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MULTI SENSORY LEARNING IN VIOLIN TRAINING

Beyza Karakaş Gökçe

Gazi University, Turkey

E-Mail:beyza.karakas.22@gmail.com

Mehlika Dündar

Gazi University, Turkey

E-Mail:mehlika@gazi.edu.tr

Abstract: *It is known that there are more than a hundred billion nerve cells in the human brain. Impulses from the five known sense organs are received by these neurons and transported to the central nervous system. The received stimuli are interpreted by comparing them with the information coming from other organs and the information previously stored in the brain, and converted into perception. Brain; There are different areas where all visual, auditory and tactile stimuli are related. When more than one stimulus specific to these areas is received, different regions interact. Thus, interactive learning can take place by using more than one interconnected path. When playing the violin, at least two or more senses are used. In violin learning and individual studies, there are generally auditory, visual sense-based and numerous repetition studies. This method can minimize the existing problems of the player, but it can often prolong the solution time of the problems and even cause the problems to be reinforced. It is known that multisensory learning-based learning and teaching strategies have a different effect than the unisensory repetition method by activating more than one sense, presenting information in different ways, and activating the right and left hemispheres of the brain. Studies have shown that by activating many regions of the brain with sensory integrations, more robust and permanent changes occur in the sound, rhythm and movement components of violin performance. In this study, it is aimed to discuss the Multi-Sensory Learning Approach,*

which can be defined as using more than one sense while receiving information, within the framework of various disciplines, and to reveal the effects of Multi-Sensory Learning-based learning-teaching strategies on music and violin education, and to discuss and conclude the studies on this in the form of a review.
Keywords: *Violin Education, Multisensory Learning, Music Education*

Introduction

All the learning we carry out throughout our lives are multisensory experiences that pick up all the sounds, touches, smells, tastes, and sights around us. All learning takes place through the senses, which act as pathways to the brain. Multi-sensory methods; It uses all the available senses at the same time, such as hearing, speaking, seeing, and writing. Accordingly, learning and teaching strategies should be active and interactive, engaging the individual at all these levels at the same time. Experts have difficulty accurately defining learning, but most people agree that it is a process of change that stems from an individual's experiences (Mazur, 2016). The basis of all knowledge is sensory experience. The most unique and reliable content of our thoughts is the sensory information we gather through experience. The experiences that our senses offer us are the source of the thoughts and pictures in our minds (Erikson, 1985). It is known that the more senses are used in the realization of learning depending on the functioning mechanism of the brain, the more likely the information will be remembered in the future. This can be explained by the fact that there will be more ways to find the stored information. A large number of scientific studies distinguish from existing studies that prioritize a single sense, promoting a multisensory approach that brings together the expertise of medicine, science, art and education disciplines by revealing the connection between other disciplines and the senses. Multi-sensory learning has many application areas. One of them is instrument training, which is a sub-dimension of music education. Due to the nature of instrument training, at least two senses are activated at the same time during both learning and playing, and many different modalities are activated. In this study, violin education, which is one of the instrument training classes, is handled specifically and the place of multisensory learning in violin education is mentioned. Various researches have shown that in instrument education, especially violin education, the player integrates more than one sense, activating different areas of the brain, providing convenience and permanence to the player in achieving the desired goal. The hand and finger movements required to perform music on an instrument must be coordinated within a very specific time frame. Quality performance requires the integration of visual, auditory, and somatic feedback, as well as extensive and long-term practice. During these applications, only the senses specific to the use of the instrument are exposed to stimuli. Considering the natural processing mechanism of the brain, when an integration is achieved through different senses and through different channels, behaviors can be acquired more easily and quickly, and a development with a high permanence rate may occur. Due to the scope of this study, the relationship between multisensory learning and multisensory perception with the disciplines of education, music education, violin education, physiology and psychology is discussed.

Method of the Research

This research is a review. It is a descriptive research and aims to determine the situation. Literature review methodology was used as a method. As it is known, research using the survey model aims to explain a situation that existed in the past or still exists as it exists today (Karasar, 2012, p. 77). Foreign and Turkish publications, theses, books and information obtained from the internet were examined. As a result of the examinations, the multi-sensory learning model has been discussed physiologically and pedagogically, and the effect of the model on violin education and music education within the framework of instrument education has been tried to be revealed in the light of the researches.

Purpose of the Research

The aim of the research is to reveal the place, importance and benefits of multisensory learning in the field of music education and violin education by considering multisensory learning within the framework of physiology, psychology, pedagogy, music education and violin education. For this purpose, the existing situation was tried to be determined by conducting a literature search on the subject and examining the researches.

The Problem of the Research

The problem of the research is "What is the effect of multisensory learning on music and violin education?"

MULTI-SENSORY LEARNING

The basis of multisensory learning is that when students use many senses simultaneously or gradually, they interact more intensely with the subject and retain what they have learned for a longer period of time. In multimodal (sensory) learning, the teacher first engages students with tactile, visual, auditory, and olfactory cues before linking the activity to the relevant learning objectives. Multisensory approaches are effective because of the interplay between sensory input and thought (Baines, 2008, p. 10) . Non-sensory education methods are not considered ideal for learning as they do not enable multiple sensory learning pathways. In contrast, multisensory-based methods are closer to natural environments and may be more effective in learning (Shams & Seitz, 2008). According to Howard Gardner's research, humans have a variety of learning styles, including nine different types of intelligence. For this reason, he argues that students should not rely only on the most comfortable type of intelligence, but should acquire knowledge through various ways of learning. According to Stevens and Goldberg, the two basic principles of brain-based learning are that learning involves the whole body and that the brain requests multiple sensory input (Gardner, 1993, 2000, Stevens and Goldberg 2001 as cited in Katai, TOTH, & Adorjáni, 2014).Although Multi-Sensory Learning has a wide scope and dimensions, violin education, which is an important sub-title of Music Education, is included in Multi-Sensory Integration; cross-mode perception; Approaches called Multisensory Illusions are closely related.

Multi-Sensory Integration

Multisensory integration is fundamental in terms of how people see and understand their environment because it allows us to combine information from the various senses or separate different events to form a coherent whole (Ghazanfar et al., 2006, Driver & Noesselt, 2008, as cited in Paraskevopoulos & Herholz, 2013). Multisensory integration is the term used to describe our brain's capacity to integrate data from several senses into a single, coherent experience of the environment. Our perception, cognitive processing, and motor control are supported by effective multisensory integration (Alais et al., 2010, Freiherr et al., 2013; Stein and Meredith, 1990, as cited in O'Brien et al., 2023). Multisensory integration has been shown to enhance and accelerate the detection, localization, and response to physiologically significant events (Corneil and Muñoz, 1996;Frens and Van Opstal, 1995;Hughes et al., 1994;Stein et al., 1989;Marks, 2004;Newell, 2004;Woods and Recanzone, 2004a;Shams et al., 2004;Sathian and Prather, 2004;Stein and Meredith, 1993, as cited in Stein et al., 2009). Candidate areas where integration can occur are the cerebellum, premotor cortices, auditory cortex, and superior prefrontal cortex (Fraisse, 1982, Grahn & Rowe, 2009, Ivry, 1996, Bengtsson, 2009 as cited in Huang et al., 2013). Multi-sensory integration can also create unified perceptual experiences. (Diedrich & Coloniusakt, 2004, Stanford & Stein, 2005 as cited in Zimmerman & Lahav, 2012) For example, when a violinist performs, you can see him leaning towards the strings in addition to hearing the music. Since these stimuli (the sound and the image of the violin) belong to the same formation, the resulting combination produces an effect that can perform much better either than the sensory input alone or the mathematical sum of them. From this point of view, neural responses derived from multisensory regions can often exceed the total responses to each sense separately by a factor of about 1000%.

Recent studies have shown that multisensory integration; It has shown that multisensory data involves the collection of prior knowledge and stimulus estimates independent of each modality (Ernst & Banks, 2002, Körding et al., 2007, as cited in Hirano & Furuya, 2022). Since various modalities provide complementary information about various events and situations, integrating information from different sensory modalities increases the persistence and efficiency of perceptual experiences.

Auditory-Motor Integration

Recently, there has been a great deal of interest in understanding how the auditory and motor systems interact. Music has a remarkable ability to influence motor action. It is instinctive to hit the foot in time to the music. This means that the auditory and motor systems are linked in terms of time and privilege. The auditory system predictably influences motor output. An example of this is the phenomenon of "hitting the beat", in which the listener senses the rhythmic accents in a piece of music. Feedback interactions are especially important when playing an instrument that requires constant control and changes in pitch, such as the violin. Each note played must be listened to carefully, and the performer must time the engine changes accordingly. If auditory feedback is blocked, musicians can perform pieces to a certain extent, but meaningful aspects of performance are affected. More importantly, when there are delays or distortions in auditory input, this significantly affects motor performance (Patel et al., 2005, Repp & Penel, 2004, Large & Palmer, 2002, Thaut et al., 1997, McIntosh et al., 1997, as cited in Zatorre, Chen, & Penhune, 2007). Past research has shown that when playing an instrument, the player's movements are inevitably influenced by auditory input, which creates a strong connection between perception and action. In music, auditory and motor function are closely linked. When musicians listen to music (played with their instruments), brain areas involved in playing, which is the main motor task, are activated together (Chen et al., 2013, Zatorre et al., 2013, as cited in Kuchenbuch et al., 2014). Since every action during a performance creates sound, and this sound affects all other actions, the connection between the auditory and motor systems is of particular importance, based on sensorimotor interaction. In one study, fMRI brain scans were collected of eight violinists and eight amateurs who silently performed the first 16 bars of Mozart's Violin Concerto in G major. Expert artists were seen to have significant activity in the primary auditory regions, which is lacking in amateurs (Lotze, 2003). In addition, previous studies have shown that multisensory interaction skills, such as audiovisual and auditory-tactile integration, reflect brain adaptations in trained people. For example, experienced musicians are better able to distinguish between auditory and visual sensory information, such as notes and sounds, compared to those without musical training. These multisensory interaction functions require deliberate control or integration of information from many sensory organs, as opposed to maladaptive stimuli, which correspond to disparities in information stored in sensory signals from various modalities (Paraskevopoulos et al., 2015, Pantev et al., 2015, Paraskevopoulos et al., 2012, Steen et al., 2014, Zarate & Zatorre, 2008, as cited in Hirano & Furuya, 2022).

Audio-Visual Integration

Audio-visual interactions affect the perception of music in many ways. Visual information from a played instrument, visual perception of musical notation and sound waves, audio-visual harmonious musical presentations help us form predictions about the auditory aspect of music and further increase the effect of perception consisting of auditory input alone. Given the visual perception of sound waves, individual sound waves can be distinguished from each other by looking at their length (Ritchie, 2023). Visual information from finger and hand movements while playing the piano can be used to predict future sound frequencies and indicate the time of musical events. This information can also be used to determine which key was played (Thompson et al., 2005, Maes et al., 2014, as cited in Sorati & Behne, 2020, p. 2). Studies have shown that audio-visual coherent presentation can lead to a more intense emotional response compared to audio-only presentation (Pan, Zhang, Ou, & Zhang, 2019). Eldridge, Saltzman, & Lahav (2010), He examined the effect of visual feedback on the ability to recognize and reinforce curtain information. As a result, it has been revealed that sensory redundancy increases the robustness of learning and the use of audiovisual training procedures should be encouraged to facilitate the learning of new skills (p.1078). The study, which examined the effectiveness of three real-time feedback methods to improve learning intonation and pitch on the violin, found that having both auditory and visual feedback allows auditory feedback to be used when visual attention is needed for other tasks, while at the same time visual feedback is available to clarify information from auditory feedback (Pardue & McPherson, 2019).

Visual-Tactile Integration

A variety of senses are used when playing the violin, but both playing and reading the music require special attention to the auditory and visual systems. Musicians use proprioception to correctly place the fingers on the fretboard; They can use their sense of environmental vision to observe the conductor or other players for tactile and various cues to feel the instrument vibrate. When musicians try to vocalize a piece from their memory or convert written music into movement and sound, a high cognitive load occurs as well as a high sensory load, and they rely on procedural automatic skills through repetition to complete this challenging effort (Johnson, 2014). Looking at theoretical perspectives on goal-directed motion control and feedback processing, three types of information can be crucial for movement accuracy: static visual information about the initial position of the left hand; information about the trajectory of the left hand and visual information about the area where the left hand should focus on the instrument. Looking from the starting point to the goal (on the instrument) can provide crucial information for planning such moves and ongoing corrections. Visual feedback was probably the primary basic correction mechanism, as visual cues served as physical reference points for the finger's final positions. The availability of visual feedback for the target and related limb positions governs changes in the movement trajectory required to focus on the target in the current control phase of goal-oriented movements (Bédard

& Proteau, 2001; Desmurget et al., 1997, Chua & Elliott, 1993; Woodworth, 1899 as cited in Lage et al., 2007).

Cross-Mode Perception

In recent years, model-to-model learning has become a whole new field of multidisciplinary study. Crossmodal learning is the synergistic synthesis of information from various sensory modalities, allowing the learning that occurs in any sensory modality to be enhanced by information from one or more other modalities. Cross-modal learning is an important part of adaptive behavior in an ever-changing environment and influences numerous examples, such as learning to walk, read, write, grasp and hold objects, understand language and its referents, etc. In all these examples, the integration of visual, auditory, somatosensory or other modalities should be included and learning should be cross-modal (Zhang et al., 2022). Crossmodal learning is an interdisciplinary subject that is not yet confined to a single field. In the field of music, applications based on cross-modal learning are also seen. For example, information from multiple modalities is processed to create semantic representations with sounds associated with the fingers. When there is an integration between fingers and sounds with information from different modalities, this effect can affect the recognition of information in one modality and information in another modality. In a study by Maimon, the relationship between tonal stability and a number of non-auditory characteristics such as visual brightness, visually transmitted emotion (facial expressions), visual size, and spatial placement (vertical and horizontal) was tested. The results showed that tonally stationary tones were associated with greater visual brightness, happier emotional expressions, and higher and more left-handed spatial placements. Results It shows how the abstract musical structure can create concrete associations in the non-auditory perceptual fields and update the theoretical concepts of music tonality (Maimon, 2019).

Multiple Sensory Illusions

The human brain seamlessly integrates data from several sensory channels, but the underlying processes are still not fully understood. The subjective experience in one mode can be greatly altered by another mode, leading to the creation of an illusion as well as increasing the importance of one mode by the simultaneous activity of another mode (Driver J and Spence, 2000, Shimojo & Shams, 2001, McDonald et al., 2000, Macaluso et al., 2000, as cited in Bhattacharya, et al., 2002). In these cases, information about a particular external appearance is often presented by two or more separate senses. Therefore, when calculating the location of an apparently multimodal event, location data from two or more modalities can be analyzed simultaneously (Alais and Burr, 2004; Ernst and Bulthoff, 2004; Helbig and Ernst, 2007, as cited in Driver & Noesselt, 2008). Similarly, the interaction between hearing and touch is also seen in frequency separation and the production of sensory illusions, and numerous studies suggest fundamental connections between the auditory and tactile systems. When there is something out there, for example, when you hear someone speak and watch them, many senses are often activated at the same time. This example relates to some of the most well-known examples of cross-mode integration. For example, the McGurk effect uses observed lip movements to change the phoneme heard for a particular sound, and ventriloquists can change the apparent position of speech sounds. McGurk-like effects can also be seen with non-speech stimuli, for example, when both hearing and seeing musical instruments, as well as with pairs of other modalities (Bertelson, 1999, Massaro, 1999, McGurk & MacDonald, 1976, Radeau, 1994, Spence & Driver, 2000, as cited in Driver & Spence, 2000). In such cases, it is clear that multiple sources of information, i.e. different modalities, must be combined in order to obtain the best estimate of the information. In this respect, it is thought that the auditory-motor combination can strongly influence each other, as in the ventriloquist effect of vision, considering that it will provide useful information about the location of the sound source.

MULTI-SENSORY LEARNING AND EDUCATION

Traditional structured education stimulates only one or two senses: sight (by reading, writing, completing written tasks, etc.) and hearing (by listening carefully to the teacher and students). As effective as this strategy is, it may not be particularly good at helping students internalize new ideas and abilities (Suryaratri, Prayitno, & Wuryani, 2019). More senses equals more information; Different students have different dominant senses; Different students have different "intelligences"; equates to more ways to find stored information; evenly distributed loading; It is equal to the compound senses. All these factors contribute to a more effective learning process (Katai et al., 2014). By integrating several senses, it allows the information to be more permanent. It is often beneficial to help students build stronger memories and gain more comprehensive knowledge by translating teachings into real experiences. Hearing or reading about an event is not the same as actually experiencing it, or at least experiencing it to the fullest. By incorporating powerful stimuli, teachers can give students authentic experiences that are not only memorable, but also more engaging and fun (Suryaratri et al., 2019). Modality power is not a fixed quality. Age affects the strength of a method. Modalities may be "relatively independent" in young children, but they become more integrated as they get older. Students can learn skills that allow them to "transfer" information. As we get older and gain more experience, the modalities integrate. Because of this capacity, the number of adults who are strong in mixed modalities is greater than that of children. It is the teacher's task to direct the student's perceptual modes. When an instrumental teacher focuses on teaching the child through his or her abilities, their weaker approach should not be overlooked. It should guide the development of various forms of learning and the child's interdependence in all three perceptual skills (Barbe & Milone, 1981, as cited in Tang, 2017).

MUSIC EDUCATION AND MULTI-SENSORY LEARNING

Playing an instrument is a multimodal experience that involves perceptions in the visual, auditory, and tactile domains. Multisensory integration is affected by music training in the same way as brain development. For example, a performer's facial expressions and body movements are through the visual system; The mechanical vibrations produced by a musical instrument can be detected through the somatosensory system. Sensory-motor networks can also cause cascading effects. For example, motor activity in response to a stroke can cause micromovements in the head and trunk, which can lead to vestibular stimulation. When motor activity is entrained, it can serve as its own sensory input channel. Thus, the perception of music is usually multisensory, combining inputs from the auditory, visual, somatosensory, vestibular and motor areas (Russo, 2019). When it comes to learning music, it is possible to speak of multi-sensory learning. Because music uses at least three of the five senses, and in some cases all the senses can be included.(Trainor, 2008) Music; It is conceived by our brain, perceived by our sense organs, played by our body, and interpreted by our brain. For this reason, it is subject to both the general limitations of our nervous system and the specific limitations of our auditory processing capacities (p.598). While senses such as taste and smell are not entirely linked to music teaching, teachers often use musical dynamics and expressions that can be associated with these senses, such as a "sour note" or a "sweet melody." When used as a musical term, such words can instantly awaken the senses of taste and smell, which helps one understand what he means ('Benefits of Music Education for Multisensory Learning – ShillerLearning', n.d.). In the field of music education, many active music education methods are used. Methods such as Kodaly, Willems, Dalcroze, Suzuki, Orff, Cobb, Cheyette, Gibbs, Heffernan Bebeau, and Gordon include multi-sensory resources to support individuals' permanent learning. (Aycan, 2018, Rau et al., 2012, 2020, as cited in Pino et al., 2022) These pedagogies include multi-sensory resources that can be combined to support individual lasting learning, giving teachers the freedom to choose which method can be used according to students' abilities. Adhering to the fourth principle of Universal Design, which gives students the chance to learn from visual, auditory and tactile information, these approaches allow the necessary information to be communicated, making learning richer and more motivating for students, allowing us to learn in a more natural and efficient way due to the generalizing effect of the multiple senses.

A Physiological Perspective on the Multisensory Aspect of Music

As a result of discoveries in neuroscience and significant advances in cognitive psychology, new perspectives have been put forward regarding the connection between the senses and learning. It is becoming increasingly clear that our brains are tuned to collaboratively detail data from various sensory channels to create the perception of reality. Accordingly, neuroimaging techniques now make it possible to map many functions in the human brain. By using fMRI in humans to identify sensory areas, it can be easily observed that it is localized in regions in the occipital cortex for vision, in and around the superior temporal gyrus for hearing, and in the post-central cortex for touch. Despite the fact that the brain has many other multisensory domains, a large number of separate cortical brain regions have been specifically associated with the area of music. These; The prefrontal cortex, intraparietal sulcus, and superior temporal sulcus are the primary components of these areas (Zimmerman & Lahav, 2012). When we play musical instruments, sing, or move, we hear sound simultaneously. We see movement and notational representations of that sound, and we react kinesthetically to what we hear and see. These multimodal requirements, which require full participation, are addressed through a physiological approach. There have been MRI studies showing that more than one brain region is active during musical performance (Sergent, 1993, as cited in (Custodero, 2002) For example(Schwenkreis et al., 2007) It has revealed evidence of a highly asymmetrical (left hemisphere activation for the right hand; right hemisphere activation for the left hand) with high agreement between changes in the primary somatosensory and motor cortex in string players (p. 3302). The transfer of information between the hemispheres depends on the corpus callosum, which is the primary white matter pathway that connects the two cerebral hemispheres. The hemisphere interactions mediated by the corpus callosum are quite important, as the coordination of two hands and the different contributions of each limb are required to achieve the goal when playing an instrument (Wahl & Ziemann, 2008; Swinnen, 2002).

Based on this knowledge, the player's work with the non-dominant hand will also benefit skill learning on the dominant side, thereby increasing dual efficiency. Again, dual efficiency is one of the most important determinants of successful and professional performance (Weigelt & Stöckel, 2009, p. 38). Perceptual processing of music; It includes a large number of parallel, anatomically organized and physiologically distinct auditory circuits. These circuits allow music to be processed in parallel from the ear to the cerebral cortex, which is called the information processing process from the bottom up and vice versa from the cerebral cortex to the peripheral auditory system, from top to bottom (Middlebrooks, 2009; Moore, 2012; as cited in Janisauska & Bernhofs, 2021). The auditory areas are located in the temporal lobe of the primary and secondary auditory cortices (Prychitko, Sonja, 2017, p. 23). The right auditory cortex has been shown to have a role in processing pitch information (Zatorre et al., 2002, as cited in Zatorre et al., 2007, p. 549). The motor regions of the parietal lobes and frontal lobes are physically connected and work in parallel to convert incoming sensory information into motor actions (Rizzolatti et al., 1998).

The processing of incoming stimuli involves the sensory system. This is then used to establish possible expectations by comparing it to the data stored in memory. Cognition allows the listener to position himself and establish musical expectations at various levels, both in the music processed at a given moment and in the music that sounds realistic, accumulated in the form of knowledge and previously heard. This is because different levels of information are stored in memory (Salimpoor et al., 2015, Rohrmeier and Koelsch, 2012, as cited in Janisauska & Bernhofs, 2021). For many years, both neuroscience and psychology have devoted a great deal of time to studying sensory perception and processing. Still, most previous studies have only accounted for one sensory method at a time (e.g., sight or touch). However, real-world circumstances often stimulate many of our senses at the same time (Driver & Noesselt, 2008).

MULTI-SENSORY LEARNING AND VIOLIN EDUCATION

A musical performance includes perceptual, cognitive, and motor components. Touch is one of the most important sensory cues when it comes to music. Similar to how many other musical instruments are played, violinists hold their instruments close to their bodies while playing. The left hand holds the neck of the violin, the right hand holds the bow, the chin and shoulder support the body of the violin. Violinists receive vibrating input from their instruments as an implicit accompaniment to the music they produce with their fingers and by pulling their bows over the strings. Therefore, the tactile interaction between the violinist and the instrument is essential to musical performance and is probably somehow linked to the feel of the violin (Wollman et al., 2014).

Playing the violin is multimodal in nature. Violinists receive visual inputs in addition to the sound that emerges from their performances, and they also receive vibrational feedback through various points of contact with the instrument, which must be relevant to the music produced. Violinists can gain control over the instrument thanks to all this sensory feedback. We assume that the impression of the sound and "feel" of the violin in a playing environment is based on the reality of these complex interactions between the performer and the instrument (Wollman et al., 2014).

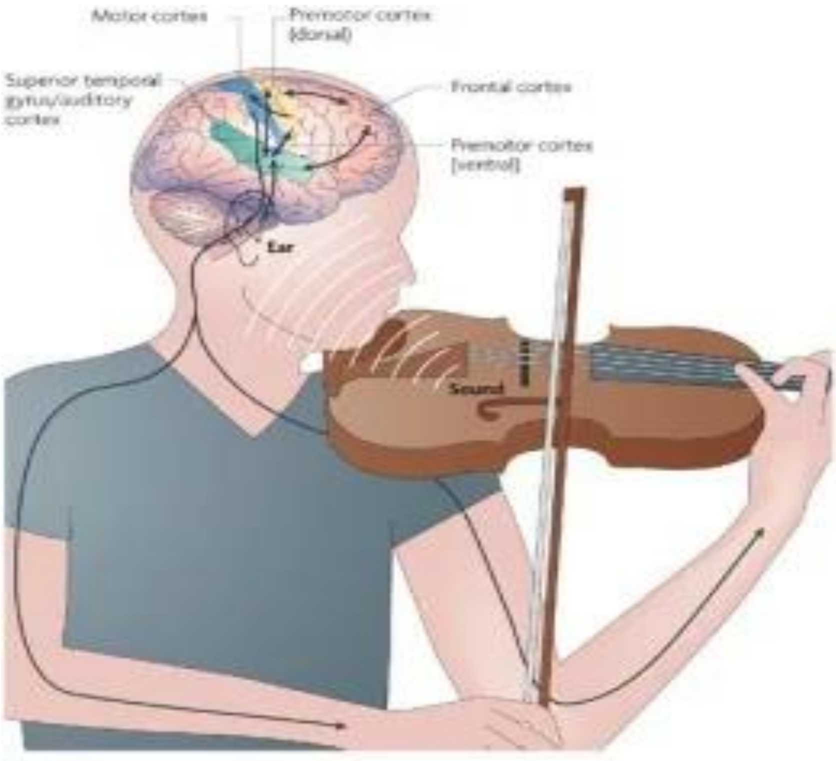

Figure 1. ('8 Amazing, Little-Known Ways Music Affects the Brain', 2013)

1. When learning to play the violin, various senses are used, such as sight, hearing, touch, and proprioception. This is known as multisensory learning on the violin. Multisensory learning enhances the entire learning process and can result in more effective skill acquisition and retention because it involves a large number of senses at the same time (see Figure 1.). Violin training can benefit from multisensory learning in the following ways:
2. Visual cues: Students can see their body position, bow technique, and watch finger placement on the keyboard through the instructor, video, or mirror. Understanding musical notes and proper violin technique can also be supported by visual aids such as various symbols, colors, and video tutorials. Visual abilities are also required to correct problems by adjusting the fingers of the left hand in response to auditory feedback.
3. Auditory feedback: The tone of the violin is crucial for self-evaluation and personal growth. Students can listen carefully to their own playing and receive feedback from

the teacher. Students can change their approach by solfeggio, using different instruments to improve tone, intonation, and musical expression.

4. Kinesthetic awareness and feedback: Learning to play the violin requires both the development of muscle memory and knowledge of one's own body. Students can focus on feeling the finger positions, the weight of the bow, its balance, the strength level of the muscles involved, their general posture. This sensory input helps to develop correct finger placement, spring control, and a relaxed playing style. In addition, by adhering to the understanding of multi-sensory learning in natural situations, the teaching strategies or materials presented to the learner during the education process and the information can be clear and the behaviors can be permanent, so that the learner can feel and internalize the target behavior more accurately with the existence of different modalities (visual, auditory, tactile, etc.).
5. Tactile learning: Another critical component of violin playing is touch learning. In order for violinists to feel where their hands and fingers should be on the fretboard, they need to have a good tactile sense. They can explore weight, balance and texture differences with a variety of materials to improve their sense of touch. Additionally, tactile feedback can be generated by experimenting with various wire types and tensions.
6. Oral and written instructions: Oral and written instructions are just as important as sensory encounters for learning the violin. Teachers should explain everything in detail, advise students on the appropriate technique, and offer constructive criticism. Students can consolidate what they have learned and track their progress by keeping written notes, sheet music, and practice journals. In addition, the player's verbal and written instructions to himself can help him focus better on the target and control his cognitive and emotional reactions.
7. Mental imagery: Mental imagery involves imagining the desired sound, movements, and musical expression before physically playing the violin. Students can hear the music in their heads, predict the notes coming in, and imagine the ideal sound. Concentration, musical interpretation, and memory can be improved through mental imagery. Students also need spatial imagination to be able to project notes onto the keyboard.

8. Integration of the senses: To support multi-sensory learning, various senses can be integrated at the same time. For example, students can see their teacher's performance, hear the voice, and imitate actions. They can practice with their eyes closed, with auditory feedback-free motor movements, to develop their kinesthetic awareness and increase their confidence in their ears.
9. Experiential learning: Music-related activities other than just playing the violin can offer a multi-sensory learning opportunity. Students can take part in ensemble performance where they hear and react to other instruments, harmonize with various parts, and experience rhythm and dynamics as a group. Watching live performances and listening to recordings can also broaden one's musical horizons.
10. String instrument performance is difficult as it relies heavily on auditory feedback. In order for a violinist to play with safe intonation, all three perceptual faculties must be used. The ability to "hear" or "think" music is known as selection and is essential for intonation. The sounds produced by an instrument should be compared to an internalized pattern when a sense of tone is developed by instrumentalists. Instrumentalists must first listen to the tones in order to compare the sounds of their instruments to this internalized model. Schleuter argues that the best decipherers hear what is to be performed. When a musician first reads sheet music, visual skills are needed to recognize musical features as patterns and to "match relevant information already stored in long-term memory." The kinesthetic skill is then used to translate these visual patterns through the application of finger and bending patterns. Other skills are also needed, such as "memory to recognize examples and problem-solving skills for improvisation and estimation." Schleuter encourages labeling rhythm sounds, syllables, and measure names first, and then emphasizing rhythm symbols that represent familiar sounds (Hallam & Guettler, 2002, Schleuter, 1997, as cited in Tang, 2017).

CONCLUSION AND DISCUSSION

Playing the violin is a multimodal experience. The fact that more than one sense is active in violin learning plays a very important role as complementary elements in the way of perception. Research on this subject and various sensory-based learning and teaching methods have revealed that the learning process becomes more effective with multisensory learning, and the acquisitions are more permanent and faster. When it comes to music and instrument learning, receiving feedback from multiple senses is much more beneficial than receiving feedback based on one sense. The results presented in this study show that multisensory education may be more effective than non-sensory education and training approaches. In violin education, when the teacher focuses on teaching the student through his strengths, the weaker modality styles should not be neglected. With the same understanding, it is seen that violin performers' individual studies with multi-sensory learning-based strategies can be more efficient and permanent than a process consisting of learning strategies limited to the senses that are active only while playing the instrument.

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