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## The Role of Technology in Music Listening For Health and Wellbeing

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### Abstract

There is growing evidence that listening to music can have significant effects upon health and wellbeing. This article briefly summarises research examining the effects of music listening on a variety of health parameters, and explores the potential role of new music technology in this growing and important area of research.

**Keywords:** Stress; Music listening; Anxiety

Music listening has positive effects upon a variety of physiological and psychological parameters important to health and wellbeing and contributes directly to physical health [1-3]. Music has been found to reduce stress [4], the effects demonstrated through reduced cortisol levels, and affect immune system strength, as measured by salivary immunoglobulin A [5]. There is now a large body of evidence highlighting the positive effect of music in a variety of clinical settings such as dental care, palliative care, paediatrics, surgery and anaesthesia [6-8]. Potential health benefits can also apply outside of a clinical or laboratory setting, and can extend to enhancement of general feelings of subjective health and wellbeing – more specifically psychological factors such as stress, anxiety and depression [9]. An important and growing area of this research is concerned with the effect of music listening on pain relief. A systematic review of music and pain studies concludes that music listening, in the appropriate context, can reduce pain intensity levels and reduce the opioid requirements of participants with postoperative pain [10]. The positive effects of music listening upon the effects of pain have been demonstrated in clinical studies. For example reduction in blood pressure [11], reduction of nausea and vomiting [12], and reduction of pain-related distress [13]. Music listening may mitigate the negative affective experiences associated with pain in addition to reducing the sensation of pain [14]. The potential implications for public health are wide ranging. Music interventions are inexpensive and can facilitate early release from care, thus possibly reducing healthcare costs [2]. Music interventions can be delivered flexibly, tailored around the everyday activities of the individual, and have few negative secondary effects compared to prescription drug treatments.

It is important that the potential of music listening interventions is investigated, and a key challenge in this regard is how findings from this research can be translated into practical applications that will benefit public health. One potential avenue is to explore the benefits of every day music listening. The ubiquity of personal music listening devices has fuelled recent changes in contemporary music listening behaviour, specifically the ability to access music all day, every day. Research has shown that people listen to music in a goal-directed way, and the most common reason given for music listening in an everyday context is a positive influence on emotions [15,16]. Emotions influence individual subjective wellbeing, and are significantly related to health [17,18]. It has been suggested that this type of music listening constitutes an informal type of self-medicated therapy [19]. This desire to have a 'soundtrack' to our lives, means music listening is a popular and regular activity for a large percentage of the population, and the use of music to regulate mood and manage negative psychological factors means there is therefore potential significance to public health [9].

There is a growing need to promote and support positive approaches to the self-management of negative psychological factors in everyday life. For example, a recent survey by the Mental Health Foundation found 47% of UK respondents feel stressed every day or every other day, and 59% reported their life is more stressful than it was 5 years ago [20]. Self-management is also particularly salient to those who suffer chronic pain. Persistent pain affects over 14 million people in England alone [21]. Self-management is an important part of managing pain in everyday life, and is necessary due to limited contact time with health professionals. In this regard, music listening has particular potential to address key areas of the persistent pain cycle - stress/anxiety, and negative thinking/mood swings. It is crucial that those suffering chronic pain have access to a variety of tools to support them [22]. This is underlined by recent Scottish government policy on chronic pain, advising that pain management programmes are delivered through a psychological approach, with emphasis on living better with chronic pain [23].

Technology can play an important role in everyday music listening to enhance health and wellbeing. An increasingly popular way to engage with music now is through mobile devices, desktop computers, laptops, tablets and phones utilising music browsing, streaming and media player software. As the user engages with this technology, it gathers information on their music choices, listening behaviour and listening context. These data can in turn be used by the software to adapt to the individual through use of music recommendation algorithms which seek to suggest music choices to match their listening needs and preferences. It may therefore be possible to adapt this technology with a view to making individualised music recommendations, designed to match the listener's listening preferences for relaxation, mood regulation, reduction of stress and anxiety and enhancement of general feelings of wellbeing. However this raises serious questions about how such a system might be implemented, which factors might be taken into account, and which music would make a 'good' recommendation. Specifically, technology such as this would have to take into account the complex relationship between the individual, their music and the context they listen to it in.

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Recent findings in the literature suggest three factors may be particularly important in this relationship; personal music preferences, the content and structure of the music, and music emotion. Personal music preference is an important factor in the study of the beneficial effects of music listening. Studies using participants' preferred music, as opposed to music chosen for supposed inherent relaxing or calming characteristics have demonstrated positive effects on pain tolerance and perception [24], reduced anxiety and increased relaxation [25], increased feelings of control over pain [26,27], and a decrease in agitated behaviour in older people with dementia [28]. Preferred music can evoke a state of balanced happiness in the listener [29]. However key mechanisms in the positive effects of preferred music listening are still not fully understood. Factors affecting our relationship with our favourite music are myriad, and include personal meaning and memories associated with music [30], factors surrounding situation/context, listener variables such as age, gender, occupation and identities [31]. Schubert et al. [32] have proposed that familiarity is key - the larger the number of factors which play a role in one's experience with a piece of music, the greater the positive aesthetic experience. The content and structure of music is another important factor in personal music preferences - for example preference for particular types or genres of music has been shown to be linked to identity and self-view [33]. However this is an area that is relatively ignored in relation to positive effects of music listening, and there is some recent evidence that acoustical content of music plays a role in music choice for pain relief [34]. More specifically the role of music content and how it dictates the emotion expressed by the music, has an influence on its positive effects [35]. Music emotion has been mooted as key to understanding how the relationship between the music stimulus and resulting response in the listener is mediated [9]. This encompasses mechanisms related to the structure of music. For example rhythmic entrainment, brain stem reflex, where basic acoustical characteristics of music cause corresponding activation of the central nervous system, and emotional contagion, where the listener mimics the mood expressed by a piece of music [36]. These mechanisms have been shown to be factors influencing emotions experienced through music listening, and may be related to the effect of music upon stress levels [37]. Thus personal preference and music emotion are potentially important mediating factors in the positive effects of music listening, and the content and structure of the music in turn plays a significant role in this relationship.

Music recommendation algorithms can be designed to take all of these factors into account. Analysis of listening preferences and information the user inputs into their music software can be used to create a detailed user profile for the individual. A structured ontology can be created which describes the user, their music preferences, and the content of the music they choose [38]. User-specific factors include personal and demographical information, familiarity with a given piece of music, personal associations and memories, subjective and semantic terms used to tag their music files and playlists. The content and structure of selected music can be analysed via metadata tags describing the genre and musical attributes of a given track. More detailed data can be extracted via analysis of the digital music file, resulting in a wide range of features related to musical dimensions such as dynamics, rhythm, timbre, pitch, tonality, and high level statistical and structure parameters [39]. In addition, music emotion can be accounted for via user-generated tags, or via classification of the emotion expressed by a piece of music by examining the acoustical content of the digital music file [34]. This data can be used as a basis for music-content based recommendation. If we have knowledge of

the music an individual listens to for self-management of negative psychological factors and regulation of mood, we can examine the music content (acoustical content, metadata and expressed emotion), and use this data to identify similar music items which are then recommended to the user [40-42]. This approach can be extended to include aspects of the personal profile of the individual - for example taking into account preference for music they are familiar with, or for which have particular personal associations. It is also possible to take into account potential similarities between individuals and their listening preferences. Collaborative filtering systems are based on the assumption that appropriate music recommendations can be made based on the preferences of others who may have similar personal profiles, or who listen to similar music for similar purposes [43]. Thus there are two key roles for the technology in this context: The first is the ability to analyse an individual's music choices in unprecedented detail, and to further utilise this data to classify their music in terms of the emotion it expresses. The second is use of this data, along with a detailed user profile, to create a personalised music playlist based around the needs and preferences of the individual.

In summary, there is a wealth of evidence supporting the positive effects of music listening upon individual health and wellbeing. In order to maximise the benefits to public health, it is necessary to translate these findings into practical applications and interventions. Music interventions are attractive as they are flexible, effective, inexpensive and low-risk. A promising focus for this research is everyday music listening to self-manage negative psychological factors, as evidence shows this is a common activity for a significant proportion of the population. The popular use of software for everyday music listening presents the opportunity to design music technology that is individualised, aware of the listening preferences of the listener, and which provides them with relevant and appropriate music recommendations. There is much work to be done, but once we understand the complex and nuanced relationship between the listener and their favourite music, we will be in the position to develop technology which in essence creates music 'prescriptions' for the individual.

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