MUSICAL EXERCISE THERAPY AND THE SAXOPHONE

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——音楽運動療法とサクソフォーン——

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In ancient Greece, music was recognized as an important tool for governing the nation. Although Plato mentions music many times in his books "The Republic" and "The Law", the mentions mostly concern how to keep public order.

Music was used for the purpose of nurturing people to be involved in the establishment of an ideal nation. In "The Republic", the ethical value of music and the importance of cultivating a sense of beauty are emphasized. At Academia, a school for educating future leaders of the nation, musical and physical education were encouraged because music was believed to be most suitable to ethics-oriented mental education, and physical training provided the basis for this spirit. Because of its importance to governing the nation, this concept of education was described in "The Republic". The Western idea of education "A Sound Mind in a Sound Body" originates from the same concept.

In "The Law", Plato also describes how to make use of the physiological mechanism of human learning for education. In that book, Plato states that in educating children, — priority should be given to the provision of enjoyable learning focusing on pleasure and displeasure,

— that an approach to forced education and learning should not be taken, and

— that enjoyable learning is effective in developing voluntariness and enhancing memory.

When applauded or animated, we feel pleasure both psychologically and physiologically, which in turn increases our wish to learn and helps us to acquire sophisticated knowledge and skills. Even patients with brain disorders can achieve good understanding and good performance without feeling discomfort during rehabiutation, provided that each walking or writing exercise is practiced enjoyably, with pleasure given by music.

This fact demonstrates that even if injured, the brain can restore its ability to learn if the opportunity to learn with enjoyable play is available. We can therefore say Plato knew that providing education using man's physiological mechanism complies with the providence of nature. This brings us to the question, "Have there been significant advances in physioiogical research into the effects of music on humans ? "

The answer is "No". Today, what is called "music therapy" focuses mainly on educational and psychological approaches. Little scientific study focuses on the brain, and only a very few reports are

available on the practical application of music to medical practice. I became interested in music therapy 30 years ago, and I have been involved in musical exercise therapy, which is based on my own theory, for the past six years. I have found that stimulation with saxophone music has a very good effect on patients with brain injury, and it can be used to good effect in all diseases associated with brain injury, At this master class today, I would like to talk about the application of musical exercise therapy for patients with Parkinson's disease and for those with consciousness disturbance. I will first explain the potential of the saxophone and its use in medical practice settings, then talk about the importance and significance of this application as a new field of activity for saxophonists.

1. On musical exercise therapy and the brain nerve

Now, I would like to define the term "musical exercise therapy" as I use it. By using a trampoline to stimulate the brainstem to maintain posture against gravity and vertical motions, and by listening to live music in synchronization with these motions, the patient's awakening and concentration of attention are promoted, and either the injured portion is repaired, or the remaining portion is activated to produce a new nervous circuit, which in turn enables the patient to regain cognition and motor control. Pleasure stimulation by music, in particular, promotes emotional changes. If satisfied by this stimulation, the patient instinctively wants to learn and memorize it as pleasure information. This pleasure emotion in turn arouses curiosity so that the patient becomes interested in the outer world. Man attempts to unify pieces of information received via all sensory organs and to memorize things and events. On the basis of this memory, we compare and check ongoing events, and according to what we find, we express our wishes and desires in facial expressions and body actions. Repeated cycles of this sequence promote our motor function and mental development, mitigating brain disorders and eventually leading to recovery.

The human brain is said to have developed as man acquired the capability of bipedalism. Stimulation by vertical motion provides the human brain with excitation and pleasure, and this experience is strongly memorized as enjoyable. Musical exercise therapy can be said to promote the development of the brain by means of the trampoline. It does not represent a forced task or training; it serves to activate the brain nervous system to allow the patient to achieve environmental adaptation. The trampoline is ideal for this purpose because it creates a condition to which the living body must respond. Physically, vertical motions and lateral swings of the body stimulate the vestibule in the inner ear, and information is then communicated from the vestibular nerve to the brainstem. At the same time, sensory stimulation by the patient's body-contact with the trampoline and the caregiver's body is also communicated to the brainstem. Of course, the patient also undergoes stimulation of the brain's visual area; the eyeball oculomotor reflex is induced, by which the patient spontaneously attempts to understand his or her spatial position and physical condition, while listening to surrounding sound, voices and music. The postural reflex, which is based on a unified complex of all pieces of stimulatory information coming from the outer world, is regulated by the brainstem and cerebellum. These stimuli activate the ascending brainstem reticular activating system and are eventually communicated to the cerebrum. Musical stimulation, in particular, simultaneously activates the hypothalamic activating system, which is projected from the hypothalamus to the cerebral cortex via the memory-associated limbic system. These two forms of sensory stimulatory information promote awakening and activate both A10 system cognition and A9 system motor nervous circuits.

This is man's wonderful physiological response produced by a combination of vertical motions and music, and represents the mechanism of enhancement of spontaneous healing power.

2. Relationship between neurotransmitters and music and physical exercise

It is quite natural for us to walk and move in synchronization with musical rhythms. When listening to light-tempo cheerful musical numbers, such as those of saxophone jazz, we move our body involuntarily. The effects of sound and music on humans are utilized not only to awaken, excite, and elevate the listener during walking, exercising and dancing, but also to help the listener to concentrate attention and perform exercise well. When listening to music, we become cheerful, with the whole body activated, and acquire the capability of concentration for spatial estimation and accurate control of motions. Music has another physiological effect in enabling the listener to feel no pain during long-term exercise or performance. Now, I would like to briefly explain this physiological mechanism. When jumping on a trampoline, we must use the femoral muscles and clench our teeth. This action of the femoral and masseter muscles stimulates the nucleus accumbens, which is a portion of the brain where the drive to do something is controlled. When stimulated, the nucleus accumbens secretes the thyrotropin-releasing hormone known as TRH. Why do baseball players chew gum during games ? The answer is that the secretion of TRH is promoted by stimulating the masseter muscles. As such, TRH causes the secretion of noradrenaline, an antihypnotic that enables humans to exercise for long periods. This substance supplies energy for continuous high-load exercise. The jumping dance of the Masai of Africa can be viewed as based on the same action.

In addition, TRH is involved in memory and learning. It is distributed in the medulla oblongata, which serves as the center of survival, the hypothalamus, which may be called the brain of desire, the limbic system, which may be called the brain of emotion, and the cerebral basal ganglia, which controls the motor system. In the pons of the brainstem, the ceruleus nucleus of the A6 nervous system is present, which stimulates all portions of the brain and serves as the center of awakening and activities. The nucleus is activated by musical exercise therapy. This portion of the brain is rich in TRH, and TRH receptors and abundantly distributed in the frontal association areas, which control behavior, and the temporal lobe, which concerns memory, learning and speech. In this context, sensory input by musical exercise therapy has major impact on human thinking, planning, intents, decision-making, actions and behavior. Musical exercise therapy is based on this biological response and physioiogical action. The target diseases for this therapy include Parkinson's disease, depression, cerebral palsy, developmental retardation , hydrocephalus, various forms of consciousness disturbance , including cerebral stroke, fall accidents and traffic accidents, severe brain disorders, including meningitis, congenital and acquired encephalopathy and hypoxic encephalopathy, and autism. Senile dementia, Alzheimer's disease, and disuse syndrome in bedridden patients are also targeted. In musical exercise therapy, the situation to be managed is spontaneously sent forth from the lower brain, or the brainstem, to the upper brain, or the cerebral cortex, stimulating spontaneous healing power for curing the disordered portion. Specifically, repeated exercise with musical emotion leads to functional restoration, improvement and acquirement. This therapy can be viewed as acting on the plasticity, learning capability and compensating capability of the brain, and promoting the action and production of neurotransmitters of the catecholamine series,

such as adrenaline, noradrenaline and dopamine. For this reason, the effects of musical exercise therapy occur earlier in Parkinson's disease, a disease caused by dopamine depletion.

3. An example of musical exercise therapy for a patient with Parkinson's disease. [Video presentation]

When activated by vertical motions of the body, the brain recognizes the background music number in synchronization with the physical condition, and forms the habit of listening to the music. This harmonization of actions and paying attention to the surroundings, while listening to sound, promotes the coordination of the entire body and concentration of attention. Our daily activities involve surprisingly complicated coordination. Although we usually do not walk while throwing and catching a ball, we occasionally do it in daily life. We act spontaneously to protect ourselves against unexpected situations, such as by avoiding someone in front of us who has suddenly stopped walking, or who has come close to colliding. This fact is not properly realized. Accordingly, the motions involved in musical exercise therapy, including catching balls coming from different directions, and walking while waving a ribbon, are intended to activate other reflex nerves by providing constant exercise to achieve motor control.

This harmonization of willful behavior and spontaneous motions involves two nervous systems, and cannot be achieved unless both the direct and indirect pathways for autokinetic directions are activated.

When walking with a tambourine or hand bell in one hand, the patient listens to acoustic information from the outer world, walks in synchronization with the sound, and recognizes his or her own motor action that generates the sound. This provides an opportunity to coordinate motion direction and performance, and the patient becomes able to control the resulting coordination.

Although nerves are unable to grow rapidly, motor function can be enhanced by daily practice. This is evident from the fact that athletes and saxophonists gain sophisticated skills. After becoming skillful to some extent, the player can well kick the ball or perform difficult phrases by spontaneous motions of his or her legs or hands. This therapy is never oriented to the actions based on understanding by head; music helps to create a new nervous circuit for learning and memorizing by the body. In other words, this therapy is intended to re-educate the body to have a smooth daily life by means of music. With its light rhythms, characteristic tones, and diverse musical performance, the saxophone is very useful in the treatment of patients with Parkinson's disease.

4. The application of musical exercise therapy to patients with consciousness disturbance.

Consciousness disturbance occurs when brain function is disordered. Its causes include cerebral vascular injuries, traumas caused by traffic accidents or falls, and hypoxic encephalopathy due to cardiac arrest or respiratory failure. In the case of cerebral infarction and cerebral hemorrhage, the brain is only partially affected, so consciousness disturbance does not always occur. However, it always develops in the case of encephalitis, metabolic enephalopathy and other diseases that affect the entire brain. There are two types of consciousness disturbance due to cerebral vascular disorder. In one type, the brainstem is directly disordered; the other type is characterized by secondary onset and exemplified by cerebral edema. The term consciousness can be defined as being able

to recognize the environment and to respond to stimuli from the environment.

In extreme cases where no means is available for communicating recognized information and the patient cannot respond to stimulation, the patient cannot be described as awake. Consciousness is maintained by the ascending brainstem reticular activating system; awakening is caused by sensory stimuli that are communicated to the thalamus and the hypothalamus via number of ascending sensory pathways. These stimuli are unified by the thalamus, transmitted to the two sides of cerebral cortex, and recognized there. Unless the brainstem functions, the cognitive function of the cerebral cortical region cannot serve in recognizing and understanding things and human face. The great majority of cases of severe consciousness disturbance are caused when the brainstem or deep brain region is injured, and can be viewed as a form of awakening disorder that differs from the cognitive disorder of cerebral cortex. Of course, without brainstem functioning, the upper cerebrum fails to show its cognitive function. Before various stimuli are transmitted to the cerebrum, information is processed at the hypothalamic activating system, which is mediated by the hypothalamus, at the limbic system, which is associated with memory and emotion, and at the amygdaloid body. In other words, each stimulus is checked against the empirical values of preference, after which it is transmitted as necessary for the purpose of awakening. After rupture of cerebral aneurysms or cerebral hemorrhage, the consciousness level is usually low. Although consciousness can be restored surgically by removing the hematoma with craniotomy, such surgery is impossible in some cases where particular portions are injured, such as in the case of pontine hemorrhage. Because brainstem hemorrhage or infarction directly affects the ascending brainstem reticular activating system, consciousness is severely disturbed. Even if the patient survives, complete recovery is sometimes unachievable. Because patients with prolonged consciousness disturbance are unable to move by themselves, they unavoidably become bedridden. In this state, body functions are decreased and deteriorated as not only the motor nervous system, including brain function, but also the circuiatory system, the respiratory system, and the autonomic nervous system, pause their actions. Therefore, I believe it necessary to strengthen the patient's spontaneous healing power and accelerate his or her awakening by introducing musical exercise therapy at a relatively early stage. The patient's condition should be monitored, and provided that the patient's body can endure it, this should be done to aggressively promote awakening, rather than solely awaiting spontaneous recovery. The principle of treatment by musical exercise therapy resides in the emergence from unconsciousness and recovery of concentration of attention by brainstem stimulation by maintaining posture against gravity and vertical motions of the body using a trampoline. Because the vertical motions generated by using a trampoline directly stimulate the brainstem, which serves as the center of consciousness, it provides a major environmental change for the patient. The patient first opens his or her eyes, raises his or her face, straightens his or her neck, and looks around at his or her surroundings. The patient must spontaneously show the postural reflex, sense of equilibrium, and sense of vestibule. Specifically, vibrations are transmitted to the patient's limbs; the patient's body comes in contact with the trampoline and the caregiver's hands; the patient's trunk is stimulated by touch; the patient's head swings forward and backward; the sense-of-equilibrium organs of the inner ear — the semicircular duct and otolith — generate electrical signals to transmit information about the head

position and motion direction to the brainstem, which information enters the cerebellum and activates the ascending brainstem reticular activating system via the sensory nervous pathway. At this time, the oculomotor response for eyeball movement for spatial positioning is promoted, and this reflex is also regulated by the brainstem. Musical and other sounds are also communicated directly to the brainstem via the auditory nerve, so that the brainstem is further stimulated. Because voices, sounds and music have emotional effects, including joys and miseries, the patient recalls complicated human feelings and memories.

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Of course, each patient has his or her own history of music listening. The memory circuit associated with sound is stimulated, and the hippocampus and the limbic system, which is associated with memory, are activated. [Video presentation]

Because this stimulation with voices or music stimulates the hypothalamic activating system, which is projected to the cerebral cortex, the entire brain is stimulated so that awakening is enhanced. Physiologically, this stimulation promotes awakening on the basis of the activity of monoamine neurotransmitters such as noradrenaline and dopamine. In addition, it causes the secretion of adrenocorticotropic hormone or ACTH, which acts to provide mental calm and mitigate muscular system tension, and restores motor function for relaxed limbs. When the patient is stimulated by musical exercise therapy mainly with his or her favorite musical numbers, physiological pleasure makes the patient to feel joy and to have conation for life; the patient's brain spontaneously attempts to make biological adjustments necessary to functional recovery.

As such, musical exercise therapy represents a functional recovery training system based on simultaneous stimulation by physical means and memory-oriented mental means to transmit stimulatory information from the central nervous system to the peripheral nervous system.

Scientific verification of musical exercise therapy and discussion.

When patients with consciousness disturbance were stimulated simultaneously with a combination of music and vertical motions of the body, EEG and autonomic nerve examination showed activation of the entire brain , but the injured portion was particularly activated. It is believed that this stimulation promoted metabousm, improved blood circulation, and increased oxygen uptake, and that the same stimulation, in synchronization with the brain frequency, amplified the body's action potential and activated the brain neurons. Since an analysis of the autonomic nervous system on the basis of heart rate change demonstrated that 1/f fluctuation appeared as a numerical index of pleasure during treatment, it can be said that musical stimulation in connection with emotional pleasure increased the patient's spontaneous healing power and activated the pathway of information transmission from the lower brainstem to the limbic system, the thalamus, the hypothalamus, and the entire cerebral cortex. As far as my clinical experience with patients who achieved recovery is concerned, the most important thing to the restoration of memory is to induce body actions with pleasure and intellectual behavior. In other words, it is speculated that therapeutic effects are obtained as a result of a combination of stimulation of senses, activation of the ceruleus nucleus and hippocampal neurons, which are associated with compensation, and potentiation of

the nervous circuit to the prefrontal area, produced by musical exercise therapy. Regarding the timing for initiation of musical exercise therapy, clinical data show that patients with consciousness disturbance achieve only little mitigation if the therapy is initiated several years after onset. For this reason, in order to prevent the patient from progressing to prolonged consciousness disturbance it is believed appropriate to initiate the therapy within at most 4 months from the start of the subacute stage following the acute stage. There are so many kinds of music, and it is nearly impossible to perform all of them. However, the saxophone is suitable for expressing human feelings at it possesses good acoustic characteristics and great power of expression. The saxophone can be described as offering more direct contact with humans than other musical instruments. As you all know, the saxophone is a unique musical instrument in that it is capable of producing various sounds ranging from sultry tones to sophisticated expression. I hope many saxophonists will become actively involved in the field of medical practice to provide musical exercise therapy as I have described here.

Finally, I with to express my great appreciation to Chairman Jean Francois Guay for inviting me to participate in the 12th World Saxophone Congress Montreal 2000, and Mr. and Mrs. Lemay and other staff for the opportunity of talking to you about musical exercise therapy at this master class.

Last of all, I would like to perform my recent number.

Titlle: La fée de la neige. pour Saxophone Soprano Seul(World premier)

Thank you.