



# Research Journal of Pharmaceutical, Biological and Chemical Sciences

## Thinking With Your Sixth Sense

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### ABSTRACT

The Vestibular System: A Sixth Sense plays a vital role in everyday life, contributing to a surprising range of functions from reflexes to the highest levels of perception and consciousness. Vestibular stimulation modulates cognition through its connections with concerned brain structures. It is the need of time to identify the importance of vestibular stimulation and to start translational research for the wellbeing and peak performance of human being and also for patient care and treatment.

**Keywords:** thinking, sixth sense, vestibular stimulation

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## INTRODUCTION

The Vestibular System: A Sixth Sense plays a vital role in everyday life, contributing to a surprising range of functions from reflexes to the highest levels of perception and consciousness. Cognition" is a word that dates back to the 15th century when it meant "thinking and awareness [1]. It is the process by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used. Stimulating vestibular system by controlling direction, duration, frequency and intensity. Ideal direction, duration, frequency and intensity are yet to be determined. Rocking is soothing because it is similar to the movements in utero [2].

Vestibular dysfunction involves a complex syndrome characterised not only by reflex deficits but also by attention and memory deficits and anxiety disorders[3]. Vestibular lesions may also lead to cognitive deficits, including deficits in attention, learning and memory [4]. Vestibular impairment have demonstrated difficulty in counting backwards by twos and sevens and exhibit deficits in short-term and working memory on standard psychological tests [5-7] Application of vestibular stimulation activated areas of brain which are involved in learning and memory [8]. Vestibular stimulation improved motor execution during the cognitive task.[9] Noisy GVS is effective in boosting the neurodegenerative brains of patients with multi system atrophy or Parkinson's disease, or both, including those unresponsive to standard levodopa therapy.Vestibular stimulation modulates cognition through its connections with hippocampus, limbic system and neocortex. CVS interfered with emotional circuits and thus attenuated the pleasant and rewarding effect of acquisition [10]. A small literature exists on the use of vestibular stimulation to enhance cognition in humans [1].

The purpose of this article is to review research reports related to vestibular stimulation and its effect on cognition, with the intent of clarifying the present knowledge base in this area, and suggesting future research.

## MATERIALS AND METHODS

Searches of the review study register articles from google.com, pubmed.com, British medical journal.com, Medline, ERIC, frontiersin.org, Scope med and online standardized journals.

### **Controlled vestibular stimulation modulates cognition through hippocampus**

The human hippocampal formation is known to have an important function in various aspects of memory, such as early encoding, consolidation, and retrieval [11]. Various anatomical connections have been proposed to exist between vestibular nuclei and hippocampus [12]. At least three distinct pathways have been proposed to connect the vestibular nucleus to hippocampus (Fig:1). In humans fMRI studies have provided evidence for hippocampal activation during vestibular stimulation [13]. High frequency electrical stimulation of specific vestibular sensory regions of the right labyrinth in anaesthetized guinea pigs induced an evoked field potential in the hippocampal formation bilaterally with a latency with a latency

of about 40ms following stimulation onset [14]. Studies in humans have shown that hippocampal volume can be modulated by spatial memory experience. Bilateral loss of vestibular function is associated with a significant bilateral atrophy of the hippocampus, which correlated with the patients' spatial memory deficits [15]. Spatial navigation critically depends on preserved vestibular function, even when the subjects are stationary, e.g. without any actual vestibular or somatosensory stimulation [16]. Vestibular stimulation induced acetylcholine release in the hippocampus, and acetylcholine is known to facilitate long-term potentiation (LTP) in the hippocampus [17]. Vestibular information modulates hippocampal formation for spatial processing and place cell firing [18].

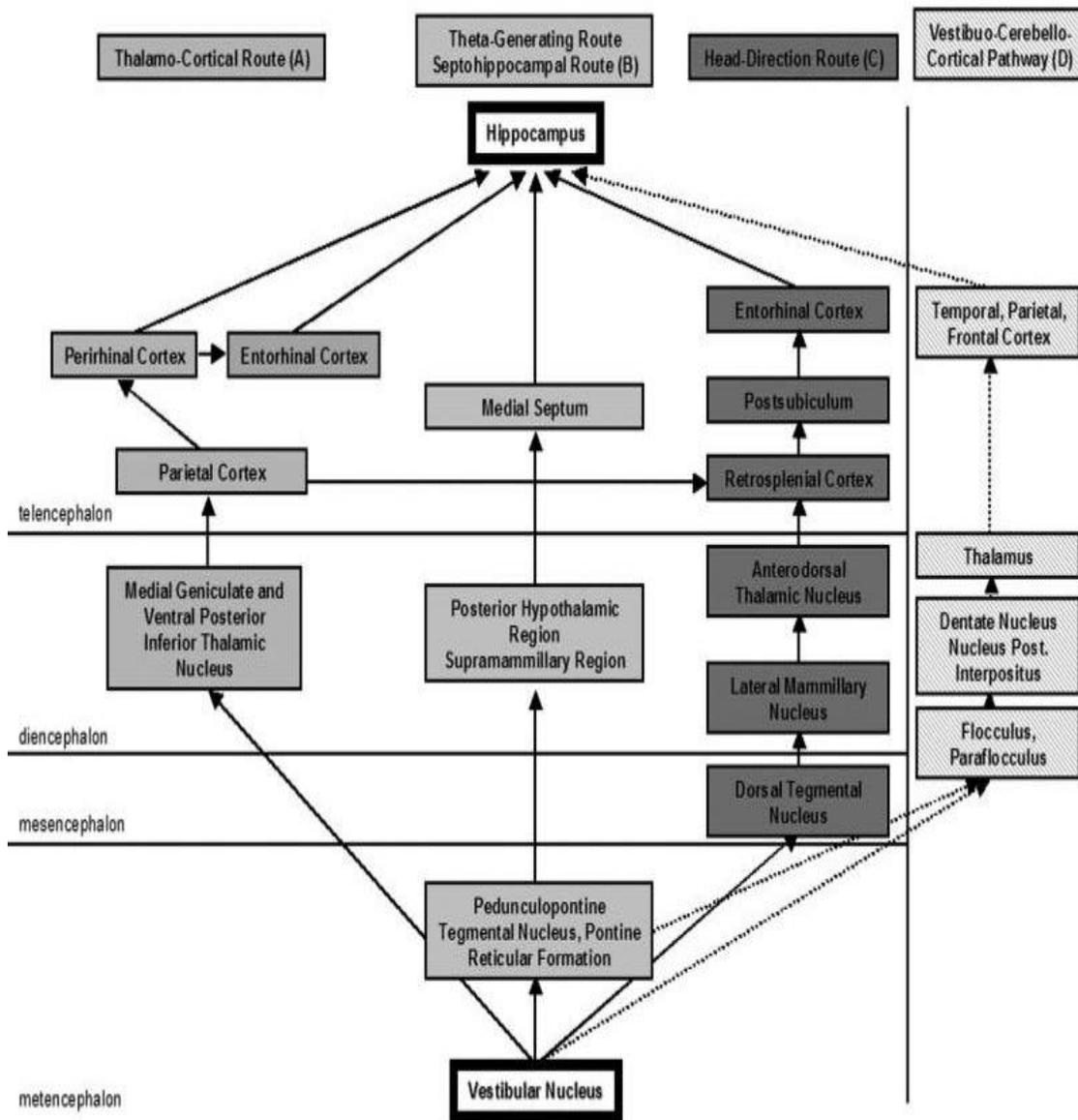


Figure 1: Vestibulo-hippocampal connections

### **Controlled vestibular stimulation modulates cognition through HPA axis**

Chronic stress impairs cognition. Considerable evidence exists of both HPA axis dysfunction and cognitive disturbances [19]. Chronic mild stress exposure-induced impairment of cognitive behaviour might be attributed to the stress-related alterations in brain homeostasis that were reflected in changes in the neuroimmune and neuroendocrine systems as well as in neurogenesis [20]. Vestibular stimulation inhibits both HPA axis and SAM axis and decreases cortisol level and heart rate and blood pressure within normal limits and brings to stress- less condition and modulates cognition [14]. Conversely unilateral vestibular deafferentation (UVD) have been shown to activate the stress axis [21].

### **Controlled vestibular stimulation modulates cognition through neocortex and limbic system**

Emotion has powerful influence on learning and memory. Amygdala, in conjunction with prefrontal cortex and medial temporal lobe, is involved in consolidation and retrieval of emotional memories. Amygdala, prefrontal cortex and hippocampus are also involved in the acquisition, extinction and recovery of fears to cues and contexts.[21] Caloric stimulation of the inner-ear vestibular labyrinth activates the limbic system and neocortex, providing a neuroanatomical link between vestibular stimulation and the limbic dopaminergic system.[22]

### **CONCLUSION**

Vestibular stimulation modulates cognition through its connections with concerned brain structures. It is the need of time to identify the importance of vestibular stimulation and to start translational research for the well being and peak performance of human being and also for patient care and treatment.

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