



Default Mode Network (DMN) for Human Five Senses and Sensory Environments

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Abstract

The default mode network (DMN) plays a crucial role in sensory perception. The primary roles of the DMN include preparing for crises, predicting future events, and organizing information and memories. It comprises brain regions such as the medial prefrontal cortex, posterior cingulate cortex, precuneus, and inferior parietal lobule. For the five senses, including visual, auditory, olfactory, gustatory, and tactile senses, the activation of a combined multisensory network is important. Such integration may foster a more natural and stable psychological state. From a psychosomatic health point of view, prescribing, adopting, and designing sensory environments may contribute substantially to supporting our daily wellness and happiness in the future.

Keywords

Default Mode Network, Autonomic Nervous System, Designing Sensory Environments, Integrative Medicine, Mindfulness

Abbreviations

ANS: Autonomic Nervous System; CAM: Complementary and Alternative Medicine; DMN: Default Mode Network; EEG: Electroencephalography; EM: Eastern Medicine; fMRI: Functional Magnetic Resonance Imaging; HRV: Heart Rate Variability; IM: Integrative Medicine; IPL: Inferior Parietal Lobule; mPFC: Medial Prefrontal Cortex; PCC: Posterior Cingulate Cortex; PCD: Positive Constructive Daydreaming; WM: Western Medicine.

Commentary

What constitutes the foundation of health promotion? Across fields such as general medicine, internal medicine, primary care, and integrative medicine, three fundamental factors exist: nutrition, exercise, and sleep, which serve as the physical basis for health. From a psychological perspective, the regulation of the autonomic nervous system (ANS) is crucial. It is

also important to maintain appropriate awareness of the five senses: sight, hearing, smell, taste, and touch. Achieving a balance among these elements has become a topic of significant interest in recent years.

In this field, concepts in psychosomatic and holistic medicine have played vital roles, such as yoga in complementary and alternative medicine (CAM) and

mindfulness in holistic care [1]. The concept of Eastern medicine (EM) may offer a rather accessible framework. EM has adopted a monistic view that the body and mind mutually influence one another. In contrast, Western medicine (WM) usually treats physical medicine and psychology as separate entities. WM has adopted a dualistic perspective, where the body and soul exist separately. In this regard, it is likely important for people to consciously direct their attention to their five senses in their daily lives and to cultivate an environment that supports sensory well-being (Table-1).

Table-1: Five Senses for Cultivating Sensory Environment

No.	Recommendations
1	Soak up the morning sunlight to reset internal clock.
2	Start the day listening to favorite or natural music.
3	Enjoy the aroma of warm beverage during breaks.
4	Rest the eyes by gazing green trees with calmness.
5	Dim the lights in the evening for reducing stimulus.
6	Take deep breaths listening to comfortable music.
7	Pay attention to soft bedding and relaxing textures.
8	Create adequate environment for high-quality sleep.

When considering human sensory perception, the default mode network (DMN) plays a crucial role. The DMN is a neural circuit that activates when the brain is not engaged in conscious activity, in other words, when the mind is wandering or at rest [2]. It comprises brain regions such as the medial prefrontal cortex (mPFC), posterior cingulate cortex (PCC), precuneus, and inferior parietal lobule (IPL) (Fig-1). While consuming

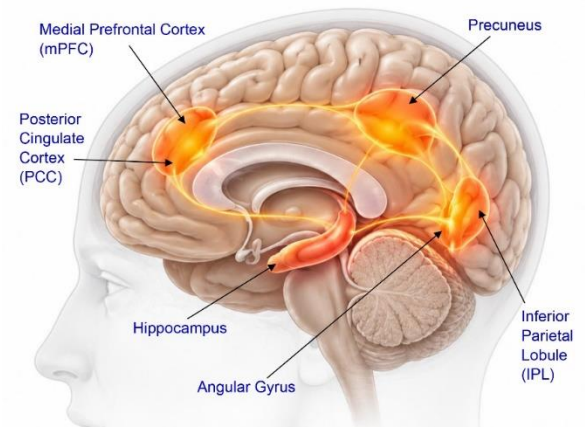


Fig-1: Key brain regions of the Default mode network (DMN)

a significant portion of the brain's energy, approximately 60-80%, it performs tasks such as organizing memories and predicting future events.

The primary roles of the DMN include i) preparing for crises and ii) organizing information [3]. The former is similar to the idling state of a car. If the brain were to shut down completely, it would struggle to react to sudden emergencies. Thus, the DMN keeps a part of the brain in standby mode, ready for immediate action. The brain is thought to process information through the following three stages: a) Input: gathering information via the five senses; b) Organization: sorting and selecting the input information; and c) Output: expressing information through words or actions.

Among these, the DMN plays a particularly crucial role in organization during the second stage. If the DMN functions poorly, information remains disorganized, potentially leading to brain exhaustion. This carries risks such as the failure of input information to consolidate in the brain and an overall decline in brain activity. Proper functioning ensures that information is effectively organized. Meditation and daydreaming are among the simplest and best-known ways to engage the DMN. Daydreaming is easier than meditation; specifically, daydreaming that evokes a pleasant mood is known as Positive Constructive Daydreaming (PCD) [4]. PCD is considered effective for releasing the brain from a state of intense focus and allowing the mind to relax.

The key roles of the DMN can be summarized as follows. They are: 1) Memory organization and integration: It organizes information acquired in daily life and past experiences. It can consolidate them into memory. 2) Generation of creativity and insights: It connects pieces of information at a subconscious level to produce good ideas. This can occur during moments of relaxation and free-flowing thought, such as taking a bath or going for a walk. 3) Self-awareness and introspection: It facilitates processes such as contemplating one's identity, reflecting on the past, and inferring the feelings of others [5].

Recently, digital bathing has attracted attention as a form of self-care that combines sensory stimuli, such as visuals, sound, scent, and light, to replicate the

physiological and psychological effects of natural environments [6]. Scientific research in forest medicine has reported reductions in cortisol levels and improvements in heart rate variability (HRV), while EEG studies have shown increases in α/θ waves. Furthermore, functional magnetic resonance imaging (fMRI) findings indicate suppressed amygdala activity alongside modulation of the prefrontal cortex and the DMN. Consequently, research into music therapy and mindfulness has demonstrated ANS stabilization, emotional regulation, and improved attentional function, with sensory integration driven by multisensory stimulation considered a key mechanism underlying these effects.

From the perspective of sensory integration, the human brain cannot derive a full sense of security from visual input alone. By combining visuals, sound, scent, and light, and even temperature and tactile sensations, a multisensory network is activated. Such integration may be associated with fostering a more natural and stable psychological state. fMRI studies on mindfulness meditation have also demonstrated that focusing attention on breathing or natural sounds suppresses excessive activity in the DMN [7]. Consequently, this can heighten the required concentration on the present experience. Indeed, digital technology cannot fully replace authentic nature, but it holds significant value as a complementary means of bringing nature into our living spaces. This is because we cannot frequently visit outdoor environments such as forests, mountains, or seashores.

Modern healthcare has entered an era of integrated treatment approaches that transcend traditional boundaries. One highly original method involves the fusion of music therapy, integrative medicine, and preventive medicine. Moving forward, the effects of digital bathing can be quantitatively evaluated by combining objective indicators such as the HRV 5-axis model, electroencephalography (EEG), and fMRI. This paves the way for future developments toward a "Sensory Environment Prescription" optimized for each individual [8]. At home, we can avoid looking at a smartphone before bed. Instead, practicing deep breathing while enjoying visuals of forests or starry skies and the sound of waves can boost parasympathetic

nervous system activity. In recent years, various wearable devices that easily measure HRV and sleep patterns have become common. Thus, an era has arrived in which we can objectively evaluate the music and environments best suited to us. In the field of music therapy, personalized approaches utilizing physiological indicators are also advancing, opening up new medical possibilities for prescribing sensory environments [9].

Promoting health involves more than just exercise and nutrition. In the light of environmental medicine, it becomes crucial to consider the sensory stimuli that surround us in our daily lives. In an office setting, forest imagery with natural sounds can be shown for just 5-10 minutes during a lunch break. Adjusting lighting to warmer tones and incorporating houseplants or wooden elements can help. Even simply introducing the gentle scents of cypress or citrus may improve work efficiency and mood. In the workplace or at home, it is important to have a perspective on adopting sensory environments [10].

While the digital society has distanced us from nature, it has also spawned technologies that allow us to reintegrate nature into our lives. Human experience of nature using digital technology has become a practice that consciously combines visuals, sound, scent, and light to harmonize the five senses. It is not about pitting nature against technology, but rather about developing a new health strategy that brings them into balance. Even though people may not have time to visit a forest, it is possible to connect with nature through human senses. The perspective of "designing sensory environments" may become a crucial pillar supporting well-being in music therapy and preventive medicine [11].

In summary, the DMN plays a crucial role in human sensory perception. From a psychosomatic health point of view, prescribing, adopting, and designing sensory environments may contribute substantially to supporting our daily wellness and happiness in the future. It is expected that this article will become a useful reference for holistic medicine and integrative medicine (IM).

Conflict of Interest

The authors have read and approved the final version of the manuscript. The authors declare no conflicts of interest.

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