# Psychology Units 1 & 2

## Chapter 10 — Distortions of perception



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## Chapter 10 Distortions of perception — 10A Fallibility of visual perception (illusions and agnosia)

### Theory

**Perception** is the process by which the brain selects, organises and interprets the raw sensory information it receives, so that we experience a meaningful picture of the world. Crucially, perception is not a simple "recording" of what is out there: the brain **actively constructs** our experience by interpreting the incoming signals. Because the brain interprets — and can **misinterpret** — perception is **fallible**, meaning it is **capable of being inaccurate**. **The fallibility of visual perception** refers to the fact that **the visual perception we construct does not always match physical reality**: what we perceive can differ from what is actually there. This subtopic looks at two ways visual perception can go wrong — **visual illusions** and **agnosia**.

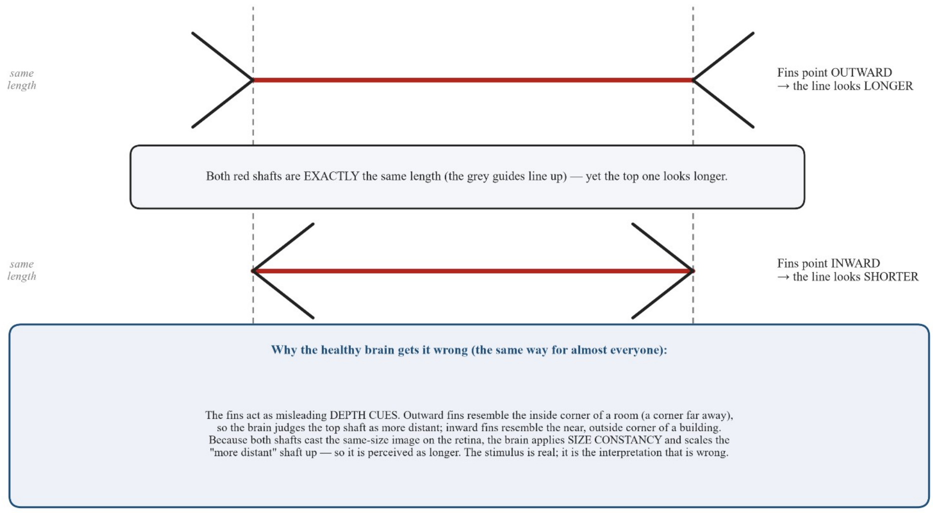
**Visual illusions.** A **visual illusion** is a **consistent misinterpretation of a real, external visual stimulus** — that is, a real stimulus is genuinely seen, but the brain interprets it in a way that does not match its true physical properties, and **almost everyone tends to misinterpret it in the same way**. The stimulus is real and the eyes work normally; it is the brain's **interpretation** that is "wrong".

*How illusions arise.* To turn the flat, two-dimensional image on the retina into an experience of a three-dimensional world, the brain relies on **depth cues** (features that suggest how near or far things are) and on **size constancy** (the tendency to perceive an object as staying the same size even as its distance — and therefore its retinal image size — changes). The brain does this by combining the size of the retinal image with its judgement of distance: if two objects cast the same-size image but one is judged to be further away, the brain concludes that the further object must actually be **larger**. Normally this is extremely useful and accurate. A visual illusion occurs when a stimulus contains **misleading depth cues**, so the brain **misapplies** these normally-helpful rules and reaches a perception that does not match reality.

Standard illustrative illusions include:

- **The Müller-Lyer illusion** — two lines of equal length appear to be different lengths because of the "arrow" fins on their ends. The line with **outward-pointing** fins looks longer than the line with **inward-pointing** fins. The fins act as depth cues (resembling the far, inside corner of a room versus the near, outside corner of a building); the brain judges the "outward-fin" line as more distant and, applying size constancy, scales it up so it is perceived as longer (see the figure below).
- **The Ponzo illusion** — two identical horizontal lines are placed across a pair of lines that converge into the distance (like railway tracks). The line nearer the point of convergence looks longer, because the converging lines act as a depth cue suggesting it is further away, so the brain enlarges it.
- **The Ames room** — a specially built room that is actually a strange, distorted shape but, viewed through a peephole, looks like an ordinary rectangular room. Two people standing in its two back corners appear to be wildly different sizes (one a "giant", the other tiny), even though they are the same size, because the brain wrongly assumes the room is rectangular and the two corners are equally distant.

**The Müller-Lyer illusion — a visual illusion**



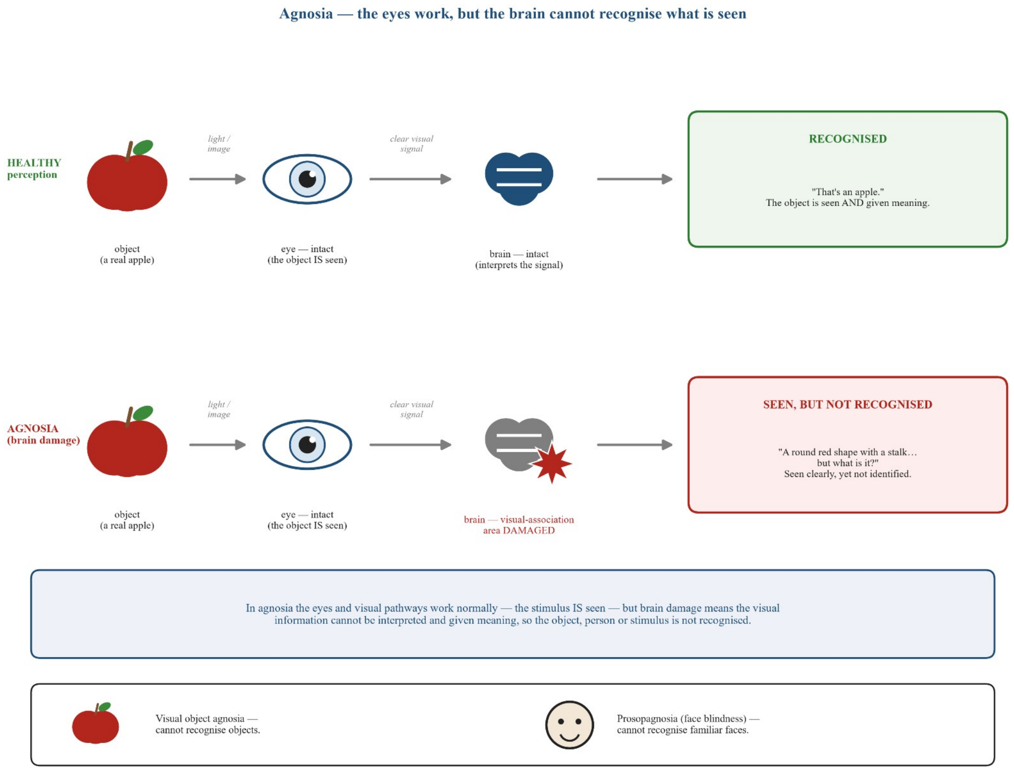

Because illusions depend on how the brain has **learned** to interpret depth cues, **culture and experience can affect how susceptible a person is** to a given illusion. For example, people raised in highly "carpentered" surroundings full of straight edges and right-angled corners tend to be more susceptible to the Müller-Lyer illusion than people from environments with fewer such features. This shows that susceptibility is partly learned, not fixed.

The key point: a visual illusion is **not a fault of the eye**. The eye and visual pathways work perfectly; the stimulus is real and is seen. The illusion is a **shared misinterpretation** produced by a **healthy** brain applying its normal perceptual rules to a misleading stimulus — which is why nearly everyone experiences the same illusion in the same way.

**Agnosia. Agnosia** is the **inability to recognise or identify objects, people or stimuli despite intact sensory function**. In visual agnosia the eyes work, visual acuity may be normal, and the visual signal reaches the brain — but the brain **cannot interpret that information or attach meaning to it**, so the person **sees** the stimulus without **recognising** what it is. Agnosia is therefore a failure of **recognition**, not a failure of **sensation**. It usually results from **brain damage** (for example from a stroke, injury or illness) to the **visual-association areas** — the parts of the brain that interpret visual information and give it meaning.

Two examples within the study-design scope are:

- **Visual object agnosia** — the inability to **recognise or name everyday objects by sight**, even though the person can see them clearly. Shown a key, for instance, a person might accurately describe "a small, flat metal thing with a jagged edge" and even copy its shape, yet be unable to say that it is a key — until they hold it (recognising it by touch) or hear it jingle. The sensory information is intact; the meaning is missing.
- **Prosopagnosia** (**face blindness**) — a specific inability to **recognise familiar faces**, sometimes including close family members or even one's own face in a mirror, despite being able to see the face's individual features perfectly well. People with prosopagnosia often learn to recognise others by non-face cues such as voice, hairstyle, gait or clothing.




**Distinguishing an illusion from agnosia.** Both illusions and agnosia show that visual perception is **fallible** — the perception does not match reality — but they are very different:

- A **visual illusion** is a **misinterpretation of a real stimulus** by a **healthy, intact** visual system. The stimulus is perceived, but a property of it (such as length or size) is judged wrongly. Illusions are **shared** — almost everyone experiences the same illusion in the same way — and are caused by the brain **misapplying normal perceptual rules** (depth cues, size constancy).
- **Agnosia** is a **failure to recognise** a stimulus, caused by **brain damage**. The stimulus is seen clearly but cannot be identified or given meaning. Agnosia is **individual** — it affects only the person with the damage, not the population at large — and is caused by **damage to the visual-association areas of the brain**, not by any misleading feature of the stimulus.

In short: an **illusion** is a **normal brain misinterpreting a real stimulus** (everyone, consistently), whereas **agnosia** is a **damaged brain failing to recognise** a stimulus (specific individuals).

**How to analyse a scenario.** (1) Check whether the visual **sense** is working — in both cases the person can *see* the stimulus, so do not confuse either with blindness. (2) Ask **what goes wrong**: is a real stimulus being **misjudged in the same way by everyone** (length, size, distance)? That points to a **visual illusion**. Or is a person **unable to recognise or identify** what they are clearly seeing? That points to **agnosia**. (3) Check the **cause**: a **healthy** brain misapplying perceptual rules (illusion) versus **brain damage** to visual-association areas (agnosia). (4) If it is agnosia, decide the **type**: objects in general (visual object agnosia) or specifically familiar faces (prosopagnosia).

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## Worked examples

### *Example 1 — scaffolded*

A student is shown two lines of exactly equal length. The first line has fins pointing **outward** at each end; the second has fins pointing **inward**. The student is certain the first line is longer. Explain why the two lines appear to be different lengths, referring to depth cues and size constancy.

| Working | Comment |
| --- | --- |
| Establish the truth: the two lines are **physically equal**, so this is a **visual illusion** (the Müller-Lyer illusion) — | Name the phenomenon before explaining it. |

| Working | Comment |
|---|---|
| a consistent misinterpretation of a real stimulus. | |
| The fins act as **depth cues**: the outward fins resemble the far, inside corner of a room, so the first line is judged as **more distant**; the inward fins resemble a near corner, so the second is judged **closer**. | Identify the misleading cue the brain latches onto. |
| Both lines cast the **same-size image** on the retina. Applying **size constancy**, the brain scales the "more distant" first line **up**, so it is perceived as **longer**. | Link the depth judgement to size constancy — the mechanism. |
| The eyes and the stimulus are fine; only the **interpretation** is wrong — and almost everyone sees it the same way. | Reinforce: illusion = healthy brain, shared misinterpretation. |

### *Example 2 — scaffolded*

Following a stroke, a man can see objects placed in front of him and can describe their colour and shape, but cannot say what they are; when he picks up a comb, he immediately names it. Identify the condition, and explain why it is a recognition problem and not a problem with his eyes.

| Working | Comment |
|---|---|
| He can **see** the objects (he describes colour and shape) but cannot **identify** them → **visual object agnosia**. | The tell-tale pattern: intact vision, failed recognition. |
| His **sensory function is intact** — the eyes and visual pathways deliver a clear image — so this is not blindness or a visual-acuity problem. | Rule out a sensory cause explicitly. |
| The deficit is in **interpreting** the visual information and attaching **meaning** to it — the result of **brain damage** (the stroke) to the **visual-association areas**. | Locate the failure: recognition, from brain damage. |
| Recognising the comb **by touch** shows his knowledge of the object is intact; only the **visual** route to recognition is lost. | The cross-check that proves it is agnosia, not lost knowledge. |

### *Example 3 — unscaffolded*

Distinguish between a visual illusion and agnosia.

A **visual illusion** is a **consistent misinterpretation of a real, external visual stimulus** by a **healthy, intact** visual system: the stimulus is seen, but a property such as its length or size is judged wrongly, and almost **everyone** misinterprets it in the **same way** because the brain is **misapplying normal perceptual rules** such as depth cues and size constancy. **Agnosia**, by contrast, is the **inability to recognise or identify a stimulus despite intact sensory function**: the stimulus is seen clearly but **cannot be given meaning**, and this is caused by **brain damage** to the visual-association areas, so it affects only **particular individuals** rather than everyone. ∴ an illusion is a normal brain **misinterpreting** a real stimulus (shared, no brain damage), whereas agnosia is a damaged brain **failing to recognise** a stimulus (individual, caused by brain damage).

### *Example 4 — unscaffolded*

A student claims, "Visual illusions prove that our eyes do not work properly." Evaluate this claim.

The claim is **incorrect**. In a visual illusion the **eyes work perfectly** — the stimulus is real and is accurately detected and sent to the brain. What produces the illusion is the **brain's interpretation** of that signal: to build a three-dimensional perception the brain uses **depth cues** and **size constancy**, and when a stimulus contains misleading cues (such as the fins of the Müller-Lyer figure) the brain **misapplies** these normally-reliable rules and reaches a perception that does not match reality. This is why the same illusion is experienced by **almost everyone in the same way** — it reflects **normal** perceptual processing, not faulty eyes. ∴ illusions show that perception is an **active, fallible interpretation by the brain**, not that the eyes are defective.

## Practice questions

### *Scaffolded*

**Q1.** Define each of the following: (a) the fallibility of visual perception; (b) a visual illusion; (c) agnosia.

**Q2.** Two lines of equal length are shown; one has outward-pointing fins and the other has inward-pointing fins, and they appear to be different lengths. (a) Name this illusion and state which line appears longer. (b) Explain the role of depth cues in producing the illusion. (c) Explain the role of size constancy in producing the illusion.

**Q3.** After a head injury, a woman can see a pair of glasses on the table and describe its shape and colour, but cannot say what the object is until she picks it up and feels it. (a) Name the condition she is showing. (b) Explain why this is not a problem with her eyes. (c) Identify the part of the brain most likely to be affected.

**Q4.** Illusions and agnosia are both examples of the fallibility of visual perception, but they are different. (a) State whether an illusion occurs in a healthy or a brain-damaged visual system. (b) State whether agnosia occurs in a healthy or a brain-damaged visual system. (c) Explain one other way in which the two differ.

**Q5.** A man is unable to recognise the faces of his own family members, even though he can see their eyes, nose and mouth clearly, and he recognises each person as soon as they speak. (a) Name the condition. (b) State one way this condition differs from visual object agnosia. (c) Explain how he is still able to recognise his family.

**Q6.** Perception is described as an active process that can be inaccurate. (a) State what it means to say visual perception is "fallible". (b) Explain how a visual illusion demonstrates this fallibility. (c) Explain how agnosia demonstrates this fallibility.

### *Unscaffolded*

**Q7.** Distinguish between a visual illusion and agnosia. *(2 marks)*

**Q8.** At a museum, every visitor who looks at a particular display sees two identical statues as clearly different in size because of the way the surrounding room is built. Identify whether this is best explained as a visual illusion or as agnosia, and justify your answer. *(3 marks)*

**Q9.** Explain how the Müller-Lyer illusion arises, referring to both depth cues and size constancy. *(4 marks)*

**Q10.** In an Ames room, two people of the same height stand in the two back corners; to an observer looking through the viewing hole, one appears to be a giant and the other tiny. Explain why this size illusion occurs. *(4 marks)*

**Q11.** Name the type of agnosia in which a person is unable to recognise familiar faces. *(1 mark)*

**Q12.** A student writes: "A person with visual agnosia has damaged eyes and so cannot see the object in front of them." Identify and correct the error in this statement. *(2 marks)*

**Q13.** Explain why both visual illusions and agnosia are described as demonstrating the "fallibility" of visual perception. *(2 marks)*

**Q14.** *Research scenario.* A psychologist investigates whether the direction of the fins changes how long a line appears. Forty adults are each shown a series of lines of identical length; some lines have outward-pointing fins and some have inward-pointing fins. For each line, the participant adjusts a separate comparison line until they judge it to be the same length as the fin line, and the psychologist records the length they set. (a) Identify the independent variable and the dependent variable in this investigation. (b) Explain why using lines that are actually identical in length is important for this study. (c) Write a possible hypothesis for this investigation. *(4 marks)*

**Q15.** *Case study.* A woman is referred to a neuropsychologist after a stroke. Testing shows her eyesight is normal: she can see and reach for objects and describe their shape and colour. However, she cannot name common objects by sight, though she names them instantly when she holds them. (a) Identify the deficit the woman is most likely showing, and justify your answer using the evidence. (b) Explain one limitation of drawing general conclusions about agnosia from this single case. *(4 marks)*

**Q16.** *Data interpretation.* Researchers measured how much longer the "outward-fin" line of a Müller-Lyer figure appeared than its true length (its percentage overestimation) in two groups of participants who grew up in different everyday environments.

| Group | Average overestimation of the line (%) |
|---|---|
| Grew up in a "carpentered" environment (many straight edges and right-angled corners) | 21 |
| Grew up in an open environment (few straight edges or corners) | 8 |

(a) State which group was more susceptible to the illusion, and quote the percentages from the table that support your answer.
(b) Explain what these results suggest about the role of experience in visual illusions.
(c) Explain why both groups still show at least some overestimation. *(4 marks)*

**Q17.** *Apply.* At a family dinner, everyone at the table looks at a placemat with a printed pattern and agrees that one line on it looks longer than another, although the two lines are actually the same length. Meanwhile the grandmother, who had a stroke last year, cannot recognise her granddaughter by sight but knows her at once when she speaks. Identify who is experiencing a visual illusion and who is experiencing agnosia, and justify each answer. *(4 marks)*

**Q18.** Explain why size constancy, which is normally helpful and accurate, can lead the brain to misjudge size or length in a visual illusion. *(3 marks)*

**Q19.** *Extended response.* Using an example of each, distinguish between a visual illusion and agnosia, and explain how each demonstrates that visual perception is fallible. In your answer, refer to whether the visual system is healthy or damaged, and to whether the error is shared by most people or specific to an individual. *(6 marks)*

## Answers

**Q1.** (a) Visual perception is capable of being inaccurate — the perception the brain constructs does not always match physical reality. (b) A consistent misinterpretation of a real, external visual stimulus (almost everyone misinterprets it the same way). (c) The inability to recognise or identify objects, people or stimuli despite intact sensory function, usually due to brain damage. **Q2.** (a) The Müller-Lyer illusion; the line with outward-pointing fins appears longer. (b) The fins act as misleading depth cues, so the outward-fin line is judged as more distant. (c) Because both cast the same retinal image, size constancy scales the "more distant" line up, so it looks longer. **Q3.** (a) Visual object agnosia. (b) Her eyes and vision are intact (she sees and describes the object); the problem is recognising/interpreting it. (c) The visual-association area(s) of the brain. **Q4.** (a) Healthy/intact. (b) Brain-damaged. (c) Any one: illusions are shared by almost everyone whereas agnosia affects only the damaged individual; an illusion misinterprets a real stimulus whereas agnosia fails to recognise it; an illusion is caused by misapplied perceptual rules whereas agnosia is caused by brain damage. **Q5.** (a) Prosopagnosia (face blindness). (b) Prosopagnosia is a specific inability to recognise familiar faces, whereas visual object agnosia is an inability to recognise everyday objects by sight. (c) By non-face cues such as voice (also gait, hairstyle or clothing). **Q6.** (a) It is capable of being inaccurate — what we perceive need not match reality. (b) In an illusion a real stimulus is misinterpreted (e.g. equal lines seen as unequal), so perception does not match reality. (c) In agnosia a clearly-seen stimulus cannot be recognised, so the visual system fails to deliver an accurate, meaningful perception. **Q7.** An illusion is a shared misinterpretation of a real stimulus by a healthy visual system; agnosia is a failure to recognise a stimulus, caused by brain damage, affecting specific individuals. **Q8.** A visual illusion — a real stimulus (two equal statues) is consistently misperceived (as different sizes) by every healthy visitor because of misleading depth information built into the room. **Q9.** The fins act as depth cues (outward = far inside corner, judged more distant; inward = near corner, judged closer); with equal retinal images, size constancy scales the "more distant" line up, so it looks longer. **Q10.** The brain wrongly assumes the room is rectangular and the two corners are equally distant; with that false distance assumption, the different retinal-image sizes of the two people are read as differences in real size. **Q11.** Prosopagnosia (face blindness). **Q12.** Error: agnosia is not damaged eyes or an inability to see. Correction: the eyes and vision are intact and the object is seen clearly; agnosia is an inability to recognise/identify it, caused by brain damage. **Q13.** Because in both the perception does not match reality — an illusion misjudges a real stimulus, and agnosia fails to recognise a clearly-seen one — showing perception can be inaccurate. **Q14.** (a) IV = fin direction (outward vs inward); DV = the length the participant sets the comparison line to (perceived length). (b) So any difference in judged length is due to the fins, not to a real difference in line length. (c) e.g. "Adults will judge lines with outward-pointing fins to be longer than lines of the same actual length with inward-pointing fins." **Q15.** (a) Visual object agnosia — normal eyesight but cannot name objects by sight, yet names them by touch, showing intact sensation and object-knowledge but failed visual recognition. (b) A single case may not generalise — one person's brain damage may be unique, so we cannot be sure the pattern applies to others (low external validity). **Q16.** (a) The carpentered-environment group (21% vs 8%). (b) Susceptibility to the illusion is partly learned/shaped by experience of one's environment, not fixed. (c) Everyone's brain uses depth cues and size constancy, so the illusion affects people in every environment to some degree. **Q17.** The family (all seeing equal lines as unequal) are experiencing a visual illusion — a shared misinterpretation of a real stimulus by healthy systems; the grandmother (cannot recognise her granddaughter by sight but can by voice, after a stroke) is experiencing agnosia (prosopagnosia). **Q18.** Size constancy normally combines retinal-image size with judged distance; a false depth cue feeds the wrong distance into the rule, so the brain scales the image up or down inappropriately and misjudges size/length. **Q19.** Model response given in the solutions.

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## Fully-worked solutions

**Q1.** (a) The **fallibility of visual perception** means that visual perception is **capable of being inaccurate** — because the brain actively **interprets** the sensory signals it receives, the perception it constructs **does not always match physical reality**. (b) A **visual illusion** is a **consistent misinterpretation of a real, external visual stimulus**: the stimulus is genuinely seen, but the brain interprets one of its properties wrongly, and **almost everyone misinterprets it in the same way**. (c) **Agnosia** is the **inability to recognise or identify objects, people or stimuli despite intact sensory function** — the person can see the stimulus but cannot attach meaning to it — and it usually results from **brain damage**.

**Q2.** (a) The illusion is the **Müller-Lyer illusion**, and the line with the **outward-pointing fins appears longer**. (b) The fins act as **depth cues**: the outward-pointing fins resemble the **far, inside corner of a room** (so the brain judges that line as **more distant**), while the inward-pointing fins resemble the **near, outside corner of a building** (judged as **closer**). (c) Because both lines cast the **same-size image on the retina**, the brain applies **size constancy** — which scales up the perceived size of things judged to be further away — so the “more distant” outward-fin line is **scaled up and perceived as longer**, even though the two lines are identical.

**Q3.** (a) She is showing **visual object agnosia**. (b) It is **not a problem with her eyes** because her **vision is intact** — she can **see** the glasses and accurately **describe their shape and colour**; the difficulty is in **recognising or identifying** what the object is, not in detecting it. (c) The area most likely affected is the **visual-association area(s)** of the brain, which interpret visual information and attach meaning to it.

**Q4.** (a) An illusion occurs in a **healthy (intact) visual system**. (b) Agnosia occurs in a **brain-damaged** visual system. (c) One other difference (any one): an **illusion is shared** by almost everyone in the same way, whereas **agnosia affects only the individual** with the brain damage; or, an illusion is a **misinterpretation of a real stimulus** that is still perceived, whereas agnosia is a **failure to recognise** a clearly-seen stimulus; or, an illusion is caused by the brain **misapplying normal perceptual rules**, whereas agnosia is caused by **damage to the visual-association areas**.

**Q5.** (a) The condition is **prosopagnosia** (**face blindness**). (b) It differs from **visual object agnosia** in **what cannot be recognised**: prosopagnosia is a **specific** inability to recognise **familiar faces**, whereas visual object agnosia is an inability to recognise **everyday objects by sight**. (Both are failures of **recognition** despite **intact sensory function**.) (c) He can still recognise his family through **non-face cues**: here, by **voice** (as soon as they speak), and more generally by cues such as **gait, hairstyle, clothing or a distinctive feature**, because only the recognition of **faces** is impaired.

**Q6.** (a) To say visual perception is **“fallible”** means it is **capable of being inaccurate** — what we perceive **need not match** what is physically there, because perception is an active interpretation by the brain. (b) A **visual illusion** demonstrates this because a **real stimulus is misinterpreted**: for example, two lines that are **actually equal** are perceived as **unequal**, so the perception **does not match reality**. (c) **Agnosia** demonstrates it because a stimulus that is **clearly seen cannot be recognised or given meaning**, so the visual system **fails to deliver an accurate, meaningful perception** of what is there.

**Q7.** A **visual illusion** is a **shared misinterpretation of a real, external stimulus** produced by a **healthy, intact** visual system — the stimulus is perceived, but a property of it (such as length or size) is **judged wrongly**, and almost everyone experiences the illusion the **same way**. **Agnosia** is an **inability to recognise or identify** a stimulus **despite intact sensory function**, caused by **brain damage**; the stimulus is seen but not given meaning, and it affects **only the damaged individual**. They differ in what goes wrong (misinterpret vs fail to recognise), in the state of the system (healthy vs damaged) and in whether the error is shared or individual.

**Q8.** This is best explained as a **visual illusion**. A **real** external stimulus (the two statues) is present and is **clearly seen** by every visitor, yet it is **consistently misperceived** — the statues look **different sizes** although they are the same — and this happens to **everyone who looks**, in the **same way**, because the **healthy** brain is misled by the depth information built into the surrounding room and **misapplies size constancy**. There is **no brain damage** and no failure to *recognise* the statues, so it is an illusion, not agnosia.

**Q9.** The Müller-Lyer illusion arises because the **fins on the ends of the lines act as misleading depth cues**. The **outward-pointing** fins resemble the **inside corner of a room** — a corner that is **further away** from the viewer — so the brain judges that line as **more distant**; the **inward-pointing** fins resemble the **outside (near) corner of a building**, so that line is judged as **closer**. Both lines, however, cast the **same-size image on the retina**. The brain then applies **size constancy**, the rule that an object judged to be further away must be **larger** to produce a retinal image of a given size. It therefore **scales the “more distant” (outward-fin) line up**, and it is **perceived as longer** — even though the two lines are physically identical. The stimulus is real and the eyes are working; only the **interpretation** is wrong.

**Q10.** In an **Ames room** the room is actually a **distorted, non-rectangular shape**, with one back corner much **further from the viewing hole** than the other, but it has been built so that, seen through the peephole, it **looks like an ordinary rectangular room**. The brain **assumes the room is rectangular** and therefore assumes the **two back corners are the same distance away**. Given that (false) assumption of equal distance, the **two people cast very different-sized images on the retina**, and the brain — using **size constancy** — interprets those different retinal-image sizes as **real differences in size**, so one person is perceived as a **giant** and the other as **tiny**. The illusion works because the brain's normally-reliable **distance assumption is wrong**, so size constancy produces a badly mistaken perception.

**Q11. Prosopagnosia** (also called **face blindness**).

**Q12.** The **error** is the claim that a person with visual agnosia has **damaged eyes and cannot see** the object. **Correction:** in agnosia the **eyes and visual pathways are intact** and the object **is seen clearly** (the person can usually describe its shape and colour). The deficit is an inability to **recognise or identify** the object — to attach **meaning** to what is seen — and it is caused by **brain damage** (to the visual-association areas), **not** by any problem with the eyes.

**Q13.** Both are described as showing the **fallibility** of visual perception because in **each case the perception does not match reality**. In a **visual illusion** the brain **misjudges a real stimulus** (for example, perceiving equal lines as unequal); in **agnosia** the brain **cannot recognise a clearly-seen stimulus** and so fails to build an accurate, meaningful perception of it. Both therefore demonstrate that visual perception is an active brain process that **can be inaccurate**.

**Q14.** (a) The **independent variable** is the **direction of the fins** (outward-pointing versus inward-pointing). The **dependent variable** is the **length the participant sets the comparison line to** — that is, the **perceived length** of the fin line. (b) Using lines that are **actually identical in length** is important because it **controls the real length** of the stimulus: if the lines were genuinely different, any difference in the participants' judgements could be due to that real difference rather than the fins. By keeping the true length constant, the researcher can be confident that any difference in perceived length is caused by the **independent variable (the fins)**. (c) A possible hypothesis: **"Adults will judge lines with outward-pointing fins to be longer than lines of the same actual length with inward-pointing fins."** (This names the population, both levels of the IV and a directional prediction for the DV.)

**Q15.** (a) The woman is most likely showing **visual object agnosia**. The evidence: her **eyesight is normal** (she can see, reach for and describe the shape and colour of objects), so **sensation is intact**; yet she **cannot name objects by sight**, which shows a failure of **visual recognition**. Because she **names the objects instantly when she holds them**, her underlying **knowledge of the objects is intact** and she can recognise them by **touch** — so the problem is specifically the **visual route to recognition**, following her stroke (brain damage). (b) A key limitation is that a **single case may not generalise** to other people: this is **one individual** with a particular location and extent of brain damage, so her results may be **unusual or specific to her**, and we cannot be confident the same pattern would appear in others (**low external validity / generalisability**). Studying more cases would be needed to draw general conclusions.

**Q16.** (a) The **"carpentered environment"** group was more susceptible, with an average overestimation of **21%** compared with **8%** for the open-environment group. (b) The results suggest that **experience shapes susceptibility to visual illusions**: people who grew up surrounded by **straight edges and right-angled corners** appear to have **learned** to read the fins as corner/depth cues more strongly, so they are **more affected** by the Müller-Lyer illusion. Susceptibility is therefore **partly learned**, not fixed. (c) Both groups still show **some overestimation** because **everyone's brain uses depth cues and size constancy** to interpret visual images; the illusion draws on these **normal perceptual processes**, so it affects people in **every** environment to at least some degree — experience changes the **size** of the effect, not whether it occurs at all.

**Q17.** The **family members** looking at the placemat are experiencing a **visual illusion**: a **real** stimulus (two lines that are actually equal) is **consistently misperceived** as unequal by **everyone at the table**, whose **healthy** visual systems are all misled in the **same way** — a shared misinterpretation of a real stimulus. The **grandmother** is experiencing **agnosia** (specifically **prosopagnosia**): despite being able to **see** her granddaughter's face clearly, she **cannot recognise** her by sight, but **recognises her instantly by voice**; this failure of **recognition** followed a **stroke** (brain damage) and is **specific to her**, not shared by the rest of the family. The distinction is that the family are **misinterpreting** a real stimulus with healthy brains, while the grandmother **fails to recognise** a clearly-seen stimulus because of brain damage.

**Q18. Size constancy** normally works by **combining the size of the retinal image with the brain's judgement of how far away the object is**: because a given object produces a **smaller retinal image** as it moves further away, the brain **scales the perceived size up** for objects judged to be more distant, so the object is correctly seen as staying the **same size**. This rule is usually **accurate and helpful**. In a **visual illusion**, however, the stimulus provides a **false or misleading depth cue**, so the brain feeds the **wrong distance** into the size-constancy calculation. Applying a **correct rule to an incorrect distance** makes the brain **scale the image up or down inappropriately**, producing a

**misjudgement of size or length** even though the object's real size is unchanged. ∴ it is precisely because size constancy is doing its normal job — but with bad distance information — that the illusion occurs.

**Q19.** *Model response (6 marks).* **Visual perception is fallible**, meaning the perception the brain constructs **can be inaccurate** and need not match physical reality; **visual illusions** and **agnosia** are two illustrations of this. A **visual illusion** is a **consistent misinterpretation of a real, external stimulus** by a **healthy, intact** visual system. For example, in the **Müller-Lyer illusion**, two lines that are **physically equal** appear to be **different lengths** because the fins on their ends act as **misleading depth cues**, and the brain, applying **size constancy**, scales up the line it judges to be more distant. The stimulus is real and is seen accurately; only the **interpretation** is wrong, and because it reflects **normal** perceptual processing, **almost everyone experiences the illusion in the same way** — the error is **shared**. **Agnosia**, by contrast, is the **inability to recognise or identify a stimulus despite intact sensory function**, caused by **brain damage** to the visual-association areas. For example, a person with **visual object agnosia** can **see** a key and describe its shape and colour but **cannot say what it is** until they touch it; here the stimulus is **clearly seen** but **cannot be given meaning**. Because it results from a particular person's brain damage, agnosia is **specific to that individual**, not shared by others. Both conditions show the **fallibility** of visual perception — in each, the perception fails to match reality — but they differ in two key ways: an illusion arises in a **healthy** visual system and is a **shared misinterpretation** of a real stimulus, whereas agnosia arises from **brain damage** and is an **individual failure to recognise** a clearly-seen stimulus. *(Full marks require: one correct example of each; an explanation of how each shows perception can be inaccurate; and the healthy-versus-damaged and shared-versus-individual contrasts.)*

### Theory

**Gustation** is the sense of **taste** — the detection of chemicals dissolved in saliva by **taste receptors**, which are clustered in **taste buds** found mainly in the small bumps (**papillae**) on the tongue. **Gustatory perception** is how the brain **selects, organises and interprets** this taste information so that we experience a flavour. There are five basic taste qualities — **sweet, sour, salty, bitter** and **umami** (savoury).

To say that gustatory perception is **fallible** means that it is **liable to be inaccurate or to vary** — it is **not a fixed, objective read-out of the chemicals in a food**. The very same food can be perceived differently by different people, and one person's perception can be changed by altering the receptors or by non-taste cues. In other words, the taste and flavour we experience are **constructed by the brain**, so they are **subjective** rather than a direct, perfect measurement of what is in the mouth. The study design illustrates this with three examples: **supertasters**, **exposure to miraculin**, and **the judgment of flavours**.

**Supertasters.** People differ in how many taste buds they have. A **supertaster** is a person whose tongue carries **more, more densely packed papillae** — specifically the **fungiform papillae** near the tip and edges — and therefore **more taste buds**, since each papilla carries several buds. Because they have more receptors, supertasters experience tastes — **especially bitterness — more intensely** than **medium tasters**, who in turn taste more intensely than **non-tasters**. This is largely a **biological, partly genetic** difference. Its significance for fallibility is clear: presented with the **same** food (say, a strong black coffee or a piece of raw broccoli), a supertaster may find it overwhelmingly bitter while a non-taster finds it mild and pleasant. The food is identical, so the difference lies in the **perceiver**, not the food — taste perception is **not uniform or objective across people**. (This is also why supertasters more often dislike bitter foods such as certain vegetables, strong coffee or tonic water.)

**Exposure to miraculin. Miraculin** is a **protein** found in the berry of the "miracle fruit". When a person eats miraculin, it **binds to the sweet-taste receptors** on their taste buds. In the presence of **acidic (sour)** food, this binding causes those sweet receptors to send a "sweet" signal to the brain, so **sour foods are perceived as sweet** for a while afterwards. After eating miraculin, biting into a **lemon** — which is genuinely sour and acidic — can taste **sweet**, like lemonade. The important point for fallibility is that **the food has not changed at all** — the lemon still contains exactly the same acids. What has changed is **how the receptors respond**. This shows that taste perception can be **dramatically altered or distorted** by changing the receptor response — further proof that perception is not a direct reading of the chemicals present.

**The judgment of flavours.** In everyday speech "taste" and "flavour" are used loosely, but they are not the same. **Taste** refers narrowly to the five qualities detected by the taste receptors. **Flavour** is the **whole experience** of a food, and it is **multisensory**: the brain combines taste with **smell (olfaction)** — much of it from odours reaching the nose from inside the mouth as we chew — together with **appearance (colour and shape), texture (mouthfeel), temperature**, and even **expectation, memory and labelling**. Because flavour is judged from all of these cues at once, the judgement of flavour is easily **distorted**:

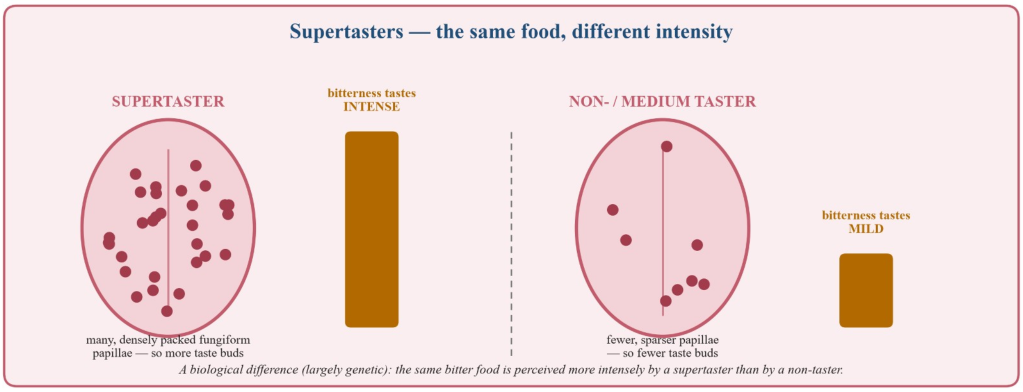
- **Smell:** most of what we call "flavour" is actually smell. When a head-cold **blocks the nose**, food tastes **bland or "flat"** even though the taste receptors work normally — the flavour has lost its olfactory contribution.
- **Appearance / colour:** the **colour** of a food or drink strongly shapes the flavour we expect and then report. A drink dyed **red** is commonly judged to taste of cherry or berry; the **same** drink dyed **green** is judged to taste of lime — even when the actual flavouring is identical.
- **Expectation / context:** a label, a price or a description ("premium", "artisan") can raise expectations and shift the flavour a person reports, independent of the food itself.

Because these **non-food factors** change the flavour we perceive, flavour judgement is clearly **fallible**.

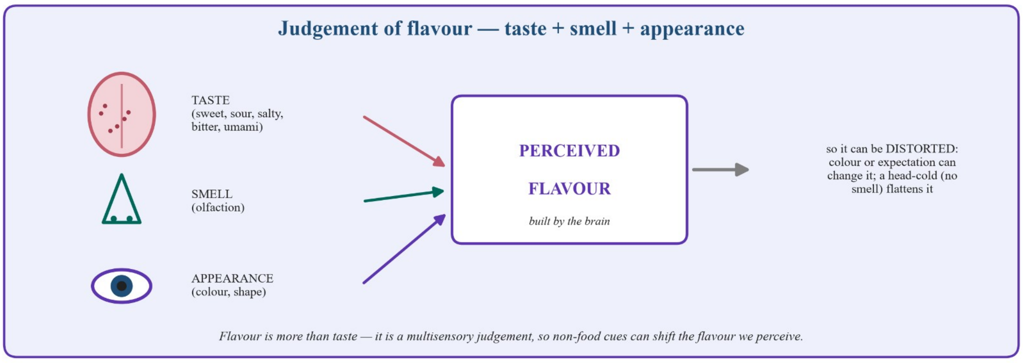
**Putting it together.** Supertasters show that taste perception **varies between people**; miraculin shows that it can be **altered at the receptor**; the judgment of flavours shows that it is **shaped by smell, sight and expectation**. In every case, the food's chemistry stays the same while the **perception changes** — so gustatory perception is **fallible and subjective**, an interpretation built by the brain rather than an objective read-out of the food.

**Distinctions to keep straight.**

- **Taste vs flavour** — taste = the five qualities from the taste receptors; flavour = the whole multisensory experience (taste + smell + appearance + expectation).
- **Biological sources of fallibility** (supertaster taste-bud density; miraculin binding receptors) **vs psychological / contextual sources** (colour, labelling, expectation, memory).
- **"Fallible" does not mean "broken"** — it means perception is not a perfect, objective measurement: it can vary between people and can be misled.





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## Worked examples

### *Example 1 — scaffolded*

At a family dinner, Aunty Reti and her nephew Sam each try a square of the same very bitter 85% dark chocolate. Sam screws up his face and says it is "unbearably bitter", while Reti finds it "only mildly bitter, and quite nice". Identify which person is more likely to be a supertaster, and explain, with reference to taste buds, why the same chocolate is perceived so differently.

| Working | Comment |
| --- | --- |
| Sam experiences the **same** chocolate as far more bitter, so **Sam** is more likely to be the **supertaster**. | Compare how *intensely* each person perceives the *same* food. |

| Working | Comment |
| --- | --- |
| Supertasters have **more, more densely packed fungiform papillae**, and therefore **more taste buds**, so more receptors detect the bitter compounds → bitterness is felt **more intensely**. | Give the biological cause of the difference. |
| The chocolate is **identical** for both, so the difference lies in the **perceiver**, not the food. | This is the fallibility point — perception is not objective. |
| ∴ taste perception **varies between people**: Sam's intense bitterness reflects his taste-bud density, not a "different" chocolate. | Link back to subjective / fallible perception. |

### *Example 2 — scaffolded*

In a science demonstration, students let a miracle-fruit tablet dissolve on the tongue, then bite into a wedge of plain lemon and report that it tastes "like sweet lemonade". Explain why the lemon tastes sweet, and state what this demonstrates about the fallibility of gustatory perception.

| Working | Comment |
| --- | --- |
| **Miraculin** (a protein from the miracle fruit) **binds to the sweet-taste receptors** on the taste buds. | Name the mechanism first. |
| In the **acidic** environment of the sour lemon, those bound receptors are activated and send a **"sweet" signal** to the brain. | Explain the sour → sweet effect. |
| The lemon's chemistry is **unchanged** — it is just as acidic as before; only the **receptor response** has changed. | The key idea: the food did not change. |
| ∴ perception of taste has been **altered at the receptor**, showing gustatory perception is not a direct reading of the food — it is fallible. | Link to the concept. |

### *Example 3 — unscaffolded*

A café normally serves a lime-green cordial, but one day a batch is accidentally coloured bright red. Several customers complain that the "raspberry" cordial "tastes wrong", even though the flavouring in the cordial was not changed at all. Using the idea that flavour is multisensory, explain why the colour changed the perceived flavour.

Flavour is **not taste alone**: the brain judges flavour by combining taste and smell with other cues, including **appearance and colour**. Seeing red, the customers **expected raspberry**, so their brains interpreted the same taste-and-smell information through that expectation and then judged it "wrong" because the **lime** taste did not match the **raspberry** flavour the red colour had led them to expect. The cordial's actual chemistry — its taste and odour molecules — was **unchanged**; only the **visual cue** changed, and that shifted both the expected and the perceived flavour. This shows that appearance is a genuine input to the judgement of flavour, so flavour can be distorted by a non-food cue. ∴ it was the **colour**, not the flavouring, that changed the flavour the customers perceived — evidence that gustatory perception is fallible.

### *Example 4 — unscaffolded*

With a heavy head-cold, Priya says her favourite curry "tastes like nothing", yet her flatmate insists the curry is as flavoursome as ever. Distinguishing taste from flavour, explain why the curry seems bland to Priya.

**Taste** (the five qualities detected by the taste receptors) and **flavour** (the whole multisensory experience) are different things, and a large part of flavour comes from **smell (olfaction)**. Priya's **blocked nose** removes the olfactory contribution, so although her taste receptors still detect the salt, sweetness and sourness of the curry, the rich flavour she normally experiences — which depends heavily on smell — is **lost**, and the curry seems bland. The curry itself is **unchanged**; her perception of its flavour is reduced because **one sensory input is missing**. ∴ flavour is more than taste, and losing smell flattens flavour — a clear example of the fallibility of gustatory perception.

## Practice questions

### *Scaffolded*

**Q1.** Define each of the following: (a) gustatory perception; (b) a supertaster; (c) flavour.

**Q2.** At a taste-testing stall, Owen and Bianca each sip the same cup of very strong, unsweetened black coffee. Owen finds it “far too bitter to drink”, while Bianca finds it “only mildly bitter”. (a) Identify which of the two is more likely to be a supertaster. (b) Explain, with reference to taste buds, why that person experiences the coffee as more bitter. (c) Explain what this scenario shows about whether taste perception is objective.

**Q3.** A student eats a miracle-fruit tablet and then drinks plain, unsweetened lemon juice, which tastes sweet to her. (a) Name the protein in the miracle fruit that is responsible for the effect. (b) Describe how this protein makes the sour lemon juice taste sweet. (c) Explain why this is described as a distortion of gustatory perception, referring to the fact that the lemon juice itself is unchanged.

**Q4.** Flavour is often described as “more than taste”. (a) Distinguish between taste and flavour. (b) Identify **two** senses, other than taste, that contribute to flavour. (c) Explain why a person with a nose blocked by a cold reports that food “tastes bland”.

**Q5.** A juice company sells the same apple-and-pear juice in two bottles: one with a green label showing an apple, the other with a red label showing berries. In a taste test, many people say the red-labelled juice “tastes more like berries”. (a) Identify the factor that has changed the perceived flavour. (b) Explain how this factor changed the flavour people reported, using the idea that flavour is multisensory. (c) Explain what this result suggests about the fallibility of gustatory perception.

**Q6.** For each situation, identify the **main factor** causing the person’s taste or flavour perception to differ from a plain, objective reading of the food: (a) Two siblings eat the same grapefruit; one finds it very bitter, the other does not. (b) After eating a miracle-fruit tablet, vinegar tastes sweet. (c) A plain dessert dyed brown is judged to taste more “chocolatey” than the identical undyed dessert.

### *Unscaffolded*

**Q7.** Supertasters and exposure to miraculin both show that gustatory perception is fallible, but they show it in different ways. Distinguish between what each of the two demonstrates. *(2 marks)*

**Q8.** Explain what it means to say that gustatory perception is *fallible*. *(2 marks)*

**Q9.** Explain why a supertaster and a non-taster can perceive the same food very differently. Refer to taste buds in your answer. *(3 marks)*

**Q10.** A person eats miraculin and then finds that sour foods taste sweet. Explain how miraculin produces this effect, and explain what it demonstrates about the fallibility of gustatory perception. *(4 marks)*

**Q11.** Identify **one** non-biological factor that can distort a person’s judgement of a food’s flavour. *(1 mark)*

**Q12.** Explain how **texture (mouthfeel)** and **temperature** can change the flavour a person perceives, even when the food’s taste and odour molecules are unchanged. *(2 marks)*

**Q13.** A student writes: “Miraculin works by chemically changing the acid in a lemon into sugar, which is why the lemon then tastes sweet.” Identify and correct the error in this statement. *(2 marks)*

**Q14.** *Research scenario.* A researcher investigated whether supertasters rate a bitter substance as more intense than non-tasters do. Each of 60 adult volunteers was first classified as a supertaster or a non-taster from the density of papillae on their tongue. Every participant then tasted the same strip of paper treated with a harmless bitter chemical and rated its bitterness on a scale from 0 (no bitterness) to 10 (extremely bitter). (a) Identify the independent variable and the dependent variable. (b) Write a possible directional (one-tailed) hypothesis for this investigation. (c) Explain why the researcher used the same bitter paper strip for every participant. *(5 marks)*

**Q15.** *Research scenario.* A class investigated whether the colour of a drink changes its perceived flavour. They prepared one large batch of identical lemon–lime cordial, then divided it into three jugs and coloured them green, red and clear. Each of 30 students tasted a sample from one jug (10 students per colour) and wrote down the flavour they thought it was. The results are shown below.

| Colour of cordial | Said "lime / citrus" | Said "raspberry / berry" | Said "not sure" |
|---|---|---|---|
| Green | 8 | 1 | 1 |
| Red | 2 | 7 | 1 |
| Clear | 5 | 2 | 3 |

(a) Identify the independent variable and the dependent variable.
(b) Using the data, describe the effect that colour had on the flavour students reported.
(c) Explain how this result illustrates that flavour is a multisensory judgement. *(5 marks)*

**Q16.** At a restaurant, the same soup is served to two diners. One bowl is described on the menu as "farmhouse vegetable broth"; the other, identical, bowl is described as "premium hand-picked garden soup". Diners rate the "premium" soup as tasting better. Using the concept of the judgement of flavour, explain this result. *(3 marks)*

**Q17.** Distinguish between a **biological** cause and a **psychological (non-biological)** cause of the fallibility of gustatory perception, giving **one** example of each. *(4 marks)*

**Q18.** At a school fete, a stall sells "mystery blue slushies". Many students insist the blue slushie "tastes like blueberry", but the stallholder reveals it is actually lemonade flavour — and a few students who tried it **blindfolded** correctly said "lemonade". Using this scenario, explain why gustatory perception is described as *subjective*, referring to at least **two** factors that shaped the students' flavour judgements. *(4 marks)*

**Q19.** *Extended response.* "Gustatory perception is not an objective read-out of what is in a food." Using **supertasters**, **exposure to miraculin** and **the judgment of flavours**, explain why gustatory perception is considered fallible and subjective. *(6 marks)*

## Answers

**Q1.** (a) How the brain selects, organises and interprets taste information to experience a flavour. (b) A person with more/denser taste buds who tastes more intensely (especially bitterness). (c) The whole multisensory experience of a food (taste + smell + appearance + expectation), not taste alone. **Q2.** (a) Owen. (b) He has more/denser taste buds, so more receptors detect the bitter compounds and bitterness is more intense. (c) It is not objective — the same coffee is perceived differently by different people, so perception depends on the perceiver. **Q3.** (a) Miraculin. (b) It binds to the sweet-taste receptors; in the acidic lemon juice those receptors are activated and signal "sweet". (c) The lemon juice is chemically unchanged — only the receptor response changed — so perception was altered, not the food; this is a distortion. **Q4.** (a) Taste = the five qualities from the taste receptors; flavour = the whole multisensory experience. (b) Any two of: smell (olfaction), sight/appearance, touch (texture/temperature). (c) Much of flavour comes from smell; a blocked nose removes the olfactory input, so flavour is flattened even though taste still works. **Q5.** (a) Appearance / colour (the red label and berry image). (b) Flavour combines taste and smell with appearance/expectation; the red/berry cue led people to expect and report a "berry" flavour. (c) Flavour can be shifted by a non-food cue, so gustatory perception is fallible/subjective. **Q6.** (a) Supertaster status (taste-bud density). (b) Miraculin binding the sweet-taste receptors. (c) Appearance/colour (and expectation). **Q7.** Supertasters show that perception varies *between people* — the same food is perceived more or less intensely depending on the perceiver's own anatomy. Miraculin shows that perception can be altered *within the one person* — the receptors' response is temporarily changed, so the same food tastes different to that person before and after. **Q8.** It is not a fixed, objective read-out of a food: taste/flavour perception varies between people and can be altered or misled, because it is constructed by the brain. **Q9.** The supertaster has more, more densely packed fungiform papillae — and therefore more taste buds — than the non-taster, so more receptors detect the food and it is perceived more intensely (especially bitterness); the food is the same, so the difference is in the perceiver. **Q10.** Miraculin binds to the sweet-taste receptors; in acidic (sour) foods this makes them signal "sweet", so sour foods taste sweet. The food is unchanged — only the receptor response changes — showing perception is fallible, not a direct reading of the food. **Q11.** Any one of: colour/appearance, labelling/description, price, expectation, context/memory. **Q12.** Flavour is multisensory, so the brain folds texture and temperature into it: how thick, creamy or crisp a food feels changes the flavour reported, and the same food served hot or cold is judged differently (melted ice cream tastes sweeter than the same ice cream frozen). **Q13.** Error: miraculin does not change the acid into sugar / does not change the food. Correction: it is a protein that binds the sweet-taste receptors so they signal "sweet" in acidic food; the lemon's acid is unchanged — only the perception changes. **Q14.** (a) IV = taster status (supertaster vs non-taster); DV = rated bitterness (0–10). (b) e.g. "It is hypothesised that adults classified as supertasters will rate the bitter paper strip as more bitter than adults classified as non-tasters." (c) To control the food (a potential extraneous variable) so any difference in ratings is due to taster status, not to a different strip. **Q15.** (a) IV = colour of the cordial (green/red/clear); DV = the flavour the students reported. (b) Colour shifted the reported flavour: green → mostly "lime/citrus" (8/10), red → mostly "raspberry/berry" (7/10), clear → more mixed/unsure. (c) The cordial was identical, so the visual cue (colour) changed the flavour reported — flavour combines taste with appearance, i.e. it is multisensory. **Q16.** The "premium" description raises expectations, and expectation is part of the judgement of flavour; so the same soup is judged to taste better — a distortion by a non-food cue. **Q17.** Biological, e.g. supertaster taste-bud density (or miraculin acting on receptors); psychological, e.g. colour/label/expectation changing perceived flavour. Both make perception differ from an objective reading, but one comes from the body's receptors and the other from mental/contextual cues. **Q18.** The blue colour and the expectation of "blueberry" shaped the judgement (blindfolded students, without the colour cue, correctly said lemonade); the same drink was perceived differently depending on these cues, so perception is subjective. **Q19.** Model response given in the solutions.

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## Fully-worked solutions

**Q1.** (a) **Gustatory perception** is how the brain **selects, organises and interprets** taste information from the taste receptors so that a flavour is experienced. (b) A **supertaster** is a person whose tongue carries **more, more densely packed fungiform papillae** and therefore **more taste buds**, and who therefore experiences tastes — **especially bitterness — more intensely** than medium tasters or non-tasters. (c) **Flavour** is the **whole multisensory experience** of a food: the brain combines **taste** with **smell**, **appearance**, texture and **expectation** — it is more than taste alone.

**Q2.** (a) **Owen** is more likely to be the supertaster. (b) A supertaster has a **greater number and density of taste buds** on the tongue, so **more receptors** detect the bitter compounds in the coffee; this produces a **more intense** sensation of bitterness. (c) Because the **same** cup of coffee is experienced as very bitter by Owen but only mildly bitter by Bianca, taste perception is **not objective** — it depends on the **perceiver** (their taste-bud density), not simply on the chemicals in the coffee.

**Q3.** (a) The protein is **miraculin**. (b) Miraculin **binds to the sweet-taste receptors** on the taste buds. In the **acidic** conditions of the sour lemon juice, those bound receptors are **activated and send a "sweet" signal** to the brain, so the juice is perceived as sweet. (c) The lemon juice is **chemically unchanged** — it is still just as acidic — so the change is entirely in **how the receptors respond**, not in the food. Perception has been **altered** while the stimulus stays the same, which is exactly what it means for gustatory perception to be **distorted / fallible**.

**Q4.** (a) **Taste** is the **five qualities** (sweet, sour, salty, bitter, umami) detected by the **taste receptors**; **flavour** is the **whole multisensory experience** that the brain builds by combining taste with smell, appearance and expectation. (b) Any **two** of: **smell (olfaction)**, **sight/appearance**, **touch (texture and temperature)**. (c) Because **most of flavour comes from smell**, a **blocked nose** removes the **olfactory contribution**; the taste receptors still work, so basic tastes are detected, but the rich flavour is lost and the food seems **bland**.

**Q5.** (a) The factor is the **appearance / colour** (the red label and berry image). (b) Flavour is **multisensory** — the brain combines taste and smell with **appearance and expectation**. Seeing the **red, berry** packaging leads people to **expect** a berry flavour, so they **interpret and report** the same juice as tasting "more like berries", even though the juice is identical. (c) It shows that a **non-food cue** can shift the flavour a person perceives, so gustatory perception is **fallible and subjective** rather than an objective reading of the drink.

**Q6.** (a) **Supertaster status** — a difference in **taste-bud density** between the siblings. (b) **Miraculin** binding to the **sweet-taste receptors** so the acidic vinegar is signalled as sweet. (c) **Appearance / colour** (with the **expectation** it creates) — the brown colour cues "chocolate", so the dessert is judged more chocolatey.

**Q7. Supertasters** show that gustatory perception varies **between people**: because one person's tongue carries more fungiform papillae, and therefore more taste buds, than another's, the **same** food is perceived as far more intense by one than by the other — a **stable, largely genetic** difference in the perceiver. **Miraculin** shows that gustatory perception can be altered **within the one person**: eating the protein temporarily changes **how that person's sweet-taste receptors respond**, so the **same** food (a lemon) tastes sour before and sweet afterwards. So one is a **difference between perceivers**, the other a **temporary change inside a single perceiver** — but in both the food is unchanged. *(1 mark each side, congruent.)*

**Q8.** To say gustatory perception is **fallible** means it is **not a fixed, objective read-out** of the chemicals in a food. The taste and flavour a person experiences are **constructed by the brain**, so they can **vary between people** (e.g. supertasters) and can be **altered or misled** (e.g. by miraculin or by a food's colour). Perception can therefore differ from an objective measurement of the food.

**Q9.** A **supertaster** has **more, more densely packed fungiform papillae** — the small bumps that carry the taste buds — and therefore **more taste buds** than a **non-taster**. Because the supertaster has **more receptors**, more of the food's chemicals are detected, so the taste — **especially bitterness** — is experienced **more intensely**. The **food is identical** for both people, so the difference in perception comes from the **perceiver's biology**, not from the food. This is why the same food can be overwhelming to one person and mild to another. *(1 mark: more papillae and therefore more taste buds; 1: more intense perception; 1: same food, difference in the perceiver.)*

**Q10. Miraculin** is a **protein** from the miracle fruit that **binds to the sweet-taste receptors** on the taste buds. In the presence of **acidic (sour)** food, this binding causes those receptors to be **activated and signal "sweet"** to the brain, so sour foods such as lemon are **perceived as sweet**. Crucially, the **food itself is unchanged** — the lemon is still just as acidic; only the **way the receptors respond** has changed. This demonstrates the **fallibility** of gustatory perception: taste is **not a direct reading** of the chemicals present but can be **dramatically altered at the receptor**, so the same food can be perceived completely differently. *(1 mark: protein/miracle fruit; 1: binds sweet receptors → sour tastes sweet; 1: food unchanged; 1: link to fallibility.)*

**Q11.** Any **one** of: the **colour / appearance** of the food; its **labelling or description**; its **price**; the person's **expectation**; or the **context / memory** in which it is eaten. *(Award the first answer only.)*

**Q12. Flavour** is a **multisensory** judgement, so the brain builds it from **texture and temperature** as well as taste and smell. **Texture (mouthfeel):** how **thick, creamy, crisp or gritty** a food feels in the mouth is folded into the flavour experienced — a thicker, creamier version of the **same** recipe is judged **richer**. **Temperature:** the **same** food served hot or cold is judged differently — melted ice cream tastes noticeably **sweeter** than the same ice cream frozen. In both cases the food's **taste and odour molecules are unchanged**, so the difference lies in the **perception**, not the food.

**Q13.** The statement is **incorrect**. Miraculin does **not chemically change the acid in the lemon into sugar**, and it does **not change the food at all**. **Correction:** miraculin is a **protein** that **binds to the sweet-taste receptors** on the taste buds; in the **acidic** conditions of the lemon it makes those receptors **signal "sweet"**. The lemon's **acid is unchanged** — only the **receptor response, and therefore the perception**, has changed. *(1 mark: identify the error; 1: correct mechanism — receptors, not the food.)*

**Q14.** (a) The **independent variable** is **taster status** — whether the participant is a **supertaster or a non-taster** (determined from papillae density). The **dependent variable** is the **rated bitterness** of the paper strip (the score from **0 to 10**). (b) A suitable **directional hypothesis:** *"It is hypothesised that **adults** classified as supertasters will rate the bitter paper strip as more bitter (a higher score) than adults classified as non-tasters."* (It names the **population**, both **levels of the IV** and a **direction** for the DV — all three parts.) (c) Using the **same bitter paper strip** for everyone **controls the food** as an **extraneous variable**: because the stimulus is held constant, any difference in bitterness ratings can be attributed to the **taster status** of the participants rather than to differences in what they tasted. *(a: 2 marks; b: 2 marks; c: 1 mark.)*

**Q15.** (a) The **independent variable** is the **colour of the cordial** (green, red or clear); the **dependent variable** is the **flavour the students reported**. (b) Colour **shifted the reported flavour**: with the **green** cordial, **8 of 10** students said "lime/citrus"; with the **red** cordial, **7 of 10** said "raspberry/berry"; and the **clear** cordial gave a **more mixed and uncertain** result (5 "lime", 2 "berry", 3 "not sure"). So a **red** colour pushed judgements towards berry and a **green** colour towards lime. (c) Because **every jug contained the identical cordial**, the only thing that differed was the **colour** — yet the reported flavour changed with it. This shows the brain judges flavour by **combining taste with appearance (and the expectation colour creates)**, i.e. flavour is a **multisensory judgement**, and therefore fallible. *(a: 2 marks; b: 2 marks; c: 1 mark.)*

**Q16.** The two bowls of soup are **identical**, so any difference in how they taste must come from **how the flavour is judged**, not from the food. **Flavour** is **multisensory** and includes **expectation**: the description **"premium hand-picked garden soup"** raises diners' expectations, and this expectation is **integrated into the flavour they perceive**, so the same soup is judged to **taste better**. This is a **distortion of flavour by a non-food (contextual) cue**, illustrating that gustatory perception is **subjective**. *(1 mark: identical food; 1: expectation is part of flavour judgement; 1: link to the result / fallibility.)*

**Q17.** A **biological** cause of fallibility arises from the **body's taste apparatus** — for example, being a **supertaster**, whose **greater taste-bud density** makes bitter foods taste more intense (or **miraculin** altering how the receptors respond). A **psychological (non-biological)** cause arises from **mental and contextual cues** — for example, the **colour of a food or a "premium" label** creating an **expectation** that changes the flavour a person reports. **Both** make perception **differ from an objective reading of the food**, but the biological cause acts through the **receptors/anatomy** while the psychological cause acts through **expectation and interpretation**. *(2 marks each side, with an example each.)*

**Q18.** Gustatory perception is **subjective** because the flavour a person experiences is **built by the brain from several cues**, not read directly off the drink. In this scenario at least **two factors** shaped the students' judgements. First, **appearance/colour**: the **blue** colour cued the expectation of "blueberry", so most students **interpreted and reported** the flavour as blueberry. Second, **expectation**: once students expected blueberry, they judged the taste to fit that expectation. The decisive evidence is that students who tasted it **blindfolded** — with the **colour cue removed** — correctly identified **lemonade**. Since the **same drink** was perceived differently depending on whether the colour/expectation cues were present, its perceived flavour clearly depends on the **perceiver and the context**, i.e. it is **subjective and fallible**. *(1 mark each for two factors; 1 for using the blindfold evidence; 1 for the link to subjectivity.)*

**Q19.** *Model response (6 marks).* **Gustatory perception is fallible and subjective** because the taste and flavour we experience are **constructed by the brain**, not read directly off the food; the three study-design examples each show this in a different way. **Supertasters** show that perception **varies between people**: a supertaster has **more, more densely packed fungiform papillae and therefore more taste buds**, so more receptors detect the food and tastes — **especially bitterness** — are experienced **more intensely** than by a non-taster. The **same** food is therefore perceived differently by different people, so taste is **not the same, objective experience for everyone**. **Exposure to miraculin**

shows that perception can be **altered at the receptor**: miraculin is a **protein** that **binds to the sweet-taste receptors**, so in **acidic (sour)** foods those receptors signal "sweet" and a lemon tastes sweet. The **lemon's chemistry is unchanged** — only the **receptor response** differs — so the same stimulus produces a completely different perception. **The judgment of flavours** shows that perception is **shaped by more than taste**: flavour is **multisensory**, combining taste with **smell, appearance and expectation**, so a **head-cold flattens flavour**, a **colour** makes a drink taste of "berry", and a **"premium" label** makes soup taste better — all distortions caused by **non-food cues**. Across all three examples the **food's chemistry stays constant while the perception changes**, which is exactly what it means to say gustatory perception is **not an objective read-out** but a **fallible, subjective interpretation** built by the brain. *(Full marks require: all three examples used correctly — supertasters/papillae and taste-bud density, miraculin/receptor binding, flavour as multisensory — and an explicit argument that perception changes while the food does not, so perception is fallible/subjective.)*

## Chapter 10 Distortions of perception — 10C Distortions of taste and vision in healthy individuals (synaesthesia, spatial neglect)

### Theory

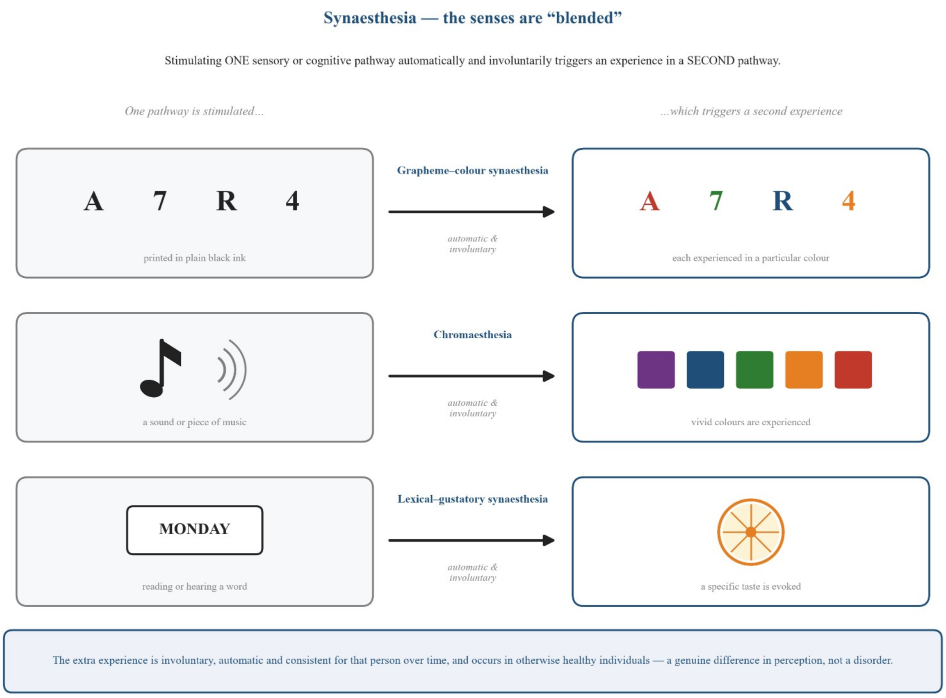
Perception is normally **reliable** — it usually gives us an accurate, useful model of the world. But perception can also be **distorted**, so that what a person perceives does not match the physical stimulus. Two well-studied examples are **synaesthesia** and **spatial neglect**. They are opposite kinds of distortion: synaesthesia **adds** an extra perceptual experience that the stimulus did not contain, while spatial neglect **leaves part of the world unperceived**.

**Synaesthesia** is a perceptual phenomenon in which stimulation of **one sensory or cognitive pathway automatically and involuntarily triggers an experience in a second pathway**. In everyday terms, the senses are “blended”: a stimulus that would normally produce just one kind of experience produces an extra one as well. Synaesthesia occurs in **otherwise healthy individuals**, and for any one person it is **involuntary** (it happens without being willed), **automatic** (it cannot be switched off) and highly **consistent** — the same trigger produces the same extra experience each time, often unchanged across a person’s whole life.

Common forms of synaesthesia include:

- **Grapheme–colour synaesthesia** — seeing specific letters or numbers as having particular colours (for example, the letter “S” always looks green and the number “4” always looks red), even when they are printed in plain black ink.
- **Chromaesthesia** — experiencing colours when hearing sounds or music (a particular note or voice reliably produces a particular colour).
- **Lexical–gustatory synaesthesia** — certain words evoking a particular taste in the mouth.

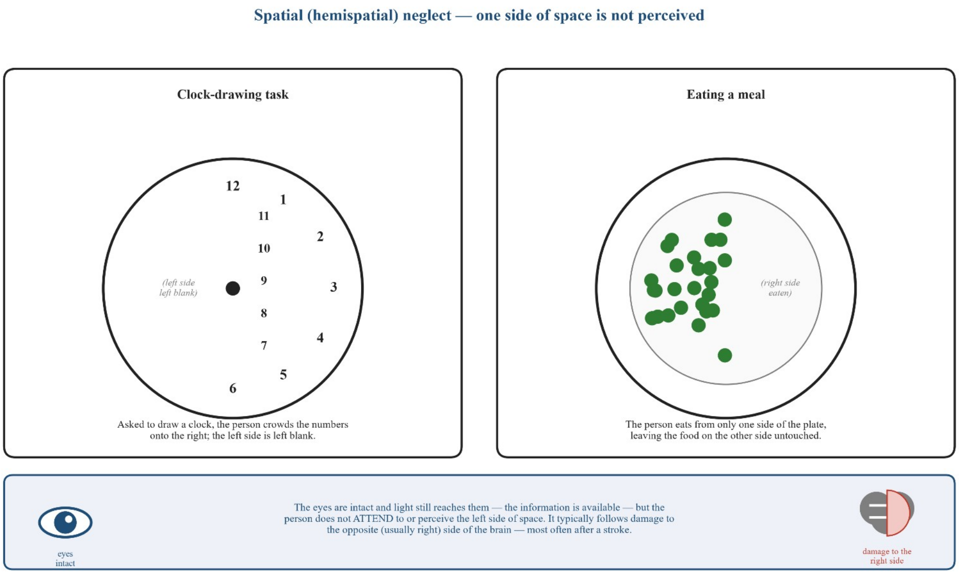
Synaesthesia is best understood as a **difference** in perceptual experience, not a disorder or a deficit: people who have it are healthy, and many describe it as a pleasant, useful feature of how they perceive the world.




**Spatial neglect** (also called **hemispatial** or **unilateral neglect**) is a perceptual and attentional distortion in which a person **fails to notice, attend to or perceive stimuli on one side of space** — most commonly the **left** side. The key feature is that the person’s **sensory system is intact**: the eyes work normally and light still reaches them, so the visual information is available. The problem is one of **attention** — the information simply is not attended to, and so it does not reach awareness. A person with left neglect may, for example, eat food from only the right side of a plate, read only the right-hand side of a page, shave or apply make-up to only one side of the face, or draw a clock with all the numbers crowded onto the right and the left side left blank.

Spatial neglect **typically follows brain injury**, most often a **stroke**. The study design lists spatial neglect as an example of a distortion of the perception of **vision**; note that, strictly, the phrase "in healthy individuals" fits **synaesthesia** most directly, whereas spatial neglect follows brain injury — a distinction worth stating accurately in an answer.

*(Background — beyond the Units 1 & 2 study design: the injury is usually on the opposite side of the brain to the neglected side of space, most often the right side and especially the right parietal lobe. Neglect is more common, and more lasting, on the left because the right side of the brain directs attention to both sides of space whereas the left side directs attention mainly to the right; damage on the right therefore leaves the left side of space with nothing attending to it, while damage on the left is largely compensated for by the intact right side. Which side of the brain is injured is useful context, but it is not required, and is not credited, in a Units 1 & 2 answer — describe what has happened to the person's perception instead.)*




**Keeping the two straight.** Both show that perception can depart from the physical stimulus, but in opposite directions.

- In **synaesthesia**, perception **adds** an experience: an extra, cross-sensory experience (a colour, a taste) is triggered that is not part of the stimulus itself. It is involuntary, automatic and consistent, and occurs in otherwise healthy people.
- In **spatial neglect**, perception **omits** part of the world: one side of space is not attended to or perceived, even though the sense organs are undamaged. It is an **attentional** distortion and usually follows a brain injury such as a stroke.

**How to analyse a scenario.** (1) Ask what has happened to perception. If an **extra** experience is being triggered by a stimulus (letters seen in colour, sounds heard as colour, words tasted), it is **synaesthesia** — then name the specific form. (2) If **one side of space** is being missed or left out (only one side of a plate, page or drawing), it is **spatial neglect** — then state the side of space affected and note that the sense organs are intact. Handle real-life descriptions **respectfully** and in **person-first** language (a person who has synaesthesia; a person who has had a stroke), not as figures of fun.

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## Worked examples

### *Example 1 — scaffolded*

Priya, an otherwise healthy Year 11 student, reports that whenever she sees the letter "S" it looks tinged with green, and the number "4" always looks red — even when both are printed in black ink. She says it has been this way for as long as she can remember. Name the perceptual phenomenon and its specific form, and identify three features that are characteristic of it.

| Working | Comment |
|---|---|
| A visual stimulus (a letter or number) is triggering an **extra** experience — a colour → this is **synaesthesia**, not a normal perception. | First ask what has happened to perception: an experience is being *added*. |
| The trigger is **letters and numbers** and the added experience is **colour** → the specific form is **grapheme–colour synaesthesia**. | Name the specific form from the trigger and the triggered experience. |
| It happens on its own (she does not choose it) → **involuntary**; it cannot be switched off → **automatic**. | Two hallmark features. |
| "S" is always green and "4" is always red, and it has been stable her whole life → **consistent over time**; and she is **otherwise healthy**. | Consistency and healthy status are characteristic of genuine synaesthesia. |

### *Example 2 — scaffolded*

A man who has recently had a stroke affecting the right side of his brain shaves only the right side of his face and, when served a meal, eats only the food on the right of his plate, leaving the left side untouched. His optometrist confirms that his eyes are undamaged. Identify the condition and the side of space affected, and explain why this is described as a distortion of *perception* even though his eyes work normally.

| Working | Comment |
|---|---|
| He consistently misses **one side of space** (the left) across different activities → **spatial (hemispatial) neglect**. | Missing one whole side of space is the signature of neglect. |
| The side left out is the **left** side of space. | State the affected side explicitly. |
| His **eyes are undamaged** and light still reaches them, so the information is available — the problem is that he does not **attend to** or perceive the left side. | It is an *attentional* distortion, not blindness. |
| The stroke damaged the **right** side of his brain, and the side of space neglected is the opposite one — the **left**. | Useful background only. The marks here are in the rows above: the study design asks about the distortion of *perception*, not about which side of the brain was injured. |

### *Example 3 — unscaffolded*

A professional musician says that whenever she hears a particular violin note she also sees a specific shade of blue "in her mind's eye", and a different note reliably produces gold. She has always experienced this and finds it helpful when composing. Name the phenomenon and its specific form, and explain how it distorts her perception.

The phenomenon is **synaesthesia**, and because a **sound** (an auditory stimulus) automatically triggers the experience of **colour**, the specific form is **chromaesthesia**. It distorts her perception because the sound stimulus itself contains no colour, yet stimulating her auditory pathway **involuntarily and automatically triggers an experience in a second (visual/colour) pathway** — an extra experience that is *added* to the stimulus. The mapping is **consistent** (the same note reliably produces the same colour) and she is an **otherwise healthy** individual, so this is a genuine difference in perceptual experience rather than a disorder. ∴ her perception is distorted by having an additional, cross-sensory colour experience blended into what she hears.

### *Example 4 — unscaffolded*

A student writes: "Spatial neglect just means the person has gone blind on one side, because their eye on that side has stopped working." Evaluate this claim.

The claim is **incorrect**. Spatial neglect is **not** blindness and is **not** caused by a failure of the eye. In neglect the **sensory system is intact** — the eyes work and light still reaches them, so the visual information is available — but the person fails to **attend to** or perceive one side of space, so it is an **attentional** distortion rather than a sensory loss. This is why neglect can affect a whole side of space across many tasks (eating, reading, drawing) and is not confined to one eye. Neglect also typically follows a **brain injury such as a stroke**, not damage to the eye. ∴ the student has confused an attentional distortion of perception with a loss of vision in the eye, which is inaccurate.

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## Practice questions

### *Scaffolded*

**Q1.** Define each of the following: (a) synaesthesia; (b) spatial (hemispatial) neglect; (c) grapheme–colour synaesthesia.

**Q2.** Leo, a healthy adult, reports that he always sees the days of the week in fixed colours — "Monday" looks dark blue and "Friday" looks yellow — even when the words are written in black. (a) Name the perceptual phenomenon. (b) State two features that are characteristic of it. (c) Explain why Leo's experience is described as involuntary.

**Q3.** After a stroke, a woman is asked to copy a simple drawing of a house; she copies only the right-hand half and leaves the left half blank. Her vision has been tested and her eyes are healthy. (a) Name the condition shown. (b) State which side of space is affected. (c) Explain why this is a distortion of perception even though her eyes are undamaged.

**Q4.** In chromaesthesia, a person hears a piece of music and experiences vivid colours. (a) State which sensory pathway is stimulated and which experience is then triggered. (b) Explain what is meant by saying the experience occurs in a "second pathway".

**Q5.** A neuropsychologist checks for spatial neglect by placing a printed clock face in front of a person and asking them to copy it. (a) State what the neuropsychologist would need to check about the person's eyesight before concluding that the copy shows spatial neglect. (b) Describe what the copy would look like for a person with left neglect. (c) Explain why the result counts as a distortion of perception.

**Q6.** Synaesthesia and spatial neglect are both distortions of perception, but in opposite ways. (a) State what happens to perception in synaesthesia. (b) State what happens to perception in spatial neglect. (c) Using both, explain the difference between a distortion that *adds* to perception and one that *omits* from it.

### *Unscaffolded*

**Q7.** Distinguish between synaesthesia and spatial neglect. *(2 marks)*

**Q8.** A healthy teenager says that certain words leave a distinct taste in her mouth — the word "table" tastes of toast, and this has never changed. Name the phenomenon and its specific form, and explain how it distorts her perception. *(3 marks)*

**Q9.** Explain why synaesthesia is described as *involuntary* and *automatic*. *(2 marks)*

**Q10.** A man who has had a stroke reads aloud from a novel but consistently reads only the words on the right-hand side of each line, so the story makes little sense. An eye examination after the stroke found his vision to be normal. Identify the distortion, and explain why it is best described as an *attentional* rather than a *sensory* problem. *(3 marks)*

**Q11.** A healthy woman with lexical–gustatory synaesthesia says that the word "Thursday" fills her mouth with the taste of peppermint, even though she is eating nothing at the time. Explain why this is a distortion of the perception of *taste* even though there is nothing wrong with her taste receptors, and state **one** feature of the experience that shows she is not simply imagining the taste. *(3 marks)*

**Q12.** *Research scenario.* A researcher tests whether a participant's grapheme–colour synaesthesia is genuine. In the first session the participant is shown 100 letters and numbers one at a time and, for each, selects the colour it evokes from an on-screen palette. Without warning, the same 100 items are presented again ten weeks later and the participant again selects a colour for each one. A group of non-synaesthetic controls completes the identical task. (a) Identify the independent variable and the dependent variable. *(2 marks)* (b) Explain why the researcher re-tests after a ten-week delay rather than immediately. *(2 marks)* (c) Predict how the synaesthete and the controls would differ, and state one conclusion the researcher could draw. *(2 marks)*

**Q13.** A student claims that a person with spatial neglect "cannot see anything on their left". Identify and correct the error in this statement. *(2 marks)*

**Q14.** For each description, identify the distortion of perception and then go one step further: if it is synaesthesia, name the specific form; if it is spatial neglect, state the side of space affected. Justify each answer. (a) A healthy person always experiences the sound of a trumpet as bright orange. (b) After a stroke, a person crosses out only the shapes on the right-hand side of a worksheet. *(4 marks)*

**Q15.** Describe **two** everyday situations, other than copying or drawing a clock, in which a person with left spatial neglect would be noticeably affected. For each, state what the person fails to perceive. *(2 marks)*

**Q16.** *Research scenario.* A neuropsychologist reports a single case. A woman who has had a stroke is asked to (i) draw a clock from memory and (ii) cross out all the short lines scattered across a page (a cancellation task). She crowds all the numbers into the right half of the clock face, and crosses out only the lines on the right of the page. (a) Identify the perceptual distortion shown. *(1 mark)* (b) Explain what using *two different* tasks reveals about the distortion. *(2 marks)* (c) State one limitation of drawing conclusions about spatial neglect from this single case. *(1 mark)*

**Q17.** Explain why synaesthesia is regarded as a difference in perception in an otherwise healthy individual, rather than a disorder or deficit. *(2 marks)*

**Q18.** The table gives two people's descriptions of their perception.

| Person | Description |
|---|---|
| P | "Ever since I was a child, seeing the number 7 makes me experience a strong green colour; it is always green." |
| Q | "Since my stroke I keep bumping into door frames on one side, and I only notice people when they are on my right." |

For **each** person, classify the perceptual distortion and justify your answer with reference to the description. *(4 marks)*

**Q19.** *Extended response.* The study design lists "distortions of perception of taste and vision in healthy individuals, such as synaesthesia and spatial neglect". Using synaesthesia and spatial neglect, compare these two distortions: describe what each is (with one example), explain how each distorts perception, and comment accurately on how the phrase "in healthy individuals" applies to each. *(6 marks)*

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## Answers

**Q1.** (a) A phenomenon in which stimulating one sensory/cognitive pathway automatically and involuntarily triggers an experience in a second pathway (the senses are "blended"). (b) A distortion in which a person fails to attend to or perceive one side of space (usually the left) despite an intact sensory system. (c) A form of synaesthesia in which letters or numbers are experienced as having particular colours. **Q2.** (a) Synaesthesia (grapheme–colour / word–colour). (b) Any two of: involuntary; automatic; consistent over time; occurs in an otherwise healthy person. (c) It happens on its own, without Leo choosing or trying to produce it. **Q3.** (a) Spatial (hemispatial) neglect. (b) The left side of space. (c) The visual information is available (her eyes are fine) but she does not attend to/perceive the left side — an attentional distortion of perception. **Q4.** (a) The auditory (hearing) pathway is stimulated; a colour (visual) experience is triggered. (b) The experience appears in a different pathway from the one stimulated — colour (a visual experience) is triggered by sound, so the response occurs in a "second" pathway. **Q5.** (a) That the person's eyes and vision are healthy — the sensory system is intact — so a missing left half cannot be explained by a loss of vision. (b) The numbers would be crowded onto the right side of the clock face with the left side left blank. (c) The person perceives only part of the space (the right), omitting the left, so their perception does not match the actual layout. **Q6.** (a) An extra, cross-sensory experience is added to the stimulus. (b) One side of space is omitted from perception. (c) Synaesthesia *adds* something not in the stimulus; neglect *removes* part of what is there — opposite kinds of distortion. **Q7.** Synaesthesia adds an extra cross-sensory experience (one pathway triggers a second) in an otherwise healthy person; spatial neglect omits one side of space from perception, is attentional, and follows a brain injury such as a stroke. **Q8.** Synaesthesia; specifically lexical–gustatory synaesthesia; a word (heard/read) involuntarily triggers a taste that is not present in the stimulus — an added, cross-sensory experience. **Q9.** Involuntary = it occurs without being willed/chosen; automatic = it cannot be switched off or prevented. **Q10.** Spatial (left) neglect; his vision has been tested as normal, so the words on the left do reach him, but he fails to attend to the left side, so the deficit is attentional, not sensory. **Q11.** No food is in her mouth, so her taste receptors are not being stimulated; the trigger is a word, which contains no taste, and it automatically triggers an experience in a second (gustatory) pathway — the taste is added by her perception, so perception does not match the stimulus. Feature: it is involuntary and automatic (every time, and cannot be switched off) — or: it is highly consistent. **Q12.** (a) IV = whether the participant is a synaesthete or a control; DV = the consistency of the colour choices across the two sessions. (b) A long delay prevents the person simply remembering their earlier answers; genuine synaesthetes still match closely because the mapping is fixed. (c) The synaesthete's choices would be highly consistent across sessions and the controls' far less consistent; conclusion: the participant's synaesthesia is genuine/automatic. **Q13.** Error: it is not blindness. The eyes work and the information reaches them; the person fails to *attend to* the left side — an attentional distortion, not loss of vision. **Q14.** (a) Synaesthesia — chromaesthesia (a sound triggers an added colour experience in a healthy person). (b) Spatial neglect — the **left** side of space (only the right-hand shapes are crossed out). **Q15.** Any two, e.g.: eating a meal — only the food on the right of the plate is eaten, the food on the left not perceived; reading — only the right-hand side of each line is read, the words on the left not perceived; grooming — only the right side of the face is shaved or made up; moving about — furniture or door frames on the left are not noticed and are bumped into. **Q16.** (a) (Left) spatial neglect. (b) The left side is omitted in both a drawing task and a visual-search task, showing the neglect is of one side of space generally, not specific to one task. (c) A single case cannot be generalised to all people with neglect (no control/comparison; individual differences). **Q17.** The person is otherwise healthy and the experience is stable, involuntary and often useful; it is a different way of perceiving, not a loss or impairment of function. **Q18.** P = synaesthesia (grapheme–colour): a number consistently triggers a colour in a healthy person. Q = spatial neglect: one side of space is missed after a stroke. **Q19.** Model response given in the solutions.

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## Fully-worked solutions

**Q1.** (a) **Synaesthesia** is a perceptual phenomenon in which stimulating **one** sensory or cognitive pathway **automatically and involuntarily triggers an experience in a second** pathway, so that the senses are effectively "blended". (b) **Spatial (hemispatial) neglect** is a perceptual and attentional distortion in which a person **fails to notice, attend to or perceive stimuli on one side of space** (most commonly the left), **despite the sensory system being intact**. (c) **Grapheme–colour synaesthesia** is the form of synaesthesia in which **letters or numbers are experienced as having particular colours**, even when printed in black.

**Q2.** (a) The phenomenon is **synaesthesia** (a word/grapheme–colour form). (b) Any **two** of: it is **involuntary**; it is **automatic**; it is **consistent** over time (Monday is always dark blue); it occurs in an **otherwise healthy** person. (c) It is

**involuntary** because Leo does not decide, choose or try to see the colours — they simply occur on their own whenever he reads the words, without any effort or intention on his part.

**Q3.** (a) The condition is **spatial (hemispatial) neglect**. (b) The **left** side of space is affected. (c) It is a distortion of **perception**, not of the eye, because her **sensory system is intact** — her eyes are healthy and the left side of the drawing is fully available to them. The problem is that she **does not attend to or perceive** the left side of space, so it is left out of her copy; this failure of attention, not a failure of the eye, is what distorts her perception.

**Q4.** (a) The **auditory (hearing)** pathway is stimulated by the music, and this triggers a **colour (visual)** experience. (b) Saying the experience occurs in a "**second pathway**" means that the triggered experience belongs to a **different** sense from the one that was stimulated: the ears are stimulated by sound, yet the experience produced is **colour**, which is normally a visual experience. Stimulation in one pathway (hearing) automatically produces an experience in another (colour/vision).

**Q5.** (a) The neuropsychologist would need to confirm that the person's **eyes and vision are healthy** — that the **sensory system is intact**, so the whole clock face is genuinely available to them. Without that check, a copy missing its left half could simply be the result of a **loss of vision** rather than of neglect. (b) The person would copy the clock face but **crowd all the numbers onto the right-hand side**, leaving the **left side blank** (or squeeze the numbers so the left is empty). (c) It counts as a distortion of **perception** because the whole clock face is physically present in front of them and available to their eyes, yet the person **perceives and represents only the right side**, omitting the left — their perception does not match the actual stimulus.

**Q6.** (a) In synaesthesia, perception has an **extra, cross-sensory experience added** to it (for example a colour triggered by a letter or a sound). (b) In spatial neglect, **one side of space is omitted** from perception — it is not attended to or perceived. (c) A distortion that **adds** (like synaesthesia) produces an experience the stimulus did not contain, so the person perceives **more** than is there; a distortion that **omits** (like neglect) removes part of what is present, so the person perceives **less** than is there. The two are therefore opposite kinds of distortion.

**Q7. Synaesthesia** is a distortion in which stimulating one pathway **automatically and involuntarily adds an extra experience in a second pathway** (e.g. seeing letters in colour); it occurs in **otherwise healthy** people. **Spatial neglect** is a distortion in which a person **fails to attend to or perceive one side of space** (usually the left) despite intact senses, and it typically **follows a brain injury such as a stroke**. In short, synaesthesia **adds** a cross-sensory experience, whereas neglect **omits** one side of space. *(Two-sided: 1 mark each side, congruent contrast.)*

**Q8.** The phenomenon is **synaesthesia**, and because a **word** triggers a **taste**, the specific form is **lexical–gustatory synaesthesia**. It distorts her perception because the word itself contains no taste, yet reading or hearing it **involuntarily and automatically triggers a taste experience** — an extra, cross-sensory experience blended into her perception. The fact that "table" always tastes of toast shows the **consistency** typical of genuine synaesthesia.

**Q9.** Synaesthesia is **involuntary** because the extra experience occurs **without the person choosing or intending it** — they cannot decide whether or not to have it. It is **automatic** because it happens **every time** the trigger is present and **cannot be switched off or suppressed**; the person cannot look at the letter or hear the sound without the linked experience arising.

**Q10.** The distortion is **spatial (left) neglect**. It is best described as an **attentional** rather than a **sensory** problem because his **vision has been tested and found to be normal**: the words on the left of each line are physically present on the page and the light from them does reach his visual system, so the information **is** available to him. What fails is **attention** — he does not attend to the left side of space, so that information never reaches awareness and is never read aloud. A **sensory** problem would mean the information never arrived in the first place; here it arrives and is simply not used.

**Q11.** Nothing is in her mouth, so **her taste receptors are not being stimulated by any food —** there is no chemical on her tongue for them to detect, and her taste organs are working normally. The trigger is instead a **word**, which contains no taste at all. Reading or hearing that word **automatically and involuntarily triggers an experience in a second, gustatory pathway**, so the taste of peppermint is **added by her perception** rather than delivered by the stimulus. Her perception therefore departs from the physical stimulus, and that is exactly what makes it a **distortion of the perception of taste**: the distortion lies in how the perception is produced, not in the sense organ. One feature showing this is not imagination: the experience is **involuntary and automatic —** it happens every time she meets the word, without her choosing it, and she cannot switch it off, whereas an imagined taste has to be deliberately produced.

*(Accept instead: the experience is highly consistent — the same word produces the same taste every time, even years apart.)*

**Q12.** (a) The **independent variable** is **whether the participant is a synaesthete or a non-synaesthetic control**; the **dependent variable** is the **consistency of the colour choices across the two sessions** (how closely the second colours match the first). (b) The **ten-week delay** is used so that the participant **cannot simply remember** the colours they picked in the first session. A genuine synaesthete has a **fixed, stored mapping**, so they will match closely even after a long delay; a control, relying only on memory of arbitrary earlier choices, will match poorly. Testing immediately would let anyone score highly just by remembering. (c) The **synaesthete's** choices would be **highly consistent** across the two sessions, whereas the **controls'** would be **much less consistent**. The researcher could conclude that the synaesthete's experience is **genuine and automatic** (a stable perceptual mapping) rather than made up.

**Q13.** The statement is **incorrect**. Spatial neglect is **not blindness**: the person's **eyes work normally and the information on the left does reach them**. What is impaired is **attention** — the person **fails to attend to or perceive** the left side of space — so it is an **attentional distortion of perception**, not a loss of vision in the eye.

**Q14.** (a) **Synaesthesia**, and the specific form is **chromaesthesia**, because the trigger is a **sound** (the trumpet) and the added experience is a **colour** (orange): stimulating the auditory pathway automatically and consistently triggers an experience in a second, visual pathway, in an **otherwise healthy** person. (b) **Spatial neglect**, affecting the **left** side of space. The person crosses out only the shapes on the **right** and leaves those on the left untouched, so it is the **left** side of space that is omitted — the failure to attend to or perceive one whole side of space that defines neglect. The shapes on the left are on the page and available to their eyes.

**Q15.** Any **two** everyday situations in which one side of space matters, each with what is missed stated. For example: (1) **Eating a meal** — the person eats the food on the **right** of the plate and leaves the food on the **left** untouched; they do not perceive the left-hand half of the plate and may say they have finished when half the meal remains. (2) **Reading** — the person reads only the words on the **right-hand side** of each line and does not perceive the words on the left, so the text stops making sense. Other acceptable answers include **grooming** (shaving or applying make-up to only the right side of the face, the left side not being perceived) and **moving about a room** (bumping into furniture or door frames on the left, which are not noticed). In each case the objects on the left are physically present and available to the person's eyes; what is missing is the **perception** of that side of space. *(1 mark per situation, each with what is not perceived.)*

**Q16.** (a) The distortion is **(left) spatial neglect**. (b) Using **two different tasks** — a drawing task (the clock) and a visual-search/cancellation task (crossing out lines) — and finding the **same one-sided pattern** in both shows that the neglect is of **one side of space in general**, not a quirk of a single task or an inability to draw; the person consistently omits the **left** side whatever the task. (c) A **single case** cannot be **generalised** to all people with neglect (there is no control or comparison group, and individual differences mean one person's pattern may not represent others').

**Q17.** Synaesthesia is regarded as a **difference** rather than a **disorder** because the person is **otherwise healthy** and their functioning is not impaired: the extra experience is **stable, involuntary and often useful** (for example, aiding memory or creativity). It is simply an **additional way of perceiving**, not a loss or breakdown of a perceptual ability, which is why it is described as a distortion **in healthy individuals** rather than a deficit.

**Q18. Person P — synaesthesia (grapheme–colour).** A **number** (the numeral "7") **consistently** and involuntarily triggers an experience of **colour** (green), the experience has been present since childhood, and P is otherwise healthy — all hallmarks of grapheme–colour synaesthesia, in which a stimulus **adds** an extra cross-sensory experience. **Person Q — spatial neglect.** Following a **stroke**, Q **fails to notice one side of space** (bumping into things on one side, noticing people only on the right), which is the failure to attend to/perceive **one side of space** that defines neglect; here perception **omits** part of the world despite intact senses.

**Q19.** *Model response (6 marks).* Synaesthesia and spatial neglect are both **distortions of perception** — perception departs from the physical stimulus — but they are **opposite** in what they do. **Synaesthesia** is a phenomenon in which stimulating **one sensory or cognitive pathway automatically and involuntarily triggers an experience in a second pathway**; for example, in **grapheme–colour synaesthesia** a person sees letters or numbers as having fixed colours even in black ink. It distorts perception by **adding** an extra, cross-sensory experience that the stimulus did not contain, and it is involuntary, automatic and consistent. **Spatial neglect** is a perceptual and attentional distortion in which a person **fails to attend to or perceive one side of space** (usually the left) despite an intact sensory system; for example, drawing a clock with all the numbers crowded onto the right and the left side blank. It distorts perception by **omitting** part of the world — the information reaches the eyes but is not attended to. Finally, the phrase "**in healthy individuals**" applies **most directly to synaesthesia**, which occurs in otherwise healthy people and is a difference rather than a deficit; **spatial neglect**, by contrast, is accurately described as **following brain injury**, most often a **stroke**, and is included here as the study design's second named example of a distortion of the perception of vision. *(Full marks require: a correct definition and example of each; a clear statement that synaesthesia adds while neglect omits; and an accurate comment on the "healthy individuals" framing.)*

## Topic 5 Test A — Multiple choice

*Reading time: 5 minutes. Writing time: 25 minutes. 20 questions, 20 marks. No calculator, no notes. Choose the response that is correct or that best answers the question. A correct answer scores 1 mark; an incorrect answer scores 0. Marks are not deducted for incorrect answers.*

**Question 1**

At a crowded party a student is able to follow one friend's voice while filtering out the many other conversations going on around her. This ability to focus on one chosen stimulus while ignoring others is:

**A.** selective attention

**B.** divided attention

**C.** sustained attention

**D.** bottom-up processing

**Question 2**

A learner driver finds that she can no longer keep up a conversation the moment traffic becomes heavy and she must change gears often. This breakdown, when attention must be spread across two demanding tasks at once, illustrates the limits of:

**A.** sustained attention

**B.** selective attention

**C.** divided attention

**D.** size constancy

**Question 3**

A factory inspector must watch a moving belt for a single type of faulty part for the whole of a two-hour shift. Maintaining focus on this one task over a prolonged, continuous period is:

**A.** divided attention

**B.** selective attention

**C.** a perceptual set

**D.** sustained attention

**Question 4**

Bottom-up processing is best described as perception that:

**A.** relies on prior knowledge, context and expectations to interpret information

**B.** begins with the raw sensory features of a stimulus and builds them into a whole perception

**C.** focuses on one stimulus while filtering out competing stimuli

**D.** fills in the missing parts of a figure so that it is seen as complete

**Question 5**

Reading a doctor's untidy handwriting, a pharmacist cannot make out one scrawled word on its own but works it out from the meaning of the whole sentence. Using prior knowledge and context in this way is an example of:

**A.** bottom-up processing

**B.** sustained attention

**C.** top-down processing

**D.** retinal disparity

**Question 6**

Which of the following is the best example of mainly bottom-up processing?

**A.** Instantly recognising a close friend's face in a crowd

**B.** Guessing a partly hidden word from the sentence around it

**C.** Reading a familiar STOP sign at a single glance

**D.** Carefully building up a perception of a completely unfamiliar object from its individual features

**Question 7**

When you look at a coffee cup sitting on a busy patterned tablecloth, you automatically see the cup as a distinct object standing out from its background. This organisation of a scene into an object and its surroundings is the Gestalt principle of:

**A.** closure

**B.** figure–ground

**C.** similarity

**D.** proximity

**Question 8**

Anxiously expecting to find their lost cat, a family briefly "see" it in a dark shape near the fence that turns out to be a rolled-up bag. Their expectation shaped what they perceived. This is best described as:

**A.** a perceptual set

**B.** bottom-up processing

**C.** size constancy

**D.** divided attention

**Question 9**

Retinal disparity — the slightly different image received by each of the two eyes — is best classified as:

**A.** a monocular depth cue

**B.** a Gestalt principle

**C.** a binocular depth cue

**D.** a visual constancy

**Question 10**

In a landscape photograph a nearer tree partly blocks the view of a tree behind it, so the partly hidden tree is judged to be further away. This monocular depth cue is:

**A.** retinal disparity

**B.** interposition (overlap)

**C.** convergence

**D.** accommodation

**Question 11**

As a friend walks away from you along a street, the image she casts on your retina steadily shrinks, yet you continue to perceive her as her true, unchanged height. This is an example of:

**A.** shape constancy

**B.** a perceptual set

**C.** a visual illusion

**D.** size constancy

**Question 12**

Cross-cultural research suggests that people raised in “carpentered” environments full of straight edges and right angles are more strongly deceived by the Müller-Lyer illusion than people raised where such structures are rare. This finding shows that visual perception can be shaped by:

**A.** social and cultural experience

**B.** the number of taste buds a person has

**C.** the maturation of the binocular eye

**D.** the involuntary blending of the senses

**Question 13**

Compared with an average taster, a “supertaster” typically:

**A.** has fewer papillae and finds strong flavours bland

**B.** can detect only sweet and salty tastes

**C.** has more papillae, and therefore more taste buds, and experiences tastes such as bitterness more intensely

**D.** permanently loses all taste sensitivity by early adulthood

**Question 14**

A café sells a single lime-flavoured cordial but dyes one batch bright red. Many customers insist the red batch tastes of strawberry. This shows that gustatory perception can be influenced by:

**A.** the number of papillae on the tongue

**B.** the appearance of the food and the expectations it creates

**C.** miraculin binding to the sweet receptors

**D.** damage to one side of the brain

**Question 15**

A dish that is treasured as a delicacy in one culture is often judged revolting by visitors from another culture who never grew up eating it. This difference is best explained by:

**A.** genetic supertaster status

**B.** binocular depth cues

**C.** a visual agnosia

**D.** cultural learning and past experience

**Question 16**

In the Müller-Lyer illusion, a line ending in outward "fins" looks longer than an identical line ending in inward "arrowheads". A widely accepted explanation is that the healthy visual system:

**A.** has permanently damaged feature-detecting neurons

**B.** blends the sense of vision with the sense of touch

**C.** misapplies depth cues and size constancy, treating one line as though it were further away

**D.** fails to recognise the lines because of brain damage

**Question 17**

After a stroke, a man can see a pair of scissors clearly, describe their shape and colour, and even copy a drawing of them, yet he cannot say what they are until he picks them up and feels them. His difficulty is best described as:

**A.** a visual illusion

**B.** visual agnosia

**C.** spatial neglect

**D.** synaesthesia

**Question 18**

After eating a berry containing miraculin, a person finds that a slice of sour lemon now tastes sweet. The best explanation is that miraculin:

**A.** chemically turns the acid in the lemon into sugar

**B.** destroys the person's bitter taste buds

**C.** is a visual illusion that changes how the lemon looks

**D.** alters how the tongue's sweet receptors respond, so the unchanged sour food is perceived as sweet

**Question 19**

A healthy man reports that every time he reads the letter "A" he automatically and reliably experiences the colour red, without any effort or choice. This involuntary blending of the senses in a healthy person is:

**A.** synaesthesia

**B.** spatial neglect

**C.** visual agnosia

**D.** a perceptual set

**Question 20**

After damage to the right side of her brain, a woman consistently eats food from only the right half of her plate and ignores the left half, even though her eyes and visual pathways are undamaged. This is best described as:

**A.** synaesthesia

**B.** a visual illusion

**C.** spatial neglect

**D.** divided attention

*End of Topic 5 Test A*

### *Test A — solutions*

| Q | Ans | Q | Ans | Q | Ans | Q | Ans |
|---|---|---|---|---|---|---|---|
| 1 | A | 6 | D | 11 | D | 16 | C |
| 2 | C | 7 | B | 12 | A | 17 | B |
| 3 | D | 8 | A | 13 | C | 18 | D |
| 4 | B | 9 | C | 14 | B | 19 | A |
| 5 | C | 10 | B | 15 | D | 20 | C |

**Q1.** A — following one chosen voice while filtering out the others is selective attention; sustained attention is focus over time and divided attention is spreading focus across tasks.

**Q2.** C — the conversation collapses only when two demanding tasks must be handled at once, showing the limits of divided attention.

**Q3.** D — maintaining focus on a single task over a prolonged, continuous period (vigilance) is sustained attention.

**Q4.** B — bottom-up (data-driven) perception starts from the raw sensory features and builds up to the whole; option A describes top-down processing.

**Q5.** C — using context and prior knowledge to work out the word is top-down (knowledge-driven) processing.

**Q6.** D — building a perception of a wholly unfamiliar object from its features alone is mainly bottom-up; the other options all rely on prior knowledge (top-down).

**Q7.** B — separating a main object from its surroundings is the Gestalt principle of figure–ground.

**Q8.** A — expectation shaping what is perceived is a perceptual set, not a data-driven (bottom-up) process.

**Q9.** C — retinal disparity compares the two eyes' images, so it is a binocular depth cue; monocular cues need only one eye.

**Q10.** B — one object partly blocking another is interposition (overlap), a monocular depth cue.

**Q11.** D — perceiving a person's true, stable height despite a shrinking retinal image is size constancy.

**Q12.** A — differing illusion susceptibility according to upbringing shows a social and cultural influence on perception.

**Q13.** C — supertasters have more papillae, and therefore more taste buds (each papilla carries several buds), so they experience tastes, especially bitterness, more intensely.

**Q14.** B — colour changing the perceived flavour shows the influence of appearance and expectation, a psychological factor.

**Q15.** D — the same food being prized in one culture and rejected in another reflects cultural learning and past experience.

**Q16.** C — the Müller-Lyer illusion is explained by a healthy visual system misapplying depth cues and size constancy; there is no brain damage (A, D) and no cross-sensory blending (B).

**Q17.** B — being able to see and describe the object but not recognise it after brain damage is visual agnosia, not an illusion (the stimulus is not misjudged, it simply is not recognised).

**Q18.** D — miraculin changes how the sweet receptors respond so the unchanged sour food is perceived as sweet; it does not turn acid into sugar (A).

**Q19.** A — an involuntary, consistent blending of the senses in a healthy person is synaesthesia.

**Q20.** C — ignoring one side of space after damage to the opposite side of the brain, with intact eyes, is spatial neglect.

## Topic 5 Test B — Short answer

*Writing time: 35 minutes. Total 30 marks. No calculator, no notes. Answer all questions. Where more than one mark is available, full marks require the depth the command term and mark allocation ask for.*

**Question 1** (4 marks)

**a.** Distinguish between sustained attention and selective attention. 2 marks

A student walks along a footpath while typing a text message and fails to notice a raised step, tripping on it.

**b.** Identify the type of attention that is being over-stretched in this situation, and explain why the student's performance dropped. 2 marks

**Question 2** (4 marks)

**a.** Distinguish between top-down processing and bottom-up processing. 2 marks

**b.** A child who is just learning to read sounds out a completely unfamiliar word one letter at a time. State whether this is mainly top-down or mainly bottom-up processing, and justify your answer. 2 marks

**Question 3** (5 marks)

A researcher shows the Müller-Lyer illusion to two groups of 40 adults. Group 1 grew up in a large city full of rectangular, straight-edged buildings; Group 2 grew up in a remote community with very few such structures. Each participant adjusts one line until it *looks* equal in length to a standard line. The table shows each group's mean error — how far, on average, their judgement was from the truly equal length.

| Group | Mean error (mm) |
|---|---|
| 1 (city) | 9.8 |
| 2 (remote) | 3.1 |

**a.** Identify the independent variable and the dependent variable in this investigation. 2 marks

**b.** Using the data, state what the results suggest, and name the type of factor influencing visual perception that this demonstrates. 2 marks

**c.** Name one *psychological* factor that can also influence visual perception, and briefly say what it is. 1 mark

**Question 4** (4 marks)

**a.** Distinguish between a visual illusion and agnosia as examples of the fallibility of visual perception. 2 marks

**b.** A person looks at the Müller-Lyer figure and is certain that one line is longer, although a ruler shows the two lines are exactly equal. Explain why this is classified as an illusion and not as agnosia. 2 marks

**Question 5** (4 marks)

**a.** After eating a berry containing miraculin, a person finds that sour foods taste sweet. Explain how this happens, making clear what does and does not change. 2 marks

**b.** A person with a heavy head cold complains that their meal is almost "tasteless". Explain this, referring to how the flavour of food is judged. 2 marks

**Question 6** (3 marks)

Explain how, for many Aboriginal and Torres Strait Islander peoples, connection to Country illustrates that perception can be a multimodal experience shaped by social and cultural factors.

**Question 7** (6 marks)

Synaesthesia and spatial neglect are both described as distortions of perception, but they differ fundamentally. Compare the two: for each, explain what the person experiences, whether it occurs in a healthy brain or results from brain damage, and give an example. Then use spatial neglect to explain how perception depends on more than the eyes working correctly.

*End of Topic 5 Test B*

## *Test B — solutions*

**Q1. (a) Sustained attention** is concentrating on **one stimulus or task continuously over a prolonged period** (vigilance) — for example, watching a screen for a rare event across a long shift. **Selective attention** is **choosing to focus on one particular stimulus at a given moment while filtering out other competing stimuli** — for example, following one voice in a noisy room. The key difference is that sustained attention is about **maintaining** focus **over time**, whereas selective attention is about **choosing** which of several competing stimuli to focus on. **(b)** The student is over-stretching **divided attention** — they are trying to spread attention across **two tasks at once** (walking and typing). Because attention is a **limited resource**, spreading it across two tasks means **less is available for each**, so the student failed to process the visual information about the step and tripped.

**Q2. (a) Top-down processing** uses **prior knowledge, expectations and context** to interpret sensory information; it is **knowledge-driven** and works from the whole down to the details. **Bottom-up processing** starts from the **raw sensory features of the stimulus** and builds them up into a whole perception; it is **data-driven** and works from the details up to the whole. **(b)** This is mainly **bottom-up** processing. Because the word is **completely unfamiliar**, the child has **little prior knowledge or context** to draw on and must build the word up from its **individual features** (the letters and their sounds), one piece at a time — that is, starting from the sensory data rather than from expectation.

**Q3. (a)** The **independent variable** is the **type of environment the person grew up in** (a city/"carpentered" environment versus a remote environment with few straight-edged structures). The **dependent variable** is the **mean size of the error** (in mm) in judging the two lines to be equal — that is, how strongly each group was fooled by the illusion. **(b)** Group 1 (city) made a **much larger error** (9.8 mm) than Group 2 (3.1 mm), so the city group was **more susceptible to the Müller-Lyer illusion**. This suggests that the **environment and culture a person grows up in — a social (sociocultural) factor — influences visual perception**. **(c)** A **perceptual set**: a **predisposition or readiness to perceive a stimulus in a particular way**, based on factors such as expectation, context, past experience, motivation or emotion.

**Q4. (a)** A **visual illusion** is a **consistent misinterpretation of a real, present stimulus by a healthy visual system** — the person **does perceive** the stimulus but perceives it **wrongly** (for example, two equal lines seen as unequal). **Agnosia** is a **failure to recognise objects despite intact vision**, caused by **brain damage** — the visual information arrives normally, but the brain **cannot interpret or recognise** what is seen. In short: an illusion is a **misperception by a healthy system**, whereas agnosia is a **failure to recognise, caused by brain damage**. **(b)** It is an **illusion** because the person's **visual system is healthy** and is responding to a **real stimulus** (the lines), but **misjudges** it — perceiving equal lines as unequal. It is **not agnosia** because the person has **no brain damage** and can **recognise the lines perfectly well as lines**; they simply **misjudge their length**. Agnosia would mean being unable to recognise what the figure is at all.

**Q5. (a) Miraculin binds to the sweet-taste receptors** on the tongue. In **acidic (sour) conditions** it **changes the way those receptors respond**, so that **sour foods are perceived as sweet**. The important point is that the **sour food itself is chemically unchanged** — miraculin does **not turn acid into sugar**; only the **way the receptors respond, and therefore the perception**, changes. **(b)** The **flavour** of food is **not taste alone** — it is judged from **taste (gustation) combined with smell (olfaction)** and other cues such as appearance and texture. A heavy cold **blocks the nose and reduces smell**, so a large part of the flavour information is **lost**, and the food seems bland or "tasteless" **even though the taste buds still work normally**.

**Q6.** For many Aboriginal and Torres Strait Islander peoples, **perceiving and connecting to Country** is understood as a **whole-of-body, multisensory experience** rather than something achieved through vision alone. Perceiving Country can **draw together sight, sound, smell, taste, touch and movement**, alongside **deep cultural knowledge, story and relationship** built up and shared over generations. This illustrates that perception is shaped by **social and cultural factors**: what and how a person perceives depends not only on the raw sensory information reaching the senses, but also on the **cultural knowledge, meaning and connection** the person brings to it. *(Full marks: the multimodal/multisensory nature of the experience; that it is more than vision alone; and that this shows a social/cultural influence on perception.)*

**Q7.** *Model response (6 marks).* **Synaesthesia** and **spatial neglect** are both distortions of perception, but they are opposites in their cause and in what the person experiences. **Synaesthesia** is an **involuntary, automatic and consistent blending of the senses**, in which stimulation of one sense (or of a symbol such as a letter or number) also triggers an experience in **another** sense — for example, **hearing a musical note and automatically seeing a**

**particular colour**, or experiencing letters as always coloured. It occurs in **healthy individuals with no brain damage**; it is **not chosen** and stays **consistent over time**, so it is best thought of as **extra, blended perception in a healthy brain**. **Spatial neglect**, by contrast, is a **failure to notice or respond to stimuli on one side of space** (usually the left), **despite the eyes and visual pathways being completely intact**. It is caused by **brain damage to the opposite side of the brain** (usually the right parietal lobe, causing neglect of the left). For example, a person with spatial neglect may **eat food from only one side of the plate, draw only half of a clock, or groom only one side of their body**. So spatial neglect is **missing perception of part of the world following brain damage**, the reverse of synaesthesia's extra perception in a healthy brain. Spatial neglect shows clearly that **perception depends on more than the eyes working correctly**: the person's **eyes and visual pathways are undamaged**, yet they still **fail to perceive one side of space** because the **brain region that directs attention to and interprets that side is damaged**. Perception therefore requires the **brain to attend to and make sense of** sensory information — healthy sense organs alone are not enough. *(Full marks require: what each person experiences; that synaesthesia occurs in a healthy brain while spatial neglect results from brain damage; an example of each; and the point that spatial neglect shows perception needs the brain, not just the eyes.)*