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Original Article

# Evaluating the Effects of Singing Songs in Ethnic Music Therapy for Dementia Patients with a Novel Near-infrared Spectroscopy (Data Analysis Method)☆

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SUMMARY

*Background:* Dementia is already critical issues in the world. This situation requires establishment of rehabilitation for relieving symptoms of patients. We have done research based on our assumption that most effective music therapy differs from culture, because music is dependent on cultural context. In this paper, we focus on active behavior (sing a song) of music therapy, and studied its effects. We used Near-Infrared Spectroscopy (NIRS) as a method for evaluating effectiveness of music therapy, though standard procedures of NIRS data processing has not been established. This is the reason why we here propose a new analysis method of NIRS data for evaluating effectiveness of music therapy.
*Methods:* We collected 87 volunteers including 79 dementia patients. We let the volunteers hear music prepared by us as follows: 2 famous nursery songs, 2 famous play songs, 2 original music, and 2 classical scale. We observed their response in 2 ways: one is a physiological response measured by NIRS, and the other is a subjective response measured by questionnaires.
*Results:* Our result showed dementia patients prefer Japanese old melodies, but they don't understand tonality of the Japanese music. This tendency is strengthened by adding Song task. Also, dementia patients are poor at careful control of the blood volume change. Our result displayed singing a song induces out-of-control state of brain blood flow in every stage. Our results revealed characteristic responses of dementia patients onto Japanese music.
*Conclusion:* We expect our result provides an evidence for better music therapy for dementia patients with Japanese culture.


## 1. Introduction

Our research goal is to prove the effectiveness of music by quantifying human responses to hearing music. Fig. 1 shows our research goal. In this figure, we show three features of our research. The first feature is that our research requires profound interdisciplinary knowledge in three distinguished research fields (i.e., music theory, acoustic engineering, and medicine). The second features is that our research analyzes biological information in two aspects (1) by objective data (biological reaction) and (2) by subjective data (i.e., emotional reaction). The third feature is that our research utilizes two kinds of music analysis methods: (1) using music theory and (2) using acoustic engineering. In this study, the input is music and the output is human subjective and objective responses. Based on this scheme, we discuss the most effective music therapy for dementia patients using Japanese music.

In recent years, the elderly portion of the population has increased significantly, which has led to a related increase in the number of patients with dementia[1,2]. For this reason, prevention, effective rehabilitation, and treatment/therapy for dementia are most required in a super-aging society. Each of these aspects is equally important. However, the current work focuses on the

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rehabilitation and treatment/therapy aspects of dementia. We chose music therapy for the method of treatment/therapy. In our research, we are investigating the effects of Japanese music on alleviating dementia symptoms in Japanese patients, compared to the effects of classical music[3–6].

Music therapy has some serious problems because (1) only the people who are in a setting realize the clinical response of music therapy, (2) music therapy involves trial and error, and (3) music therapy does not have objective proof. This situation caused us to believe the effect of the music therapy should be proven.

Furthermore, near-infrared spectroscopy (NIRS) has disadvantages. However, the primary advantages of NIRS are that it is performed in real-time, it is noninvasive, and it has low cost in the view of researchers who design experiments. The four disadvantages of NIRS are (1) poor spatial resolution, (2) a lack of an established numerical analysis method, (3) lack of reference values, and (4) noise contamination. Because of these disadvantages, previous researchers had to develop numerical analysis methods of NIRS data on their own accord. In addition, standard analysis procedures of NIRS data for intersubject comparison have not been established. This situation has caused a short of experiments in which intersubject NIRS data is analyzed.

Various studies have investigated the utility of music therapy in alleviating dementia. Several authors have proposed non-pharmaceutical methods for treating dementia[7,8], which include music therapy for dementia patients[9]. These reports suggest that such care for dementia patients alters underlying physiologic, psychosocial, and environmental factors. Several empirical studies have reported significant effects of music therapy on dementia patients[10]. Music therapy lowers the agitation level of patients. These studies show that music intervention is effective, facilitates the recollection of long-term memories[11], and improves the management of verbally disruptive behavior. In addition, some studies displayed that agitation levels fell significantly in response to music therapy.[12–15] Studies using music therapy have reported an improvement in language functioning[15] a reduction in depressive symptoms[16], an increased recognition of music-based exercises[17], and a sparing of melodic recognition in dementia patients[18]. The overarching aim of these studies is to reduce the burden of the care staff in charge of these patients. These studies do not examine music therapy as a brain rehabilitation for the patients. What is more important is that these studies are not objective, but subjective. Furthermore, the music used in these studies was selected without considering the effect of each music choice (i.e., the music choice was random or by trial and error).

Other studies on music therapy for dementia patients focus on the neurological aspects of processing musical input, specifically the role of the temporal lobes. These reports have shown that the auditory cortex influences recognition of pitch and tempo[19], and that the ability to understand a melody is reduced when the temporal lobe is damaged[20]. In these experiments, the patients had an injury to or excision of the temporal lobe. Other work has examined the relationship between psychological stress and music[10,21]. The application of music therapy led to a reduction in the levels of salivary cortisol, a stress hormone. In addition, several studies report significant emotional responses to music. Mental fatigue is reduced more by major modern music than minor modern music[21]. In healthy adults, happy and sad moods are mediated by different neural correlates[22], and retrieval of memories with happy or sad affects activates separate areas of the prefrontal and hippocampus[23]. However, the mechanisms for musical processing and the generation of emotional responses to music in dementia patients remain unknown.

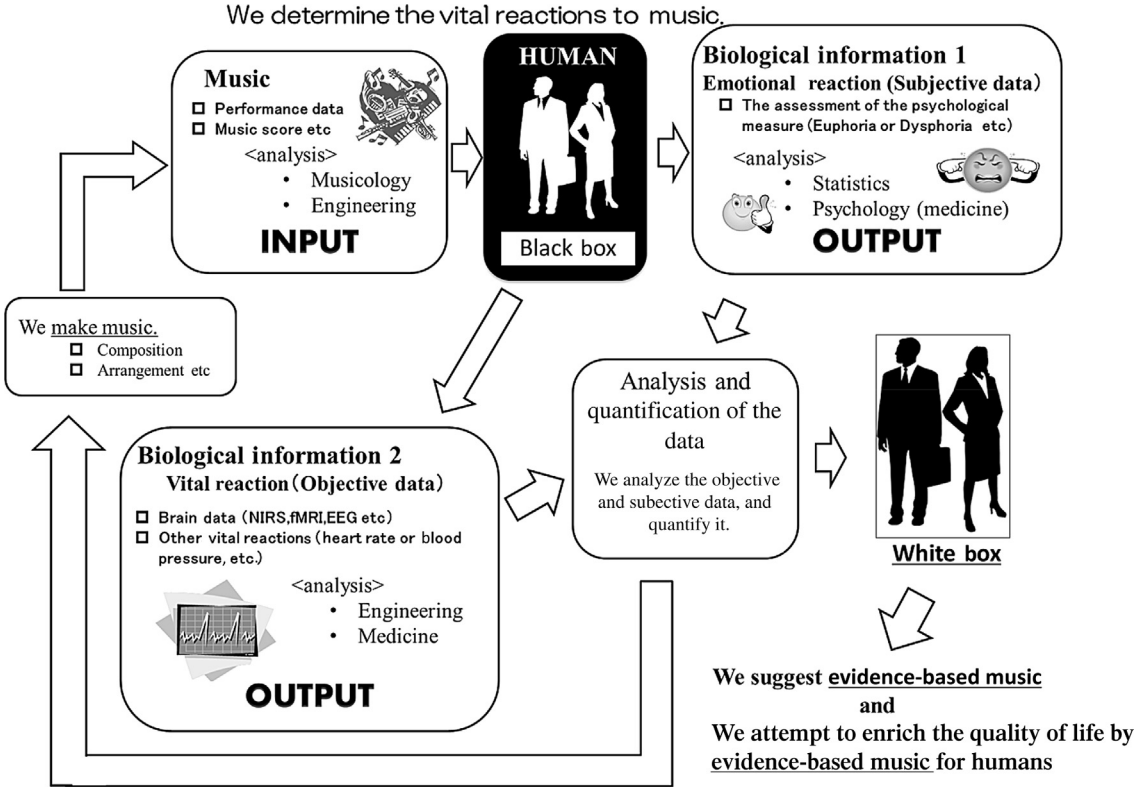


**Fig. 1.** Research aims. The major goal of this work was to objectively quantify the musical input and the physiological/biological output in response to music therapy. The final aim of our research was to increase quality of life by establishing evidence-based medicine. EEG = electroencephalogram; fMRI = functional magnetic resonance imaging; NIRS = near-infrared spectroscopy.