260-2017-02-20-hormones

Rick Gilmore

2017-02-20 10:13:10

Prelude

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Today's topics

- Hormonal communication
  - Basic concepts
  - Case studies

A reuptake inhibitor has what effect on neurotransmitters?

- Reduces extracellular levels.
- Accelerates their reuptake.
- Increases extracellular levels.
- Causes neurotransmitters to bind to ionotropic receptors.

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A reuptake inhibitor has what effect on neurotransmitters?

- ~~Reduces extracellular levels~~ Reuptake reduces
- ~~Accelerates their reuptake~~ INHIBITOR!
- Increases extracellular levels.
- ~~Causes neurotransmitters to bind to ionotropic receptors~~. NTs do that normally.

The ???? contains neurons that release ????.

- striatum; oxytocin
- ventral tegmental area; serotonin
- tectal; glycine
- substantia nigra; dopamine

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- ~~striatum; oxytocin~~ Hypothalamus into post. pituitary
- ~~ventral tegmental area; serotonin~~ Dopamine
- ~~tectal; glycine~~ TecTUM, ???
- substantia nigra; dopamine

Types of chemical communication

- *Neurocrine*
  - Sending cell -> Receiving cell
- *Autocrine*
  - Sending cell -> itself
  - e.g., presynaptic autoreceptors
- *Paracrine*
  - Sending cell -> neighboring cells
  - NO and CO NTs

Types of chemical communication

- *Endocrine*
  - Sending cell -> many cells elsewhere in body
- *Pheromone*
  - Sending cell -> other animals of same species
- *Allomone*
  - Sending cell -> cells in other species

Hormones

- Chemical secreted into blood
- Act on specific target tissues
- Produce specific effects

Can a substance be a hormone AND a neurotransmitter?

- Yes, why not?
- No, absolutely not.

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- Yes, why not?
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Examples of substances that are both hormones and neurotransmitters

- Melatonin
- Epinephrine/adrenaline
- Oxytocin
- Vasopressin

Behaviors under hormonal influence

Behaviors under hormonal influence

- Ingestive (eating/ drinking)
  - Fluid levels
  - Na, K, Ca levels
  - Digestion
  - Blood glucose levels

Behaviors under hormonal influence

Snails mating.

Behaviors under hormonal influence

- Reproduction
  - Sexual Maturation
  - Mating
  - Birth
  - Care giving

Behaviors under hormonal influence

Behaviors under hormonal influence

- Responses to threat/ challenge
  - Metabolism
  - Heart rate, blood pressure
  - Digestion
  - Arousal

What do these behaviors have in common?

- Biological imperatives
- Proscribed in space and time
- Foraging/hunting
  - Find targets distributed in space, evaluate, act upon
- Often involve others

Principles of hormonal action

- Gradual action
- Change intensity or probability of behavior
- Behavior influences/influenced by hormones
  - +/- Feedback
- Multiple effects on different tissues

Principles of hormonal action

- Produced in small amounts; released in bursts
- Levels vary daily, seasonally
  - or are triggered by specific external/internal events
- Effect cellular metabolism
- Influence only cells with receptors

Differences between neural and hormonal communication

- Point to point vs."broadcast"
  - Wider broadcast than neuromodulators
- Fast vs. slow-acting
- Short-acting vs. long-acting
- Digital (yes-no) vs. analog (graded)
- Voluntary control vs. involuntary

Similarities between neural and hormonal communication

- Chemical messengers stored for later release
- Release follows stimulation
- Action depends on specific receptors
- 2nd messenger systems common

Where are hormones released

Where are hormones released?

- CNS
  - Hypothalamus
  - *Pituitary*
    - *Anterior*
    - *Posterior*
  - Pineal gland

Where are hormones released

Where are hormones released?

- Rest of body
  - *Thyroid*
  - *Adrenal (ad=adjacent, renal=kidney) gland*

    * *Adrenal cortex*
    * *Adrenal medulla*
  - *Gonads* (testes/ovaries)

Two release systems

- Direct
- Indirect

Direct hormone release into bloodstream

- Hypothalamus (paraventricular, supraoptic nucleus) to
- Posterior pituitary
  - *Oxytocin*
  - *Arginine Vasopressin (AVP, vasopressin)*

Direct release

https://upload.wikimedia.org/wikipedia/commons/thumb/7/70/1807_The_Posterior_Pituitary_Complex.jpg/594px-1807_The_Posterior_Pituitary_Complex.jpg

Indirect release

- Hypothalamus -> *releasing hormones*
- Anterior pituitary -> *tropic hormones*
- End organs

Indirect release

Case studies

Case 1: Responses to threat or challenge

- Neural response
  - *Sympathetic Adrenal Medulla (SAM) response*
  - Sympathetic NS activation of adrenal medulla, other organs
  - Releases NE and Epi

Case 1: Responses to threat or challenge

- Endocrine response
  - *Hypothalamic Pituitary Adrenal (HPA) axis*
  - Adrenal hormones released
- Hypothalamus
  - *Corticotropin Releasing Hormone (CRH)*
- Anterior pituitary
  - *Adrenocorticotropic hormone (ACTH)*

Case 1: Responses to threat or challenge

- Adrenal cortex
  - *Glucocorticoids (e.g., cortisol)*
  - *Mineralocorticoids (e.g. aldosterone)*

Adrenal hormones

- *Steroids*
  - Derived from cholesterol
- *Cortisol*
  - increases blood glucose, anti-inflammatory
  - negative consequences of prolonged exposure
- *Aldosterone*
  - Regulates Na (and water) retention in kidneys

Case 2: Reproductive behavior – the milk letdown reflex

- Hypothalamus releases oxytocin into posterior pituitary
- Targets milk ducts in breast tissue

Milk letdown reflex

Oxytocin's role

- Sexual arousal
- Released in bursts during orgasm
- Stimulates uterine, vaginal contraction
- Links to social interaction, bonding (Weisman and Feldman 2013)
- Alters face processing in autism (Domes et al. 2013)

Oxytocin

Next time...

- Your brain on sex

References

Domes, Gregor, Markus Heinrichs, Ekkehardt Kumbier, Annette Grossmann, Karlheinz Hauenstein, and Sabine C. Herpertz. 2013. "Effects of Intranasal Oxytocin on the Neural Basis of Face Processing in Autism Spectrum Disorder." *Biological Psychiatry* 74 (3): 164–71. doi:http://dx.doi.org/10.1016/j.biopsych.2013.02.007.

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