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Basic Function of Sensory-Motor Transformations for Music Activity Associated with Human Six Senses

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Abstract

In the field of Complementary and Alternative Medicine (CAM), music therapy (MT) has been known and widely accepted. Authors are registered music therapists (rMTs), and continued research for MT and piano-playing. Human has five senses including hearing, sight, smell, taste and touch. Stimuli of auditory, visual and somatosensory data assemble into post parietal region, which are transmitted to prefrontal cortex. This is called as sensory-motor transformations (SMT). Consequently, neuroimaging can demonstrate several factors for activation of various brain areas, which generate the perception of musical and emotional feeling. Further research development is expected for brain function, SMT and piano-playing.

Keywords: Complementary and Alternative Medicine (CAM); Music therapy; Sensory-motor transformations; Neuroimaging; Piano-playing

Introduction

For patient-centered medicine, Complementary and Alternative Medicine (CAM) and Integrative Medicine (IM) have been gradually prevalent [1]. Among them, music therapy (MT) has been known for its acceptable and reasonable situation [2]. Authors et al. have practiced IM, CAM, MT sessions and research for years [3]. We have many music therapists and pianists associated with the office of Shikoku Island division of Integrative Medicine Japan (IMJ) [4]. In this article, some commentary about brain function influenced by playing the piano will be introduced.

Playing the piano requires various factors. They include reading music score, making a judgment, and pushing down the keyboard by 10 fingers with appropriate rhythm and strength. Furthermore, it is necessary for listening the sound, conducting adequate feedback the current music, evaluating the performance and aiming for improved playing in the future. Once the pianist gets used to the piece, he can play without score and improvise freely as he likes. Thus, playing the piano would be various high-dimensional activity [5]. Impressive musical investigation was conducted for a renowned classical pianist in the light of listening, playing, imagining music [6]. Methods included functional MRI and measuring of pupil size from psychological points of view. Several situations gave the influence to pupil size in several circumstances such as silenced playing, normal playing, imagining and listening. Regarding this study, psychophysiological methods may evaluate mental status associated with no awareness of the subject. Before starting piano-playing, auditory and visual abilities are usually involved in the initiating activities. Two types of photoreceptor cells are present, which are cone cells and rod cells. The former can recognize colours in bright places, but its function deteriorates in the dark. The latter is indistinguishable in colour, but can detect even the slightest light, so it works mainly in dark environments. The music score has been written in black on white paper so far. In addition to printed sheet music, portable smartphone screens will be used in the future. Then, there will be possible changes in the role of the retina for reading the sheet music.

Human has five senses which are hearing, sight, smell, taste, and touch [7]. Moreover, the sixth sense has been known in the parapsychology. It is similar to telepathy or psychic power as extra-sensory perception (ESP). When the brain receives these various data, it communicates with other parts of the brain, analyses the information, and makes a comprehensive judgment. This means the process of thinking. As a result, one decides to conduct something

and outputs a signal to move the body. This is the "command to exercise", and the muscles can be moved through the motor nerves. Summarizing the above processes, the brain can complete a series of neural processes [8]. They include the following: i) various sensations are input, ii) thoughts are made, iii) judgments are made comprehensively, iv) commands are output and v) exercise is performed.

What is the process of making a decision to take action after evaluating data from the sensory organs? Visual information from the occipital lobe, auditory information from the temporal lobe, and spatial information of the body from the parietal lobe are combined together to parietal region and sent to the prefrontal cortex (Figure 1).

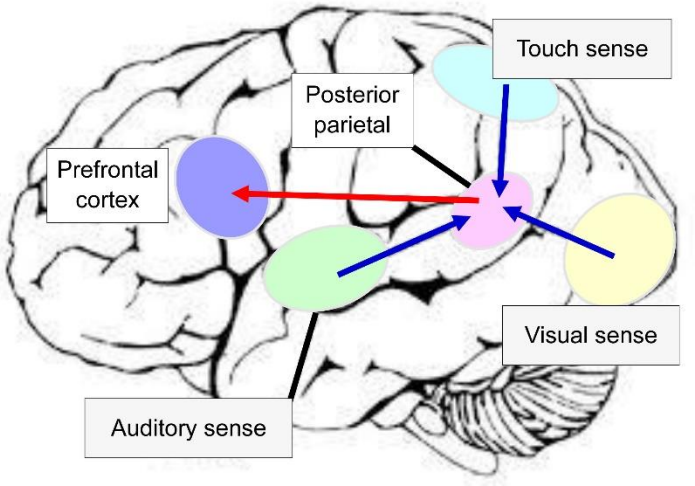

Figure 1: *Scheme of brain function concerning sensory-motor transformations.*

Consequently, it is judged that the situation is ready to start, and then the performance will be started. For older musicians (n=30, 70.8 years), behavioural performance, brain activity, larger grey matter volume (GMV) and functional connectivity (FC) during melodic working memory (MWM) tasks were compared with controls [9]. The results showed that task-related FC showed greater cerebellar-hippocampal FC in musicians, which supposed advantages of music performance, imagery cognitive ability in musicians. When playing a melody on the piano, the pianist sometimes sings himself. Glenn Gould was famous for his groaning loudly while playing Bach [10]. In contrast, humming with a small voice would be better way. Even if there is no actual voice or no breath in and out, vocal cords expand and contract according to the melody.

Regarding human feeling, auditory, visual and somatosensory stimuli assemble into the brain. The region includes inferior parietal lobule (IPL) and superior parietal lobule (SPL).Furthermore, muscle and skin sensations will be added to IPL and SPL [11]. Then, general image of piano-playing is made comprehensively. Finally, the created image in IPL/SPL will be transmitted to premotor cortex (PMC), leading to actual movement. This is sensory-motor transformations (SMT). Through this process, the image created in the parietal area is transformed into the performance that a pianist actually plays on the keyboard. Vigorous debate for SMT has been observed, and cortical localization of SMT was recently investigated. The protocol included whisker detection go/no-go task for male/female mice [12]. The results supposed that i) sensory encoding would originate in S1, sensory amplification and sensory-motor transformation within M1 and motor signals in anterior lateral motor cortex (ALM) after SMT.

If there are no sensory input or motor output, it is difficult to imagine or practice music just within the mind. For the experiment of primates, neural activity of sensory and motor processing hierarchy was investigated [13]. As a result, maintaining rhythm is involved in several brain areas, such as hippocampal, visual, prefrontal, premotor and parietal regions. In order to study corticospinal output changes, 10 professional piano players received transcranial magnetic stimulation [14]. The results showed that specific muscle synergy was emerged for the cross-modal elaboration in the imagery of musical performances. From mentioned above, neuroimaging can demonstrate several factors of musical activation of the brain areas, which generate the perception of musical and emotional feeling [15]. When music is adopted as the therapeutic tools, it can contribute many subjects and patients with various problems for providing somatic and mental beneficial results as music therapy. Further research development will be expected concerning brain function, SMT, piano-playing and related matters.

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Conflicts of Interest

The authors declare no conflict of interest.

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