Design of Interactive Systems (DIS)

Lecture 15: Perception and navigation

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Part IV Foundations of designing interactive systems

- **Chapter 21**: Memory and attention
- **Chapter 22**: Affect
- **Chapter 23**: Cognition and action
- **Chapter 24**: Social interaction
- **Chapter 25:** Perception and navigation

Introduction

- Two different abilities of people: Perception and navigation
- Perception is concerned with how we come to know an environment through our senses
- Navigation is concerned with how we move through environments.

Aims

- Understand various theories of visual perception
- Understand other forms of perception
- Understand how we navigate in physical environments
- Understand navigation in information spaces.

Introduction

- Importance of perception and navigation in the existence of humans
- Other than knowing things in the environment, it is important to know what those things can do
- Mixed reality world is dynamic while physical world is relatively static (road, buildings etc.).
- understanding human perceptual abilities is important background for the design of visual experiences
- Navigation is central to the development of any information space, including mobile and ubiquitous environments, websites and collaborative environments.

Visual perception

- **Visual perception** is concerned with extracting meaning from the light falling on our eyes.
- Visual perception allows us to recognize a room and the people and furniture therein, or to recognize the Windows XP ‘start’ button.
- **Vision** is concerned with such things as detecting colour, shapes and the edges of objects.
- The study of visual perception is often divided into a number of interwoven threads, namely theories of visual perception, including **depth perception**, **pattern recognition** and **developmental aspects** (how we learn to perceive, or how our perceptual abilities develop)

Visual perception

- A red car appears red in normal daylight because it reflects the red elements of (white) light. Yet the same car will appear red at night or parked under a yellow street light. This is an example of a perceptual constancy - in this instance, colour constancy.
- A coin always appears coin-shaped no matter how it is held in one’s hand. This too is an example of another constancy - shape constancy

Visual perception

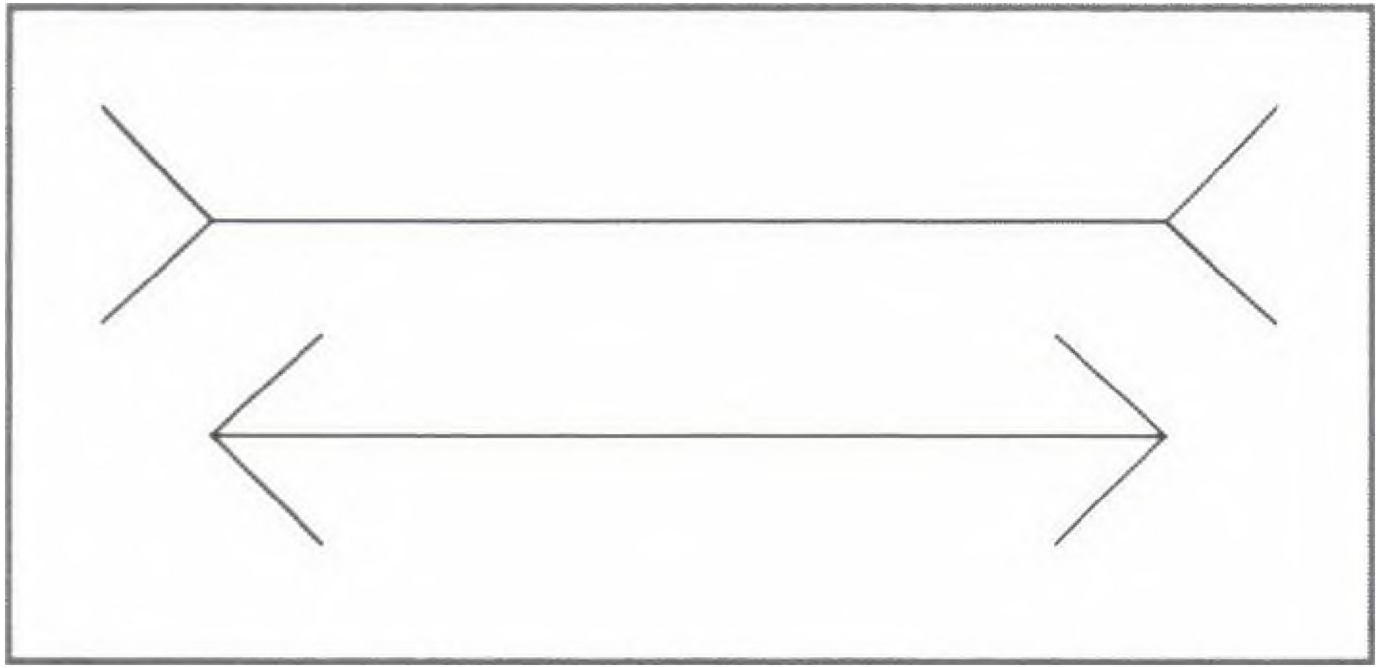


Figure 25.1 The Muller-Lyer illusion

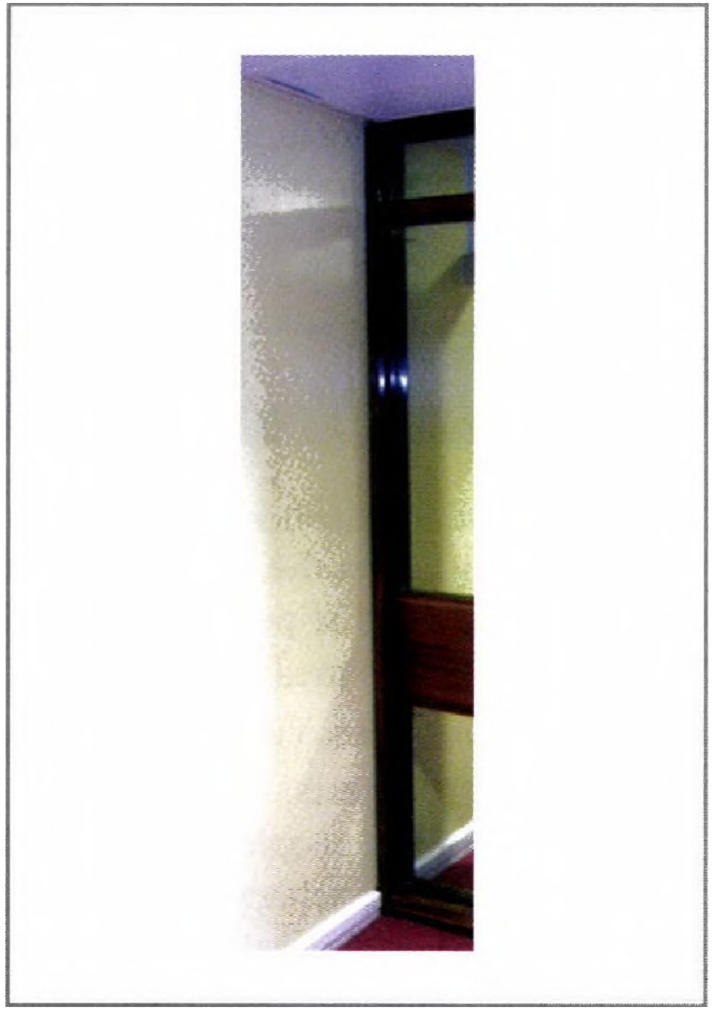


Figure 25.2 The Muller-Lyer illusion in the world

Visual perception

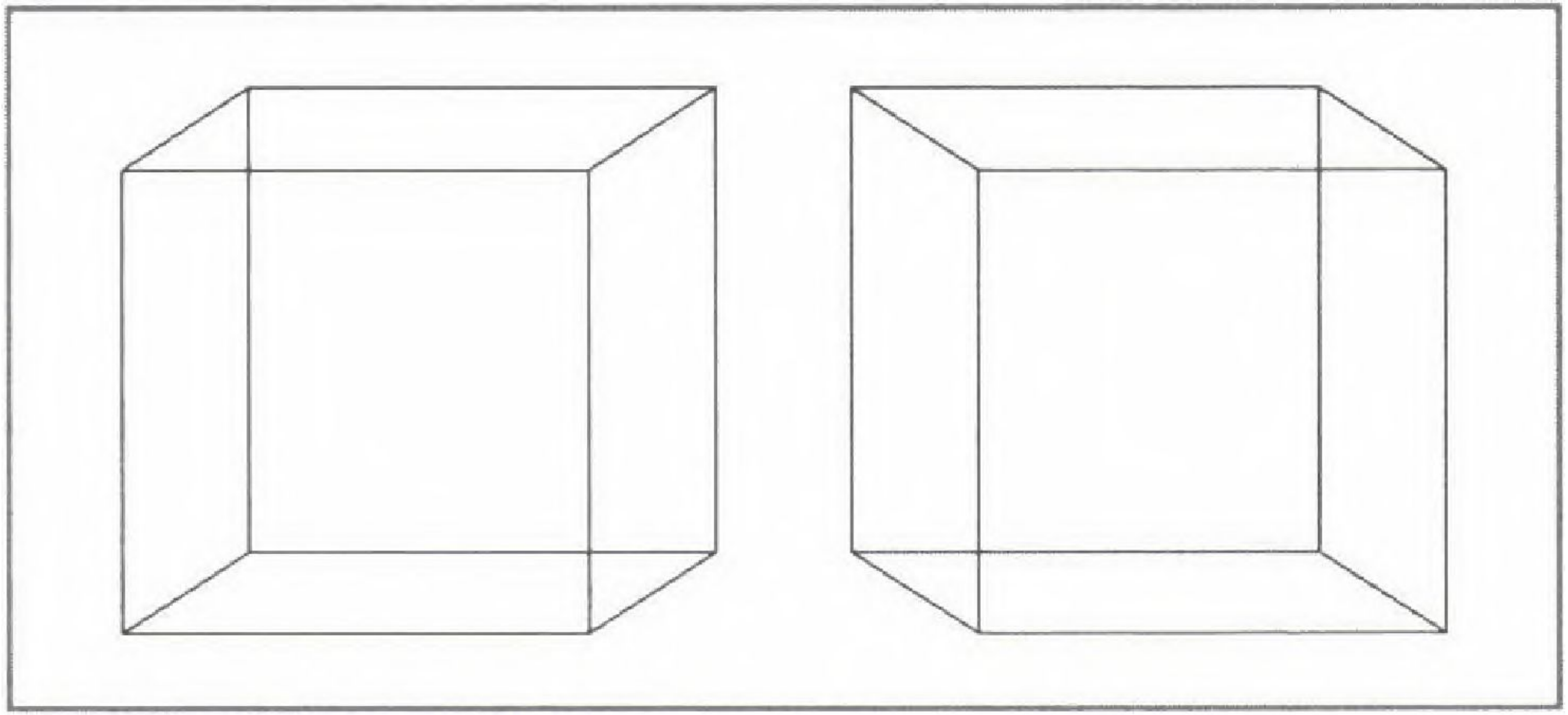


Figure 25.3 A pair of Necker cubes

Direct perception

- Gibson’s work for the US military in improving the training of aircraft pilots, particularly during taking off and landing
- Pilot sitting in the fixed point experiences the world apparently flowing past him. Gibson called this flow of information the optic array
- This optic flow supplies *unambiguously* all information relevant to the position, speed and altitude of the aircraft to the pilot.
- As we drive down a road the environment appears to flow out and past us as we move. What is actually happening is that the texture of the environment is expanding.

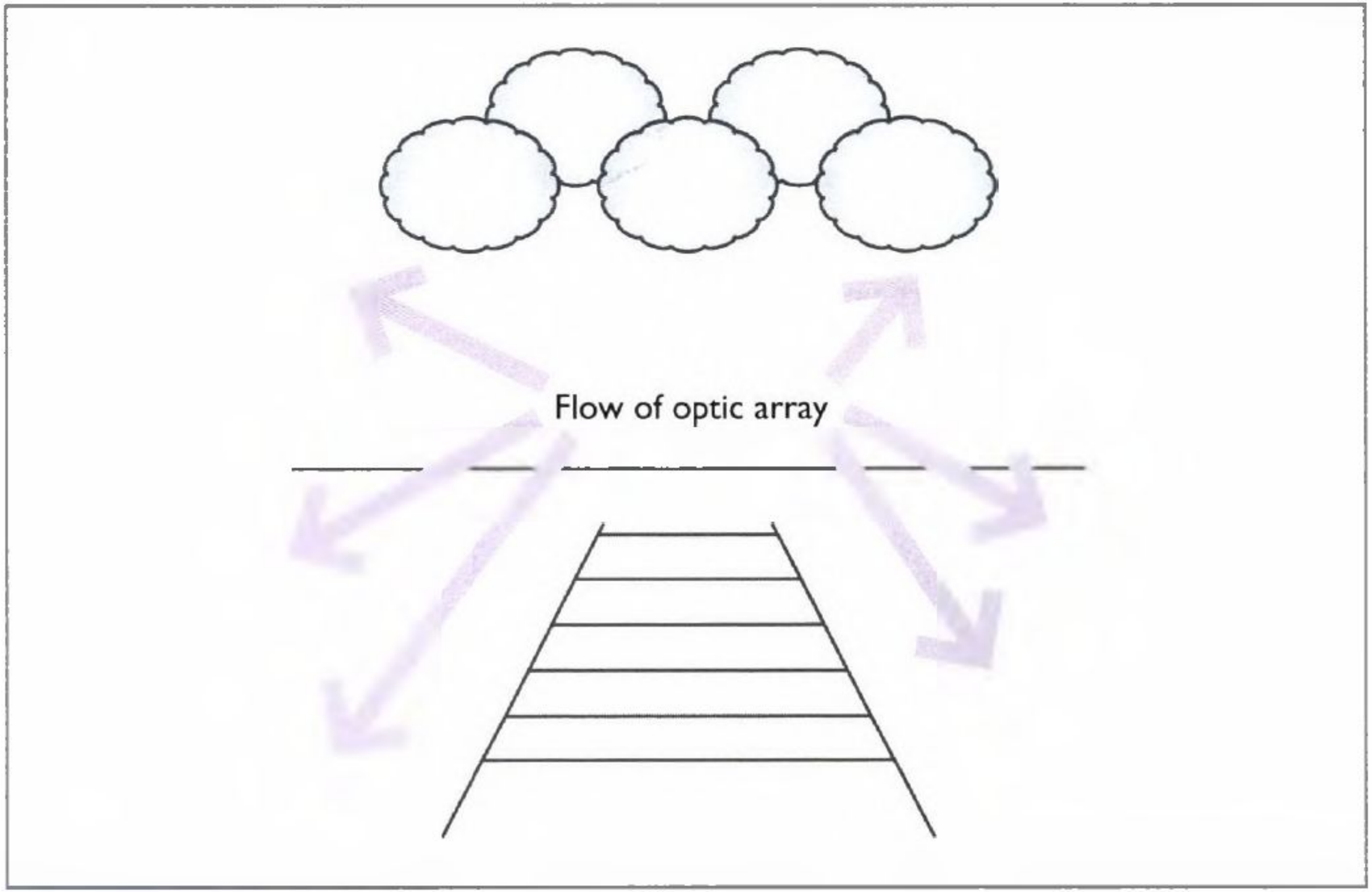


Figure 25.4 Flow of optic array

Direct perception

- Texture gradients provide important depth information.
- Examples of texture gradients include such things as pebbles on a beach or trees in a wood.
- As we approach a beach or a forest the texture gradient expands as individual pebbles or trees reveal themselves against the higher density of pebbles and trees of the beach or forest.

Depth perception

- How we perceive depth is not particularly relevant to everyday office applications, it is often essential to the effective design of games, multimedia applications and virtual reality systems.
- When designing to give the impression of three- dimensionality (a sense of depth and height) we need to understand how we pick up information from the environment which we interpret as height and depth
- Depth perception is usually divided into the role of primary (relevant to immersive **virtual reality systems**) and secondary depth cues (more important to non-immersive applications such as **games**).

Primary depth cues

A **cue** is a means or mechanism that allows us to pick up information about the environment.

- *Retinal disparity.* As our eyes are approximately 7 cm apart, each retina receives a slightly different image of the world. This difference is processed by the brain and interpreted as distance information.
- *Stereopsis* is the process by which the different images of the world received by each eye are combined to produce a single three-dimensional experience.
- *Accommodation.* This is a muscular process by which we change the shape of the lens in our eyes in order to create a sharply focused image. We unconsciously use information from these muscles to provide depth information.
- *Convergence.* Over distances of 2-7 metres we move our eyes more and more inwards to focus on an object at these distances. This process of convergence is used to help provide additional distance information.

Secondary depth cues

- Secondary depth cues (also called monocular depth cues - i.e. they rely on only one eye) are the basis for the perception of depth on flat visual displays
- These secondary depth cues are light and shade, linear perspective, height in the horizontal plane, motion parallax, overlap, relative size and texture gradient

Secondary depth cues

- *Light and shade.* An object with its attendant shadow (Figure 25.5) improves the sense of depth.

Figure 25.5 A three- dimension teacup

Secondary depth cues

- *Linear perspective.* Figure 25.6 illustrates some examples of the use of linear perspective to give an impression of depth.

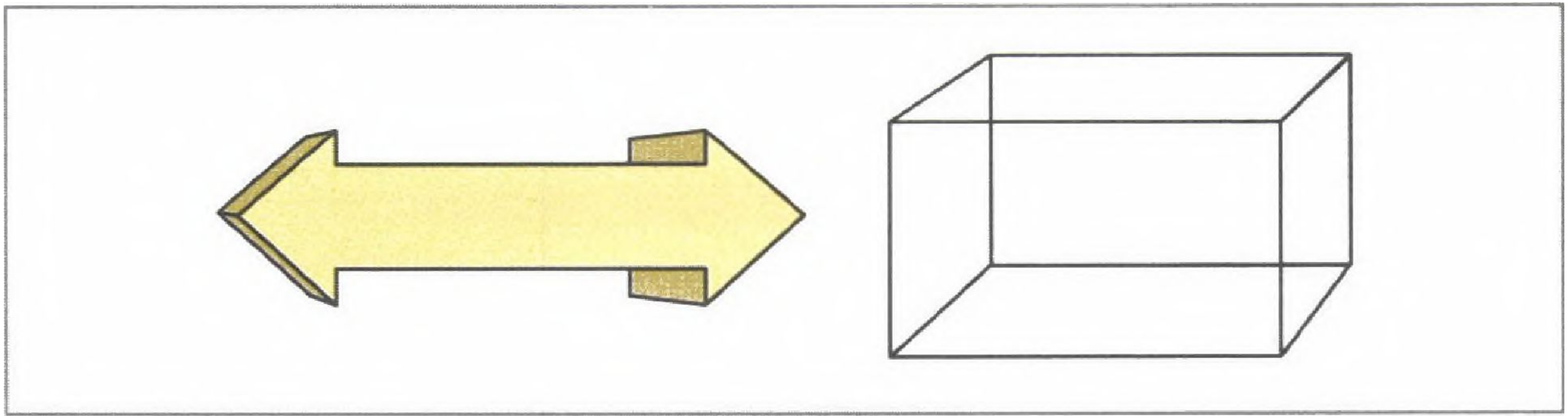


Figure 25.6 Examples of linear perspective, using 'shadow' and wire frame

Secondary depth cues

- *Height in horizontal plane.* Distant objects appear higher (above the horizon) than nearby objects. Figure 25.7 is a screenshot of a chessboard which uses height in the horizontal plane to give the impression of the black pieces being further away than the white.

Figure 25.7 Use of height in the horizontal plane to give an impression of depth

Secondary depth cues

- *Motion parallax.* This cannot be demonstrated in a static image as it depends upon movement.
- It is perhaps best seen when looking out through a window in a fast- moving train or car.
- Objects such as telegraph poles that are nearby are seen to flash past very quickly while, in contrast, a distant building moves much more slowly.

Secondary depth cues

- *Overlap.* An object which obscures the sight of another is understood to be nearer. Figure 25.8 illustrates this point with an image of three overlapping windows.

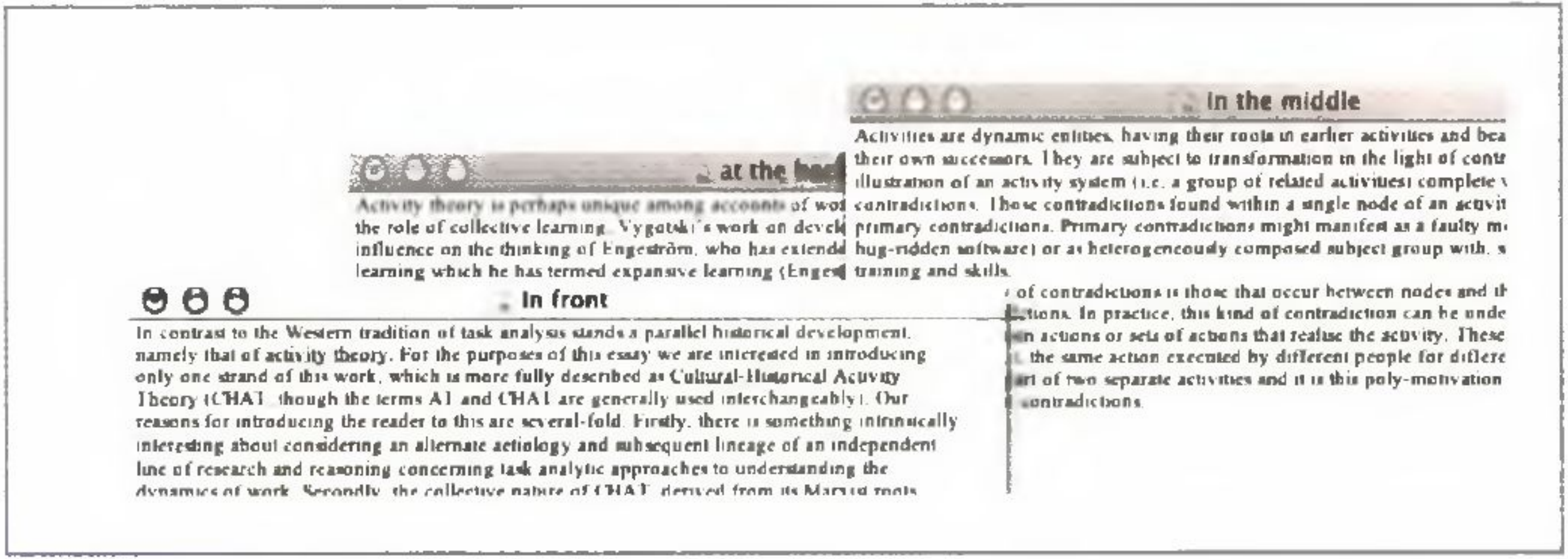
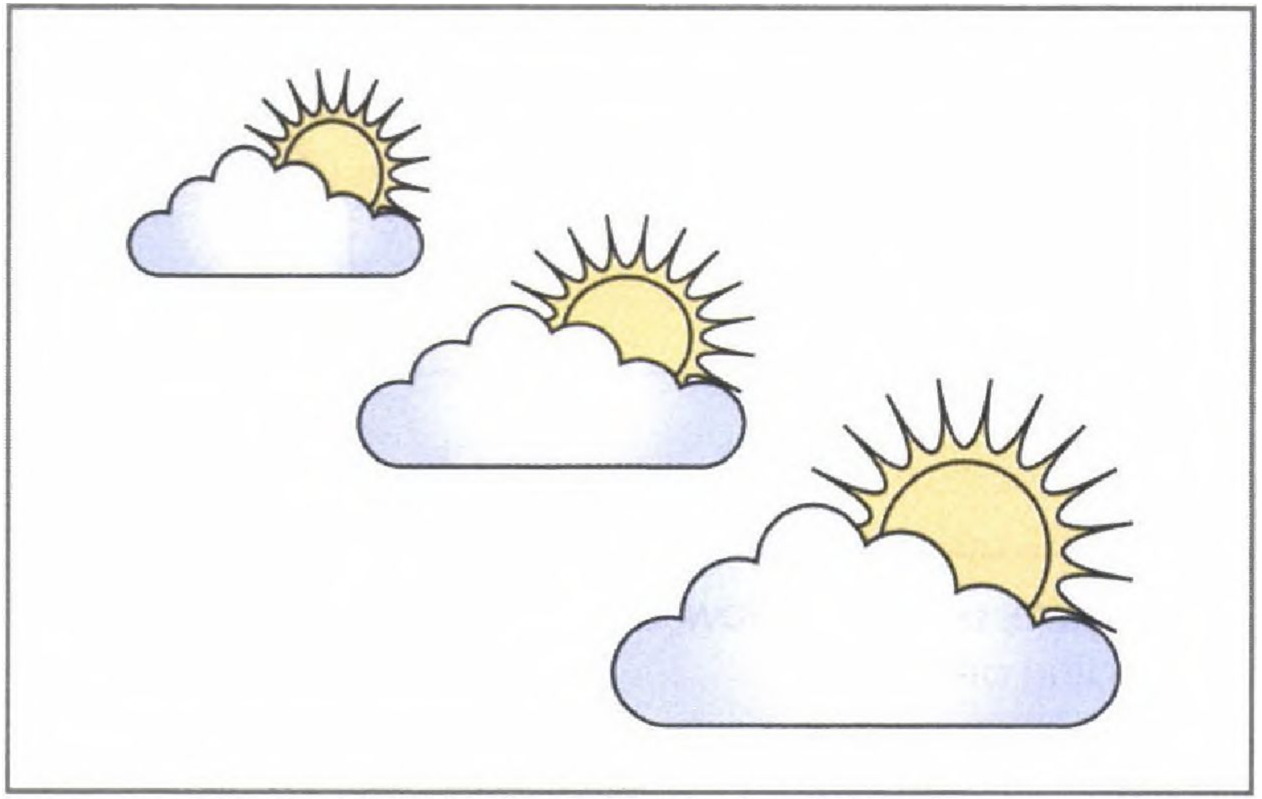


Figure 25.8 Overlapping documents

Secondary depth cues

- *Relative size.* Smaller objects are usually seen as being further away, particularly if the objects in the scene are of approximately the same size (Figure 25.9).



25.9 Relative size

Secondary depth cues

- *Texture gradient.* Textured surfaces appear closer; irregularities out over distance (Figure 25.10).

Figure 25.10 Texture gradient

The Gestalt laws of perception

- The Gestaltists were a group of psychologists working in the early years of the twentieth century who identified a number of 'laws' of perception that they regarded as being innate (i.e. we are born with them).

Proximity

- The law of proximity refers to the observation that objects appearing close together in space or time tend to be perceived together. For example, by the careful spacing of objects they will be perceived as being organized into either columns or rows (Figure 25.12).

The Gestalt laws of perception

Continuity

- We tend to perceive smooth, continuous patterns rather than disjoint, interrupted ones. Figure 25.13 will tend to be seen as a continuous curve rather than the five semi-circles from which it was actually constructed.

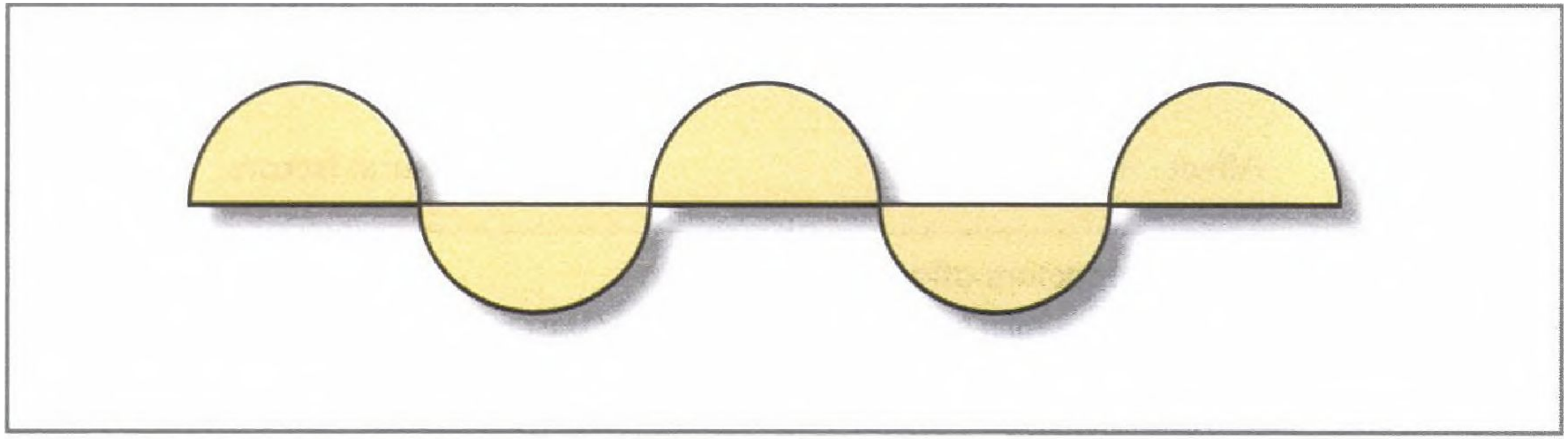


Figure 25.13 Continuity

Part-whole relationships

- This is an example of the classic Taw' - the whole is greater than the sum of its parts. Figure 25.14(a) is made up from the same number of H's as Figure 25.14(b): same parts - different whole (s).

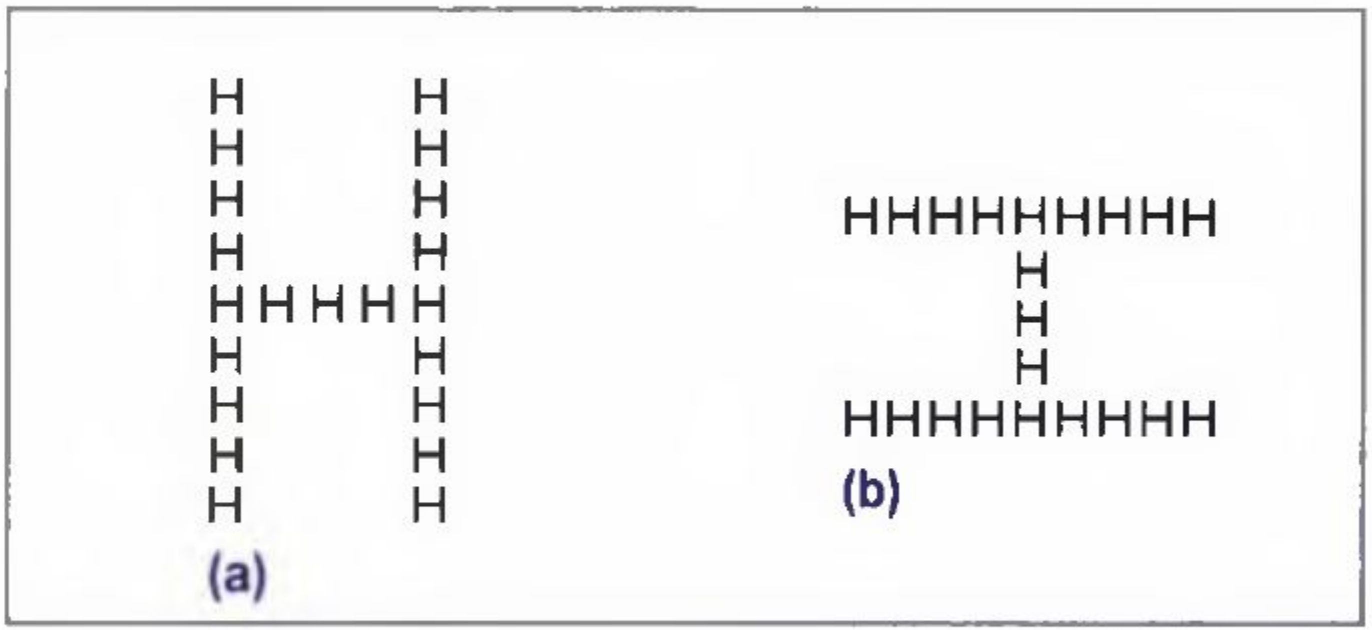
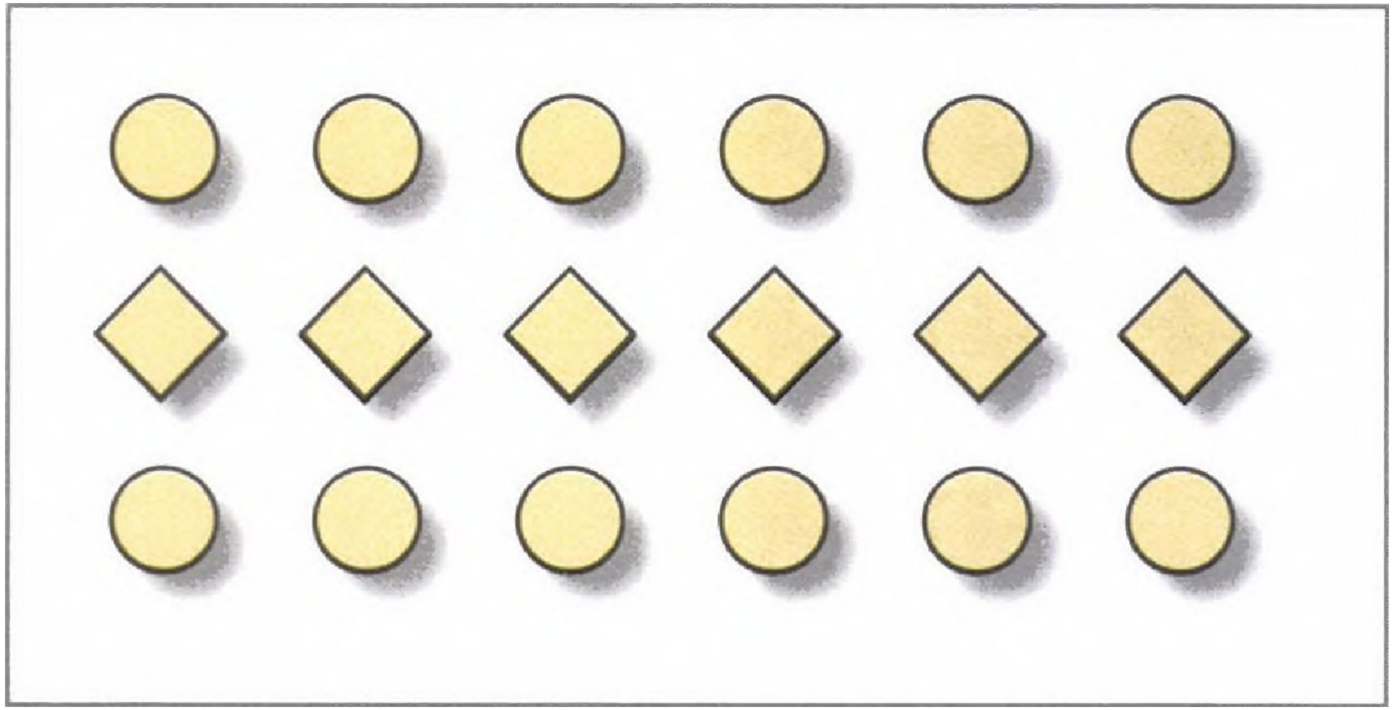


Figure 25.14 Part–whole relationships

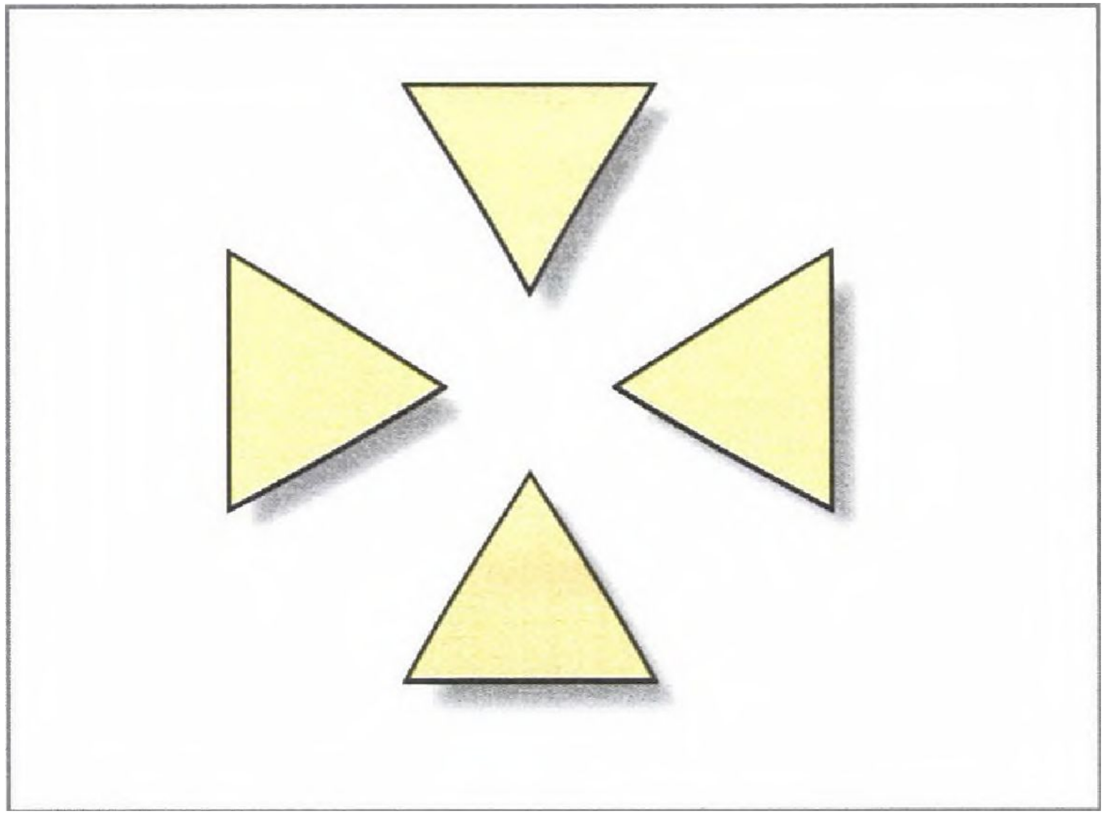
Similarity

- Similar figures tend to be grouped together. Figure 25.15 is seen as two rows of circles with a single row of diamonds sandwiched between them.



Closure

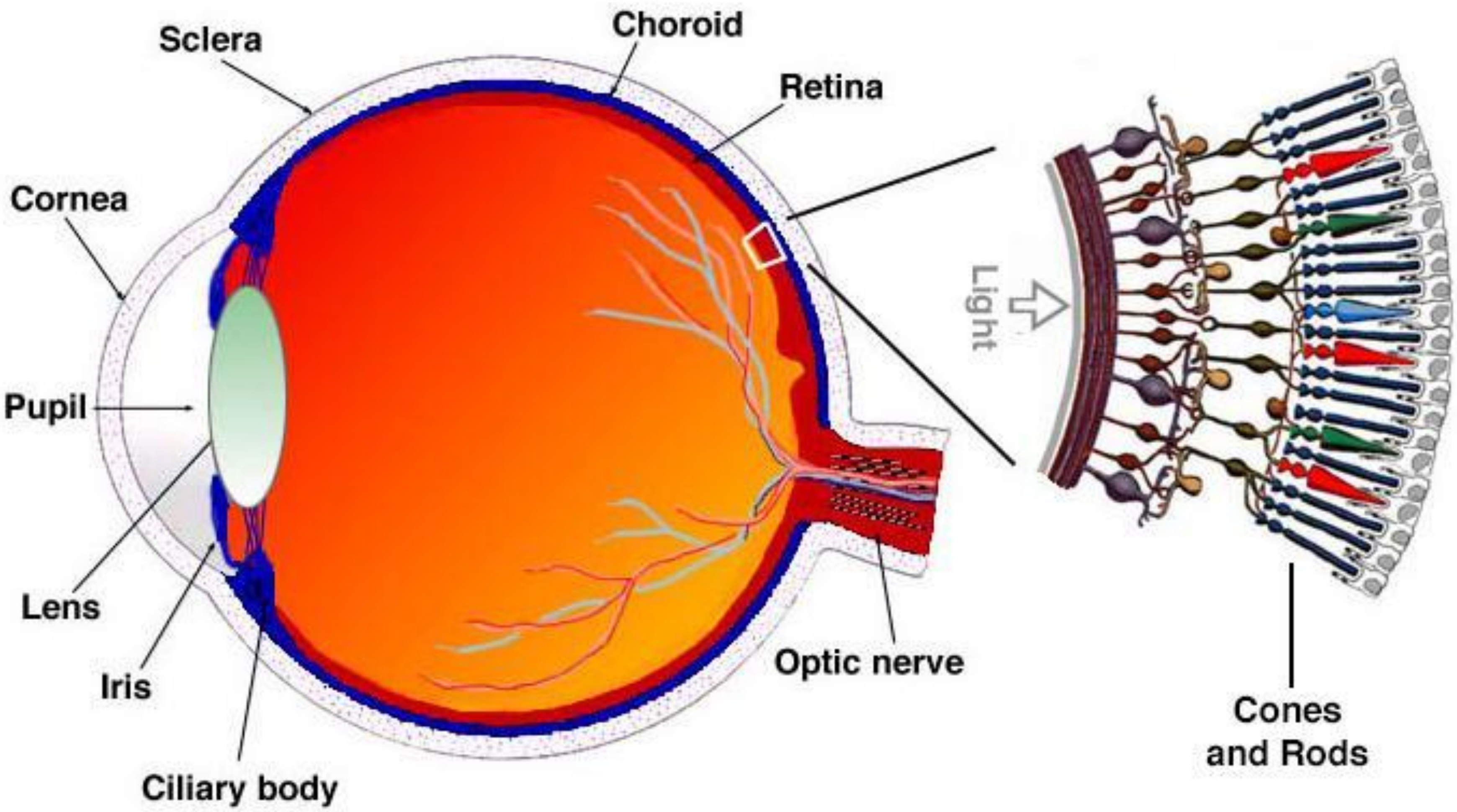
- Closed figures are perceived more easily than incomplete (or open) figures. This feature of perception is so strong that we even supply missing information ourselves to make a figure easier to perceive. Figure 25.16 is either four triangles or a Maltese cross.



Color perception

- At the back of each eye is the retina, which contains two types of light-sensitive cells called rods and cones.
- The rods number approximately 120 million and are more sensitive than the cones. However, rods are not sensitive to colour. The 6 or 7 million cones provide the eye's sensitivity to colour.
- The cones are concentrated in the part of the retina called the *fovea* which is approximately 0.3 mm in diameter. The colour-sensitive cones are divided into 'red' cones (64 per cent), 'green' cones (32 per cent) and 'blue' cones (2 per cent).
- The cones are also responsible for all high-resolution vision (as used in such things as reading), which is why the eye moves continually to keep the light from the object of interest falling on the fovea.

Color perception



Non-visual perception

- In addition to visual perception, people are endowed with other ways of sensing the external environment. These are usually identified as our other four senses: taste, smell, touch and hearing.

Auditory perception

- The first distinction to be made is between *hearing* and *audition (auditory perception).*
- *H*earing is the processing of variations in air pressure (sound) and auditory perception is the extraction of meaning from the patterns of sound, for example recognizing a fire alarm or holding a conversation
- Sound comes from the *motion* (or vibration) of an object. This motion is transmitted through a *medium* (such as air or water) as a series of *changes in pressure.*

Non-visual perception

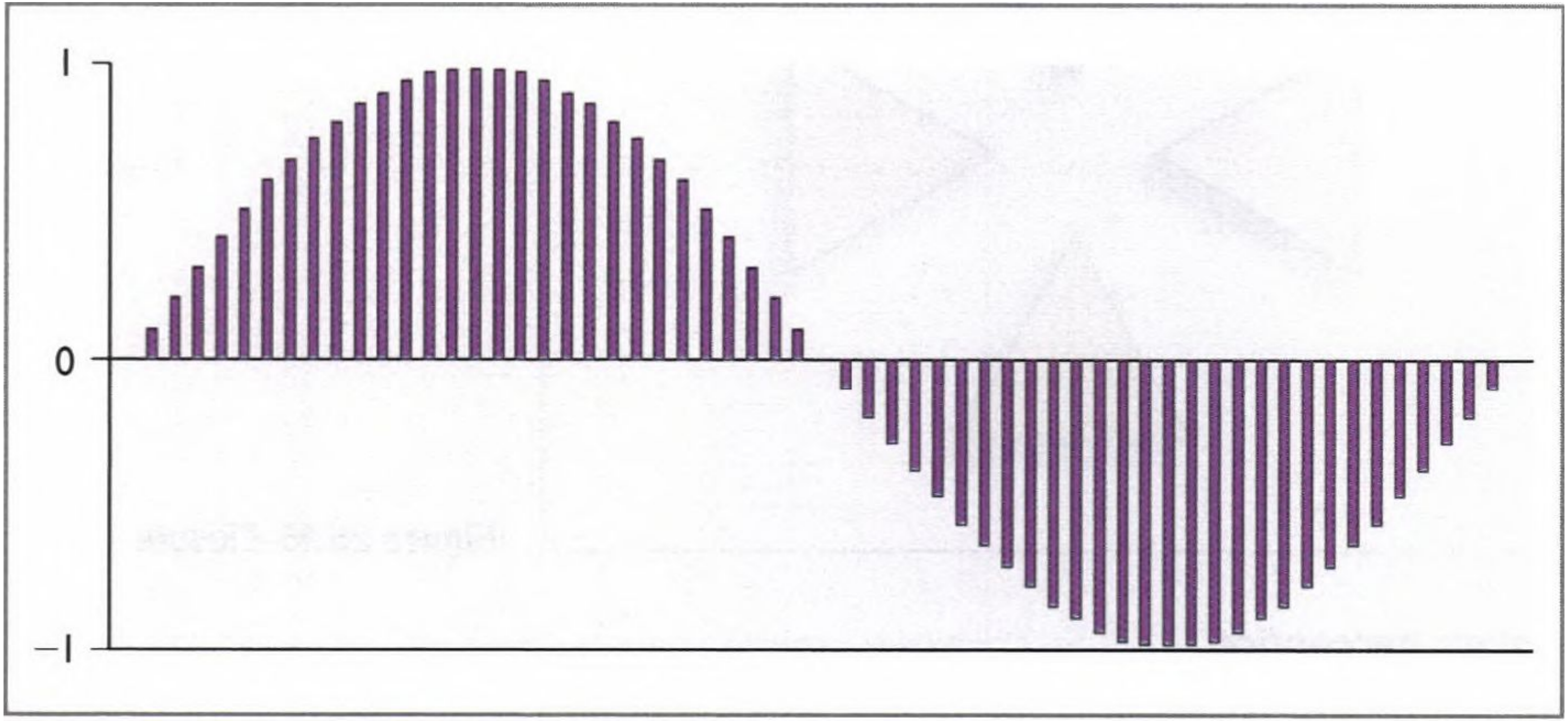


Figure 25.17 A pure sound wave

Loudness

- The heights of the peaks indicate how loud the sound is. Loudness is measured in decibels (dB).
- On the decibel scale, the smallest audible sound (near total silence) is 0 dB.
- The decibel scale is logarithmic, which means that a sound of 40 dB is 10 times louder than the same sound at 30 dB
- It should be noted that prolonged exposure to any sound above 85 dB will cause hearing loss.

Near total silence	0dB
A whisper	15 dB
Normal conversation	60 dB
A car horn	110 dB
A rock concert	120 dB

Frequency

- The frequency of the sound wave is the pitch of the sound - low-frequency sounds like the rumble of an earthquake have a very low pitch,
- while high-frequency sounds like those of screaming children have a high pitch.
- As we get older we tend to lose the ability to hear higher-pitched sounds.
- So while children may be able to hear a dog whistle or the sound of a bat's echo location, adults usually cannot. (The pipistrelle bat emits its echo- location signals at about 45 kHz, whereas the noctule bat uses a lower frequency of about 25 kHz or so.)
- The range of hearing for a typical young person is 20 to 20,000 hertz

Haptic perception

- Haptic perception starts with touch, which is sensed by receptors lying both beneath the skin surface (cutaneous receptors) and in the muscles and joints (kinaesthetic receptors).
- Heat and vibration can also be sensed from a source with which we are not in direct contact. Haptic perception provides a rich ‘picture’ of an individual’s immediate surroundings and is essential to manipulating objects.

Haptic perception

- Tan divides haptics into two components - *tactile sensing,* that is, sensing via the outsides of our bodies (skin, nails and hair), and *kinaesthetic sensing,* which concerns the knowledge we have of our body's position
- Activities such as the reading of Braille text by blind people require the use of both the sensing and manipulation aspects of the haptic system.

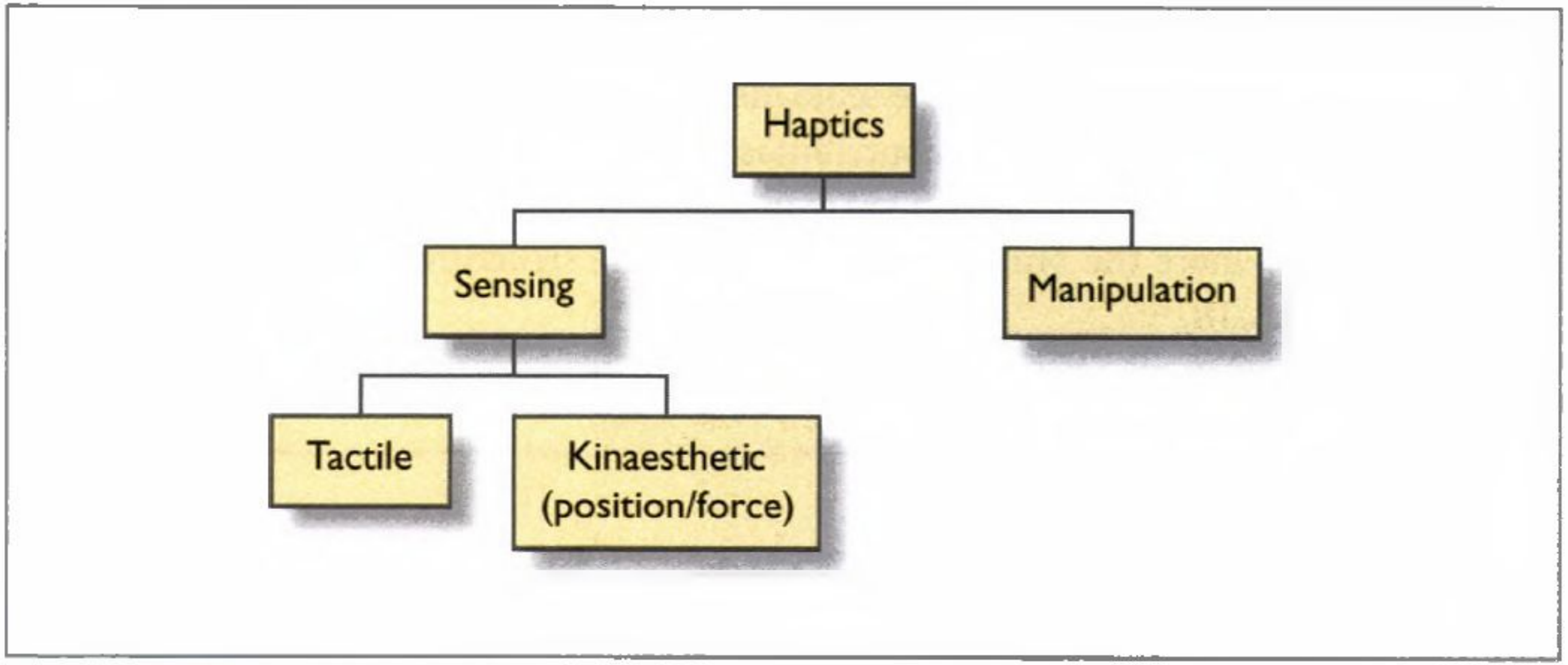


Figure 25.19 Defining haptics

Navigation

- Perception is how we sense the environment; navigation is concerned with finding out about, and moving through, the environment.

Navigation includes three different but related activities:

- ***Object identification***, which is concerned with understanding and classifying the objects in an environment.
- ***Exploration***, which is concerned with finding out about a local environment and how that environment relates to other environments.
- ***Wayfinding***, which is concerned with navigating towards a known destination.

Designing for navigation

- Designing for navigation has been the concern of architecture, interior design and urban planning for years and many useful principles have been developed that can be applied to the design of information spaces
- The practical aim of navigation design is to encourage people to develop a good understanding of the space in terms of landmark, route and survey knowledge.
- another aim is to create spaces that are enjoyable and engaging

Designing for navigation

- Too much similarity between different areas of an environment can cause confusion.
- The design should encourage people to recognize and recall an environment, to understand the context and use of the environment.
- Designers should aim for a ‘responsive environment’, ensuring the availability of alternative routes, the legibility of landmarks, paths and districts and the ability to undertake a range of activities.

Signage

- There are three primary types of sign that designers can use:
- ***Informational signs*** provide information on objects, people and activities and hence aid object identification and classification.
- ***Directional signs*** provide route and survey information. They do this often through sign hierarchies, with one type of sign providing general directions being followed by another that provides local directions.
- ***Warning and reassurance signs*** provide feedback or information on actual or potential actions within the environment.