

Biological Bases of Behavior

AP Psychology ■ Unit 1

AP Psychology



What we will cover

- 1 Nature and Nurture
- 2 The Nervous System
- 3 Neurons and How They Fire
- 4 Neurotransmitters, Hormones, and Drugs
- 5 The Brain
- 6 Consciousness and Sleep

1

Nature and Nurture

Explain the interaction, rather than choosing one cause

Psychology studies **behavior** 行为 and **mental processes** 心理过程. **Nature and nurture** 先天与后天 asks how inherited characteristics and experience shape them together.

An illustrative music-learning case

Assume a student inherits a predisposition that helps distinguish musical sounds. Lessons, regular practice and access to an instrument help develop this ability. After a school provides instruments, the student's performance improves.

What is inherited? What is environmental? Why does the improvement not show that inheritance is irrelevant?

Link each source to the behaviour in the case

Heredity 遗传 is the inherited predisposition stated in the example. **Environment** 环境 includes teaching, practice and instrument access. The opportunity helps the student develop the predisposition.

The change after access improves is consistent with an environmental contribution. It does not show that every difference between students is environmental, or that inherited characteristics fix the final performance.

Use evidence from the scenario for both sources, then explain how they work together. Do not infer an inherited ability merely because someone performs well.

What can twin and adoption comparisons establish?

Evaluate the conclusion

In an illustrative study, identical twins raised in different families show similar scores on a behavioural trait. A student concludes: "The trait is entirely inherited, and family experience cannot affect it."

Explain what the similarity supports and why the conclusion is too strong. How might comparisons with relatives raised together, or with adoptive family members, add evidence?

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Twin and adoption studies 双生子与收养研究 compare patterns of similarity across relatedness and upbringing. They do not cleanly assign a single person's behaviour to one cause.

Similarity supports a contribution, not genetic destiny

Similarity between identical twins raised apart is consistent with an inherited contribution. But their experiences need not be wholly different: they share prenatal conditions and may encounter similar environments. Placement into families is not a random experiment.

Comparing several kinds of relatives and adoptive families helps researchers examine patterns. It does not establish that environment has no effect or that a trait cannot change.

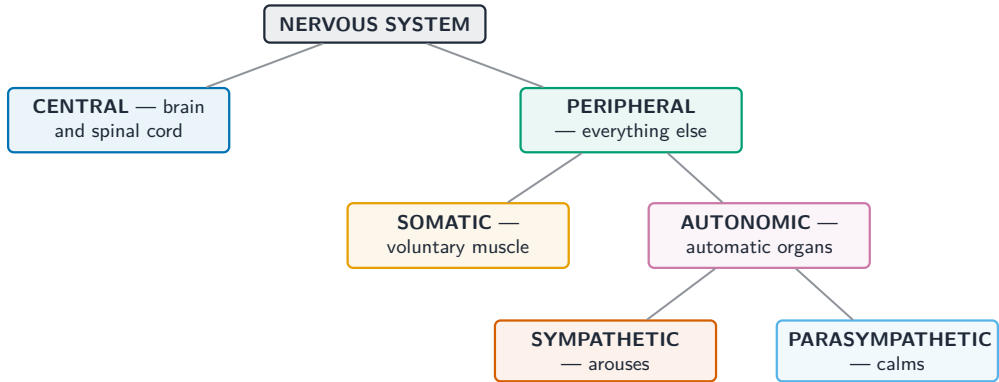
The **evolutionary perspective** 进化论视角 asks how inherited tendencies may relate to survival and reproductive success. A plausible story about an advantage is not, by itself, proof of a particular behaviour's origin.

Distinguish evidence consistent with a contribution from a claim that one cause completely determines the outcome.

2

The Nervous System

Locate the division before naming its function



The **central nervous system (CNS)** 中枢神经系统 is brain and spinal cord. The **peripheral nervous system (PNS)** 周围神经系统 links the CNS with the rest of the body. Somatic and autonomic are subdivisions of the PNS.

One event can recruit several nervous-system divisions

A presentation starts unexpectedly

A student chooses to raise a hand, notices a faster heartbeat, and later experiences a slowing heart rate during recovery. Identify the division most directly associated with each response and cite the clue that supports it.

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Do not classify the whole event as only voluntary or only automatic. Classify the particular response described.

Match the response to the pathway and the evidence

Raising the hand deliberately involves **voluntary** 随意的 skeletal movement: the **somatic nervous system** 躯体神经系统 carries motor commands to those muscles.

Heartbeat is an **involuntary** 不随意的 process governed by the **autonomic nervous system** 自主神经系统. Its **sympathetic nervous system** 交感神经系统 branch supports arousal; its **parasympathetic nervous system** 副交感神经系统 branch supports recovery and a slower heart rate.

These PNS pathways interact with the CNS. Naming a peripheral division does not mean the brain and spinal cord are uninvolved. Nor does a racing heart alone identify one particular emotion.

Response in the case → relevant function → named division. A label without the link is incomplete reasoning.

The divisions of the nervous system

Central nervous system

The **central nervous system (CNS)**: brain and spinal cord – where information is integrated and decisions are made.

Peripheral nervous system

The **peripheral nervous system (PNS)**: everything else, split into somatic (voluntary) and autonomic (automatic).

The three neuron types

Sensory neurons carry in, **motor neurons** carry out, and **interneurons** connect them inside the CNS.

The reflex arc

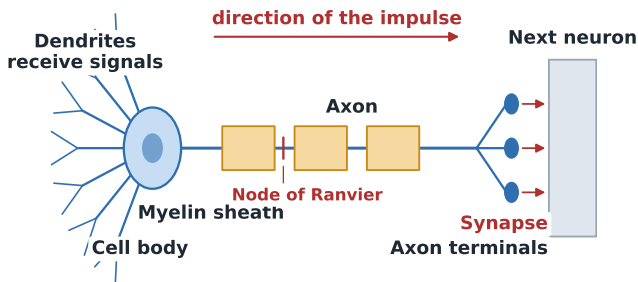
A **reflex arc** routes sensory to motor through the spinal cord, so a withdrawal can begin before conscious awareness; signals also travel toward the brain.

Name the division *and* the direction. Use sensory for input toward the CNS and motor for output toward muscles.

3

Neurons and How They Fire

Dendrites receive, the axon carries, the synapse passes it on



- At rest the neuron holds a **resting potential** 静息电位, ready but not firing.
- If incoming signals pass the **threshold** 閾限, the neuron **depolarizes** 去极化 and fires.
- Firing follows the **all-or-none principle** 全或无原则: the neuron fires at full strength or not at all.
- Straight after firing there is a **refractory period** 不应期

Neurons and How They Fire

Two kinds of cell do the work. **Neurons** 神经元 transmit information. **Glial cells** 神经胶质细胞 provide structure, insulation, communication, and waste transport. Together they are the building blocks of all behavior and mental processes.

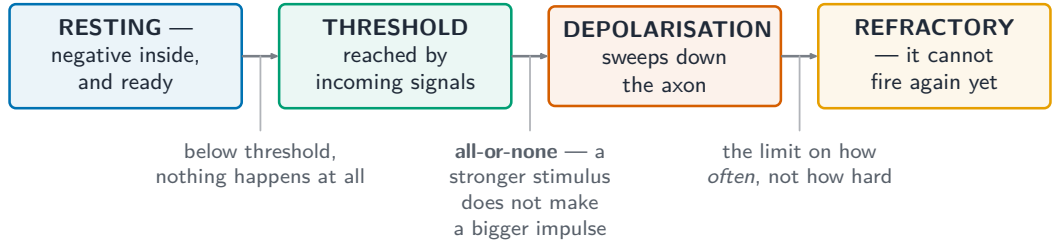
- At rest the neuron holds a **resting potential** 静息电位, ready but not firing.
- If incoming signals pass the **threshold** 阈限, the neuron **depolarizes** 去极化 and fires.
- Firing follows the **all-or-none principle** 全或无原则: the neuron fires at full strength or not at all. A stronger stimulus makes it fire more often, not harder.
- Straight after firing there is a **refractory period** 不应期 when the neuron cannot fire again.
- At the **synapse** 突触, the gap between neurons, chemicals cross to the next cell. Leftover chemicals are taken back in a process called **reuptake** 再摄取.

Neurons and How They Fire, continued

A neuron has **dendrites** 树突 that receive signals, a **cell body** 细胞体, and an **axon** 轴突 that carries the signal away. Many axons are wrapped in a **myelin sheath** 髓鞘, which speeds the signal up.

Damage to this process can cause disorders such as **multiple sclerosis** 多发性硬化 or **myasthenia gravis** 重症肌无力.

How a neuron fires



Intensity is coded by **how often** a neuron fires and how many fire – never by how strongly a single impulse travels

4

Neurotransmitters, Hormones, and Drugs

Identify what changes at the synapse

Three hypothetical substances, one excitatory signal

The transmitter normally activates a receiving receptor and makes firing more likely. X activates that same receptor. Y occupies the receptor without activating it and prevents the transmitter acting. Z prevents the released transmitter being taken back into the sending cell.

Classify X, Y and Z by mechanism. Explain why Z changes the transmitter's time in the **synapse** 突触, rather than directly copying it at the receiving receptor.

A mechanism is more precise than “it changes activity”

X acts as an **agonist** 激动剂: it activates the receiving receptor in this example and supports the transmitter's effect. With the stated excitatory signal, firing becomes more likely.

Y acts as an **antagonist** 拮抗剂: it blocks the transmitter's action at that receptor. With the stated excitatory signal, it reduces that contribution to firing.

Z is a **reuptake inhibitor** 再摄取抑制剂: it blocks reabsorption into the sending cell, allowing more transmitter to remain available in the gap. It does not need to mimic the transmitter at the receiving receptor.

State the affected step and explain its consequence using the signal described. Do not assume a mechanism's name predicts every effect in the brain.

Use the transmitter's effect when predicting firing

The previous case explicitly used an **excitatory** 兴奋性的 signal. An **inhibitory** 抑制性的 signal instead makes firing less likely. Supporting that signal can strengthen inhibition; blocking it can remove inhibition.

Thus “agonist” is not a universal synonym for stimulation of the whole nervous system. The receptor, transmitter and location matter. The introductory AP examples use encouraging or discouraging firing; retain the mechanism and the stated context when applying them.

Hormones 激素 travel through the blood and can influence the brain as well as other organs. A signal's route is different from its effect: blood-borne does not mean unable to affect behaviour.

The three taught drug mechanisms are examples of how neurotransmission changes, not a claim that all drugs act in only three possible ways.

Chemicals, drugs and pain

Endorphins

Endorphins are the body's own opioids: they dampen pain and are released by exercise, injury and stress.

Psychoactive drugs

Psychoactive drugs work by mimicking a transmitter (agonists) or blocking it (antagonists) – which is why their side effects follow the transmitter's other jobs.

Gate control theory

Gate control theory: the spinal cord has a “gate” that other input can close – rubbing a knock really does reduce the pain.

Phantom limb

Phantom limb sensation shows the same point from the other side: pain can be felt in an absent limb, showing that its felt location need not be a current injury site.

Pain depends on processing and modulation as well as incoming signals. These examples do not imply that all pain has the same cause.

Hormones, and the three ways a drug acts

hormones 激素

travel through the **blood** and influence the brain as well as other organs

agonists 激动剂

mimic or boost a neurotransmitter's effect

antagonists 拮抗剂

block the receptor so the transmitter cannot act

reuptake inhibitors 再摄取抑制剂

stop the transmitter being reabsorbed, so it stays in the **synapse** 突触 longer – how SSRIs work

Five hormones are examinable: **adrenaline** 肾上腺素, **leptin** 瘦素, **ghrelin** 胃饥饿素, **melatonin** 褪黑素, **oxytocin** 催产素. Apply each taught **psychoactive drug** 精神药物 mechanism to the step it affects, using evidence from the scenario.

The eight listed neurotransmitters

dopamine 多巴胺

reward and movement

serotonin 血清素

mood and sleep

norepinephrine 去甲肾上腺素

alertness and arousal

glutamate 谷氨酸

the main **excitatory** transmitter – learning and memory

GABA γ -氨基丁酸

the main **inhibitory** transmitter – calming

acetylcholine 乙酰胆碱

muscle movement and memory

endorphins 内啡肽

modulation and reduction of pain

substance P P 物质

pain signalling

These eight are listed in the course document. Use this reference to explain a scenario; effects depend on where and how the transmitter acts.

Neurotransmitters, Hormones, and Drugs, continued

Drug categories: **stimulants** 兴奋剂 (caffeine, cocaine) increase neural activity; **depressants** 抑制剂 (alcohol) decrease it; **hallucinogens** 致幻剂 (marijuana) distort perception; **opioids** 阿片类药物 (heroin) relieve pain.

Repeated use can lead to **tolerance** 耐受性, where more is needed for the same effect, and to **addiction** 成瘾, with **withdrawal** 戒断反应 symptoms when use stops.

5

The Brain

The Brain

The brain is studied from the bottom up, because the lower structures handle the most basic jobs.

- The **brain stem** 脑干, including the **medulla** 延髓, controls breathing and heart rate.
- The **reticular activating system** 网状激活系统 controls alertness and arousal.
- The **cerebellum** 小脑 controls coordination, balance, and some **procedural learning** 程序性学习.
- The **limbic system** 边缘系统 sits inside the cerebral cortex and includes the **thalamus** 丘脑 (a relay station for the senses), the **hypothalamus** 下丘脑 (hunger, thirst, temperature), the **pituitary gland** 脑垂体, the **hippocampus** 海马体 (forming new memories), and the **amygdala** 杏仁核 (fear and emotion).

The Brain, continued

The **cerebral cortex** 大脑皮层 is divided into two **hemispheres** 半球 and four lobes: the **occipital lobes** 枕叶 process vision at the rear; the **temporal lobes** 颞叶 process hearing and language at the sides; the **parietal lobes** 顶叶 hold the **somatosensory cortex** 体感皮层 for touch; and the **frontal lobes** 额叶 handle higher-order thinking and **executive function** 执行功能.

Language sits mainly in the left hemisphere: **Broca's area** 布罗卡区 for speech production and **Wernicke's area** 韦尼克区 for comprehension.

Choose a brain method for the question

Two research aims, different measurements

A researcher wants to identify rapid electrical patterns that distinguish sleep stages. Another wants to compare where blood-oxygen signals change during a memory task and a comparison task. Which aim fits EEG, and which fits fMRI? What would each measurement leave uncertain?

Both methods can track changes over time. “Activity over time” alone does not distinguish them.

Distinguish the signal from the conclusion

EEG 脑电图 records electrical patterns using electrodes on the scalp. Its fine timing helps identify sleep-stage patterns; locating the precise source of activity is more limited.

fMRI 功能性磁共振成像 commonly tracks regional blood-oxygen changes associated with activity. It provides useful spatial detail, but this is an indirect, slower-changing signal, not a direct recording of each neuron's firing.

A regional change during a task does not, by itself, prove that region is necessary for the task or reveal a person's exact thoughts. A method's strength must match the research question.

Research aim → signal measured → useful inference → limitation.

Studying the brain, and what sleep does

Lesioning

Lesioning destroys tissue deliberately in animal studies; in humans, natural damage plays the same role – and **prosopagnosia**, the inability to recognise faces, is one such case.

REM and NREM

NREM sleep deepens through three stages; **REM sleep** brings vivid dreams with the body paralysed – and **REM sleep behavior disorder** is that paralysis failing.

Why we sleep

Restoration repairs the body, and **memory consolidation** moves the day's learning into long-term storage.

Dream theories

Activation-synthesis theory says the cortex weaves a story from random brain-stem activity; **hypnagogic sensations** are the falling jolts at sleep onset.

Each dream theory makes a different prediction about *content*. That is how they can be told apart.

Split-brain research, plasticity, and how the brain is studied

split-brain re- search 裂脑研究

patients whose **corpus callosum** 胼胝体 was cut to treat severe epilepsy – the two hemispheres then work **independently**

what it showed

language is usually **left**-lateralised: an object shown only to the right hemisphere can be picked up but not named

brain plastic- ity 大脑可塑性

the brain rewires and forms new connections, which supports **recovery after damage**

research methods

EEG 脑电图 for electrical timing, **fMRI** 功能性磁共振成像 for regional blood-oxygen changes, and lesion studies

Plasticity is why the same injury has different outcomes in a child and an adult – a favourite comparison question.

Brain regions, by their deficit

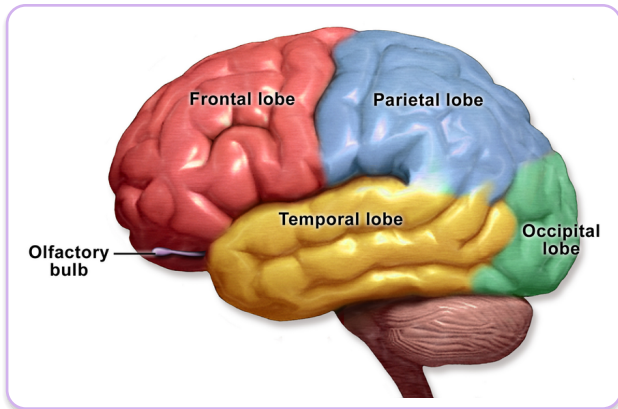
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Brain regions, by their deficit, in detail

REGION	WHAT IT DOES	DAMAGE LOOKS LIKE
brainstem and medulla	breathing, heart rate, arousal	life-threatening — these are not optional
cerebellum	balance, and smooth learned movement	clumsy, uncoordinated movement
hippocampus	forming new long-term memories	old memories intact, no new ones
amygdala	fear, and emotional salience	blunted fear, poor threat learning
frontal lobe	planning, judgement, inhibition	impulsivity and personality change

The **reticular activating system** 网状激活系统 controls alertness and arousal.

The four lobes of the cortex



- **occipital lobes** 枕叶 – vision, at the rear
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6

Consciousness and Sleep

Consciousness and Sleep

The sleep/wake cycle is a **circadian rhythm** 昼夜节律 of about 24 hours. **Jet lag** 时差反应 and shift work disrupt it.

REM sleep 快速眼动睡眠 is called **paradoxical sleep** 异相睡眠 because the brain looks awake while the body is most relaxed, and most dreaming happens here.



measuring sleep, in practice

Dreams and sleep disorders

consciousness 意识

awareness of internal and external events – it varies in **level**, not just presence

activation– synthesis 激活-综合理论

the brain **interprets random activity** generated during REM sleep

consolidation theory 巩固理论

dreaming is a by-product of **transferring memories** into long-term storage

not examinable

the psychoanalytic theory of dreams is outside the exam's scope

the disorders

insomnia 失眠, **narcolepsy** 发作性睡病, **sleep apnea** 睡眠呼吸暂停, **somnambulism** 梦游 and REM sleep behaviour disorder

Both examinable dream theories are **biological**. Neither says a dream means anything – which is precisely the distractor the exam offers.

7

Sensation

Sensation

The **just-noticeable difference** 最小可觉差 is the smallest change a person can detect.

Sensory adaptation 感觉适应 is reduced sensitivity to an unchanging stimulus – you stop noticing a smell.

Sensory interaction 感觉相互作用 means the senses work together.
Synesthesia 联觉 is when one sense triggers another.

The other senses, and the thresholds

olfaction 嗅觉

smell – the **only** sense not relayed first through the thalamus, which is why odours reach memory and emotion so directly

gustation 味觉

sweet, sour, salty, bitter and **umami** 鲜味

touch and pain

skin receptors transduce touch; “hot” comes from warm *and* cold receptors firing together. Pain is processed in body **and** brain, which is why expectation changes it

absolute threshold 绝对阈限

the weakest stimulus detected **half** the time

difference threshold 差别阈限

the smallest change that can be noticed – a **proportion** of the original, by Weber’s law

Sensory adaptation 感觉适应 means constant stimuli fade from awareness. You stop feeling your watch within minutes of putting it on.

Vision and hearing, in the terms the exam uses

visual accommodation 视觉调节

the **lens** 晶状体 changes shape to focus light on the **retina** 视网膜

when it fails

nearsighted focuses in front of the retina, **farsighted** behind it

place theory 位置理论

pitch from **which part** of the cochlea vibrates – explains **high** frequencies

frequency theory 频率理论

pitch from **how fast** the whole membrane fires – explains **low** frequencies

deafness

conduction deafness 传导性耳聋 damages the mechanism; **sensorineural** 感音神经性耳聋 damages the hair cells or nerve

Sound is air movement: **wavelength gives pitch**, **amplitude gives loudness**. Two theories are needed because neither covers the whole range alone.

The senses, receptor by receptor

Rods and cones

Rods see in dim light with no colour; **cones** need light and give colour and detail, packed most densely at the **fovea**.

Focus and hearing

Nearsightedness focuses the image in front of the retina, **farsightedness** behind it. **Sensorineural deafness** is damage to the hair cells or the auditory nerve.

Colour and afterimages

Opponent-process theory explains **afterimages**: cells signal red-or-green, so fatiguing one leaves the other.

The other senses

Kinesthesia senses limb position; the **semicircular canals** sense balance; **oleogustus** is the taste of fat; **sound localization** compares the two ears' timing and intensity.

Trichromatic theory works at the receptor, opponent-process after it. Both are right, at different stages.

Use the actual sample when judging generalization

The 2025 AP Psychology Set 1 Article Analysis study recruited 127 students at one large university for course credit. Ages ranged from 18 to 39; the mean was 21.21. The sample included 69% women and 31% men.

Write a claim tied to participant evidence

Explain a limit on extending this study's findings to adults aged 65 and over. Would "127 is a large sample, so the findings apply to everyone" answer the task?

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Identify the population, select a relevant feature of the participants and connect it to the extent of the claim.

Connect the population, evidence and limit

One supported response: The findings may not extend to adults aged 65 and over because all participants were university students aged 18–39. The study provides no direct participant evidence about that older population.

This is a limit on the evidence, not proof that older adults would behave differently. A sample's size alone does not show that its participants represent every population.

Random assignment to misinformation conditions helps compare the experimental groups; it does not turn a university sample into a representative sample of all adults.

The official Part E criterion requires a generalization claim supported by relevant participant evidence. An unexplained label such as “biased” or a sample-size statement is insufficient.

Exam tips

- Learn only the listed **neurotransmitters** and **hormones**; the exam will not ask about others, and the endocrine glands are out of scope apart from the pituitary.
- Keep **sensation** separate from perception: sensation is detecting and transducing, perception is interpreting (Unit 2).
- The **all-or-none principle** means intensity is coded by how *often* a neuron fires, never by how strongly.
- Match structure to job before you write: hippocampus forms memories, amygdala handles fear, cerebellum coordinates movement.
- **Sympathetic** arouses, **parasympathetic** calms. If a question describes a racing heart, name the sympathetic branch.
- Say what a scan can and cannot show. **EEG** records rapid electrical patterns; **fMRI** commonly tracks regional blood-oxygen changes associated with activity.

8

Recap

Unit 1 – key takeaways

1

Neurons

all-or-none; intensity is firing *rate*

2

Autonomic

sympathetic arouses;
parasympathetic calms

3

Brain

hippocampus memories; amygdala
fear; cerebellum movement

4

Senses

sensation detects; perception
interprets (Unit 2)

Check yourself

- 1 How is stimulus intensity coded in a neuron?
- 2 A racing heart: which autonomic branch?
- 3 What does the hippocampus do?
- 4 Which method records rapid electrical sleep-stage patterns?

Answers: firing rate (not strength) ■ sympathetic ■ forming new memories ■ EEG (fMRI tracks regional blood-oxygen changes)