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

Nature and Nurture

Psychology studies **behavior** 行为 (what a person does) and **mental processes** 心理过程 (what a person thinks and feels). Unit 1 asks where these come from in the body.

- **Nature and nurture** 先天与后天 always interact. Height is inherited, but poor nutrition lowers it.
- The **evolutionary perspective** 进化论视角 explains behavior that helped ancestors survive and reproduce. Fear of snakes is easy to learn because it once kept people alive.
- **Twin and adoption studies** 双生子与收养研究 separate the two sources. If identical twins raised apart are still similar, heredity matters for that trait.

Nature and Nurture, continued

> Every trait grows from two sources working together. **Heredity** 遗传 is what a person inherits from their parents. **Environment** 环境 is everything that happens around them. Neither one acts alone.

2 The Nervous System

The Nervous System

The **nervous system** 神经系统 carries information around the body. It has two main parts.

- The **somatic nervous system** 躯体神经系统 controls **voluntary** 随意的 movement, such as raising your hand.
- The **autonomic nervous system** 自主神经系统 controls **involuntary** 不随意的 processes, such as heartbeat and digestion. It has two branches that work against each other: the **sympathetic nervous system** 交感神经系统 prepares the body for action (the "fight or flight" response), and the **parasympathetic nervous system** 副交感神经系统 calms the body down afterwards.

Voluntary or automatic, then arousing or calming

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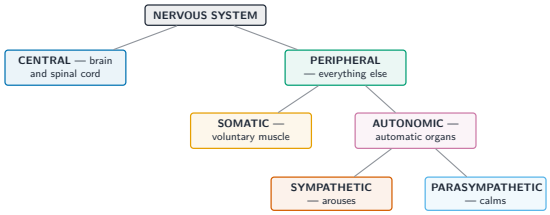
The divisions of the nervous system

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 the response happens before the brain is involved.

Name the division *and* the direction. Half the marks in this unit are in getting sensory and motor the right way round.

Voluntary or automatic, then arousing or calming, in detail



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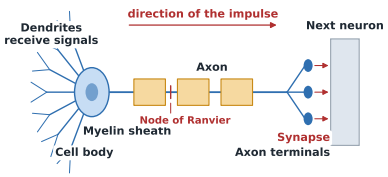
3 Neurons and How They Fire

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** 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.
- 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.

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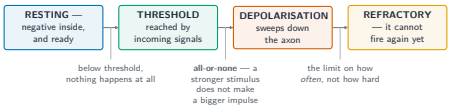
- If incoming signals pass the **threshold** 阈限, the neuron **depolarizes** 去极化 and fires.
- Firing follows the **all-or-none principle** 全或无原则: the neuron fires at full strength or not at all. A stronger stimulus makes it fire more often, not harder.
- Straight after firing there is a **refractory period** 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

Neurotransmitters, Hormones, and Drugs

- An **agonist** 激动剂 encourages neural firing.
- An **antagonist** 拮抗剂 discourages it.
- A **reuptake inhibitor** 再摄取抑制剂 blocks reabsorption, leaving more transmitter in the synapse.

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: the brain can generate pain with no input at all.

Pain is constructed, not transmitted. Both the gate and the phantom limb are evidence for that one claim.

Hormones, and the three ways a drug acts

hormones 激素	act outside the nervous system, travelling more slowly through the blood
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. And every **psychoactive drug** 精神药物 on the syllabus is one of those three mechanisms – naming it, not just the drug, is what earns the mark.

The six examinable neurotransmitters

dopamine 多巴胺	reward and movement
serotonin 血清素	mood and sleep
norepinephrine 去甲肾上腺素	ness 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

Only these six are examinable. Learn each one's one-line job – that is the level the multiple-choice questions test at.

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.

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 brainstem 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 research 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 plasticity 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 activity over time, **fMRI** 功能性磁共振成像 for which regions are active, 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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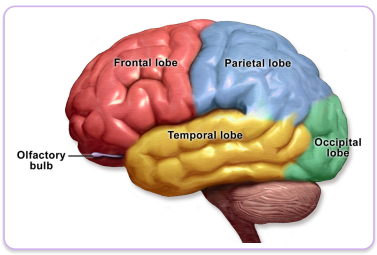
Brain regions, by their deficit, in detail

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
- **temporal lobes** 颞叶 – hearing and language, at the sides
- **parietal lobes** 顶叶 – **somatosensory cortex** 体感皮层 for touch
- **frontal lobes** 额叶 – higher-order thinking and **executive function** 执行功能

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	**Kinesthesis** 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.

Worked example – how far do the findings generalize?

2025 Article Analysis: *"Explain the extent to which the research findings may or may not be generalizable, using specific and relevant evidence from the study."*

- **Full marks:** *"The findings may not generalize widely because the participants were undergraduates at a single university, so the sample does not represent the age range or the range of backgrounds in the population the claim is about."*
- Name the limitation **and** tie it to evidence in the study.

> "The sample was biased" names nothing. Say *which* feature of the sample, and *which* population it fails to represent.

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. fMRI shows activity over time; EEG shows electrical patterns and identifies sleep stages.

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. What can fMRI show that EEG cannot?

Answers: firing rate (not strength) ▪ sympathetic ▪ forming new memories ▪ activity over time / localisation