
Perception and Displays

Prof. Leia Stirling

September 15, 2016

16.400/16.453J/HST.518J

Learning Objectives

- Discuss principles of effective displays as related to perception of the information
- Describe attributes of auditory, visual, and haptic displays

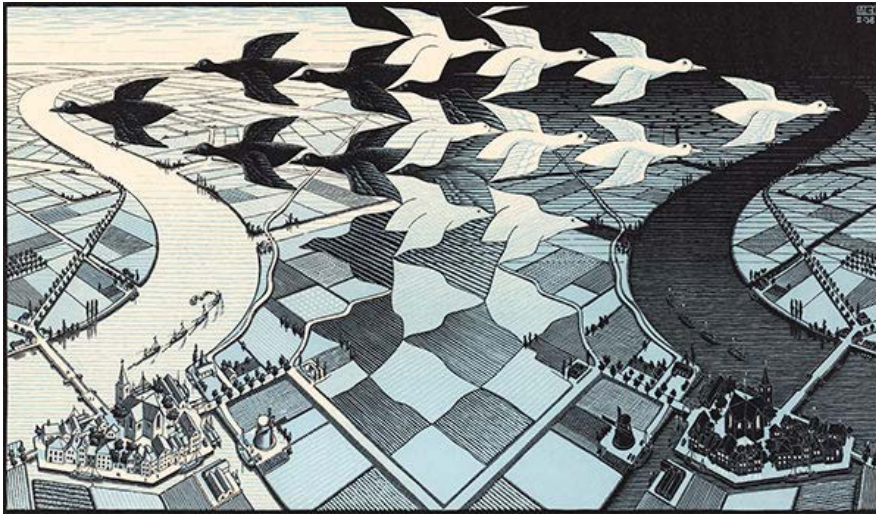
PERCEPTION

Detectability vs. Perceptibility

- ***Detectability***: Can it be seen/heard at all?
- ***Perceptibility***: Can the forms/sounds be recognized?

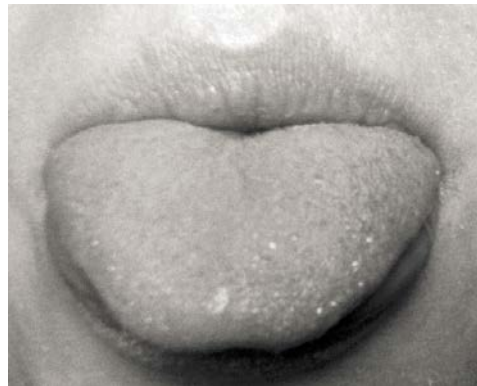
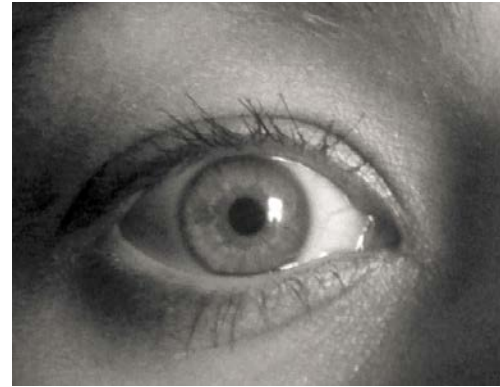
Perception

Ability of the brain to extract information from the stimulation of the sensory organs



M.C. Escher (www.mcescher.com/gallery/)

Perceptual Modalities



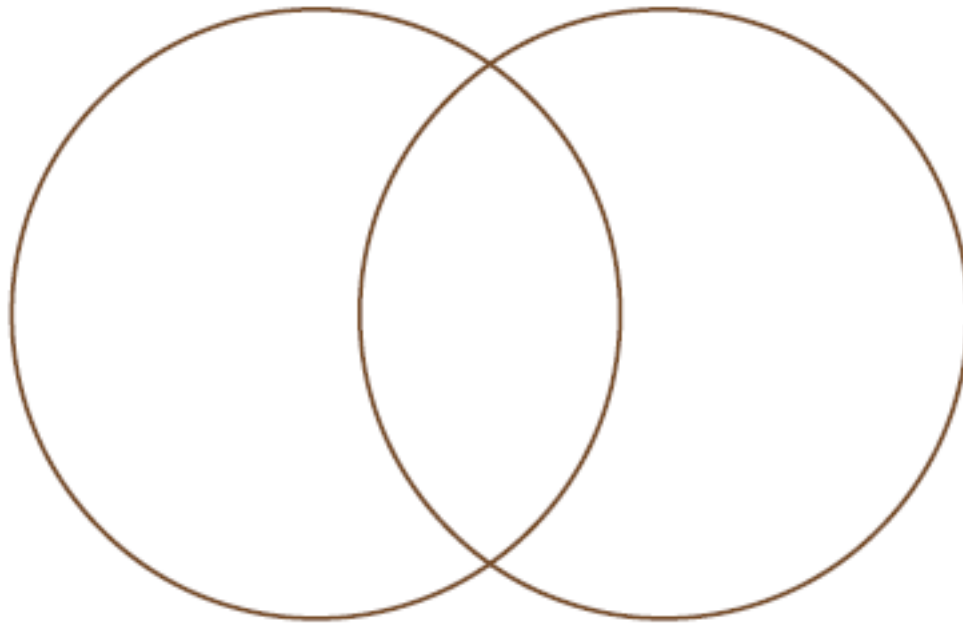
Images from wikipedia.org

Perceptual Organization

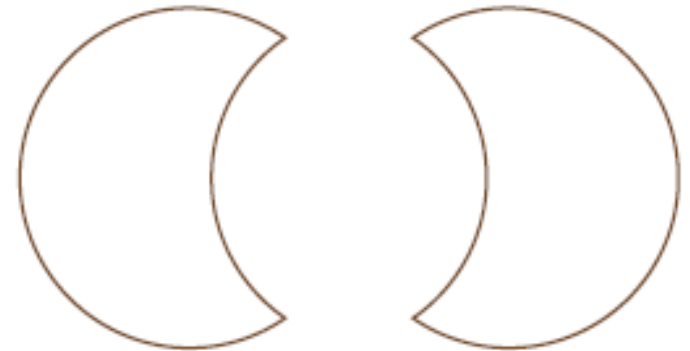
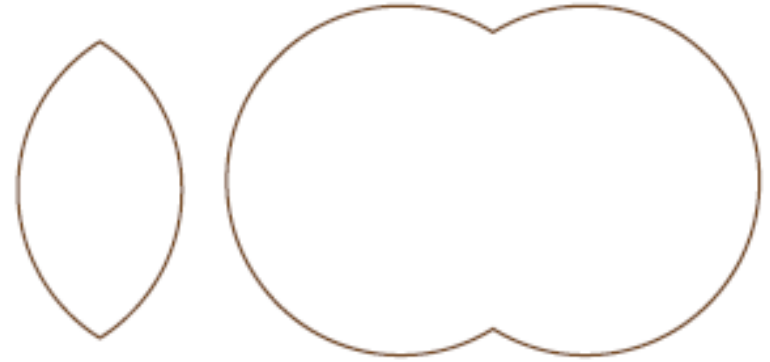
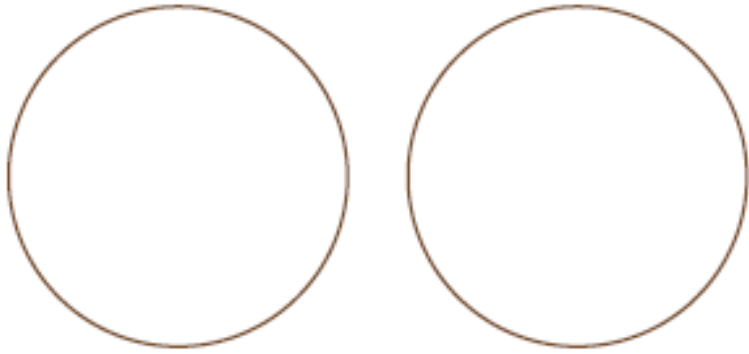
Process by which we apprehend particular relationships among potentially separate stimulus elements

- Gestalt Psychology— *The whole is other than the sum of the parts*
 - *Emergence*
 - *Reification*
 - *Multistability*
 - *Invariance*

What are the components?



Some of the Combinations

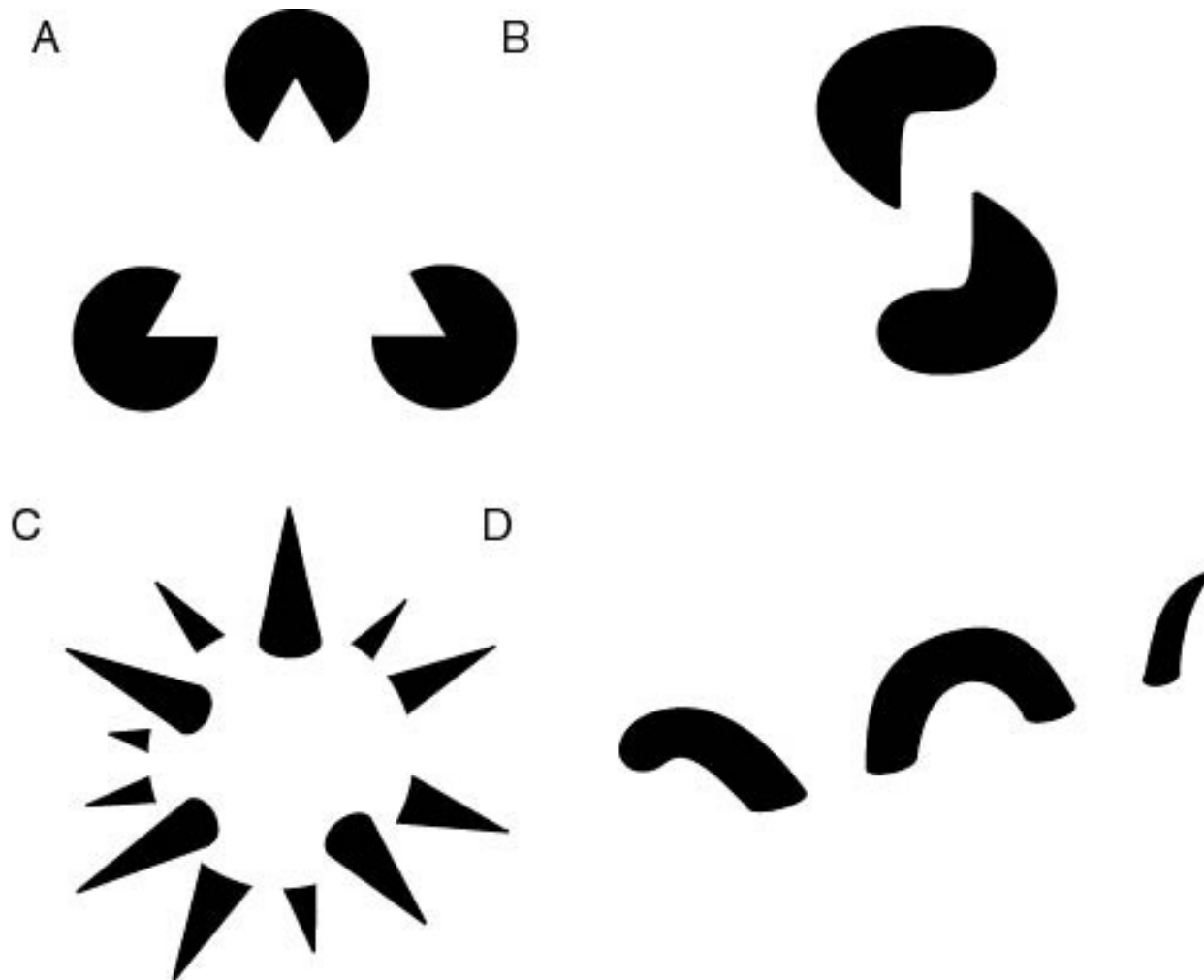


Principles of Gestalt Systems—Emergence



<https://commons.wikimedia.org>

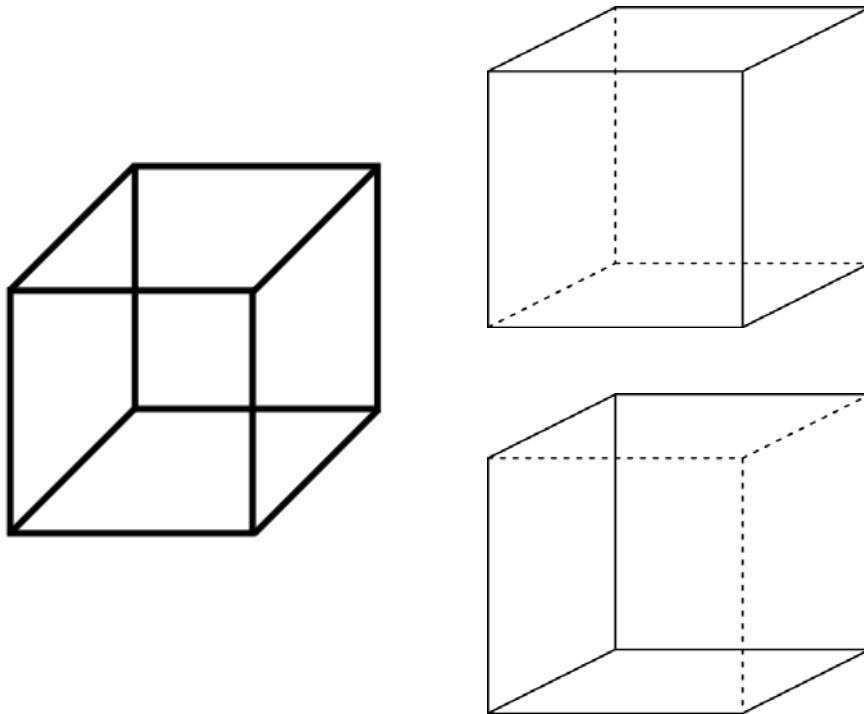
Principles of Gestalt Systems—Reification



<https://commons.wikimedia.org>

Principles of Gestalt Systems—Multistability

Necker Cube

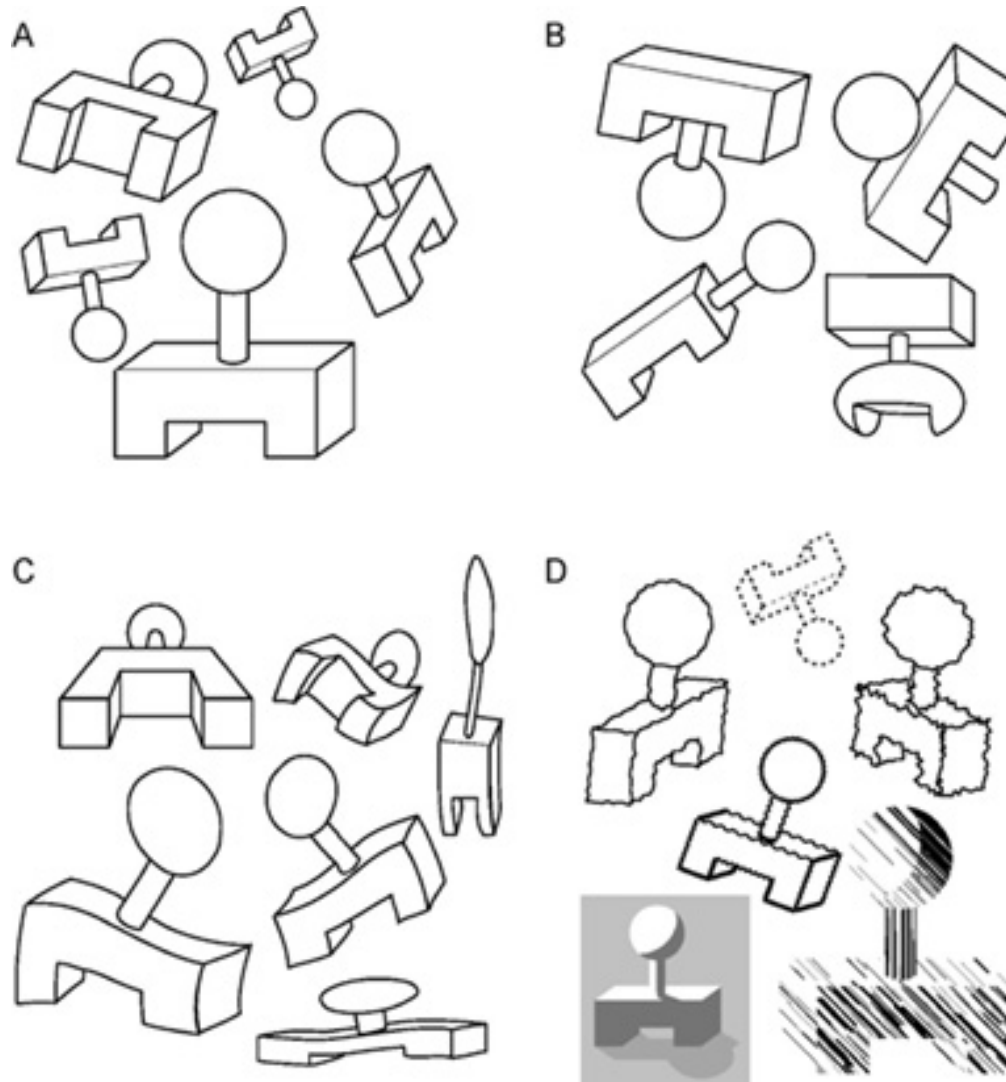


Rubin Vase



<https://commons.wikimedia.org>

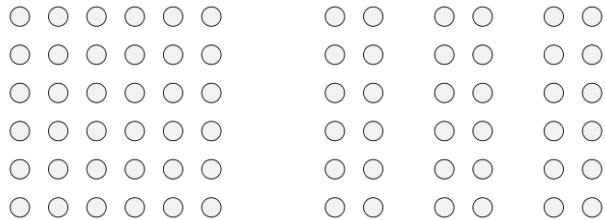
Principles of Gestalt Systems—Invariance



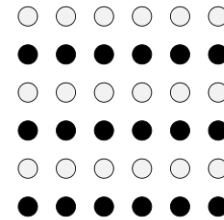
<https://commons.wikimedia.org>

Gestalt Grouping Principles

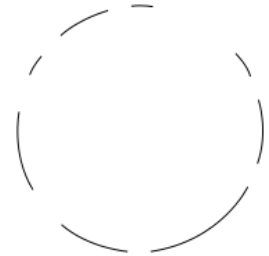
Proximity



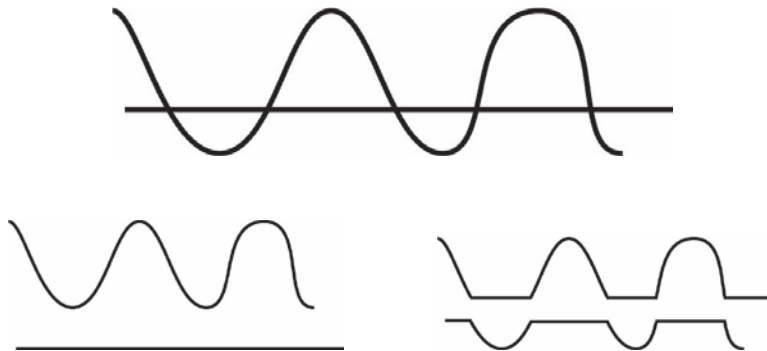
Similarity



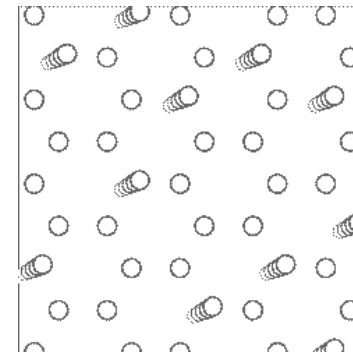
Closure



Continuity

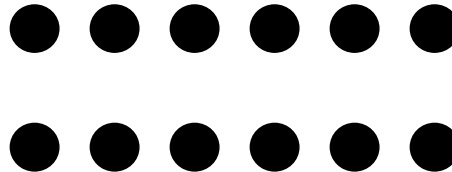


Common Fate

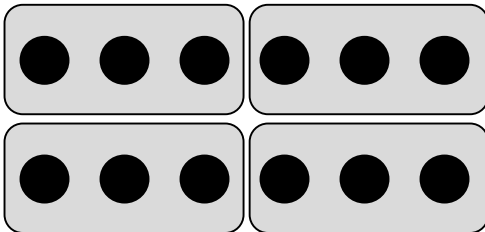


<https://commons.wikimedia.org>

Artificially Induced Gestalt Grouping Principles



Common Region



Connectedness

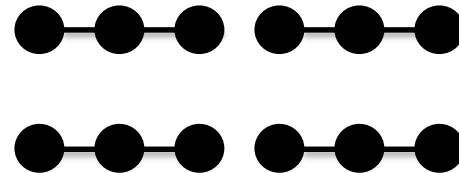
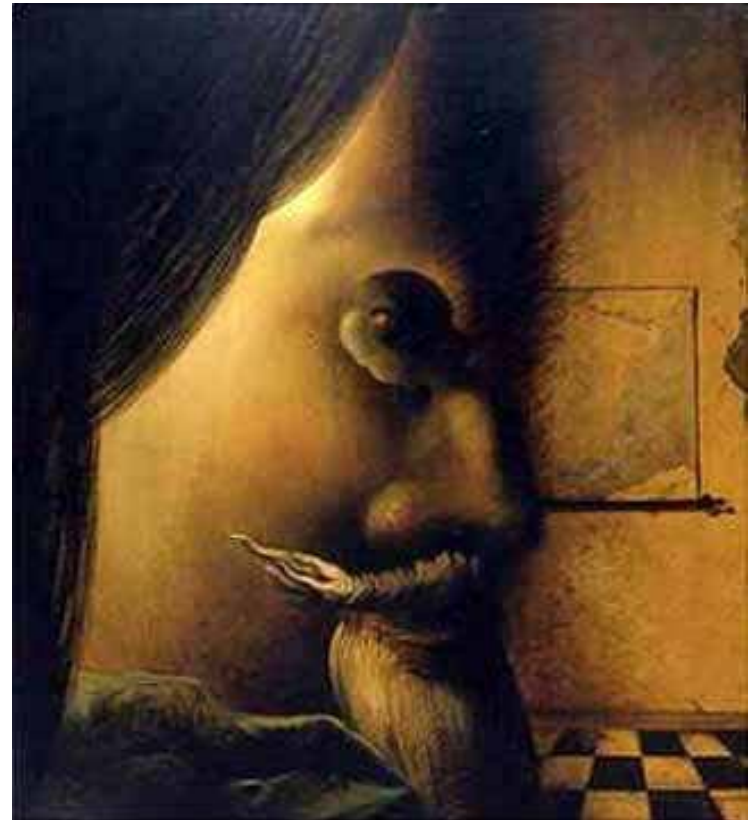


Figure and Ground



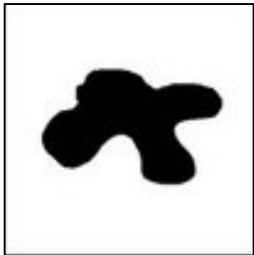
Unknown Artist



Salvador Dali

Principles of Figure-Ground Organization

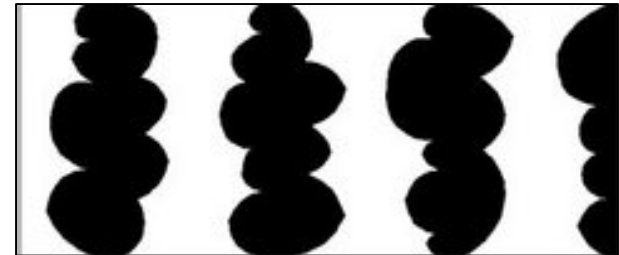
Surroundedness



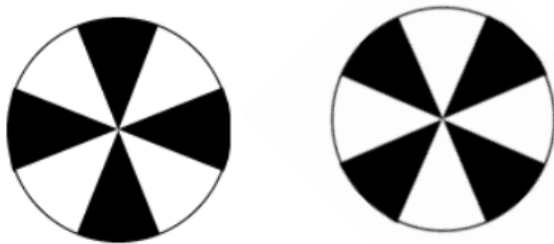
Symmetry



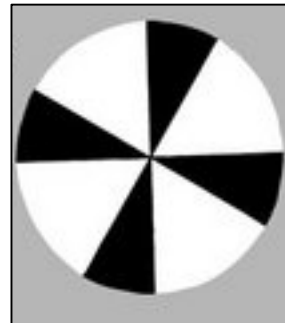
Convexity



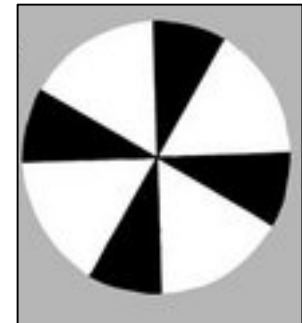
Orientation



Contrast



Area

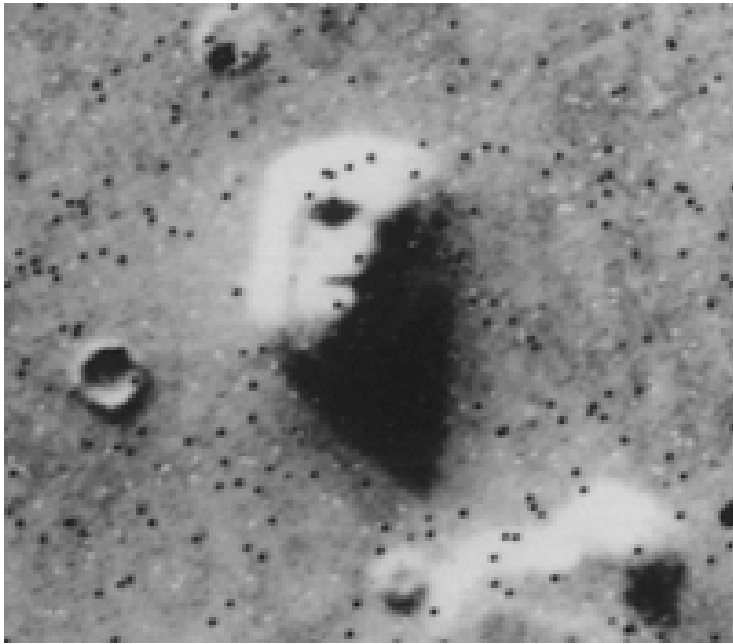


Images from <http://www.scholarpedia.org>

Pareidolia

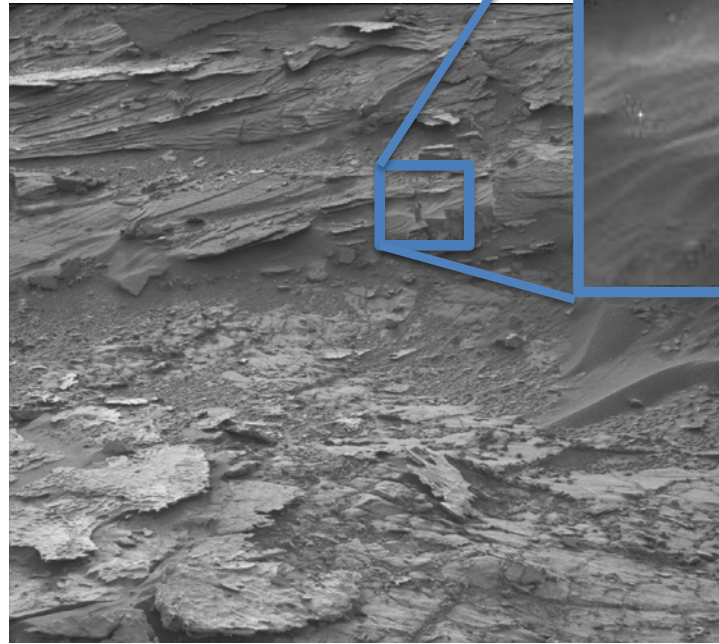
Where the mind perceives a familiar pattern where none actually exists.

Face on Mars



<https://commons.wikimedia.org>

Lady on Pluto



<http://mars.jpl.nasa.gov/>

Depth Perception



Edgar Mueller (<http://www.metanamorph.com/>)

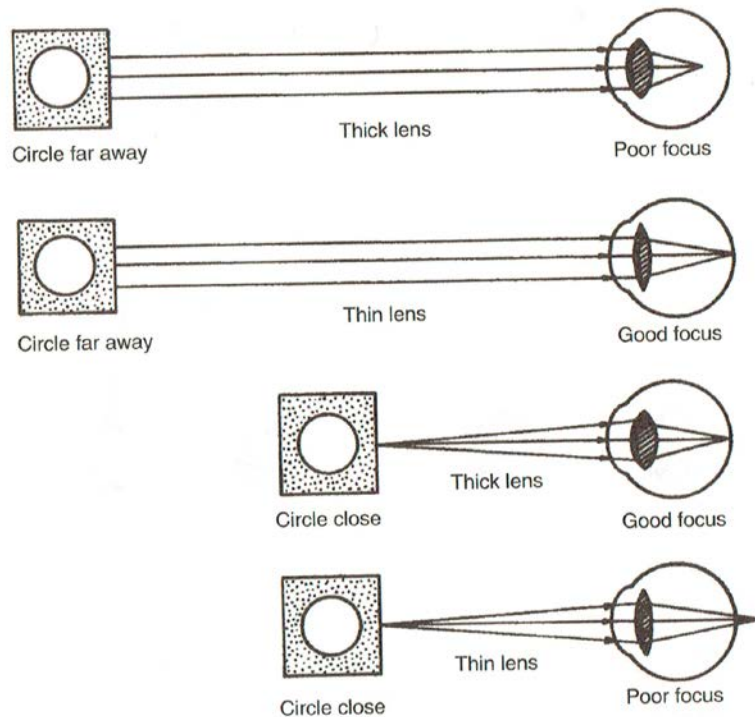
Depth Perception



Julian Beaver (<http://www.artmart.cc/beaver-julian/index.html>)

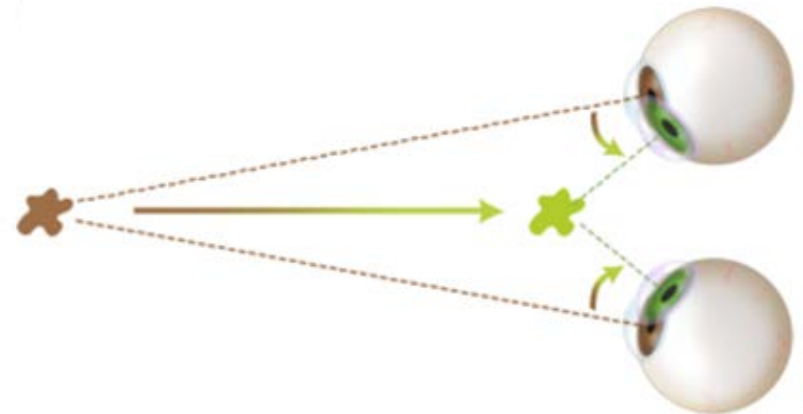
Depth Perception—Oculomotor Cues

Accommodation



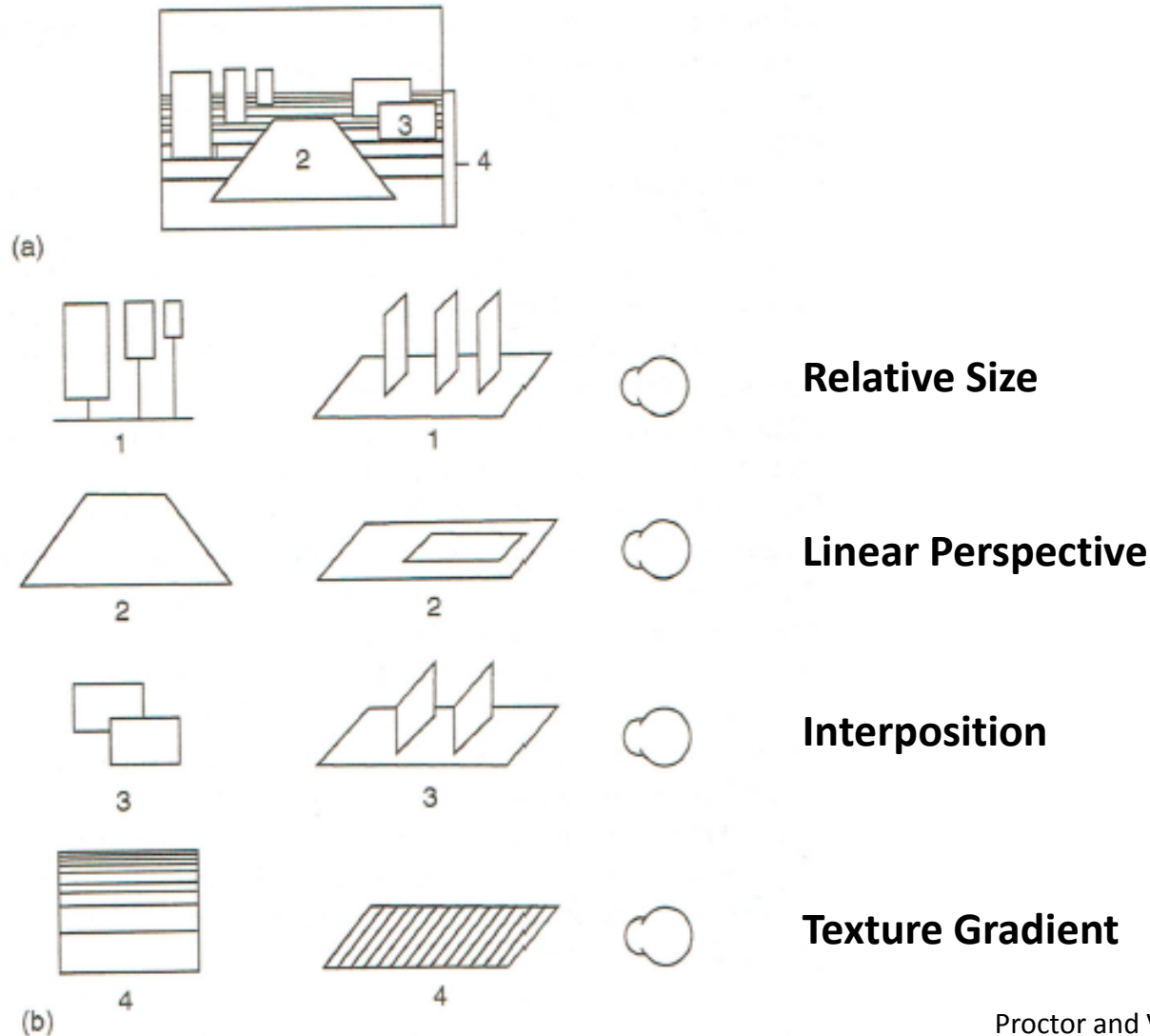
Proctor and Van Zandt, 2008

Vergence



<http://www.eyebraintopia.com/>

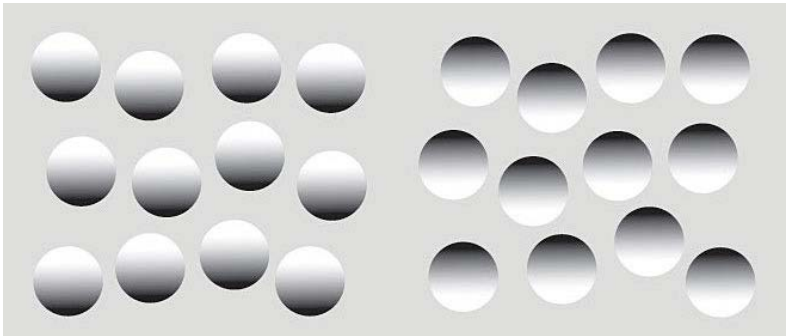
Depth Perception—Monocular Cues



Proctor and Van Zandt, 2008

Depth Perception—Monocular Cues

Contrast



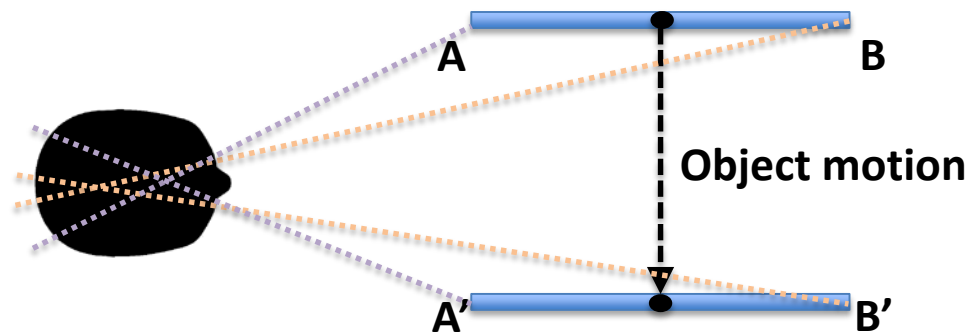
commons.wikimedia.org

Aerial Perspective



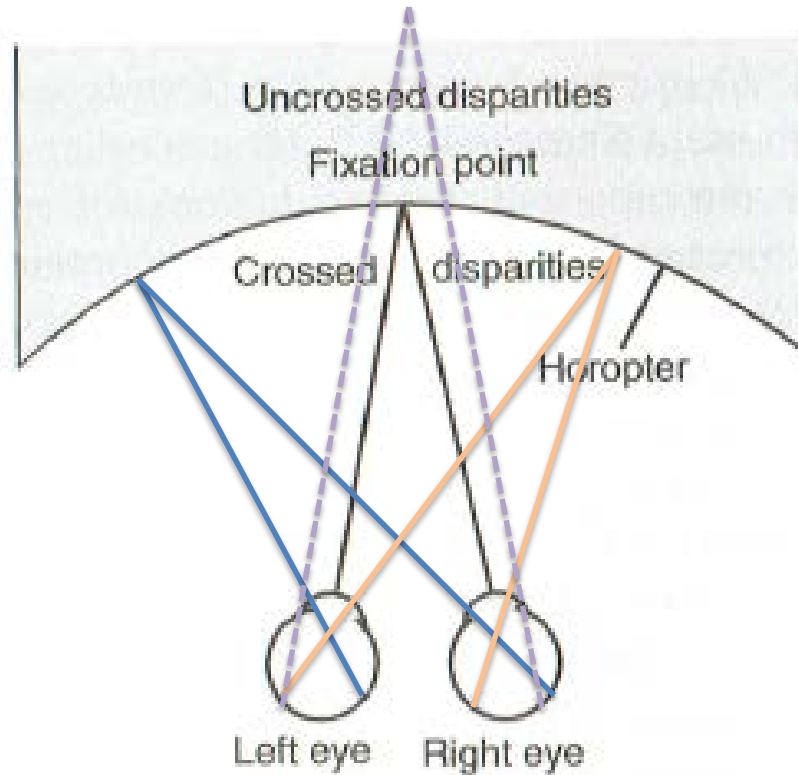
commons.wikimedia.org

Motion Parallax



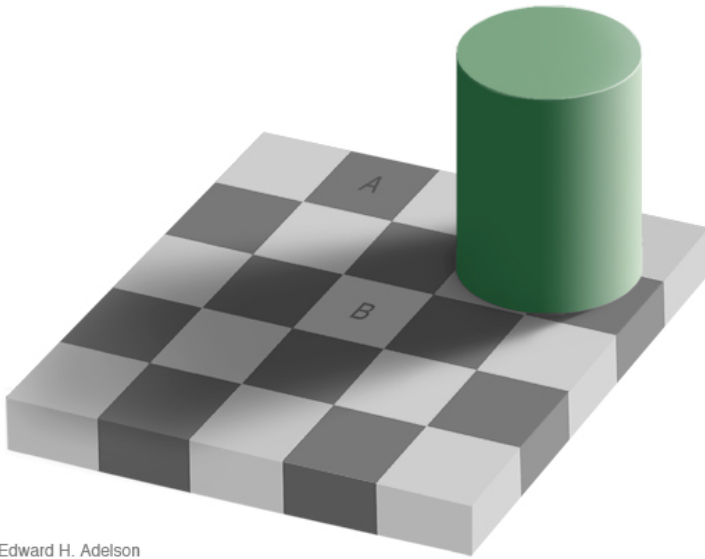
Depth Perception—Binocular Cues

Binocular Disparity

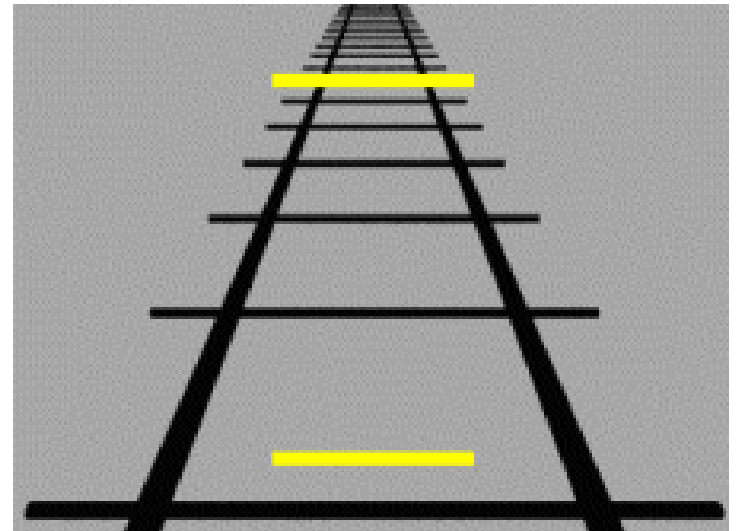


Proctor and Van Zandt, 2008

Additional Visual Perceptual Illusions

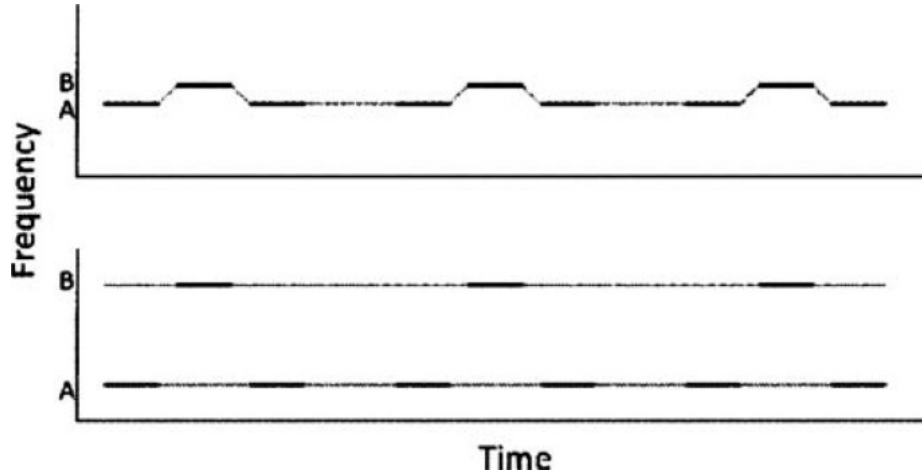


Edward H. Adelson



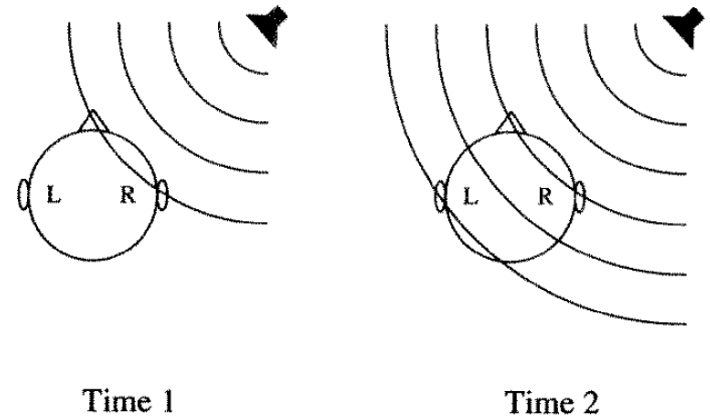
Auditory Perceptual Cues

Stream Segregation



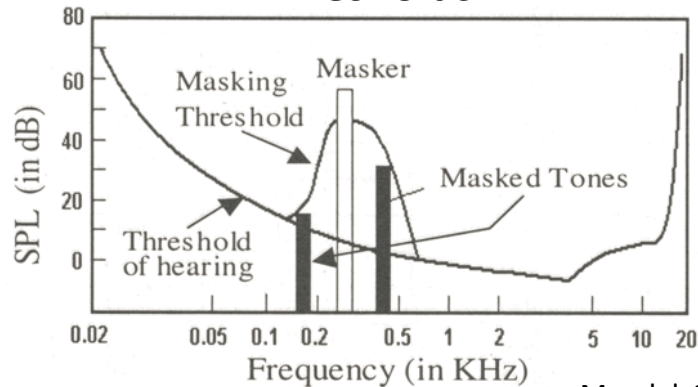
Oxenham, 2008

Localization



Plack, 2005

Thresholds



Mandal, 2003

Speech Perception

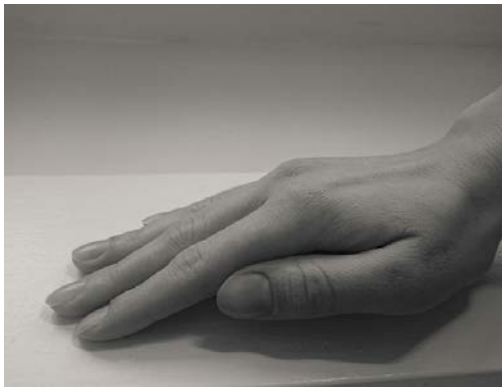
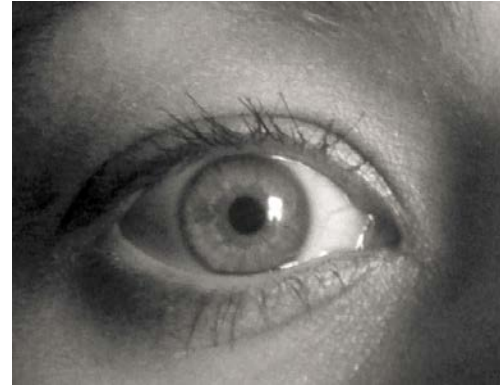
“Bears steal honey from the hive”

“Across bears eyes work the kill”

Proctor and Van Zandt, 2008

DISPLAYS

Display Modalities



wikipedia.org

Auditory or Visual Displays

Audio	Visual
Message is simple	Message is complex
Message is short	Message is long
Message won't be referred to later	Message will be referred to later
Message deals with time	Message deals with space
Immediate action required	Action not required
Visual channel overburdened	Auditory systems overburdened
Brightness/darkness problems	Noisy environment
Person is moving	Person is static

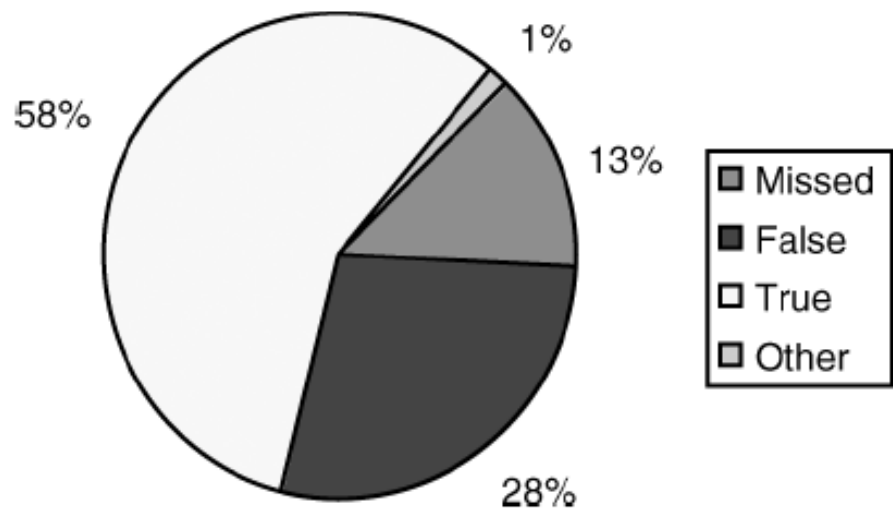
Sound Design Parameters

- Signals
 - Intensity (15-30 dB above masked threshold)
 - Frequency/Pitch (150-1000 Hz)
 - Duration (>100 ms)
 - Rhythm/Speed
 - Timbre (use of harmonics, additional tones)
- Voice
 - Signal parameters
 - Selection of words

Auditory Displays

- Standardization
 - System integration (across and within a system)
- Reliability
 - False alarms
 - Missed alarms
 - True alarms
 - Nuisance alarms

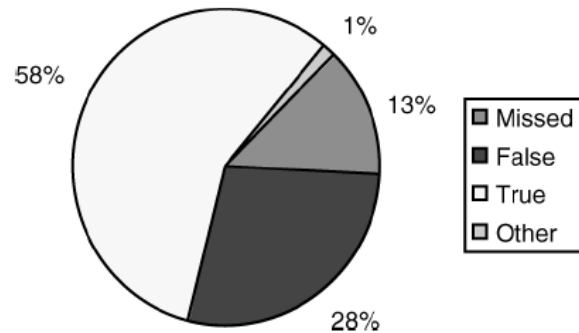
**Aviation Safety Reporting System
Database (1991-1997)**



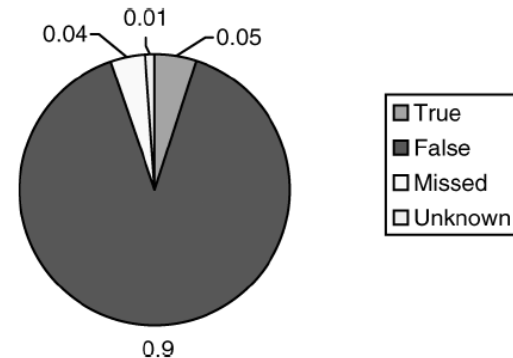
Bliss, 2003

Alarm Incidents

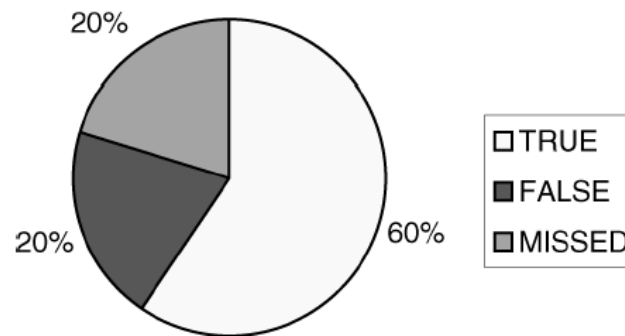
**Aviation Safety Reporting System
Database (1991-1997)**
n=158 alarms



**US Army Aviation Safety
Database (1995-2000)**
n=477 alarms



NTSB Database (1994-1997)
n=107 alarms



Bliss, 2003

Alarm Incidents in Clinical Care

- False alarms problematic (81% respondents)
- Nuisance alarms disruptive to patient care (77% respondents)
- Distrust alarms and disable devices (78% respondents)



nursing.advanceweb.com

Korniewicz et al., 2008

Visual Display Design Principles

- Conspicuity
- Visibility
- Legibility
- Intelligibility
- Emphasis
- Standardization
- Maintainability
- Principle of Information Need
- Proximity Compatibility
- Redundancy
- Principle of Pictorial Realism
- Principle of the Moving Part
- Predictive Aiding

Wickens et al., 2004

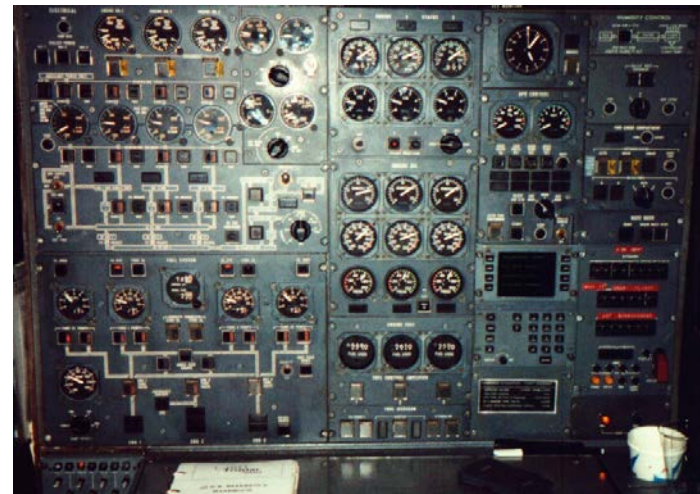
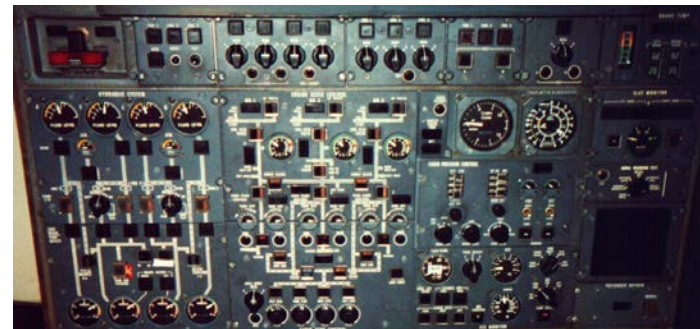
Principle of Information Need

Information required for potential tasks should specify what is displayed.

L-1011 Pilot's overhead and instrument panel



L-1011 Flight Engineer's upper and lower panel



Images taken by Bjorn Hellstrom

Principle of Information Need

767-424 flight deck



Proximity Compatibility

Effort required for task is decreased when displays that are related, compared, or integrated to perform a task are closer together

Vertical control



Lateral control

User name:

Password:

Sign in

Redundancy

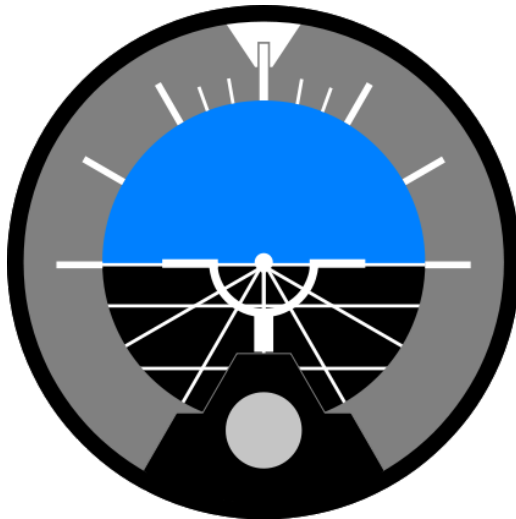
Repeat the message in alternate forms



commons.wikimedia.org

Principle of Pictorial Realism

A display should match the human's internal model of the variable that it represents



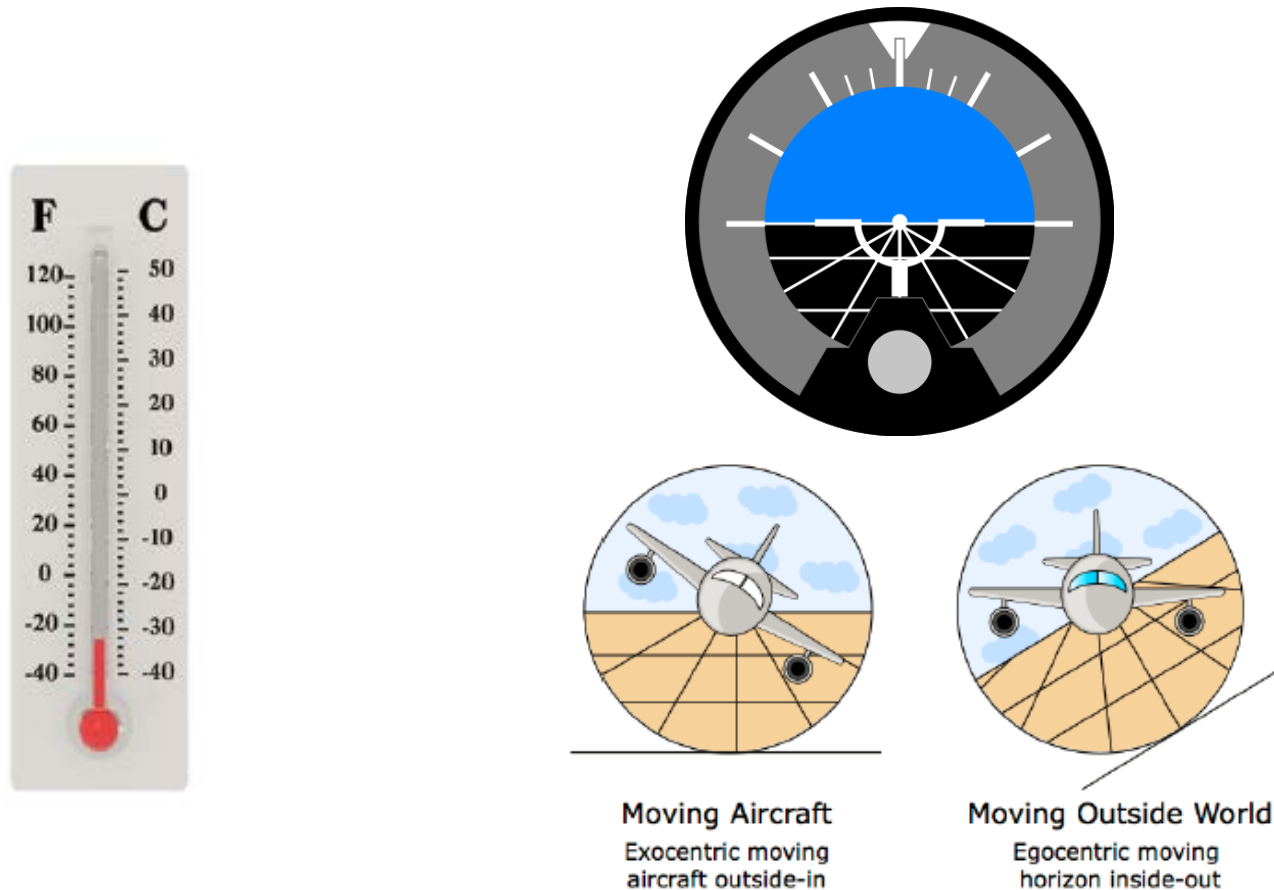
wikipedia.org



pixabay.com

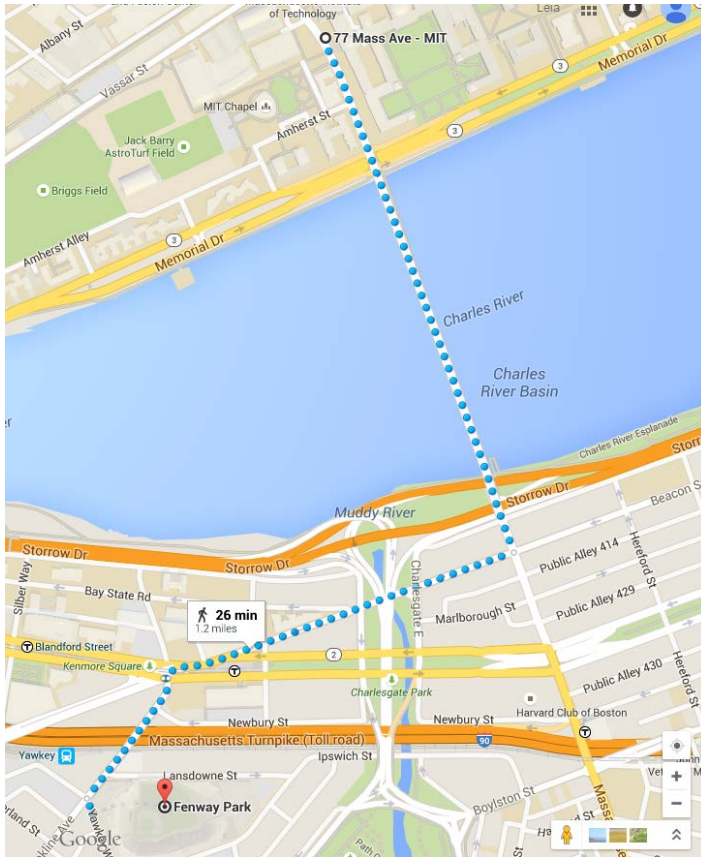
Principle of the Moving Part

The moving element on a display should correspond with the element that moves in the user's mental model



Predictive Aiding

Helps operators to see the future state of the system



Example: Blind Spot Detection

Toyota Blind Spot Monitor



Honda LaneWatch



BMW Lane Change Warning (w/ synchronous vibrating wheel)



Summary

- Perceptual organization describes how we understand sensory stimuli
- Described many different principles for display designs. These can be used as guidance as you develop a system interface to optimize user performance.

References

- Bliss J. Investigation of Alarm-Related Accidents and Incidents in Aviation. The International Journal of Aviation Psychology 13(3): 249-268, 2003.
- Korniewicz D, Clark T, David Y. A National Online Survey on the Effectiveness of Clinical Alarms. American Journal of Critical Care Management 17(1): 36-41, 2008.
- Mandal M. Multimedia Signals and Systems. Springer, 2003.
- Oxenham A. Pitch Perception and Auditory Stream Segregation: Implications for Hearing Loss and Cochlear Implants. Trends in Amplification 12(4): 316-331, 2008.
- Proctor R, Van Zandt T. Human Factors in Simple and Complex Systems 2nd Edition. CRC Press, 2008.
- Petersen M, Salvagio E. Figure-Ground Perception. Scholarpedia 5(4): 4320, 2010.
http://www.scholarpedia.org/article/Figure-ground_perception.
- Plack C. The Sense of Hearing. Psychology Press, 2005.
- Wickens C, Lee J, Liu Y, Becker G. An Introduction to Human Factors Engineering, Second Edition. Pearson Prentice Hall, 2004.