

1.6 Sensation

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

KEY WORDS retina 视网膜 • cones 视锥细胞 • rods 视杆细胞 • absolute threshold 绝对阈限
• difference threshold 差别阈限

Objective

Build the skills to answer exam questions on **sensation** 感觉 and **transduction** 转导.

You must be able to:

- define **transduction** and give an example in one sense
- distinguish **absolute threshold** 绝对阈限 from **difference threshold** 差别阈限
- state what **sensory adaptation** 感觉适应 is and why it is useful
- describe how the eye and ear convert energy into neural signals

1 Worked examples

Study these first. Each one shows the method for a task used later.

■ Transduction

Sense organs convert physical energy into neural signals. Light becomes a signal in the **retina**; sound becomes one in the **cochlea**; pressure becomes one in receptors in the skin.

■ Two thresholds

Absolute threshold is the smallest stimulus detectable 50% of the time. **Difference threshold** (just-noticeable difference) is the smallest change detectable 50% of the time, and it grows in proportion to the starting intensity.

■ Sensory adaptation

Constant, unchanging stimulation produces a declining response — you stop noticing a smell or the weight of clothing. This frees attention for **change**, which is what usually matters.

■ Eye and ear

In the eye, light passes the lens and strikes **rods** (dim light, no colour) and **cones** (colour, detail) in the retina. In the ear, sound vibrates the eardrum, is amplified by three small bones, and moves fluid in the cochlea, bending hair cells.

■ From physical energy to a neural signal

Transduction 转导 is the conversion of physical energy from a stimulus into a **neural signal** the brain can use. Every sense does it, and the exam expects one example named precisely:

Sense	Energy	Receptor	Where
vision	light	rods and cones	retina
hearing	sound waves	hair cells	cochlea, in the inner ear
touch	pressure	mechanoreceptors	skin
taste	chemicals	taste receptors	taste buds
smell	chemicals	olfactory receptors	olfactory epithelium

The eye, in order: light passes the cornea, pupil and lens, which focus it on the **retina**; **rods** (very sensitive, no colour, peripheral, good in dim light) and **cones** (colour, fine detail, concentrated at the fovea, need bright light) transduce it; the signal passes to bipolar and then ganglion cells, whose axons form the **optic nerve** and leave at the **blind spot**, which has no receptors.

The ear, in order: sound waves vibrate the eardrum; the three ossicles amplify the vibration and pass it to the oval window; the fluid in the **cochlea** moves; **hair cells** bend and transduce the movement; the signal travels along the auditory nerve.

Three thresholds, distinguished:

- **Absolute threshold** 绝对阈限 — the minimum stimulation needed to detect a stimulus **50% of the time**. The “50%” is the mark.
- **Difference threshold** (just noticeable difference) 差别阈限 — the minimum difference needed to tell two stimuli apart 50% of the time. **Weber’s law** says it is a constant **proportion** of the original, not a fixed amount: adding one candle to ten is noticeable, adding one to a hundred is not.
- **Sensory adaptation** 感觉适应 — reduced sensitivity to a constant, unchanging stimulus. It is useful because it frees attention for **change**, which is what carries information: you stop noticing your clothes, but you notice at once when someone touches your arm.

Worked example. A person walks into a bakery and the smell is overwhelming, but after ten minutes they barely notice it. Name the process and explain why it is adaptive.

1. **Sensory adaptation** — sensitivity to a constant stimulus decreases.
2. It is adaptive because an unchanging stimulus carries no new information; ignoring it frees attention for changes in the environment, which are far more likely to matter.

2 Practice

2.1 Define transduction and give one example. [2]

2.2 State the difference between an absolute threshold and a difference threshold. [2]

2.3 A person stops noticing the hum of a fan after a few minutes.

(a) Name the process responsible. [1]

(b) State one advantage of this process. [1]

2.4 Describe how the ear converts sound waves into a neural signal. [2]

2.5 Distinguish absolute threshold from difference threshold. [2]

2.6 State Weber's law and give an everyday illustration. [2]

3 Exam-style questions

3.1 Rods differ from cones mainly in that rods [1]

- **A** detect colour and fine detail
- **B** work better in dim light without colour
- **C** are located in the cochlea
- **D** transmit sound

3.2 Adding one candle to a room with two candles is noticeable; adding one to a room with fifty is not. This illustrates [1]

- **A** absolute threshold
- **B** a difference threshold that grows with intensity
- **C** sensory adaptation
- **D** transduction

3.3 A hearing test finds the quietest tone a person can detect half the time.

(a) Name the measure being taken. [1]

(b) State one reason results vary between people. [1]

3.4 A student is tested in a laboratory on their senses.

(a) Define transduction, and describe where and how it happens in the eye. [4]

(b) Compare rods and cones in two ways. [2]

(c) The student is asked to say when they can just detect a faint tone. Name the threshold being measured and state the criterion used to define it. [2]

(d) The student can tell 100 g from 105 g but cannot tell 1000 g from 1005 g. Name the principle this illustrates and explain it. [3]

(e) After several minutes in the laboratory the student stops noticing its constant hum. Name this process and explain why it is useful. [3]

Solutions

2.1 the conversion of physical energy into neural signals; e.g. light converted to a signal in the retina, or sound in the cochlea.

2.2 absolute threshold: the smallest stimulus detected 50% of the time; difference threshold: the smallest detectable change in a stimulus, which grows with starting intensity.

2.3 (a) sensory adaptation. (b) it frees attention for changes in the environment, which are usually more informative.

2.4 Sound waves vibrate the eardrum, and the three ossicles amplify the vibration and pass it to the fluid in the cochlea; the moving fluid bends the hair cells, which transduce the movement into a neural signal that travels along the auditory nerve.

2.5 Absolute threshold is the minimum stimulation needed to detect a stimulus 50% of the time; difference threshold is the minimum difference needed to tell two stimuli apart 50% of the time.

2.6 The difference threshold is a constant proportion of the original stimulus, not a fixed amount; adding one candle to ten is noticeable, but adding one to a hundred is not.

3.1 B. rods support vision in dim light but do not code colour.

3.2 B. the just-noticeable difference is proportional to the original intensity.

3.3 (a) the absolute threshold for that tone. (b) any one of: age-related hearing loss; prior noise exposure; attention or motivation during the test.

3.4 (a) Transduction is the conversion of physical energy into a neural signal; in the eye it happens at the retina, where rods and cones convert light energy into an electrical signal; that signal passes through bipolar and ganglion cells to the optic nerve.

(b) Any two: rods are more sensitive and work in dim light while cones need bright light; rods give no colour while cones detect colour and fine detail; rods are peripheral while cones concentrate at the fovea.

(c) Absolute threshold; it is the minimum stimulation detected 50% of the time.

(d) Weber's law; the difference threshold is a constant proportion of the original stimulus rather than a fixed amount; 5 g is 5% of 100 g and detectable, but only 0.5% of 1000 g, which falls below the proportion needed.

(e) Sensory adaptation; sensitivity to a constant, unchanging stimulus decreases; this is useful because an unchanging stimulus carries no new information, so ignoring it frees attention for changes, which are more likely to matter.