

Nervous System Activation by Musical Exercise Therapy

— in the Case of Patients with Parkinson's Disease —

音楽運動療法による神経系賦活 ——パーキンソン病患者の例から——

INTRODUCTION

The treatment principle of musical exercise therapy which I propose is to recover patient's vigilance and concentration ability by stimulating the brainstem by vertical movement, using a trampoline, while keeping an anti-gravitative posture (1). As inducing such somatological reactions, the therapy in which a therapist plays pleasant music activates the physical functions and the high level of brain function necessary for maintaining the life, and promotes to repair and recover disturbed areas, or regenerate affected nerves.

1. Treatment principle and structure of musical exercise therapy

(1) Pleasant sensation and experience

Generally, a human being feels pleasant when moving their body up and down with a music. It is also understood from the scene where children enjoy jumping up and down. A human being jumps up and down when he or she is pleasant, and jumps again because jumping is felt pleasant. When a crying infant is lifted as being said "becoming high and higher", the infant turns from crying to laughing. This can be said to apply the physiological instinct well. That is, pleasant sensation leads

pleasure and repeated experiences with pleasure will become a mental bread to live pleasantly.

When a person experiences good feelings repeatedly, the person never forget the pleasant sensation. For example, a strong memory is formed with pleasant experiences such as being received or played kindly by a person or persons, being held by a person wearing a soft sweater, being given tasty cakes by a person with delicious perfume, so on.

Being pleasant or unpleasant is judged at the tonsillar body in the limbic system. At this site, all external emotional stimulation are judged as being pleasant or unpleasant, and all five senses including touch and taste are unified, and pleasant experiences are memorized. The site is an origin of the nervous fibers to the hypothalamus and the upper cerebral region. Repeated good experiences encourage the person to make him or her pleasant. Such conditions facilitate to receive various events and even to have a volition to expect new stimulation. Applying this physiological system, it is the musical exercise therapy to repair, recover, activate, and then regenerate nerves.

(2) Communication through music

Musical and linguistic communications are different. Although it is difficult to remove fear or anxiety verbally, music has the effect to influence

living body directly. As it was proved that in the victims from the Hanshin Great Earthquake, their anxieties disappeared by listening to music, music enables to alleviate anxiety and calm the nerves.

Showing specifically in “Summer-time”(score example 1), the music structured with the chord of E minor (score example 3) such as si, sol, mi, si (score example 2) facilitates subjects to receive their actual situations as facing it directly, and encourages them with consolation to conquer the situation. In contrast, the music of “On the sunny side of the street” (score example 4) is structured with the ascending chord of G major (example 6), namely, si, sol, si, re, si (example 5) and is thus felt like living toward the hopeful tomorrow. These music can be said to transmit their messages to human bodies through the senses directly, As such, music used for the musical exercise therapy must be ones appropriate for transmitting through the senses. Music can activate the areas to maintain human life, or conversely confuse the living body. From the meanings, music can be said to be a language to communicate with human lives.

score example 1) "Summer-time"

The image shows two musical examples. The first, 'Summer-time', is in 4/4 time and consists of a melody line (1) and a chord progression (2). The chord progression includes B, G, E, and B, with a section labeled 'e-minor' (3). The second, 'On the sunny side of the street', is also in 4/4 time and consists of a melody line (4) and a chord progression (5). The chord progression includes B, G, B, D, and B, with a section labeled 'G-major' (6).

Score example 1)–6)

(3) Sounds and memory

Sounds play an important role in ordinary living. For instance, we wake up in the morning with sounds of alarm clocks and take up telephone receivers when telephones ring. Because of the habit, in responding to sounds by pocket telephone,

some drivers may drive wrongly and cause accidents. This is because auditory stimulation affects human behaviors. Applying this principle, when nervous circuits are recombined to conduct necessary movement by exercising and memorizing with sounds or music, and eventually adjusting the directive central system, patients with Parkinsonism may be healed. The exercise with trampoline and pleasant musical stimulation promote to activate the functions such as dopamine system and thus facilitate to move the body naturally. Above all, music is assumed to promote to recombine new nervous transmission circuits. That is, nervous activation becomes possible by enhanced memory accompanying repeated good feeling and pleasant sensation.

(4) Principle of necessity or unnecessary

As one of etiologies of Parkinson’s disease, the nervous circuit to transmit own will is inactivated because actions which do not follow unpleasant emotion are restricted and it causes to decrease the nervous function. When the problem of the Principle of necessity or unnecessary occurs, the functional structure changes as such that physical parts which could move previously can not move. If the principle of necessity or unnecessary creates all functions and structures, resuming movements in ordinary living will lead to prevention, maintenance, and recovery of reduced function.

Human thinking and movement are acquired by daily training. The training is conducted intently at first, and subsequently is mastered naturally after the trainee becomes accustomed to it. For instance, in case of playing a wind instrument, at first, a trainee concentrates to learn how to use keys and fingers, how to blow air, how to hold the mouthpiece in the mouth, and moreover, to evaluate whether produced sound color, volume, and interval are appropriate and whether the music is played

beautifully. With the feedback in which the trainee listens to sounds produced by him, or herself and corrects the sounds or continues them, the sounds and the fingering are adjusted intently.

What is important here is to evaluate it and newly correct it while exercising, involving three works. As for movement, when movement can be made unconsciously to some extent, a thinking which is different from previous one occurs and movement and expression are confirmed again from another viewpoint. Such repeated process to evaluate and think while exercising nourishes human high level of movement, thinking, and ability. Regardless of patients with Parkinsonism, cerebral palsy, or hydrocephalus, it is helpful for the patients to have such chances more to think while exercising in acquiring their functions.

(5) Autonomic nervous system and music

In a sense, the musical exercise therapy intends to give some stress within a safe range, and promotes to activate vital defense and living power to conquer the stress and recover.

Human vigilance and sedation by music is possible through both actions to the autonomic sympathetic nerves and parasympathetic nerves. Drum's sounds, rock or rhythmic music stimulate a human body to excite and move hard with unified movement. At this time, condition of the sympathetic nervous system is promoted to awaken through the norepinephrine agonistic action. Conversely, gentle music with softly flowing melodies, or decaying sound quality by harp, vibraphone, or piano acts on the parasympathetic nervous system to rest the body and recover it through the acetylcholine agonistic action. As such, a music has both actions of activation and sedation.

When the memory of pleasant sensation is considered, there are mysterious things. The experiences are expressed as "sound like velvet",

"soft sound", "keen sound", "crystal sound", "metallic sound", "moist sound", "dry sound", "warm sound", "cold sound", "rough sound", "fresh sound", or "sweat sound" as if the sensory organs such as touch and taste experienced it. However, expression by the vision is less in number. This fact indicates that a human being memorizes the experiences with direct touch and taste stronger than those with sight. Since sounds cannot be seen, experiences with sounds are memorized with touch as physical experiences. However, it is important that there is the system in which a vital body perceives sounds directly and reacts it. This may be an evidence that the tonsillar body perceiving tactility judges instinctively before the visual recognition at the cerebral upper level.

As such, a human being has the instinct to receive pleasant events physically and mentally and memorize them. Therefore, music acting directly on emotion with the exercise of up and down will be very useful when used appropriately. That is, regardless of diseases, it activates the nervous system, applying the action to activate vital body before intellectual understanding. This therapy promotes to activate the high level of cerebral functions from the animal level in human beings. I believe that Reanimatology is to nourish patient's volition and hope to live by using various music, accumulate energy to live by patient's own volition, and consequently enhance the treatment ability.

(6) Behaviors and understanding

A human being may think of the intention and meaning of a sound system when listening to it, and it may act on the brain invisibly. As for how to deal with external information, they may assume its meaning from own experiences of pronunciation before analyzing acoustic symbols simply and understanding words.

For example, if a person speaks a foreign language and cannot be understood well by the native speakers due to insufficient ability, the person will use gesture to let them understand what he or she wants to tell. As such, when a person wants to be understood, the person may imitate a speech or an action by gestures or others. This conduct is said as a phenomenon to strive to understand the meaning. That is, behaviors and understanding of other people are understood with repeated experiences of the others' wills and expressions by own physical sensation.

(7) Control of movement

Human recognition is made by understanding subjects with sympathy and differences recognized. The process is proceeded unconsciously. For instance, when the mechanism of Parkinson's disease is assumed as such that the inhibitory function on the voluntary movement acts when external information is given and it does not function by the internal direction, the external influence can be made by a circuit as own volition. The hands and legs with feet which do not move by the directive have already received so strong inhibitory directive that they cannot move anymore. On the other hand, the directive is so irregular and slight that it cannot transmit. This can be a condition similar to that an electric power is too small to increase motor's rotation. Muscular shrinkage type is the former and tremor type is the latter. It is Parkinson's disease in which there are lack of energy to move the muscles and insufficient neurotransmitters as directives and consequently, the GABA nervous system as an inhibitor on movement is too strong to move. In addition to insufficient dopamine, a poor cholinergic balance is present in the disease.

When music and exercise activate the vital body in patients with Parkinsonism, it is assumed that in

the brain, the adjustment of nervous transmission necessary for control of movement may proceed at molecular level.

(8) Activation and rearrangement of nervous system

Reasons why substances necessary for vital body are not produced may be because the body recognizes it unnecessary or because its necessity cannot be transmitted to the body. When this is assumed from the viewpoint of musical exercise therapy, it is natural that the patients with Parkinsonism can move by music. Because in addition to up and down movement by trampoline and modulated musical rhythm, verbal information such as "right, left" or "one, two, three, four", or "forward, backward, upward, downward" induces to activate the brain and create a condition under which the intention and will of movement can be transmitted smoothly. This therapy intends to promote to readjust and regenerate new circuits through which physiological actions adopting this environment execute patient's will, expression, intention, or plan. Particularly, when Parkinson's disease is interpreted as a disease having disturbed circuits before transmitting to the motor area, this therapy can be said to be a treatment by activating the vital body at molecular level.

As another view, the disease is a condition that it is unknown where own volition is, or motor apraxia condition, with a motor memory loss. In a sense, it can be said the condition that time stops. Conversely, in the disease, it may be said that the body can move without patient's will or intention. That is, in this therapy, the patient find comparative subjects with oneself externally and recognizes oneself through conversation with the others, and then connect nervous circuits newly. The patients who could not make rope jumping could do it two or three months after the therapy started and can continuously do it at present. The patients who were always bed-ridden could walk

independently after one-month therapy once a week. If it is assumed that dopamine level may increase rapidly, the physical strength may be enhanced rapidly, or patient's will may act specifically strongly, receptors inducing new nervous connection may be activated or previous motor memory may be called from other circuits.

As for the mechanism, I assume that intracerebral narcotics such as Met and enkephaline which activate dopamine may be activated by the mutual introduction of music and exercise and consequently, movement may become possible.

2. The method to apply imaging diagnosis by PET to the musical exercise therapy in patients with Parkinsonism

(1) Diagnosis by PET

Dr. Chihiro Ohe et al., Gunma University, conducted studies on high level of cerebral function by PET (2). According to the diagnosis by intracerebral blood flow volume, the changes in the cerebral basal ganglia were not expected and rather, reduction of blood flow and oxygen metabolic rate in the cerebral cortex, especially the frontal lobe, was pointed out. Moreover, the reduced blood flow improved simultaneously when administered L. dopa alleviated the symptoms.

In diagnosing by PET, the cases were divided into two groups, a group mainly with muscular shrinkage and another group mainly with tremor, and the blood flow volume, oxygen metabolic rate, and glucose metabolic rate in the cerebral cortex, basal ganglia, thalamus, or others were investigated in detail. The results showed that the reduced blood flow in the cortex was found mainly in the muscular shrinkage type, but not so markedly in the tremor type. Moreover, in the area of cerebral basal ganglia, the circular oxygen metabolic rate in the tailed ganglia decreased in the

muscular shrinkage type. In the same type, the oxygen metabolic rate in the lenticular nucleus (putamen pale globe) decreased and the glucose metabolic rate remained at a high level. These findings indicate that the tremor type is more similar to the normal condition in contrast to the high metabolic rate in the tailed ganglia. In the lenticular nucleus (putamen pale globe), the possibility of anaerobic glycolysis was also indicated. It is reported that the findings may suggest the mitochondria abnormalities seen in biochemical examinations.

From the blood flow volume, oxygen metabolic rate, and glucose metabolic rate, it is understood which sites function normally or abnormally. In the condition in which the muscular shrinkage improved after L-dopa administration, the glucose metabolism in the cortex increased slightly and the glucose metabolism in the basal ganglia decreased to approximate the normal level. This finding indicates interestingly that the overall profile of the glucose metabolism approximate the normal condition.

(2) Selection of music

<1> Muscular shrinkage type and music

Referring to these data, we considered of whether or not it is possible to select music used for the musical exercise therapy for the muscular shrinkage type or tremor type, and types of music which can activate inactive regions in the body.

For the shrinkage type, from the meaning of activating inactive regions, selected music include music having elements to think such as music of movies seen previously and favorite music which act on the entire cortex, music strongly influencing mentally, melodic music (Romeo and Juliet, Summer time, God father, Love is a many-splendored things, or others) leading subjects to think or imagine. Precaution must be exercised to

mainly select moody music, which should not stimulate the cerebral lower level and can lead subjects to think or imagine. Precaution must be exercised to mainly select moody music, which should not stimulate the cerebral lower level and can lead subjects to relax. Especially, optimal music selected relax the body unconsciously, give comfort, act on the parasympathetic nervous system, and alleviate the muscular shrinkage. That is, without stimulating the sympathetic nerves, the musical exercise therapy intends to inhibit excessive emotional appearance and to adjust the balance.

<2> Tremor type and music

For tremor type, favorable music promote emotional appearance associated with physical movement. It is suitable to select pleasant and rhythmic music with which the patients tend to move their bodies naturally. Because the tremor type generally presents an inactive condition of the whole body, and many patients are thin. Accordingly, to enhance the physical strength, music inducing movement such as dance music are suitable, including rhythmic ones acting on the upper level from the lower level (waltz, tea for two, Satin dole, On the sunny side of the street, or others). The music which enhance physical excitation and stimulate the sympathetic nervous system are enjoyable, while dancing with others makes the patients forget their tremor. It makes aware of own body moving smoothly and help the patients have self-confidence.

As other precautions, it is necessary to select music under the consideration of individual patients' character, preference, and mental condition. Whether the patient wants to be released from other persons or whether he or she wants to be taken care of by other persons must be also taken into consideration.

Finally, music must be selected to meet individual patients' needs, as considering of whether the music

enhances the intellectual excitation or acts on the emotion. However, because repeated experiences to music changes ways if listening and feeling, music never act on the upper or lower level clearly differentially. It must be kept in mind that music influence entire physical and living activities including the brain. Although the diagnosis by PET depends on assumption by the reader, the fact that the diagnosis by the up-to-date PET enables to select music in different types, in a sense, can be said to be an encounter between art and science.

CONCLUSION

The up and down movement by a trampoline at anti-gravitative posture with music stimulates the brainstem and hypothalamus and help the patients maintain the life instinctively. At that time, in association with production of intracerebral narcotics, neurotransmitters such as dopamine receptors are activated. Simultaneously, it may promote to memorize external emotional information mainly in the tonsillar body, rearrange and regenerate near nervous circuits, and consequently enables to control movement.

DEVELOPMENT IN THE FUTURE

A human being is an animal. To move, it is necessary to input the activity of neurocytes to external stimulation such as reflex of the spine or peripheral nerves and then to transmit it to the central cells. In inputting it, it is a human being who considers of how to move, with previously memorized matters and takes appropriate action. Not all functions are under a specific intellectual control in the brain. Particularly, in case of patients with Parkinsonism, a posture-reflex disturbance is present. In attempting to improve the condition, the

stimulation with movement on a trampoline and verbal stimulation promote spinal action responding unconsciously and physiological activation in addition to vigilance.

“Conventionally, to awake persons with consciousness disturbance, there is the stimulation method in which an electrode is inserted into the brainstem and spine. Without such physical means, it is the musical exercise therapy by which physiological reactions to the up and down movement on a trampoline and sounds are induced to awake. Thus, the therapy can be applied to patients with consciousness disturbance. This musical exercise therapy activates the brainstem and hypothalamus and greatly involves in the autonomic nervous system. Taking the action into consideration, the therapy enables to adjust the activation control of immune system related to the vascular and lymph systems through the spleen, as well as the control of the cardiovascular, reproductive, muscular, digestive, and respiratory systems by hormones from the endocrine organs. (3) In the future, the musical exercise therapy can be applied to diseases such as malignant tumors in which the immuno competence decreases.

Key words: Anti-gravitative posture, dopamine, music, tonsillar body, autonomic nervous system

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