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Music, Steroids and Vertebrate Neuron

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Abstract

The most significant finding has been that music enhances synaptic changes in the brain. In other words, studies comparing musicians and non-musicians and music learners and non-learners have clarified that music brings about cerebral plasticity. Music affects neuronal learning and readjustment (response of brain cells to sound and music stimuli, and changes in cell counts), and this effect lasts for a long period. Listening to music facilitates the neurogenesis, the regeneration and repairs of cerebral nerves by adjusting the secretion of steroid hormones, ultimately leading to cerebral plasticity. Music affects levels of such
steroids as cortisol (C), testosterone (T) and estrogen (E), and we believe that music also affects the receptor genes related to these substances, and related proteins..

1. INTRODUCTION:

The fact that music has an effect on the human body, particularly on stress and easing pain or anxiety, has been generally known since the Greeks. Music influences the endocrine system to keep the body normal, as shown by many studies. Musical behaviour is believed to invigorate several parts of the nervous system, as auditory information passes through the limbic and Para limbic systems including the thalamus, the hypothalamus, and amygdala, to the neocortex, and influences the pituitary gland; as a result, various Music and Steroids – Music Facilitates Steroid–Induced Synaptic Plasticity.

Physiological effects are induced. Much research has been done regarding the physiologic effects of music, with results showing increases or decreases in respiration, heart rate, blood pressure, skin temperature, GSR (galvanic skin response), and electroencephalogram findings. Unfortunately, there is still no unified concept regarding the physiological effects of music, although the fact that music causes physiological effects in the human body is well accepted. Enormous advances have been made in recent years toward an understanding of the brain structures involved in music. Using the brain imaging techniques of PET, fMRI, and magneto encephalography, the brain structures and activity related to music were clarified. Interestingly, these structures (limbic and para limbic structures) are involved in the

initiation, generation, detection, maintenance, regulation, and termination of emotions that have survival value for the individual and the species. Needless to say, emotions are deeply affected by steroids.

2. HYPOTHESIS

Music affects levels of steroids as cortisol(C), testosterone (T) and estrogen (E), 17β-estradiol and we believe that music also affects the receptor genes related to these substances, related proteins and cerebral plasticity.

3. EVALUATION OF THE HYPOTHESIS

Hormones not only have organizational effects but also affect cognition, perception, and other behaviours. Because the endocrine and nervous systems do not function in isolation but as an integrated whole, many aspects of neuronal functioning are affected by hormones (gonadal steroids). However, we still lack data regarding the effect of music on hormones. The fact that testosterone influences growth of the larynx is well known. It is believed that testosterone also influences the auditory sense and the vocal organ. Reports also indicate that the utterance of song birds is influenced by testosterone and point to the existence of similarities between the vocal tract of song birds and humans. The fact that the auditory sense of the human females undergoes cyclical changes affected hormones has been reported. Moreover the female voice is also influenced by 17β-estradiol. The hypothesis that the perception of sound is influenced by hormones is based on the idea that hormones influence dorsal division and reticular formation in the auditory pathways.

Plastic effects of steroids on the brain have been documented in many animal species. For example, vocal communication is a common characteristic among many vertebrates, and steroid hormones are closely involved in the formation of neural mechanism for vocal behaviours in fish, amphibians, birds and mammals (including primates). In anurans, androgen and E are involved in the expression of vocal behaviours by controlling vocal organ formation, advertisement calling and release calling. The most well-known relationship between steroids and cerebral plasticity is vocal (singing) behaviours in birds. The development of vocal behaviours in singing birds involves complicated processes including neurons and muscles, and steroid hormones (T and E) are involved during many steps, such as neuron organization, neuron survival and neural song-system formation.

Testosterone influences the development of the neural pathways of the brain and stimulates cerebral lateralization. This provides males with right brain superiority, which results in making him proficient in spatial ability, such as securing food and adapting to the environment. Other reports also show that spatial ability is influenced by sex hormones; for example, men with lower testosterone levels performed better than men with higher testosterone levels whereas women with higher testosterone levels performed better than women with lower testosterone levels on special ability tests. Further a relation between spatial ability and musical ability has been reported and listening to music has been shown to improve spatial ability.

The relationship between steroids and cerebral plasticity has been confirmed in humans. It is well known that the nervous system is a target for steroids (peripheral glands and neurosteroids which are synthesized by nerve cells). Even if those steroids varies its origin, both are neuroactive. They regulate important functions such as reproduction, feeding behaviour, brain development, neurogenesis, neuroprotection, cognition and memory. Psychological and physiological stress affects testosterone and cortisol levels in both sexes.

Generally, cortisol levels increase significantly in the presence of stress. It has been reported that music eases stress responses psychologically, physiologically, and endocrinologically. It is well known that listening to music reduces uneasines, depression, and fatigue, changes mood, and suppresses pain. However, some reports that compare listening to music with other relaxation methods show no differences in alleviation of anxiety, depression, and fatigue or reduction of heart rate. In addition, some authors have reported that there is differences in psychological and physiological responses among different genres of music (classical, hard rock, "favourite music," "relaxation music") and others have reported no such differences. In humans, primates, rodents and birds, steroids (C, T and E) influence cognitive abilities (spatial perception and cognition; visual (object recognition) and spatial memory (object placement and radial arm maze)). Particularly in birds, steroids (17beta-estradiol (E2)) improve spatial cognition (memory). In rats and mice, many studies have reported that steroid hormones improve spatial Perception and cognition (learning and memory). In humans, steroid hormones are involved in spatial perception and cognition. The relationship between T and cognitive abilities is negative in men and positive in women. In women, the balance of T and E associated with the menstrual cycle alters cognitive abilities. Furthermore, in women, age-related decreases in E are thought to be involved in cognitive dysfunction, memory disorder, learning disorder, depression and mood disorder. Most of these studies have been on the stress-reducing effects of listening to music and has been reported to cause a reduction in the cortisol levels. Cortisol is involved in many vital functions such as glucose metabolism and immune function, but in cases of chronic stress, it has been known to induce symptoms such as hypertension and impaired cognitive function. In addition, increasing cortisol levels with age may lead to a decline in memory or progression of Alzheimer's disease. Thus, the reduction of cortisol through the passive activity of listening to music may be useful for the treatment and prevention of diseases and disabilities.

Numerous studies have also examined the relationship between E and Alzheimer's disease accompanying marked cognitive dysfunction. The level of E is lower for Alzheimer patients than for healthy individuals, and this decrease in E may hasten the progression of Alzheimer's disease and facilitate amyloid beta accumulation, which is one of the causes of characteristic disorders such as memory disorders. T administration to elderly men reportedly improves cognitive function. The correlation between musical ability and spatial cognition has long been known. Many studies have investigated the relationship of musical ability to spatial perception and cognition in humans. The assumption that some correlation exists between musical ability and steroid hormones also appears reasonable. In fact, the relationship between T and musical ability (music composition) resembled that between T and other forms of spatial perception and cognition.

Tissue experiments using test tubes and post-mortem brains have shown that E suppresses amyloid beta elevation and deposition to prevent nerve cell damage. Moreover, T administration to elderly men reportedly improves cognitive function. Research reported that musical activities (listening and playing) adjust steroid secretion in elderly individuals and are likely to alleviate psychological states such as anxiety and tension. Furthermore, levels of steroids changed in directions, increasing in subjects with low hormone levels and decreasing in subjects with high hormone levels.

Listening to music for short periods could lower cortisol regardless of the subject' s mental state, and music has been shown to significantly lower or suppress cortisol levels even during surgery. Other papers reported that not only listening to music but also playing music (percussion instruments) lowered cortisol levels. In addition, studies have shown that cortisol responses differed by music experience, such as and the subject's preference. However, so far results are contradictory and there is no consensus regarding the relation between cortisol and music category or preference. However, judging from published research results, listening to one's favourite music decreases cortisol levels.

Testosterone has been shown to influence musical ability, and its effects produce discrepancies between the sexes. The existence of an optimal testosterone level in proportion to musical ability. Reports also discuss the existence of a correlation between hormone levels (testosterone) and musical ability in puberty. Another report indicates that during puberty, children show poor results in music tests because of low testosterone levels at this stage. Moreover, there is a report that composition has a seasonality that might be influenced by the circannual rhythm of testosterone. In addition, most composers are male, and composers tend to show a low level of testosterone compared with control. Further reports show that musicians have a tendency to demonstrate relatively low levels of sex-role stereotyping, which again, may be related to testosterone levels. The point is that testosterone influences musical ability. Regarding musical ability and testosterone, there is a high positive correlation between spatial cognitive ability and musical ability (talent). A high correlation is also found between spatial cognitive ability and testosterone. Furthermore, these correlations differ between males and females.

Male composers had relatively low testosterone levels, and that testosterone values increased as musical ability increased in female composers. On the other hand, only one report is available on sex-related differences in testosterone responses associated with music playing or listening. Fukui examined testosterone level changes between before and after listening to a wide variety of music, including favourite music, pop, jazz, and classical, in male and female students, and showed sex-related differences. Specifically, testosterone values decreased in males and increased in females after listening to music, regardless of genre. Interestingly, the sex-related difference in testosterone levels while listening to music were the same as sex-related differences in stress responses**.** Grape et al. compared between patients with irritable bowel syndrome who took part in singing in a choir with those who took part in a group discussion and found that testosterone levels decreased in the singing group.

4. CONCLUSION

Music listening and playing altered steroid levels agree and correlations between steroids and spatial perception and cognition and the effects of music listening on steroid secretion. The hypothesis that listening to music adjusts the steroid hormone cascade and facilitating the neurogenesis, regeneration and repair of neuron appears highly plausible. At this point, the effects of music on steroids are unclear, but music appears to be involved with steroid production via the pathway from the auditory system to the auditory area, particularly the neural pathway (emotion circuits) mediated by the cerebral limbic system (hypothalamic-pituitary- adrenal axis and amygdaloid complex).

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