker...

Interaktionsframework



Airbus A380-841

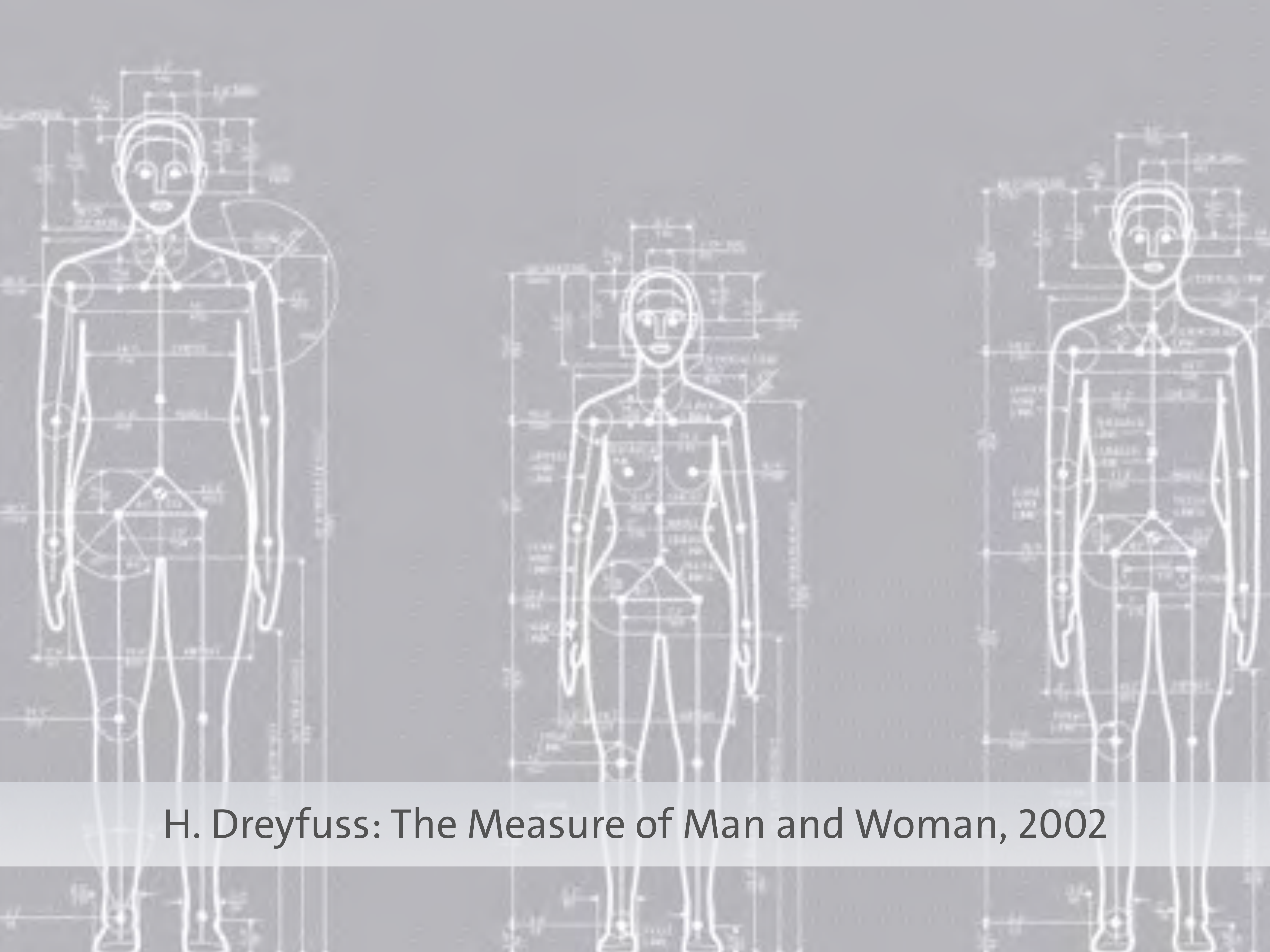
*“The domain of concern to us [...] is how **humans** interact with **computers**. A **scientific psychology** should help us in arranging the **interface** so it is easy, efficient and error free - even enjoyable.“*

S. Card, T. Moran, A. Newell: Model Human Processor, 1983

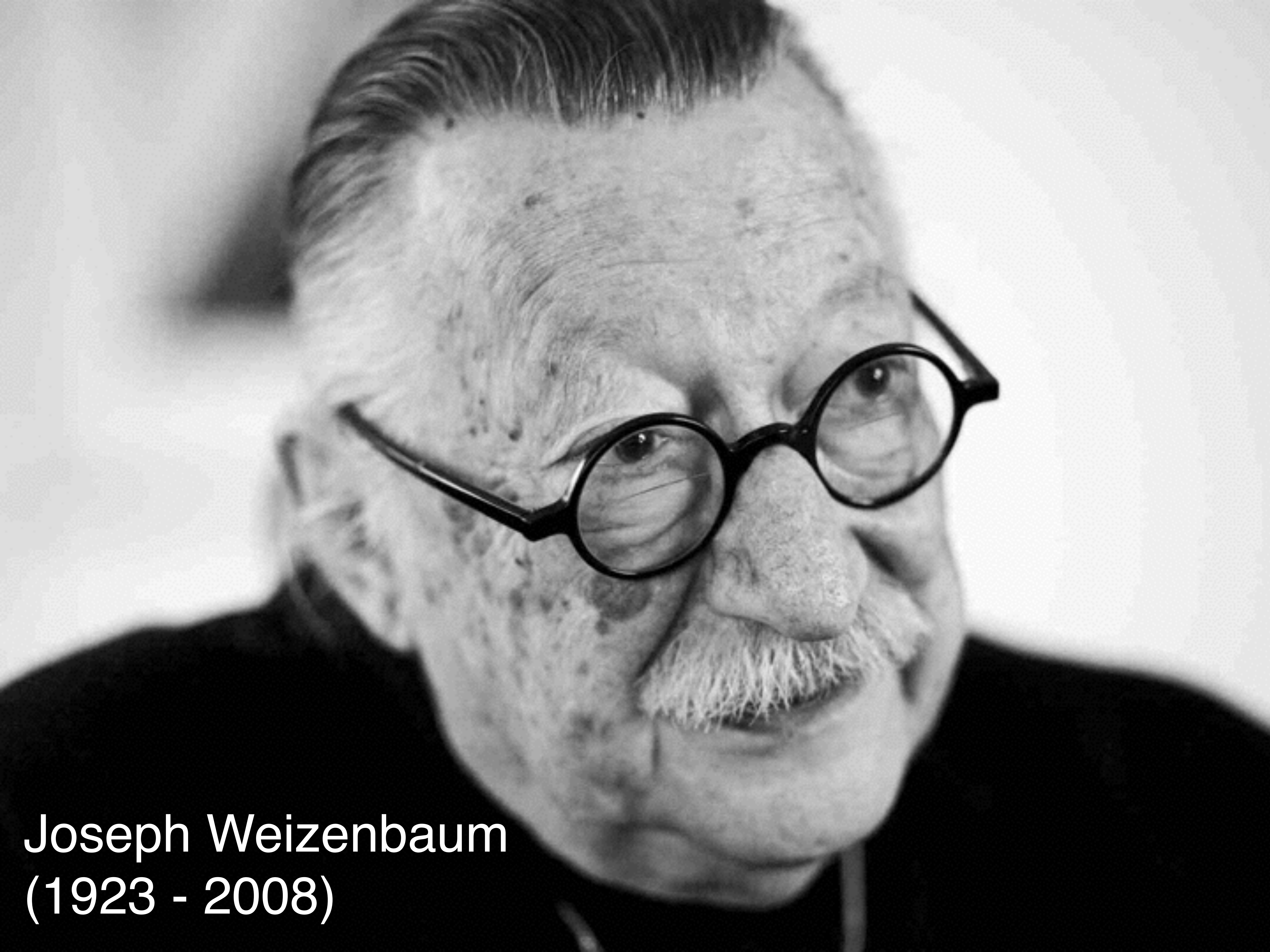
Sichten auf Mensch

- **Perzeptuell**: Informationen wahrnehmen durch sehen, hören, berühren usw.
- **Konzeptionell**: Rückmeldungen des Systems verstehen und Arbeitsschritte planen
- **Physisch**: Knöpfe drücken, Maus bewegen usw.

Leonardo da Vinci: Homo Vitruvianus, ca. 1490



H. Dreyfuss: The Measure of Man and Woman, 2002



Joseph Weizenbaum
(1923 - 2008)

```
                    Eliza
      Original by Creative Computing
           BB remake by WolRon

HI, I'M ELIZA.  WHAT'S YOUR PROBLEM?
I don't have any friends.
DON'T YOU REALLY HAVE ANY FRIENDS.
and the friends that I do have, aren't very nice.
WHY DO YOU BRING UP THE TOPIC OF FRIENDS?
some of them call me names
NAMES DON'T INTEREST ME.
and the names hurt my feelings
I DON'T CARE ABOUT NAMES-- PLEASE GO ON.
i often dream about them teasing me
WHAT DOES THAT DREAM SUGGEST TO YOU?
that I don't stick up for myself
WHY DON'T YOU STICK UP FOR MYSELF
I dont stick up for ME, not YOU.
DO YOU WISH TO BE ABLE TO STICK UP FOR ME, NOT YOU.
what?
WHY DO YOU ASK?
because you're the psychoanalyzer!
WHAT MAKES YOU THINK I AM THE PSYCHOANALYZER
```

```
;Eliza
;written in Blitz3D
;by WolRon

Graphics 640, 480, 0, 0
Delay 2000
Flip
Locate 0, 0
Text 200, 0, "Eliza", True
Text 200, 12, "Original by Creative Computing", True
Text 200, 24, "BB remake by WolRon", True
;Initializing
Dim  Sarray(38), rarray(38), narray(38)
n1 = 38
n2 = 14
n3 = 117
Restore ReplyData
For x = 1 To n1
      Read Sarray(x), L
      rarray(x) = Sarray(x)
      narray(x) = Sarray(x) + L - 1
Next
Locate 0, 50
Print "HI, I'M ELIZA.  WHAT'S YOUR PROBLEM?"

;User Input section
.userinputsection
i$ = Input$()
If i$ = ""
      Print "SORRY, BUT I DIDN'T UNDERSTAND YOU."
      Goto userinputsection
EndIf
i$ = " " + i$ + " "
i$ = Upper(i$)

;Get rid of apostrophes; Check for Shut up
For l = 1 To Len(i$)
      If Mid$(i$, l, 1)="'" Then i$ = Left$(i$, l - 1) + Right$(i$, Len(i$) - l)
      If l + 7 <= Len(i$)
            If Mid$(i$, l, 7) = "SHUT UP"
                  Print "SHUTTING UP..."
                  Delay 1000
```

Informavore

soziales Wesen

Was ist der Mensch?

- **Physikalische Sicht**: Körper und Ergonomie (engl. *Human Factors*)
- **Informationsverarbeiter**: Kognitive Psychologie
- **Verarbeiter natürlicher Sprache** und **Kommunikation**: Linguistik
- **Informavore** und **soziales Wesen**: Soziologie, Anthropologie, Informations- und Kommunikationswissenschaft
- ...

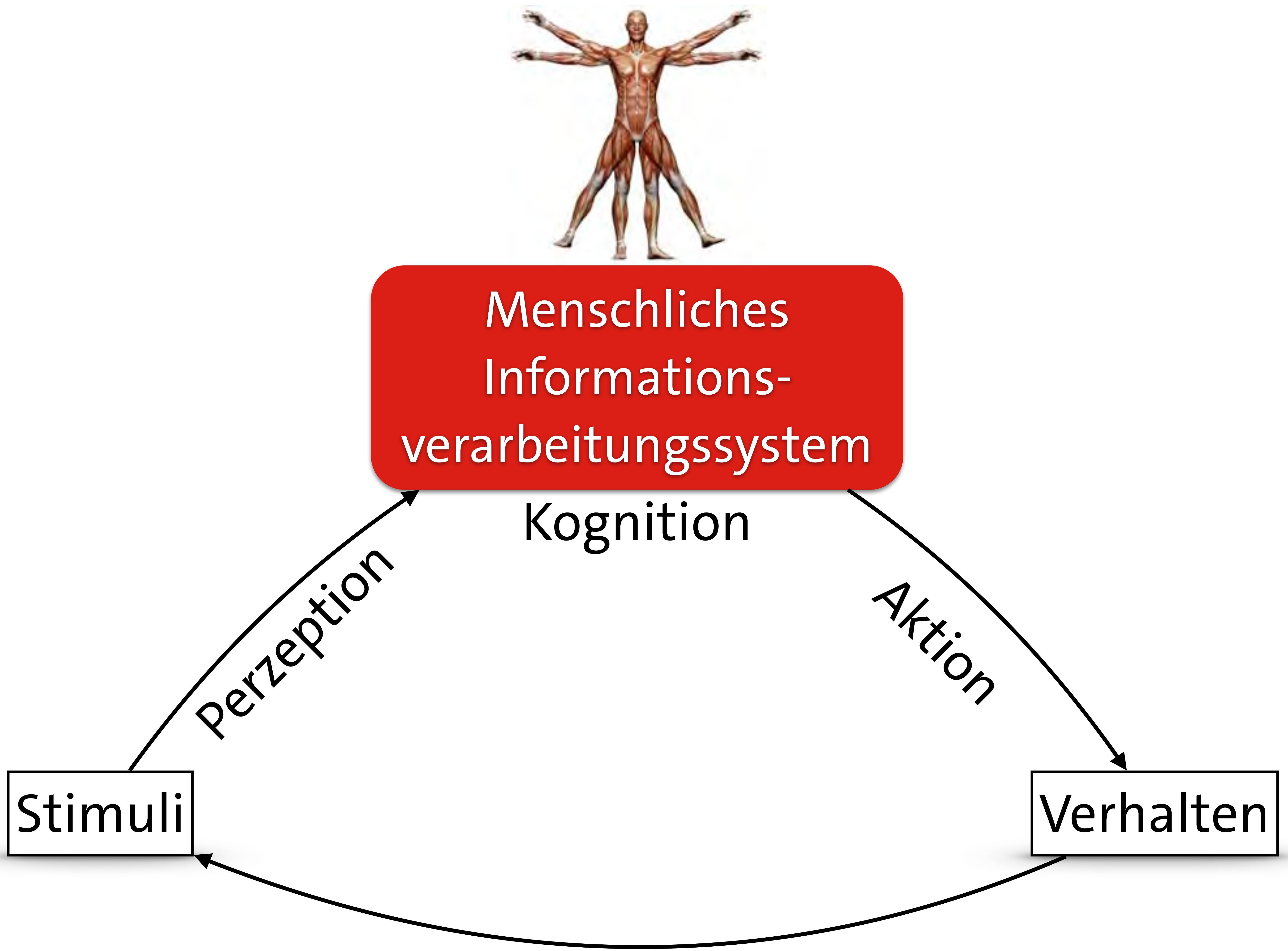
Inhalt

- Benutzerschnittstellen
- Sichten auf Mensch
- Informationspsychologie
- Modelle der menschlichen Informationsverarbeitung
- Präattentive vs. attentive Merkmale

Mensch-Computer-Interaktion

Menschliche Informationsverarbeitung

Informationspsychologie


Menschliches Informations-verarbeitungssystem
Kognition
Perzeption
Aktion
Stimuli
Verhalten

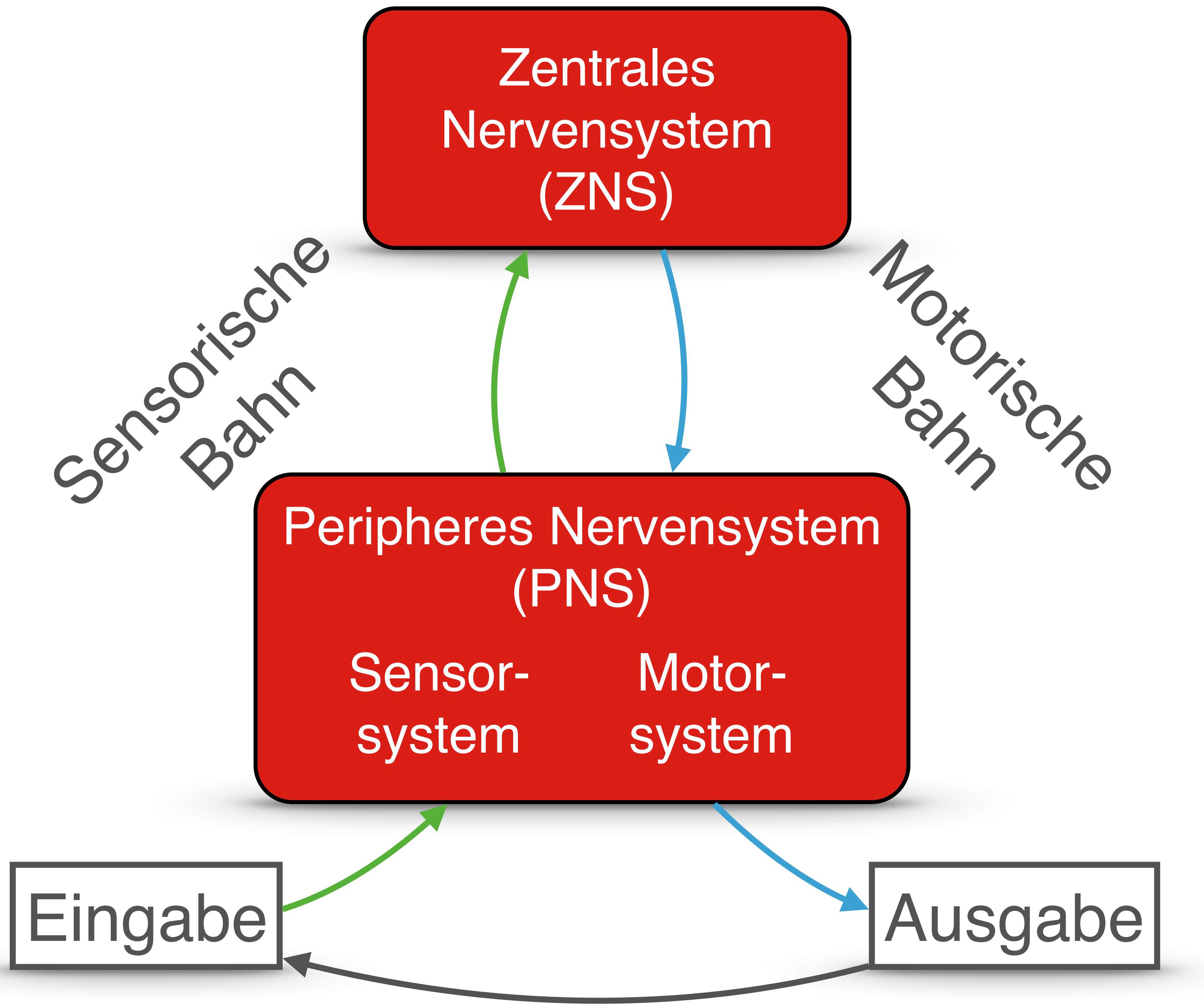
Informationsverarbeitung

Mensch I/O

	Perzeption	Kognition	Aktion	
Reize / Stimuli →	Rezeptoren →	Zentrales Nervensystem →	Motorische Neuronen →	Motor-aktionen

Informationsverarbeitung

Mensch I/O



S. Beckhaus, E. Kruijff: Unconventional Human Computer Interfaces, ACM SICGGRAPH Course 2004

Informationsverarbeitung

- Mensch ist aktiv **Informationen suchendes**, **aufnehmendes** und **verarbeitendes** System

1. **Informationsaufnahme** (engl. ***Perception***)
2. **Informationstransformation** und -**speicherung** (engl. ***Cognition***)
3. **Motorische Aktionen** (engl. ***Motor Action***)

Informationsaufnahme

- Informationen werden durch unterschiedliche **sensorische Modalitäten** empfangen
- Beispiele:
  - visueller Kanal
  - auditiver Kanal
  - haptischer Kanal
  - ...

Sensorische Modalitäten

Wahrnehmungssystem	Organ	Empfindung
visuell	Auge	Farbe, Helligkeit
auditiv	Ohr	Tonhöhe, Lautstärke
haptisch	Haut, Muskelspindel	Vibration, Druck, Stellung
thermisch	Haut	Wärme/Kälte
olfaktorisch	Nase	Geruch
gustatorisch	Mund	Geschmack
...	...	...

Speicherung

- Informationen können gespeichert werden im

1. **sensorischen Speicher (Ultrakurzzeitgedächtnis)**
2. **Arbeitsgedächtnis (Kurzzeitgedächtnis)**
3. **Langzeitgedächtnis**

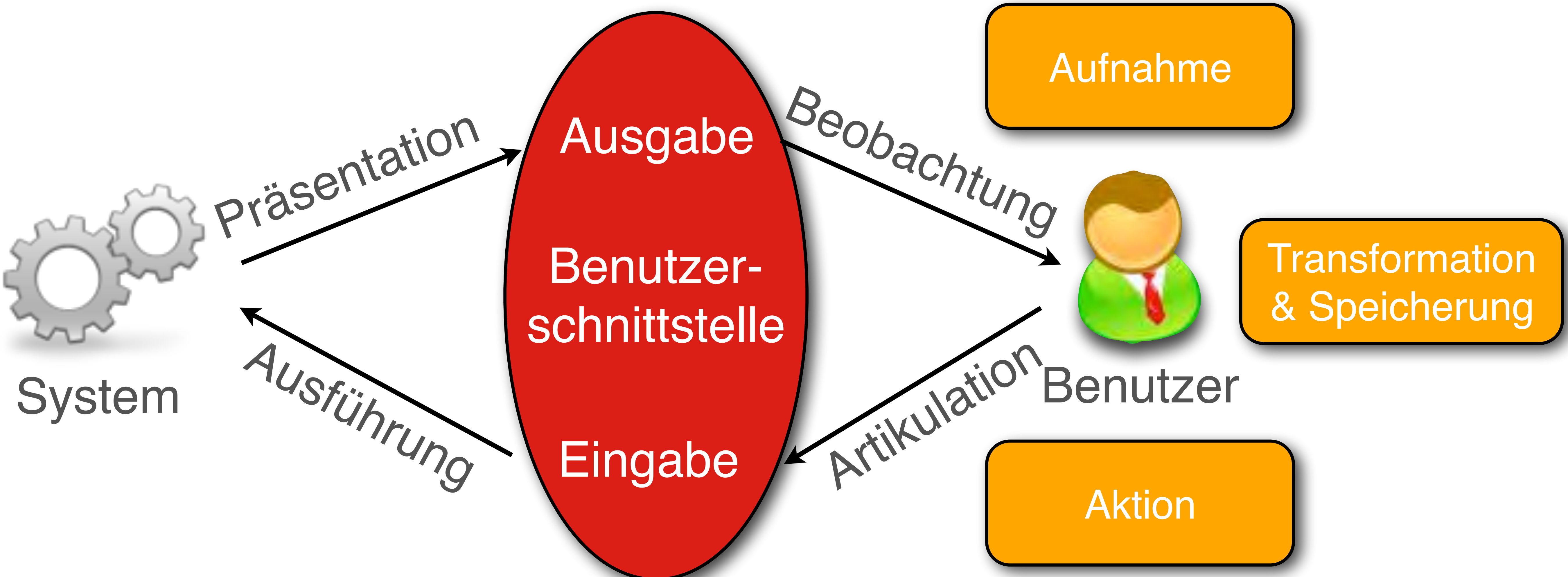
Transformation

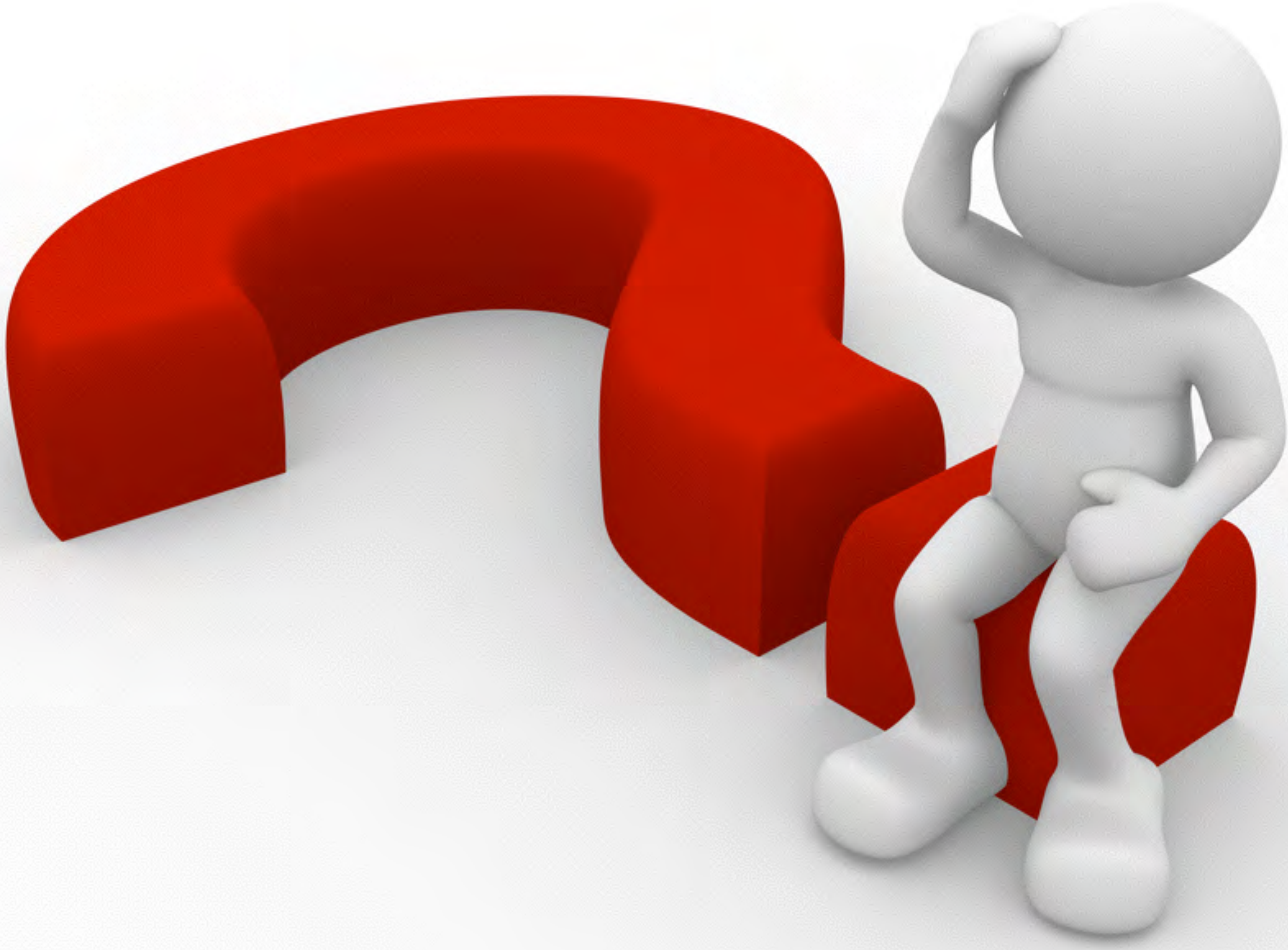
- Information können transformiert werden durch
  - logisches Denken
  - Problemlösen
  - Aneignung von Fähigkeiten
  - ...

Aktion

- Nach Informationsverarbeitung kann Mensch Aktionen mit **Endeffektoren** auslösen
  - Hände, Arme, Finger, Beine
  - Gesicht, Augen
  - Stimmbänder
  - Körperhaltung, -position
  - ...

Interaktionsframework





Mensch-Computer-Interaktion

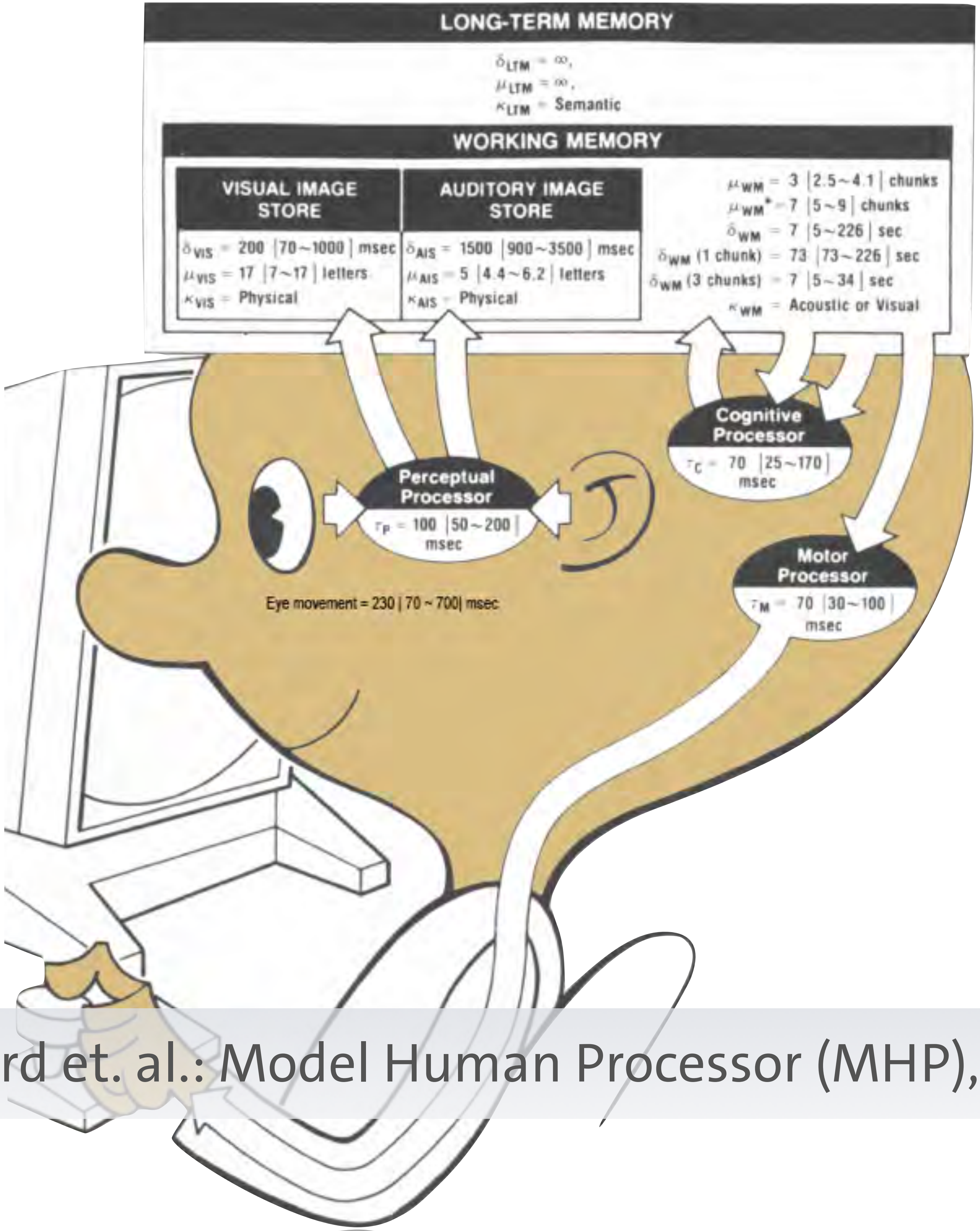
Menschliche Informationsverarbeitung

Modelle und Architekturen

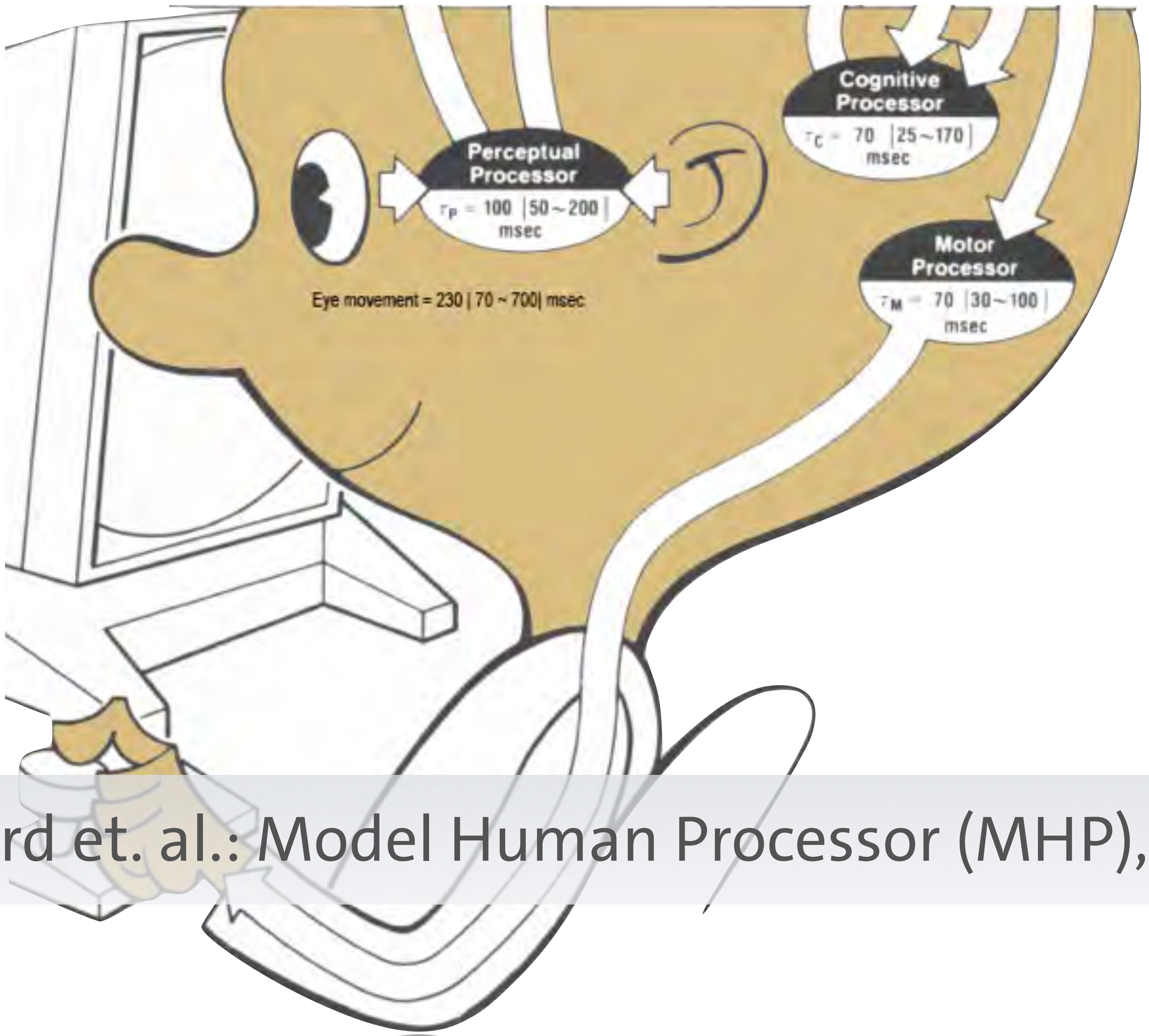
Model Human Processor

- **Model menschlicher Informations-verarbeitung** aus gemeinsamer Sicht der (Kognitions-)psychologie und Informatik
- Idee ist **Simplifizierung** des **Menschen** zur einfacheren Analyse und Studium der Schnittstelle zwischen Mensch und System

S. Card, T. Moran, A. Newell: Model Human Processor, 1983



S. Card et. al.: Model Human Processor (MHP), 1983



S. Card et. al.: Model Human Processor (MHP), 1983

Model Human Processor

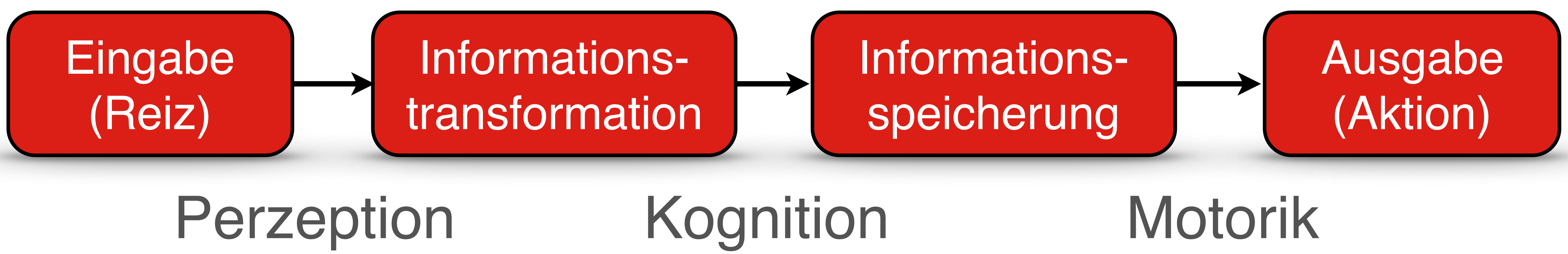
- **Model menschlicher Informations-verarbeitung** besteht aus 3 Subsystemen

1. **Perzeptuelles (Eingabe-)system**, welches Stimuli aufnimmt
2. **Kognitives System** zur rationalen Verarbeitung der Information
3. **Motor (Ausgabe-)system** zur Kontrolle von Aktionen

S. Card, T. Moran, A. Newell: Model Human Processor, 1983

Model Human Processor

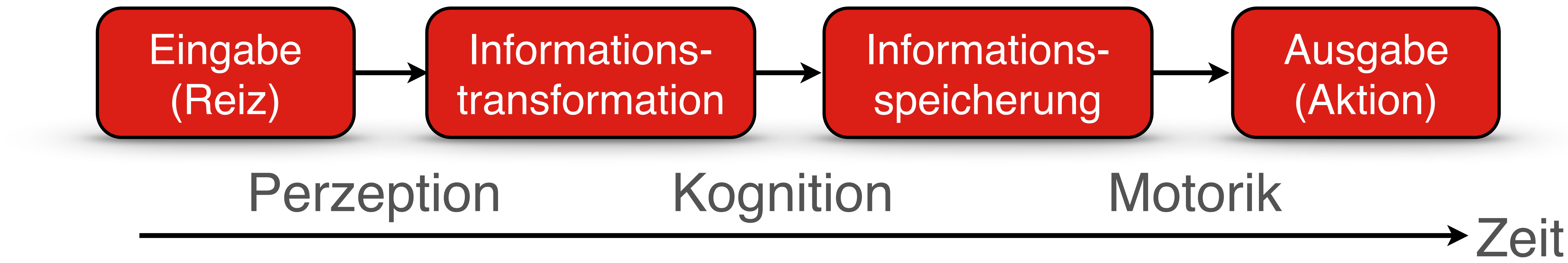
- Jedes Subsystem hat eigenen **Prozessor** und **Speicher**
- Analogie zu Informationssystem



S. Card, T. Moran, A. Newell: Model Human Processor, 1983

Model Human Processor

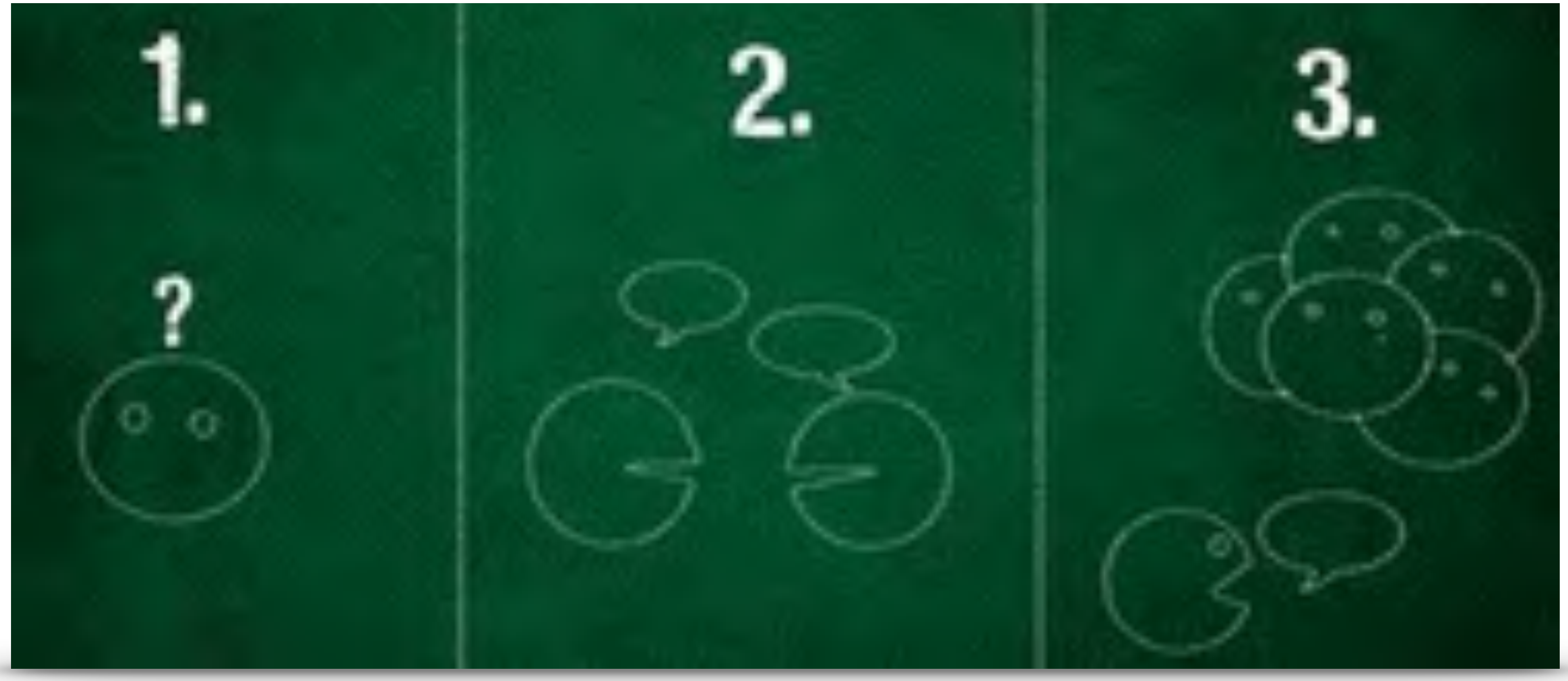
Laufzeiten



- Alle Prozessoren benötigen empirische ermittelte **Laufzeiten**:
  - **perzeptueller Prozessor**: τ_P=100 [50 ~ 200] ms
  - **kognitiver Prozessor**: τ_C=100 [25 ~ 170] ms
  - **motorischer Prozessor**: τ_M=100 [70 ~ 360] ms

S. Card, T. Moran, A. Newell: Model Human Processor, 1983

Think! Pair! Share!



Wie viele **Bilder pro Sekunde** sollten BetrachterIn gezeigt werden, damit Illusion einer flüssigen Bewegung entsteht?

ARSnova

Session-ID: 71 67 90 24

Wie viele **Bilder pro Sekunde** sollten BetrachterIn gezeigt werden, damit Illusion einer flüssigen Bewegung entsteht?

- A 10
- C 20
- B 40
- D 50

Model Human Processor
Beispiel: Bilder pro Sekunde

- Für **Perzeptuellen Prozessor** gilt:
  $\tau_P = 100\ [50 \sim 200]\ \text{ms} = 0.1\ [0.05 \sim 0.2]\text{s}$
- Zur Wahrnehmung von Bewegungen sollte daher Anzahl der Bilder pro Sekunde (engl. ***Frames per Second,*** kurz ***fps***) $> 1 / \tau_P$ sein, d.h.

$$\text{fps} > 1 / \tau_P = 1 / 0.05 = 20$$

S. Card, T. Moran, A. Newell: Model Human Processor, 1983

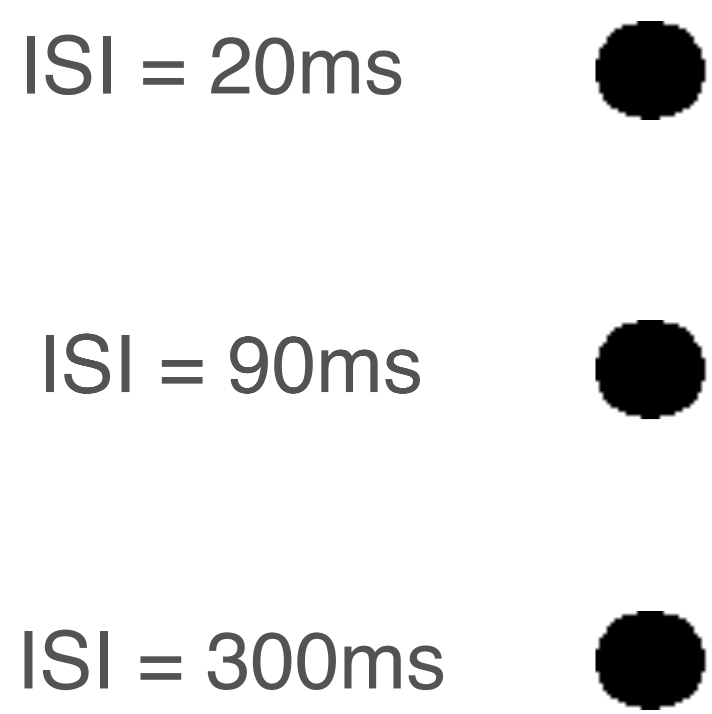
Bewegte Bilder
Beispiele

Format	Bemerkung	Bilder pro Sekunde
Super-8-Film	veraltet	18
Kinofilm (35-mm-Film)	weltweit	24
Fernsehen (CCIR-B/G)	Europa	25
Fernsehen (CCIR M)	USA/Japan	30

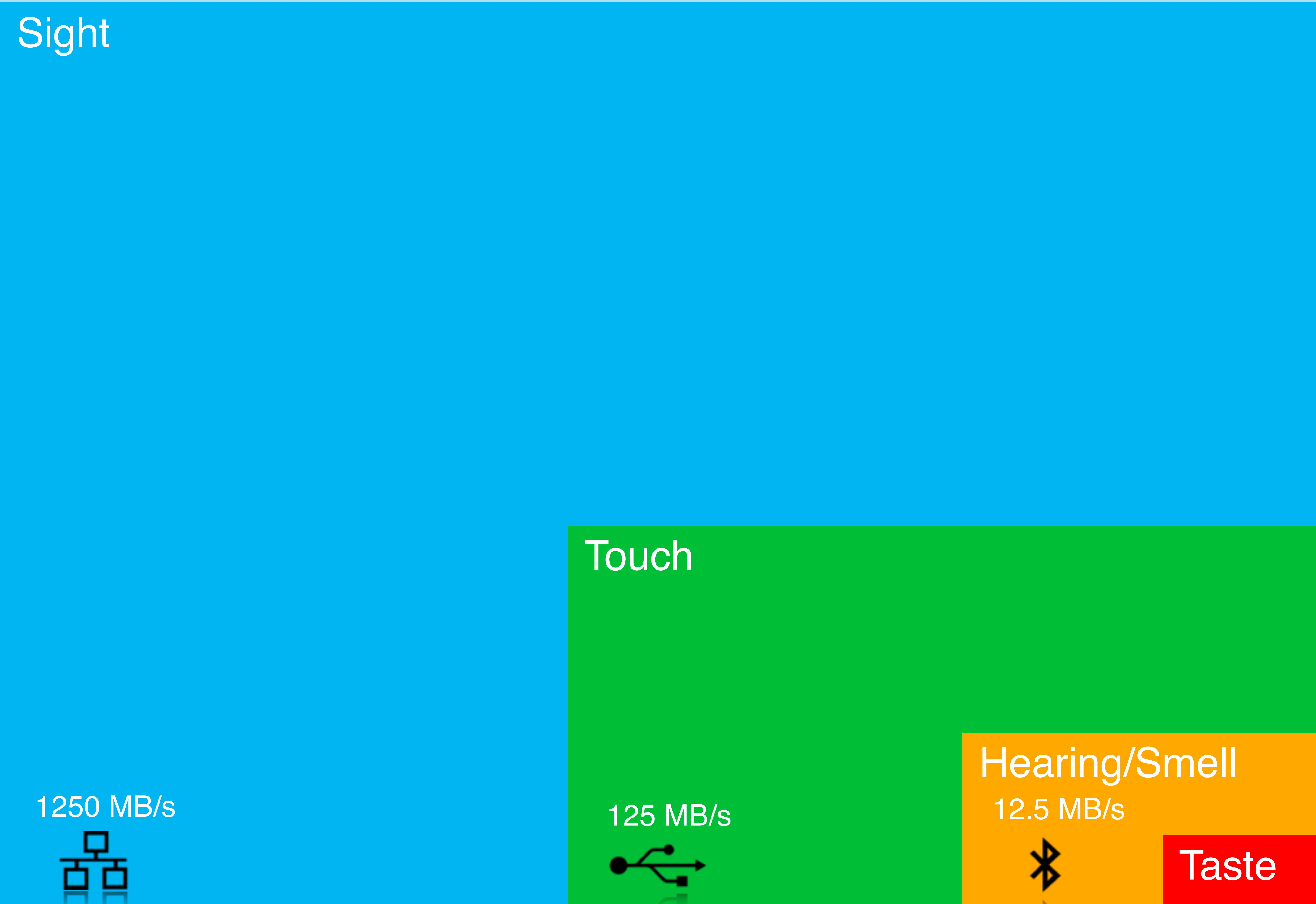
Model Human Processor

Beispiel: Scheinbewegung

- Bewegungswahrnehmung hängt vom **Inter-Stimulus Intervall** (ISI) zwischen beiden Stimuli ab

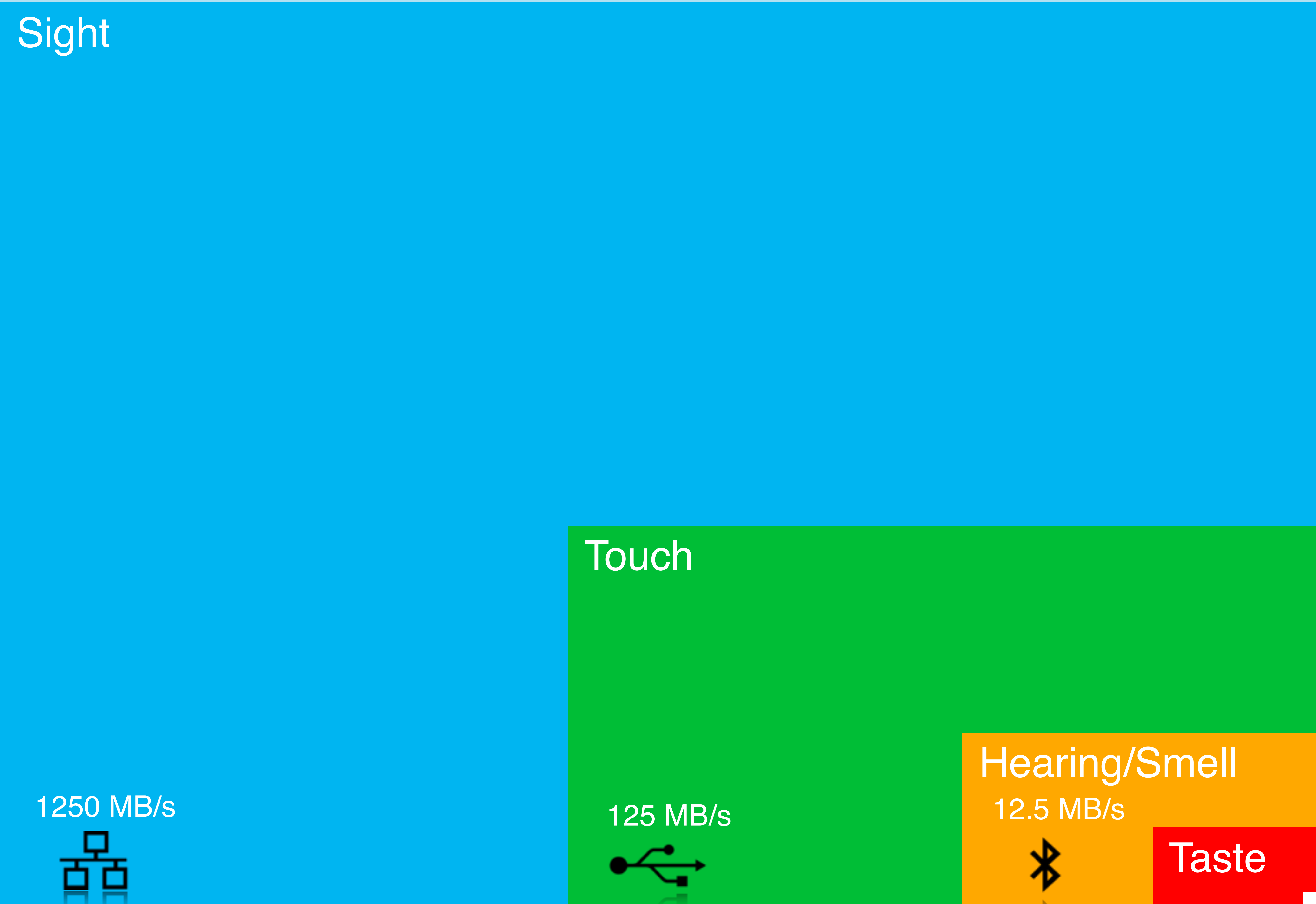


D. McCandless: The beauty of data visualization, TED Talk, 2013




WHODUNNIT?

D. McCandless: The beauty of data visualization, TED Talk, 2013



Filterung & Selektion

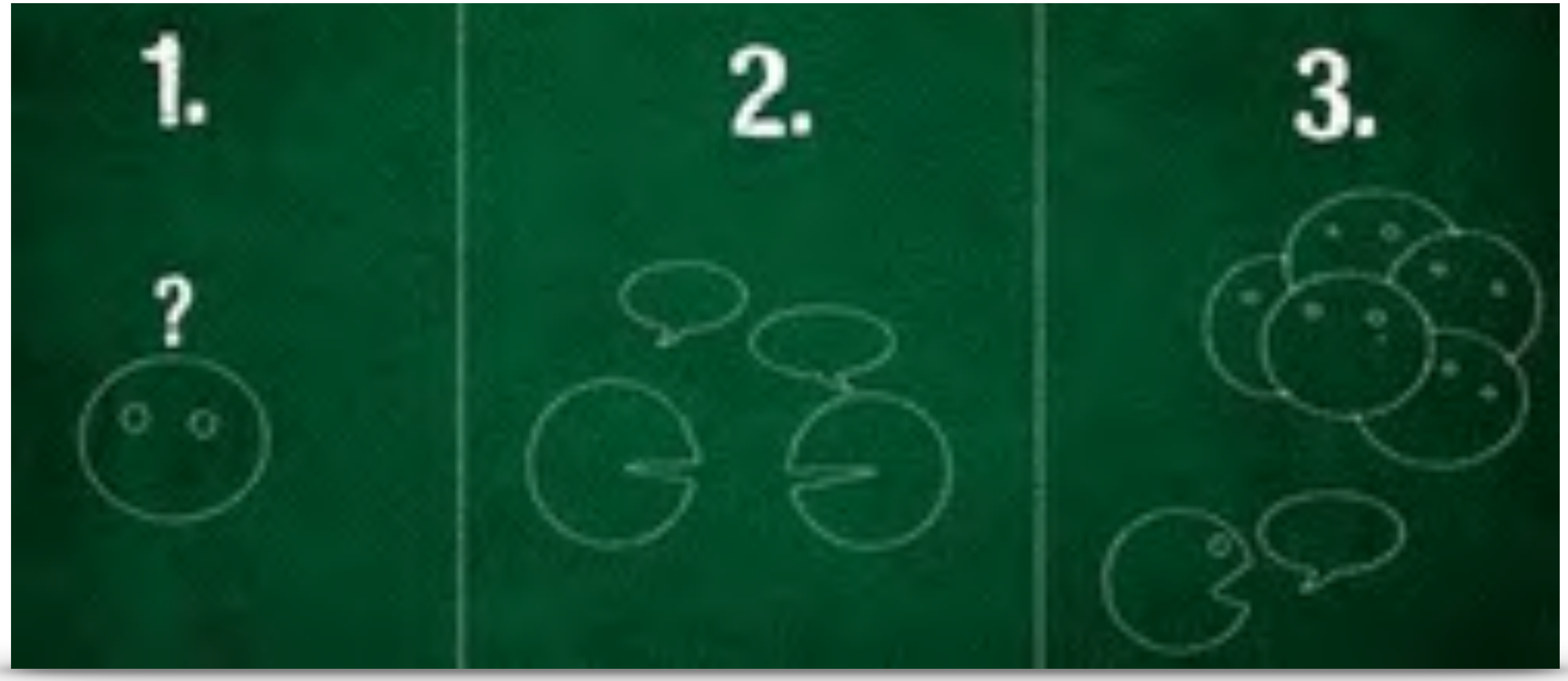
- beschränkte Speicher- und Verarbeitungskapazität hinsichtlich
  - Wahrnehmung
  - Gedächtnis
- hierbei keine festen Grenzwerte
  - **inter**- und **intra-individuelle Varianz**

Filterung & Selektion

- Gesamte „einfließende“ Informationsmenge ca. 1.5 GBits/s
  - ca. 15 MBits/s erreichen Rezeptoren
  - ca. 100 Bits/s erreichen Bewusstsein

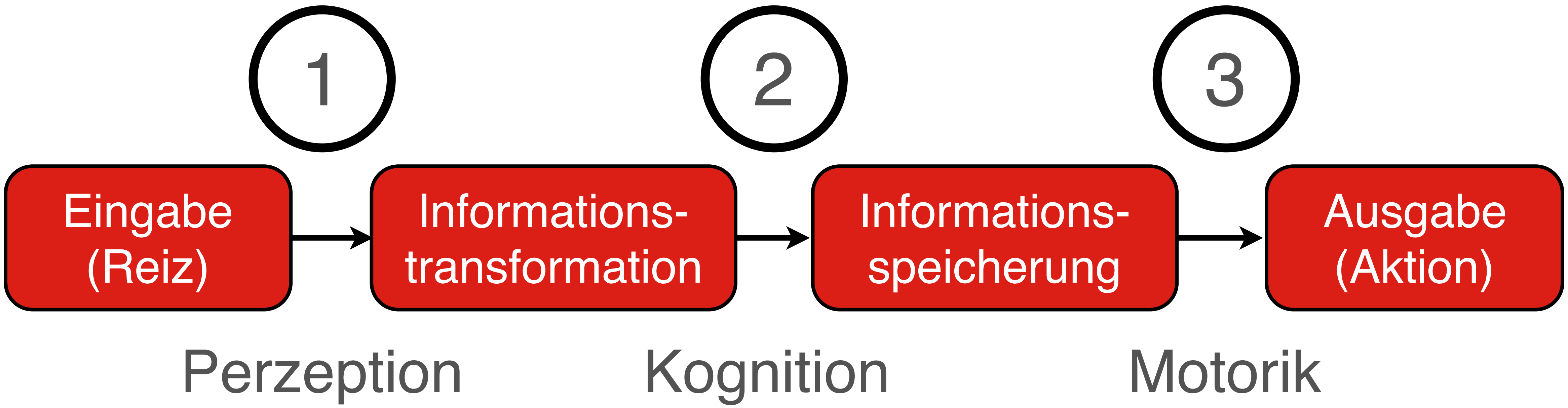
➡ **Filterung** und **Selektion** der Informationen

Think! Pair! Share!



Wo wird **gefiltert** und wo wird **selektiert**?

Session-ID: 71 67 90 24



A 1: Filterung
2: Selektion

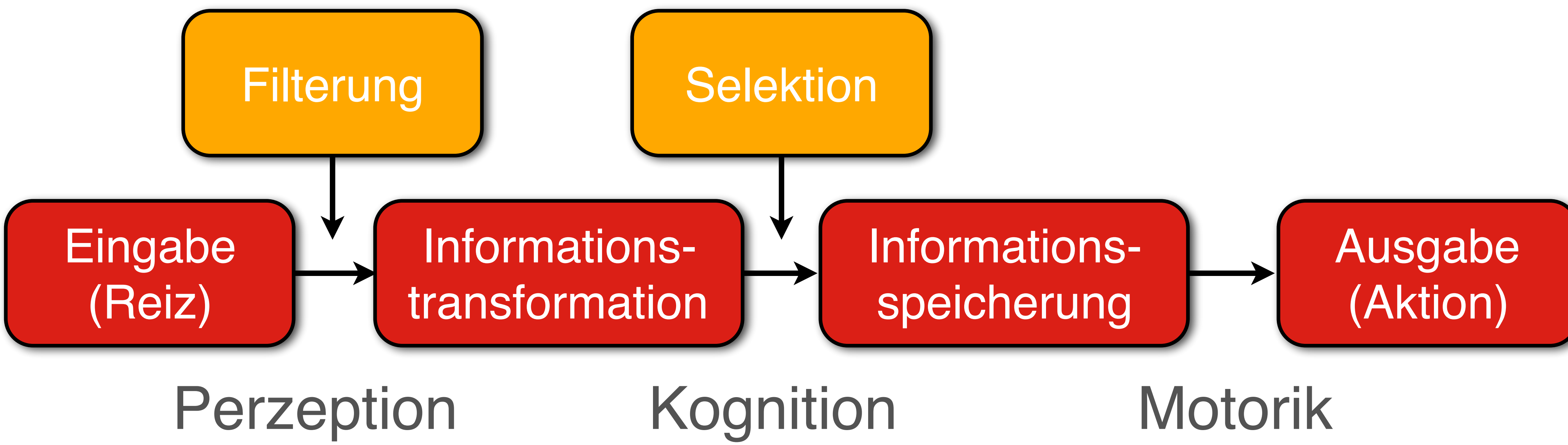
B 1: Selektion
2: Filterung

C 1: Filterung
3: Selektion

D 2: Selektion
3: Filterung

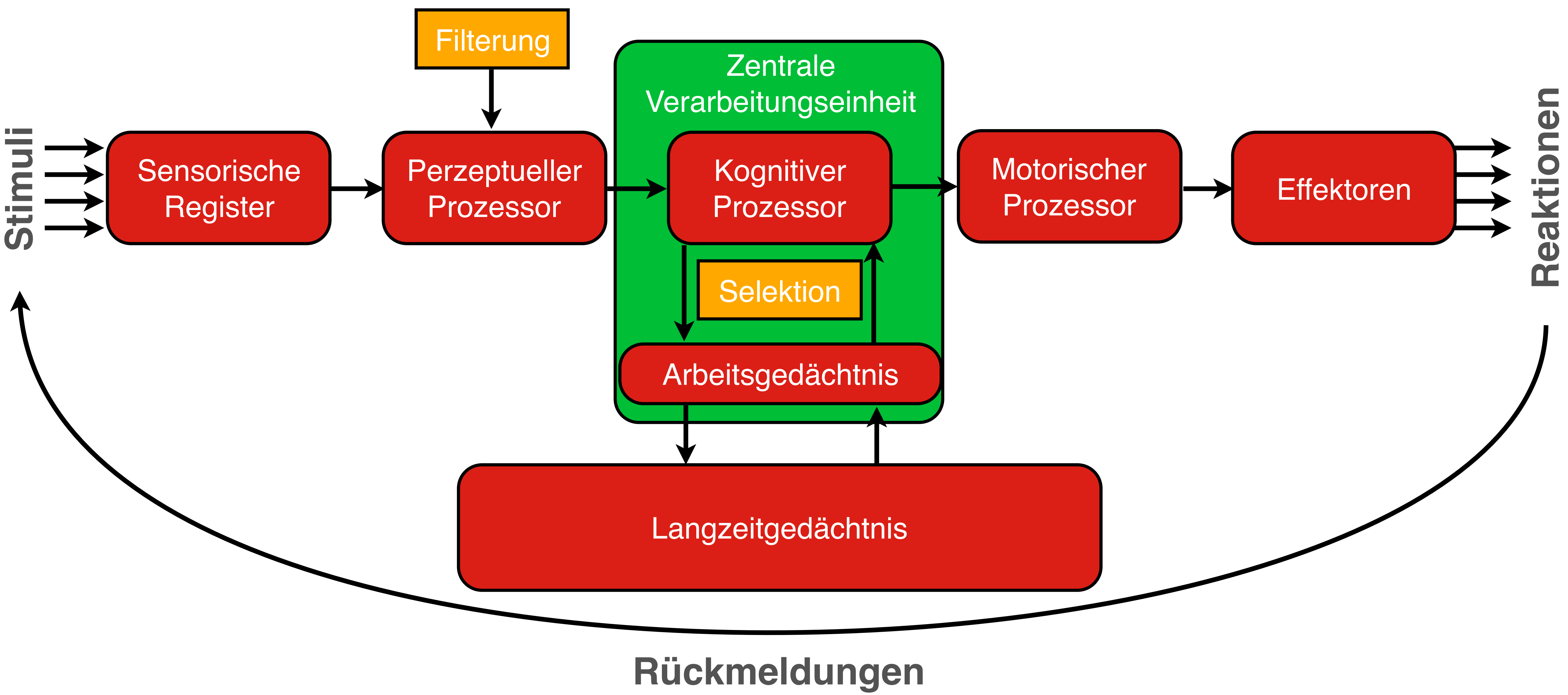
Model Human Processor

- Jedes Subsystem hat eigenen **Prozessor** und **Speicher**
- Analogie zu Informationssystem



Card, S.K; Moran, T. P; and Newell, A. The Model Human Processor: An Engineering Model of Human Performance. Handbook of Perception and Human Performance, 1986, 1–35.

Model Human Processor



Card, S.K; Moran, T. P; and Newell, A. The Model Human Processor: An Engineering Model of Human Performance. Handbook of Perception and Human Performance, 1986, 1–35.

Soar

- **Soar** (ursprünglich Akronym für ***State***, ***Operator***, ***Apply***, ***Result***) ist **kognitive Architektur**, die alle **primitiven Mechanismen** und **Strukturen** definiert, die menschlicher Kognition zugrunde liegen
- **primitiven Prinzipien** bleiben über lange Zeiträume und verschiedene Anwendungsdomänen hinweg konstant

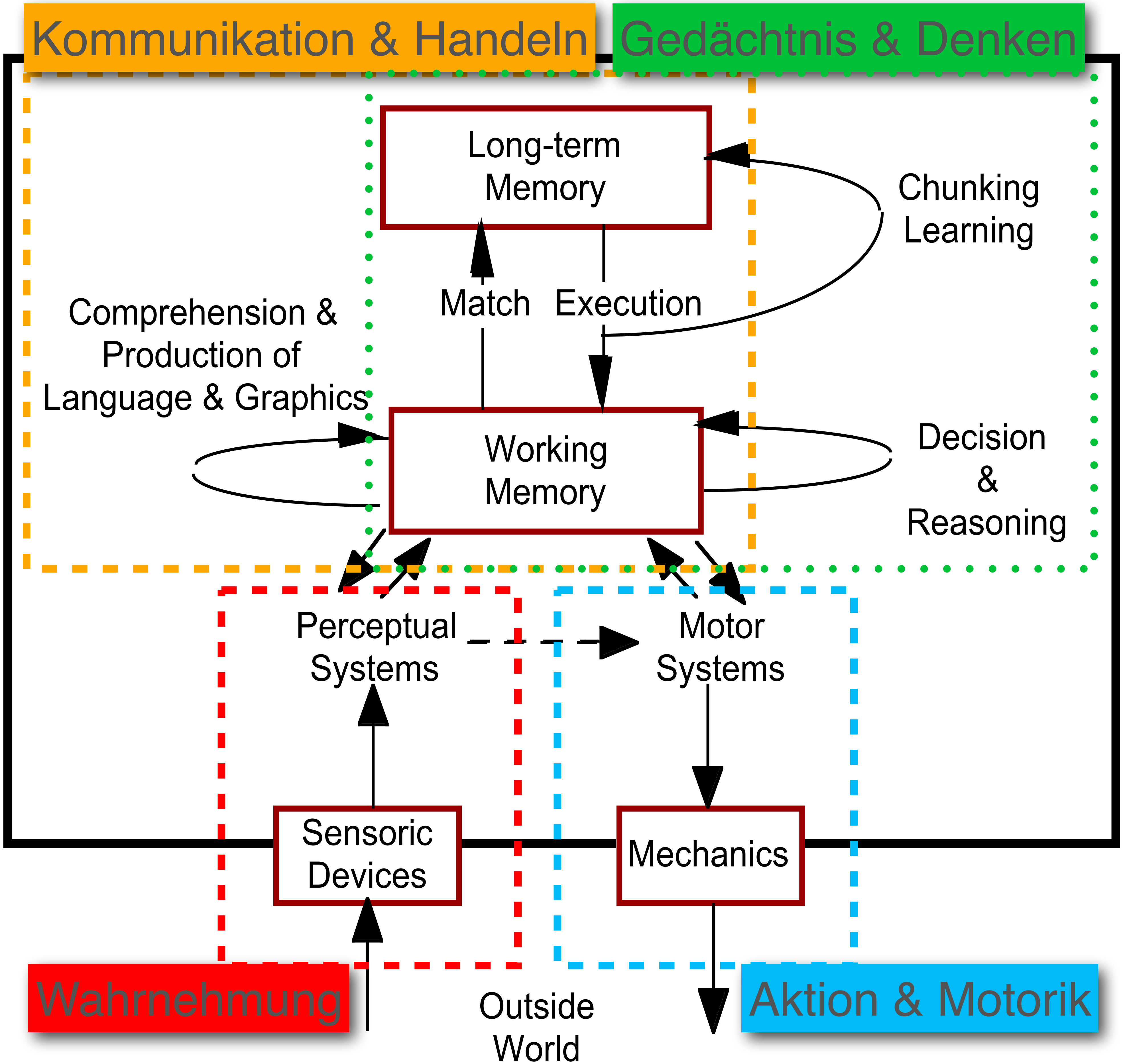
J. Laird, P. Rosenbloom, A. Newell: Soar: An Architecture for General Intelligence, Artificial Intelligence, 33, 1987

Soar

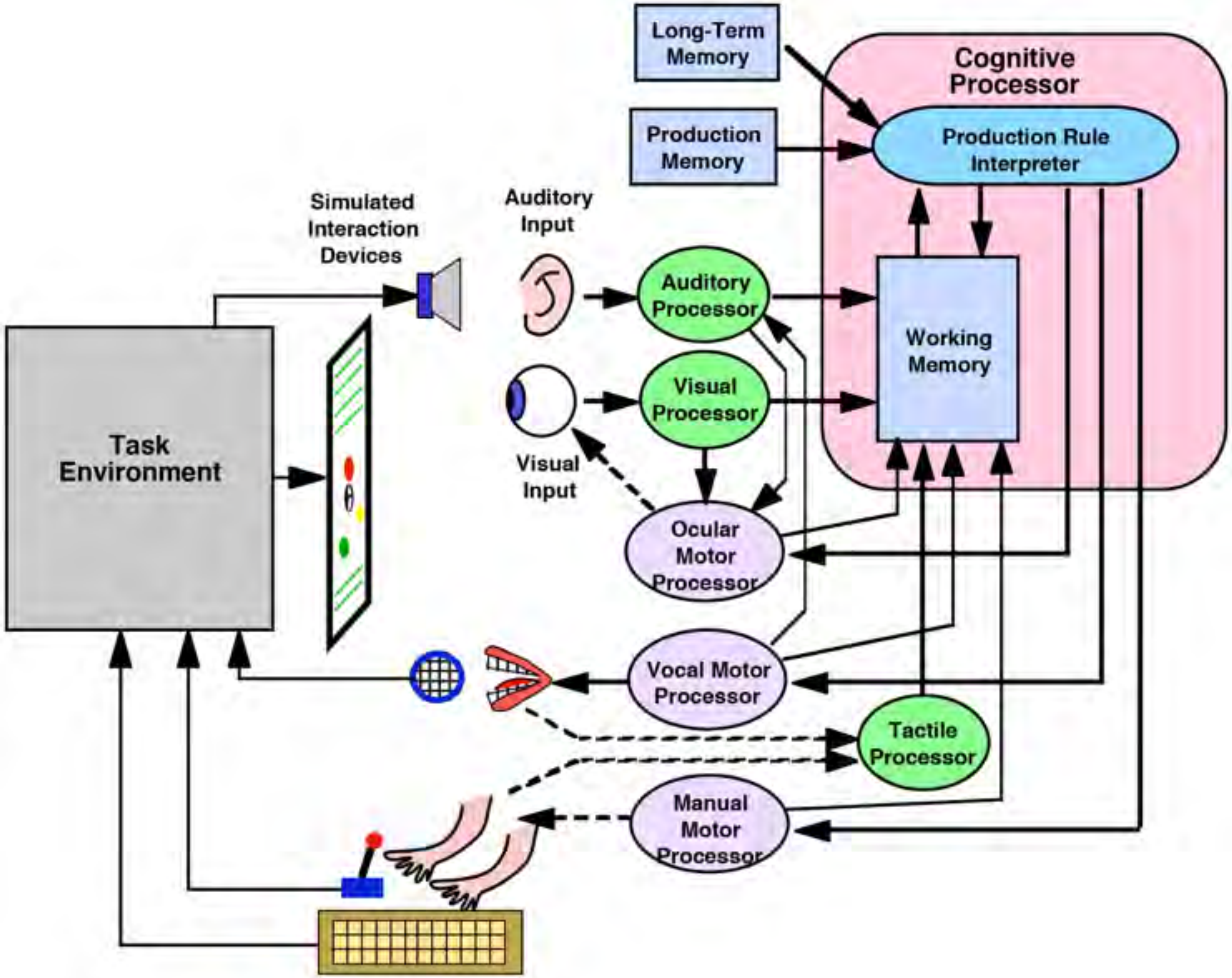
Primitive Prinzipien

1. **Problemlösen** wird als Suche in Problemräumen repräsentiert
2. **Dauerhaftes Wissen** wird durch **Produktionsregeln** repräsentiert (im **Langezeitgedächtnis**)
3. **Temporäres Wissen** wird durch Objekte repräsentiert (im **Arbeitsspeicher**)
4. **Neue Ziele** werden nur generiert, wenn Sackgassen (engl. ***Impasses***) auftreten
5. **Lernmechanismus**: *Chunking* und *Reinforcement Learning*

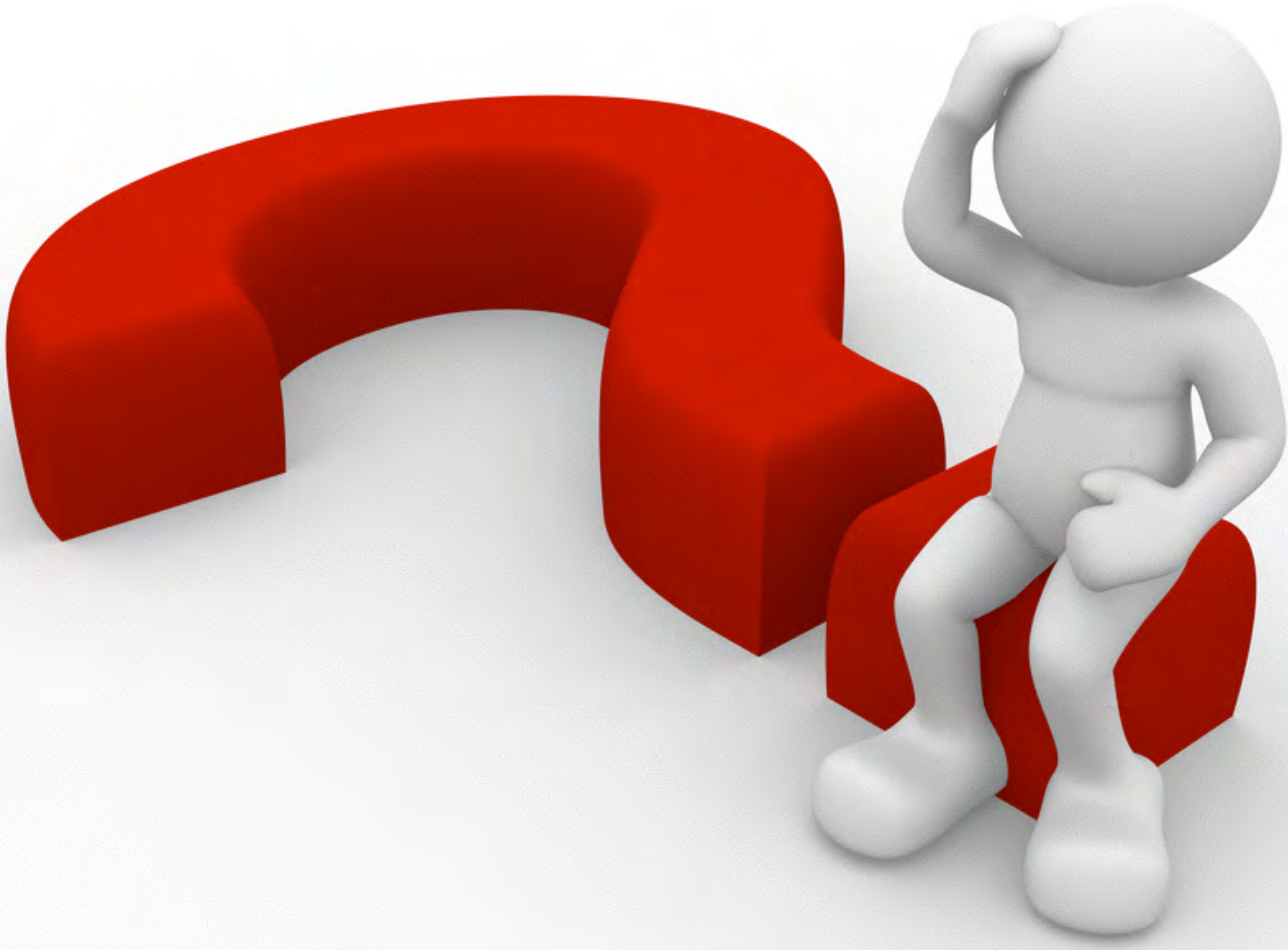
J. Laird, P. Rosenbloom, A. Newell: Soar: An Architecture for General Intelligence, Artificial Intelligence, 33, 1987



State
Operator
Apply
Result



D. E. Kieras: EPIC: A cognitive architecture, 1997



Mensch-Computer-Interaktion

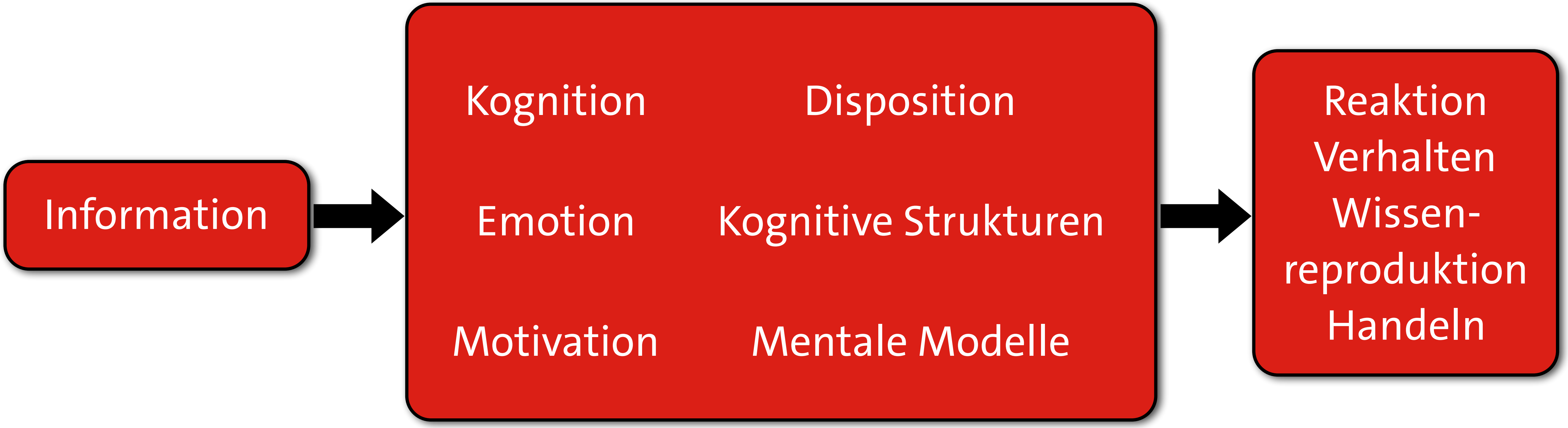
Menschliche Informationsverarbeitung

Präattentive vs. attentive Merkmale

Vereinfachung

- Limitierender Faktor bei Betrachtung von interaktiven Systemen ist i.d.R. Mensch
  - Mensch ist komplexes Wesen
  - Fähigkeiten sind limitiert und unterschiedliche ausgeprägt
  - Emotionen beeinflussen menschliche Fähigkeiten
  - ...

Vereinfachung



- Übergänge zwischen **Wahrnehmen** (**Perzeption**) und **Erkennen (Kognition)** sind fließend

Fließende Übergänge
Beispiel: Visuelle Merkmale

- Visuelle Merkmale, die in getrennten Gehirnarealen parallel verarbeitet werden:
  - Form, Farbe und Größe
  - Richtung und Krümmung
  - Geschlossenheit
  - Bewegung
  - ...

Visuelle Wahrnehmung

attentiv	präattentiv
kontrolliert	**automatisch**
benutzt zumeist Fovea	auch peripher möglich
detailliert	oberflächlich
seriell	parallel
langsam	schnell
kann unterdrückt werden	nicht zu unterdrücken
bewusstseinspflichtig	unbewusst
beansprucht Aufmerksamkeit	voraufmerksam

Visuelle Wahrnehmung

Beispiel: Attentive Aufgabe

28348682794629478392

7490709237982359812

13496198346198264959

0739087392807916212

73498398983247829347

9817349817498172324

Visuelle Wahrnehmung

Beispiel: Präattentive Aufgabe

28**3**486827946294782**3**92

74907092**3**7982**3**59812

1**3**496198**3**46198264959

07**3**9087**3**92807916212

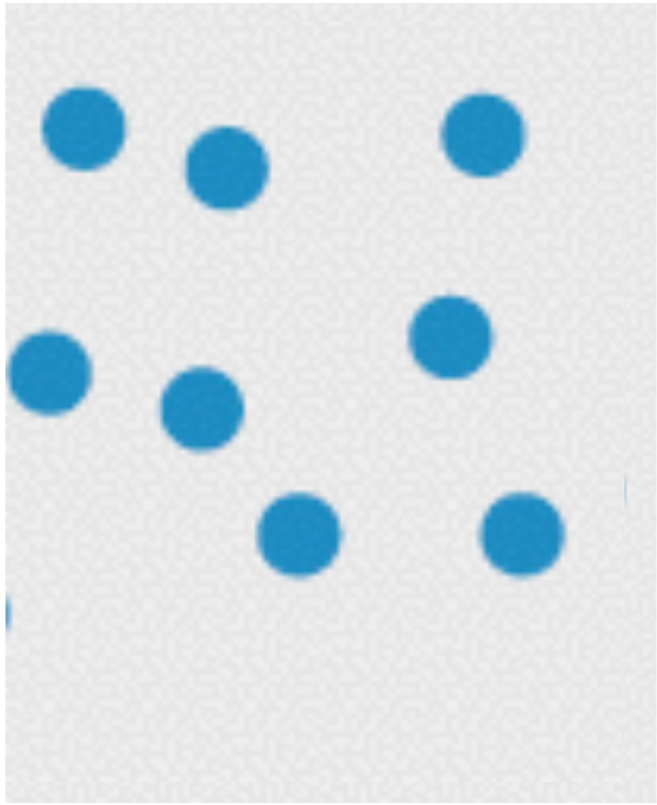
7**3**498**3**9898**3**2478293**3**47

98173498174981723**3**24

Visuelle Wahrnehmung

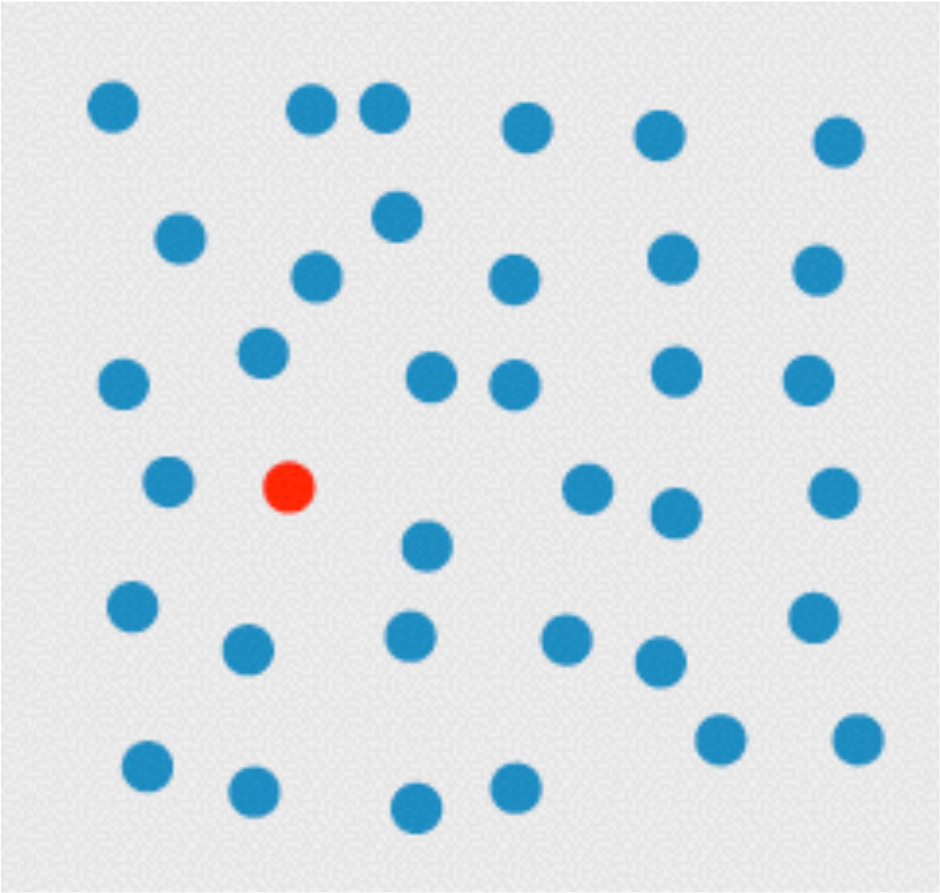
Bsp: Präattentive Eigenschaften

- Erkennen eines Zielobjekts (roter Kreis) in Gruppe von Distraktoren (blaue Kreise)

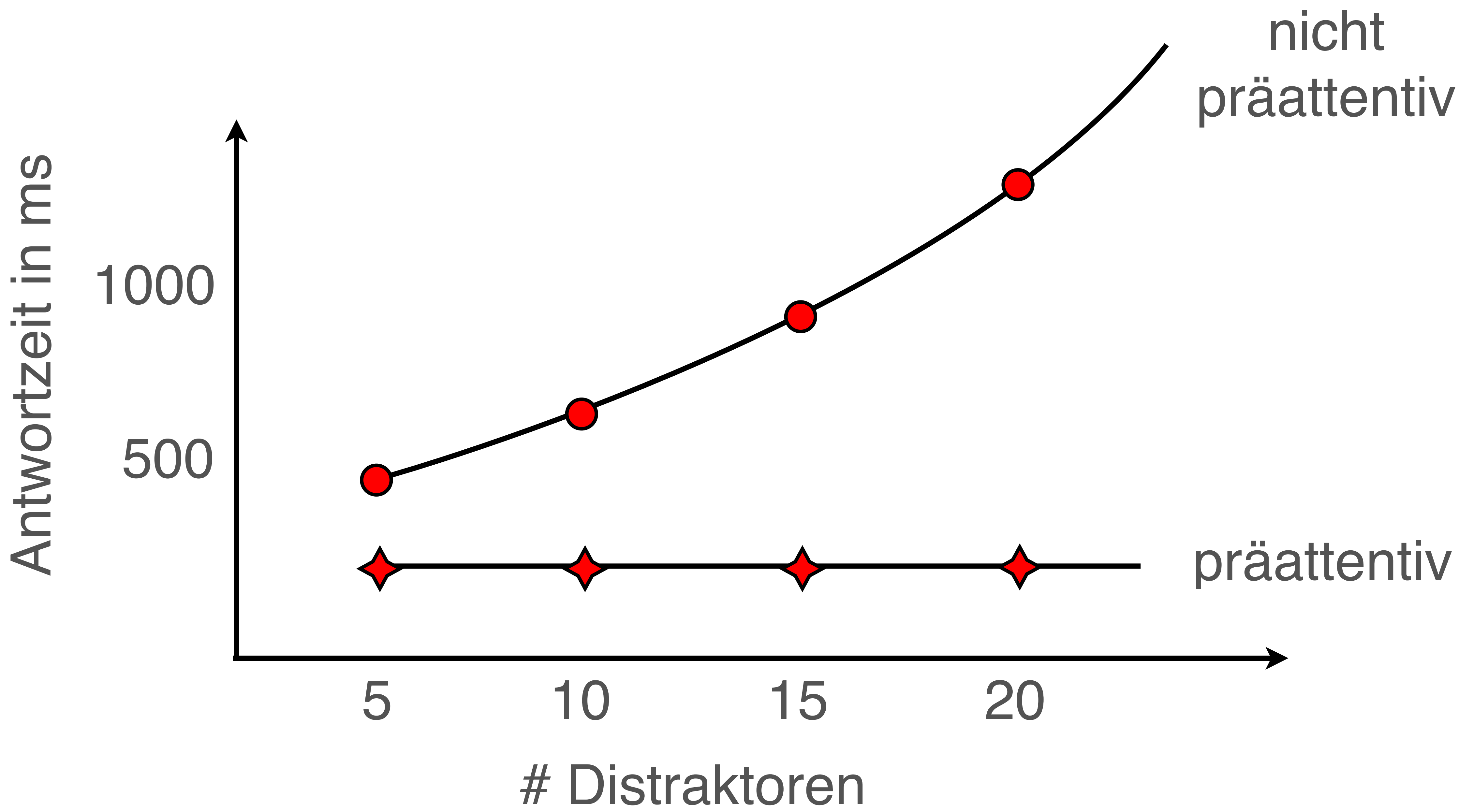


Visuelle Wahrnehmung
Bsp: Präattentive Eigenschaften

- Erkennen eines Zielobjekts (roter Kreis) in Gruppe von Distraktoren (blaue Kreise)



Präattentive Aufgabe



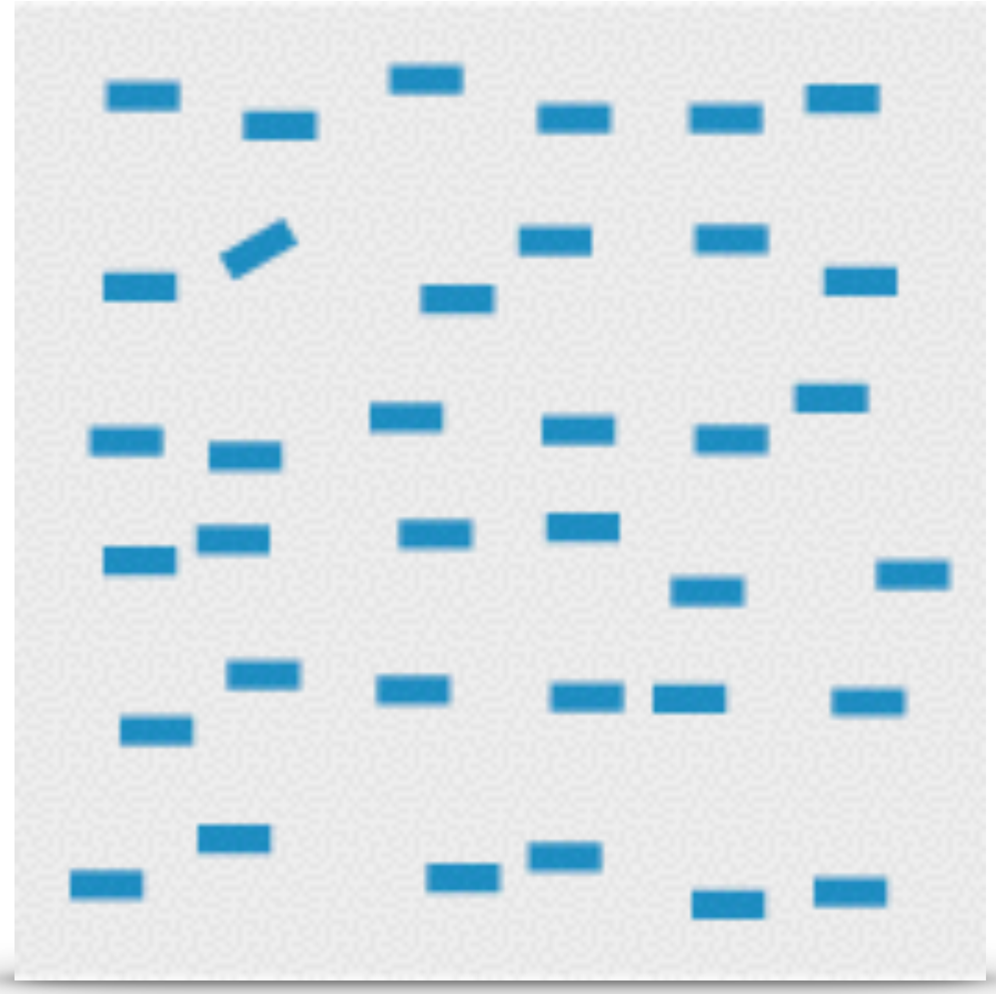
Präattentiv
Eigenschaften

- Farbe
  - Farbton
  - Intensität
- Bewegung
  - Flackern
  - Richtung

Präattentiv
Eigenschaften

- Form
  - Orientierung
  - Länge und Weite
  - Kolinearität
  - Gruppierung
  - Markierungen

Präattentiv
Bsp: Orientierung



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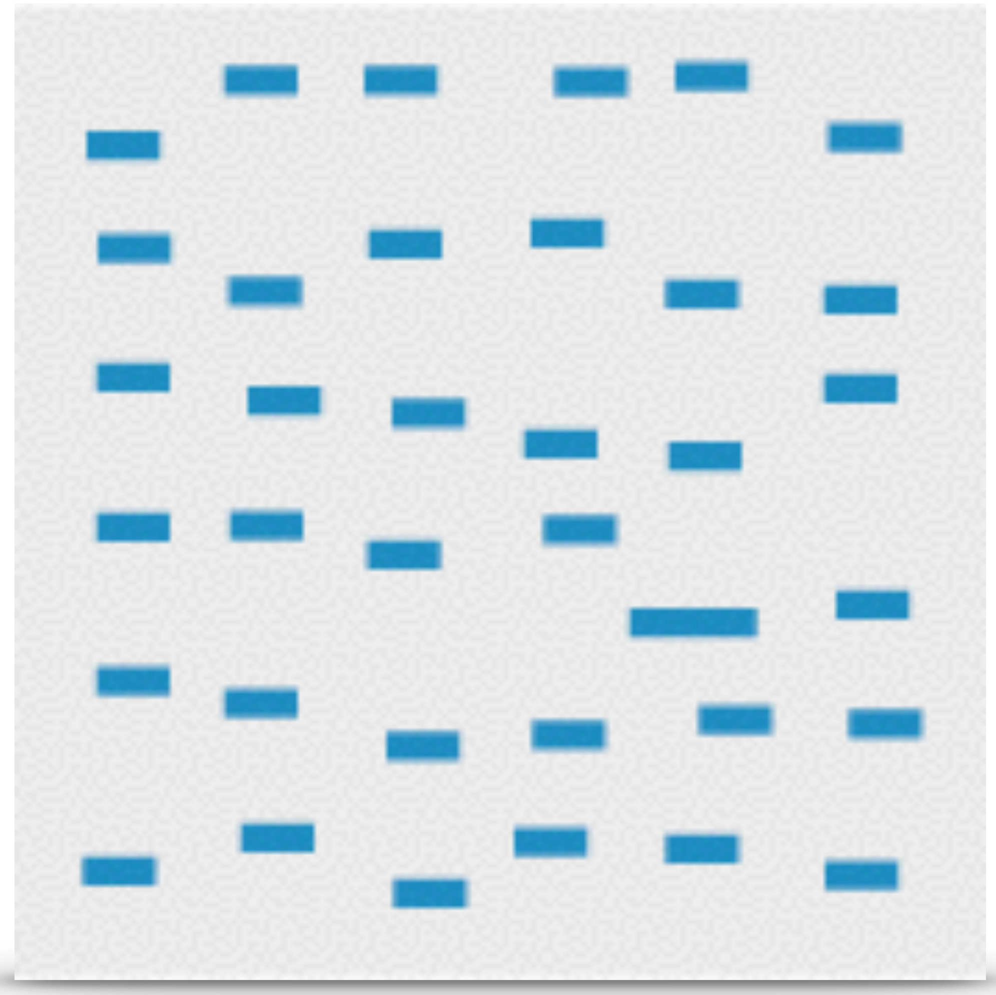
Präattentiv

Bsp: Länge/Weite



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Präattentiv

Bsp: Abschluss

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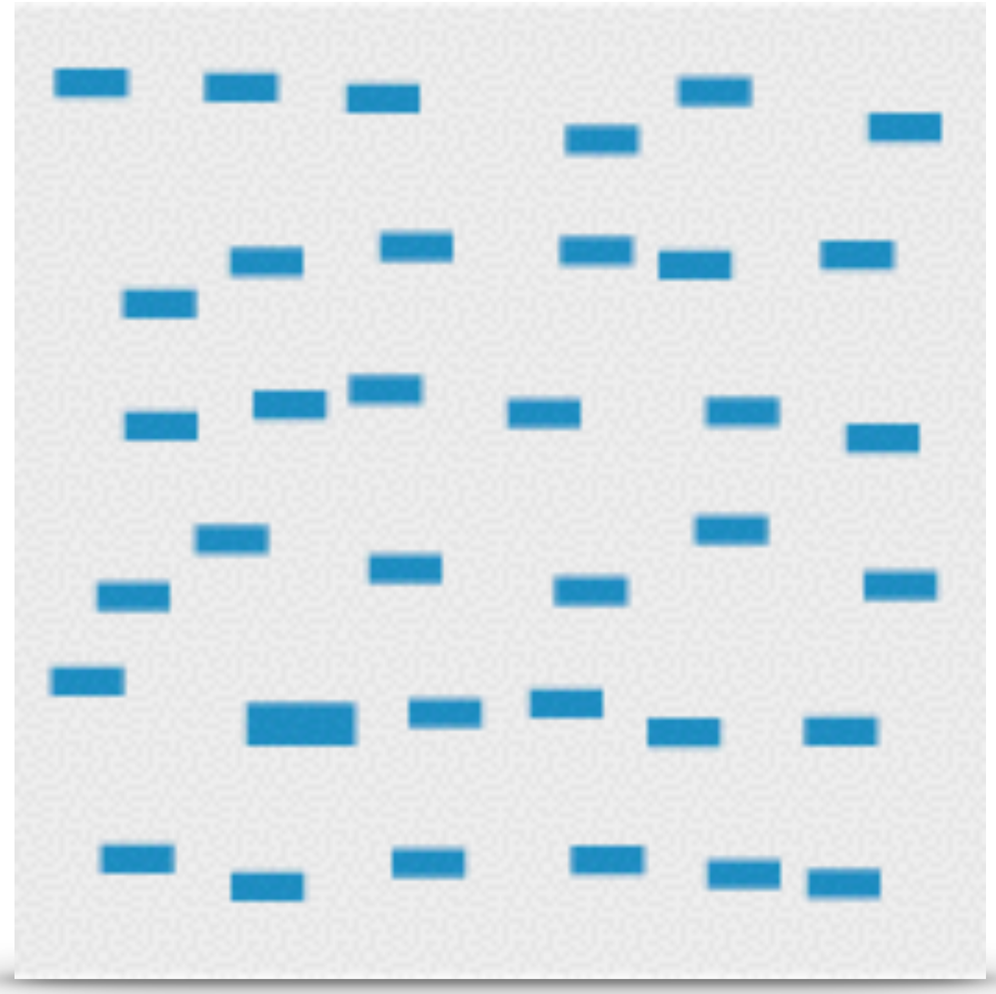
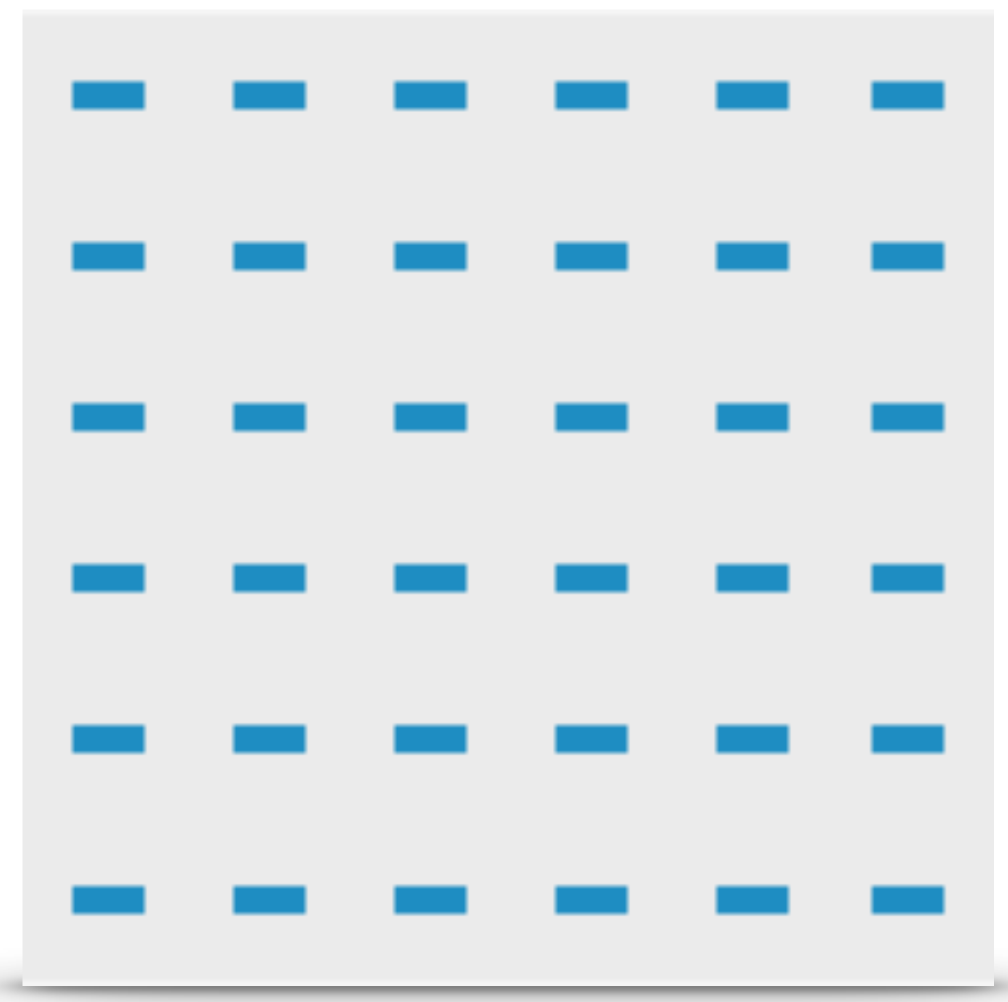
Präattentiv

Bsp: Größe



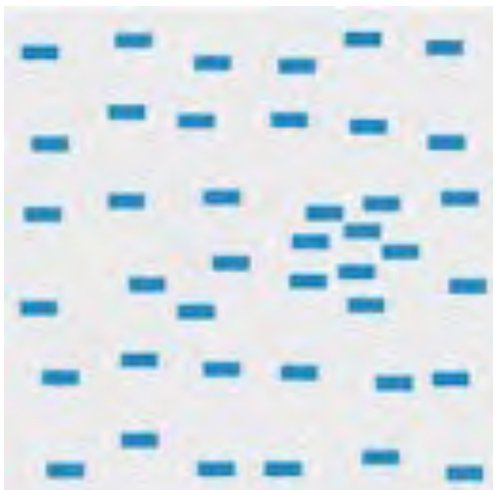
Präattentiv

Bsp: Flackern

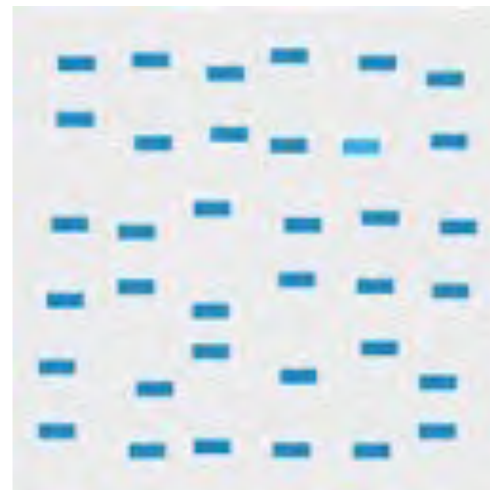


Präattentiv

Weitere Beispiele

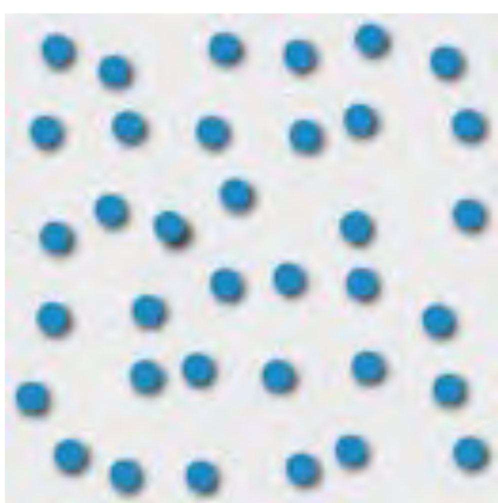


Dichte

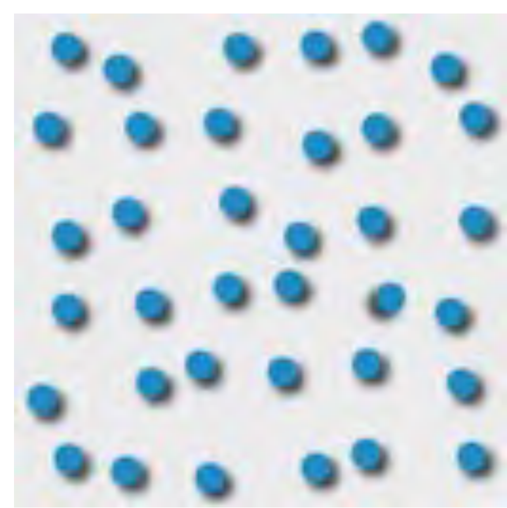


Helligkeit

Kreuzung



Tiefenhinweise



Lichtrichtung

Abschluss

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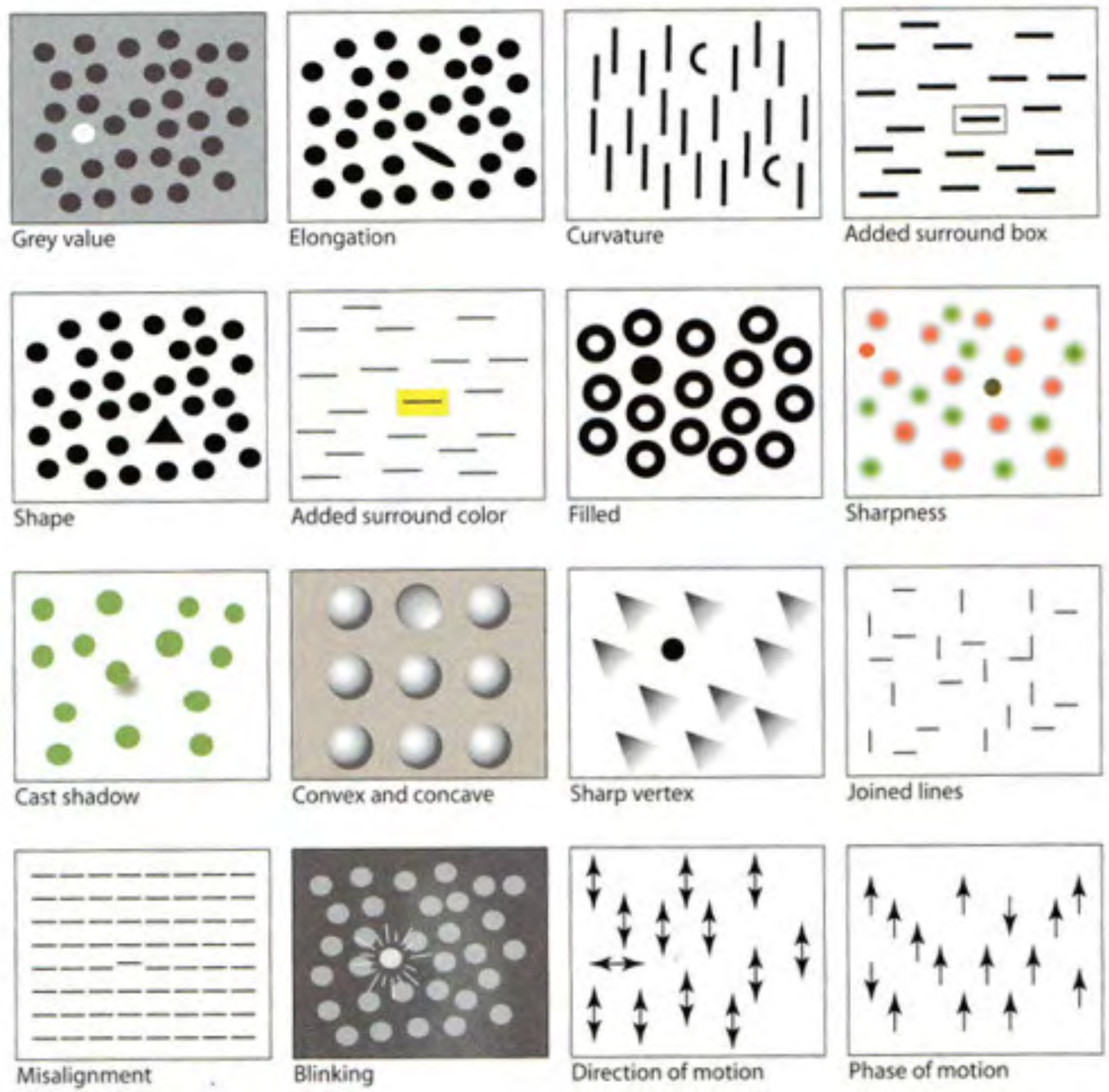
Präattentiv

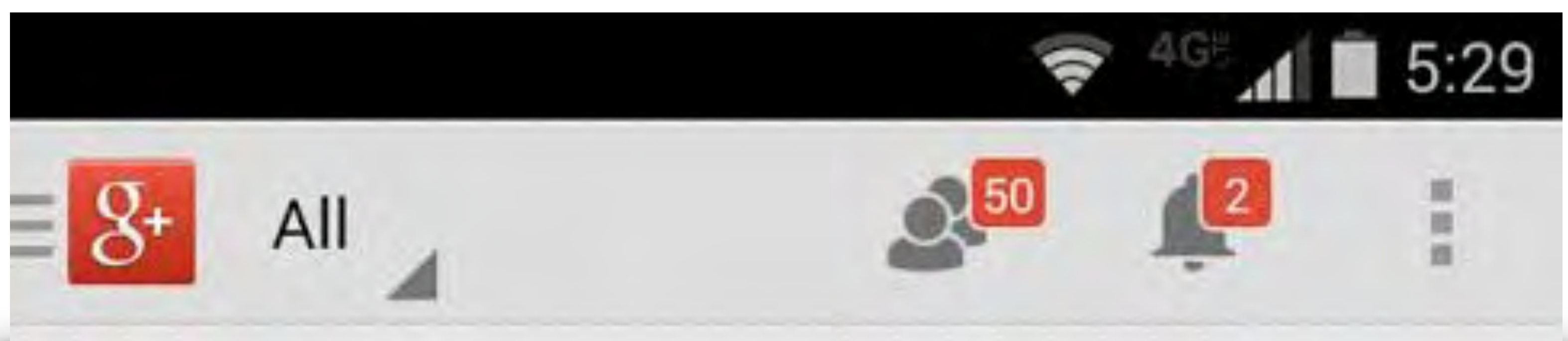
Weitere Beispiele

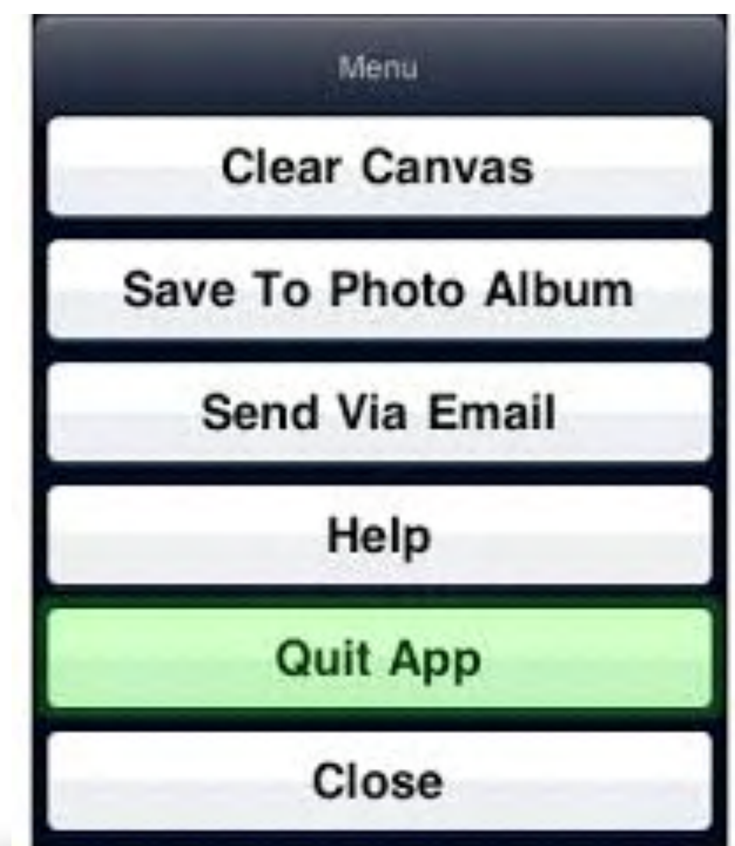


http://visualizedd.wordpress.com/process-paragraph/

Fokus: MCI

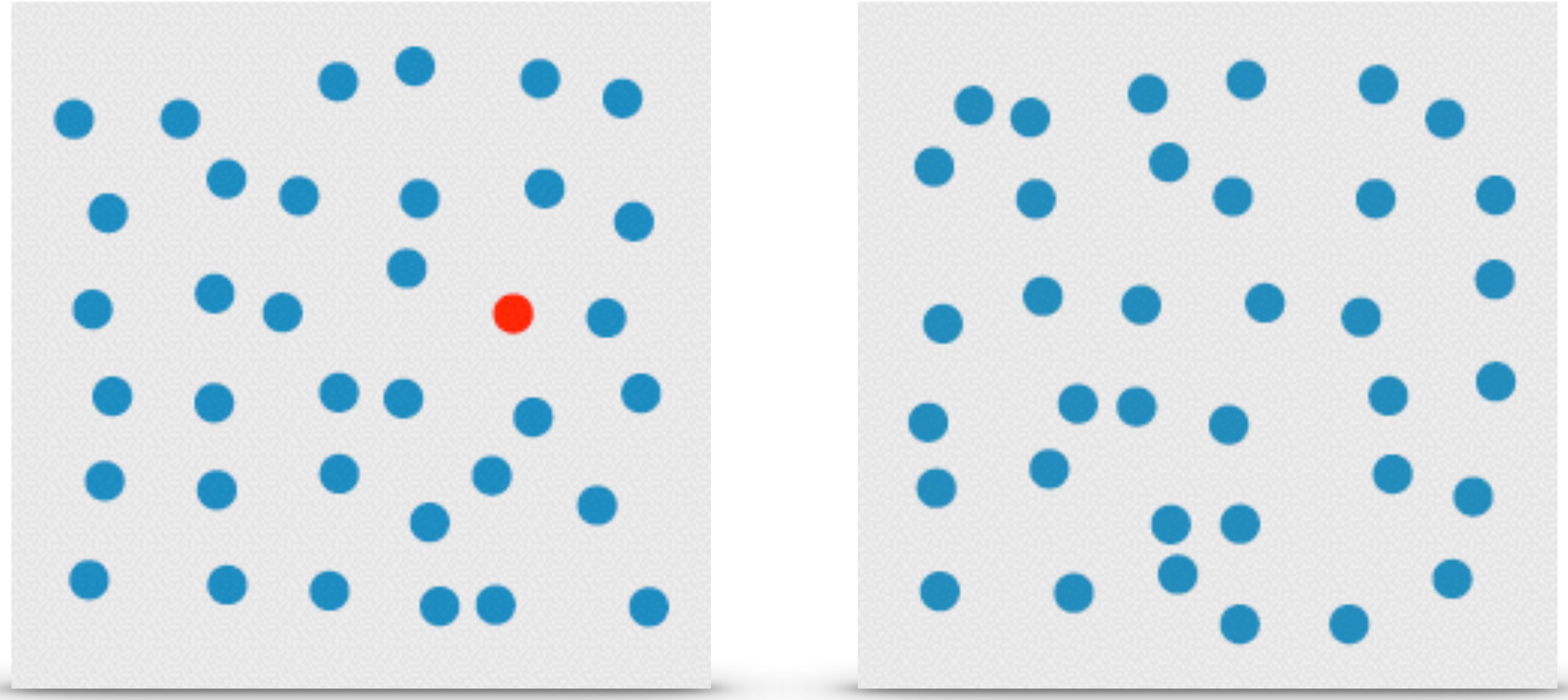
Bsp:: Präattentive Merkmale





Präattentiv

Bsp: Farbe



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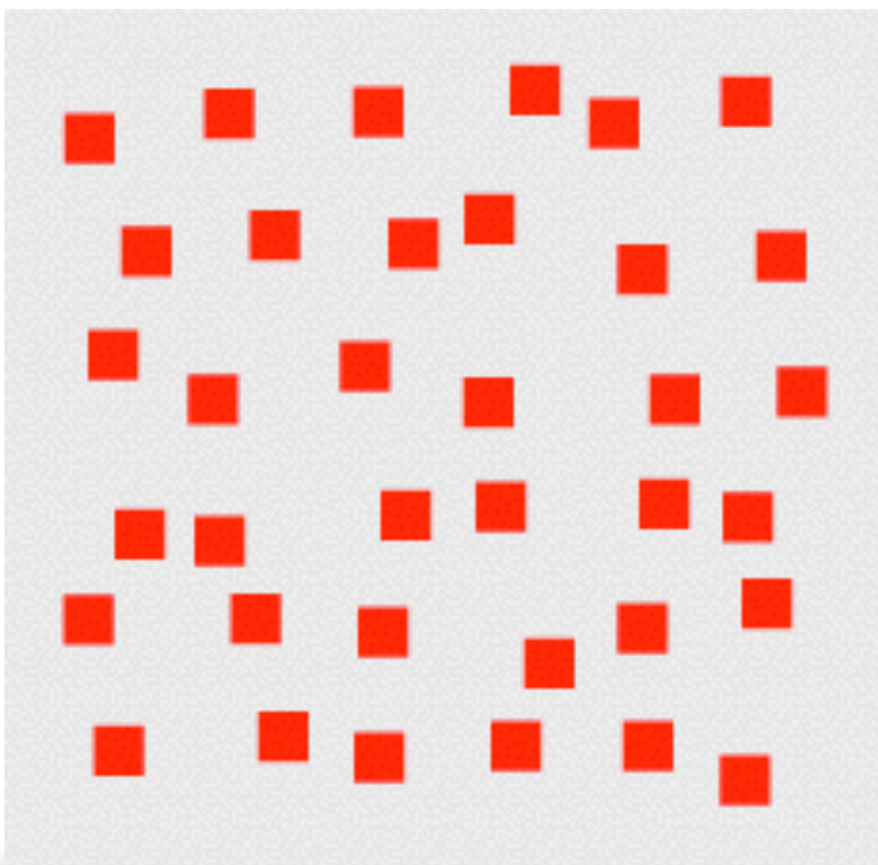
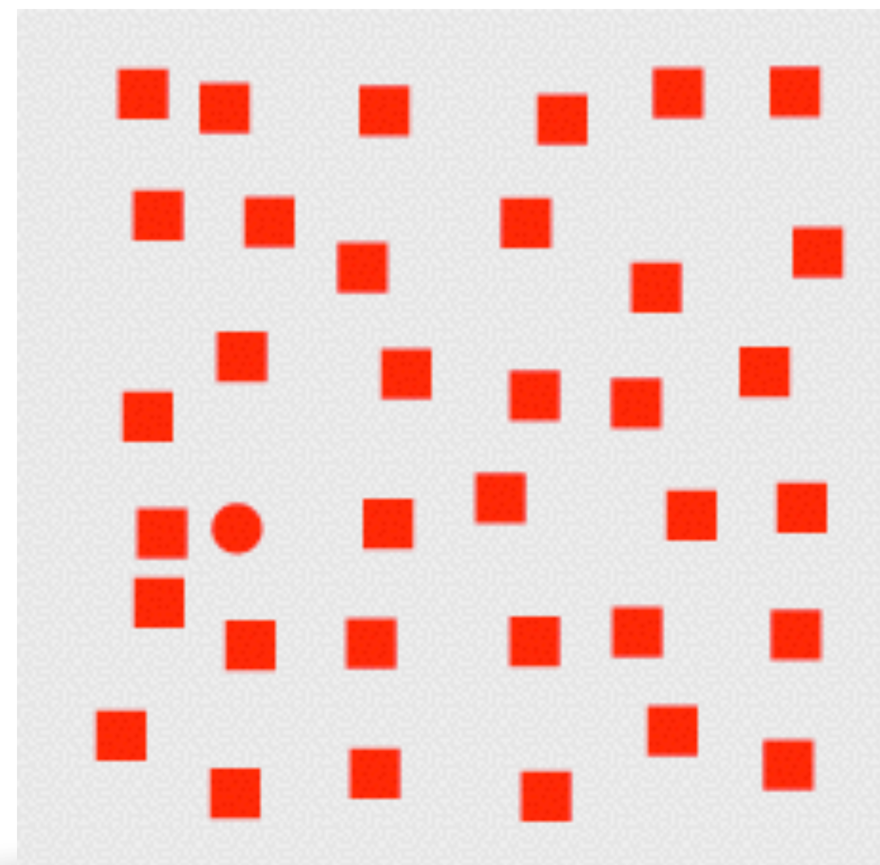
Präattentiv

Bsp: Form





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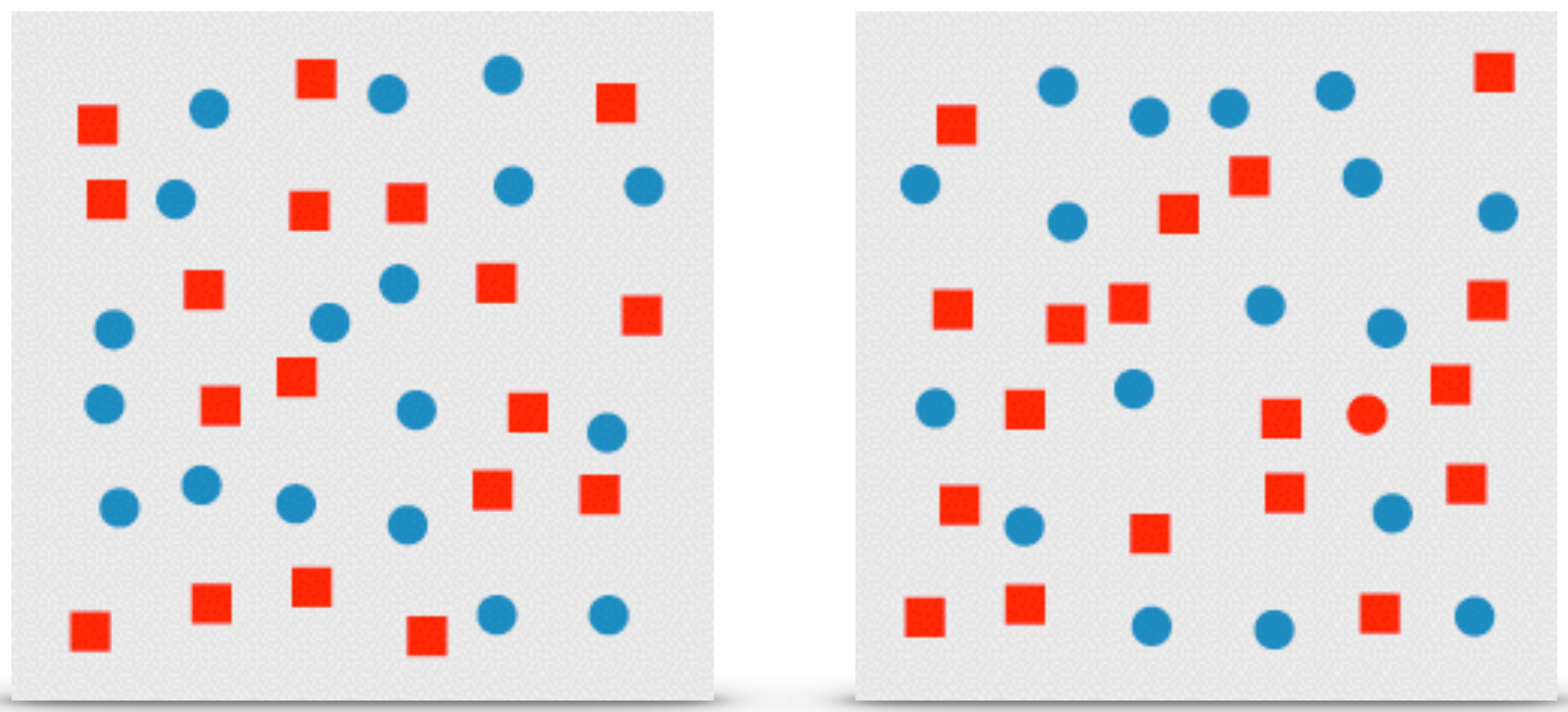
Präattentiv

Gegen-Bsp.: Verbindende Suche



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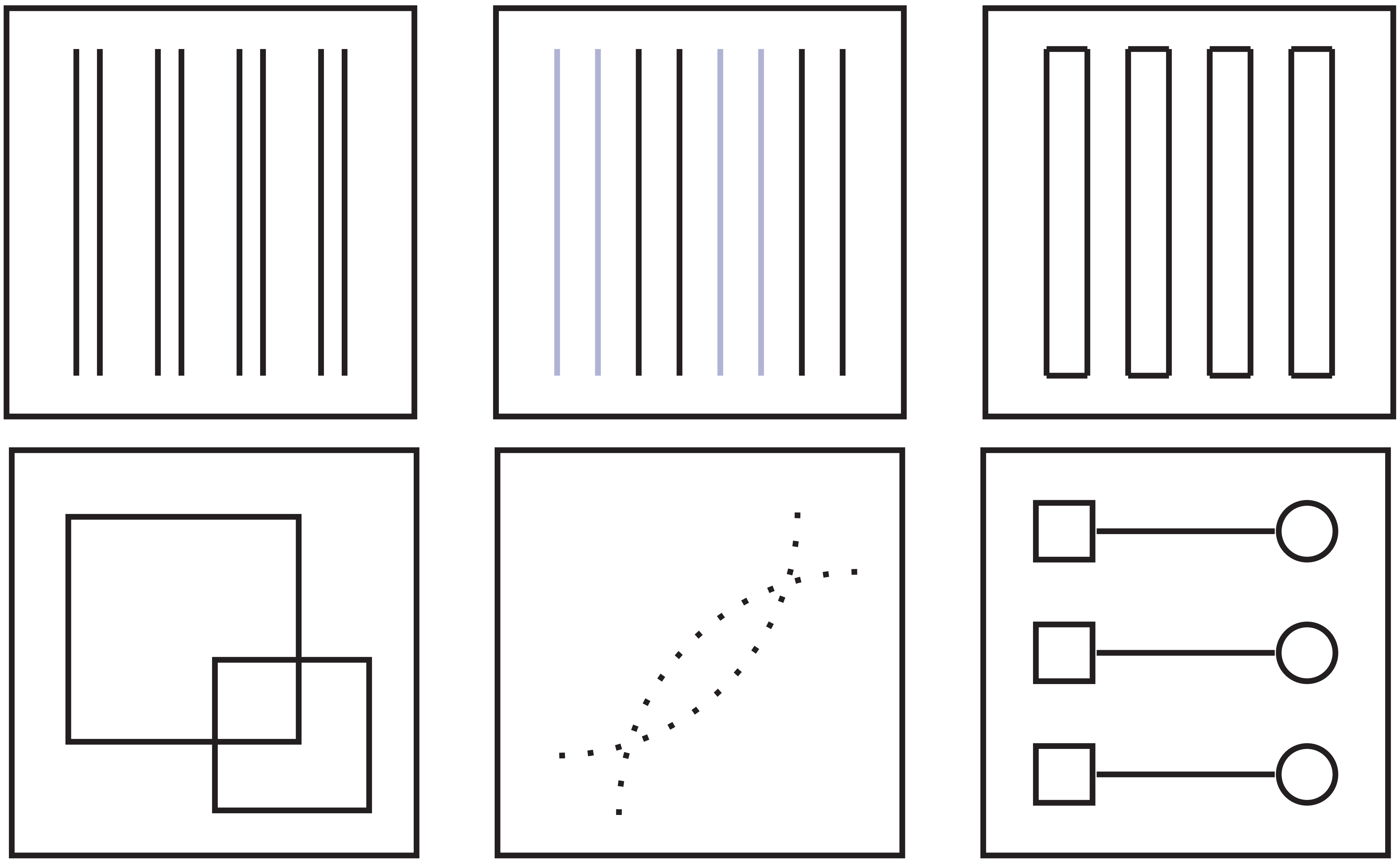
Gestaltgesetze

Beispiele

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