Module 4:Hormone-Behaviour Relationship

Lecture 19: Pituitary Gland

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Pituitary Gland

Pituitary gland is also known as the 'Master Gland'. It is further divided into three lobes— anterior, interior and posterior. The animation below shows the location of pituitary gland in the brain.

See video on web

The hormones secreted by the anterior pituitary are prolactin, growth hormone (GH), thyroid stimulating hormone (TSH), adrenocorticotrophic hormone (ACTH), luteinizing hormone (LH), follicle stimulating hormone (FSH), melanin stimulating hormone (MSH), gonadotropin and interstitial cell stimulating hormone (ICSH). Intermedin is secreted by the interior pituitary and the posterior pituitary secretes oxytocin, antidiuretic hormone (ADH). ADH is also known as vasopressin. The table given below summarizes the effects of various secretions of the pituitary gland on our physiological system.

Pituitary Secretions	Physiological Effects
Adrenocorticotrophic hormone (ACTH)	Stimulates adrenal cortex to produce corticosteroids (glucocorticoids, mineral corticoids, cortisol and androgens)
Follicle stimulating hormone (FSH)	Stimulates development of Graafin follicles in ovary and estrogen production in females and spermatogenesis in males
Luteinizing hormone (LH)	Stimulates ovulation, formation of the corpus luteum and production of progesterone in females Stimulates production of testosterone in males
Growth hormone (GH)	Stimulates protein synthesis and growth
Thyroid stimulating hormone (TSH)	Stimulates thyroid to secrete thyroxin
Prolactin	Stimulates milk production in the female breast
Antidiuretic hormone (ADH) or Vasopressin	Stimulates kidneys to retain/ re-absorb water; Blood pressure
Oxytocin	Uterine contractions; Stimulates contraction for ejecting milk in females
Gonadotropin	Secondary sexual characteristics
Interstitial Cell Stimulating Hormone (ICSH)	Stimulates sperm production in seminiferous tubules in testes
Intermedin	Melanocyte production

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The secretions of the pituitary gland affect a wide range of psychological processes. In fact, the smaller pituitary volume itself has to do with bipolar disorder, eating disorder and obsessive-compulsive disorder. Let us discuss the impact of the pituitary secretions on the behaviour.

Adrenocorticotropic hormone (ACTH): The pituitary gland secrets ACTH which regulates hypothalamic-pituitary-adrenal (HPA) axis activity. Abnormalities of HPA axis are evident in psychosis. Increase in the levels of cortisol and ACTH has been witnessed in patients experiencing first psychotic episode. Increase in the volume of the pituitary gland leads to increase in the size and number of corticotroph cells producing ACTH. Hyperactivity of the HPA axis is associated with major depression. This increase in the volume of pituitary is also seen in those with lack of negative inhibitory feedback. This increase in the females leads to increase in luteinizing hormone (LH) and follicle-stimulating hormone (FSH) during puberty and menstrual cycle. Psychotic patients have reduced levels of LH and FSH. On the contrary, decrease of pituitary volume has been associated with mental disorders such as bipolar disorder, eating disorder, and obsessive-compulsive disorder.

In our day-to-day life we do come across situations posing difficult cognitive tasks such as addressing a small gathering, facing a cross-examination and so forth. Such situations activates HPA axis causing increased cortisol in blood, saliva and urine. The whole mechanism operates like this. Perception of a stressful stimulus activates hypothalamus to release corticotropin-releasing hormone. This, in turn, stimulates the anterior pituitary to release ACTH. When ACTH reaches the adrenal cortex it makes the outer layer of adrenal gland to release cortisol. According to Dickerson and Kemeny (2002) the peak cortisol response takes place 20-40 minutes after the onset of acute stressor and return to baseline levels happens 40-60 minutes after the end of the stressor.

Marital conflict is a common observation in most of the societies. Studies exploring the effect of positive and negative behaviours during marital conflict on changes in ACTH and cortisol have reported adaptive physiological responses when one constructively engages in discussions during interpersonal conflict. Hostile and negative behaviour during conflict is coupled with increased level of ACTH, which triggers production of cortisol. Studies show that compared to positive behaviours negative behaviours has considerable effect on HPA axis.

Prolactin: Disruption of the normal prolactin secretion results in hyperprolactinaemia. Hyperprolactinaemia is the common endocrine disorder of the hypothalamic-pituitary axis. It can result into short-term sexual dysfunction besides adversely affecting bone mineral density. A proposed explanation for this is the partial suppression of gonadotropin-releasing hormone (GnRH), follicle-stimulating hormone (FSH), luteinizing hormone (LH), and testosterone pulsatility on the gonad. In females, hyperprolactinaemia is associated with vaginal dryness or lack of swelling. Anorgasmia can be seen in both, males as well as females. Prolactin is secreted from the anterior pituitary gland. It is affected depending on the nature of the stressors. Dopamine has an inhibitory effect on prolactin secretion. Dopamine mediates the effect of stress on prolactin secretion. As it prepares breast tissue for lactation and stimulates milk secretion in females in the perinatal period, variation in the level of secretion is likely to affect milk release.

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Oxytocin: Oxytocin is significant for vaginal contraction during child birth as well as ejection of milk during lactation. The magnocellular neurons of the paraventricular and supraoptic nuclei of the hypothalamus project to the posterior pituitary where oxytocin is released into the blood. The parvocellular neurons of the hypothalamic also projects to limbic area (hippocampus, amygdala, striatum, hypothalamus, nucleus accumbens) and the brain stem. This affects maternal and sexual behaviour, pair bonding, as well as social recognition (Donaldson & Young, 2008).

Although both males and females have oxytocin receptors, it is relevant only for females.

Very interesting studies have been conducted in the recent past which shows the significance of oxytocin. For instance, increase in oxytocin level has been reported in study of eye gaze indicating social interest (Guastella, Mitchell, & Dadds, 2008), value of money transferred by the investor indicating interpersonal trust (Campbell, 2010). Faces are crucial for human identity and the right fusiform gyrus is responsible for face recognition. fMRI results confirm association between oxytocin and the activation of fusiform gyrus (Petrovic, Kalisch, Singer, & Dolan, 2008). Together with amygdala and superior temporal sulcus, fusiform gyrus processes facial expressions. Oxytocin receptors are present in the amygdala and hippocampus. Animal research shows that oxytocin is involved in social memory in rats. It regulates prosocial behavior and social cognition in animals.

Oxytocin reduces fear behaviour by reducing amygdala activation, increases parasympathetic functioning, inhibiting corticotropin releasing factor, and decreasing corticosteroid level. fMRI images confirm positive findings in human beings. Oxytocin reduces activation of amygdale and the connection between the amygdale and the upper brainstem in response to fearful visual stimuli, thus affecting autonomic nervous system reactions to threat (Kirsch et al., 2005). Besides reducing fear, oxytocin also helps conserve trust in events of betrayal. “Oxytocin….may serve to inhibit defensive behaviors associated with stress, anxiety or fear, and allows positive social interactions and the development of bonds” (Carter, 1998, p. 782). It facilitates empathy and prepares the person to take other’s viewpoint into account. This has been found in romantic relationships where oxytocin facilitates continuous monitoring of other’s viewpoint. Oxytocin is also referred to as “love hormone” or “liquid trust” as increased level of oxytocin makes the person altruistic, trusting and generous.

The thalamocingulate division of the limbic system activates maternal behaviour. This is specially found in the areas with high receptors for estrogen, progesterone, prolactin, and oxytocin. The orbitofrontal part of the right hemisphere controls attachment. Oxytocin, prolactin and opioids facilitate attachment. Opioid activity and high cortisol facilitates care giving behaviour. Glutamate facilitates separation distress. ACTH and adrenal cortical secretions are high in the depressed phase of separation. Sadness and depression activate the parasympathetic nervous system and HPA axis. Oxytocin, vasopressin, opioids and serotonin affect the hypothalamus and medullary source nuclei of the visceral vagus. Activation of vagus decreases pulse rate, blood pressure, cholesterol, triglycerides, glucose and epinephrine-norepinephrine levels. Thus, one can infer that social bonding will protect against cardiovascular disease.

Oxytocin and opioid systems are considered the physiological basis of sense of security. It makes our attachments essentially pleasurable. Oxytocin provides chemical basis of formation of social preferences. Studying the oxytocin level during pregnancy and first postpartum month, Feldman, Weller, Zagoory-Sharon, and Levine (2007) found positive correlation between oxytocin level and maternal behaviour such as gazing, vocalization, affectionate touch, positive affect, and maternal checking behaviour. Oxytocin released during sexual behaviour reinforces social bonding between the partners. Tend-befriend behaviour has attracted many psychologists. Estrogen augments the effect of oxytocin which, in turn, influences tend-befriend behaviour in females.

Anti-diuretic hormone (ADH)/ Vasopressin: The posterior pituitary secretions influences learning

and memory processes. The posterior pituitary secretes vasopressin and oxytocin. These two hormones influence behaviour in opposite ways. Vasopressin facilitates memory processes. It affects consolidation as well as retrieval process. On the other hand, oxytocin facilitates passive avoidance behaviour and extinction of active avoidance reaction.

Increase in certain hormones at puberty increases the risk for psychopathology. Adrenarche and gonadarche are supposed to do this at puberty. For example, adrenarche refers to the maturation of HPA axis. It usually occurs between 6-9 years of and is characterized by rise of adrenal androgens such as dehydroepiandrosterone (DHEA) and its sulfate (DHEAS). Adrenal androgens have been associated with dominance, depression, and antisocial behaviour. On the other hand, gonadarche refers to the maturation of hypothalamic-pituitary-gonadal (HPG) axis. It usually occurs between 9-11 years of age. The HPG axis hormones such as gonadotropins, follicle stimulating hormone (FSH), luteinizing hormone (LH), estradiol, progesterone and testosterone rapidly increase during this state. Studies have associated testosterone and estradiol levels to negative affect aggressive behaviour. Pubertal hormones have been linked to psychopathology due to its impact on cortisol secretion. However, the sensitivity of the developing brain decreases with time. Studies have observed higher levels of adrenal androgens during early stages of puberty in females with early growth of pubic hair (before 8 years). Comparatively, this level declined after puberty.

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