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Happy hormones and their significance in animals and man

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Abstract

Happiness is a state of the mind which depends on the complex interplay of chemicals in the brain. The feeling of happiness is related to release of certain chemicals in the brain called neurotransmitters. In this article, firstly we focus on how happy hormones relates to positive social behavior, pleasure, and stress tolerance, and second on which management factors stimulate release of such hormones. Consequently, assessments of good welfare are becoming increasingly important. Under these circumstances, affiliative behavior and positive social interaction have been used as good welfare indicators. In addition, dopamine, serotonin, oxytocin, endorphin, cortisol and adrenaline which are considered as happy hormones have been used as indicators to evaluate good animal welfare.

Keywords: Happy hormones, neurotransmitters, welfare, animals, man

Introduction

Happiness is a new concept in positive psychology and although, everyone uses this concept commonly as a clear concept, it has a complex meaning and composed of several factors. All the effective factors divided into two dimensions: endogenic and exogenic. In spite of the influence of exogenic factors on happiness, endogenic factors form the basis of happiness. Endocrine glands which release hormones control various processes like growth, metabolism, and emotional regulation and so on. Medical science has shown that hormones have a significant role in neurological functions. Most of the negative emotional condition and the subsequent health defects are due to an imbalance in activity of the nervous system and secretions of specific hormones. Thus, happy hormones can be defined as those hormones that can ease this imbalance in neurological activity and restore a positive emotional state. Serotonin, endorphin, dopamine and oxytocin can be listed technically as happy hormones based on their positive neurological restorative activity. Recently, phenylethylamine and ghrelin have found extensive attention as happy hormones [1]. Phenylethylamine, feel good hormone has been found to be associated with early courtship and romantic behavior. Adequate levels of this compound can enhance the mood of love and thus, happiness. Cocoa is an excellent source of phenylethylamine and chocolates contain cocoa in abundance. Though Ghrelin has been a known hunger stimulating hormone, its role as a stress buster and restorative for stress related depression has been recently recognized [1]. An active life style, a healthy diet and a life full of love are the essential precursors for enjoying adequate happy hormone levels and happiness itself. The hormonal changes that occur when humans and dogs interact could help people cope with depression and certain stress-related disorders. Preliminary results from a study show that a few minutes of stroking our pet dog prompts a release of a number of "feel good" hormones in humans, including serotonin, prolactin and oxytocin. Numerous studies have shown that dogs, one of the earliest domesticated animals can help lower blood pressure, ease the loneliness of the elderly in nursing homes and help children overcome allergies.

Pathways of the brain that involved in the localization of happiness

The human brain weighs over a kilogram i.e. 2.2 pounds and has an estimated 86 billion neurons.

Signals are transmitted along each nerve electrical gradients of charged ions, and each neuron makes hundreds of connections to those around it. This enormous chemical and electrical network provides the complexity that enables us to feel emotion, from the all-consuming addiction of love, to the raw devastation of grief [2]. Brain studies have no clear findings about localization of happiness, but some part of brain introduced as emotion control centers: prefrontal cortex, amygdale, hippocampus, anterior cingulated cortex, and insular cortex. Neurotransmitters have no exact explain, but most related neurotransmitters in relation with happiness are as followed: endorphin, dopamine, serotonin, norepinephrine, and melatonin. The limbic system is involved in memory processing and decision-making. The nucleus accumbens is also known to have an involvement in the processing of emotion. The basal ganglia known to have an involvement in the planning and co-ordination of movement, but certain areas also light up in response to positive emotional stimuli, and are thought to be involved in reward and reinforcement. The orbito-frontal cortex, located just above the eyes is also thought to play a role in evaluating reward versus punishment. The hypothalamus links the nervous system to the endocrine system – which produces hormones, some of which are key mediators of mood and emotion [2]. There are several ‘reward pathways’ in the brain, but the best studied is the mesolimbic pathway. The pathway transmits dopamine signals from nerves in the middle of the brain, upward and forward, to the limbic system and the prefrontal cortex, both of which are involved in emotional processing. Under normal conditions, this pathway serves as a motivator for positive actions, producing pleasurable feelings that reinforce evolutionarily beneficial behaviour *viz.* eating high-calorie food, social interaction and reproduction. The sympathetic nervous component of ANS uses the neurotransmitters adrenaline and noradrenaline to prepare the body for "fight or flight", raising the heart rate and mobilizing resources to fuel the muscles. The parasympathetic nervous component of ANS uses acetylcholine to allow the body to rest and digest, slowing the heart and breathing, diverting the blood supply to the gut [2].

Synthesis

The neurotransmitters are responsible for transmission of message from one neuron to another, across a synapse. Scientists have discovered that some foods influence the brain's production of these neurotransmitters. Complex carbohydrates contribute to increased levels of serotonin and protein foods promote the production of dopamine and norepinephrine. Neurotransmitters are easily oxidized, so the intake of adequate amount of antioxidants is recommended.

Dopamine

“The Reward Molecule” dopamine is responsible for reward-driven behavior and pleasure seeking. A dopamine molecule consists of a catechol structure (a benzene ring with two hydroxyl side groups) with one amine group attached via an ethylchain. Dopamine is the simplest possible catecholamine. Every type of reward seeking behavior that has been studied increases the level of dopamine transmission in the brain. It is an inhibitory neurotransmitter which blocks the transmission of impulse across a receptor. Adequate dopamine levels improve pleasure and reward pursuits that are vital for happiness. L-Phenylalanine and L-Tyrosine are common amino acids that are essential for dopamine synthesis in our body. Dopamine is synthesized in a restricted set of cell types,

mainly neurons and cells in the medulla of the adrenal glands [3]. Two main brain areas produce dopamine. One is called the *substantianigra*, which a tiny strip of tissue on either side of the base of the brain and is located in a region known as the midbrain. Close by is the *ventral tegmental area*, which also makes dopamine. The primary and minor metabolic pathways respectively are:

Primary: L-Phenylalanine → L-Tyrosine → L-DOPA → Dopamine [4, 5]

Minor: L-Phenylalanine → L-Tyrosine → *p*-Tyramine → Dopamine [6]

Minor: L-Phenylalanine → *m*-Tyrosine → *m*-Tyramine → Dopamine [6]

Cocaine blocks the reuptake of dopamine, leaving these neurotransmitters in the synaptic gap longer. Substances like cocaine, opium, heroin, alcohol and nicotine increase the levels of dopamine. There is evidence that people with extroverted personality types tend to have higher levels of dopamine than people with introverted personalities. Dopamine is mainly secreted in nigro-striatal tract where it is involved with the control of mood. Dopamine also helps with reinforcement — motivating an animal to do something again and again. Dopamine is what prompts a lab animal, for instance, to repeatedly press a lever to get tasty pellets of food. Reward and reinforcement help us learn where to find important things such as food or water, so that we can go back for more. Lowering dopamine can make animals lose pleasure in activities like eating and drinking. This joyless state is called anhedonia. Because of its roles in reward and reinforcement, dopamine also helps animals focus on things [7].

Serotonin

“The Happiness Hormone” is serotonin or 5-hydroxytryptamine is a monoamine neurotransmitter. In animals including humans, serotonin is synthesized from the amino acid L-tryptophan by a short metabolic pathway consisting of two enzymes: tryptophan hydroxylase (TPH), aromatic amino acid decarboxylase and the coenzyme pyridoxal phosphate. Serotonin is involved in regulation of a range of behaviours *viz.* sleep, appetite, arousal and aggression. Serotonin prevents depression and makes a person happy. It is released on exposure to sunlight, by eating foods rich in carbohydrates and during exercise. The major site of serotonergic cell bodies is in the upper pons and the midbrain. These neurons connect to the basal ganglia, the limbic system, and the cerebral cortex. Serotonin is synthesized in the axonal terminal from the precursor amino acid tryptophan. A deficiency of tryptophan in diet causes irritability and hunger. Its supplementation has been found to induce sleep, relieve anxiety and increase a sense of well-being. The key enzyme involved in the metabolism of serotonin is monoamine oxidase and the metabolic product is 5-hydroxyindoleacetic acid. The principal association of serotonin with a psychopathological condition is with depression. The hypothesis on mood disorders states that depression is associated with too little serotonin and that mania is associated with too much serotonin. Serotonin is best known for eliciting feelings of happiness in the human brain, but scientists at the University of Wisconsin–Madison have found the hormone plays a role in milk production in dairy cows. Hypocalcaemia is considered a major health event in cows and is associated with immunological and digestive problems, decreased pregnancy rates and longer intervals between pregnancies. These all pose a problem for dairy farmers,

whose profitability depends upon regular pregnancies and a high-yield of calcium-rich milk. Happy cow makes more nutritious milk. Milk fever, a disease—where the amount of calcium circulating in their blood decreases and cows get cold and develop noticeable tremors. In the recent *Journal of Endocrinology*, a study that shows that increased serotonin levels lead to increased calcium levels. The study included both Jersey and Holstein cows, which received injections of a compound that is metabolized into serotonin. In the Jersey cows, serotonin increased calcium in the milk, but in the Holsteins, serotonin increased calcium in blood. In both the breeds, the calcium regulation is different and these work on a molecular level and translate the findings into treatments for milk fever. The higher levels of serotonin would increase circulating calcium, calcium that would otherwise be strengthening bones. While in cows, this provides benefits for treating milk fever [8].

Oxytocin

“The Bonding Molecule” or “Trust Hormone” or “Love hormone”, the oxytocin is a peptide hormone and neuropeptide. Oxytocin is normally produced by the paraventricular nucleus of the hypothalamus and is secreted by the posterior lobe of the pituitary gland. The oxytocin peptide is synthesized as an inactive precursor protein. This precursor protein also includes the oxytocin carrier protein neurophysin I. Oxytocin is a hormone directly linked to human bonding and increasing trust and loyalty. In some studies, high levels of oxytocin have been correlated with romantic attachment. This hormone is sometimes referred to as the “cuddle hormone” or the ‘love hormone’ because it is secreted in response to social recognition and bonding. Even playing with a dog can cause an oxytocin surge, according to a 2009 study published in the *Journal of Hormones and Behavior*. The levels have been found to decrease with negative social encounters like an insult and negative thinking. Foods rich in proteins, oils with high density lipoproteins (HDL) and fruits viz. avocados and bananas are recommended. Maternal behavior includes licking, grooming, and nursing of the offspring, and plays an important role in supporting the life of the offspring. It is evident that studies on oxytocin in relation to maternal behavior in farmed animals are important for improving the welfare and survivability of the offspring. The increased release in oxytocin following positive social interactions may have a positive impact in recovery from an illness. In a 2003 study, oxytocin levels rose in both the dog and the owner after time spent ‘cuddling’. The strong emotional bonding between humans and dogs may have a biological basis in oxytocin. Oxytocin is known to be critical for milk let down reflex. Oxytocin with relation to positive social behavior, such as maternal and affiliative behavior, may contribute greatly towards improving the welfare and fitness of farm animals [9]. Oxytocin was involved in the HPA axis in exerting an anti-stress effect. It was reported that intranasal oxytocin administration attenuated the adreno-cortico-tropic-hormone response in monkeys and centrally administered oxytocin attenuated cortisol secretion in Holstein steers [10]. The serum oxytocin concentration tended to be higher in grazing cows than housing cows. It might be reasonable to suppose that the grazing system leads to more feeding and chewing behavior and more comfort to cows than the housing system resulting increased comfort induces serum oxytocin release in cows [11]. The welfare of farm animals would be improved under the natural suckling rearing system via an increase in serum

oxytocin concentration [12]. The natural suckling systems, where calves are nursed by dams and have social contact with other calves and cows, are more beneficial to calf welfare, with results such as a greater positive effect on daily gain and vitality of the calf than is seen in the artificial rearing systems. These results might be partly mediated by oxytocin [12].

Endorphins

“The Pain-Killing Molecule” the name endorphin translates into “self-produced morphine.” Endorphins resemble opiates in their chemical structure and have analgesic properties. Endorphins are endogenous opioid neuropeptides and peptide hormones in humans and other animals. They are produced by the central nervous system and the pituitary gland during strenuous physical exertion. Many activities can release endorphins, such as intense exercise, eating hot peppers, eating chocolate or laughing and during making love. They are involved in the regulation of stress, pain, and mood. Endogenous opioid-containing neurons are found in several brain regions, including the medial hypothalamus, diencephalon, pons, hippocampus and midbrain. Endorphins are connected to the ‘feeling no pain’ aspect of aerobic exercise and are produced in larger quantities during high intensity ‘anaerobic’ cardio and strength training. The late Dr. Johannes Odendaal, research professor of the Life Sciences Research Institute in Pretoria, South Africa, conducted a study with dogs and humans in 2003 that indicated petting a dog and cat released endorphins as well as other “feel good” chemicals in the brain, including dopamine, oxytocin, prolactin, and norepinephrine. Dr. Adnan Qureshi of the Zeenat Qureshi Stroke Research Center concluded from his research in 2009 that cat ownership significantly reduced the risk of heart disease in at-risk patients. He even suggested in his report that owning a cat could be an effective form of prevention for patients at risk of heart disease [13]. In Animal Assisted Therapy (AAT), patients interact with companion animals for many purposes, viz. to relieve depression, reduce anxiety and bring a sense of well-being and purpose to people who are suffering in some way. Because interacting with animals can release endorphins, Animal Assisted Therapy is used to help people in many ways, from boosting mood in nursing home residents to helping developmentally disabled children improve their cognitive function.

Cortisol

Hydrocortisone is well-known glucocorticoids in the body that is released from adrenal glands and is released in response of inflammation. This hormone regulate by CRH that release from hypothalamus and increase ACTH. The role of this hormone in psychological process is managing stress. Several studies investigated the relation between cortisol and depression as a contrary dimension of happiness. Cortisol has been shown to be a consistent marker for depression. High levels of morning cortisol have been linked to depression and neuroticism. Also, atypical cortisol secretion patterns have been linked to depression, stress, and anxiety. Researches indicate that less salivary cortisol is good predictor of happiness. But still the relation of happiness and level of cortisol needs to more studies. Animal welfare has been commonly assessed by measuring circulating levels of cortisol, the major physiologic indicator of stress in dogs [14, 15], as well as analyzing stress-associated behavior. Cortisol release is activated by a variety of mental and physical stimuli, including extraordinary situations, activities, and emotions [16]. Although cortisol is secreted in response to

negative events, it can also be secreted in response to situations that are not inherently regarded as distressful, such as courtship, copulation, and hunting^[17, 18]. Individuals with higher levels of “personal growth” and “purpose in life” registered lower and more stable levels of salivary cortisol.

Adrenaline

Adrenaline or epinephrine, a hormone and a neurotransmitter releases from adrenal glands. Adrenaline, the body's activator released in response to anxiety, exercise, or fear, which is a crucial component of the fight-or-flight response of the sympathetic nervous system. When an animal is threatened, the options are usually either to stand its ground and fight, or run away as fast as possible. Fright causes the brain to send signals to the renal glands which start pumping large amounts of adrenalin into the bloodstream. This increases the heart and breathing rate in preparation for the ensuing action. Researches indicate that urinary adrenaline is a good predictor of happiness. Individuals with higher levels of “personal growth” and “purpose in life” registered lower and more stable levels of urinary adrenaline. Epinephrine is used to treat severe allergic (anaphylactic) reactions, severe asthma attacks and increase blood pressure for dogs and cats.

Conclusion

Happiness hormones are key indicator of good welfare, enhancing pleasure, suppressing stress, and stimulating their own release. The release of these hormones are related to the performance of positive normal behavior, and enrichment, such as brushing, pleasure, which can further accelerate their secretion. Hence, studies on the welfare of farm animal should pay more attention to methods to improve management practices to induce the secretion of these hormones and hence improve the comfort and stress tolerance of the animals.

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