Music and single-sided deafness: challenges and solutions

BY GEMMA CRUNDWELL AND DAVID M BAGULEY

Music is an integral part of many of our lives, providing entertainment, relaxation and a backing track to our past experiences. In this overview, **Gemma Crundwell** and **David Baguley** examine the impact of SSD on the perception of music and describe some of the strategies that can be employed to mitigate against some of these effects.

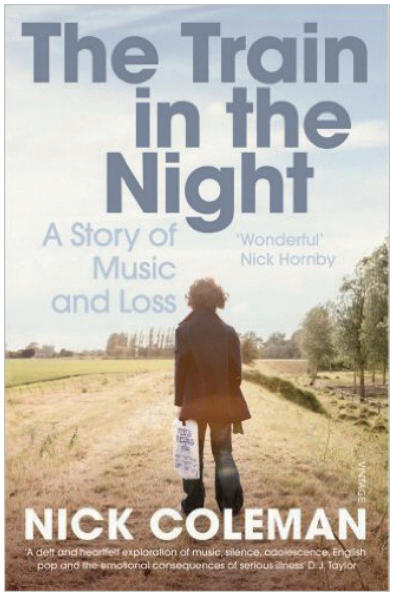

Figure 1: *The Train in the Night: A Story of Music and Loss* by Nick Coleman.

"Given that listening to music is a source of joy and solace to many of us, how can we as clinicians enable our SSD patients to enjoy music again?"

Whilst the causes of single sided deafness (SSD) are varied, one complaint that is common to many individuals with SSD is difficulty enjoying recorded music. This is movingly described in the memoir *The Train in the Night: A Story of Music and Loss*, (Figure 1), wherein noted music critic Nick Coleman describes his experiences listening to music after he became unilaterally deaf:

"Music has changed now that I can't hear it properly... it is now flat and unrevealing, distorted and partially concealed by the uproar filling...my head" [1]

SSD has significant implications for listening to music in stereo. A stereo signal is played through two channels, one to the listener's left, the other to the right, and the signals have a relationship such that the listener perceives an image of the original sound source [2]. The change in perception (and in the case of earphone listening, complete loss) of one channel, due to SSD, results in the loss of important music production features including:

- Stereo-switching – where elements of a track are switched between the left, right or both channels (examples include the tracks *Purple Haze* by Jimi Hendrix and *Strawberry Fields* by The Beatles).
- Panning – creating the perception of the sound moving from one side to another either through simple level difference or in more sophisticated production phase differences and Doppler effects (for example *Amused to Death* by Roger Waters and *Collateral Damage* by Muse).
- 3D audio effects simulating sound source from a three dimensional space using head related transfer functions and reverberation.

Given that listening to music is a source of joy and solace to many of us, how can we as clinicians enable our SSD patients to enjoy music again?

For some, hearing aid or hearing implant technology may have restored some ability to hear in 360˚, either with pseudo-binaurality, as with a CROS hearing aid or bone conduction hearing aid, or true-binaurality, as with a cochlear implant (CI) in an SSD ear. It is however important to note that the perception of music via a cochlear implant is significantly affected by signal processing, electrical stimulation and individual factors resulting in a wide range of outcomes. While much research exists on music perception in cochlear hearing loss, hearing aids and cochlear implants, published data on the benefits for appreciation of music in SSD cases is sparse, and much research remains to be done.

What solutions are available for SSD patients in general to enjoy music? Essentially there are two themes to explore; modulating characteristics of the music or relearning how to listen to music.

Modulating characteristics of the music

One approach is to seek out monaural (or mono) recordings, made using a single channel recorder. Few such recordings are currently in print however historically music was recorded with the understanding that it was going to be

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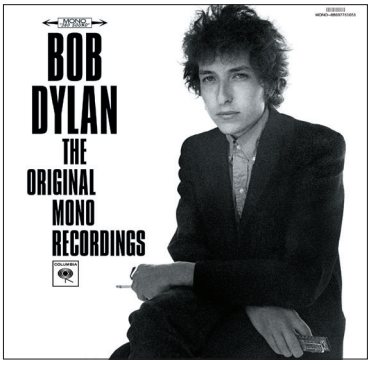

Figure 2: Early Bob Dylan records are an example of monaural recordings.

listened to in mono on the radio or TV. Examples of monaural recordings include early Bob Dylan (Figure 2), The Beatles, and The Kinks. Whilst enjoyable enough, these hardly constitute the rich and varied musical diet that some of us appreciate.

Alternatively some digital music platforms allow stereo signals to be encoded into mono. The operating systems of some smart phones, tablets and computers allow mono listening, often placed in an 'accessibility' menu. Various methods of encoding stereo signals into mono exist. Innovative encoding of the signal could be used to create an artificial perception of binaural listening in mono by simulating psycho-acoustical properties present in binaural hearing such as precedence and Doppler effect, phase, level and timing differences.

A pragmatic solution would be to place loudspeakers playing a stereo track on top of one another, to create a single sound source. If listening with headphones, then a small and inexpensive adaptor can convert stereo signals into mono. Alternatively mono headsets exist, developed for telephone and voice over IP communication. In some cases the merging of two stereo channels can lead to phase cancellations that muffle the sound. Whilst not tested by the authors, a crowd-funded headphone specifically developed for persons with SSD has been marketed, claiming to allow persons with SSD to experience some aspects of stereo such as the movement of a sound source [3].

The listening enjoyment of music can be further enhanced by controlling the listening environment such as a quiet non-reverberant room, and investing in good quality audio equipment.

Relearning how to listen

Formal music training similar to techniques used for CI patients [4] can enhance perceptual processing skills and music appreciation in patients with SSD. Individuals are advised to find a simple piece of music with which they are unfamiliar; one voice, one instrument, focusing on music dominated by structural features, such as a clear, strong rhythmical beat. Listening in this way allows the patient to follow the music and with repeated listening begin to appreciate the development and structure of the piece. Moving on to music of greater complexity, both in terms of instrumentation, but also musical characteristics, allows the (re) development of listening skills, until the patient is ready to appreciate familiar and favourite pieces.

The alternative approach is to utilise familiar pieces immediately. The patient will need support and an understanding that such listening can be disappointing at first (and may compound feelings of loss and distress), but that the 'musical score' held in their memory may allow them to fill in those elements that their SSD hearing does not give them access to.

To enhance training in hearing music with a hearing loss Looi and colleagues (2012) [4] also recommend:

- Using visual cues such as watching the performer, following the score or lyrics,
- Regular repeated exposure to the same musical sections,
- Varying the type of music; as individuals find particular musical tasks easier than others.

As with many aspects of SSD, the impact upon music and how music appreciation might be optimised remains an under-researched area, and one where there are many opportunities to benefit our patients. Studies are underway in Cambridge and elsewhere to quantify the extent to which appreciation of music is impacted in SSD, and to identify optimal strategies for reducing this.

References

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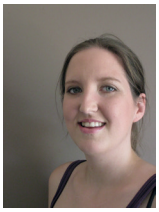

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Declaration of Competing Interests

David Baguley has advised several hearing aid manufacturers on aspects of their devices, but none specifically pertaining to single sided deafness and music.

ABOUT THE AUTHORS

Gemma Crundwell is a specialist audiologist at Cambridge University Hospital, UK working in complex adult aural rehabilitation, hearing implants and tinnitus. She has several peer-reviewed publications. Dr David Baguley is a Consultant Clinical Scientist (Audiology) at Cambridge University Hospitals, UK. He has over 120 peer-reviewed publications, and a PhD on tinnitus from the University of Cambridge. He is a co-author on the books: *Tinnitus: a multidisciplinary* approach (Whurr, 2005) and *Hyperacusis* (Plural, 2007), and edited the seventh edition of *Ballantyne's Deafness* with John Graham. A new book, *Tinnitus: Clinical and Research Perspectives* edited with Marc Fagelson, is forthcoming in January 2016. David is a Fellow at Wolfson College, University of Cambridge, and is Visiting Professor at Anglia Ruskin University, Cambridge, UK.