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Musical Activities and Cognitive Enhancement in Dementia

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Introduction

Musical activities—either listening passively, or participating actively—have long been applied to health settings, from very uncontrolled paradigms where music is for instance only used to modulate mood in the background, to very specific protocols that directly target symptoms of specific neurological disorders (for instance see the Neurological Music Therapy or NMT program, Thaut 2005). The breadth of possible health applications reflects the range of elements that can be included in musical interactions, which can be featured in an intervention and potentially developed, such as perceptual acuity in pitch or time, individual or joint movement, (nonverbal) affective communication, directing of attention, improvisation, and so on. The element that is crucial to any intervention will thus depend on the problem that is being targeted, and whether the aim is to fully recover, to actively slow decline, or to offer palliative care.

Music therapy is increasingly used for individuals with dementia, based on the idea that musical processing is preserved even though cognitive functions decline over the course of the disease (Baird and Samson 2015). However, in the various stages of impairment, there are wide-ranging individual differences and as such, the level of functioning also clearly determines the kind of intervention or activity that may be both feasible and helpful for a specific patient. In the following, we will focus on the potential effects of music-based interventions on cognitive function in dementia. For the scope of the current discussion, we are interested in effects that are not based on direct practice of a specific function (i.e., using music as a

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mnemonic aid), but rather the implications of engaging in a multimodal, hierarchically structured activity to increase cognitive functioning. Here, we discuss passive and active musical interventions of different intensities, looking at single sessions of music listening as well as longer, protocolled interventions.

Music Listening: Incidental or Regular

Cognitive effects of music have been evaluated using single listening sessions, either directly preceding, or played during cognitive tasks as a background stimulus. Additionally, more structured programs of music listening, termed 'passive music therapy', have also been investigated in terms of cognitive improvements.

Brief increases in spatiotemporal abilities were originally reported right after single instances of music listening in healthy young subjects, eventually hypothesized to be driven by music-induced arousal (cf. Rauscher et al. 1993; Nantais and Schellenberg 1999). While the nature and size of this effect are still under some debate (cf. Pietschnig et al. 2010), evidence from small samples of older adults with mild cognitive impairment (MCI, Cacciafesta et al. 2010) and early stage Alzheimer's disease (AD, Johnson et al. 2002) suggests that spatiotemporal abilities can also increase in these groups directly after about 10 min of music listening. Interestingly, individuals with AD who experienced higher impairment in visuospatial tasks seemed to benefit the most from the music listening session, suggesting that this form of musical rehabilitation may also be beneficial for individuals in more progressed stages of AD. Using music as a background stimulus during cognitive tasks has also been reported to have positive effects on healthy elderly (Ferreri et al. 2014; Mammarella et al. 2007), focusing specifically on memory aspects (episodic memory and working memory, respectively), interpreting the increases seen with background music as effects of mood and arousal, but also of an enriched learning context. Small enhancements in category fluency and autobiographical recall were also found for individuals with AD while listening to music as compared to a silent condition (Thompson et al. 2005; Irish et al. 2006). Interestingly, Irish et al. (2006) found no differences in terms of galvanic skin response (GSR) between music and silent conditions, suggesting the cognitive increase was not related to arousal. Conversely, negative effects of background music on memory have also been reported for healthy elderly (Reaves et al. 2015), suggesting that while music may increase arousal and perhaps engagement, music listening also claims attentional resources and can thus be distracting. Although most research into the effects of music listening uses single sessions, an extension of the work on individuals with MCI mentioned above reports that listening to music over a period of 6 months enhanced spatial–temporal abilities without immediate previous listening exposure (Cacciafesta et al. 2010). This implies that repeated music listening may also lead to a more stable cognitive enhancements than those potentially caused by transient increases in arousal. Interestingly, evidence from stroke patients indicates that regular music listening can lead to enhancements in verbal memory and focused

attention, thought to be related to structural reorganization of the brain (Särkämö et al. 2008, 2014), suggesting that the longer term effectivity of passive music therapy greatly depends on the potential for neural adaptation.

In sum, a single music listening sessions may enhance several cognitive skills, thought to be driven by an arousal response, although this idea has not been supported directly. Moreover, the patient samples tend to be limited, and potentially relevant aspects of the music—emotional qualities, liking, familiarity for the listener, etc.—have not been formally investigated. As such, various elements of music listening need further assessment, namely which aspects of the chosen musical pieces may increase arousal or enhance cognition, which cognitive skills may be enhanced, the timescale at which this enhancement may take place, and which clinical populations can benefit. Regular music listening may enhance cognitive skills in individuals with dementia, but more research is necessary to support this assertion and assess the therapy characteristics (e.g., how many sessions, or type of music) that may create the optimal outcome.

Active Music Therapy

Active music therapy requires the participant to interact with the music, for instance by singing or playing an instrument. Although a number of meta-analyses indicate that active music therapy is effective in lowering agitation and improving mood, effects on cognitive improvements in dementia patients are generally very small, or quite specific to the trained task (Chang et al. 2015; Ueda et al. 2013 Vasionytė and Madison 2013), and not seen for healthy elderly (Li et al. 2015). The different meta-analyses varied in their inclusion criteria, indicating a weakness in this approach. While single music listening sessions show promising results in terms of cognitive increases, longer interventions appear to lead to improvement in specific functions rather than general cognition. For instance, individuals with AD who sang songs and discussed its content showed an enhancement in speech content and fluency but not in general cognition, when compared to participants of speech therapy (Brotons and Koger 2000). Participating in singing training minimally three times a week with the use of songs from their youth and a karaoke machine in a small group of individuals with mild/moderate AD led to enhanced psychomotor speed, but no difference in more general cognitive measures such as the Mini-Mental State Examination (MMSE), word fluency, or memory (Satoh et al. 2015). Conversely, a small group of individuals with dementia who sang or played percussion instruments showed enhancements in language skills, but not in general cognition (Suzuki et al. 2004). However, methodologically stronger studies, which include larger sample sizes and active control groups (receiving another form of therapy), tend not to replicate these results. A weekly therapy for individuals with moderate to severe AD that consisted of listening and singing/playing percussion found no short- or long-term enhancements in cognition (Narme et al. 2014), although emotional state was markedly improved.

Intuitively, it appears that passive (i.e., listening) and active (i.e., participating) activities might differ substantially, but for individuals with mild to moderate AD, both a therapy comprising singing along with familiar songs, and therapy based on listening to familiar songs and trying to remember past events improved general cognition, attention, and executive functioning. However, the active therapy also temporarily enhanced short-term memory and working memory. For both therapies a long-term enhancement was found in orientation compared to a control group (Särkämö et al. 2013). Although cognitive functions were not tested specifically, clapping or singing along with music enhanced general functioning more than passively listening to a music recording, but this increase was only maintained when the therapy was continued (Sakamoto et al. 2013). Two multi-element music therapies, which are arguably more challenging and engaging, found (short-term) enhancements in general cognition in individuals with AD and either consisted of songwriting elements (e.g., creating lyrics/melodies) and actively remembering past events and social contact (Hong and Choi 2011) or consisted of listening, singing, playing an instrument, stimulating other senses, telling jokes, and encouragement of laughter (Bruer et al. 2007). For these therapies, it remains unclear what element caused the cognitive enhancement, but it underlines an important issue regarding the complexity and richness of the intervention activities.

Taken together, the support for the increase of cognitive function in dementia can be said to be patchy at best, but isolated cases show substantial potential, with increased effects for more complex interventions. While some meta-analyses do make distinctions between passive and active involvement, or even specific intervention elements (cf. Ueda et al. 2013, who separate listening, singing, rhythm, and improvisation-based methods), it is difficult to compare studies due to diverse forms of therapies used. Additional to active or passive engagement, group or individual therapy, use of autobiographical memories or music preference, and the involvement of a trained music therapist are sometimes considered as relevant features. Importantly, the control interventions that are chosen as comparisons can speak to the uniqueness of music in enhancing cognition, and the findings do not suggest that music is necessarily more effective than other cognitively stimulating activities, with multisensory stimulation ('Snoezelen') showing similar and sometimes better results than music interventions (cf. Sánchez et al. 2016; Strøm et al. 2016). Finally, the main effects of music therapy on individuals with dementia appear to target mood and emotion, which of course could in turn also be at the basis of cognitive effects. Therefore, continuing investigations are necessary in order to identify elements of music therapy that may directly affect cognition.

Conclusion

Music therapy in its various forms is a promising tool to enhance cognitive skills that are not specifically trained by the therapy, due to the potential richness of the activities involved. However, research is scarce, effects on cognition are often small

and most studies contain methodological limitations, such as small sample sizes, lack of longitudinal data or active control groups (Chang et al. 2015; Young et al. 2016). Also, studies often differ in included intervention elements, making it impossible to compare them, thus reducing the value of meta-analytic approaches. Furthermore, as music therapy is often found to reduce disruptive behavior and anxiety level or enhance mood (Chang et al. 2015), mood enhancement may also mediate between music therapy and cognitive enhancement by influencing arousal/attention.

Findings outside the current scope suggest not only that music can be used as a mnemonic aid in dementia patients (cf. Moussard et al. 2014; Simmons-Stern et al. 2012), but also that playing music regularly reduces the chance of developing the clinical symptoms of dementia (Grant and Brody 2004; Stern 2012; Verghese et al. 2003; Wan and Schlaug 2010). These findings suggest that musical activities can impact the clinical expression of brain damage, potentially through increased neural connectivity and task flexibility, and can still be a valuable tool for individuals with neurological disorders. As such, we can consider music therapy a promising way to enhance cognitive skills either directly or through task transfer, but more methodologically valid research is necessary that takes into consideration the characteristics of the patient, the stage and characteristics of the disorder, the elements of the musical therapy, and the possible influence of mood enhancement.

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