Music, The Brain and Parkinson's Disease

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Music and its relationship to brain function have been investigated for many years. The positive impact of music on the motor and sensory system as well as the impact on the emotional aspects of life such as mood is well accepted. Such impact can be from various aspects of what music supplies to the individual. Some might see music as simply melodious and enjoy the tonal quality of the notes. Some see rhythm and patterns that they can identify with while for other listeners, music is an operation of symbol manipulation with complex dynamics that appeal as structurally (physically) and mathematically beautiful. The response to a piece of music is variable across individuals. It is very likely that while a particular piece of music causes a similar surface response at a deeper level and possibly a level that is not even appreciated by the individual themselves, the response is unique. The result is an alteration in the physical structure of the nervous system that will also be unique. This interaction among the sensory input into the neural system, the neuronal connections that receive and process this information and the output in terms of the individual behavioural response changes over time. These underlying mechanisms and properties of change can be used for the treatment diseases such as Parkinson's disease.

THE MUSIC AND THE MUSICIAN: Many components are involved in the generation and appreciation of music. The musician has to produce music, whether it is vocal or instrumental, in such as way so as to generate certain architecture of the experience that he or she is attempting to convey. The richer and more complex this musical architecture, the more likely it is to stimulate and engage interconnected areas of the brain. For example, if the music generates an emotional response, it is possible that the limbic cortex is activated. However if the music triggers visual imagery such as the first time you saw a rose garden, it may engage the olfactory and even the visual parts of the brain. A single piece of music is a multi-sensory experience capable of activating a variety of areas in the brain simultaneously. One can imagine that the more a musician has the ability to generate such a response from the listeners' brain, the more the music will appeal. Loud and dissonant music that stimulates the auditory cortex alone may not have the same impact in terms of music-brain interaction as a complex piece of classical music. Therefore, it is likely that the complexity of the music itself and the ability of the musician to generate musical patterns and structure that is complex, has a better chance of engaging the brain and enhancing the musical experience.

THE TYPE OF MUSIC: It is also likely that the music itself may be responsible in making the output complexity variable. We know that the kind of response that a human being generates is intricately linked to the nature of the input that the brain has received. In terms of walking, if the road is fraught with obstacles, then the brain has to generate a response that is going to respect this and hence allow that person to walk through the obstacles. So a simple unobstructed road will produce a motor response that is much simpler. The same theoretical construct may be applied to the concepts of the interaction of music and the brain. If the incoming music is simple in melody or harmonic structure, then one can envision the response of the brain to be simple as well. There is no need for processing at a higher level because the incoming music does not require or does not stimulate this response from the brain. What does this mean? It means that the higher and more complex the music is, the more complex the neural response will be. As well, this more structurally and harmonically complex music may result in a richer activation of the neuronal connections in order to process the music. This complex neural response pattern can then produce both an emotional and physical response. The individual may have mood elevation and at the

same time improve the rhythm of walking by listening to the drum beat of a military march composition.

Western and eastern classical music may very well be the answer to this issue. These forms of music are excellent examples of two different yet equally complex ways of producing music. In western classical music, many instruments are used to produce melodies and rhythmic sound that is woven into complex patters such as in a symphonic or an orchestral piece. The composer sets the tone, rhythm harmony, and timing of a piece of music. For someone to recognize a particular piece of this music say Beethoven's 5th symphony, it has to match our memory of the piece and all notes have to be played as written by Beethoven. Since the music is intrinsically complex, it meets all the requirements for generating a complex neuronal response from the brain. Eastern classical music is different. In most cases this music is not orchestral. An individual artist uses a template of notes, termed a "Rag" and then composes by improvisation, using both well constructed rules and individual creativity, a complex and melodious rendition of that Rag. The richness of this texture woven by the artist determines the complexity of the piece and if our theory is correct, a richer neuronal response from the brain. You enjoy the piece more as the emotional and physical state of the listener is heightened. Interestingly, due to the free form or improvisational performance of Indian Classical music, the same Rag can be delivered in many different forms of complexity at various times. This style of music actively engages the listener and likely increases engagement of multiple brain areas and connections through its complexity and unpredictability.

The conclusion here is that those forms of music that are complex, with many dimensions can activate many more areas of the brain than simpler music. This does not require many instruments, nor overbearing melody. What the music requires is to bring multiple areas of the brain together in a neural symphony.

THE LISTENER: Experience of the music is dependent on multiple sensory systems receiving input and transmitting to the brain for processing. These systems include the ears to hear sound, the vibratory receptors for feeling the vibration and energy of music, visual system to see the responses of the musician as well as the audience, and the kinematic system as you move, dance or clap with the music. In certain settings all these systems are engaged at some level. A mismatch between these systems or malfunction in these systems will result in reduced input. Once the input is received, the brain has to respond in a proper way, be that in terms of the emotional parts of the brain, the motor parts of the brain depending on the rhythmic components in the music or the response desired, especially when it comes to therapy. Thus one can envision that an individual may be asked to speak to a certain beat of the music or walk at a certain rate. However, such forms of one dimensional treatments, generally based on rhythm only are not really music and may not maximize engagement of the full richness of neurological connections. They do not fit into the definition and physiology of music as we have defined above. In order for music therapy to be truly that, the listener must be engaged with a variety of levels of complexity of the music and the nervous system must also be similarly engaged. It is quite likely that the nervous system will not alter in any significant way unless this kind of complex musical intervention is consistently provided.

EFFECT ON PARKINSON DISEASE: So what are we to do when it comes to Parkinson's disease? As patients, there are two alternatives: Either be a musician, which may be difficult if the patient is not already a musician, or listen to music in such a way that it provides the kind of experience that I have described above. However, the current type of music therapy in PD is not anywhere at that level. Music has been used predominantly in the form of rhythm generation to help people move and to get out of bed in the morning. Devices such as walkmans and iPods that play rhythmic music can be used with some success to perform a very specific set of tasks such as walking and crossing the street.

Rhythmic components of music have a specific effect on motor systems. Most of the research is done with rhythmic auditory stimulation in gait training for patients with PD. For example, one study used a three week training program with music for improving walking. After 3 weeks, the patients with PD demonstrated longer stride length and improved gait velocity by an average of 25%. This research and other such work shows that at least at some level using a component of music, i.e. rhythm can help in improvement of some aspects of Parkinson's disease. However, these effects are limited to gait rhythm and do not encompass the full spectrum of improved movement.

Basic neuroscience has tackled the issue of the impact of music on the brain. Data shows that music presentation elevates significantly the dopamine levels and other neurotransmitters in avian brain. Sad and happy mood music showed significant increase in signal intensity in the left amygdala. However, this has never been demonstrated in patients with PD.

CONCLUSION: The use of music in Parkinson disease is therefore in its primitive stages. In fact, the only use of music is the rhythm of music. One does not need music at all if all that is required is a beat. However, most of the actions that we perform are not dependent only on beat. As I have discussed above, the need for generating a complex brain response for therapeutic use implies the need to challenge the brain with patterns that are themselves complex. Music has the intrinsic ability to doing exactly that. Classical and jazz music forms as examples are able to provide variety and complexity that can be used to stimulate responses from the brain. In complex diseases like PD, music not just rhythm therapy may hold promise in helping retune multiple brain areas simultaneously.

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