

Human Factors and Human-Machine Interaction

Cognitive Basics

FACULTY
OF COMPUTER SCIENCE

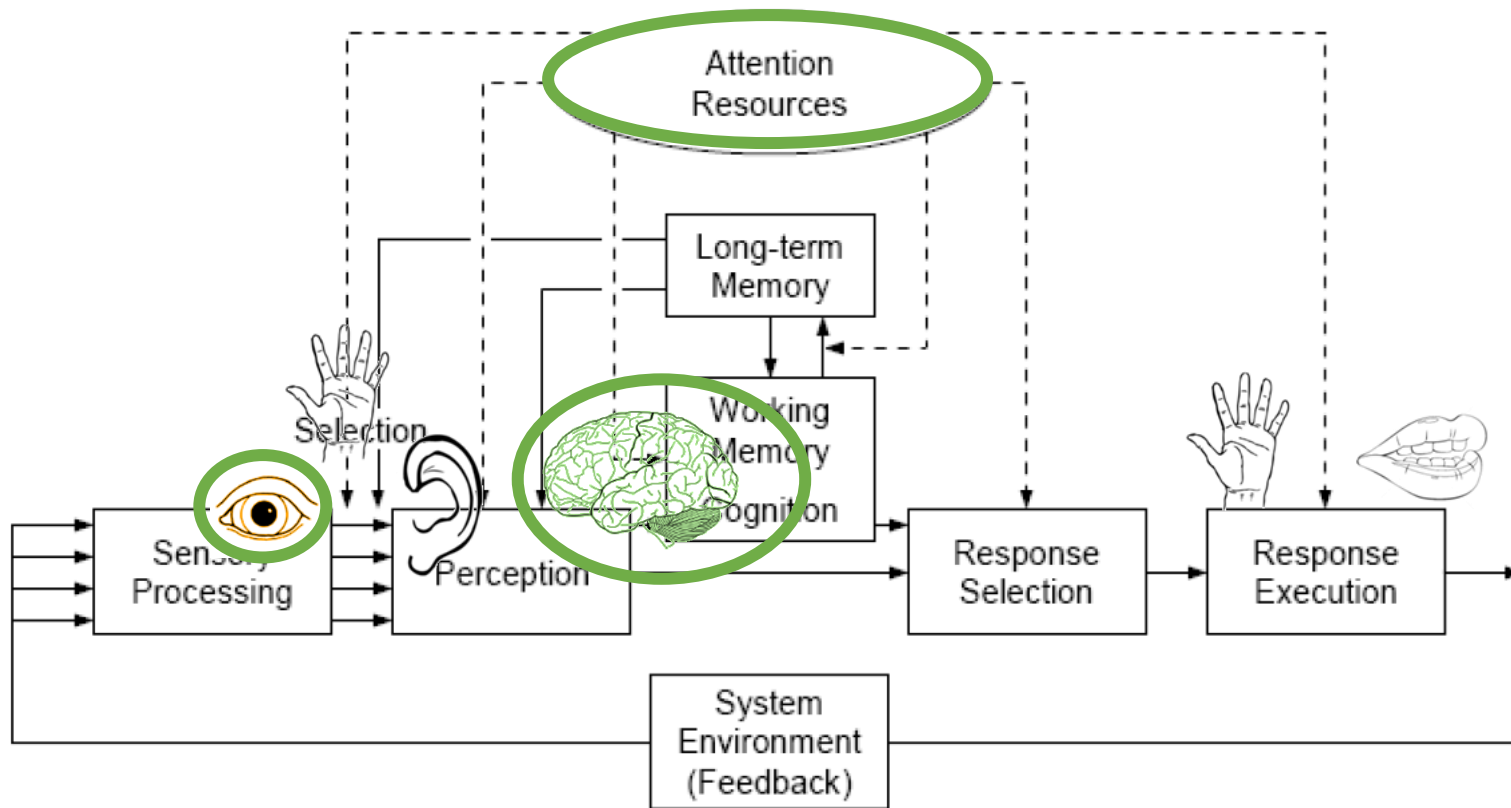


OVERVIEW

- Information Processing
- Visual Perception
- Attention
- Applied cognitive phenomena



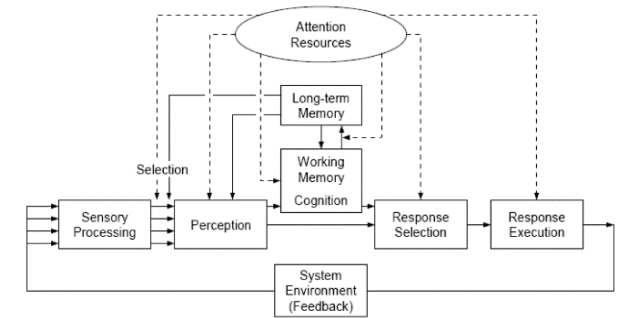
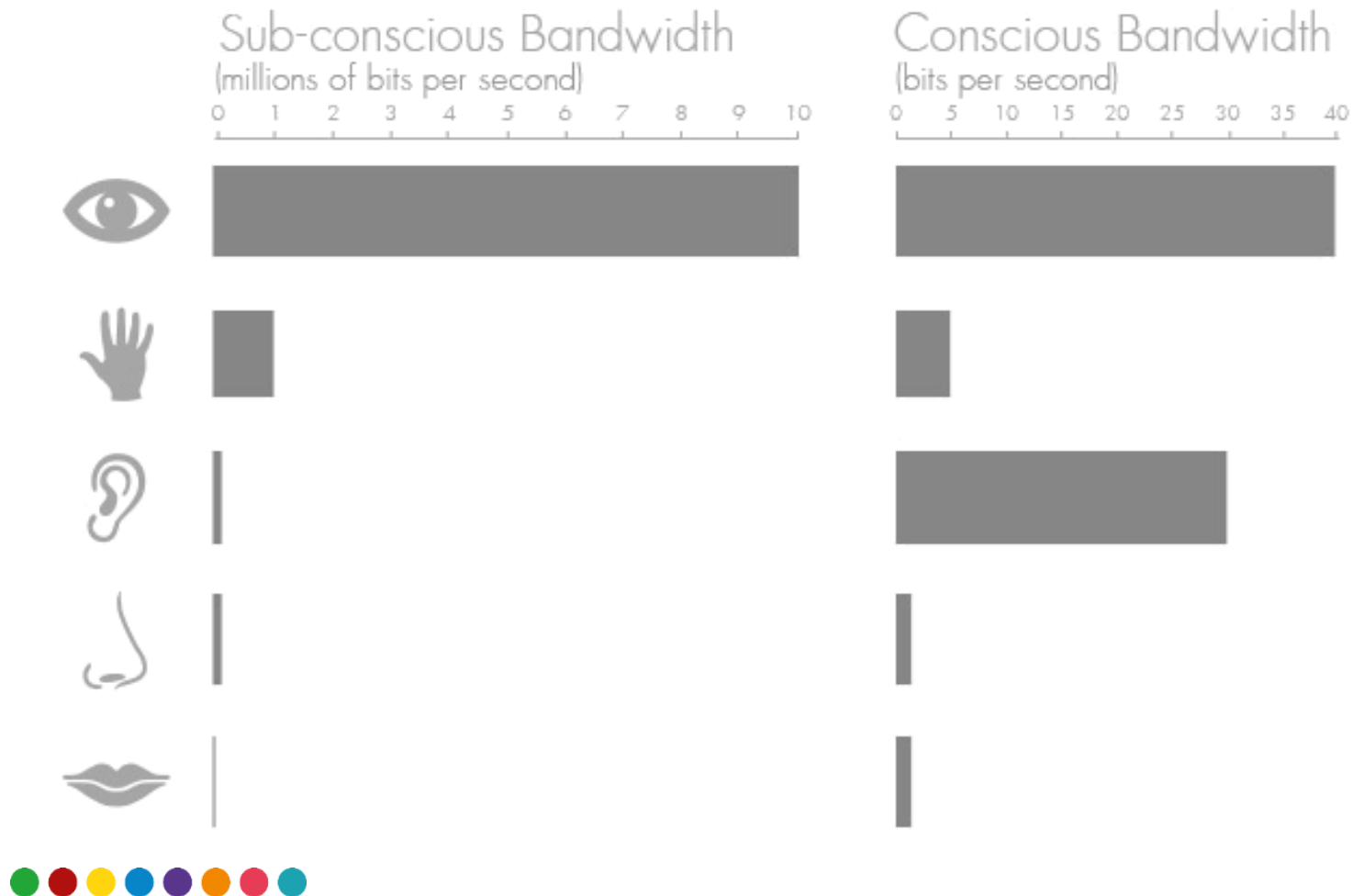
INFORMATION PROCESSING MODEL



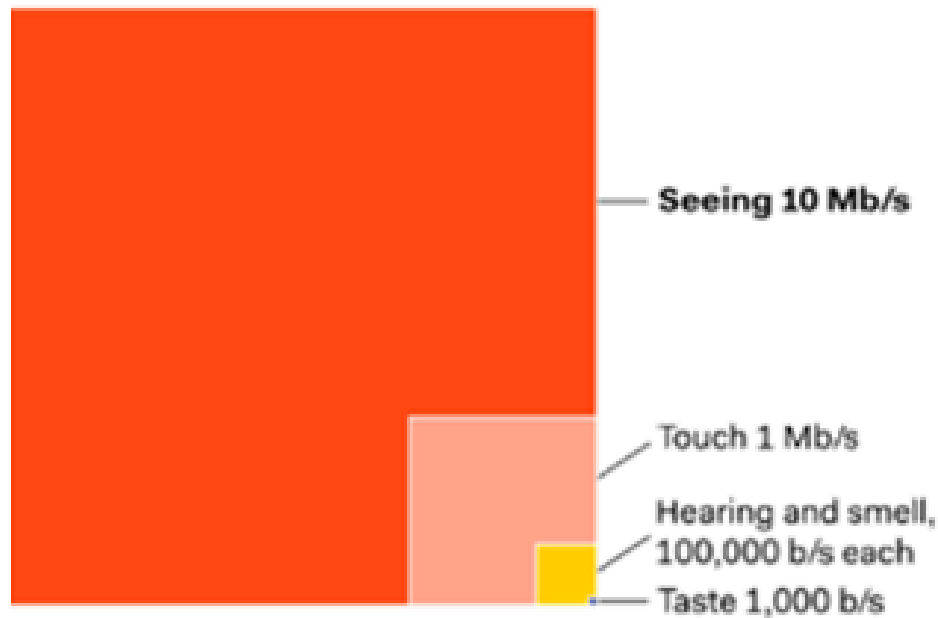
(Wickens, C. & Carswell, C. (2006). Information Processing. In G. Salvendy(Hrsg.), Handbook of Human Factors and Ergonomics (S. 111-149). Hoboken: John Wiley.)



INFORMATION PROCESSING



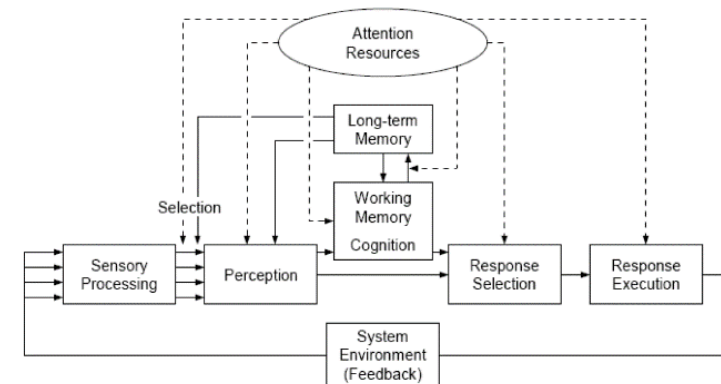
INFORMATION PROCESSING



Koponen, J., & Hildén, J. (2019). Data visualization handbook. Espoo: Aalto Arts Books.

We are able to visually perceive our environment, and changes in it considerably more quickly and precisely than using other senses.

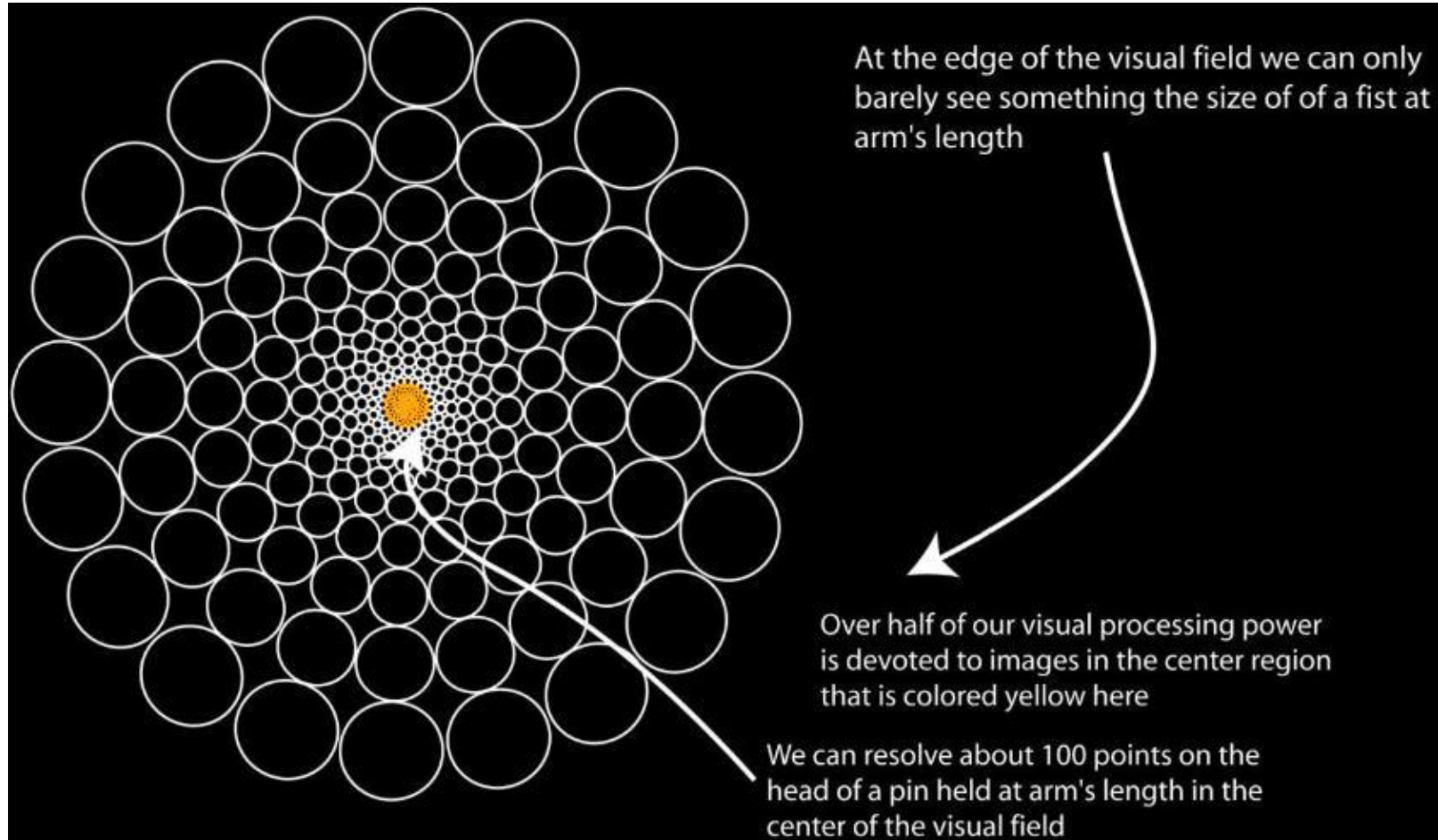
It is estimated that, each moment, our visual system sends our brains around eight times more information than all the other senses combined. (p. 21)



INATTENTIONAL BLINDNESS

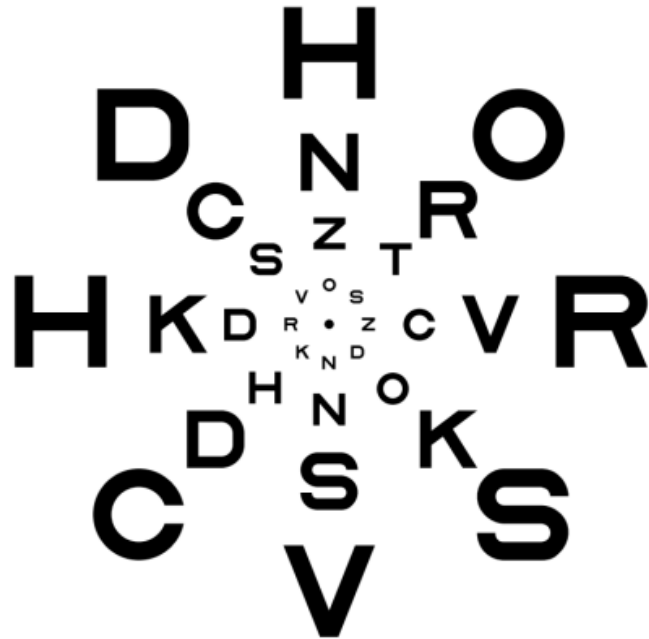


PERCEPTION: BRAIN PIXELS



PERCEPTION: BRAIN PIXELS

ANSTIS' PERIPHERAL ACUITY CHART



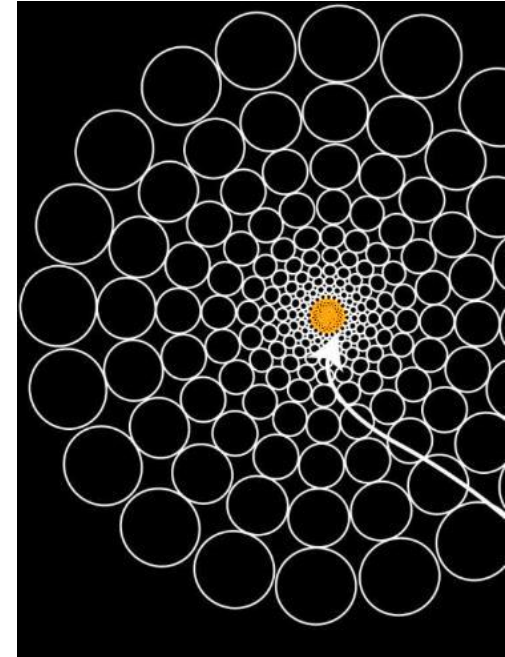
The so-called Anstischart, created by UC San Diego professor Stuart Anstis (Anstis, 1972) demonstrates how rapidly visual acuity decreases towards the periphery of the visual field. When the gaze is fixated at its center all the letters should be equally readable.(p. 48)

Koponen, J., & Hildén, J. (2019). Data visualizationhandbook. Espoo: Aalto Arts Books.



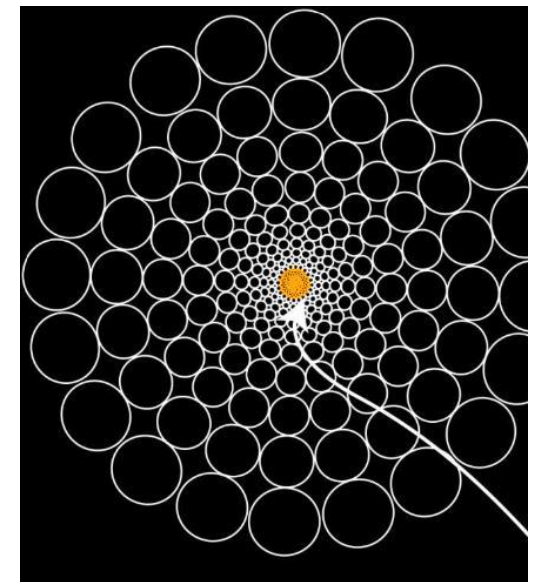
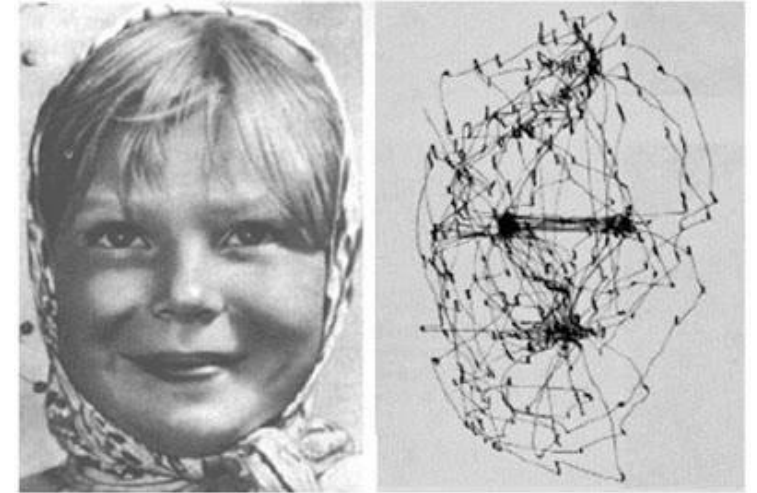
STRUCTURE → SACCADES

- The visual information from **100 million receptors** is compressed and transported via **a million nerve tracts** to the responsible brain areas.
- 50% of the **processing power** (area of the parafovea) corresponds to 5% of the visible environment.
- Consequence: fast eye movements (**saccades**) are necessary to capture interesting and necessary details: saccade speed up to 900°/sec.
- The eyes move in a series of jumps, but we do not perceive them as such. I.e.: We do not perceive what the first stages of visual information acquisition offer us, but a coherent whole.



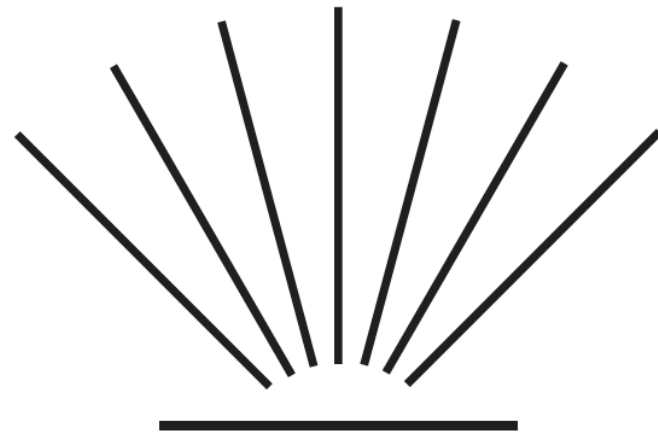
SACCADES

- We **do not perceive a stable image** of the environment
- **Saccade jumps:** 3/sec
- **Goal:** centering interesting parts on the fovea
- **Consequence:** effects of selective perception

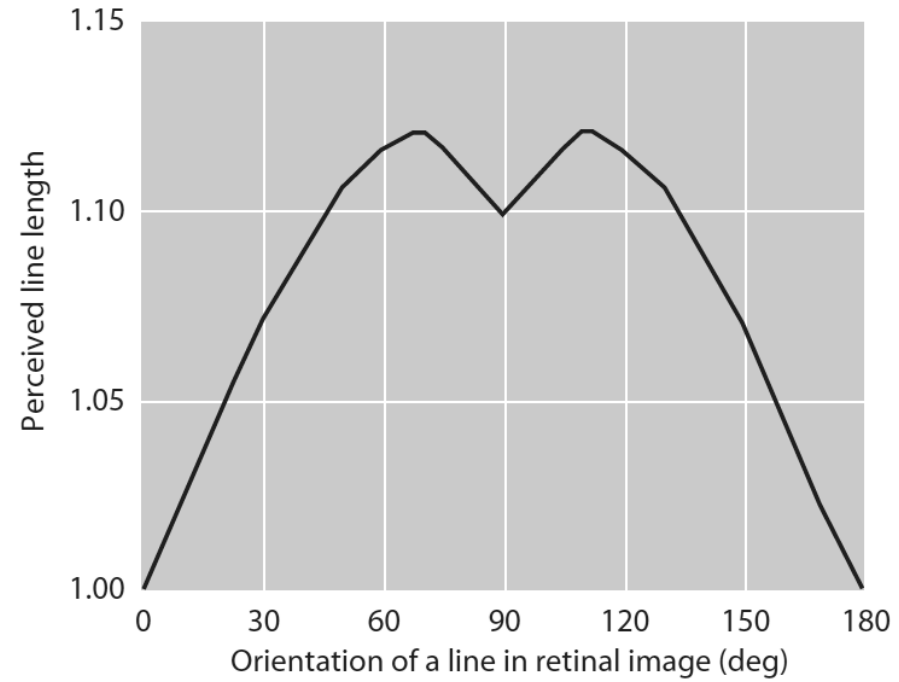


PERCEPTION OF LENGTH

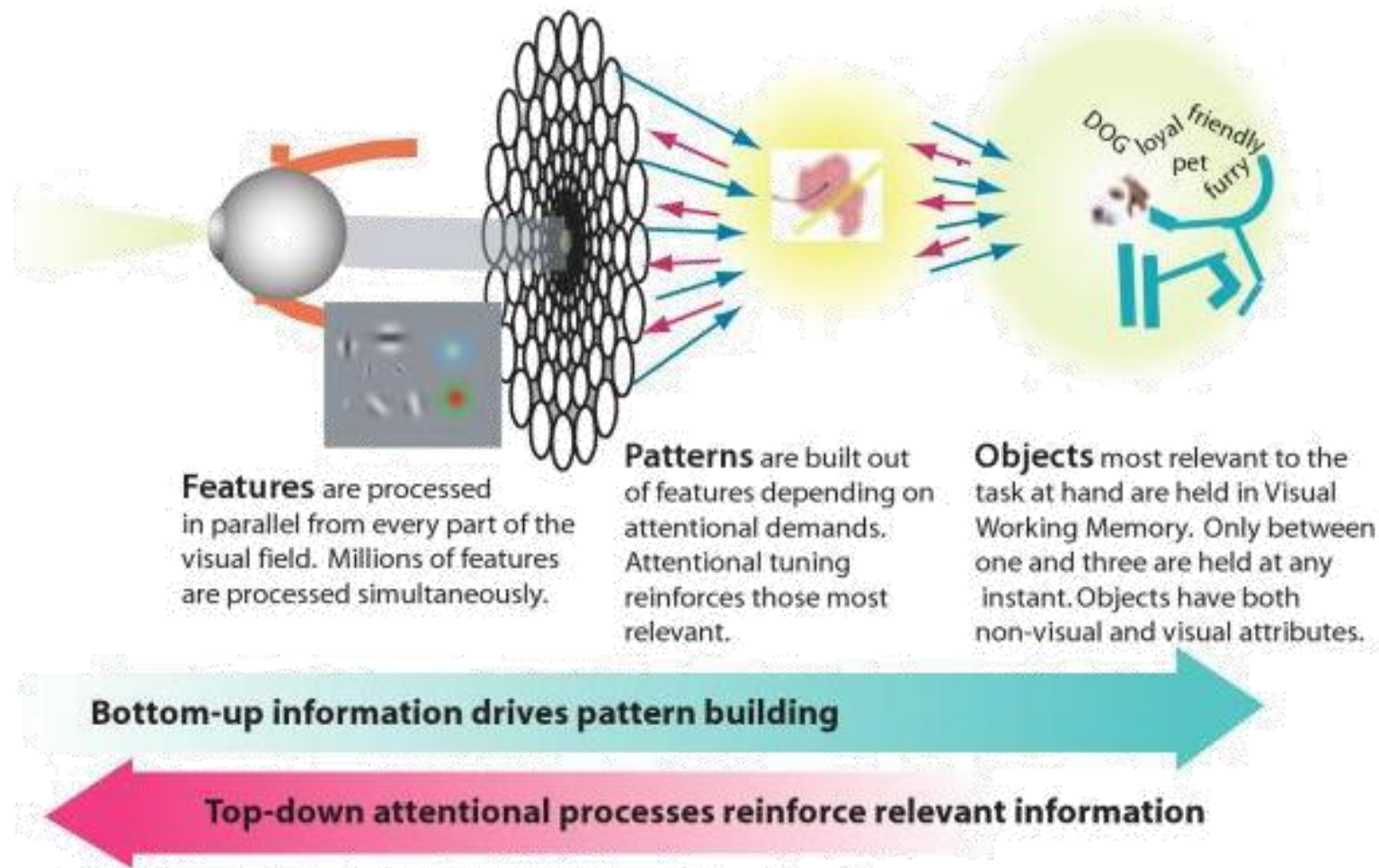
(A)



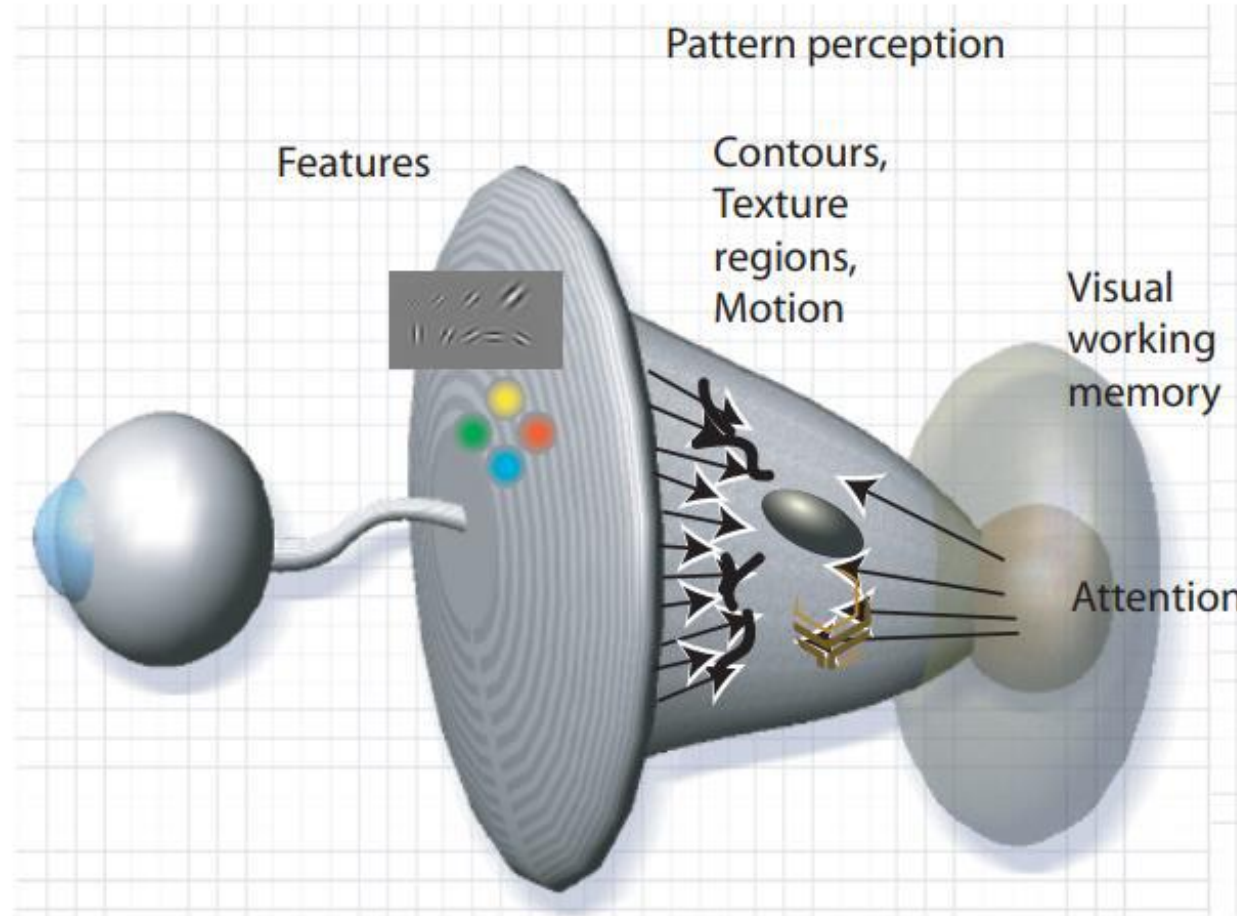
(B)



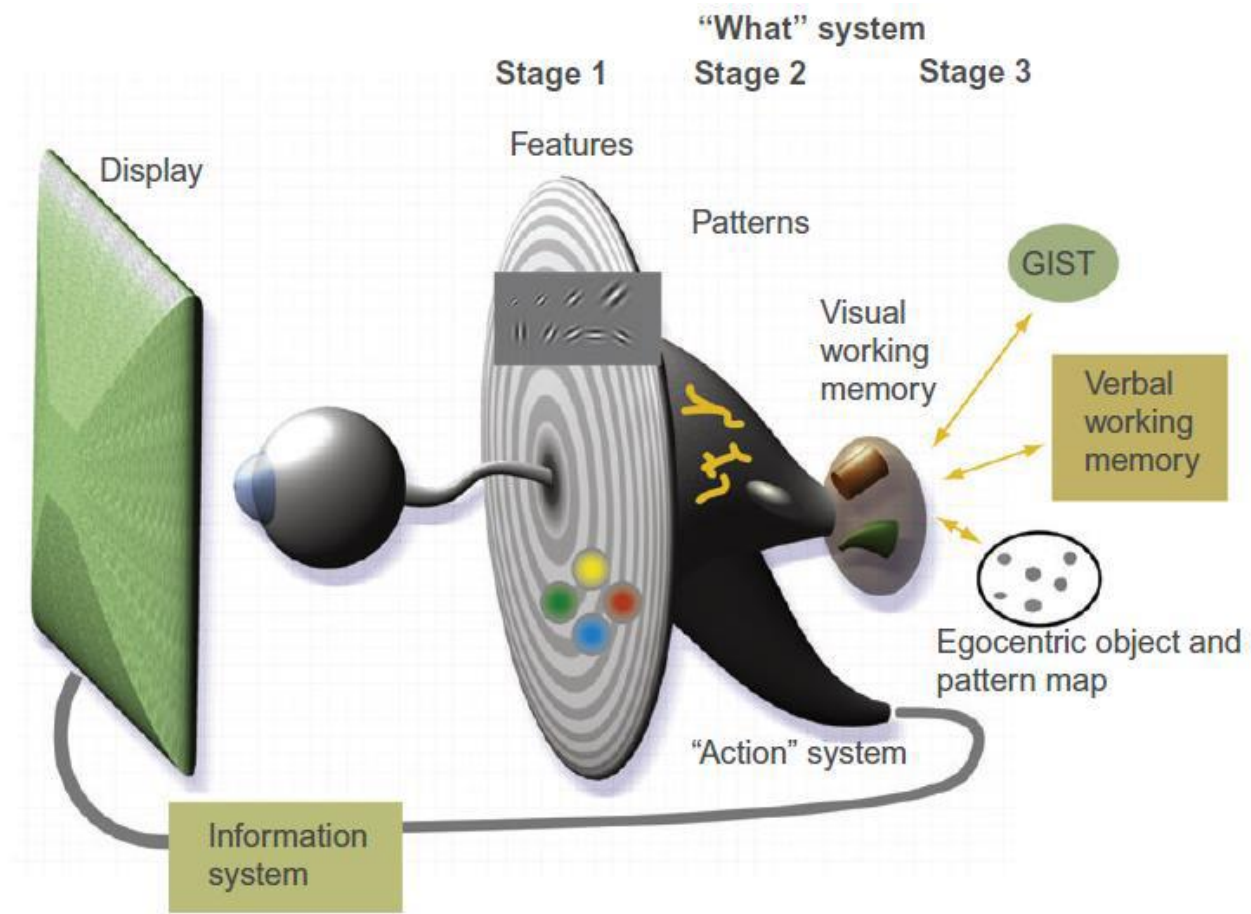
VISUAL PERCEPTION: BOTTOM UP



3 STAGES OF VISUAL PERCEPTION

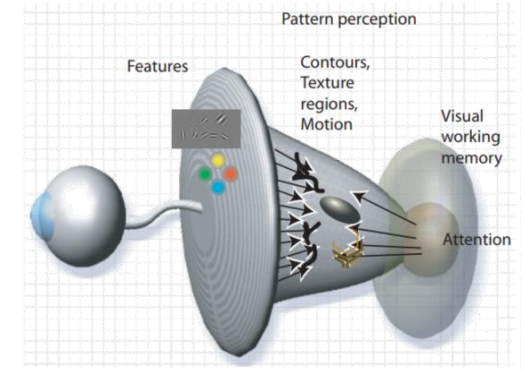


3 STAGES OF VISUAL PERCEPTION



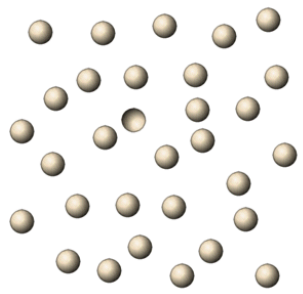
VISUAL PERCEPTION: BOTTOM UP

- Five billion neurons form a parallel processor that processes the information provided by a million neural pathways.
- Specialized brain areas take care of **the recognition of features**: size, color, shape, movement,
- In **pattern recognition**, visual space is divided and organized into regions, contours, boundaries of the same texture or color (Gestalt laws).
- The last stage of information compression is the **formation of visual objects**, which are stored in the visual working memory.
- Number: 3 - 5 objects; duration 0.1 - 2 sec. The capacity of visual working memory is severely limited. Therefore, it is dependent on external visual support.

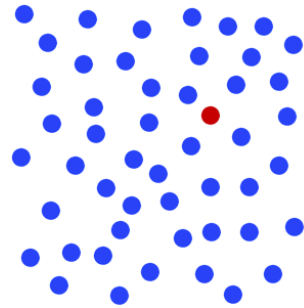


VISUAL PERCEPTION: FEATURES

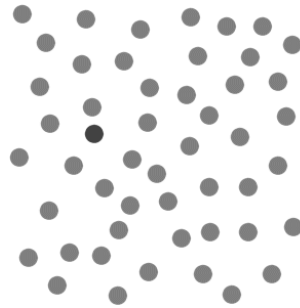
=**preattentive cues**; can be used to control eye movements (e.g., to support search processes).



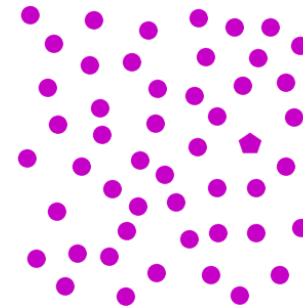
convex/concave



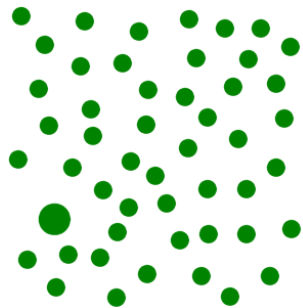
color



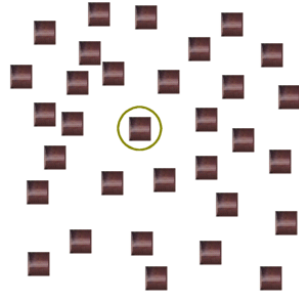
intensity



shape



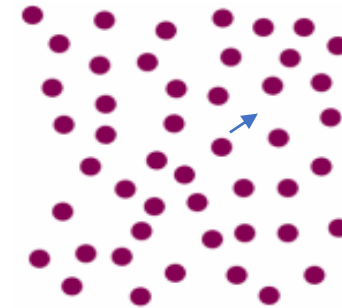
size



marker



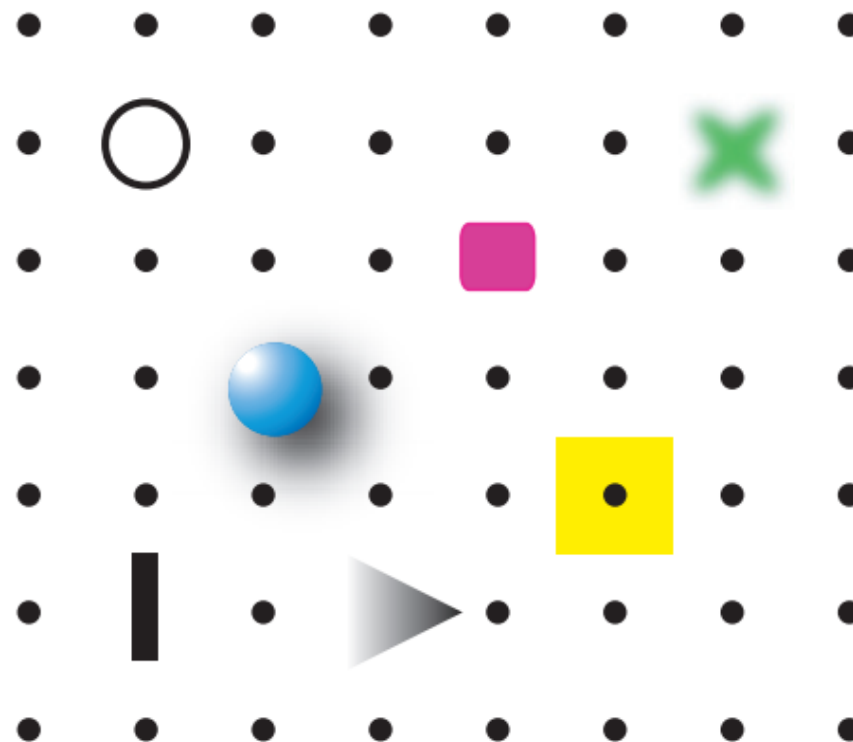
orientation



movement



VISUAL PERCEPTION: FEATURES

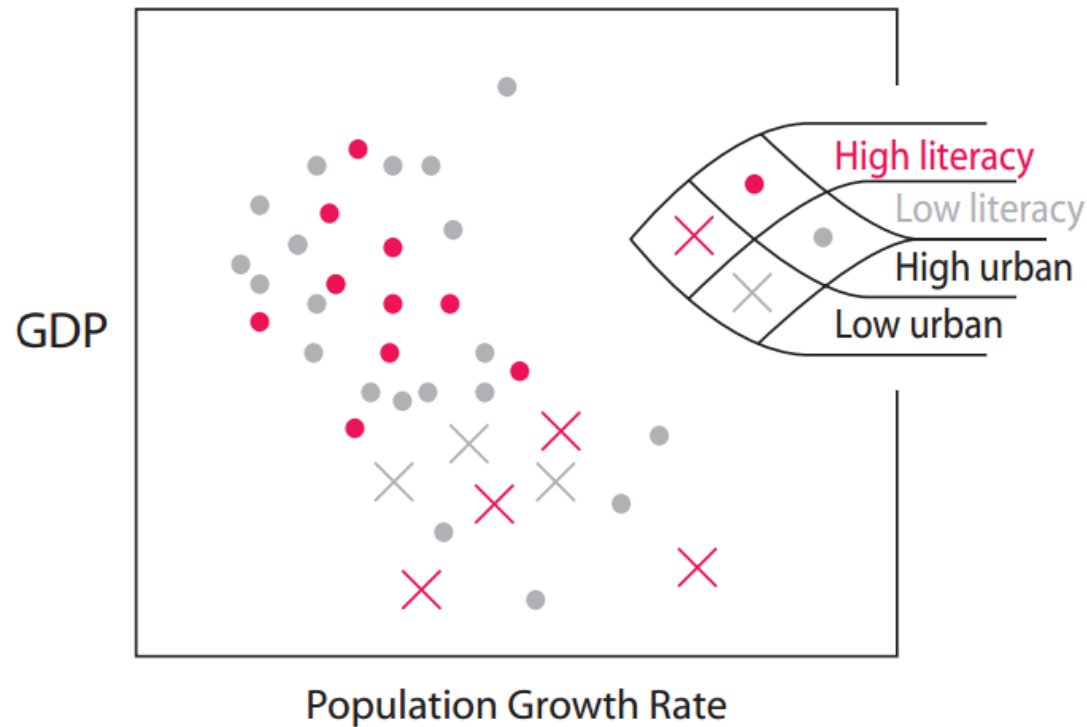


A set of symbols designed so that each would be independently searchable.

Each symbol differs from the others on several channels. For example, there is only one green symbol; it is the only one with oblique lines and it is the only one with no sharp edges.



VISUAL PERCEPTION: FEATURES



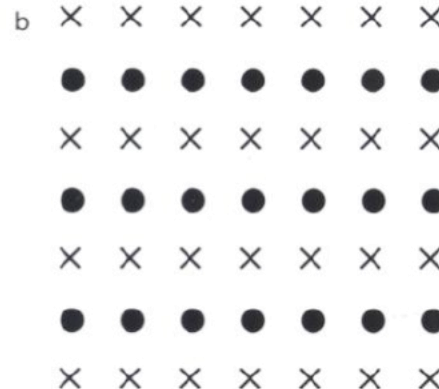
In this scatter plot, two different kinds of points are easy to find. It is easy to visually query those data points representing countries with a high level of literacy. These use color coding. It is also easy to visually query the set of points representing countries with a low urban population. These are distinct on the orientation channel because these symbols are made with **X**s containing strong oblique lines.



ORGANISE PATTERNS: GESTALT PRINCIPLES/LAWS



Proximity



Similarity



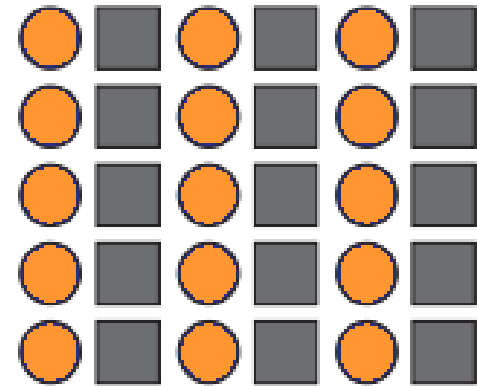
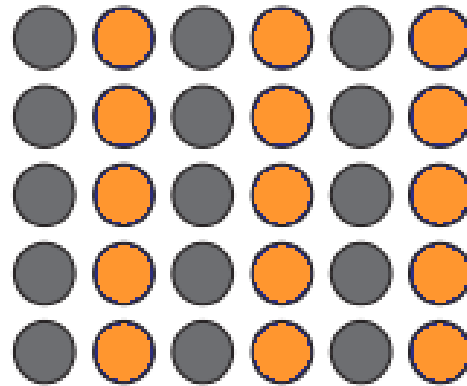
GESTALT PRINCIPLES

- Similarity
- Proximity
- Closure
- Simplicity or good figure
- Continuity and completion
- Common destiny
- Familiarity



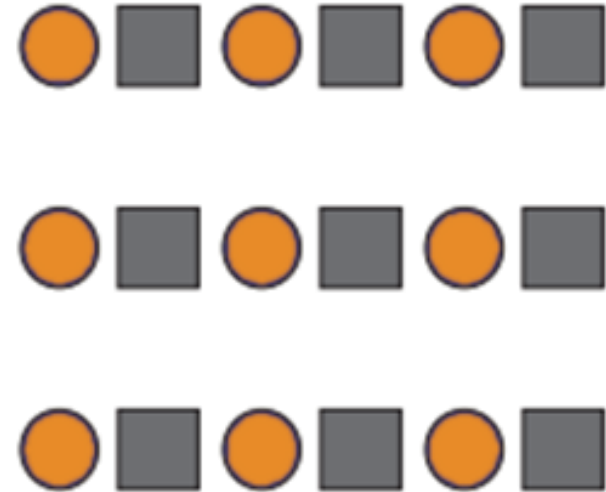
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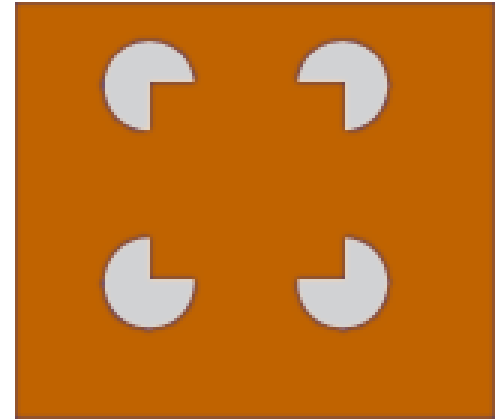
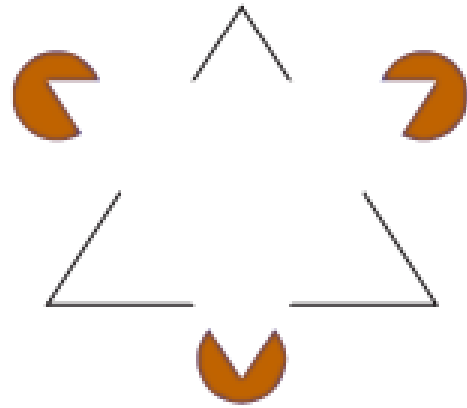
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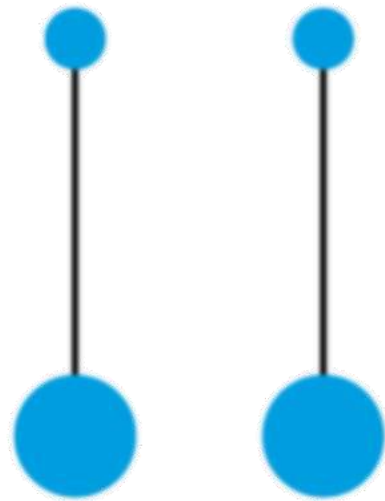


GESTALT PRINCIPLES

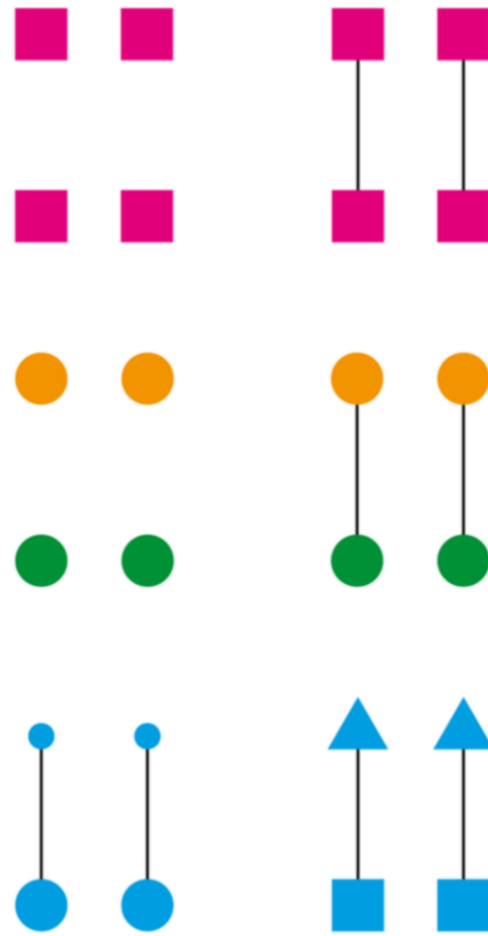
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LAW OF CONNECTIONS

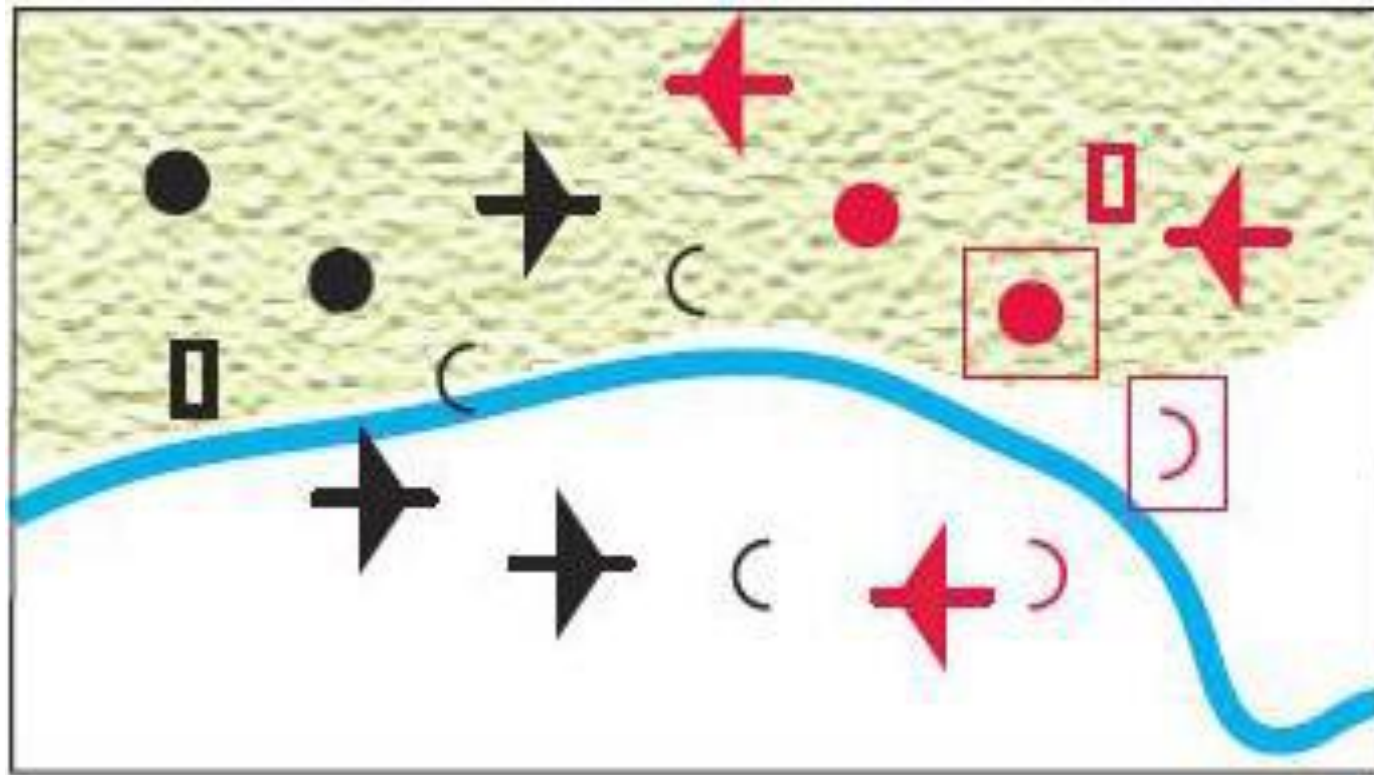


LAW OF CONNECTIONS





FEATURES AND GESTALT LAWS



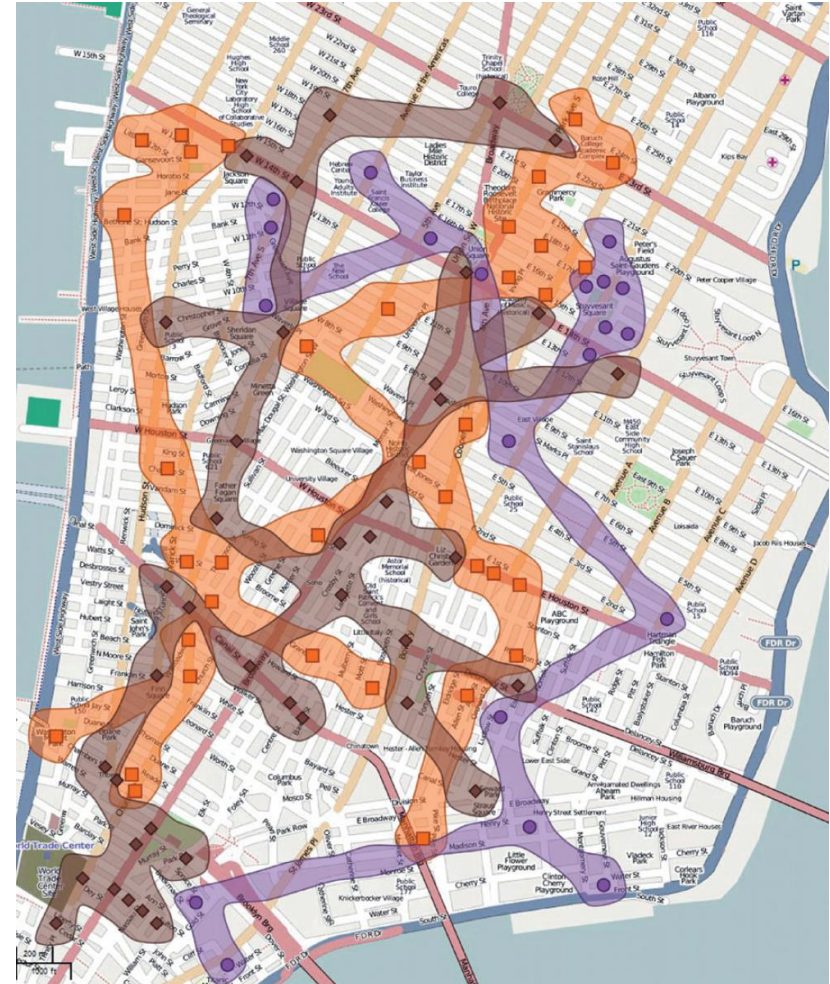
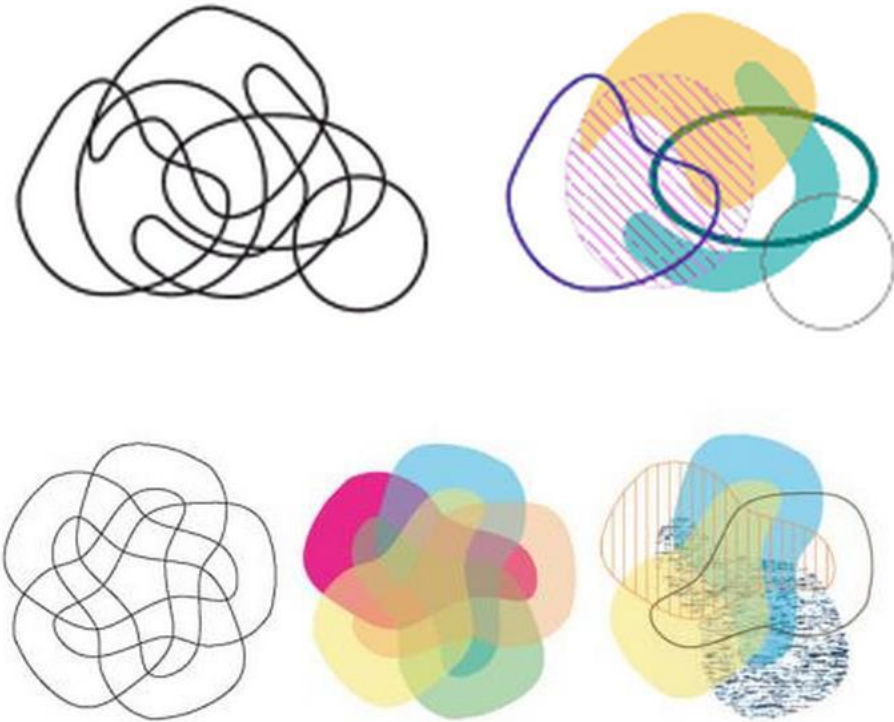
FEATURES + GESTALT LAWS: FEATURE LEVEL TUNING



Feature level tuning
can allow us to attend
to different layers of
information



FEATURES AND GESTALT LAWS



Ware, C. (2013). Information Visualization: Perception for Design. Elsevier

EXCERCISE: APPLYING THE GESTALT PRINCIPLES

1. Find bad design of everyday thing (see microwave) and interface that misuse the Gestalt Principles
2. Why is the interaction misleading? Which laws are hurt? Explain with what you know about Gestalt Laws and visual features
3. Re-design. Use a sketching app (e.g., [excalidraw/draw.io/...](https://excalidraw.com)) to improve the interaction design. Employ your knowledge of Gestalt Principles and visual perception.
4. Present.

