Sensation, perception and psychophysics

Supported GRE teaching and original transfer practice

Sensation, perception and psychophysics

- Define the absolute threshold and the **difference threshold 差别阈限**, and use Weber's law.
- Separate sensitivity from response bias with **signal detection theory 信号检测论**.
- Describe **transduction 换能** and **sensory adaptation 感觉适应**.
- Use Gestalt grouping and top-down processing.

Thresholds

- The absolute threshold is the weakest stimulus detected on a stated share of trials, usually 50%. It is not a sharp line between "always seen" and "never seen".
- The **difference threshold**, or just noticeable difference (JND), is the smallest change detected on 50% of trials.
- Weber's law: the JND is a constant fraction of the starting level, $\Delta I / I = k$. With $k = 0.02$, 100 g needs a 2 g change and 500 g needs 10 g.
- Fechner's law: felt intensity grows with the logarithm of physical intensity. Stevens's power law, $S = kI^n$, fits more senses: brightness grows slowly $(n < 1)$, electric shock fast $(n > 1)$.

Signal detection theory

- On each trial a signal is present or absent, and the observer says yes or no. The four outcomes are hits, misses, false alarms and correct rejections.
- Sensitivity, d', is how far apart the signal and noise distributions are: $d' = z(\text{hit rate}) - z(\text{false-alarm rate})$.
- The criterion is how willing the observer is to say yes. Rewards for hits move it; they do not change d'.
- A higher hit rate alone does not show better sensitivity, if false alarms rose too.

From energy to experience

- **Transduction**: receptors convert physical energy into neural signals. Rods and cones respond to light; hair cells in the cochlea respond to sound vibrations.
- **Sensory adaptation**: the response to a constant stimulus weakens, as with the feeling of a watch on your wrist.
- Dark adaptation: in dim light, sensitivity recovers over about 30 minutes, first through the cones and then, more slowly, the rods.

Organising perception

- Gestalt grouping: we group by proximity, similarity, closure and good continuation. The whole is seen before the parts.
- Bottom-up processing builds a percept from features; top-down processing uses context and expectation. The same smudge reads as "H" in "THE" and "A" in "CAT".
- Perceptual constancy: we see a door as rectangular and a friend as the same size, though the image on the eye changes.

Worked example: Weber's law

- From 100 g, the JND is $0.03 \times 100 = 3$ g.
- From 300 g, it is $0.03 \times 300 = 9$ g.
- A constant 3 g change at both levels would ignore the law: equal ratios, not equal amounts, are noticed equally.

Worked example: a radiologist

- Before: $d' = z(0.84) - z(0.16) = 0.99 - (-0.99) = 2.0$.
- After: $d' = z(0.93) - z(0.31) = 1.48 - (-0.50) = 2.0$.
- Sensitivity is unchanged. The criterion moved: the radiologist now says yes more readily.

Figure: Worked example: a radiologist

Signal detection: four outcomes separate sensitivity from bias

	Signal present	Signal absent
Respond yes	Hit	False alarm
Respond no	Miss	Correct rejection

- Four outcomes let sensitivity be measured separately from the bias towards saying yes
- Match each part of the diagram to the text.

Common errors

- Treating the JND as a fixed amount rather than a fraction.
- Reading a higher hit rate as better sensitivity.
- Confusing **sensory adaptation** (receptors) with habituation (learning).

Common errors (2)

- Treating thresholds as sharp boundaries.
- Thinking perception copies the input without interpretation.

Key terms

- **difference threshold**: The smallest change in a stimulus that is detected on half of the trials.
- **signal detection theory**: A model that separates an observer's sensitivity from their willingness to report a signal.
- **transduction**: The conversion of physical energy into neural signals by receptors.
- **sensory adaptation**: A weakening response of the senses to an unchanging stimulus.

Check yourself

- The JND for a 200 g weight is 4 g. What is it for 600 g?
- An observer's hits and false alarms both rise. What has probably changed?
- Which receptors respond to sound vibrations?