Unit 2

How do external factors influence behaviour and mental processes?

AREA OF STUDY 1
What influences a person’s perception of the world?
CHAPTER 7 Sensation and perception
CHAPTER 8 Distortions of perception

AREA OF STUDY 2
How are people influenced to behave in particular ways?
CHAPTER 9 Social cognition
CHAPTER 10 Social influences on behaviour

On completion of this unit, you should be able to:

OUTCOME 1
- compare the sensations and perceptions of vision and taste, and analyse factors that may lead to the occurrence of perceptual disorders

OUTCOME 2
- identify factors that influence individuals to behave in specific ways, and analyse ways in which others can influence individuals to behave differently

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<Permission clearance pending>
UNIT 2 KEY KNOWLEDGE

CHAPTER 8 Nature of psychology
- scope of psychology including specialist fields and fields of application and their contribution to understanding human behaviour;
- classic and contemporary theories that have contributed to the development of psychology from philosophical beginnings to an empirical science, including the relationship between psychology and psychiatry;
- differences between contemporary psychological research methods and non-scientific approaches to investigating and explaining human behaviour;
- major perspectives (biological, behavioural, cognitive and socio-cultural), that govern how psychologists approach their research into human behaviour;

CHAPTER 9 Research methods in psychology 1
- experimental research: construction of hypotheses; identification of independent, dependent and extraneous variables;
- sampling procedures in selection of participants: random sampling and stratified sampling;
- techniques of qualitative and quantitative data collection: case studies; observational studies; surveys; questionnaires; interviews; rating scales; longitudinal, cross-sectional, twin and adoption studies;
- statistics: calculation of percentages; construction of tables, bar charts, histograms, pie charts, line graphs and frequency polygons; generalisation of findings to other populations (external validity);
- ethics and professional conduct: the role of the experimenter; protection and security of participant’s rights;
- confidentiality; voluntary participation; withdrawal rights; informed consent procedures; use of deception in research; debriefing; use of animals in research; role of ethics committees.

CHAPTER 10 The visual perception system
- application of psychological perspectives to explain visual perception:
  - characteristics of the visual perceptual system and the visual processes involved in detecting and interpreting visual stimuli;
  - the effect of psychological factors on perceptual set;
  - distortions of visual perceptions by illusions;
- research methods and ethics associated with the study of psychology.

CHAPTER 11 Nature of development
- stages of the lifespan: infancy, childhood, adolescence, early adulthood, middle age and old age;
- the interaction between heredity and environmental factors ‘nature versus nurture’ in influencing psychological development;
- research methods and ethics associated with the study of lifespan psychology.

CHAPTER 12 Theories on development
- classic and contemporary theories that contribute to an explanation of psychological development including:
  - perceptual development: Eleanor Gibson’s work on infant perception;
  - emotional development: John Bowlby and Mary Ainsworth’s work on attachment theory with reference to Harry Harlow’s work on attachment in monkeys;
  - cognitive development: Jean Piaget’s four-stage theory;
  - psycho-social development: Erik Erikson’s eight-stage theory;
  - moral development: Lawrence Kohlberg’s six-stage theory;
- cognitive and psychosocial changes in the very old: successful ageing, as inform by Paul Baltes’ work;
- research methods and ethics associated with the study of lifespan psychology.

CHAPTER 13 Mental illness across the lifespan
- the nature and incidence of mental illness in the population across the lifespan;

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SENSATION AND PERCEPTION

KEY KNOWLEDGE

- sensation and perception as two complementary but distinct roles in the reception, processing and interpretation of sensory information
- taste and vision as two examples of human sensory systems, including the roles of sensory receptors and receptive fields, transmission of sensory information to the brain, and representation of sensory information in the cerebral cortex

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CHAPTER CONTENT

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  Transduction .......................................................................................... 000
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  From eye to brain .................................................................................. 000
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Taste perception ................................................................................................. 000
  From mouth to brain .............................................................................. 000
Five basic tastes .............................................................................................. 000
Influences on taste perception ........................................................................... 000
  Age ........................................................................................................ 000
  Genetics ................................................................................................. 000
  Perceptual set – food packaging and appearance .................................. 000
  Culture .................................................................................................. 000

- the influence of biological, psychological and social factors on visual perception, including depth cues, visual perception principles and perceptual set
- the influence of biological, psychological and social factors on gustatory perception, including age, genetics, perceptual set (including food packaging and appearance) and culture.
Imagine what it would be like to have no senses or sensory capabilities. Your life would be in complete darkness and silence. You would not be able to taste fruit or smell the fragrance of a flower. You would not be able to feel the warmth of heat or the coolness of ice. Never feeling pain means that you would always be vulnerable to physical harm. Standing or moving around would be a problem as you would never know whether you were upright, laying down, moving a leg or the direction in which you were facing. And you would never be aware of conditions inside your body.

We have a number of different senses, including vision, hearing, taste, smell, touch, pain and kinaesthesia (body position and movements). Each of these senses provides information in the form of a different kind of energy. When we ‘sense’ something, we are actually detecting and responding to physical stimuli — information which is in the form of a specific kind of energy and has stimulated receptor cells. It is not until we ‘perceive’ the information that we have interpreted and assigned meaning to the information.

Most of the sensory information (‘stimuli’) comes from our external environment; for example, light (for vision), air vibrations (for hearing) and chemical molecules (for taste and smell). Other sensory information comes from sensory receptor sites within our body, such as from muscle tendons and joints (for kinaesthesia).

All human sensory systems, also called perceptual systems, have many characteristics in common. This includes a similar sequence of information processing for detecting and responding to stimuli through sensation and perception. In this chapter we examine the two distinctive processes of sensation and perception using vision and taste (gustation) as examples of human sensory systems.

Vision is the sense on which most people are most reliant and taste is the least crucial but the most multisensory of our perceptual experiences. We will consider how biological, psychological and social factors can influence our perception of visual and taste stimuli originating in our external environment. In the next chapter, we explore circumstances where perceptual distortions, or ‘mistakes’, of vision and taste may occur.

**DISTINCTION BETWEEN SENSATION AND PERCEPTION**

**Sensation** is the process by which our sensory receptors and sense organs detect and respond to sensory information that stimulates them. The information at this stage is simply raw sensory data. It is meaningless until it is sent to the relevant sensory area in the brain for processing.

**Perception** refers to the process by which we give meaning to sensory information. This processing results in the conscious experience of our external (and internal) environments. The essence of perception is interpreting sensations. Our sensory systems ‘translate’ the sensations into information that is meaningful and useful.

Most of the time we process sensory information automatically, without realising that we are doing it. However, perception is not a passive process. It does not work like a camera or recorder, digitally capturing information. Perception is an active process. What we see, taste, hear, smell and so on is the result of brain activity that constructs our personal understanding of reality from raw sensory information. This allows us to adapt to our environment and function in everyday life as we do.

Psychologists often distinguish between sensation and perception. This is mainly done for the purposes of study. There is actually no clear boundary that identifies where sensation ends and where perception begins. Perception includes sensory processes and involves the entire sequence of events that begins with the detection of a stimulus (sensation) through to interpretation of the stimulus.

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**Figure 7.1** Sensation and perception are inter-related but commonly described as distinctive processes.
RECEPTION, PROCESSING
AND INTERPRETATION OF
SENSORY INFORMATION

All human sensory systems are information processing systems in which raw sensory information is detected and converted into a form that can be sent to the brain where it can be given meaning. The specific processes that enable sensation and perception of stimuli in our external environment are commonly called reception (or detection), transduction, transmission and interpretation. The details are slightly different for each sense but there is more in common than not.

Reception and receptive fields

Our eyes, tongue and other sense organs contain cells called sensory receptors (or simply receptors) that receive and process sensory information. For each sense, these are specialised to detect and respond to a specific type of sensory information, such as light or chemical molecules. Reception is the process of detecting and responding to incoming sensory information. Every receptor organ and cell within a sensory system has an area of sensitivity. This is the specific part of the world to which it can respond and is called its receptive field.

A receptive field is the area of space in which a receptor can respond to a stimulus. For example, when you look directly in front of you, everything you see is the receptive field of your eyes. If you close one eye, this reduces the area of the receptive field to what your open eye can see. At night time, when you look into a starry sky, the receptive field for vision is extensive in distance. For the sense of hearing, a stimulus can be a moderate distance away. For some senses, such as taste and touch, the stimulus must come in direct contact with the sense organ and therefore a part of the body.

Not every receptor cell for each sense has the same receptive field. For example, within the eye, each receptor cell points in a slightly different direction and so has a unique receptive field. This means that the brain receives slightly different information from each receptor cell. This information is used to not only identify incoming sensory information, but also to compare and contrast the information that each receptor cell is providing. In addition, receptor cells can specialise in their responses to stimulation within their receptive fields. For example, some receptors involved in the sense of touch are fully activated by light touch but not heavy touch or a painful stimulus (Breedlove, Watson, Rosenzweig, 2010; Kolb & Whishaw, 2014).

The different types of sensory organs and receptors are also considered to have receptive fields. The receptive field of a sensory organ or an individual receptor cell is the specific area or part where a stimulus will affect its activity. For example, the retina at the back of the eye is the receptive field for sight and the receptive field of an individual visual receptor within the retina will become active only when light falls on it.

Clusters of receptor cells form more complex receptive fields. For example, the retina has distinctive areas where light activates receptor cells and there are distinctive areas on the tongue that are receptive fields. The information from each receptive field may be processed separately in different areas of the relevant sensory cortex. The brain then combines all these bits of information in a meaningful way, like assembling the bits of a jigsaw puzzle to form a complete image or a taste experience, but in an effortless and highly efficient way.

When sensory information reaches sensory receptors, it arrives in a form of energy which cannot be sent to or processed by the brain. It must therefore be converted into a form that can be sent along neural pathways to the brain. For vision, the energy is visible light in the form of electromagnetic energy. For taste, it is in the form of chemical molecules in foods and fluids.

Figure 7.2 (a) The retina at the back of the eye contains all the sensory receptors that enable visual perception, whereas (b) the sensory receptors enabling taste perception are mostly located on the tongue.
Transduction

Transduction is the process by which the receptors change the energy of the detected sensory information into a form which can travel along neural pathways to the brain as action potentials (which are also called neural impulses). If transduction did not occur, sensory information would travel no further than the receptors and perception would not be possible.

Transmission

Transmission is the process of sending the sensory information (as action potentials) to relevant areas of the brain via the thalamus (except information for smell which bypasses the thalamus). As shown in figure 7.3, the area for vision is the primary visual cortex in the occipital lobe and the area for taste is the primary gustatory cortex in the rear part of the underside of the frontal lobe. When the sensory information reaches the relevant brain areas, interpretation can occur.

Like the primary visual cortex, the primary gustatory cortex has receptive fields. Different areas are arranged in such a way that different sets of neurons are selectively responsive to each of the five basic tastes.

Interpretation

Interpretation is the process in which incoming sensory information is given meaning so that it can be understood. For example, interpretation enables us to understand what we are looking at or what we have tasted or heard. Interpretation does not entirely occur in the cortical areas where it is received. The visual, gustatory and other sensory cortices are connected to other parts of the brain where information is sent for additional processing that enables perception. For example, the primary gustatory cortex sends information to several other areas of the cerebral cortex, including an area called orbitofrontal cortex, where neural connections for taste and smell are combined.

Interpretation involves bringing together incoming sensory information and using existing knowledge to make sense of sensory input. This may include information we have learnt then stored in memory, as well as such information as our current motivational and emotional states and the situation in which the perceptual experience is taking place. Multiple areas of the brain are involved. However, the processing of information from different brain areas is so rapid that we are rarely conscious of it occurring at all.

It is usually only when a stimulus is vague, confusing or ambiguous that we become aware of the interpretative process. For example, our experience with many visual illusions often requires us to test a number of possible interpretations to make a meaningful perception. In some cases, as with the objects in figure 7.4, we may struggle to make a meaningful interpretation, regardless of how often or long we consider it.

![Figure 7.3](image_url)

Figure 7.3 The primary areas in the cerebral cortex for receiving and processing different sensory information
Figure 7.4 Visual illusions such as the ‘impossible triangle’ and ‘three-pronged widget’ illustrate that we can sometimes become confused by a stimulus and struggle to make a meaningful interpretation, regardless of how often or long we consider it.

### BOX 7.1 Thresholds: absolute and differential

How dim can a light be and still be visible? Is there a specific light intensity that represents the limit at which a person is able or unable to perceive a visual stimulus? Is there a specific amount of sugar required before we can detect and then taste sweetness?

In order for sensation and perception to occur, the relevant receptors must be able to detect a stimulus. When examining sensory and perceptual processes, psychologists use the term threshold to refer to our ability to detect a stimulus or changes in a stimulus. Two types of thresholds are commonly described - absolute and differential.

**Absolute threshold**

The absolute threshold is the minimum amount of energy that is necessary in order for a stimulus to be perceived. For vision, this would involve the minimum amount of light energy required to stimulate the light receptor cells in the retina and trigger action potentials. The weakest visual stimulus that can be perceived has the light energy equivalent to a candle flame seen at about 50 kilometres when viewed under ideal conditions (e.g. a clear, pitch-black night). Examples for other senses are shown in Table 7.1 below.

The term ‘absolute’ can be a little misleading. Researchers have found, for example, that there is no specific level of intensity of light at which our eyes ‘switch’ from seeing no light to seeing light. Rather, the light stimulus gradually increases in intensity, and the likelihood of our responding to it tends to increase.

Consequently, researchers often define the absolute threshold in statistical terms to be the lowest or weakest level of a particular stimulus that can be detected, on average, 50% of the time. This means that if you were tested with a light stimulus, the absolute threshold would be the measure of light intensity where half the time you detected the presence of light and half the time you did not.

**Differential threshold**

Researchers have also examined our sensitivity to small differences (or changes) in the intensity of a given stimulus. This is referred to as the differential threshold.

The differential threshold (also called the just noticeable difference) for vision is the smallest perceptible difference (or perceptible change) that can be detected between two visual stimuli by the eye. For example, in an experiment on differential thresholds for visual perception, a researcher might investigate when a difference in the brightness of a light undergoing slight increases or decreases in its intensity can just be perceived by a participant; that is, when a change in brightness is ‘just noticeable’. As with absolute thresholds, the researcher would define the differential threshold in statistical terms as the point at which participants detect (‘just notice’) a difference between the intensity of two stimuli, on average, 50% of the time.

Differential thresholds also apply to other senses as well as specific capabilities. For example, differential threshold is relevant to visual acuity — the sharpness of our vision and our ability to detect fine detail. A Snellen eye chart with letters that vary in size is commonly used by optometrists as a measure of visual acuity.

<table>
<thead>
<tr>
<th>Sense</th>
<th>Stimulus energy</th>
<th>Absolute threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>vision</td>
<td>light</td>
<td>a candle flame seen from a distance of 50 kilometres on a clear, dark night.</td>
</tr>
<tr>
<td>taste</td>
<td>chemical</td>
<td>one teaspoon of sugar dissolved in eight litres of water</td>
</tr>
<tr>
<td>hearing</td>
<td>sound</td>
<td>the ticking of a watch under quiet conditions at a distance of six metres</td>
</tr>
<tr>
<td>smell</td>
<td>chemical</td>
<td>one drop of perfume diffused throughout a three-room apartment</td>
</tr>
<tr>
<td>touch</td>
<td>pressure</td>
<td>the wing of a bee falling on your cheek from a height of one centimetre</td>
</tr>
</tbody>
</table>

Table 7.1 The absolute thresholds for some common stimuli illustrate the sensitivity of different human sensory systems.

**eGuideplus**

Prac activities on thresholds.
VISUAL PERCEPTION

Visual perception occurs through the visual sensory system. The visual sensory system consists of the complete network of physiological structures involved in vision. This includes all the parts of the eyes, the neural pathways that connect the eyes and the brain, and the areas of the brain that process visual information. However, visual perception involves more than biological structures and processes. It is also influenced by psychological processes, many of which occur automatically to assist our interpretation of what we are looking at, as well as social factors.

Although the diverse range of influences on visual perception can be classified as biological, psychological and social, this does not mean that a neat line or boundary can be drawn between different types of factors. To do so would be like trying to draw a line between sensation and perception. In the same way that sensation and perception are closely interrelated, so too are biological, psychological and social factors that influence any perception interrelated. The interaction between them is responsible for the unique personal realities we each construct of the world around us.

Visual perception starts at the eye where light is received, transduced then sent to the brain for interpretation. We consider key structures of the eye and the roles they play in enabling visual perception.

**LEARNING ACTIVITY 7.1**

**Review questions**

1. (a) Define sensation and perception.
   (b) How are sensation and perception best distinguished?
2. Why is perception considered to be an ‘active process’?
3. (a) What are sensory receptors?
   (b) Are all sensory receptors neurons?
4. (a) What role does reception play in a sensory system?
   (b) Describe the relationship between a receptive field and reception.
5. (a) What is transduction?
   (b) Why is transduction essential in perception?
   (c) Where does information go after transduction and how does it get there?
6. (a) Explain the role of interpretation in a sensory system.
   (b) Give an example of a biological process and a psychological process involved in interpretation.
   (c) How might social factors influence perception?

**LEARNING ACTIVITY 7.2**

**Reflection**

We are not aware of all incoming sensory information. It is not until we pay attention to a physical stimulus that it is processed and enters conscious awareness. In this way, attention acts like a filter for sensory information, enabling selection of what may be relevant.

Comment on what the human experience could be like if we became aware of all sensory information that reaches our sensory receptors.
From eye to brain

The eye is the sense organ for vision. An important function of the eye is to collect light that has been reflected or given out by objects in the environment. Light enables sight to occur.

Light initially enters the eye through the cornea, a transparent, convex-shaped (curved outwards) covering which protects the eye and helps to focus light rays onto the retina at the back of the eye. After passing through the cornea, light then passes through the aqueous humour which fills the space between the cornea and the lens. The aqueous humour is a watery fluid which helps to maintain the shape of the eyeball and provides nutrients and oxygen to the eye, as well as carrying away waste products.

The passage of light continues through the pupil which looks like a black circle in the centre of the eye. The pupil is not a structure in itself, but an opening in the iris that helps to control the amount of light entering the eye. In a place where there is dim light, such as a darkened movie theatre, the pupil dilates (expands) to allow more light into the eye. However, in a place where there is bright light, such as at the beach on a clear summer day, the pupil contracts and becomes smaller to restrict the amount of light entering the eye. In a place where it is extremely bright, the pupil may be no larger than a pinhead. When it is extremely dark, the pupil may become as big as the diameter of a pencil.

The iris, which surrounds the pupil, is the coloured part of the eye. The iris is a ring of muscles which expand or contract to change the size of the pupil and control the amount of light entering the eye.

Having passed through the pupil, light then enters the lens, which is a transparent, flexible, convex structure located immediately behind the pupil. The lens plays a major role in focusing light onto the retina for processing. In order to focus light onto the retina, the lens adjusts its shape according to the distance of the object being viewed. Its shape is changed by the ciliary muscles attached to each end of the lens. These muscles expand and contract, enabling the lens to automatically bulge to focus nearby objects onto the retina and flatten to focus distant objects onto the retina.

After incoming light passes through the lens, it continues through vitreous humour. Vitreous humour is a jelly-like substance which helps to maintain the shape of the eyeball and also helps focus light. Finally, the light reaches the retina at the back of the eye.

![Figure 7.6 The structure of the eye](image-url)
The retina receives and absorbs light, and also processes images. The image focused onto the retina is an inverted (upside-down) and reversed (back-to-front) image of the object being viewed. When received at the brain, it is rearranged so that we can perceive whatever we are looking at as it is in reality.

The retina consists of several layers of nerve tissue made up of different types of neurons that include light-sensitive visual receptor cells called photoreceptors. There are two types of photoreceptors — rods and cones — that react to different ways. Rods respond to very low levels of light and are primarily responsible for night vision. They are very poor at detecting the fine details in an image and are not involved in colour vision. This is why everything on a dark, moonless night appears as shades of grey. In contrast to rods, cones respond to high levels of light (and do not respond well to dim light). They are primarily responsible for our vision in well-lit conditions, and for detecting fine detail and colour vision. When rods and cones detect light, they respond by changing the light energy into a form of energy that can be sent to the brain for further processing.

The photoreceptors do not transmit what the eye has sensed directly to the brain. They convert light into signals that can be processed by other types of neurons in the retina. These signals are sent to ganglion cells located elsewhere in the retina for processing (see Figure 7.7). Ganglion cells then generate action potentials which enable transmission of the information to the brain via their axons.

The axons of the ganglion cells from all over the retina are gathered into a bundle that forms the optic nerve to the brain.

**Figure 7.7** How we see — biological processes in visual sensation and perception
optic nerve. The **optic nerve** transmits the visual information from the retina to the primary visual cortex. The optic nerve exits the eye at the back of the retina, the same point where blood vessels enter and exit the eye. There are no rods or cones here so it is known as the blind spot. The term **blind spot** refers to the fact that there are no photoreceptors on that small area of the retina so light cannot be detected there. This means that any part of a visual image that is focused on this ‘spot’ will not be visually processed and we will remain ‘blind’ to it.

We are seldom aware that we have a blind spot and that some visual information escapes us. If visual information entering one eye hits the blind spot, usually the other eye provides information that can compensate for any gaps in the overall image. This occurs because we receive slightly different images on each retina (as the eyes are set a small distance apart). Therefore, the gap in visual information from one retina can be filled in by the equivalent part of the image from the other retina.

The optic nerve provides the pathway for the transmission of action potentials carrying visual information to the primary visual cortex, via the thalamus. The axons of ganglion cells in the optic nerve that originate from the left side of each retina transmit visual information that reaches the left visual cortex. The axons that originate from the right side of each retina transmit visual information to the right visual cortex. This occurs because the transmission of visual information from each retina involves a partial cross-over of neural pathways. The point where the axons cross is called the **optic chiasm** (see Figure 7.7).
**BOX 7.2 Visible light**

The human eye captures and responds to visible light. Light is a part of the range of electromagnetic energy (radiation) to which we are exposed. Electromagnetic energy is a form of energy produced by electrically charged particles that travel in waves. Light waves vary in length (frequency) and height (amplitude). The length of the waves (wavelength) determines the colour of the light. The height of the waves determines the intensity of the light.

Photoreceptors in the human eye are sensitive only to a very narrow range of electromagnetic waves commonly called the *visible light spectrum*. The visible light spectrum extends from about 380 nanometres (perceived as violet light) to about 780 nanometres (perceived as red light) depending on which source is used. It also depends on the sensitivity of an individual’s eyes. One nanometre is equivalent to one billionth of a metre. Electromagnetic waves outside the visible light spectrum cannot be detected by the human eye. For example, waves of 350 nanometres and 810 nanometres would not normally be detected.

While the human eye responds only to a limited range of wavelengths in the electromagnetic spectrum, other species can detect certain wavelengths that we cannot. For example, many insects are capable of responding to wavelengths shorter than 380 nanometres (they can detect ultraviolet), and reptiles and fish respond to wavelengths greater than 780 nanometres (they can detect infra-red).

**Figure 7.8** The visible light spectrum is just a tiny ‘slice’ of the total electromagnetic energy (radiation) spectrum.
**BOX 7.3 Visual impairments**

Some visual impairments develop because of abnormalities in the structure of the eye. In particular, either the eye itself is misshapen (e.g. too short or too long), a structural part is misshapen (e.g. the cornea or the lens), or a structural part lacks flexibility. These are quite common problems that can be corrected with glasses, contact lenses or surgery to make vision clearer.

**Farsightedness (hyperopia)** means that you can see better far away than you can close up. This occurs when the distance between the lens and the retina is unusually short because the eye is smaller than average. Incoming light is therefore focused behind the retina rather than on the retina, which blurs the image.

**Nearsightedness (myopia)** means that you can see better close up than you can at distances far away. This occurs when the distance between the lens and the retina is unusually long because the eye is larger than average. The light that is focused in the eye lands in front of the retina rather than on the retina, regardless of the lens elongating (or “flattening”) to its maximum length. Again, the image on the retina is not focused and is therefore blurry.

**LEARNING ACTIVITY 7.3**

**Review exercise**

**Part A Matching eye structures and functions**

Match each structure in the left column with the correct function in the right column.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. cornea</td>
<td>a. a round band of muscles which expand and contract to control the amount of incoming light</td>
</tr>
<tr>
<td>2. pupil</td>
<td>b. focuses light onto the retina</td>
</tr>
<tr>
<td>3. iris</td>
<td>c. generates action potential</td>
</tr>
<tr>
<td>4. lens</td>
<td>d. protective cover on the eye and helps focus incoming light</td>
</tr>
<tr>
<td>5. photoreceptor</td>
<td>e. opening which helps regulate the amount of incoming light</td>
</tr>
<tr>
<td>6. retina</td>
<td>f. light sensitive visual receptor cell</td>
</tr>
<tr>
<td>7. ganglion cell</td>
<td>g. receives, absorbs and processes light</td>
</tr>
</tbody>
</table>

**Part B Location of eye structures**

Without looking at the diagram of the eye on page 296, identify the following structures on the diagram below: cornea, pupil, iris, lens, optic nerve, retina.

**Part C Pathway of light in vision**

Create a flow chart or another type of diagram which shows the pathway of light as it travels from the cornea to the retina. Identify the various anatomical structures through which light passes and briefly describe the role of each structure. Present your diagram digitally or as a poster on paper.
**Visual perception principles**

**Visual perception principles** are ‘rules’ that we apply to visual information to assist our organisation and interpretation of the information in consistent and meaningful ways. These help us to ‘make sense’ of visual information that is sometimes inconsistent or incomplete. We tend to automatically use these principles, without any conscious effort or awareness that we are doing so.

Visual perception principles can also be intentionally used. This can be seen in the work of artists, designers of road traffic signs and advertisers. For example, many artists make use of visual perception principles to give the impression of three-dimensional depth and/or distance on a canvas or piece of paper, which is a two-dimensional medium. Designers of road signs may also use visual perception principles to help ensure that the signs stand out in an often cluttered environment so that they can be interpreted and understood quickly. Symbols are also used by advertisers to attract attention to their products and services or to try to influence our interpretation in a certain way. For example, a symbol such as an abstract eye might be used as a company logo for a vision restoration clinic in order to draw our attention to it (through its novel or unusual form) and to consider the clinic whenever we see the symbol.

Visual perception principles can be classified into three broad categories: Gestalt principles, depth cues and perceptual constancies.

**Gestalt principles**

**Gestalt principles of visual perception** refer to the ways in which we organise the features of a visual scene by grouping them to perceive a whole, complete form. This is usually done in the simplest possible way. For example, if part of what we are looking at is hidden or covered, then, in order to make sense of what is being observed, we simply construct a ‘whole’ or complete form by mentally filling in the part that we cannot see. In this way, Gestalt principles help us construct a meaningful whole object from an assortment of parts that, when considered as individual bits, lack any real meaning.

Artists experimented with the concept of parts which make up the whole long before Gestalt psychologists considered the principle scientifically.

Psychologists have identified numerous Gestalt principles that are used in visual perception. These include figure–ground organisation, closure, similarity and proximity.

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**Figure–ground organisation**

Figure–ground is used when you read this sentence — the words printed in black (figure) stand out against the white paper (ground) on which they are printed. Similarly, your teacher is perceived as the figure against the background of the rest of the classroom. When we use **figure–ground**, we organise visual information by perceptually dividing a visual scene into a ‘figure’, which stands out from the ‘ground’, which is its surroundings. By making an object the centre of our focus it becomes the figure, while all other visual information becomes the **back**ground.

Figure–ground organisation is generally achieved when we separate the figure from the ground using a line or boundary between the figure and ground, which may or may not exist in the scene. This line of separation between the figure and ground is known as a **contour**. The contour is always perceived as belonging to the figure. In figure 7.9, the contour can belong to either the faces or the vase. This means that we can perceive either faces or a vase, depending on whether we view the faces or the vase as the figure.

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![Figure 7.10](image-url) A food artist has used Gestalt pineapples to create this buffet display. The individual ‘parts’ are various fruits and vegetables which are organised into the ‘whole’ form of a person.
The importance of being able to attribute a contour to part of the stimulus (the figure) in order to separate it from the background is highlighted when we have difficulty in doing this. When this happens, either by design or unintentionally, it creates camouflage.

Camouflage occurs when the figure and ground are not easily separated, but blend together. Camouflage restricts our ability to separate the figure from the background because the colour(s) and pattern (or design) of the figure are similar to the background. For example, military uniforms are designed to use the colours of the surrounding environment so that the figure (soldier) is difficult to separate from the ground (environment) in which the soldier is located.

Road signs use the figure–ground organisation principle to support quick perception of their messages. Road signs in particular, are designed so that the figure stands out clearly from the background. For example, the letters on the ‘STOP’ sign in Figure 7.12 are written in white to stand out as the figure against a contrasting red background. Similarly, signs indicating speed limits that need to be seen quickly and clearly, make use of black numbers against a contrasting white background. The contours are attributed to the numbers, making them the figure against the white background.

Some artists make clever use of figure–ground in their works by presenting artworks that have an ambiguous contour. Normally, we can quickly perceive the contour as belonging to the figure, and the rest of the scene is perceived as the ground. Artists such as Maurits (‘M.C.’) Escher have produced many artworks that deliberately confuse the observer into making alternating interpretations of the same scene (see figure 7.13). The confusion occurs because the artworks make it possible for us to perceive the contour as belonging to either the figure or the ground, depending on our focus of attention. Visual stimuli that enable figure and ground to be perceived as ‘legitimate’ alternatives are commonly called reversible figures.

Figure 7.11 In 1915, the Danish psychologist Edgar Rubin produced an image like this one. It is commonly called an ambiguous or reversible figure. The term ambiguous figure refers to the fact it can be perceived as either two silhouetted faces in front of a white background or as a white vase against a black background. The term reversible figure refers to the fact that it can produce alternative perceptions based on whether we identify the faces or vase as the figure or ground. The differing interpretations of the image occur with shifts in attention and how we perceive the contour. When we focus our attention on the vase, the contour belongs to the vase and this separates it from the ground. When we focus on the two faces, they ‘own’ the contour and the vase becomes the ground.

Figure 7.12 Road signs use the figure–ground organisation principle to support quick perception of their messages.
Closure

Closure is the perceptual tendency to mentally ‘close up’, fill in or ignore gaps in a visual image and to perceive incomplete objects as complete (‘whole’). For example, with the IBM logo in figure 7.15, we fill in the gaps between each of the horizontal lines to mentally form solid letters and/or ignore the gaps that prevent solid letters.

Figure 7.13 In these artworks, Dutch artist M.C. Escher (1898–1972) used figure–ground reversal to create an ambiguous figure from which two interpretations are possible. (a) Can you see birds and fish? (b) Can you see birds flying in two directions?

Figure 7.14 Can you find all the people in this photo? Camouflage makes them difficult to spot.

Figure 7.15 Company logos and signs often require the use of closure by the observer to mentally complete an incomplete figure.

M.C. Escher’s ‘Symmetry Drawing E66’ © 2013 The M.C. Escher Company — The Netherlands. All rights reserved. www.mcescher.com
Closure is also applied to non-verbal information. For example, the standard sign for disabled people’s facilities requires the use of closure to reach the interpretation of a person in a wheelchair. Similarly, we use closure to organise then interpret the shape in the Australian Made, Australian Grown logo as a kangaroo and the World Wildlife Fund logo is a panda.

**Similarity**

The principle of similarity involves the tendency to perceive parts of a visual image that have similar features — such as size, shape, texture or colour — as belonging together in a unit, group or ‘whole’. For example, this principle is used when we group people wearing the same uniform and identify them as belonging to the same team, school or workplace.

Similarity is applied by the designers of uniforms for school, sports teams, emergency services and defence forces personnel, as well as to uniforms worn by employees of commercial organisations such as fast food chains, supermarkets and petrol stations so as to identify people as belonging to a particular group. Whether it is students from different schools at a bus stop, players in opposing sports teams, or even bikies dressed in particular clothes that are typical of their gang, we visually group those who are dressed similarly and perceive them as belonging to the whole group.

Tests for colour blindness examine whether we have normal colour vision by requiring us to use the principle of similarity to group sections of the images in the test items to visually perceive numbers. These numbers will remain hidden if we are unable to group the dots accurately on the basis of colour. An example of an image like one used in tests of colour blindness is shown on the left. Can you perceive the letter E?

**Proximity**

The principle of proximity (also called nearness) is the tendency to perceive parts of a visual image which are positioned close together as belonging together in a group. We group the separate bits into a whole based on how close they are to each other. For example, a series of letters located physically close together might be grouped to be perceived as a word (see Figure 7.17), or a series of musical notes grouped together on a score may become a melody (see Figure 7.18).

![Figure 7.16](image-url) (a) Individuals in this photo can be perceived as belonging to different groups based on similar-coloured uniforms when you apply the principle of similarity. (b) This image is similar to one used in the tests for colour blindness.

![Figure 7.17](image-url) The series of letters located physically close together might be grouped to be perceived as a word.

Figure 7.19 shows two examples of the principle of proximity. In figure 7.19(a) we perceive four horizontal rows of blocks, whereas in figure 7.19(b) we perceive four vertical columns of blocks.

**eBookplus**

Weblink
Online Ishihara colour blindness test

What’s that on the road ahead?
What’s that on the road a head?

Figure 7.17 The series of letters located physically close together might be grouped to be perceived as a word.
Prominent Russian psychologist Alexander Luria (1902–1977) was a pioneer of a specialist area now called cultural or sociocultural psychology. From this perspective, he queried Gestalt principles of perceptual organisation such as closure, proximity and similarity. Many of the Gestalt principles had been developed from experimental research by German psychologists using participants who were university educated and lived in big cities such as Berlin and Munich. Luria was interested in finding out whether the Gestalt principles were also relevant to people from other socio-cultural backgrounds. He was particularly interested in studying people who lived in rural areas and did not have any formal education.

In what is regarded by many psychologists as a pioneering study, Luria (1976) conducted experimental research using five groups of participants which he described as follows:

1. Ichkari women living in remote villages who were illiterate and not involved in any modern social activities
2. peasants in remote villages who were illiterate (and self-supporting)
3. women who attended short-term courses in the teaching of kindergarten children. As a rule, they still had no formal education and almost no literacy training.
4. active kolkhoz (collective farm) workers and young people who had taken short courses. They actively involved themselves in running the farms; had acquired a much broader outlook than had the isolated peasants; had attended school only briefly; and many were still barely literate.
5. women students admitted to a teachers' school after two or three years of study. Their educational qualifications, however, were still fairly low.

In sum, Groups 1 and 2 had no formal education and were illiterate, Groups 3 and 4 were semi-literate, and Group 5 had been formally educated and were literate.

Luria was concerned that an experiment in a laboratory setting would be entirely inappropriate. He believed that such a formal situation would be too far removed from the real life experiences of many participants and may therefore influence the results in unwanted ways. Instead, he conducted a field experiment during which he tested...
participants in what he described as their ‘habitual’ (or normal) environments. In his research report, he described a part of his procedure as follows:

As a rule our experimental sessions began with long conversations (sometimes repeated) with the subjects in the relaxed atmosphere of a tea house — where the villagers spent most of their free time — or in camps in the fields and mountain pastures around the evening campfire.

Luria and his research assistants tested participants with the visual stimuli shown below in figure 7.20. When asked to name the shape in each stimulus, the formally educated female students (Group 5) were the only ones who identified each item using the correct term.

For example, items 1–3 were all identified as a circle, regardless of whether it was made of a solid line (item 1), an incomplete line (item 2) or a solid colour (item 3). However, most of the participants in Groups 1–4 named the shapes according to the objects they resembled.

For example, a circle was called a watch, plate or moon, and the square was called a mirror, house, or even an ‘apricot-drying board’. When asked if items 12 and 13 were alike, one Group 1 participant answered, ‘No, they’re not alike. This one’s not like a watch, but that one’s a watch because there are dots’.

Based on his research findings, Luria suggested that Gestalt principles may only be relevant to people who have studied geometrical concepts in a formal education system, such as in a school or university. Contemporary psychologists have suggested that experience with two-dimensional drawings on a sheet of paper may also be a factor that explains the results (Matsumoto, 2000; Price & Crapo, 1999).

**LEARNING ACTIVITY 7.4**

**Review questions**

1. Explain the meaning of:
   (a) visual perception principle
   (b) Gestalt principle of visual perception.

2. Complete the table below to summarise four Gestalt principles described in the text and an additional principle you identify through your own research. Write a definition of each principle and give two examples of artworks, signs and/or symbols that illustrate the four principles in the text. For each principle, one of the examples should be your own. For the fifth principle you identify, include at least two examples in total.

<table>
<thead>
<tr>
<th>Principle</th>
<th>Definition</th>
<th>Artworks</th>
<th>Signs</th>
<th>Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>figure–ground</td>
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<td>closure</td>
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3. Outline how Luria investigated the role of socio-cultural influences on the use of Gestalt principles, as described in box 7.3 on p. 304.
**LEARNING ACTIVITY 7.5**

**Application of Gestalt principles**

1. Consider the image in figure 7.15, which is like those used to diagnose colour blindness. When tested for colour blindness, people are required to visually perceive a number located within the stimulus figure. Explain, with reference to two Gestalt principles, how someone who is not colour blind (or colour weak) would visually perceive the number within the visual stimulus.

2. Identify two Gestalt principles used to organise and interpret the figure shown in Figure 7.21 below.

For each of these principles:
- describe the area of the figure to which you are referring
- name the relevant principle
- explain how it contributed (or could have contributed) towards your interpretation of the whole figure.

3. Consider Figure 7.22 below. Do you perceive a young woman with her head turned away, or an old woman with a large nose, in semi-profile? Explain the alternate perceptions of the image with reference to figure–ground.

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**BOX 7.5 Research on the Gestalt approach to visual perception**

Israeli psychologist David Navon was intrigued by the Gestalt approach to visual perception. In particular, Navon was interested in whether we first perceive the elements (parts) of a visual scene and build them up to a whole, complete image, or whether we perceive the whole first and then perceive the elements through further visual processing.

In order to conduct an experiment on this question of research interest, Navon (1977) distinguished between local and ‘global’ features of a visual stimulus. The 14 participants were required to briefly observe a large letter (global feature) that was made up of many small letters (local features) such as those shown in figure 7.20.

Each participant was required to make responses under two different experimental conditions. The conditions required their attention to be focused either globally (‘the whole’) or locally (‘the parts’). In the globally focused condition, the participant had to indicate whether the global letter was the letter H or the letter S. In the locally focused condition, the participant had to indicate whether the local letter was the letter H or the letter S. On half the trials the global and local letters were the same letter of the alphabet, and on the other half they were different, as shown in figure 7.20.

The participants were asked to identify the letters as quickly and accurately as possible. They were paid a monetary bonus for their responses. The amount paid depended slightly on speed, but more on accuracy. Navon recorded the speed and accuracy with which participants could recognise the same or different global/local letters.
The results showed that the type of local letters used (whether the same or different from the global letter) had no effect on the speed with which the global letter was recognised. However, identification of the small, local letters (that is, accuracy) was less accurate when the global and local letters did not match. From these results, Navon concluded that we mentally process the whole before we analyse the parts (or detail); that is, we perceive the entire global letter before we start to analyse its composition of local letters.

Drawing on the results of Navon’s experiment, some psychologists have argued that it may be virtually impossible to avoid perceiving the whole (Eysenck & Keane, 1990). However, researchers who have replicated Navon’s experiment to test factors that may influence these results.

**LEARNING ACTIVITY 7.6**

**Analysis of research by Navon (1977) on visual perception**

Consider the experiment by Navon (1977), described in Box 7.5 above on visual perception, on how research participants ‘mentally processed’ local and global features of a visual stimulus.

Analyse the research by answering the following questions.

1. What is the aim of this experiment?
2. Identify the operationalised independent and dependent variables in the experiment.
3. Identify the two conditions of the experiment.
4. Briefly state the results obtained by Navon.
5. Briefly state the conclusion(s) that was drawn from these results.
6. Identify any extraneous or confounding variables that may not have been adequately controlled and suggest why they may have affected the results.
7. To what extent can the results be generalised to visual perception by people in everyday life? Explain your answer.

**Depth cues**

One of the most important tasks of our visual perception system is to locate objects in space. Without this ability, we would find it difficult to navigate and interact with our world. In order to locate objects in space, we need to judge whether one object is above, below, or to the left or right of another. We also need to judge how far away objects are from each other and ourselves.

We need to make these judgments automatically and rapidly or our interaction with the world would be something like being in continual slow motion. Judgments about where objects are in space enable you to efficiently reach for a pen on your desk. They are also vital for your survival. For example, when crossing a street you need to judge where approaching vehicles are in relation to yourself and judge the distances between you and the vehicles so that you safely reach the other side. Locating objects in space involves depth perception.

**Depth perception** is the ability to accurately estimate the distance of objects and therefore perceive the world in three dimensions. Many psychologists describe our depth perception as a ‘remarkable’ ability because objects in our world are arranged in three dimensions — length, width and depth — but our retinas hold only two-dimensional images of the world around us.

Depth cues provide the information that enables us to translate the two-dimensional images on the retinas into three-dimensional reality. **Depth cues** are sources of information from the environment (external cues) or from within our body (internal cues) that help us to perceive how far away objects are and therefore to perceive depth. Depth cues are often categorised into two groups — binocular or monocular.

**Binocular depth cues**

**Binocular depth cues** require the use of both eyes working together in order to provide information to the brain about depth and distance. These cues are especially important in determining the distance of objects that are relatively close. Consequently, if for some reason our vision is limited to the use of only one eye, tasks requiring us to focus on detail over short distances can be difficult to accomplish.
**Convergence**

Imagine you are watching someone approach a small, round, shiny object on the footpath. If you could watch their eyes as they picked it up and brought it in close to their eyes to work out what it is, you would see their eyeballs turning in slightly towards their nose. If they held the object right up near the tip of their nose, their eyeballs would turn inwards ("converge") like the girl's eyeballs in figure 7.24.

**Convergence** involves the brain detecting and interpreting depth or distance from changes in tension in the eye muscles that occur when the two eyes turn inwards to focus on objects that are close. The brain interprets greater tension in the eye muscles as an object gets closer and less tension as an object gets further away.

Convergence is particularly useful when the object we are looking at is within about six metres. Beyond this distance, the lines of sight from our eyes to the object are virtually parallel and there is no need for our eyes to converge to keep the object in focus. For example, fully extend one of your arms in front of you and point a finger upwards. Slowly move the finger towards your nose. You should be able to ‘feel’ the muscle tension associated with the convergence of your eyes, particularly as your finger gets very close to your nose. Your eye muscles relay this information to your brain, enabling you to make judgments about how far away your finger is as you focus on it.

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**Figure 7.24** Convergence involves the two eyes turning inwards to focus on objects that are very close.

**Figure 7.25** Our brain receives information from the muscles that turn each eye in towards the nose as an object in focus gets closer. The change in muscle tension is used by the brain to perceive depth and distance.
Retinal disparity

Because our eyes are about six or seven centimetres apart, each retina receives a slightly different visual image due to the different angle of view from each eye. The difference in the visual image cast on each retina decreases as the object we are viewing moves further away from us. Beyond about 10 metres or so, there is hardly any difference in the image cast on each retina.

Retinal disparity refers to the very slight difference (‘disparity’) in the location of the visual images on the retinas (due to their slightly different angles of view), which enables us to make judgments about the depth or distance of an object.

When the two different retinal images are fused (combined) in the brain, the images received from each eye are compared. Any disparity or difference between the two images provides information about the depth of the object or its distance from the viewer.

Figure 7.26 ‘Magic Eye’ images take advantage of retinal disparity. Hold the centre of the image right up to your nose. It should be blurry. Stare as though you are looking through the image. Very slowly move the image away from your face until you begin to see depth. Now hold the image still and try not to blink. Most people eventually see the three-dimensional image.
Monocular depth cues require the use of only one eye to provide information to the brain about depth and distance, but they also operate with both eyes. Most depth cues are monocular, so we can still perform many of our daily activities without difficulty if we lose vision in one eye.

Monocular depth cues include accommodation, and pictorial cues such as linear perspective, interposition, texture gradient, relative size, and height in the visual field. Pictorial cues are commonly used to create depth and distance in artworks.

Accommodation
The size of the visual image of a large object viewed at close range would normally be too large to fit onto the retina. The lens in each eye plays a key role in enabling images of close, large objects to fit onto each retina. The flexibility of the lens enables it to bulge to fit (‘accommodate’) close objects on the retina and to elongate (flatten) when looking at objects that are further away. The closer (and therefore larger) the object, the more the lens needs to bulge to fit the object’s image on the retina.

Accommodation involves the automatic adjustment of the shape of the lens to focus an object in response to changes in how far away the object is. The brain monitors the movement of the ciliary muscles that control the shape of the lens. The ciliary muscles contract to enable the bulging of the lens, and expand to allow it to elongate (flatten), as shown in figure 7.27.

Information about how much the lens bulges or elongates is used by the brain to determine the depth and distance of the object in focus. For example, as you watch a golf ball leave the club head and travel 200 metres down the fairway, the lens quickly elongates. Alternatively, as you watch a basketball come towards you, the lens quickly bulges.

Pictorial cues
Many monocular depth cues are referred to as pictorial cues. Pictorial cues are so named because artists use them to create depth and distance on two-dimensional surfaces such as paper and canvas. Pictorial cues include linear perspective, interposition, texture gradient, relative size and height in the visual field.

Figure 7.27  (a) The lens bulges to focus the light rays reflected from a nearby object such as the flowers. (b) The lens elongates (flattens) to focus the light rays when the object is further away.
Linear perspective
When you are travelling in a car on a long, straight highway through the countryside and you look ahead, the view through the front windscreen is one of a road that appears to be narrowing. In fact, if you look all the way to the horizon, it will look as if the two parallel edges of the road have come together to a single point. This illustrates the depth cue called linear perspective. **Linear perspective** is the apparent convergence of parallel lines as they recede (‘go back’) into the distance.

Interposition
When we see two footballers racing for the ball from a front-on perspective, it’s sometimes difficult to tell which player is going to get there first. However, when one player starts to block our view of the other, we know that the partially ‘covered’ player is behind the other player and therefore further away. The image received on the retina of one footballer overlapping the other provides the brain with information about which player is closer and which player is further away. **Interposition**, also called overlap, occurs when one object partially blocks or covers another, and the partially blocked object is perceived as further away than the object that obscures it (and vice versa).

Figure 7.28 Linear perspective is evident in this photo by the parallel lines that appear to converge as they recede into the distance.

Figure 7.29 (a) The building on the left partially covers the Tower of Pisa on the right so we can use interposition as a depth cue to judge that the tower is further away than the building that covers it (and vice versa). (b) Non-availability of the interposition cue makes it difficult to judge which of the two building is more distant.
Texture gradient

When we look down a long pathway made of pavers, the amount of detail that we can perceive in the pavers reduces more and more the further we look. For example, at our feet we can see individual pavers that make up the pathway, whereas if we look 30 or 40 metres further along the pathway, it looks like a single surface, with little detail.

Texture gradient refers to the gradual reduction of detail that occurs in a surface as it recedes into the distance, compared with a surface that is close and perceived in fine detail. Thus, our judgment about depth and distance is influenced by the extent to which we can detect fine detail. We perceive objects for which fine detail is clear as being closer and those that lack detail, as being further away.

Relative size

Imagine watching a cartoon about outer space. The cartoon shows a huge explosion of a planet and pieces flying through space in all directions. Some of the pieces appear to be hurtling towards you. How does the artist who draws each separate image that makes up this scene lead you to perceive how far away the pieces are?

The pieces that appear to be coming towards us are drawn as larger in each image than those going away or sideways from the exploding planet. The size of the pieces in relation to each other provides us with information about distance from us. As we move around in the real world, we use this information about the size of objects in relation to each other to judge depth and distance.

Relative size refers to the tendency to visually perceive the object that produces the largest image on the retina as being closer, and the object that produces the smallest image on the retina as being further away. However, the objects being perceived must be expected to be about the same size in real life. For example, we do not necessarily perceive that a car is further away than a truck because the car is smaller. We take into account what we know about their size, which is learnt through past experience, and enables us to become familiar with the size of different objects in our environment.

![Figure 7.30](image.png)

**Figure 7.30** Note that the pavers and vegetation closest to us in this photo can be seen in detail and as these recede into the distance they become a blur and less detail is apparent. This use of texture gradient helps us to judge depth and distance. Linear perspective is also helpful, demonstrating that we use combinations of depth cues.

![Figure 7.31](image.png)

**Figure 7.31** Photo (a) shows a man leaning against a wall in the foreground and two men in the background. Our familiarity with the relative size of objects enables us to perceive the largest image on the retina (the man leaning against the wall) as closer than the smaller images on the retina (the other two men). Photo (b) has been manipulated. The retinal-sized image of the man in the white shirt has been placed next to the man leaning against the wall so that both the man leaning against the wall and the man in the white shirt are the same distance from the observer. If you measure the height of the image of the man in the white shirt you will realise that he is exactly the same size in both photos.
Height in the visual field
When we draw a picture, objects that are in the sky, such as clouds, birds and planes, will be perceived as further away when they are drawn near the horizon. When we draw objects on the land, such as trees, animals and cars, they will also be perceived as further away when they are drawn near the horizon.

**Height in the visual field** refers to the location of objects in our field of vision, whereby objects that are located closer to the horizon are perceived as being more distant than objects located further from the horizon.

**Figure 7.32** The hot-air balloon that is higher in the visual field is perceived as closer than the other balloon as it is further away from the horizon. The car lower in the visual field (but also below the horizon) is also perceived as closer, as it is further away from the horizon.

**Figure 7.33** The photo above of the Taj Mahal illustrates the use of all five pictorial depth cues.
BOX 7.6 Cultural differences in pictorial depth cues

Look at the picture of the hunting scene in figure 7.30 below. This was used to test the ability to respond to pictorial depth cues. Which animal is closer to the hunter, the elephant or the antelope?

Using pictorial depth cues (monocular), you probably chose the antelope. The picture was shown to tribal Bantu indigenous people in Africa, who had little or no formal education and lived in isolated areas. Many of these participants selected the elephant, which is physically closer to the tip of the spear in the picture.

The researcher classified this answer as a two-dimensional response. The Bantu people had not used the interposition depth cue, nor had they taken into account what they know about the relative size of the animals; that is, that an elephant is bigger than an antelope (Hudson, 1962).

This cultural evidence also indicates the importance of past experience in visual perception. It is possible that the Bantu who made incorrect perceptual judgments did so because they had limited opportunities to see three-dimensional representations in two-dimensional forms. Therefore, they have difficulty judging distance from pictures (Deregowski, 1989).

Figure 7.34 Which animal is closer to the hunter?

LEARNING ACTIVITY 7.8

Summarising depth cues

Complete the table below to describe and classify each depth cue listed, and give an example of when each cue is used.

<table>
<thead>
<tr>
<th>Depth cue</th>
<th>Description</th>
<th>Monocular (M) or Binocular (B)</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>retinal disparity</td>
<td></td>
<td></td>
<td></td>
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<td>convergence</td>
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<td>accommodation</td>
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<td>texture gradient</td>
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<td>relative size</td>
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<tr>
<td>height in the visual field</td>
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</table>
LEARNING ACTIVITY 7.9

Review questions

1. (a) Briefly describe a task that would be difficult for a person with sight in only one eye.
   (b) Which depth cues would this person be unable to use?
   (c) How would the inability to use both eyes affect the person’s performance on this task?

2. The lens can alter its shape for near or distant objects.
   (a) Name the depth cue that uses information associated with change in lens shape.
   (b) Explain how and why the lens would change shape as a jeweller looks on a shelf for a tiny part to repair a watch, then closely inspects the part.

3. The retina receives a two-dimensional image, yet we visually perceive a three-dimensional environment. Explain how this occurs, with reference to depth cues.

4. Examine the Renaissance painting shown in Figure 7.35 and the street scene in Figure 7.36. Identify three depth cues that are evident in the artwork and three in the photo.

5. Explain, with reference to three examples of pictorial cues, why it is difficult to judge depth or distance in Figure 7.37.

Figure 7.35  The Annunciation by Crivelli, c.1430–95. © The National Gallery London

Figure 7.36

Figure 7.37
Perceptual constancies

As we move around, the images that are cast on each retina are constantly changing. Yet, we still perceive the world as a fairly stable place. Objects such as trees, houses and people are not perceived as changing in size, shape or brightness from one minute to the next. Despite the stable nature of the real world, visual information received at the retina is constantly changing. For example, as you move away from an object, such as a tree, the size of the image it casts on the retina becomes smaller. But you do not perceive the tree to be shrinking. Similarly, a car is not perceived as changing in shape as we walk around it and view it from different angles, despite the fact that different shapes are produced on the retina. These are examples of what is known as perceptual constancy.

In vision, perceptual constancy refers to the tendency to perceive an object as remaining stable and unchanging (‘constant’) despite any changes that may occur to the image cast on the retina. Three of the perceptual constancies involve size, shape and brightness.

Size constancy

Size constancy involves recognising that an object’s actual size remains the same, even though the size of the image it casts on each retina changes. For example, when you are on a railway station platform watching a train coming towards you, the image it casts on each retina gets progressively bigger. However, you do not perceive the train as actually increasing in size. Similarly, when you watch a train depart into the distance, the size of the retinal images become progressively smaller. Despite this, you still perceive the train’s size as remaining constant. You know it hasn’t shrunk. This indicates the role of learning in size constancy. Past experience with objects has enabled you to become familiar with objects of different sizes and you now know that they don’t necessarily change size if they appear smaller.

LEARNING ACTIVITY 7.10

Visual presentation using depth cues to perceive depth and distance

Prepare a digital presentation or A3-size poster that identifies, describes and explains the use of pictorial depth cues in an artwork. The presentation should include a copy of the artwork.

You could use an artwork you may have created yourself (such as a painting or photograph). When selecting the artwork, ensure that at least three of the following pictorial cues can be identified: linear perspective, interposition, texture gradient, relative size and height in the visual field. Figure 7.32 shows a way of organising your presentation.

LEARNING ACTIVITY 7.11

Reflection

What are some of the difficulties that could be experienced in everyday life if someone had impaired depth perception?

Shape constancy

As you move around a room which has a round clock on the wall, the angle from which you view the clock changes. Consequently, the image of the clock cast on the retina also changes. It might change from a circle when viewed face-on to an ellipse (oval shape) when viewed from side-on. Despite these changes to the retinal image, your perception is still of a clock that is circular in shape (see Figure 7.38).

Shape constancy is the tendency to perceive an object as maintaining its shape despite any change in shape of the image of the object on the retina. As we move around in our daily lives, the angles at which we view objects change. Consequently, the image of the object that is cast on the retina also changes. If we interpreted the image in terms of how it actually occurs on the retina, the object would be perceived as constantly changing shape. However, by automatically using the principle of shape constancy we know that the object hasn’t changed shape and we perceive it as remaining stable (constant).
Brightness constancy

Suppose you are seated in a room at dusk with overhead lighting on. Suddenly, the electricity supply is cut off. Despite the changed lighting conditions, you still perceive the objects around you as remaining the same colour. You know, for example, that the cover on the lounge chair hasn’t suddenly become dull even though there is a reduction in brightness (‘light intensity’) on the image produced on the retina and it ‘looks’ duller.

Because everything in your immediate environment has been reduced in light intensity by the same amount, the colours of all objects are perceived with the same brightness as they were before the lights went off. In this situation, your visual perception system has maintained brightness constancy. Brightness constancy is the tendency to perceive an object as maintaining its level of brightness in relation to its surroundings, despite changes in the amount of light being reflected from the object to the retina.

LEARNING ACTIVITY 7.12

Demonstration of size and shape constancy

Look at the figure below. Try to imagine whether you could fit a five cent, 10 cent, or 20 cent coin on the top surface of this figure. Which coin(s) do you think would fit?

Now use real coins to see which (if any) fit on the top surface. What did you find? Explain your answer in terms of the concepts of size and shape constancy.

LEARNING ACTIVITY 7.13

Review questions

1. (a) What is size constancy?
   (b) Give an example of a psychological or cultural factor that may influence the use of size constancy.

2. (a) What is shape constancy?
   (b) Suggest how we might perceive objects or events if we did not use shape constancy.

3. (a) What is brightness constancy?
   (b) Explain how you use brightness constancy when you look at the colour of your bedroom wall under different lighting conditions — in the middle of a sunny day and at night.

4. What do you think orientation constancy is? Suggest a definition.
Perceptual set
Look closely at the illustration of a seal act for a circus in figure 7.41. What do you see?
You may have identified a seal balancing a ball on its nose with its trainer on the right holding a fish in one hand and a stick in the other. However, if you had been told that this picture was of two people at a costume party, how would you then have described it? Would your perception of the same illustration have been different? Look again at Figure 7.40 until you can identify the woman on the left handing the man on the right an object. He has a sword in his right hand.

Figure 7.41

The ambiguous illustration demonstrates that an individual can arrive at entirely different perceptions from the same visual information. Why is it that our perceptions of the same visual scene can differ? Why is it that you could be led to perceive the same visual scene in two different ways? This can be explained by perceptual set, one of the most widely researched psychological factors that influences visual perception.
Perceptual set is the predisposition, or ‘readiness’, to perceive something in accordance with what we expect it to be. Our expectations of what an object or event will be make us more likely to interpret the object or event in the predetermined way. Perceptual set is often referred to as expectancy because various psychological and social factors create an ‘expectation’ to perceive something in a particular way. Experimenters effects in research described on page ## in chapter 2 are attributed to perceptual set and its expectancy influence.

Visual perception is usually assisted by perceptual set when we correctly anticipate what something is and therefore interpret it more quickly. For example, as your teacher writes on the board at the front of the classroom, a perceptual set may enable you to interpret a misspelt word such as ‘rember’ as a meaningful word (remember) in order to make sense of what is being written. Thus, you perceive the total message more quickly than if you had to try to work out what the word ‘rember’ meant before interpreting the whole message.

Sometimes, however, perceptual set can lead to perceptual distortions or mistakes. For example, look at the photo in figure 7.36 and complete the activity. Our expectations of what something might be may cause us to notice only the information that is consistent with our expectations and ignore or overlook information that may be relevant. This can lead to a misinterpretation of an object or event.

Figure 7.42 Consider this photo of Jennifer Lawrence, who co-starred in The hunger games movies, then turn to Figure 7.46 on page ## and complete the simple activity.
Consider the situation of waiting for a friend on a busy corner in the Melbourne CBD. The two of you have arranged to meet there and go to a movie. Your past experience with this person tells you that she walks faster than most people. You also know from past experience that she is always late, and today is no exception. Given the busy setting (i.e. context), you may be predisposed to look for the person walking fastest in the approaching crowd.

A perceptual set, such as one based on these factors, often enables you to visually perceive information quickly. You would eliminate all the people in your field of vision who are not walking quickly, because you expect your friend to be in a hurry. However, what if she has sprained her ankle, and is now hobbling slowly to meet you? Or, what if you rush to greet a fast-moving young woman who resembles your friend to find that you are totally mistaken?

There are several factors that may interact in influencing or bringing about perceptual set. Most of these involve personal characteristics of the perceiver, such as their past experience, motivation, emotional state and cultural background. The context in which the perception occurs may also influence perceptual set.

**Context**

In visual perception, context refers to the setting or environment in which a perception is made. When interpreting visual information, we often take account of the setting and pay more attention to those aspects of the setting that are immediately relevant. In this way, context has a 'focusing' role in visual perception and usually assists us to make a quick and accurate interpretation of what we are looking at.

For example, consider the different interpretations that could be made of a fast-moving bright light in the sky that has a tail streaking behind it. How would you interpret this visual stimulus if you observed it in the sky over:

1. outback central Australia?
2. a war zone?
3. a NASA launch site in the USA?
4. Melbourne’s Yarra River on New Year’s Eve?
5. a ship at sea?

As the context of the visual stimulus changed, your interpretation may also have changed from: (1) a meteorite, (2) a missile, (3) a rocket headed for outer space, (4) a skyrocket, (5) a distress flare.

Context can also lead us to make slower or inaccurate interpretations. For example, have you ever bumped into someone who seems familiar but found you cannot recall their name or where you know them from? The person may have been one of your primary school teachers, but because they were ‘out of context’ in a different situation from that in which you have known them, you were unable to readily identify them.

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**BOX 7.7 Pioneering research on context**

The importance of context in visual perception was first demonstrated in an experiment by American psychologists Jerome Bruner and Leigh Minturn (1955).

In this experiment, one group of participants who were assigned the role of observers (Group A) was shown a visual stimulus like that in Figure 7.38 for 80 thousandths of a second after viewing the series of letters L, M, Y, A. Another group of observers (Group B) was shown the same visual stimulus for the same exposure time after viewing the series of numbers 16, 17, 10, 12. The task given to each group of observers was to identify what they saw and to draw it.

Results from Group A (who saw the letters first) indicated that 92% of the participants perceived the visual stimulus as a ‘B’. For Group B (who saw the numbers first), 83% of the participants perceived the visual stimulus as a ‘13’.

Bruner and Minturn concluded that the context of either letters or numbers ‘set’ predisposed the observers to interpret the ambiguous symbol in accordance with the type of symbols that had preceded it. A perceptual set had been established by the time the ambiguous figure was shown. Observers expected the next symbol to be one that was consistent with the established context.

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**Figure 7.43** Our perception of a bright light with a tail streaking across the night sky is likely to be influenced by the context in which it is observed.

**Figure 7.44** The ambiguous ‘B or 13’ stimulus figure used by Bruner and Minturn (1955)
Analysis of research by Bruner and Minturn (1955) on context in visual perception

Consider the experiment on context summarised in box 7.6 above. Analyse the research by answering the following questions.

1. Formulate a possible research hypothesis.
2. Identify the operationalised independent and dependent variables in the experiment.
3. Briefly state the results that were obtained.
4. Briefly state a conclusion for the experiment based on the results obtained.
5. Would a perceptual set have been established by showing one number/letter prior to showing the ambiguous figure? Explain your answer.

Motivation

Motivation can also influence perceptual set. **Motivation** refers to internal processes which activate behaviour that we direct towards achieving a particular goal. Motives can be influenced by psychological factors (such as interests, ambitions and desires), biological factors (such as bodily processes associated with hunger or thirst), or social factors such as the influence of our cultural background on people and institutions within our society.

Visual perception can be influenced by our motives when, for example, we see what we want to see, rather than what is actually there. When supporters of opposing teams are sitting side by side at a football match, the difference in their perceptions of the same event may be considerable. Physically, the images cast upon their retinas are almost identical, but the influence of their respective motivational states to see their team win brings about perceptual differences which can be so great that they may appear (to the impartial observer) to be watching two different games.

Emotional state

Our **emotional state** — how we are feeling — can also influence the way in which we perceive visual information. Different emotions can ‘set’ us to perceive information in a particular way which is consistent with the emotion being experienced. For example, a child who is afraid of being in their darkened bedroom may interpret the shadow of their dressing gown hanging on the back of the bedroom door as a ghost, or the teddy bear sitting on the end of the bed as a monster.

Figure 7.45 Many AFL fans will arrive at a game with a perceptual set established by their motivation to see their team win.
Past experience

Past experience refers to our personal experiences throughout our lives. This includes everything we have learnt, both intentionally and unintentionally. Our unique combination of past experiences can lead to many individual differences in perception. Such experiences also predispose, or ‘set’, us to perceive information in a particular way.

A well-known experiment on the effect of past experience on perceptual set was conducted by American psychologists Hans Toch and Richard Schulte (1961). They hypothesised that past experience (operationalised as ‘type and stage of training’) influenced which illustration would be perceived more readily when two illustrations were briefly presented to participants.

The Toch and Schulte experiment involved the use of binocular rivalry. Binocular rivalry occurs when a different visual image is briefly and simultaneously presented to each eye. Usually one image or the other is seen, but participants rarely see both.

All participants were presented with nine pairs of illustrations. In each pair, one illustration was of a violent scene and the other was of a neutral (neither violent nor non-violent) scene. One of the pairs of illustrations used in this experiment is shown in Figure 7.46. The illustrations were deliberately drawn to be somewhat ambiguous in order to maximise the potential influence of the participants’ training on their perceptions.

The participants were drawn from three different backgrounds: Group 1 had completed police-style training at the School of Police Administration and Public Safety at an American university, Group 2 had just begun their police-style training at the same school, and Group 3 were university students with no police-style training of any kind.

The results indicated that Group 1 participants perceived the violent pictures on 52% of the trials, compared with Group 2 on 26% and Group 3 on 22%. Toch and Schulte concluded that the past experience of police training (which had involved considerable time discussing, recognising and managing potentially violent and dangerous situations) increased the probability of perceiving the violent pictures.
Culture

Culture refers to the way of life of a particular community or group that sets it apart from other communities and groups. Culture includes such things as the customs, traditions, beliefs, values, attitudes, rules about what is right and wrong, food and music, as well as any other features of that community or group which distinguish it from other communities or groups.

Experience with or in a particular culture, can influence the way we process and interpret visual information. This was demonstrated in a study with Malawi people, a remote village community in Tanzania, Africa.

Before the Malawi people had access to photographs, a group of them were shown a black and white photograph of a dog. Despite the fact that many of the observers owned dogs or had experience with dogs, they were unable to identify the subject of the photograph as a dog. Even when the various features of the dog such as the head, ears and tail were pointed out to them, many of the Malawi people still had difficulty interpreting the photograph as a dog and, in some cases, the specific features of the dog, such as the paws and tail (Deregowski, 1980).

This could be explained by the possibility that, being a remote tribal community, the Malawi people had little, if any, exposure to picture books. Consequently, they had little or no experience with photographs or two-dimensional drawings of dogs on paper. When they were shown a two-dimensional photograph, they may not have been able to use relevant visual perception principles to identify the features and the overall image of the dog.

Figure 7.48 How many aces of spades do you see? Most participants shown the above display for a few seconds report seeing three aces of spades. However, there are actually five — two of them are coloured red instead of black. Because of past experience with playing cards, particularly with the ace of spade being coloured black, we are predisposed to look only at the black cards when given the task, which often results in an inaccurate perception. The above stimulus was used in a pioneering experiment conducted by American psychologists Jerome Bruner and Leo Postman (1949) who found that perceptual set based on past experience may cause perceptual error.
LEARNING ACTIVITY 7.15

**Review questions**

1. (a) Explain the meaning of perceptual set.
   (b) Suggest why perceptual set is sometimes referred to as 'expectancy'.
2. Give an example of how one or more biological factors may influence perceptual set.
3. (a) What does context mean in relation to visual perception?
   (b) Give an example of how context may lead to a perceptual interpretation of having ‘seen’ a UFO, a Tasmanian Tiger, the Loch Ness monster or a similarly rarely sighted phenomenon.
4. Briefly explain, with reference to relevant examples, how each of the following can influence perceptual set.
   (a) motivation
   (b) emotional state
   (c) past experience
   (d) culture
5. Explain how past experience can lead to errors in visual perception.

LEARNING ACTIVITY 7.16

**Analysis of research by Toch and Schulte (1961) on the influence of past experience**

Analyse the experiment on the influence of past experience on visual perception conducted by Toch and Schulte (1961). Your summary and evaluation should include responses to the following questions.

1. Formulate a possible research hypothesis for the experiment.
2. Identify the operationalised independent and dependent variables in the experiment.
3. Identify the experimental and control conditions of the experiment.
4. Briefly state the results that were obtained.
5. Briefly state the conclusion drawn by Toch and Schulte from their results.
6. Identify three ethical considerations relevant to the experiment.

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Practical activity — the effect of past experience on the interpretation of an ambiguous stimulus
TASTE PERCEPTION

Taste seems to be the least critical of our senses but long ago it contributed more directly to our survival. It is believed that taste evolved to protect us from eating things that are poisonous and to ensure we have an appetite for the calories and nutrients we need. For example, many toxic or spoilt foods and liquids are either bitter or sour. These are tastes we tend to avoid. In contrast, pleasure through sweet and salty-tasting foods helps ensure we meet nutritional requirements to keep us healthy. Identifying tastes is our brain’s way of telling us about what’s going into our mouth, and in some cases, keeping us safe.

Taste perception is of renewed interest in psychology because it plays a significant role in overeating and in the rising incidence of obesity, diabetes and other eating or food-related disorders. Research studies have found, for example, that people who have a low sensitivity to the taste of sweetness in foods tend to eat more sweet foods and are more likely to be overweight. In addition, loss of taste sensitivity can lead people to eat too much sugar or salt to make their food taste better. This can be a problem for people with diabetes or high blood pressure. In some cases, loss of taste can even lead to a mental health problem or disorder.

From mouth to brain

Our perception of taste, or gustation as it is formally called, starts with the physical stimulation of taste receptor cells in the mouth. The stimuli that produce taste sensations are chemical molecules in whatever you eat or drink. These molecules are dissolved by saliva, allowing the chemicals to stimulate taste buds. Food, fluids or any substance that is soluble in saliva can stimulate the taste buds, which is why you can taste dirt and dust. Similarly, you may have noticed that after you have brushed your teeth in the morning, orange juice tastes bitter. The chemical residues from the toothpaste mix with those of the orange juice to produce a new taste sensation.

When taste receptors are stimulated, they convert the sensory input into signals that can be sent to the brain along neural pathways. The ‘taste’ pathways are cranial nerves which connect directly to the brain. Which one is used depends on where in the oral cavity the taste receptors that have been stimulated are located. Most messages travel to the brain along the facial cranial nerve.

After initial processing by the thalamus, the sensory information is relayed to the gustatory cortex for interpretation. Taste alone does not affect how much you like a certain food or drink so the information is combined with other sensory inputs about the food.

Taste receptors, sometimes called gustatory cells, are the sensory receptors that detect the chemical molecules that enable taste. The taste receptors are located within the taste buds. Most of the taste buds are on the tongue. But they are also found under the tongue, on the roof of the mouth, on the sides of the

**Figure 7.50** How we taste — biological processes in taste sensation and perception
mouth, and at the back of the mouth on the upper part of the throat behind the nose. It is estimated that most people have about 8000 to 10 000 taste buds, but the number of taste buds peaks in early childhood and gradually declines during adulthood.

On the tongue, the taste buds are located within the thousands of small bumps called papillae that you can see and feel on the surface. An individual papilla may hold one or more taste buds. Each taste bud consists of a cluster of 50–150 taste receptors. Unlike sensory receptors in the eye, taste receptors have a limited lifespan of about 10 days, so they are constantly being replaced. The sensory receptors in the eye are true neurons but taste receptors are not (because they do not have an axon and are replaced after they die).

Taste pores on the surface of the tongue open into the taste bud, thereby connecting the surface of the tongue to the taste receptors within the taste buds. The connection is through fine gustatory hairs that extend from the taste receptors into the taste pores. These hairs come in contact with tastants. Tastants are the dissolved chemical molecules that can be tasted. The hairs stimulate their connected taste receptor cells to pass signals on to sensory neurons which transmit the messages to the brain.

Not all papillae contain taste buds and therefore taste receptors. Those found around the sides and at the front of the tongue contain taste buds, whereas those found predominantly in the centre of the tongue do not have taste buds. Some papillae have other functions. For example, some are pain receptors that respond to hot and spicy sensations (caused by the substance capsaicin found in foods with chilli), others help break down fats and others are touch receptors that contribute to the perception of food texture. In addition, the tongue is sensitive to the temperature sensations of hot and cold.

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Weblinks
Videos on taste

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**Figure 7.51** A cross-section of the tongue
**Five basic tastes**

The pleasure we can derive from eating delicious food suggests that we can discriminate many tastes. However, we detect only five basic tastes — sweet, sour, salty, bitter and umami.

The sweet taste is usually caused by sugar and its derivatives such as fructose or lactose, as well as artificial sweeteners such as saccharine. Other types of substances can also activate taste receptors that respond to sweetness. These include alcohols in fruit juices or alcoholic drinks.

It is mostly acidic solutions like lemon juice, lime juice and vinegar that taste sour. Tasting acidity helps us to judge the ripeness of food. Unripe fruits, for example, have less sugar and therefore taste sour. Foods that are ‘off’ can also become acidic and therefore taste sour, so the ability to taste sour also has a protective function.

Food containing table salt is mainly what we taste as salty. This is produced by salts containing sodium, such as sodium chloride (table salt) and sodium bicarbonate (baking soda). Mineral salts like the salts of potassium or magnesium can also cause a sensation of saltiness. Almost every fluid in our body contains salt (e.g. blood, sweat and tears) so we need salt to survive. Popcorn, pretzels and potato chips taste so salty because the grains of salt lie mainly on the surface of the food.

Bitter taste is produced by a variety of different substances and is generally identified as undesirable or unpalatable. Toxic chemicals produced by poisonous plants have a bitter taste which, from an evolutionary perspective, results in our negative reaction to bitter foods. Recognising which ones were poisonous was a matter of survival. Sugar can mask the taste of bitterness.

**Umami**, also called savoury, is a rich, ‘mouth-filling’ taste in protein-based foods due to the presence of glutamate. Meat, aged cheese, ripe tomatoes, mushrooms, soy sauce, Vegemite and MSG that is often added to food as a flavour enhancer are examples of foods that contain glutamate. Most people first experience umami in breast milk, which is rich in glutamate.

It was once believed that different parts of the tongue are more sensitive to certain tastes. It is now known that taste buds are spread relatively evenly throughout the tongue and mouth. Therefore, areas on the tongue do not differ too greatly in the taste sensations that they activate.

All five tastes can be experienced anywhere on the tongue where there are taste receptors. About half of the receptor cells react to several of the five basic tastes. They differ only by having varying levels of sensitivity to the different basic tastes. For example, a particular cell might be most sensitive to sweet, followed by sour, salty and bitter, while another cell will be more or less sensitive to other basic tastes.

Most taste experiences are complex and result from the activation of different combinations of more or less of the five tastes from the different parts of the tongue. Our appreciation of food, however, depends on more than taste alone. As you probably know from when your sense of smell is impaired by a stuffy nose, the perception of taste is dulled as well. Block your nose and an apple will taste the same as a raw potato. This occurs because taste perception relies very heavily on smell. Taste, smell, sight and other sensory inputs influence the perceptual experience we commonly call flavour.

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**Weblinks**

Practical activities on taste perception

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**Figure 7.52** Smell contributes heavily to taste perception. This is why smelling is part of the wine tasting ritual. Without smell it would be very difficult to taste subtle differences between wines.
that are shaped by the complex interaction of them. Some people love sour lollies while others example, some people hate oysters while others love We each have individual taste preferences. For \( \text{PERCEPTION} \) \( \text{INFLUENCES ON TASTE} \) Discuss with reference to information in this text. \( \text{basic taste by psychologists (and scientists in general)?} \) \( \text{be required for fat to be widely adopted as a sixth taste.} \) \( \text{Consider the article on fat as a sixth taste. What would} \) \( \text{LEARNING ACTIVITY 7.18} \) \( \text{Media analysis/response} \) Consider the article on fat as a sixth taste. What would be required for fat to be widely adopted as a sixth basic taste by psychologists (and scientists in general)? Discuss with reference to information in this text. biological, psychological and social factors. We consider the influences of age and genetics (biological), perceptual set (psychological) and culture (social). \( \text{Age} \) The ability to taste many substances is already well-developed at birth. Even premature infants show characteristic responses to basic tastes. For example, they suck more in response to a sweet substance used to coat a dummy and try to spit out the dummy when it is coated with a bitter substance. Full-term infants start out with relatively few taste buds, but during childhood the number steadily increases until the final total is reached. The persistence of an aversion to bitterness may help protect children from eating poisonous foods during their early development, before they have learned what can be eaten and what must not be eaten.
Research also shows that children are much more responsive to taste than adults. One explanation is that they have more taste receptors than adults. We start to lose taste buds as we age, but exactly how many and when remain unclear. Some researchers have estimated loss of more than half our taste buds by the time we turn 20, whereas others report that loss of taste buds may not start until at least age 50. Nonetheless, a greater number of taste buds in childhood may bring with it a greater range of taste sensations and partly explain why young children seem to be ‘fussy eaters’. The explanation of fussiness in relation to the tastes of bitter and sour may have far more to do with genetics (Kolb & Whishaw, 2014; Schacter, Gilbert, Wegner, 2009).

There is also considerable research evidence that taste perception fades with age as part of the normal ageing process. In particular, there is some decline in taste in people aged over 60. Many report loss of taste and that it gradually deteriorates as they get older. Loss of taste receptors does not, however, fully account for this change. Many older people mistakenly believe they have a problem with taste, when they are actually experiencing a problem with smell. In older people, there is a normal age-related decline in the sense of smell which substantially contributes to loss of taste and the associated belief of having a taste problem.

True taste disorders are uncommon. Other than smell dysfunction, when a problem with taste exists it is more likely to be caused by upper respiratory infection, medications, a dental, mouth or throat disease, a cancer treatment, or a history of middle ear infection (one taste nerve travels through the middle ear on its way to the brain).

Chewing problems associated with tooth loss and dentures can also interfere with taste sensations, along with the reduction in saliva production. Rather than whole mouth taste loss, decline in specific areas of the mouth is much more common. Despite their higher prevalence in elderly people when compared with young people, most elderly people are unaware of regional taste deficits (Bartoshuk, 1989; Boyce & Shone, 2006).

Genetics
People vary in their ability to taste. One reason is that genetic differences make us more or less sensitive to the chemical molecules in different foods. Our genes can therefore influence how sensitive we are to bitterness, sweetness or any other tastes. For example, variants of one gene (called TAS2R38) have been found to influence how strongly an individual will be able to detect bitter tastes, which may explain why some people refuse to eat broccoli, Brussels sprouts and similar dark green, leafy vegetables throughout their lives.

If you enjoy these vegetables, this may seem a little strange. But some people actually experience the taste differently and research indicates this may be attributable to their genes (Perry, 2011; Rawal, et. al, 2013). American psychologist Linda Bartoshuk (2014), an eminent researcher in the study of taste, believes that “bitter is hard-wired in the brain to hate” so “we are born hating it”, whereas “we are born loving sweet!”. Bartoshuk coined the term ‘supertaster’ to describe individuals who experience taste sensations intensely. According to Bartoshuk (2015a), supertasters find tastes to be 2 to 3 times as intense as do other people. Supertasters are extremely sensitive to bitter tastes, highly aware of food flavours and textures and are more likely than others to feel pain when eating very spicy foods. They also experience more intense likes and dislikes for certain foods.

Figure 7.53 Fussy eater or too many taste buds resulting in a sensory overload of taste?

Figure 7.54 Are we born loving sweet?
Supertasters inherit an unusually high number of taste buds. This relationship with tongue anatomy indicates that the more taste buds we have, the more intense our taste experience is likely to be. It is estimated that 25% of the population are supertasters, with more men than women. About 25% of people are ‘non-tasters’ with an unusually low number of taste buds. The other 50% of people fall in between these extremes (Bartoshuk, 2015b; Duffy, et. al., 2010; Grison, Heatherton & Gazzaniga, 2015).

Although it might seem enjoyable to experience intense tastes, many supertasters are especially fussy eaters because particular tastes can overwhelm them. When it comes to taste sensation, more is not necessarily better. Supertasters tend to avoid bitter-tasting foods, which they find extremely distasteful. They also tend to get more ‘burn’ from chilli peppers and more creaminess from fatty foods and thickeners in foods. In addition, they experience pain in the mouth more intensely than non-supertasters. Non-tasters tend to find tastes less intense. They are often easier to please in food choices (Bartoshuk, 2000).

Avoidance of vegetables and fruits with tastes that are experienced as extremely bitter may place supertasters at an increased risk for colon cancers that bitter foods may protect against. However, their dislike of fatty, creamy foods means that they tend to be thinner and therefore have a decreased risk of cardiovascular disease. They are also less likely to smoke because of the bitter taste of nicotine and avoid the bitter taste in coffee or blunt it with milk and/or sugar (Bartoshuk, 2000).

**Perceptual set — food packaging and appearance**

The taste we experience is shaped by our perceptual set. This means that we often taste what we expect to taste. A significant influence is our expectation of how a food ‘should look’. Sometimes what we see can override what we think we taste. Although taste perception is dependent on the various sensory properties of food, the process often begins with the eyes. This is why food producers, retailers and marketers pay so much attention to how they package and present food.

Past experience determines our expectations of how something should taste. Changing the known colour of a food is usually all it takes to manipulate our expectations and change the taste. Researchers have found, for example, that orange juice tends to taste better when it is bright orange, cheddar cheese is tastier when yellow rather than white, and tomato sauce will often taste more like tomato sauce when it is red rather than brown or blue. When sweet tasting pink soft drink is changed to yellow with a neutral food dye, it is reported as losing its sweetness despite no real change in its original taste properties (Piqueras-Fiszman, Giboreau & Spence, 2013; Spence et al., 2010).

Even a more subtle feature of food such as shape can influence perception of its taste. For example, French fries are reported as tasting better when thin than fat (but not if the fries are too thin). And square donuts contradict what we know about the essential features of donuts. When given the opportunity to taste a square donut, people are not as confident in predicting its taste because their perceptual set for its taste has been distorted by the unexpected, square appearance. When tasting, they tend to take longer to report on the experience than the time taken for a round donut.
We also use a food’s appearance for clues on whether it is safe to eat. For example, appearance helps us judge whether a food is fresh or not fresh, ripe or unripe and rotten or not rotten. Each of these aspects of food is associated with taste. Colours associated with the ripening of fruits are particularly effective in influencing perceived sweetness, while foods and drinks with a green colour (which is associated with unripe fruits) are often judged to be sourer (Spence et al., 2010).

In addition, when we make an overall judgment that a particular food is safe to eat, our expectancy is that it will taste as it should and that it will not be harmful in any way. When we actually taste the food and it meets our taste expectation, the experience reinforces our perceptual set of its taste. Similarly, when we believe that food is unsafe to eat, we usually expect that it will have a bitter or sour taste, which are in themselves biologically determined signs to avoid such food.

Packaging, labelling and branding also influence our perception of taste. For example, research participants report that Coca-Cola™ and peanut butter taste worse when consumed from a plain, unlabelled container than from one marked with a familiar brand. Children report that an apple, tastes better if it comes from a bag with the McDonald’s logo. Adults report that red wine tastes more full-bodied and complex if it costs more. And plain, home brand bottled water tastes just like expensive Perrier water when there is no label to give feedback about the source (Schrank, 2012).

Researchers have also investigated the effect that the arrangement of food on a plate has on taste perception. Food presented in a neat arrangement is liked more than the same food presented in a messy manner. In addition, participants expected to like the food in the neat arrangements more than in the messy ones and would be willing to pay more for them. They also indicated that the food in the neat arrangements came from a higher quality restaurant and that more care was taken with its preparation than the food in the messy ones (Zellner, et. al., 2011).

We also have expectations about food sounds that influence taste perception. For example, food-eating sounds contribute to the perception of crispness and freshness in foods such as potato chips, biscuits, breakfast cereals and vegetables. When these types of foods have louder, crisp-biting sounds, they tend to be rated by research participants as tasting significantly crisper (and fresher). Similarly, perceptions of the carbonation of a beverage served in a cup have been influenced by the intensity and frequency of the bubbly sounds they hear (Spence & Shankar, 2010).

In some cases we can develop a taste aversion whereby we expect that a taste experience will be extremely unpleasant. This may occur for a food that appears ‘perfect’ in every possible way and which is eaten with enthusiasm by most people. A taste aversion is learned through past experience with a food, usually when having become ill after tasting or eating it. It takes only a single experience of this kind to develop a taste aversion. Then, a perceptual set is created that is so strong that the mere sight of the food can make us feel or be sick. So we avoid eating it, let alone tasting it!

**Culture**

Most cultures have food practices involving the use of basic ingredients, techniques and flavour principles when cooking. Diets in Asian cultures include many more sour and bitter tastes than Western diets. We are exposed to these cultural differences from birth and they are reflected in our perceptual judgments of what tastes good and what tastes bad.

Generally, we like and prefer tastes we grow up with. This tends to persist in childhood, but most people will eventually try ‘new tastes’ when presented with the opportunity. We may also change taste preferences through learning as we get older. For example, children tend to reject the bitter taste of beer but many adults have learned to appreciate its taste.

Direct experience with different foods is one of the most important influences on taste perception. As we grow up, most of this experience occurs...
within a family setting. The family environment also exposes us to the reactions of others when they taste food. Parents, siblings and relatives can act as role models who encourage tasting of new foods or influence taste preferences through positive or adverse reactions to foods. We may also be influenced in this way when watching people eating in a movie, during lunchtime at school, when out with friends, and so on.

Other cultural influences on taste perception include being encouraged by a parent or caregiver to eat certain foods because of the health benefits, attitudes to health foods and junk foods by the various people around us, having increased or decreased access to certain foods through socio-economic circumstances, and even school food policies. In addition, some religions have rules regarding what may be eaten or drunk and whether or not a food or drink item can actually be enjoyed.

In sum, what’s delicious varies across cultures. In some cultures, fish eyes, parrots, scorpions, beatles, grasshoppers, dog meat, goat testicles, fried tarantula, chicken feet or live witchetty grubs are tasty delights, whereas in other cultures the thought of eating these foods would trigger a negative reaction in most people.

Cultural influences on taste appear to be determined early in life, perhaps even in the uterus. Research suggests, for example, that mothers can pass their food preferences on to their offspring during the months immediately before (via amniotic fluid) and after birth (via breast milk). In one study, pregnant women were randomly assigned to one of three groups. The women drank either carrot juice or water for 4 days per week for 3 consecutive weeks during the last 3 months before birth and then again during the first 2 months after birth.

Group 1 mothers drank carrot juice in the period before birth and water after birth. Group 2 mothers drank water before birth and carrot juice after birth. Group 3 mothers drank water in both periods before and after birth. All the mothers breastfed their infants, so the taste of what each mother consumed was in the breast milk which was the only source of food for the infant during the first two months after birth.

When the infants were about 3 months old, they were fed carrot juice, either alone or mixed in cereal. The infants were videotaped as they fed and immediately after the mothers rated their infants’ enjoyment of the food on a 9-point scale. The researchers also monitored the infants’ facial expressions for negative taste reactions. The results showed that the infants whose mothers drank carrot juice during the three months before birth, the first two months after birth or during both periods showed a preference for carrot juice compared with the infants whose mothers drank only water during those same months. The researchers concluded that the infants’ taste preference for carrot juice was passed on by the mothers and that this early experience may provide the foundation for cultural and ethnic differences in taste preferences (Mennella, Jagnow & Beauchamp, 2001).

Figure 7.58 What’s delicious varies across cultures and this may be influenced by how the cook prepares the food.
BOX 7.8 Taste aversions

Many of us have a dislike for certain foods. Sometimes there is a good reason for disliking the food, such as genuinely not liking the taste or smell of it. Sometimes the dislike is associated with the texture of the food (e.g. oysters or calamari) or the origin of the food (e.g. tripe or haggis). At other times there is simply an unwillingness to eat something perceived as disgusting (e.g. snails, witchetty grubs or frogs’ legs), or possibly it is rejected on moral grounds (e.g. kangaroo, whale, bear paws or monkey brains).

All these reasons for the dislike of certain foods are personal and subjective. In a different circumstance, however, our dislike of a particular food occurs suddenly and decisively, yet with very little consideration or judgment. The term used for such a response is ‘taste aversion’.

A taste aversion is a learned response that results from a person (or animal) establishing an association between a particular food and being or feeling ill after having tasted or consumed it at some time in the past. The association is usually the result of a single experience, and the particular food will be avoided in the future, hence the term ‘aversion’.

Figure 7.59 A taste aversion may be learned for any food, not only for some of the more exotic foods but also for plain everyday foods.
LEARNING ACTIVITY 7.19

Review questions

1. Complete the following table to summarise the influences of age, genetics, perceptual set and culture on taste perception.

<table>
<thead>
<tr>
<th>Influence</th>
<th>Description</th>
<th>Example</th>
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</thead>
<tbody>
<tr>
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<td>culture</td>
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</table>

2. Draw a Venn diagram like figure 6.9 on page 240 to show the interaction of biological, psychological and social factors influencing taste perception. Include factors in addition to those described in the text.

LEARNING ACTIVITY 7.20

Analysis of research by Mennella, Jagnow and Beauchamp (2001) on infants’ taste preferences

Consider the experiment on the development of infants’ taste preferences described on pages 326–7. Analyse the research by answering the following questions.

1. Formulate a research hypothesis that would be relevant to the experiment.
2. Name the experimental design.
3. Identify the operationalised independent and dependent variables.
4. Use the following table to summarise the experimental conditions:

<table>
<thead>
<tr>
<th>Group</th>
<th>Before birth</th>
<th>After birth</th>
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<tr>
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5. Which one or more of the three groups is the control group(s)?
6. What results were obtained for the different groups?
7. What conclusion about infant taste preferences and culture was drawn by the researchers?
8. Identify two extraneous variables that required strict control in this experiment.

LEARNING ACTIVITY 7.21

Reflection

Give an example of when food packaging or appearance contributed to a perceptual set resulting in a flavour judgment consistent with your expectations and an example resulting in a judgment that did not match your expectation.
CHAPTER SUMMARY

Distinction between sensation and perception

Reception, processing and interpretation of sensory information

Reception and receptive fields

Transduction

Transmission

Interpretation

From eye to brain

Visual perception principles

Visual perception

Depth cues

Binocular depth cues

Monocular depth cues

Figure–ground organisation

Gestalt principles

Similarity

Proximity

From mouth to brain

Taste perception

Five basic tastes

Perceptual set

Perceptual constancies

Shape constancy

Brightness constancy

Perceptual set — food packaging and appearance

Age

Genetics

Culture

Influences on taste perception

Context

Motivation

Emotional state

Past experience

Culture

UNCORRECTED PAGE PROOFS
### KEY TERMS

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LEARNING CHECKLIST

Complete the self-assessment checklist below, using ticks and crosses to indicate your understanding of this chapter’s key knowledge (a) before and (b) after you attempt the chapter test on pages 215–17. Use the ‘Comments’ column to add notes about your understanding.

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<th>Self-assessment of key knowledge I understand before chapter test</th>
<th>Self-assessment of key knowledge I need to do more work on after chapter test</th>
<th>Comments</th>
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<td>Reception, processing and interpretation of sensory information</td>
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SECTION A — Multiple-choice questions

Choose the response that is correct or that best answers the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks will not be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.

Question 1
Which of the following sequences has perceptual processes in the correct order?
A. reception; interpretation; transmission
B. transmission; interpretation; transduction
C. reception; transduction; transmission
D. organisation; transmission; reception

Question 2
Most of the gustatory cortex is located in the ____ lobe.
A. parietal
B. occipital
C. frontal
D. temporal

Question 3
Where are taste receptors located?
A. in taste buds
B. in papillae
C. in tastants
D. in the cranial nerve

Question 4
A receptive field is best described as
A. a sensory receptor.
B. a specific type of sensory information.
C. an area of space specialised to respond to the senses.
D. an area of sensitivity in which a receptor can respond to a stimulus.

Question 5
Which of the following is a depth cue for visual perception?
A. proximity
B. similarity
C. accommodation
D. closure

Question 6
The bumps on the tongue that are involved in taste perception are called
A. papillae.
B. taste buds.
C. taste receptors.
D. gustatory hairs

Question 7
The taste of umami is based on detection of ____ in a substance.
A. acidity
B. glutamate
C. sugar
D. salt

Question 8
When we have difficulty separating a figure from the background in a picture or in an everyday setting, it is most likely due to an inability to
A. use linear perspective.
B. use monocular cues.
C. use retinal disparity.
D. perceive the contour lines which belong to the figure.

Question 9
When our brain monitors the muscles used to change the shape of the eye’s lens, we are using
A. shape constancy.
B. retinal disparity.
C. accommodation.
D. convergence.

Question 10
The number of taste buds ____ with age.
A. increases
B. decreases
C. stabilises
D. remains the same

Question 11
Taste is most dependent on
A. the sense of sound.
B. the sense of smell.
C. what is eaten in the period immediately before birth.
D. what is eaten in the period immediately after birth.
Question 12
A white shirt looks just as white when you are ironing in conditions of artificial light as it does when you hang it on the clothes line in sunlight. This is an example of the effect of
A. brightness constancy.
B. binocular cues.
C. figure–ground organisation.
D. similarity.

Question 13
A tastant is
A. the person who is tasting.
B. a dissolved chemical that can be tasted.
C. the connection between a taste receptor and taste bud.
D. the connection between a taste receptor and taste pore.

Question 14
A taste bud has a lifespan of about ____ days.
A. 1
B. 5
C. 10
D. 50–150

Question 15
The correct sequence of the pathway of light through the eye and eventually to the brain in another form is
A. cornea, iris, pupil, retina, lens, visual cortex.
B. pupil, iris, lens, retina, optic nerve, visual cortex.
C. cornea, pupil, lens, retina, optic nerve, visual cortex.
D. pupil, lens, retina, fovea, optic nerve, visual cortex.

Question 16
Photoreceptors are located in the
A. lens.
B. pupil.
C. cornea.
D. retina.

Question 17
The difference in the images on the retina of each eye when an observer is viewing something is called
A. relative size.
B. retinal disparity.
C. texture gradient.
D. height in the visual field.

Question 18
About how many gustatory receptors are there in a typical taste bud?
A. 1–50
B. 50–150
C. 4000–8000
D. 8000–10 000

Question 19
When one object in a visual stimulus partially blocks another, the object at the back which is blocked from full view is perceived as being further away than the object in front of it. This is an example of
A. closure.
B. interposition.
C. constancy.
D. figure–ground organisation.

Question 20
The ____ assist us to see in conditions of dim light; whereas the ____ assist us to see fine detail, in colour and in bright light.
A. cones; rods
B. lens; cones
C. rods; cones
D. rods; lens
SECTION B — Short-answer questions

Answer all questions in the spaces provided. Write using black or blue pen.

**Question 1** (2 marks)
What is the difference between sensation and perception?

**Question 2** (3 marks)
Explain what transduction is and what it involves in visual perception and taste perception, ensuring you refer to the relevant stimulus for each type of perception.

**Question 3** (2 marks)
Explain why figure–ground should be considered when using camouflage.

**Question 4** (3 marks)
Describe how taste perception occurs.

**Question 5** (3 marks)
Explain the meaning of perceptual set in relation to visual or taste perception and how it may influence that type of perception.
Question 6 (4 marks)
Give two arguments in support of a genetic component of taste perception and two arguments in support of environmental influences on taste perception.

Question 7 (3 marks)
Describe an influence of each of the following types of factors on visual perception.

- Biological
- Psychological
- Social

Question 8 (5 marks)
(a) Explain the meaning of depth perception. 1 mark

(b) Distinguish between binocular and monocular cues in depth perception with reference to an example of each type of cue. 4 marks