Music Training and Amendment of the Course of Adolescent Auditory Development

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ABSTRACT

The study sought to assess how music training amends the course of adolescent auditory development. Developing a strategy to bring music training to children may as well result in improved brain-behavior and auditory health. The auditory system develops the capacity to receive, interpret, and respond to complex language, as well as the capacity to hear, discern, and respond to music. Hence, music is seen as a therapeutic tool to alter mood and moderate emotion for both infant, adolescent even in adults. It as well helps in auditory processing. Involvement in musical training promotes neural plasticity and helps in the development of auditory skill. Therefore, one of the recommendations of the study was that federal/state governments should allocate funds and help in deploying musical instruments to schools for effective music training of students.

KEYWORDS: Music Training and Adolescent Auditory Development

Introduction

Delineating the musical abilities that are specifically linked to an intensive and formal training from those that emerge through mere exposure to music is a key issue for music cognition, music education, and all of the disciplines involved in sound and music computing (Lalitte, 2008). A number of studies suggest that musical training has benefits for other cognitive domains, such as language and mathematics, and studies of children and adults indicate structural as well as functional differences between the brains of musicians and non-musicians (Trainor, Shahin and Robertsa, 2009). But in the past decades, researchers have examined whether taking musical training has a positive influence on nonmusical cognitive abilities. Such influence would represent a form of transfer. The most common design (i.e., correlational) involves comparing musically trained and untrained individuals, which makes it impossible to determine whether music lessons are the cause rather than consequence of improved cognitive performance (Swaminathan and Schellenberg, 2016). There has been an emerging evidence that music training induces changes in the brain. Indeed, the musician's brain has been used as a model of neuroplasticity (Habib and Besson, 2009; Zatorre and McGill, 2005). Early studies investigated how music training primes the brain for processing musical sounds and examined the extent to which such plasticity is specific to processing musical sounds (Peretz and Zatorre, 2005). These studies revealed that music training induces functional and structural changes in the auditory system (Hannon and Trainor, 2007). For example, compared to non-musicians, pianists show increased neural activity (measured by magnetic source imaging) in the auditory cortex in response to hearing piano notes (Gaser and Schlaug, 2003). The strength of neuronal activation to piano notes was found to correlate with the age at which piano training began and with the number of years of music training. This suggests that enhanced functional plasticity reflects experience and is not merely a reflection of innate differences between musicians and non-musicians (Kraus and Chandrasekaran, 2010).

Concept of Music Training

Music training is a demanding task that involves active engagement with musical sounds and the connection of 'sound' to 'meaning', a process that is essential for effective communication through music, language and vocal emotion (Kraus and Chandrasekaran, 2010). Music training initiated as late as adolescence can enhance neural processing of sound and confer benefits for language skills. These results establish the potential for experience-driven brain plasticity during adolescence and demonstrate that in-school programs can engender these changes. Music training according to Lmerja (2016) changes the way the brain functions in an adolescent. It improves verbal memory, phonological and reading skills. Many individuals go in music training classes for learning how to play instruments. In the course of musical training, musicians increasingly learn to attend to the fine-grained acoustics of musical sounds. These include pitch, timing and timbre, the three basic components into which any sound that reaches the human ear — including music or speech — can be broken down (Kraus, Skoe, Parbery‑Clark and Ashley, 2009). Pitch refers to the organization of sound on an ordered scale (low versus high pitch) and is a subjective percept of the frequency of the sound. Timing refers to specific landmarks in the sound (for example, the onset and offset of the sound) and timbre refers to the quality of the sound — a multidimensional attribute that results from the spectral and temporal features in the acoustic signal. Attention to these components is emphasized during music training (Kraus and Chandrasekaran, 2010). More likely Hudziak, Albaugh, Ducharme and Karama, Spottswood, Crehan, Evans and Botteron, (2014) noted that developing a strategy to bring music training to children may well result in improved brain-behavior and auditory health. However, like many health-promoting activities, it appears that music training in childhood is an activity of those with sufficient wealth. Although the most potent changes in neuroarchitecture correlate with number of hours of practice, the work of Bilhartz, Bruhn, and Olson, (2000) showed that, despite being assigned to experimental groups receiving different levels of intervention, household income influenced the actual music training that the children received; children in higher-income households ultimately received greater exposure to music training, despite random group assignment (Bilhartz, et.al., 2000).

Concept of Auditory Development

The human auditory system is unique and far different from animal's auditory system

(Graven and Browne, 2008). It differs from all others because it develops the capacity to receive, interpret, and respond to complex language. It also develops the capacity to hear, discern, and respond to music. The auditory system supports development of language as well as musical skills. Unlike the visual system where actual visual experience begins after birth at term, the auditory system requires auditory experience with voice and language, music, and meaningful environmental sounds (Hall, 2000). The auditory system in the human fetus and infant has its own developmental sequences. The anatomical or structural parts of the system develop early. The structural parts of the cochlea in the middle ear are well formed by 15 weeks' gestational age and are anatomically functional by 20 weeks' gestation (Pujol and Lavigne-Rebillard cited in Graven and Browne, 2008). The somaesthetic (touch), kinesthetic (movement), proprioceptive (position), vestibular (motion-head), and chemosensory (smell and touch) systems all are both structurally and functionally operative before 20 weeks' gestation. The auditory system follows those systems in the sequence of development (Ronca, Alberts and Lecanuet, 2005). The study of auditory development in human infants, children and adult is relatively young and have been emerged by many researchers (Streeter, 1906; Streeter, 1917; McKinnis, 1936; Hall, 1964; Bredberg, 1968) cited in Werner, (2007), for example studies of anatomical, physiological and behavioral or psychophysiological development had been published prior to 1970. It was, however, only in the 1970s that interest in assessing auditory in adolescent became serious, with the appearance of visual reinforcement audiometry and the auditory brainstem response (Trainor, Samuel, Desjardins and Sonnadara, 2001). Hence, it can be noted that auditory development and the potential for interference with auditory development are critical issues for the care of postterm infants in day care or home environments (Graven and Browne, 2008).

The Structure of the Auditory System

The auditory system is the sensory system for the sense of hearing. It includes both the sensory organs (the ears) and the auditory parts of the sensory system (Wikipedia, 2014). The external ear canal leads to the tympanic membrane (eardrum). The outer ear funnels sound vibrations to the eardrum, increasing the sound pressure in the middle frequency range. The middle ear contains a chain of three bones that connect the tympanic membrane to the cochlea. The middle-ear ossicles further amplify the vibration pressure roughly 20 times. The base of the stapes couple’s vibrations into the cochlea via the oval window, which vibrates the perilymph liquid (present throughout the inner ear) and causes the round window to bulb out as the oval window bulges in (Tillotson and McCann, 2013; Ashwell, 2016). Vibrations of the tympanic membrane according to Graven and Browne, (2008) are transmitted to the cochlea. The cochlea contains three parallel fluid chambers. The vibration of the tympanic membrane creates fluid waves in the cochlea. Within the cochlea, between the fluid chambers, is the organ of Corti. The organ of Corti contains the hair cells that have a hair-like projection from their apex (stereocilia). It is the physical movement of the stereocilia that is converted into a nerve signal that is then transmitted through the spiral ganglion and the relay nuclei in the pons and midbrain to the auditory cortex in the temporal lobe (Kandel, Schwartz and Jessell, 2000). The neurons of the temporal lobe connect to the brainstem that stimulate a physiologic response (Graven and

Browne, 2008). The structure of the external and middle ear is shown in Figure 1.

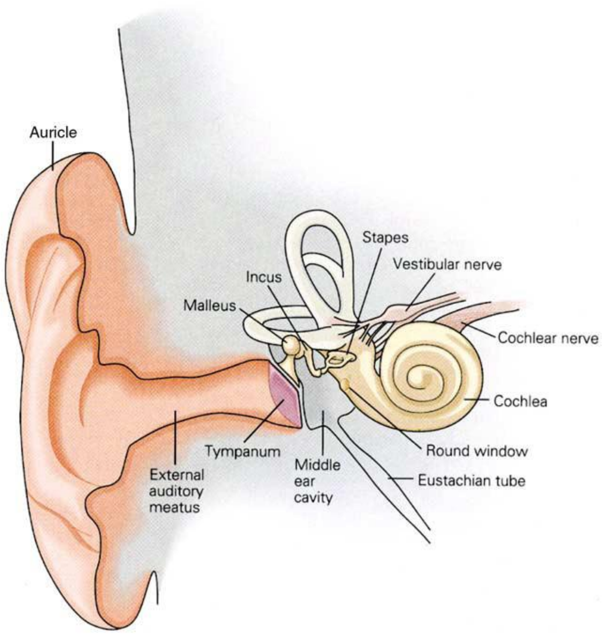

Figure 1: The structure of the human ear. The external ear, especially the prominent auricle, focuses sound into the external auditory meatus. Kandel, Schwartz and Jessell (2000) cited in Graven and Browne, (2008).

A Brain Wired the Regularities

An adaptive auditory system is primed to extract sound regularities in a predictive manner (Winkler, Denham and Nelken, 2009). The ability to extract statistical regularities in soundscapes probably underlies the well-described statistical learning processes that the brain uses to segment linguistic and non-linguistic inputs (Chandrasekaran, Hornickel, Skoe, Nicol and Kraus, 2009). The typical auditory system is capable of extracting regularities in the signal implicitly, even without the need for conscious attention. Subcortical enhancement of stimulus regularities accompanies success with linguistic tasks, such as reading and hearing speech in noise (Winkler, et. al., 2009; Chandrasekaran, et. al., 2009). For example, to track a friend's voice (a predictable regularity) in a noisy cafeteria that have amply competing voices. Adaptive sensory processing is especially beneficial in challenging listening conditions, when the incoming auditory information is noisy or unreliable (Luo, Wang, Kashani, and Yan, 2008). Through musical training, an individual may learn to pick out sound objects from a complex soundscape, and this improves the ability to track regularities in the environment. Selective enhancement of the sound stimulus in the brain may result from a superior ability to encode predictable, relevant events in the incoming sensory stream (Münte, Altenmüller and Jäncke, 2002; Parbery-Clark, Skoe and Kraus, 2009).

Music Training and Adolescent Auditory Development

Music has long been used as a therapeutic tool to alter mood and moderate emotion for both children and adults, but it is only recently that scientists have started to explore the physiological benefits that listening to and playing music can provide, and specifically how music helps auditory processing, a fundamental learning skill (Chalnick, 2016). Research has shown music therapy to be useful for all kinds of medical interventions — everything from pain attenuation to reducing blood pressure. More recently, it was reported in Neuroscience News (2010) that music is not only healing, but it can improve cognitive and auditory processing as well. Lmerja (2016) noted that scientists have discovered that many individual undergoing musical training show enhancements in the auditory system and brain structure and function. Adolescents between the age of 12-18 years throughout their three years in high school undergoing musical training showed enhancements in the auditory system and neurodevelopment. They showed earlier adulthood mental responses, which means plasticity was happening faster. Thus, music has a great importance in the mental and auditory enrichment of adolescents (Lmerja, 2016). In a likely manner, music helps to make the auditory system more sensitive towards sounds and the experience in being a good listener helps the learning process. Adolescents in music training are good listeners because music improves their listening skills. In addition, there is evidence that short-term music training in early childhood correlates with musically relevant motor and auditory cortical changes (Hyde, Lerch and Norton, 2009). Studies that compare musicians and non-musicians have identified four determinants of music training related plasticity: age of training onset, number of years of continuous training (Wong, Skoe, Russo, Dees and Kraus, 2007), amount of practice (Musacchia, Strait and Kraus, 2008) and aptitude (Schneider, 2002). The cognitive–sensory aspects of music training promote neural plasticity and this improves auditory processing of music as well as of other sounds, such as speech (Kraus and Chandrasekaran, 2010). Plasticity is influenced by the extent to which a person actively engages in music training relatively early in their life (Trainor, 2005). The importance of the age of onset of music training can be gleaned from a study that controlled the number of years an individual engages in music training and practice to help in auditory development (Watanabe, Savion-Lemieux and Penhune, 2007).

Conclusion

The human auditory system is a unique system that is far different from mammal's auditory system. It develops the capacity to receive, interpret, and respond to complex language, as well as the capacity to hear, discern, and respond to music. The auditory system supports development of language as well as musical skills. Music training is a demanding task that involves active engagement with musical sounds and the connection of 'sound' to 'meaning', a process that is essential for effective communication through music, language and vocal emotion. Music has long been used as a therapeutic tool to alter mood and moderate emotion for both children and adults, and also music helps auditory processing, which is seen as a fundamental learning skill. Involvement in musical training promotes neural plasticity and helps in the development of auditory skill.

Recommendations

1. Seeing the beneficial impacts of music training on auditory development, these should be discussed in both government and musical institution to improve `the quality and quantity of music training in schools.
2. Federal/State governments should allocate funds and help in deploying musical instruments to schools for effective music training of students.

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