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Review Article

Prakriti and neuroplasticity: integrative insights on cognitive health

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ABSTRACT

Ayurveda explains diversity of physical, physiological, and psychological attributes of individuals through the concept of prakriti, or body constitution. This variability extends to several cognitive brain functions like learning, memory etc. Modern neuroscience explains these cognitive traits through the concept of neuroplasticity, which refers to the structural and functional rewiring of neural connection as a result of experience and learning. This article aims to explore the relationship between prakriti and neuroplasticity and to understand the factors influencing neuroplasticity. It also aims to hypothesize an integrative framework that combines Ayurvedic and neuroscientific approaches to optimize cognitive health. There is only less empirical research works are available that systemically explores the connection between prakriti and neuroplasticity. Integrating prakriti-based insights with neuroplasticity offers a personalized, constitutionally aligned approach to cognitive health. Robust empirical validation through biomarkers, standardized protocols, and clinical evidence are essential for establishing a valid interdisciplinary result.

Keywords: Neuroplasticity, Synaptogenesis, Prakriti, Cognitive adaptation, Integrative healthcare, Herbal medicine for cognitive health

INTRODUCTION

Neuroplasticity is brain's ability to reorganize and rewire its neural connections by the formation of new neuronal circuits and modification of existing circuits during learning, experience or injury. The changes can be observed in structure, function and their connections. Previously it had been assumed that neuroplasticity occurs only in childhood however 20th century researches revealed that brain remain capable to change throughout the adulthood though the plasticity remains low compared to developing brain. It plays a pivotal role in learning, memory, and during adaptation to cognitive challenges.

Prakriti is a unique concept in ayurveda which divides population into multiple subgroups based on their physical, physiological and psychological features. It gives an insight of cognitive tendencies, stress response and learning patterns among different individuals. It also offers an in-depth explanation of why different people respond differently to various cognitive interventions and challenges. Ayurveda classics detailed various cognitive and behavioural traits among different prakriti group. Vata prakriti individual are characterized with srutha grahi alpa smruti (quick learning and easy forgetting), pitta prakriti are having features like medhavi, nipuna mati (intelligent and with skilled knowledge) and kapha characterized as chiragrahi, pandita (Slow in understanding but with good intelligence) etc.[1]

Despite the detailed explanation on prakriti and cognitive traits in Ayurveda classics, there is lack of meticulous scientific researches to validate this concept in the context of modern neuroscience. This review suggests a hypothesis regarding potential relationship between different prakriti and neural adaptability which ultimately forms the causative factor in learning, memory etc. Interdisciplinary researches can facilitate an evidence based and holistic understanding of customized interventions on neural rewiring and adaptability.

Aims and objectives

Aim and objectives were to explore the relationship between neuroplasticity and prakriti, to understand the factors influencing neuroplasticity in different prakriti and to hypothesize an integrative framework that combines Ayurvedic and neuroscientific approaches to optimize cognitive health.

LITERATURE RESEARCH

This study is a narrative review aimed to synthesise existing literature on neuroplasticity, explore factors influencing neuroplasticity across different prakriti types and also propose an integrative interdisciplinary framework to optimize cognitive health. A comprehensive literature search was conducted using the online database Google Scholar, covering the period from 2000 to 2025. Keywords used included *"Prakṛti*," "neuroplasticity," "cognitive traits" "cognitive training techniques", "Dinacharya", "herbal medicines", "yoga", "meditation". The sources reviewed consists of classical Ayurveda texts, peer-reviewed research journals, E- books, websites and dissertations. The inclusion criteria focused on articles exploring neuroplasticity in relation to its mechanisms, influencing factors, and interventions that enhance or regulate it and articles discussing prakriti, its association with cognitive functions, and potential interventions to overcome its limitations. Exclusion criteria were studies on prakriti unrelated to neuroscience, articles published before the year 2000, and sources not available in English.The initial search retrieved 213 articles which were reduced to 69 articles after applying filters such as "free full text", "English language", "sorting by date", "words appearing in title" and prioritizing review articles addressing *Prakṛti* and neuroplasticity. The remaining references were sourced from classical and contemporary Ayurveda texts, E books, dissertation and website.

CONCEPTUAL STUDY

Neuroplasticity: mechanisms and relevance

Neuroplasticity or brain plasticity is the process that involves structural and functional changes to the brain in response to intrinsic or extrinsic stimuli. The term neuroplasticity was coined by Polish neuroscientist Jerzy Konorski in 1948. The first anatomical evidence of brain's plasticity was given by Marian Diamond in 1964.[1]

Neuroplasticity can be broadly classified as structural and functional. Structural plasticity refers to changes in neuronal network structure like their number, size, shape and connection of synapses. It comprises synaptic plasticity and neurogenesis. Structural reorganization includes formation of new neural pathways through synaptogenesis, axonal and dendritic sprouting, changes in myelin, generation of neuron and the volume changes in brain regions.[2,3]

Functional neuroplasticity refers to the changes in physiological functioning of neuron like excitability, response level, or synchronicity within neural networks. This plasticity can be explained based on different mechanisms like homologous area adaptation, cross-modal reassignment, map expansion, and compensatory masquerade. Homologous area adaptation refers to a process in which cognitive responsibilities of damaged brain region will be carried over by homologous region in opposite hemispheres of brain after damage. Cross-modal reassignment occurs when representational brain region that has been deprived of its main inputs start to accept input from a new sensory modality. Map extension is enlargement of a cortical maps devoted to a particular information processing function on the basis of practice or frequent exposure to a stimulus. Compensatory masquerade is novel allocation of a particular cognitive process to perform a task that used to rely on a different, now-impaired cognitive process.[4] Functional neuroplasticity can be measured with variations of metabolic responses to a particular or group of brain regions while at rest and during a task.[5]

Importance of neuroplasticity

Neuroplasticity plays a remarkable role in learning, memory, recovery from brain injuries and during adaptation to cognitive challenges. Activity dependent synaptic plasticity, neurogenesis, programmed cell death, changes in gene expression, protein synthesis, dendritic density, synaptic pruning, long term potentiation (LTP) or depression (LTD) along with dendritic spine remodelling are the mechanisms which helps to gather new information and skills and its adaptability to dynamic environment. Synaptic pruning is a process where brain eliminate extra or weaker synapses and strengthen more active ones that ultimately helps in the optimization of brain function. Dendritic spine remodelling is a process where dendritic spine changes in size, shape, and number in response to experience. Long term potentiation is the continuous strengthening of synapses based on recent patterns of activity that produce a long-lasting increase in signal transmission between two neurons. Long term depression is the long-lasting decrease in synaptic strength. Cortical reorganization is the process which involves changing cortical map with respect to learning a new skill. Experience expectant and dependent mechanism form the foundational neural process set to explain dual influence like progressive and regressive neuroplastic changes during cognitive tasks training. Experience expectant mechanism, develops in earlier life time and it helps to assemble an excess of synapses which are then selectively eliminated to a functional subset based on activity /experiences by experience dependent mechanism.[6-8]

Several research studies have highlighted structural neuroplastic changes associated with activities like reading, musical training etc. A summary of most relevant readings can be presented here like volume changes of posterior hippocampus which is relevant for spatial navigation as seen in experienced London taxi drivers who have more navigational experience. Subsequent studies also opined that experience can influence relevant brain area as evident by the changes in gray matter in motor cortex and regions in the parietal sulci during various training paradigms, including complex visuomotor tasks such as juggling and music training. Learning to read enhances the coupling between left and right angular gyri and between the left dorsal occipital and left supramarginal gyrus in recently literate adult group compared to their age matched illiterate peers also substantiates structural neuroplastic changes associated with learning. Needam et al opined that enrichment experience with "sticky mittens" acts as an early simulated experience for infants and helps them to gain object exploration skills earlier than normal developmental stage. Rovee-Collier's conjugate reinforcement paradigm also opines that developmentally constrained behaviors can actually be modified over time through the neural rewiring of brain. Hyed et al suggest that children receiving greater musical instruments training showed structural increase in right precentral gyrus, corpus callosum, and the primary auditory region.[9] Schlaug et al observed volume changes in corpus callosum and improvement in non-music related motor sequencing tasks, for 5-7-year older children who practiced music and these changes correlated to total practice time. Improvements in attention was observed after 5 days of attention training intervention in 4-6-year-old children group along with a more mature pattern of activation in EEG, that imply distribution of scalp ERP similar to influence of development. Neuroplastic changes are also observed in left posterior superior temporal gyrus (STG) in dyslexic children after intervention as evident by fMRI.[10-16]

Factors affecting neuroplasticity

Neuroplastic changes can be classified as positive and negative based on physiological ability of brain to form and strengthen neurological connection or its ability to weaken the connections. In response to positive changes, dendritic connections will be strengthened leading to exponential increase in cognitive reserves. Factors influencing positive neuroplastic changes include diet,physical activity, education, social interaction, and cognitive behavioral training.[17,21]

Exercise improves neuroplasticity by increasing the levels of brain-derived neurotrophic factor (BDNF), insulin-like growth factor 1 (IGF-1), vascular endothelial growth factor (VEGF) and also through production of receptors like tropomyosin-related receptor kinase B (TrkB), p75 neurotrophin receptors. Exercise boosts the release of neurotransmitters like dopamine, serotonin, and norepinephrine, which enhance mood and cognitive functions. Aerobic exercise causes synaptogenesis and remodeling of existing synaptic networks. It promotes hippocampal neurogenesis, increases antioxidants, decreases pro-inflammatory cytokines and create a neuroprotective environment favourable to plasticity. Vascular endothelial growth factor (VEGF)enhances brain angiogenesis. Improved neural function and cognitive performance encourage continued physical activity, further reinforcing neuroplasticity. Structural imaging studies reveal that exercise enhances the volume of brain regions involved in memory, learning, and executive function (e.g., the hippocampus and prefrontal cortex). Regular exercise modulates the hypothalamic-pituitary-adrenal (HPA) axis, reducing stress, anxiety and enhancing resilience to cognitive decline. It induces volume increase in gray matter in the dorsolateral prefrontal cortex, posterior cingulate/precuneus cortex, hand motor area, occipital lobe, and cerebellum with no significant difference in the striatum.[17-19]

Studies opined that sleep can also induce neuroplastic changes like LTD and LTP. It induces hippocampal plasticity and also increases memory consolidation. It enhances myelin production, strengthens hippocampus and neocortex communication. Slow wave sleep (NREM) can enhance LTD by pruning less used synapses to refine the neural network compared to rapid eye movement sleep (REM). NREM sleep is particularly responsible for removal of neurotoxic waste such as beta amyloid via glymphatic system. REM sleep increases synaptic growth and connectivity in limbic and cortical regions.[25] Poor sleep hygeine induces negative neuroplastic changes.[20-22]

Education can also bring about structural and functional neuroplastic changes like neurogenesis, synaptogenesis, even helps in strengthening or weakening synaptic connections through LTP/LTD. Neuronal recycling hypothesis emphasize that new knowledge is mapped to preexisting flexible neural circuits, allowing these circuits to transfer their functions to accommodate new tasks. This mechanism explains how literacy, numeracy like culturally relevant educational tasks influence on neuroplasticity. Second language experience induced brain changes, including increased gray matter (GM) density and white matter (WM) integrity, can be found in children, young adults, and the elderly. Results are seen more rapidly with short-term language learning and are sensitive to age, age of acquisition, performance level, language-specific characteristics, and individual differences. Reading activities primarily improve phonemic fluency due to their engagement of the left cerebral hemisphere, posterior-dorsal left inferior frontal gyrus, the pre-supplementary motor area, and the left caudatus. The reading process leads to neuroplasticity changes such as increased synaptic density and myelination in regions like left inferior parietal lobe and left inferior frontal lobe. Reading activities reduce gray matter volume while increasing white matter in the brain, specifically observed in language-dominant regions,driving neuroplastic adaptations.[23-25]

Different dietary patterns, specific nutrients, caloric restriction, and intermittent fasting can significantly facilitate neuroplasticity by modulating synaptic plasticity, promoting neurogenesis and antioxidant defence, reducing inflammation, and enhancing brain resilience to stress and injury. Mediterranean and Ketogenic diet preserves the structural and functional integrity of brain cells, reduces inflammation, and enhances synaptic health. Gluten free diet modifies corticospinal activity. Meal size also influences on neuroplastic changes. Regular consumption of large meals can lead to a hypercaloric state, which increases oxidative stress and neuroinflammation, reduces BDNF production ultimately impairing synaptic plasticity and cognitive function, particularly in hippocampal region. It also detrimentally reduces immediate cognitive performance due to postprandial fatigue and reduced alertness. Smaller meals cause sustained energy release and enhance cognitive abilities, allowing for better engagement in activities that promote neuroplasticity. Caloric restriction and intermittent fasting mechanism also have impact on neuroplasticity. Caloric restriction has been shown to enhance hippocampal neurogenesis, increase BDNF levels, improve memory and sensorimotor function. It also reduces inflammation and oxidative damage, strengthens synaptic resilience, and decline age-related neural changes. Animal studies indicate that caloric restriction slows the age-related loss of spiral ganglion neurons, suppresses injury-induced microglial activation, attenuates cortical dendritic spine loss, and maintains cardiac synaptic terminal norepinephrine uptake. It also protects striatal neurons from mitochondrial toxins, shields synapses from oxidative and metabolic stress, prevents age-related deficits in hippocampal long-term potentiation (LTP), and enhances overall hippocampal neurogenesis. Intermittent fasting enhances hippocampal neurogenesis, reduces oxidative stress, improves glucose metabolism, strengthen synaptic resilience and increases the neurotrophic factors. Excessive intake of palatable hypercaloric foods can detrimentally affect neuroplasticity. Different food chemicals influence neuroplasticity through distinct mechanisms, such as Omega-3 fatty acids boost hippocampal neurotrophin levels, enhances synaptic plasticity, and reduces oxidative stress. Catechin Polyphenols modulates synaptic plasticity and supports memory and learning by reducing free radicals. Curcumin crosses the blood-brain barrier, reduces oxidative stress, increases BDNF, and supports hippocampal neurogenesis. Diets high in saturated fats and sugars impair synaptic plasticity and motor learning. Obesity mitigates synaptic markers, alters microglial morphology, and impairs cognitive function. Leptin resistance in adipose tissue could be a contributing factor to hippocampal plasticity deficits. Hydration plays a major role in maintaining neuroplasticity. Dehydration impairs corticospinal excitability, increases blood brain barrier (BBB) permeability, and reduces neural adaptability, while rehydration helps reduces these effects, preserving synaptic plasticity and neuronal resilience.[26-28]

Prakriti: general and cognitive traits

Prakriti is a unique concept explained in Ayurveda which divide population into multiple subgroups based on physical, physiological, psychological and behavioural characteristics. According to Chakrapani, "Prakritistu svabhava" where Svabhavamiti pratyatma niyata roopam, that means expression of one's own constitution is Prakriti. Its formation happens during shukra shonita samyoga (fertilization) by permutation and combination of dosha exists in shukra (Sperm) and shonita (ovum). During formation, people born with an equal proportion of tridosha develop sama prakriti while those with predominance of vata,pitta and kapha dosha manifests respective prakriti. Psychosomatic expression of dwandvaja Prakriti (Vata pitta, pitta kapha, vata kapha) depends upon the predominance of corresponding dosha involved. Altogether seven shareerika and sixteen manasika prakriti variations exists.[29]

Cognitive strength and weakness among different Prakriti types

Vata Prakriti individuals are always over stimulated, enthusiastic, creative with multi- tasking ability and are highly adaptive. They possess good grasping ability and excellent processing speed but struggle with minimal concentration, increased anxiety, unsteadiness, short term memory and lack sustained focus. Researches suggests that they excel in tasks assessing reaction time but may not perform well in tasks requiring long term memory recall and sustained attention. Pitta individuals are intelligent, adventurous, possess goal- oriented behaviour and analytical skills. Disadvantages include short temper, easy irritability and impulsivity. They excel in tasks requiring problem solving and decision-making skills. Kapha Prakriti individuals may learn more slowly but excel in tasks require sustained attention. General cognitive strength, weakness elaborated in Table 1.

Table 1: Cognitive and behavioral traits of shareerika prakruti.

Vata prakṛti	Pitta prakṛti	Kapha prakṛti
Shruta grahino alpa smrutayashcha (Quick in understanding and forgetting things)	Kleshasahishnu (inability to face difficult situation)	Manda Cheshta vihara (Slow in action)
Jagarooka (alert)	Kshipra Kopa Prasada (Short tempered)	Aseeghra arambha kshobha vikara (Slow in affliction with fear)

Continued.

Vata prakṛti	Pitta prakṛti	Kapha prakṛti
Chapala gati Cheshta vihara (Inconsistent action and movements)	Medhavi(intelligent)	
Seeghra trasa raga viraga (Quick in affliction with fear with quick likes and dislikes)	Nipuna Mati(skilled)	Vidyavanta (learned)
Matsarya (competeteive)	Vigruhya Vakta (Confident speaker)	Shanta (Calm)
Krodhi (angry)	Samitishu Durnivara veerya (undefeatable during debate)	Krutanja(grateful)
Adhruti (no retension power)	Shoora (Courage)	Dhrutiman (Good retention power)
Anavasthita atma, mati (Unstable mind)	Mani (Pride)	Sahishnu (Tolerant)
Chala Dhruti smruti budhi Cheshta (inconsistent memory, intelligence)	Vibhava sahasa budhi bala (adventurous)	Chiragrahi (Slow understanding)
Na jitendriya (cannot control sense)	Pandita (highly learned)	Klesha Kshama (Tolerant)
Itihasa priya (likes history)		Manayita Gurunam (Respect towards teachers)
		Druda shastra mati (Good understanding of texts)
		Parinishchita Vakya pada (True to his words)
		Budhya yukta (intelligent)
		Smrutiman (good memory)
		Deerghadarshi (forsighted)
		Kshamavan (Patience)
		Deergha sootra (Procrastination)

Table 2: Influence of dinacharya on neuroplasticity and cognition.

Dinacharya practice	Mechanism of action	Neuroplastic changes
Brahma muhurta uthishta (early rising)	**Waking** up early aligns the body with the circadian rhythm, regulates the secretion of hormones such as melatonin, cortisol, epinephrine, and norepinephrine, and influences the expression of genes that control daily diurnal activities. Sun exposure promotes the production of vitamin D and triggers the release of nitric oxide and endorphins. Endorphins enhance mood and helps to emotional well-being. Nitric oxide acts as an antioxidant and exhibits free radical-scavenging properties Maintaining a proper sleep-wake cycle supports circadian and neuro-endocrine rhythms by balancing serotonin and melatonin, repairing damaged cells, and aiding in DNA restoration.	Evidence suggests that practice of yoga during Brahma Muhurtha helps in supporting hippocampal health and overall brain plasticity.
Abhyanga (Oil massage)	Oil massage improves circulation Stimulate nerve ending and reduce stress by vagal dominance. It helps to lower cortisol and oxidative stress	Stress reduction favors hippocampal neuroplasticity. Enhances neurogenesis and inhibit neuroinflammation
Vyayama (Exercise)	Improve circulation to the brain, providing oxygen and nutrients essential for synaptic repair and formation.	Increases BDNF*
Shakrut munchana	Gut motility is a complex process comprising multilevel neural and hormonal control from the colon up to the central nervous system. Gut functionality affects the microbiome and subsequently central nervous system through linkages of the enteric nervous system and microbiome	Microbiome disturbances effect CNS** pathways
Nidra (Sleep)	Enhances glymphatic activity	Efficient glymphatic activity helps prevent the accumulation of neurotoxic substances. Supporting optimal neuronal function. Disruptions in glymphatic function can lead to the accumulation of toxins

*BDNF: Brain-derived neurotrophic factor, **CNS: Central nervous system

Hypothesis on prakriti-neuroplasticity connection

Vata individuals with their high adaptability might exhibit higher baseline neuroplasticity. However, their restlessness tendency can negatively impact cognitive adaptation in stressful situation leading to difficulty in maintaining sustained plastic changes.

Pitta individuals also exhibit efficient neuroplastic changes since they have analytical mind and keen focus but due to their impulsivity and strive for perfectionism limit their cognitive flexibility.

Kapha individuals with their inertia shows very less neuroplastic changes but the acquired plasticity will be retained for longer time. They require constant stimulation for cognitive flexibility.

CHARACTERISTICS OF SELECTED ARTICLES

A total of 69 full-text articles were selected, and the extracted data was categorized, analyzed, and consolidated according to the review theme. These articles were sourced from 59 different journals, with the majority published by frontiers media **(**Frontiers in psychology, frontiers in human neuroscience). The distribution of articles across other journals is summarized in Figure 1. The highest number of articles used in the review were published in 2019 (10.1%), as illustrated in Figure 2. Additionally, the review incorporated references from classical Ayurvedic *Samhitas* (2.4%), E books (7.2%), dissertation (2.4%), website (2.4%). Of the total articles, 37 were utilized in the conceptual study section, while the remaining contributed in discussion section.

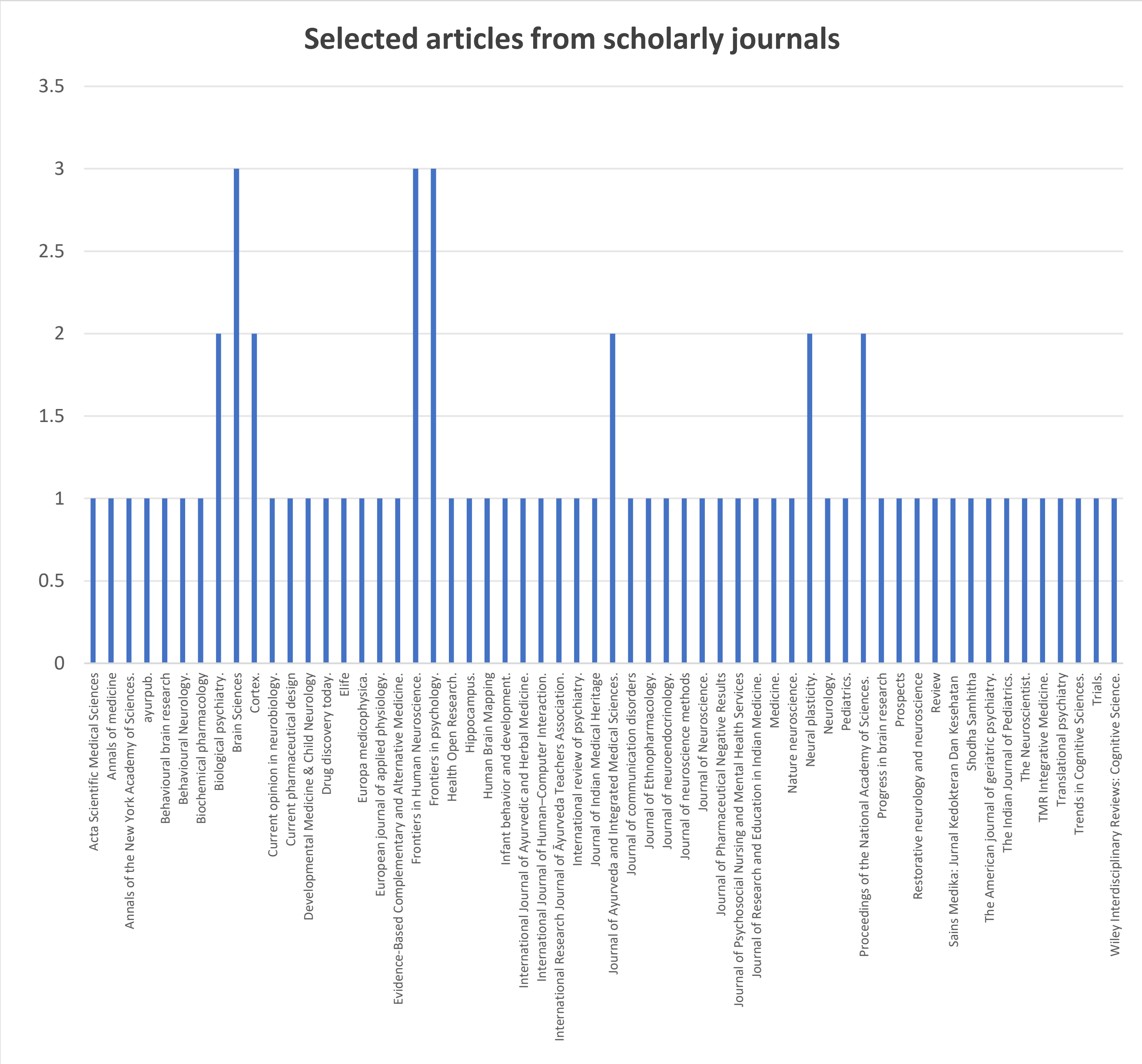

Figure 1: Selected articles from list of scholarly journals.

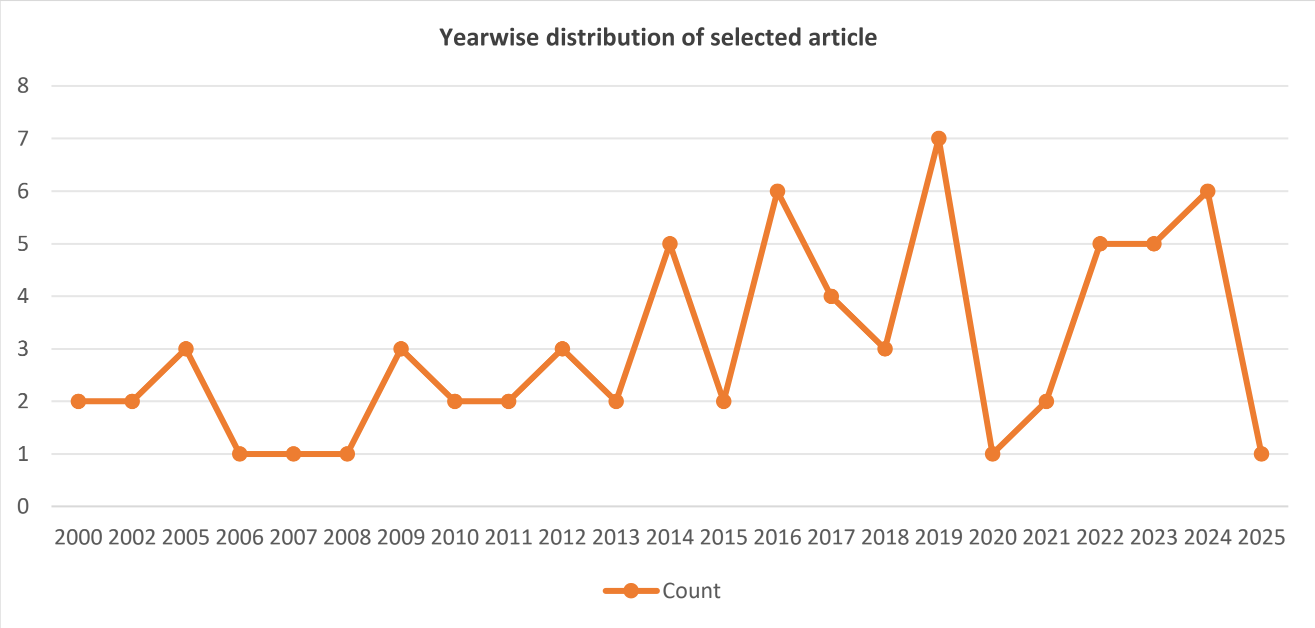

Figure 2: Year wise distribution of selected articles.

DISCUSSION

Recent research has identified key factors influencing neuroplasticity, such as diet, exercise, sleep, etc., which play critical roles in enhancing learning, memory, and cognitive adaptability. These factors have been elaborately outlined in the earlier sections, highlighting their mechanisms and physiological benefits. Ayurveda highlights these aspects through its unique framework, focusing on evaluating how factors like stress, sleep, diet etc. interact with the different prakriti types in relation to neuroplasticity. This section explores these Ayurvedic insights to understand the relationship between these factors and cognitive adaptability.

While these perceptions offer a theoretical framework for linking lifestyle factors to cognitive adaptability, but further researches and empirical validation is essential to substantiate these assumptions and connect traditional knowledge with modern neuroscience.

Factors affecting neuroplasticity from an ayurvedic perception

Role of exercise and reading habits on neuroplasticity

Regular aerobic exercise has been shown to improve both cognitive and motor functions. through neural changes that occur at molecular, cellular, and systems levels within the brain. Individuals with vata and pitta prakriti, characterized by their inclination toward activities involving motion such as hunting (Mrugaya), gardening (udyana priya), traveling (yatra priya), likes in adventurous sports (sahasa priya) may naturally engage in higher levels of physical activity compared to their kapha peers. Hence it is hypothesized that Vata, Pitta Prakruti may experience greater benefit from positive neuroplastic changes induced by physical exercise compared to their Kapha counterparts.

Focused reading and intellectual engagement stimulate neuroplasticity by enhancing cognitive processes like memory consolidation and synaptic remodeling. Kapha individuals' predisposition for activities like Śrutadhara (fond of reading or listening classical texts) or Śruta śāstra priya (fond of reading or listening classical texts) may support neuroplastic adaptability by promoting sustained mental stimulation and cognitive resilience.

Ayurvedic practices and other key factors supporting neuroplasticity

Ayurvedic practices like dinacharya (daily regimen), diet, herbal drugs, yoga and mind-fullness meditation also support neuroplasticity. To facilitate understanding, the role of dinacharya and herbal medicines are tabulated, and influence of diet, yoga and mindfulness meditation are discussed in detail below.

Dinacharya practices supporting neuroplasticity

Dinacharya stabilizes the mind by synchronizing body's circadian rhythm with external environment, minimizing hormone fluctuations, and addressing Prakriti-specific challenges like anxiety in Vata, irritability in Pitta, and lethargy in Kapha. Tailored routines such as abhynga (oil massage), warm grounding practice for Vata, cooling practices such as shiro abhyanga for Pitta and regular, stimulating exercise (Vyayama) etc. for Kapha enhance optimal brain plasticity and function.[30,31] Dinacharya improve neuroplasticity by enhancing sleep quality and by boosting BDNF through exercise etc (Table 2).

Prakriti-based diet for neuroplasticity

Prakriti-specific approaches to diet and digestion promote gut-brain axis health, regulate neurotransmitter activity ensuring cognitive performance. Vata prakriti individuals are characterized with vishamagni (erratic digestive fire), bahu bhuk (frequent and excessive eating), indicating a potential tendency toward irregular food habits, that necessitate greater dietary discipline to optimize neuroplasticity, as modern research states the role of consistent, balanced nutrition in brain adaptability. To balance erratic digestive nature (Vishamagni) of vata and to promote stability and calmness; warm food enriched with healthy fats like ghee, complex carbohydrate, food of sweet, salt predominant etc. should be advised. Individuals with pitta prakriti display characteristics such as Prabhūta āśana, Danta śūka (frequent and excessive gluttons). Their excessive food consumption may contribute to metabolic stress, requiring mindful dietary practices to leverage neuroplastic benefits. Emphasis should be given on avoiding spicy, oily, fried, alcohol and other caffeinated beverages which can intensify pitta. Cooling diets with adequate hydration and regular mealtimes are particularly beneficial for Pitta individuals. Kapha individuals should consume a low-fat, high-fiber diet with warm, light, and spicy foods is ideal for managing Kapha's lethargy and heaviness. Those individuals are known for their tendency toward slower metabolism and higher fat accumulation, are more prone to obesity, that may be producing negative neuroplastic changes. Proper interventions, combined with strategies like intermittent fasting, caloric restriction could mitigate oxidative stress in Kapha Prakruti.[32,33]

Effect of yoga and meditation practice on neuroplasticity

Yoga enhances brain health by increasing BDNF, Sirtuin 1 and Telomerase activity. It reduces cortisol and inflammatory markers (e.g., IL-6). Long-term yoga practice boosts brain volume in regions like the hippocampus, somatosensory cortex, and orbito-frontal cortex, enhancing body awareness, emotional regulation, and parasympathetic activity. Various postures during yoga contribute to changes in body awareness regions like somatosensory cortex and Superior Parietal lobule. Meditation minimizes these distractions and helps in strengthening sustained attention activities; thus, it enhances neural circuits related to attention and cognitive control. It augments structure and function of brain by increasing gray matter density in regions like hippocampus, insula, and precuneus. It also increases white matter, and cortical thickness. Meditation decreases default mode network activity, reduces mind-wandering, and promotes synaptic strengthening, neurogenesis, and stress-response regulation. Techniques like mindfulness meditation strengthen prefrontal cortex, reduce amygdala activity, and improve emotional regulation, while focused attention meditation amplifies sensory awareness and reinforces prefrontal and anterior cingulate cortex connections.

Vata types should engage in gentle exercises in moderation, avoiding over exertion to stabilize their instability (Chalatva). Mindfulness meditation focusing on breath awareness can reduce anxiety in Vata individuals. Different yogasana, surya namaskara, pranayama such as anuloma viloma, ujjai, bhramari, sukshma vyayama and meditation are best suited for vata prakriti. Dynamic yoga, power yoga, bikram yoga, suryaranuloma viloma pranayama (right nostril breathing) should be avoided. For those with a Pitta constitution, engaging in moderate-intensity activities that have a cooling effect is beneficial. Calming meditation techniques, such as guided imagery or loving-kindness meditation, can help foster patience and reduce anger in Pitta individuals. Pranayama such as chandranuloma villoma (left nostril breathing), sheetali-sheetkari-sadanta, Bhramari and meditation can be advised. Dynamic yoga, power yoga, Bikram yoga, suryaranuloma viloma pranayama should be avoided. Kaphaja types should be engaged in regular and sustained physical stimulating activities to counteract their tendency towards inactivity. Energizing meditation techniques, such as dynamic meditation or chanting, can promote alertness and motivation in Kapha individual. Chandranuloma viloma pranayama (left nostril breathing), cooling pranayama like sheethali, sheethkari and sadantha pranayama should be avoided.[33-36]

Stress handling and neuroplasticity across different prakriti types

Acute and chronic stress can negatively impact neuroplasticity. Acute stress disrupts hypothalamo pituitary adrenal axis, results in the secretion of cortisol which can impair hippocampus, whereas chronic stress results in reduction dendritic branching in the prefrontal cortex, impair hippocampal neurogenesis and synaptic connectivity, affecting learning and memory. Stress handling capacity is distinct in different prakriti group. Giri et al in their study observed that this feature is more for either kapha vata or kapha pitta prakriti compared to vata pitta group. stress handling trait, reaction to stress and their effect on neuroplasticity based on different prakriti are summarized in Table 3.[37]

Modern neuroscience techniques for neuroplasticity

Modern science offers various approaches to enhance neuroplasticity, including cognitive training techniques such as strategy games, brain-training apps, puzzles, video games, and virtual reality (VR) training. Behavioral therapies, like exposure therapy and cognitive-behavioral therapy (CBT), are also effective. Skill-based learning, such as learning a musical instrument or a new language, plays a significant role, along with the administration of nootropics and neuromodulators in boosting neuroplasticity. Therapeutic interventions like constraint-induced movement therapy (CIMT) and brain stimulation techniques, including transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS), are further contributors. Details of various modern neuroscience techniques to improve neuroplasticity, its mechanism of action and relevant application have been detailed in Table 4.[38-59] It can be hypothesized that vata prakriti individual's hyperactivity and anxiety may get more stabilized by interventions like TMS and TES. Pitta individuals, characterized by goal directed behaviour, may show faster results with therapies that involve clear objectives (e.g., CBT, CIMT). Kapha individuals, with slower adaptability and tendencies toward lethargy, may require stimulating or prolonged interventions to overcome neural inertia and achieve similar cognitive effects.

Summary of prakriti based neuroplastic responses to diverse interventions

Cognitive traits, neuroplastic responses, and Ayurvedic interventions for different prakriti types have already been discussed in detail in previous sections. However, the following table (Table 5) summarizes these key correlations in structured format. Further interdisciplinary research works are needed to validate these concepts and to bring about an evident based integrative frame work to enhance cognitive health and brain adaptability.

Table 3: Stress handling trait, reaction to stress and their effect on neuroplasticity based on different prakruti.

Prakruti	Stress handling trait	Assumptions from traits	Reaction to stress	Effect on neuroplasticity
Vata	Śīghra kṣobha (quickly gets irritated) Śīghra rāga virāga (quickly attached and detached) Śīghra vikāra (quick affliction to diseases) AdhanyaStena (stealing/hiding/plagiarism Mātsarya (jealous), Anārya (uncivilized) Kṛtaghna (ungrateful) Lolupa(lack of self-control) Hīna sattva (less tolerance power and gets frightened easily) Anavastitatma and chala manas (Unstable mind)	Stress handling trait indicates that Vata prakruti suffers difficulty in handling stress	Reacts with anxiety Highly susceptible to stress. Unstability in emotions and mind	Vata types may experience greater disruptions in neuroplasticity due to their susceptibility to stressful situation and less stress handling capacity
Pitta	Kṣipra kopa prasāda (becomes angry quickly and gets pleased quickly) Sūra (very brave/valor) Māni (egoist/superiority complex VibhavaSahasa budhi(very brave/valor) Bhūri krodha (short tempered) Bhūri īrṣyā (competitive spirit) Kleśa bhīru (less tolerance power and gets frightened easily)	They are emotionally unstable with less tolerance. Hence difficulty in handling strait	Reacts with anger Highly susceptible to stress Instability in emotions and always have competitive spirit	
Kapha	Klesha asahishnu (tolerant) Alpa kṣobha (less agitated) Krutanja (grateful) Sahiṣṇu (tolerant for physical/ psychological strain) Alolupa (have self-control) Sāttvika (person having thoughts, deeds and actions taking towards illumination and eternal enlightenment), Duḥkha atapta (tolerant for physical/ psychological strain) Alpa krodha (calm and patient/less anger) Stira mitram (stable and cordial friendship and Kṣamāvān (forgiveness)	Emotional stability, tolerance, and self-control traits are good Hence they have better stress handling traits compared to their peers	Reacts less intensely to stress. Slower to react to short-term stress rresilient but slower to recover from long-term stress	Kapha types may be less affected by short-term stress and slower to recover from long-term stress challenges.
Satvika prakruti	Jitātmana (self-controlled) Samaṃ sarvabhūteṣu (favourable disposition equally for all creatures) Kāma krodha lobha māna moha īrṣyā amarśopeta m (freedom from passion, rage, greed, pride, ignorance, grief) Upaśānta mada māna rāga dveṣa (devoid of pride, wildness, hatred and greed) Praptakāri (understanding of good and bad deeds follows accordingly)	Emotionally stable and good tolerance. Hence, they have better stress handling traits compared to their peers	Reacts calmly to stress Exhibits emotional stability	Inherent resilience minimizes stress impact on neuroplasticity Stable emotional responses support and healthy cognitive adaptability

Continued.

Prakruti	Stress handling trait	Assumptions from traits	Reaction to stress	Effect on neuroplasticity
Rajasika prakruti	Śūraṃ (Bravery) Cāṇḍam/Krūraṃ (cruelty) Asūyakaṃ(envy) Raudram (terrifying appearance) atma poojakam (indulge in self-praise) Amarśinam (Intolerance) Anubandha kopam (constant anger) Īrṣyā (envious disposition) Ati lolupa (excessive greediness) Anavasthitam (unsteadiness and ruthlessness)	They are emotionally unstable with less tolerance. Hence difficulty in handling strait	Reacts more aggressively and has less mental re-silence during stressful situation	Exponential increase in stress levels impairs neuroplasticity Increased susceptibility to dendritic and synaptic disruptions
Tamasika prakruti	Durmedhasa tvam (unintelligent) Anavasthitam (unsteadiness) Sarva buddhī aṅga hīnam (lack of the intellectual faculties)	Less appreciation of stress	Less prone to stressful situation as they don't perceive every situation as stressful	Chronic stress severely impairs neuroplasticity Pronounced reduction in learning, memory, and synaptic adaptability

Table 4: Modern neuroscience techniques for neuroplasticity.

Intervention	Mechanism of action	Key neuroplastic effects	Effect on cognition
Cognitive training methods, such as puzzles	Engages prefrontal brain networks through puzzles, games, and strategy tasks	Strengthen the prefrontal cortex Improve the integrity of grey matter in areas of the brain like the occipital-temporal cortex. Boost plasticity in areas like the middle and inferior frontal gyrus. Promotes both excitatory and inhibitory neurotransmitter system activation. Repair damaged neural circuits	Improve working memory, attention, and problem-solving skills
Virtual reality (VR)‡	Provide 3-dimensional virtual environment that replicates real life scenario and engaging motor and cognitive neural circuits for spatial navigation, memory, and problem-solving.	Stimulates motor and cognitive circuits Promote synaptogenesis Create new neural pathways related to spatial navigation, memory, and problem-solving	Processing speed, working memory and sustained attention.
Exposure therapy	Gradually introduces an individual to a feared or avoided stimulus in a controlled manner through *in vivo* exposure (direct confrontation of feared and avoided situations), imaginal exposure (detailed imagining or remembering of feared and avoided thoughts), and interoceptive exposure (exercises designed to elicit feared physical sensations)	Rewire the mal-adaptive neural pathways Strengthen adaptive responses to cope up with stress.	Enhances emotional regulation, stress resilience, and cognitive flexibility
Transcranial magnetic stimulation‡ (TMS)	TMS generates a magnetic field through a coil placed on the scalp, inducing an electric current in the brain, which depolarizes neurons.	Repetitive TMS (rTMS) can cause long-term potentiation (LTP) or long-term depression (LTD) Produces NMDA receptor activity, dendritic spine growth, and release of neurotrophic factors like BDNF. Structural changes include increased gray matter density in specific brain areas like the anterior cingulate cortex. Frequency, intensity, and targeted brain region during TMS procedure dictate the direction (facilitatory vs. inhibitory) and the magnitude of neuroplastic effects.	Cognitive flexibility, working memory, and attention Improve prefrontal cortex function, which is critical for executive tasks, decision-making, and emotional regulation

Continued.

Intervention	Mechanism of action	Key neuroplastic effects	Effect on cognition
Transcranial electric stimulation (TES)‡ Subtypes: transcranial direct current stimulation (t DCS)‡ Transcranial alternating current stimulation (t ACS)‡ Transcranial random noise stimulation (t RNS)‡	TES involves applying a weak electric current to the scalp, modulating neuronal excitability by shifting the resting membrane potential.	Promote long-term plasticity, in areas like the occipital cortex Cortical excitability is increased or decreased in anodal t DCS, cathodal tDCS respectively tDCS induces LTP/LTD, releases BDNF and several neurotransmitters Activate NMDA, GABA‡ receptors Activate signalling pathways Modify subcortical and deeper structures associated with stimulated cortical area Establish synaptogenesis tACS modulates neuronal oscillations and synchrony tRNS adds random noise to brain signals to enhance plasticity	Improve executive function, working memory cognitive flexibility, and processing speed
Constraint-Induced Movement Therapy (CIMT)‡	Designed to improve the functional use of neurologically impaired limb, by constraining unaffected limb and promoting use of affected limb.	Improves expansion of motor cortical maps for the affected limb. Increased activation has been observed in motor-associated brain regions such as the bilateral cerebellum, premotor cortex, and primary motor cortex. Encourage use dependent plasticity, increases the recruitment of neurons in both the lesioned and unlesioned hemispheres with a greater emphasis on the lesioned hemisphere.	Use-dependent plasticity also enhances problem-solving and cognitive control through increased activation of the affected hemisphere.
Nootropic	Substances that enhance cognitive functions such as memory, creativity, attention, and motivation in healthy individuals or those with cognitive impairments.	Lower adenosine levels, raise acetylcholine levels in synapses and monoamine oxidases Provide long-term potentiation by altering glutamate receptors in the brain. Improve mitochondrial activity Lower neuroinflammation Enhance BDNF‡ levels.	Improves mental functions including memory, motivation, concentration, and attention
Neuromodulators	Chemicals (Dopamine, serotonin etc) in the nervous system that regulate and modulate the activity of neurons and neural circuits	Influence neuroplasticity by boosting do wnstream signalling cascades like CRE B and neurotrophic factors like BDNF. Activated CREB supports neurogenesis by promoting BDNF transcription. Acetylcholine and norepinephrine impro ve the signal-to-noise ratio, control cortical activity, and promote neuronal excitability. Dopamine improves auditory cortical representations and the cortical signal-to-noise ratio.	Enhances reward-based learning, attention, and motivation, memory and learning

*‡VR: Virtual reality, CBT: Cognitive-behavioral therapy, CIMT: Constraint-induced movement therapy, TMS: Transcranial magnetic stimulation, tDCS: Transcranial direct current stimulation TES: Transcranial electrical stimulation, tRNS: Transcranial random noise stimulation, CREB: Cyclic AMP response element binding protein, BDNF: Brain derived neurotrophic factor, LTD: Long term potentiation, LTD: long term depression, GABA: Gamma aminobutyric acid, NMDA: N-Methyl D-Aspartate.

Table 5: Summary of integrative framework that combines ayurvedic and neuroscientific approaches to optimize cognitive health with special reference to Prakruti.

Prakruti	Cognitive trait	Neuroplastic responses	Optimal intervention
Vata	Exhibit good grasping power but tend to have minimal retention power. They possess strong competitive spirit but have unstable mind and intelligence. Poor decision-making capacity, challenges with sustained attention, easy distraction	They exhibit excellent neuroplasticity due to their high adaptability. Stress susceptibility, restlessness may significantly hinder retention and stability of plastic changes they achieve.	Yoga: Yogasana, surya namaskara, pranayama: anuloma viloma, ujjai, bhramari, sukshma vyayama. Diet: Warm food with healthy fats like ghee, food of sweet, salt predominant. Neuro-scientific therapy: CBT§ to manage anxiety. Herbal nootropics: Aswagandha, Brahmi etc to manage stress.

Continued.

Prakruti	Cognitive trait	Neuroplastic responses	Optimal intervention
Pitta	Highly intelligent, goal directed, and possess excellent analytical and communication skills. Their adventurous nature and strive for perfectionism make them highly impatient and impulsive.	They exhibit efficient neuroplastic changes in goal driven tasks due to their keen focus and drive for perfectionism. Stress may negatively impact cognitive flexibility.	Pranayama: Chandranuloma viloma, sheetali-sheetkari-sadanta, Bhramari. Diet: Cooling diets with adequate hydration and regular mealtimes. Herbal nootropics: Shatavari *(Asparagus racemosus),* amla (*Emblica officinalis*). Neuro-scientific therapy: CBT§ to relieve stress and impulsivity.
Kapha	Takes time to initiate activities and may be slow in grasping new information. They possess excellent retention power and deep intelligence. Their tendency to procrastinate everything, slower adaptability and inertia to commence tasks can be draw back.	They adapt more slowly to dynamic situations resulting in lower neuroplastic changes. However once neural changes are established, they are able to maintain it for longer duration. Consistent high threshold stimulus is essential to induce and maintain these changes	Diet: Low-fat, high-fiber diet with warm, light, and spicy foods. Neuro-scientific therapy: CIMT§ to activate neural circuits and enhance motor neuroplasticity. TES§ to stimulate underactive cognitive pathway. Dinacharya: Udvartana (powder massage) and Vyayama (physical exercise) Herbal nootropic: Haridra to increase mental alertness.

§CBT: Cognitive behavioral therapy, CIMT: Constraint-induced movement therapy, TES: Transcranial electric stimulation.

Challenges and limitation

Despite the fact that ayurveda provides thorough explanations of prakriti and cognition, there is lack of empirical research works to validate these concepts with reference to contemporary neuroscience. Since the conceptual frameworks of ayurveda and contemporary neuroscience differ significantly, an interdisciplinary research programs should be established to bridge Ayurvedic concepts with neuroscientific principles. Prakruti traits and neuroplastic responses to different Ayurvedic intervention should be validated by neuroimaging (fMRI, EEG), biomarker analysis (BDNF, cortisol, neurotransmitters), and cognitive performance tests. Ayurveda offers black box design (multi-modal interventions like diet, herbal medicine, yoga etc.), it's challenging to find out the impact of individual component on neuroplasticity in controlled trial settings.

Future research prospects

Develop longitudinal studies to examine the long-term impact of ayurvedic practices like dinacharya on cognitive health and neuroplasticity across various age groups. Establish interdisciplinary collaborations to explore the influence of Ayurvedic interventions on brain remodeling and adaptability.

CONCLUSION

Neuroplasticity plays a pivotal role in cognitive health, learning, and adaptability, and its modulation is influenced by numerous factors such as diet, lifestyle, stress, and therapeutic interventions. Each prakriti exhibits distinct baseline neuroplastic patterns, driven by their inherent physiological and neurocognitive tendencies. These constitutional differences influence the nature, pace, and stability of adaptive neural processes. Incorporating Prakriti based knowledge with contemporary understanding of neuroplasticity provides a personalized and constitutionally aligned framework to enhance neural adaptability for each prakriti group, contributing to the advancement of cognitive health. The integrative model must be supported with empirical validation including the identification of reliable biomarkers, development of standardized protocols, and establishment of robust clinical evidence.

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