

The Effects of Music on Cognitive Functioning and the Implications for Patients with Dementia and Alzheimer's Disease

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With the increasing incidence of dementia and Alzheimer's disease in our aging population, there is a growing need for interventions that can enhance cognitive functioning in aging adults. The use of music and music therapies in patients with dementia has been gaining popularity as a cost-effective, easy-to-implement method to improve quality of life, and recently, researchers have begun exploring music's cognitive benefits.

Empirical evidence indicates that music is related to cognitive functioning. For example, there are cognitive functioning differences between musicians and non-musicians. One study showed that musicians are faster at updating their working memory than non-musicians (George & Coch, 2011). These differences in cognitive functions are mirrored in anatomical and functional changes in the brain. Musical training changes gray matter volume in motor, auditory, and visuospatial areas; the white matter architecture; asymmetry of the planum temporale; and increases the size of the corpus callosum (Gaser & Schlaug, 2001; G Schlaug, 1995; Gottfried Schlaug, Jancke, Huang, & Steinmetz, 1995; Schmithorst & Wilke, 2002). Music training can also modify the organization of brain structures. For example, musicians who play string instruments have increased cortical representation of the fingers of their left hand when compared to non-musicians (Elbert, Pantev, Wienbruch, Rockstroh, & Taub, 1995). Together, these studies indicate that music can have a profound and lasting effect on the brain and behaviour.

Even in non-musicians, studies have shown that listening to music engages large-scale networks within the brain that are associated with executive functions such as attention and working memory (Janata, Tillmann, & Bharucha, 2002). Moreover, regular music activities, like playing an instrument, are associated with enhanced cognitive functions in healthy older adults who are not musicians (Bugos, Perlstein, McCrae, Brophy, & Bedenbaugh, 2007). In a music intervention study, Seinfeld et al., (2013) observed increases in cognitive functions in older adults (also non-musicians) placed in a piano-training program relative to a control group who participated in physical exercise activities.

One limitation of a music-production intervention, such as piano playing, is the requirement for participants to have strong attention and motor functions in order to learn a new instrument. However, for patients with dementia or Alzheimer's, a less intensive approach may be necessary for successful participation in the intervention. A recent study of the cognitive benefits of music found that both singing and listening to music improved cognition in early dementia patients (Sarkamo et al., 2014). This is an encouraging development as listening is less demanding than learning to play a new instrument. Thus, listening to music constitutes a promising strategy for patients with dementia or Alzheimer's and could help patients maintain a high level of cognitive functioning.

In the Sarkamo et al. (2014) study, participants listened to songs that were highly familiar and biographically important. The relevance of music familiarity for patients with dementia and Alzheimer's can not be overlooked. The profound effects of familiar music have been shown both anecdotally in films such as *Alive Inside* and scientifically by researchers exploring how memory for music is uniquely spared and can trigger seemingly lost memories in these patients (Baird & Samson, 2009; Belfi, Karlan, & Tranel, 2015; Cuddy et al., 2012; El Haj, Fasotti, & Allain, 2012).

However, the mechanism by which music alters cognition or triggers memories, the features that determine what types of music might be successful in an intervention, and the demographic factors that determine whether an individual will be a good candidate for a music-based therapy are unknown. The proposed project aims to characterize the relationship between music and cognitive functioning and ultimately to apply this knowledge to create better interventions for patients living with dementia and Alzheimer's disease. We propose to examine how music listened to before or during test-taking alters cognitive performance, and to assess the critical features of music that may enhance function. We

will manipulate objective acoustic measures (spectral flux, lyrics, instrumentation) and subjective measures (enjoyment, familiarity, etc.) to test their influence on cognitive functions.

My supervisors, Dr. Jessica A. Grahm and Dr. Adrian M. Owen, work with a series of web-based cognitive tests called *Cambridge Brain Sciences* (CBS). The tests are scientifically validated tools that assess cognitive functions, including memory, reasoning, attention, planning, and problem solving (Hampshire & Owen). The tests are designed to be straightforward, and are thus well suited to use with older participants. Because they are online, very large numbers of participants can be tested with minimal effort. To assess individual differences, we will collect demographic information on participants' musical background, preferences, and habits using the Goldsmiths Musical Sophistication Index (Müllensiefen, Gingras, Musil, & Stewart, 2014).

We will also investigate whether familiar music is important for enhancing cognitive functioning. Using an existing music database created in our lab we will select music that is highly familiar to participants and then select music of a similar style that is unfamiliar. We will have participants listen to these songs before and during testing to determine whether familiar music has a facilitatory effect on cognitive functioning.

Music listening is a non-pharmacological intervention that may have positive effects on cognitive functioning in patients with dementia and Alzheimer's. In the short-term, our study will characterize the relationship between music and cognitive functioning in healthy older adults. In the long-term, we will compare how this relationship differs in patients with dementia and Alzheimer's to create more effective therapies that target the specific deficits seen in these patients. The results from healthy older adults will enable us to optimize the research approach for adults with dementia and Alzheimer's. The resulting targeted music therapies and interventions will improve patients' quality of life and help them maintain a high level of cognitive functioning.

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