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Genetic assessment of bdnf (brain derived neurotropic growth factor) in kids learning bharatnāṭyam

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Abstract
Dance or the act of moving one's body rhythmically to music intends to express an idea or emotion. It is a self-rewarding activity as one takes delight in the movement itself. Dance is a healthy activity as it burns calories, strengthens muscles, improves balance, increases flexibility, and gives the heart a good workout. Dance has also been proven to increase cognitive development. Learning, thought, creativity, and intelligence don't just come from the brain alone, but from the entire body. Movement combinations increase memory, order, and sequencing skills. The mind-body connection gets strengthened by dance. Adding on to this, dance being a creative process, encourages the use of imagination, increases an individual's self-esteem, boosts up their self-confidence to discover multiple solutions to challenges and inculcates the importance of team spirit.

Keywords: Bharatanāṭyam, brain derived neurotropic factor, cortical neurons, fractional anisotropy, valine (Val), methionine (Met), prodomain

Introduction
Dance is a healing art. Complex and unique movements that can be associated with dance, specifically Bharatanāṭyam, stimulate the cerebellum. The process of memorizing dance sequences, also improves the functioning ability of the hippocampus, due to the regular usage. Brain Derived Neurotropic Factor (BDNF) is a key molecule involved in plastic changes related to learning and memory.

Brain derived neurotropic factor (BDNF) regulates neural development and synaptic transmission. The protein encoded by this gene is a member of the nerve growth factor family. It is induced by cortical neurons, and is necessary for survival of striatal neurons in the brain. This gene plays a role in the regulation of stress response and in the biology of mood disorders. It supports the survival of existing neurons, & encourages the growth & differentiation of new neurons and synapses. Vital to learning, long-term memory, and higher thinking.

The BDNF protein encoded by BDNF gene helps to regulate how nerve cells make new connections and maintains old ones. The protein encoded by this gene is a member of the nerve growth factor family, which supports multiple functions in the central nervous system. Hence this gene also plays a role in the regulation of stress response and in the biology of mood disorders. It supports the survival of existing neurons, & encourages the growth & differentiation of new neurons and synapses which are vital to learning, long-term memory, and higher thinking. BDNF regulates neural development and synaptic transmission that are vital for learning and long-term memory. These aspects being requisites of dance, a favourable increase in plasma BDNF levels can be associated with Bharatanāṭyam, an imperative dance form.

Brain function of rishis and dancers
Total wisdom is available deep inside all of us. No one has more than anyone else. But our access to this wisdom depends on how the brain is functioning. The brain has to be powerful enough to connect with this source of wisdom to be able to use it in practical life.

When your mind is connected to the deepest level of your own inner intelligence, to the light of the soul, it can know anything.

This is how the ancient rishis (seers) were able to explore the laws of nature without laboratory experimentation. Through their clarity of mind, they understood the precise movements of the planets and the subtle chemistry of the plants and trees. Truth is always available, but if the mind is not receptive it will miss it every time.

यत्तु चङ्क्रमणं नातिदेहपीडाकरं भवेत्। तदायुर्बलमेधाग्निप्रदमिन्द्रियबोधनम् ।[1]

Dancers and musicians differ in brain structure from untrained individuals. Investigating the brains of individuals with specialized training, such as dancers and musicians, provides insight into training-associated brain plasticity as well as brain-behavioral relationships. The neural correlates of dance and music have been examined using a wide variety of neuroimaging techniques (e.g., structural MRI, functional MRI, PET, fNIRS) and, within these techniques, a variety of measures and analysis methods (e.g., surface-based morphometric, voxel-based morphometric, diffusion tensor imaging). For example, studies comparing local Grey Matter/GM structure between experts and non-experts have found differences in widespread areas including auditory and motor regions. Dancers demonstrated reduced fractional anisotropy (FA), suggesting reduced fiber coherence and increased fanning or crossing fibers, in inter-hemispheric, motor and sensorimotor integration tracts. Apart from this, enhanced resting functional connectivity in a motor control pathway is also observed in dancers. The left dorsolateral prefrontal cortex or DLPFC is known as a region involved in executive processing functions applicable to many domains. Activity in the DLPFC has been observed in many movement-related tasks, including action observation with intent to imitate, action planning and selection, action prediction and motor imagery. Although these are functions that everyone executes on a daily basis, dancers likely execute them more accurately, frequently and consciously than untrained controls. For example, motor imagery is often integrated into dancers' training and they spend large amounts of time learning movements through imitation. This may lead to a need for a particular structure of this area in dancers in order to accommodate their unique needs for these types of functions. Internal representations of movements are generated in the DLPFC and have been found to be different in dancers vs. non-dancers.

BDNF is vital for learning and long-term memory. Dance demands learning new movements and perfecting them through training. Each newly learned pattern of Bharatanāṭyam is moved from the short-term memory to the long-term memory. These aspects being requisites of dance, a favourable increase in plasma BDNF levels can be associated with Bharatanāṭyam. A common single nucleotide polymorphism (rs6265) in the BDNF gene causes a substitution of valine (Val) to methionine (Met) at codon 66 in the prodomain (Val66Met), which influences activity-dependent release of the BDNF protein. In order to explore the influence of BDNF gene variants and establish its link with Bharatanāṭyam, we conducted an observational research study on 93 participants with their due consent. The study group included 45 dancers and 48 non-dancers. Genotype suggesting optimal BDNF production was proportionately higher in dancers (40%) than non-dancers. Many of the dancers with optimal BDNF genotype expressed a feeling of happiness as their mental status after one hour of dancing and also took up other exercises (like skating/badminton/ basketball player etc.) as well. While amongst dancers with sub-optimal BDNF genotype, most of them did not take up any other exercise (like skating/badminton/basketball player etc.) & also expressed a blank feeling as their mental status after one hour of dancing. Thus, BDNF has an evident role in the formation of new learning and memory.

Dance has been an emotion for me ever since I first danced on stage as toddler. In any form, it has the power to express like no words ever, can! As a Scientist, I've studied the brain more in terms of how it plays a role in thought, emotions, and behaviour and how it changes with various mental illnesses and neurological syndromes. Looking at the brain through this new lens has given me new insights and sparked my curiosity more than I could ever imagine! I enjoyed discovering the world of Bharatanāṭyam and the human brain.

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[1] सुश्रुतचिकित्सा 24