

Perception

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1. Sensation, attention and perceptual processing
2. Perceptual organisation, constancy, depth, colour and influences on perception

1 Sensation, attention and perceptual processing

Sensation is the detection of a physical stimulus by the sense receptors and its passage to the brain; attention selects which of the many stimuli will be processed; perception is the process by which the brain organises and interprets sensations into meaningful experience, working both bottom-up (from the stimulus) and top-down (from knowledge and expectation). Perceptual organisation (Gestalt laws), perception of form, colour, depth and time, constancy, perceptual readiness, and the role of motivation and culture are in the next note of this unit.

Core facts

- **Sensation** = the raw detection of energy (light, sound, pressure, chemicals) by **receptors**; **perception** = **organising and interpreting** that input. Perception is how we **make sense of the world around us**.
- **Transduction** = changing physical energy into **nerve impulses** in the receptor.
- **Sense modalities**: vision (eye), hearing (ear), smell (nose), taste (tongue), touch / skin senses (skin), plus **kinaesthetic** (position and movement of body parts; receptors in muscles and joints) and **vestibular** (balance; semicircular canals of the inner ear).
- **Rods** (about 120 million): dim light, black-and-white, side vision. **Cones** (about 6–7 million, packed in the **fovea**): bright light, **colour** and fine detail. Normal eyes have **three types of cones**, which give **colour vision**.
- **Psychophysics** = the study of the relation between physical stimuli and the sensations they produce. **Gustav Fechner** founded it (*Elements of Psychophysics*, **1860**).
- **Absolute threshold** = the smallest intensity of a stimulus detected **50% of the time**.
- **Difference threshold** or **just noticeable difference (JND)** = the smallest change in a stimulus detected 50% of the time.
- **Weber's law** (Ernst **Weber**, 1834): the JND is a **constant fraction** of the original stimulus ($\Delta I / I = k$). Example: for lifted weights the fraction is about 1/50 (2%): 1 g is noticed on 50 g, 2 g on 100 g.
- **Fechner's law**: sensation grows with the **logarithm** of stimulus intensity ($S = k \log I$). **Stevens' power law**: $S = k I^n$.
- **Signal detection theory** (Green and Swets, 1966): detection depends on both **sensitivity** and the person's **response bias** (criterion); outcomes are **hit, miss, false alarm, correct rejection**.
- **Sensory adaptation** = reduced sensitivity to an **unchanging** stimulus (you stop smelling your own room, stop feeling your watch). **Dark adaptation** takes about **30 minutes** to be complete; **light adaptation** is quicker.
- **Attention** = focusing awareness on some stimuli while ignoring others. NCERT names three properties: **alertness, concentration, search**.
- **Types (NCERT)**: **selective** (choose one input), **sustained** (vigilance over a long time) and **divided** (two tasks at once). **Span of attention** = the number of objects grasped in one brief glance (about 5–7).
- **Classic textbook types**: **voluntary** (by effort and will), **involuntary / non-voluntary** (captured by a strong stimulus), **habitual** (from long interest or habit).

- **Sub-processes of perception:** stimulus → sensory receptors → transmission to the CNS (brain) → perception (interpretation).
- **Processing approaches:** **bottom-up** (data-driven, from features to the whole) and **top-down** (concept-driven, from knowledge and expectation to the parts).
- **James J. Gibson:** theory of **direct (ecological) perception**; information in the environment (the **optic array**) is rich enough for perception without inference; key terms **affordances**, **texture gradients**, **optic flow**.
- **Constructivist (indirect) theory:** **Hermann von Helmholtz** (**unconscious inference**, 1860s) and **Richard Gregory** (perception as a **hypothesis**; *Eye and Brain*, 1966; *Perceptions as Hypotheses*, 1980): the brain builds perception from incomplete data plus knowledge; illusions show the hypothesis going wrong.

Explained

1. Sensation vs perception

Point	Sensation	Perception
What	detecting the stimulus	organising and interpreting it
Where	sense organs, sensory nerves	brain (cortex)
Meaning	none, raw data	meaningful object or event
Depends on	stimulus and receptor	stimulus plus past experience, motives, set, culture

The same sensation can give two perceptions (an ambiguous figure seen as a vase or two faces), and different sensations can give the same perception (a door seen as rectangular from any angle).

2. Thresholds and the methods of psychophysics

- **Method of limits:** the stimulus is raised (or lowered) in small steps until the person just reports it (or stops reporting it).
- **Method of constant stimuli:** fixed intensities are given in random order many times; the threshold is the one detected 50% of the time. Most accurate, most time-consuming.
- **Method of adjustment (average error):** the person adjusts the stimulus until it just appears or matches a standard.
- **Subliminal** stimuli are below the absolute threshold; they can have small, short-lived effects (priming), but claims that hidden advertising changes buying are not supported.
- Textbook examples of absolute thresholds (Galanter, 1962): a candle flame seen about 48 km away on a dark, clear night; a watch tick heard about 6 m away in a quiet room; one teaspoon of sugar tasted in about 7.5 litres of water.

3. Signal detection theory

	Says "yes, signal"	Says "no signal"
Signal present	hit	miss

	Says "yes, signal"	Says "no signal"
Signal absent	false alarm	correct rejection

A radar operator, a security screener or a doctor reading an X-ray may miss signals because of **fatigue** (lower sensitivity) or may say "yes" too often because missing is costly (a liberal criterion). The theory replaced the idea of one fixed threshold.

4. Adaptation vs habituation. **Adaptation** happens in the **receptors** (they fire less to a constant stimulus). **Habituation** happens in the **brain** (we stop responding to a familiar, harmless stimulus such as the sound of a fan, though the ears still detect it). A change in the stimulus brings the response back (**dishabituation**).

5. Determinants (factors) of attention

External (stimulus) factors	Internal (person) factors
intensity and size (loud, bright, big)	motives and needs (a hungry person notices food)
contrast and change	interests and attitudes
movement	expectation, mental set
novelty	emotional state
repetition	habit, past training
position (top-left of a page)	physical state (fatigue, drugs)

Advertising, road signs and warning lights use the external factors; the internal factors explain why two people in the same room notice different things.

6. Theories of selective attention

- **Colin Cherry (1953):** the **cocktail party effect**: we can follow one conversation in a noisy room; in his tests listeners took in almost nothing of the unattended message except physical features (a voice, a change from male to female). Neville **Moray** (1959) then showed that one's **own name** in the unattended message is often noticed. Studied by **dichotic listening** (a different message in each ear) and **shadowing** (repeating one message aloud).
- **Filter theory** (Donald **Broadbent**, 1958): an **early** filter selects one channel by physical features (ear, voice); the rest is blocked.
- **Attenuation theory** (Anne **Treisman**, 1960, 1964): the unattended message is only **weakened**, not blocked, so important words (one's name) can still get through.
- **Late selection** (J.A. **Deutsch** and D. **Deutsch**, 1963): all messages are analysed for meaning; selection happens **late**, near response.
- **Multimode theory** (Johnston and Heinz, 1978): selection can be early or late as needed; later selection costs more mental effort.
- **Capacity (resource) model** (Daniel **Kahneman**, 1973): attention is a limited pool of mental effort shared between tasks; this explains divided attention.
- **Feature integration theory** (Anne Treisman and Garry Gelade, 1980): simple features (colour, shape) are picked up **pre-attentively**, but **focused attention** is needed to bind them into one object.

7. Sustained and divided attention. Vigilance tasks (radar watching, long-distance driving, quality inspection) show a **vigilance decrement**: detection falls after about 20–30 minutes (Norman **Mackworth's** clock test with radar operators, 1948). Divided attention is easier when tasks are **practised and automatic** and use **different senses**; talking on a phone while driving still slows braking. Inattentional blindness: people focused on one task can fail to see an unexpected object in plain view (Simons and Chabris, 1999).

8. The perceptual process and processing approaches

- Many textbooks describe perception as **selection** → **organisation** → **interpretation**: attention selects, the brain groups the input into patterns, and meaning is given using memory and context.
- **Bottom-up**: starts from the stimulus; feature detectors in the visual cortex (David **Hubel** and Torsten **Wiesel**) respond to edges, lines and angles that are combined into objects.
- **Top-down**: starts from what we know and expect; we read a smudged word from its sentence, and the same shape is read as "B" among letters and "13" among numbers.
- **Perceptual set** = a readiness to perceive in a certain way, created by expectation, context, motives and emotion. (Perceptual readiness is treated in detail in the next note.)
- Both approaches work together in normal perception.

9. Theories of perception

Theory	Key person	Direction	Main idea
Direct / ecological	J.J. Gibson	bottom-up	the environment gives all the information needed; affordances
Constructivist / indirect	Helmholtz, Gregory, Bruner	top-down	perception is built and tested like a hypothesis
Gestalt	Wertheimer, Köhler, Koffka	organisation	the whole is different from the sum of its parts
Perceptual cycle	Ulric Neisser	both	schemas direct exploration; new data change schemas

- **Gibson's terms: optic array** (the pattern of light reaching the eye); **invariants** (features that stay constant as we move); **texture gradient** (texture looks denser with distance); **optic flow** (the scene streams outward from the point we move towards, used by pilots in landing); **affordances** (what an object offers for action: a chair affords sitting).
- **Constructivist evidence**: visual illusions (Müller-Lyer), ambiguous figures and the effect of expectation and culture. Jerome **Bruner's** "New Look" studies (1940s) showed that values and needs change perception (poorer children judged coins as larger).

Common traps

✗ "Sensation and perception are the same." ✓ **Sensation** detects; **perception** organises and interprets.

✗ "Absolute threshold = the stimulus detected every time." ✓ Detected **50% of the time**.

✗ "Fechner's law says the JND is a constant fraction." ✓ That is **Weber's law**; Fechner's law is **logarithmic** ($S = k \log I$).

✗ "Perception theory (direct perception) was given by Watson or Köhler." ✓ **J.J. Gibson** gave the direct (ecological) theory; Köhler is a Gestalt psychologist.

✗ "Gibson's theory is top-down." ✓ Gibson is **bottom-up**; Gregory and Helmholtz are **top-down / constructivist**.

✗ "Broadbent's filter weakens unattended messages." ✓ Broadbent's filter **blocks** them; **Treisman** said they are **attenuated** (weakened).

✗ "Rods give colour vision." ✓ **Cones** (three types) give colour; rods work in dim light.

✗ "Sustained attention means doing two tasks at once." ✓ That is **divided** attention; sustained = **vigilance** over time.

✗ "Sub-processes of perception: sensation → experience → stimulus." ✓ **Stimulus** → **sensory receptors** → **CNS** → **perception**.

✗ "Sensory adaptation happens in the brain." ✓ Adaptation is in the **receptors**; ignoring a familiar sound is **habituation**.

Quick revision

- Sensation = detect; perception = organise + interpret (make sense of the world).
- Fechner: father of psychophysics, 1860; Fechner's law $S = k \log I$.
- Weber's law: $JND / I = \text{constant}$ (weights about 1/50).
- Absolute threshold and JND are both defined at 50% detection.
- Signal detection: hit, miss, false alarm, correct rejection; sensitivity + criterion.
- Attention: alertness, concentration, search; selective, sustained, divided.
- Broadbent filter (early), Treisman attenuation, Deutsch and Deutsch (late), Cherry cocktail party.
- Sub-processes: stimulus → receptors → CNS → perception.
- Bottom-up = data-driven; top-down = knowledge-driven.
- Gibson: direct, ecological, affordances; Gregory / Helmholtz: constructivist, hypothesis, unconscious inference.

2 Perceptual organisation, constancy, depth, colour and influences on perception

Perception turns raw sensations into organised, meaningful, stable experience: we group parts into wholes (Gestalt laws, figure-ground), judge distance from depth cues, see colour through three cone types and opponent channels, keep objects the same size, shape and colour as conditions change (constancy), are sometimes fooled (illusions), and see what our needs, expectations, learning and culture prepare us to see (perceptual set).

Core facts

- **Perceptual organisation:** the mind groups sensory elements into **wholes** (form) before we notice the parts. Studied first by the **Gestalt** school (Wertheimer, Köhler, Koffka); the laws were set out by **Max Wertheimer (1923)**. Gestalt background (meaning of the word, founders, insight) is in EDU-LR-04.
- **Gestalt laws of grouping: proximity, similarity, closure, continuity** (good continuation), **common fate** (things moving together are grouped), **symmetry**, and the master law **Prägnanz** (simplicity, "good figure"). Classroom examples are in EDU-LR-04.
- **Figure-ground:** we see a **figure** (shaped, in front, "thing-like") standing out from a formless **ground** (background). Danish psychologist **Edgar Rubin (1915)** studied it; his **vase-faces** drawing is a **reversible figure**. Another reversible figure: the **Necker cube (1832)**.
- **Depth perception** = seeing the world in **three dimensions** and judging distance, though the retinal image is **two-dimensional**.
- **Binocular cues (need both eyes): retinal disparity** (each eye gets a slightly different image; the brain fuses them = **stereopsis**) and **convergence** (eyes turn inwards for near objects).
- **Monocular cues (one eye is enough):**
 - **Pictorial:** relative size, **interposition** (overlap), **linear perspective** (parallel lines meet in the distance), **texture gradient**, **aerial (atmospheric) perspective** (far things hazy and bluish), **height in the plane** (relative height), **light and shadow**;
 - **Movement: motion parallax** (near objects seem to rush past, far ones move slowly);
 - **Physiological: accommodation** (the lens changes shape to focus).
- **Visual cliff: Eleanor Gibson and Richard Walk (1960);** most infants of about 6–14 months **refused to crawl** over the "deep" side, so depth perception is present early.
- **Retina: rods** (about 120 million; dim light, black-white, night vision) and **cones** (about 6 million; bright light, **colour** and fine detail; packed in the **fovea**).
- **Colour vision:** normal-sighted people have **three types of cones: S** (short wavelength, "blue"), **M** (medium, "green"), **L** (long, "red"). Visible light is about **400–700 nm**.
- **Three dimensions of colour: hue** (set by wavelength), **saturation** (purity), **brightness** (intensity).
- **Colour theories:**

- **Trichromatic (Young-Helmholtz):** Thomas **Young** (1802), Hermann von **Helmholtz** (1850s); three receptor types, every colour = a mix of their outputs;
- **Opponent-process:** Ewald **Hering** (1870s); three opposing pairs: **red–green, blue–yellow, black–white**; explains **negative afterimages**;
- **Dual-process (zone) theory:** Hurvich and Jameson (1957); trichromatic at the **cones**, opponent-process **beyond** them (ganglion cells, thalamus).
- **Colour blindness:** mostly **red–green**, inherited on the **X chromosome**, so far commoner in **men** (roughly 8%) than women (under 1%); tested with **Ishihara plates** (1917). One cone type missing = **dichromat**; none working = **monochromat**.
- **Time perception:** no sense organ for time; it is judged from mental events and an internal "clock". **Vierordt's law (1868):** short intervals are **overestimated**, long ones **underestimated**.
- **Perceptual constancy:** perceiving objects as **stable** (same size, shape, brightness, colour) though the retinal image changes. Types: **size, shape, brightness (lightness), colour**, and **location (position)** constancy.
- **Illusion:** a **wrong perception** of a real stimulus, shared by most people (unlike a **hallucination**, which has no stimulus). Well-known: **Müller-Lyer** (1889), **Ponzo** (1911), **Ames room** (1946), **moon illusion, phi phenomenon** (Wertheimer, 1912, apparent motion), **autokinetic effect**.
- **Perceptual set:** a **readiness** to perceive in a particular way, created by **expectation, motivation, emotion, past experience, values and culture**.
- **Who said what: J.J. Gibson: direct (ecological) perception**, texture gradients, **affordances** (asked as "Perception theory" in 2023). **Richard Gregory:** perception as **hypothesis** (top-down, constructive).

Explained

1. Form perception.

- Form needs a **contour** (a sharp change in brightness or colour) to separate figure from ground. **Camouflage** works by breaking up contours so the figure merges with the ground.
- **Figure vs ground:** the figure looks **nearer**, has a **shape** and is **remembered**; the ground looks **behind, shapeless** and continues behind the figure. In a reversible figure the two swap, but you cannot see both at once.
- **Grouping laws decide which parts form one figure:** dots close together (**proximity**) or alike (**similarity**) form rows; a broken circle is seen whole (**closure**); crossing curves are seen as two smooth lines (**continuity**); birds flying together are one flock (**common fate**).
- **Subjective (illusory) contours:** in the **Kanizsa triangle** (1955) we "see" a white triangle that has no drawn edges: closure at work.
- **Brain basis: Hubel and Wiesel** (Nobel Prize 1981) found **feature detector** cells in the visual cortex of cats that fire to lines of a particular **orientation**, edges and movement: the building blocks of form.

2. Depth cues at a glance.

Cue	Type	How it works
Retinal disparity	Binocular	Bigger difference between the two images = nearer
Convergence	Binocular	Strain of eye muscles turning inwards; near objects only
Accommodation	Monocular, physiological	Lens bulges for near objects; works within a couple of metres
Motion parallax	Monocular, movement	Near things seem to move fast and opposite; far ones slow
Relative size	Monocular, pictorial	Of two like objects, the smaller image looks farther
Interposition	Monocular, pictorial	The object that covers another is nearer
Linear perspective	Monocular, pictorial	Parallel lines (railway tracks) meet in the distance
Texture gradient	Monocular, pictorial	Texture grows finer and denser with distance
Aerial perspective	Monocular, pictorial	Distant hills look hazy and bluish
Height in plane	Monocular, pictorial	Below the horizon, higher in the field = farther
Light and shadow	Monocular, pictorial	Shading shows bumps and hollows

Painters use only the **pictorial** cues; that is why they are also called **artistic** or **secondary** cues. A **stereoscope** (Wheatstone, 1838) and 3-D films create depth by giving each eye a different picture (disparity).

3. Colour vision explained.

- **Trichromatic theory** explains **colour mixing** and most **colour blindness** (a missing cone type).
- It cannot explain why we never see a "reddish green" or a "bluish yellow", or why staring at a **green** square leaves a **red** afterimage (yellow leaves blue). **Opponent-process theory** explains these: tiring one member of a pair lets the other dominate.
- **Both are right at different levels:** three cone types in the eye, opponent channels in the cells beyond them (**dual-process / zone theory**).

Type of colour defect	What is missing	Result
Protanopia	L ("red") cones	Red-green confusion, reds look dark
Deutanopia	M ("green") cones	Red-green confusion; green (deutan) defects are the commonest, mostly in milder form
Tritanopia	S ("blue") cones	Blue-yellow confusion; rare
Monochromacy	All but one or no cones	Sees only shades of grey

4. Time perception.

- Felt time depends on **what fills it** and on **attention to time**: a boring wait (attention on the clock) feels long; an absorbing task makes "time fly".

- **Looking back**, the rule reverses: an eventful holiday seems long in memory, an empty week short (more memories = longer remembered duration).
- **Arousal and body temperature** speed the inner clock, so time seems to drag (fever, fear). Drugs such as stimulants have a similar effect; depressants the opposite.
- William James called the brief stretch we experience as "now" the **specious present**.

5. Perceptual constancies.

Constancy	The retinal image changes...	...but we perceive
Size	A friend walking away casts a smaller image	Same-sized friend
Shape	An opening door projects a trapezium	A rectangular door
Brightness	White paper in shade reflects less light than coal in sunlight	Paper still white, coal still black
Colour	A red apple under yellow or blue light	Still red

- **Size constancy depends on distance cues.** Take the cues away (looking through a tube, or across a featureless plain) and size is judged from the retinal image alone, so constancy breaks down.
- **Brightness constancy** depends on the **ratio** of light from the object and its surroundings, not on the absolute amount.
- **Location (position) constancy:** the world seems still when we move our head or eyes, though the image sweeps across the retina.

6. Illusions.

Illusion	What is seen	Usual explanation
Müller-Lyer	Line with outward fins looks longer than an equal line with inward arrowheads	Fins read as the inner and outer corners of a room or building (depth cues), so constancy scaling misfires (Gregory)
Ponzo (railway)	Of two equal bars between converging lines, the upper one looks longer	Converging lines suggest distance; the "farther" bar is scaled up
Ames room	A person in one corner looks a giant, in the other a dwarf	The room is trapezoid but looks rectangular through a peephole; size constancy is fooled
Moon illusion	The moon looks larger near the horizon	The horizon moon seems farther (terrain cues), so it is perceived larger

- **Motion illusions: phi phenomenon** (two lights flashed one after the other look like one light moving; the basis of neon signs and films; Wertheimer 1912 started Gestalt psychology with it); **autokinetic effect** (a still point of light in a dark room seems to move; Sherif used it to study group norms); **induced motion** (the moon seems to race behind moving clouds).
- **Illusion vs hallucination vs delusion:** illusion = misperceiving a real stimulus; hallucination = perceiving without any stimulus; delusion = a fixed false **belief**.

7. Influences on perception (perceptual set).

Influence	Classic study	Finding
Expectation (context)	Bruner and Minturn (1955)	An ambiguous figure was read as "B" among letters and as "13" among numbers
Prior exposure	Bugelski and Alampay (1961)	After animal pictures, the ambiguous "rat-man" was seen as a rat
Need (motivation)	McClelland and Atkinson (1948)	Hungry sailors "saw" more food objects in dim, blank slides
Value	Bruner and Goodman (1947)	Poor children overestimated coin sizes more than rich children
Emotion	McGinnies (1949)	Taboo words needed longer exposure to be recognised (perceptual defence)

- **Selective perception:** among many stimuli we notice those linked to our needs and interests (the hungry person notices restaurants).
- **Learning:** perception is partly learnt. Adults who gained sight after cataract operations (Senden's cases, 1932) could see colour and figure-ground at once but needed weeks to recognise shapes by sight. Kittens moved passively in Held and Hein's **kitten carousel** (1963) did not develop normal visually guided behaviour; active movement was needed. People wearing **inverting goggles** (Stratton, 1890s) slowly adapted.
- **Culture:** Segall, Campbell and Herskovits (1966) found people from **"carpentered" worlds** (rectangular rooms, straight edges) more prone to the **Müller-Lyer** illusion than people living in round huts and open country. **Turnbull's (1961)** forest-dwelling BaMbuti guide, Kenge, seeing distant buffalo across open plains for the first time, took them for insects: size constancy at long distance needs experience. Hudson (1960) found that some African groups without exposure to pictures did not read pictorial depth cues.
- **Personality and attitudes:** a prejudiced person notices behaviour that fits the stereotype (link: person perception in the social-behaviour notes).

Common traps

✗ "The visual cliff is J.J. Gibson's." ✓ **Eleanor J. Gibson** (with **Richard Walk**, 1960); **J.J. Gibson** is the direct (ecological) perception theorist.

✗ "Trichromatic theory explains afterimages." ✓ **Opponent-process (Hering)** explains afterimages; trichromatic explains colour mixing.

✗ "Three cone types are called depth vision (or space vision)." ✓ They give **colour vision**.

✗ "Rods see colour." ✓ **Cones** see colour and detail; **rods** work in dim light, in black and white.

✗ "Convergence and accommodation are both binocular cues." ✓ **Convergence** is binocular; **accommodation** works with **one** eye.

✗ "Motion parallax is a binocular cue." ✓ It is **monocular** (a movement cue).

✗ "Perceptual constancy means the retinal image stays the same." ✓ The image **changes**; the **perceived** size, shape or colour stays stable.

✗ "An illusion is perceiving something that is not there." ✓ That is a **hallucination**; an illusion misperceives a **real** stimulus.

✗ "In Müller-Lyer, the line with arrowheads pointing in looks longer." ✓ The line with **fins pointing outwards** looks longer.

✗ "Phi phenomenon is real movement." ✓ It is **apparent** movement (Wertheimer, 1912).

Quick revision

- Gestalt laws (Wertheimer 1923): proximity, similarity, closure, continuity, common fate, Prägnanz; figure-ground (Rubin's vase).
- Binocular cues: retinal disparity, convergence. Monocular: pictorial cues, motion parallax, accommodation.
- Visual cliff: Eleanor Gibson and Walk, 1960. Direct perception, affordances: J.J. Gibson.
- Rods = dim light; cones = colour (S, M, L); fovea is all cones.
- Young-Helmholtz = three receptors; Hering = opponent pairs, afterimages; zone theory joins them.
- Red-green colour blindness, X-linked, commoner in men; Ishihara plates.
- Constancies: size, shape, brightness, colour, location; size constancy needs distance cues.
- Illusions: Müller-Lyer, Ponzo, Ames room, moon; phi = apparent motion; autokinetic = still light seems to move.
- Perceptual set: expectation (B/13), need (hungry sailors), value (coin sizes), emotion (perceptual defence).
- Culture: carpentered world → more Müller-Lyer; Kenge's "insect" buffalo; Vierordt: short times overestimated.