

Hearing Aids for Music

Findings and recommendations for hearing aid users, audiologists, manufacturers and researchers

2019



Executive Summary

Our project, Hearing Aids for Music (HAFM) has been a pioneering project which has mapped music and hearing aid use across England. Keeping hearing aid users' everyday experiences at its heart, the aim of the project has been to improve access to music through research that has practical and immediate day-to-day application for hearing aid users and audiologists. The HAFM team has collected data identifying the need for further research in this underexplored field, and has provided a world-first international conference open to academics, clinicians, manufacturers and hearing aid users alike.

It is predicted that 20% of the UK population – one in five of us – will have a hearing loss by 2035 (Action on Hearing Loss, 2015). The socioeconomic cost of this could be over £30 billion per year due to loss of earnings, lack of access to life opportunities, and secondary effects of these on health and well-being (Archbold et al., 2014). Engagement in musical activities has a positive impact on health and well-being, particularly among older adults (Macdonald et al., 2012). If people are participating in activities which give them pleasure and meaning (e.g. attending concerts, performing in a choir), they experience better quality of life and play a more active role in society and the wider economy. It is important therefore to map how hearing loss affects people's engagement with music in order to support continued participation in musical activities among this subset of the population.

HAFM highlights a novel way of using arts funding within health settings and the health service to access those directly affected by these issues. The project has engaged people from industry and education, the UK's National Health Service and private practices. Through a series of innovative studies, including working with over 35 Trusts within the NHS, the HAFM project has collected new data from more than 1,500 hearing aid users and over 100 audiologists, and has reached many more people through the internationally accessible website (www.musicandhearingaids.org) and Twitter feed (@musicndeafness).

The HAFM project has received excellent feedback from those who have participated. Hearing aid users reported positive changes in music listening practices as a result of participating in our work. Deaf musicians reported increased knowledge of the capabilities of hearing aid and assistive listening technologies, and that they will share what they have learned with other musicians. Audiologists gained insights that have informed their clinical practice. Hearing aid manufacturers valued the opportunity for networking created by our project, and reported that this has facilitated new productive working relationships. In a follow-up survey taking place four months after our conference, for instance, over half the delegates responding agreed that they took action and/or changed their behaviour as a direct result of attending our meeting (67% of audiologists; 53% of hearing aid users; 56% of those working in research/manufacturing).

We have used our main research findings to develop a set of resources for audiologists and hearing aid users which are now freely available on our website. These include a leaflet for hearing aid users offering guidance on music listening (directly addressing common problems identified by our study participants), a leaflet for audiologists to facilitate discussions in clinic, and a quick-start guide for audiologists to use when fitting hearing aids. We asked for feedback from participants and conference delegates to determine the likely uptake of these leaflets, and found that 71% of hearing aid users and 100% of audiologists would recommend our resources to others. We have also used the findings to make recommendations for our key stakeholder groups, which you can find within this report.

Our approach to research is pioneering in its accessibility. The website has become a single point of access for resources that were previously out of reach of the ordinary listener or audiologist. Members of the general public have shared their stories and personal experiences through our online blog, and these have engaged the wider international community. Moreover, adding a signed video version of our online survey ensured that 72 people were able to participate using British Sign Language.

This is timely interdisciplinary research with global reach. It is offering immediate help to those with hearing loss and who wear hearing aids to engage in musical activities in their everyday lives.

This stage of our work has exceeded its original aims and provides a strong platform of evidence to move forward with further research on Hearing Aids for Music. Our long-term planning to fund our website for 10 years allows continued access to our resources while we develop the next stages of this work. Many of our participants and partners detailed within this report will continue to work with us in the future, and we hope many more will join us on our journey towards improved musical experiences for those with hearing loss.

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Welcome



Welcome from Associate Professor Alinka Greasley, Principal Investigator

A warm welcome from the Hearing Aids for Music project team to our end of project report. We are proud to present to you the achievements of our research over the past three years, and to acknowledge the support and input of all our stakeholders in giving research on music and hearing aids a voice in the UK and beyond. We hope to continue to work with many of you and see this work as providing improvements in music listening through ongoing education, understanding and continuing partnerships in the UK and internationally.



Our team

The HAFM research project is a partnership between the University of Leeds and Sheffield Teaching Hospitals NHS Foundation Trust. We are a small team who are passionate about making music listening an accessible and enjoyable experience for anyone and everyone who wears a hearing aid.



Dr Alinka Greasley is an Associate Professor in Music Psychology in the School of Music at the University of Leeds where she teaches music psychology at all levels, and leads the MA Applied Psychology of Music. Her expertise lies in social and applied music psychology in which she uses different theoretical approaches and research methodologies to explore people's everyday musical behaviour. She has published in mainstream psychology and domain-specific music psychology journals and is an on-going contributor to the Oxford Handbook of Music Psychology on the topics of musical preferences and listening behaviour. She is a Chartered Psychologist with the British Psychological Society, a Fellow of the Higher Education Academy, and a member of the Society for Education, Music and Psychology Research. She is also a violinist, pianist and DJ.



Dr Harriet Crook is Lead Healthcare Scientist for Sheffield Teaching Hospitals NHS Foundation Trust. She is lead scientist for complex hearing loss and has worked in Audiology in the NHS since 2002. Her interest in hearing loss and music followed a degree in Music and Philosophy (Cardiff) and a PhD in Auditory Neuropsychology and Music (Sheffield). She has continued funded research projects alongside her clinical work, collaborating with the Departments of Music, Computer Science and Human Communication Sciences at the University of Sheffield and the School of Music at the University of Leeds, with a particular interest in the practical applications of research for patients.



Dr Amy Beeston is a Research Fellow in the School of Music at University of Leeds. She has a background in music, completing undergraduate studies in Music Technology (University of Edinburgh) and a Master's in Sonology (Royal Conservatory, The Hague). She completed her PhD in the Speech and Hearing Research Group at the University of Sheffield, examining compensation for reverberation in human listeners and machines. She worked on computer-assisted language learning and medical computing topics as a postdoc in computer science in Sheffield before joining the Hearing Aids for Music team in Leeds in 2017.



Dr Robert Fulford studied Music with Education (BA) and Educational Psychology (MPhil) at the University of Cambridge before completing a PhD in Music Psychology at the Royal Northern College of Music. His thesis explored how d/Deaf musicians access, rehearse and perform music with a focus on the use of vibrotactile feedback. He drew on insights from this to develop the HAFM grant with Alinka and Harriet, was Research Fellow in its first year, and is now a member of the advisory board. Research interests include: music and deafness, cross-modal perception and communication; gesture and sign language in music and music perception using hearing aids and cochlear implants. He is a British Sign Language user and teaches flute, piano and musical theory.



Dr Jackie Salter is Lecturer in Deaf Education at Leeds University and Leader for the MA Deaf Education and MA Special Educational Needs programmes. She joined the project in January 2016 for 16 months as Research Fellow before becoming part of the advisory board. Dr Salter studied Music and Mathematics (BSc) at Keele University before training as a teacher (PGCE). Following the birth of her twin daughters, both of whom are deaf, she trained as a teacher of the deaf (MA ToD) at Leeds and developed her British Sign Language skills (Level 3). She joined the University of Leeds in 2008.

Our advisory board

The project has received advice from some of the UK's leading specialists in fields relating to hearing loss, music, auditory processing, hearing aid technology, fitting and rehabilitation practices, and accessibility. The role of the advisory board has been to provide specialist knowledge to ensure the aims of the grant are achieved and that the project is accessible to all those who want to contribute to and who can benefit from the research.



Lena Batra is a registered hearing therapist. She completed training at Bristol University and Royal National Throat Nose and Ear Hospital in 2004 and is a member of the Registration Council for Clinical Physiologists. Lena's roles have included complex patient casework as Advanced Specialist Hearing Therapist, for six years - Royal National Throat Nose and Ear Hospital in London. A music lover with hearing difficulties since childhood, Lena developed an early professional interest in helping others identify and overcome barriers to music engagement, and she is an active advocate for the use of integrative technologies in music and healthcare settings.



Guy Brown is a Professor in Computer Science and a member of the Speech and Hearing Research Group at the Department of Computer Science, University of Sheffield. The focus of Prof. Brown's research is to build machine hearing systems that understand sound in the same way as a human listener. He has more than 20 years' experience of computational modelling of auditory function, with a particular interest in computational auditory scene analysis (CASA). He is the co-editor of an influential text on CASA, and has published more than 100 papers in areas relating to machine hearing, noise-robust automatic speech recognition and speech perception.



Paul Checkley received his MSc in audiology from University College, London in 1991. He has extensive NHS experience as a Clinical Scientist (audiology) running adult auditory rehabilitation services. He has worked in a management role for Phonak Hearing Systems in Switzerland and the U.K. where he was responsible for international product application, technical support services and paediatric hearing aid fitting concepts. He is currently Clinical Director and Senior Partner at Harley Street Hearing and Musicians' Hearing Services where together with the Musicians' Union and Help Musicians UK, he has developed the Musicians' Hearing Health Scheme.



Brian Moore is Emeritus Professor of Auditory Perception in the University of Cambridge. His research focuses on the perception of sound by people with normal and impaired hearing, and on the design and fitting of hearing aids. He is a Fellow of the Royal Society, the Academy of Medical Sciences, and the Acoustical Society of America. He has received major awards from the Acoustical Society of America, the American Academy of Audiology and the Association for Research in Otolaryngology. He has received an Honorary Doctorate from Adam Mickiewicz University, Poland. He has published over 570 refereed journal articles.



Ruth Swanwick is a Professor in Deaf Education and a member of the Research Centre for Childhood, Education and Social Justice in the School of Education at the University of Leeds. Her research and teaching centres on deafness, language and learning and the development of pedagogies and professional understanding in deaf education. She is particularly interested in developing ways to support the language development and learning of deaf children in multilingual and culturally diverse contexts. She also has a personal (as a choral singer and flautist) and professional interest in music and music education.



Paul Whittaker was born in Huddersfield in 1953 and has been deaf all his life. After reading music at Wadham College, Oxford, and getting a PG Dip from the RNCM he spent 27 years running "Music and the Deaf" before leaving in 2015 to pursue a freelance career. As well as being a motivational speaker and workshop leader Paul works as a sign language interpreter for concerts and theatre. He was awarded an OBE for Services to Music in 2007 and holds 2 Honorary degrees.

Introduction

We hope you may already have heard about the work being undertaken by the Hearing Aids for Music team. We are pleased to have the opportunity to tell you more about the project and its partnerships, what it has achieved and where it hopes to go in the future.

Background

According to Action on Hearing Loss, there are currently over 10 million people in the UK living with a hearing impairment, which equates to roughly 1 in 6 of the population – and this is predicted to rise to 15.6 million (1 in 5) by 2035 (AoHL, 2015). It is the most common physical disability in the West (Plack, 2014) and one of the most significant public health burdens. Roughly two-thirds of those with hearing impairment are over 65 years old due to age-related hearing loss.

Hearing aid technology helps people with hearing impairments by amplifying sounds to make them louder and clearer. Hearing aids are primarily designed for the amplification of speech, however, and can sometimes cause problems for music listening (Chasin & Russo, 2004; Fulford, 2013; Madsen & Moore, 2014). Music has a larger dynamic (loudness) and frequency range than speech, and also contains large, dramatic changes (for example, when a symphony orchestra changes from quiet to very loud, suddenly). These differences can cause the signal in the hearing aid to become distorted, and undesired effects may become more audible to the listener than the music itself.

Moreover, while human speech remains relatively consistent from one person to the next, musical sounds vary enormously depending on the instrument, ensemble and compositional style (Chasin & Russo, 2004). Deaf musicians report that hearing aids enable musical performance to occur, but that the aids can cause music to sound distorted and distracting (Fulford, 2013). The small number of previous studies that examined musical experience through hearing aids suggest that there is room for improvement, and inspired our research effort. The HAFM project is the first large-scale investigation of hearing aid users' experiences with music, as listeners and performers.

Hearing Aids for Music was funded for 3 years by the UK Arts and Humanities Research Council by a grant of £243,332. The aim of the project, the first of its kind, was to explore the music listening behaviours of people with hearing impairments, something that has not been done before across all levels of deafness and types of music listening. The project comprised a number of studies, including a wide-reaching online survey which has obtained information from more than 1,500 hearing aid users, and an international conference to focus attention on this important new area of research. The outputs of the research include a website devoted to project information and new resources including leaflets available free of charge for hearing aid users and audiologists and a new 'glossary of terms' to help hearing aid users, musicians and audiologists work more closely together. At its heart, our research aims to ensure involvement of everyone who wears a hearing aid and wants to access music. You can read more about the findings of our studies, our conference and resources in this report.

If you are unfamiliar with any terminology used in this report, please use our *Glossary of terms for music listening with hearing aids* which can be found on our website: www.musicandhearingaids.org/resources



Arts & Humanities
Research Council

Project aims

- To explore how music listening experiences are affected by mild, moderate, severe and profound deafness and the use of hearing aid technology.
- To provide evidence of the issues currently affecting hearing aid users with music listening so that technical improvements or advice can be targeted at particular difficulties and listening settings.
- To identify ways in which listeners can optimise their use of hearing aids for perceiving music in everyday listening situations.
- To give hearing aid users with all types and degrees of hearing loss a voice through our work.



RL Salter Photography

Our Research

We have undertaken research directly with people who wear hearing aids to find out how hearing loss and the use of hearing aids impacts upon music listening in a wide variety of settings. We have designed and undertaken four studies. Our studies have involved audiologists and participants with all levels of deafness, drawn from both public and private sectors. To ensure that our studies were accessible to those using British Sign Language (BSL), translation was available at all times.

Clinical survey

- 176 hearing aid users
- average age of 61
- 78 female, 94 male, 4 prefer not to say

Clinical survey

Designed to be completed quickly in the waiting room, this paper-based clinical survey consisted of four short questions asking patients whether they had experienced any problems with music listening, whether they felt this affected their quality of life, whether they had discussed music with their audiologist and if so, whether this had improved their experience of music. Roughly half the sample were recruited in the public sector and half in private clinic.

Audiology survey

- 99 audiologists
- average age of 39
- 54 female, 45 male

Audiology survey

The online audiology survey asked audiologists to reflect on their training and background, their experiences of discussing music listening issues, their experiences of optimising hearing aids for music listening, and their perceived confidence in their ability to do so. Around two-thirds worked only in the public sector, one quarter in private practice and the remainder worked across both sectors.

In-depth interviews

- 22 hearing aid users
- average age of 62
- 10 female, 12 male

In-depth interviews

The interview study explored the musical experiences of hearing aid users in greater depth. Questions focused on hearing aid users' hearing loss, past and current music listening practices, how their hearing loss has influenced their listening over time, and their experiences of hearing aid fitting. Hearing test data was collected to verify hearing level and to aid in the interpretation of hearing aid users' accounts. The final sample contained a mixture of musicians and non-musicians with different levels and types of hearing loss.

Online survey

- 1,507 hearing aid users
- average age of 60
- 748 female, 755 male, 4 prefer not to say

Online survey

The online survey was developed using the insights from the first three studies. It asked hearing aid users to report on their everyday music listening behaviour, their hearing loss and hearing aid technology, their experiences of music in live and recorded settings, and any discussions had with their audiologists. To make the survey accessible to people with all levels of hearing loss, questions were translated into British Sign Language. Hearing aid users completing the survey were asked to send their latest audiogram if they were happy to do so.

Participants

One of our primary aims throughout the project has been for our participants to have a voice and an active role in every part of our research. We would like to extend our warmest thanks to all those who participated. Without our participants the project could not have been successful in providing evidence on current listening patterns, the difficulties and successes of music listening with hearing aids, and in beginning to identify how we can improve music listening experiences for hearing aid users with resources, education and further research.

Participants were recruited to our research in various ways.

- For the first clinical survey and in-depth interviews, hearing aids users were recruited from two audiology clinics in England: Sheffield Teaching Hospitals NHS Foundation Trust, and Harley Street Hearing, London.
- We recruited audiologists for the audiology survey through national societies (e.g. British Academy of Audiology, British Society of Audiology).
- For the online survey, we recruited through our website, through deaf charities and music organisations, and worked in addition with NHS Trusts across England (see Figure 1). The majority of the online survey participants are from England, however around 10% come from Europe and other English-speaking countries around the world including Australia, Canada, New Zealand and the USA.

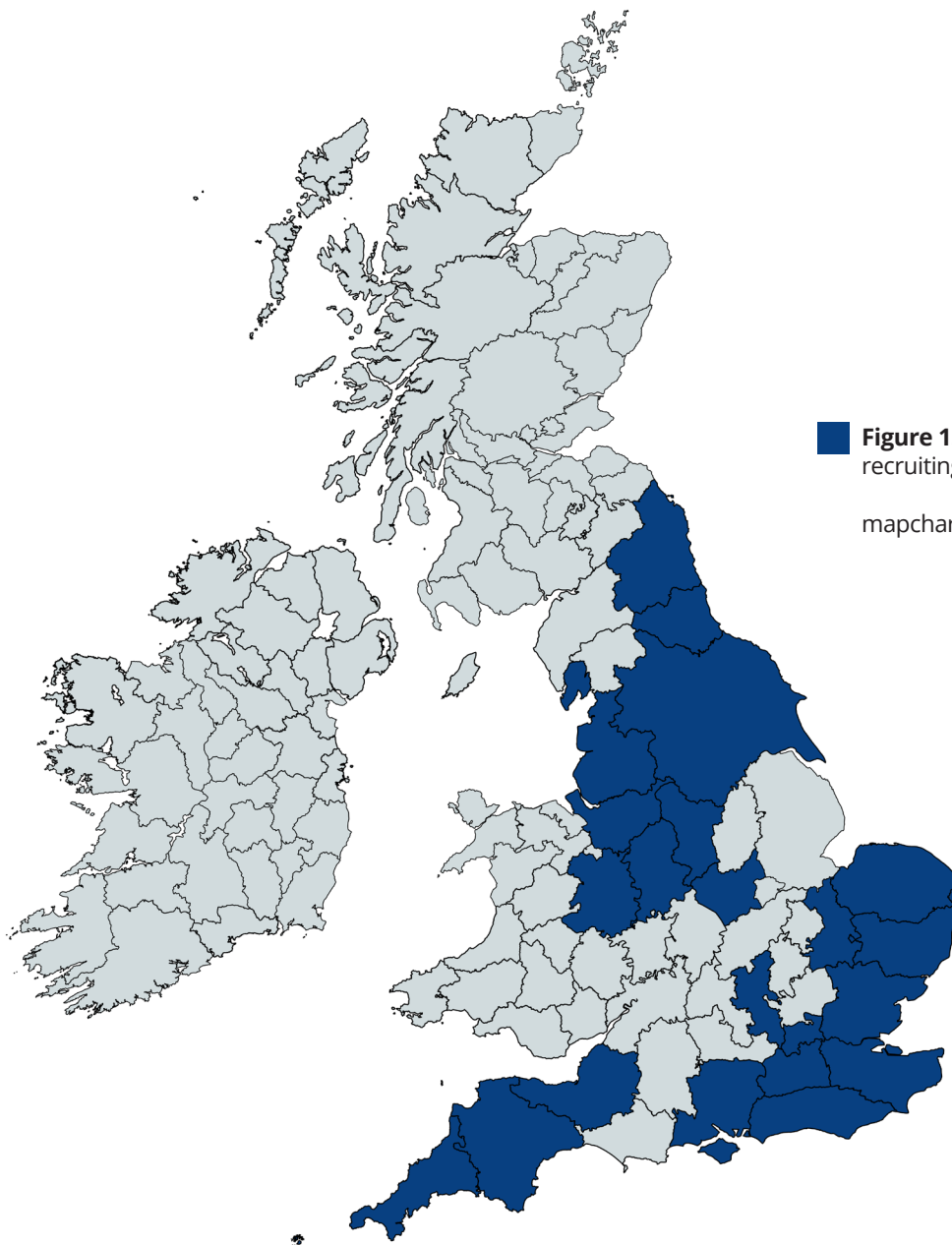


Figure 1. Counties in England where recruiting NHS Trusts are located.

mapchart.net©

Hearing aid user demographics

The project aimed to recruit hearing aid users with different levels of hearing loss (see Figure 2a), including those who use British Sign Language as first language (around 5%) and those with varying musical expertise (see Figure 2b). We also aimed to reach hearing aid users of all ages (see Figure 2c) and an equal number of males and females (see Figure 2d). We are proud to have achieved this.

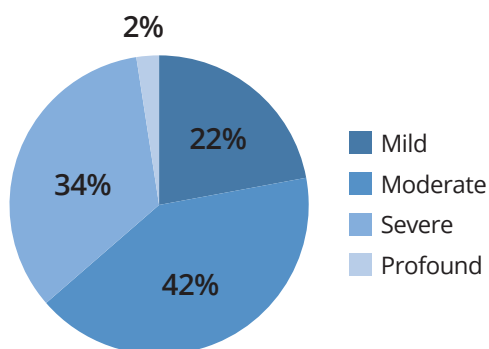


Figure 2a. Percentage of participants with different levels of hearing loss

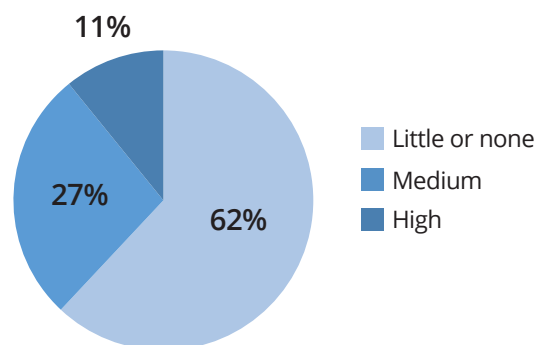


Figure 2b. Percentage of participants with different levels of musical training

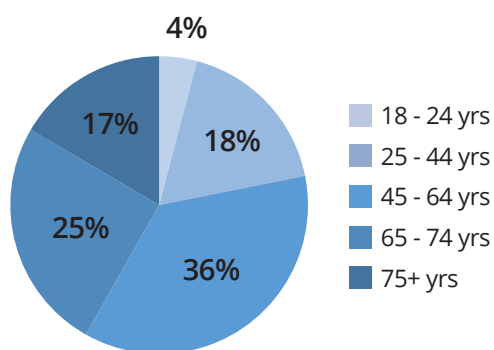


Figure 2c. Proportion of participants in each of five age categories

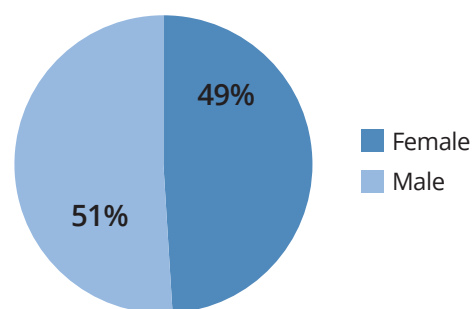


Figure 2d. Proportion of males and females participating in the research

“

Thanks for the really valuable research you are doing; music has too often been an after-thought or a ‘secondary’ right to speech and I look forward to your updates indeed.

”

Key findings

Our research was designed to gather information in an area where there was little prior scientific evidence.

Our initial clinic survey tested the hypothesis that music listening was sometimes difficult with hearing aids, and queried how often problems were occurring and how they affected hearing aid users.

Results showed:

- Around 15% of hearing aids users reported that their aids were beneficial for music and that they did not experience any problems with music listening.
- However, 46% experienced problems 'more often than not.'
- Problems reported included
 - music sounding indistinct (e.g. 'a lack of fidelity', 'tinny')
 - music sounding distorted
 - difficulties hearing words in songs
 - difficulties in live music contexts
- Very few discussions about music were taking place between hearing aid users and audiologists.
- Where discussions were happening, limited improvements were noted.
- There was a link between increased time spent discussing music with audiologist, specific tailoring hearing aids for music and positive outcomes for music listening experiences.

Our subsequent studies addressed these points in much greater detail, particularly the finding that some hearing aid users did not report problems whilst others experienced problems that had negative effects on their lives (see Figure 3).

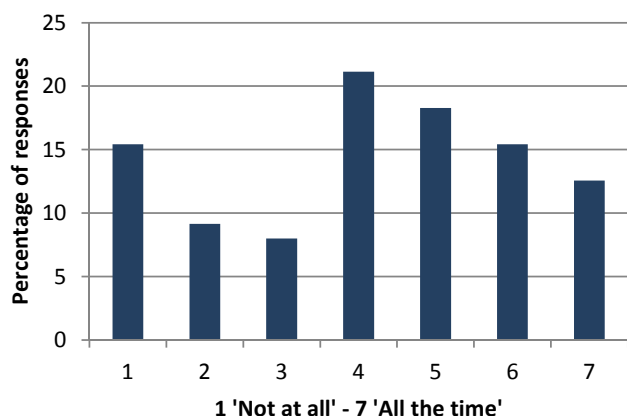


Figure 3a Frequency with which participants experienced problems with music listening

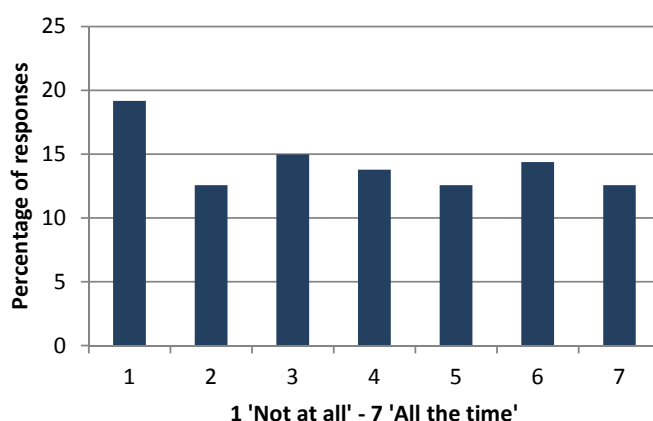


Figure 3b Frequency with which problems with music were reported to affect quality of life

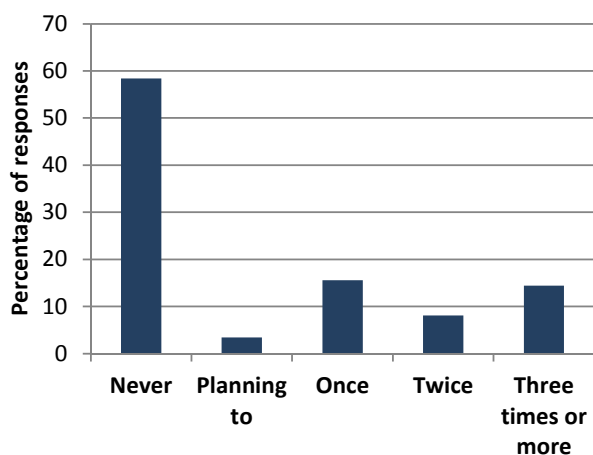


Figure 3c Frequency of discussions about music in clinic

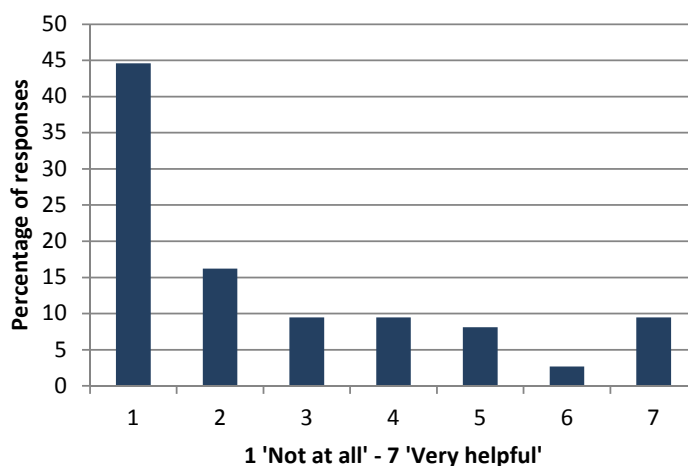


Figure 3d Ratings of whether discussions about music improved outcomes

How hearing aids help

Findings across the studies in this project showed that hearing aids are helpful for music listening for the majority of participants. There were hearing aid users in the clinic survey who reported no problems, and hearing aid users in the interview study who emphasised they would not be able to appreciate music without their hearing aids.

In the online survey, hearing aid users were asked to rate the helpfulness of their hearing aids for music listening on a scale of 1 to 10 (1 is 'Not at all helpful, they make it more difficult to listen to music' and 10 is 'Extremely helpful, they allow me to enjoy music as I would like'). The most frequent response was 8 out of 10 for both recorded and live music situations (see Figure 4).

In recorded settings, hearing aids were rated as 'fairly helpful' or 'very helpful' for the majority of musical elements including for hearing the melody, bassline, singer, and lyrics and for being able to pick out individual instruments (e.g. hearing the guitar within a band, or an oboe within an orchestra). In live settings, hearing aids were rated as helpful for hearing the melody, singer and bassline, but were less helpful for hearing the lyrics and for picking out individual instruments.

Those with mild hearing loss were more likely to report that their hearing aids were helpful than those with more severe levels of hearing loss, though there was variation in responses within the groups. Reported helpfulness also differed according to different listening and performance situations (e.g. musical style, venue acoustics).

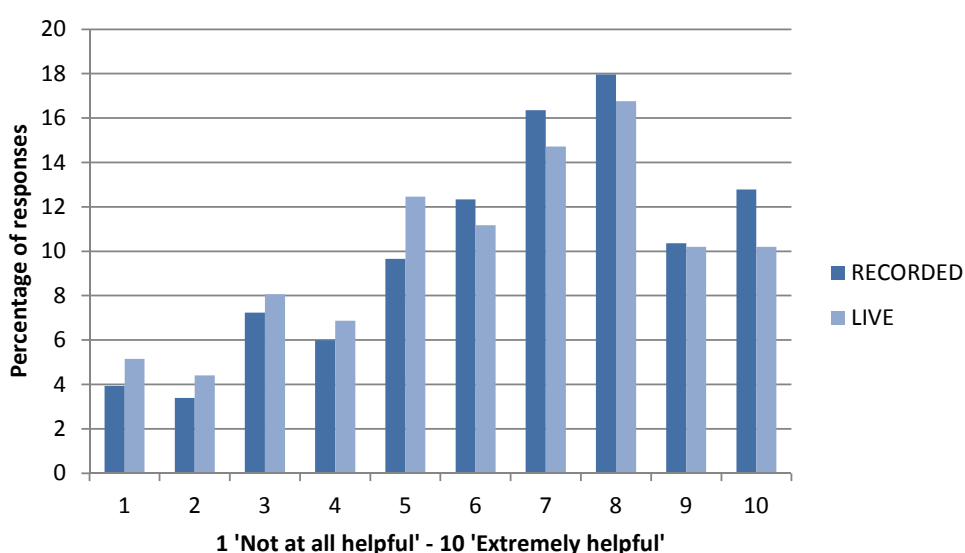


Figure 4. Percentage of ratings for overall helpfulness of hearing aids in recorded and live music contexts

“ I would probably give my hearing aids 9 out of 10, I used to struggle with lyrics, but I can hear the words clearer. ”

“ I find that my hearing aids sharpen up the pitch a lot and so are extremely helpful. ”

“ Without my hearing aids, there's nothing except the thump, thump, thud bits of a track. They do improve it vastly. ”

Reported difficulties

Hearing aid users were asked throughout the project to report on the specific problems they experienced with their hearing aids. A frequently reported problem was difficulties hearing words in songs. Hearing aid users noted that not being able to follow lyrics reduced their enjoyment of the music, particularly when listening to unfamiliar songs or pieces.

In recorded music settings, most hearing aid users did not report problems with feedback, sudden changes in loudness, or discomfort from loud sounds. However, around a third reported experiencing distortion 'often' or 'all the time', and over 80% reported they experience distortion at least occasionally. It was also found that those with more severe levels of hearing loss were more frequently experiencing too much bass in the sound they heard.

These results were mirrored in hearing aid users' experiences in live music settings, with almost all participants experiencing distortion at least sometimes. Discomfort from loud sounds was also reported more frequently in live than in recorded settings.

In some cases, these problems resulted in people withdrawing from musical activities (e.g. no longer attending concerts, stopping playing an instrument). This sometimes led to negative feelings such as anxiety and depression, and isolation. Other hearing aid users reported that they had taken up different hobbies as a result (e.g. photography).

Musicians were particularly likely to be negatively affected by issues with their hearing aid technology, reporting problems with distortion at high frequencies and high volume levels, and issues with tone quality and pitch variation. They also drew attention to the difficulty of switching between speech and music in rehearsals as an on-going problem with hearing aids, one for which there does not currently seem to be a solution.

“

Hearing aids help me enjoy musicals, but I'm aware that I do not hear the full range of sounds. I can very rarely pick out any words.

”

“

I don't feel confident to participate in music playing. I'm unable to sing along to songs as I cannot hear the words at all. This is often noticed at social occasions. I feel isolated as unable to join in.

”

“

As a musician and conductor the discernment of sound quality, pitch and balance are crucial. As a result of the deficit I have become frustrated and depressed.

”



“

I find sometimes the distortion difficult. As a live performer I wish there was an aid(s) I could use that would make sound more natural and without the “whistle”. If I play without my hearing aids, I miss the detail of others, i.e. cues. If I wear aids, I hear more but get sometimes unnatural feedback and distortion. “Devil & Deep Blue Sea” analogy.

”

Use of technologies

Our participants used a range of different hearing aid technologies from all the major manufacturers. Whilst some participants were very knowledgeable about their hearing aids, particularly if they had worn different hearing aids over time, others did not have a good understanding of the capabilities of their aids. Some people did not know whether their aids had a volume control or a music program, nor were aware these were an option to have on their hearing aids.

The online survey results showed that only 34% of hearing aid users had a music program (see Figure 5a). Whilst 35% of these reported using their music program 'often' or 'all the time', 33% reported that they had 'never' used the program. However, those who reported using their music program regularly were significantly more likely to rate their hearing aids as helpful in both recorded and live music situations.

Some participants reported that it was frustrating to have to switch between 'normal' and 'music' programs, suggesting that an avenue for future development would be to design hearing aids that are able to distinguish between speech and music automatically, or to deal with both signals simultaneously.

75% of hearing aid users who have volume control reported using it at least sometimes (and around 4% reported wearing hearing aids that control volume automatically). Those with a volume control (whether via a control on their hearing aids, or through a phone application) reported that it helped, particularly in live contexts.

Overall, we saw a very low uptake of Assistive Listening Devices (ALDs) which are tools that amplify sound and deliver it directly to the hearing aid. Only a third of hearing aid users reported using ALDs (see Figure 5b). The most frequently used ALDs were T-Loop and Bluetooth streamers. People with greater levels of hearing loss were more likely to be using ALDs, however uptake remained low overall. One reason for this may be the financial cost, as NHS audiology provision in the UK does not provide free ALDs alongside hearing aids. Some provision may come via the UK government 'Access to work' scheme, and for other hearing aid users by purchasing privately. Further research is needed to assess whether ALDs could offer significant music listening benefits with hearing aids.

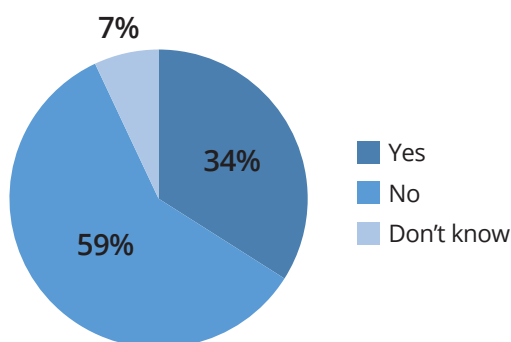


Figure 5a. Percentage of participants who reported using a music program

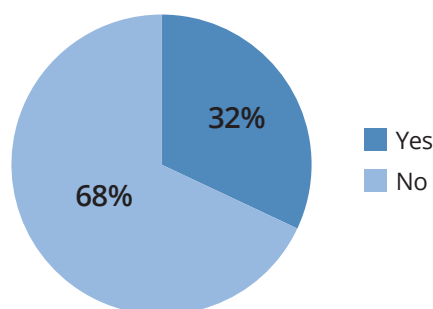


Figure 5b. Percentage of participants who reported using an Assistive Listening Device

“ I asked for a music program to be activated on my aids. My audiologist seemed surprised and said not many ask for it, which is not surprising as most people do not know about it. ”

“ I switch to my music program and this helps a lot. ”

“ Some venues have loops but they are not very reliable. My music program in conjunction with the volume control is sorting out the issue nicely. ”

Fitting hearing aids for music

Music is not a required part of any audiology curriculum, and 63% of practitioners responding to our survey had received no training in terms of fitting hearing aids for music. For those who had received some training, this had been delivered via conference sessions or other Continuing Professional Development events. As such, these types of events may provide a useful way to disseminate our project resources in the future.

We sought feedback from audiologists at an early stage on planned resources that might be used to help clients and patients. 71% of audiologists reported that they would rarely or never refer a patient on elsewhere for issues about music and hearing aids – perhaps due to the lack of services to refer on to – however a high proportion of audiologists (85%) agreed that they would use our website, audiology leaflet, hearing aid fitting guidance, and patient advice leaflet. When a draft version of our patient leaflet *Music listening with hearing aids* was piloted at our conference, 100% of audiologists responded they would recommend it.

It is not yet possible to provide a ‘one-size fits all’ guide to fitting hearing aids for music. Our evidence now demonstrates that problems and solutions vary widely due to the complex number of factors involved including the configuration of hearing loss, individual musical needs (e.g. listener/performer, acoustic/amplified), and types of hearing aids. However, we did find some strategies that were commonly helpful, such as modifying microphone directionality, changes to gain and alterations to compression (see Figure 6) and we have incorporated these into our Quickstart clinic guide for audiologists *Starting out with a music program* which gives some starting points for audiologists at any level on setting hearing aids for music. A more in-depth discussion is then provided in our leaflet *Music Counselling and Fitting: A guide for audiologists*.

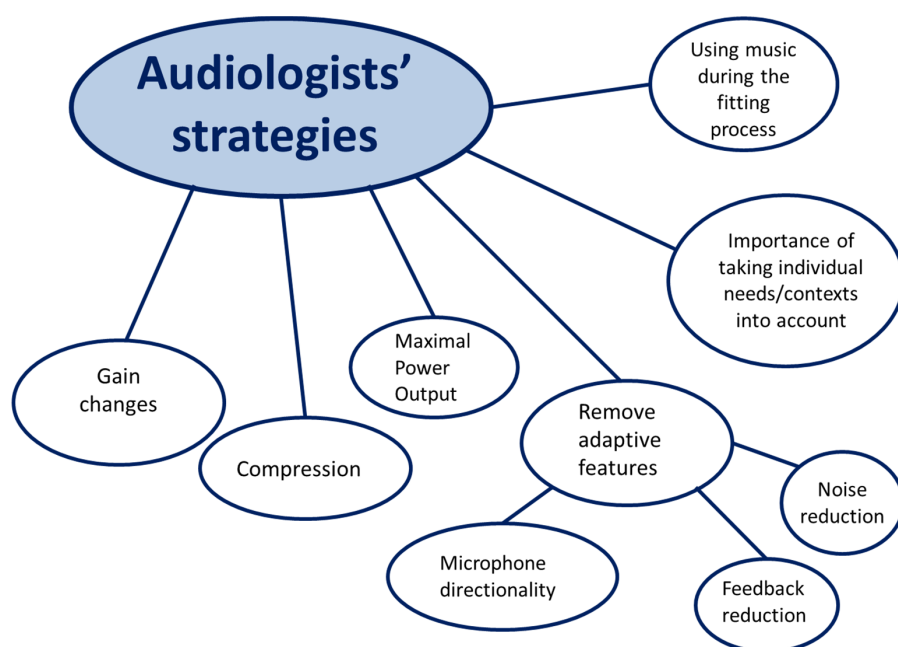


Figure 6. Summary of strategies described by practitioners in the audiology survey

Audiologists who had more experience of discussing music with hearing aid users emphasised the importance of taking individual listening and performance contexts into account, and were significantly more likely to rate hearing aids as useful for music listening.

HAFM Conference

In September 2017 we held the inaugural Hearing aids for Music Conference and welcomed 120 delegates to Leeds. The conference was the first major event to focus purely on music and hearing aids, and drew people together from across the globe. Our aim was to be truly inclusive with the conference by having visual support screens for lip-reading, T-loop, sign interpreting, and palantype. In addition, we accommodated hearing support requests prior to people attending.

The conference included 16 presentations, 8 workshops, a number of networking sessions, and a performance by the renowned FORTE Ensemble comprising professional deaf musicians. All those who had participated in our studies to date were invited, and some gave presentations. It provided an opportunity for our study participants to give their views directly to researchers, audiologists and hearing aid manufacturers in a supportive setting. Our website now hosts slides and videos for many of the conference talks.

As researchers we are often aware our work can become detached from its everyday applications. The musical performance we incorporated into the event had major significance for everyone attending as delegates' feedback confirmed.

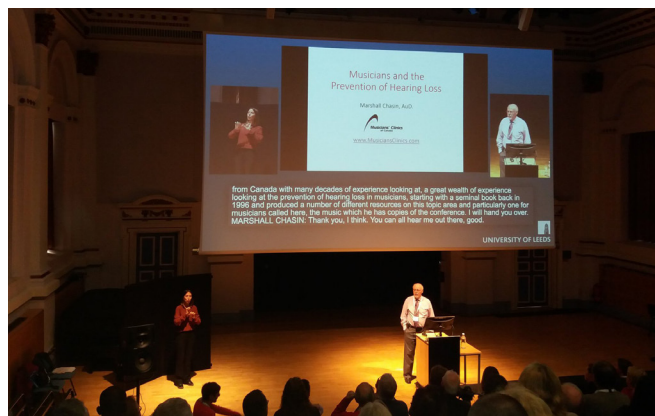


Photo: Victoria Adshead (@AudioWorldnews)

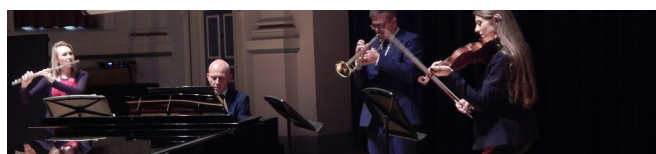


Photo: R L Salter Photography

Conference feedback

Just over a quarter of the attendees completed our conference feedback survey, 50% of whom were hearing aid users. Almost one-fifth had presented work at the conference, while four-fifths attended as audience. Furthermore, 62% of respondents have worked in a music-related field, and 56% of respondents have worked in an audiology-related field.

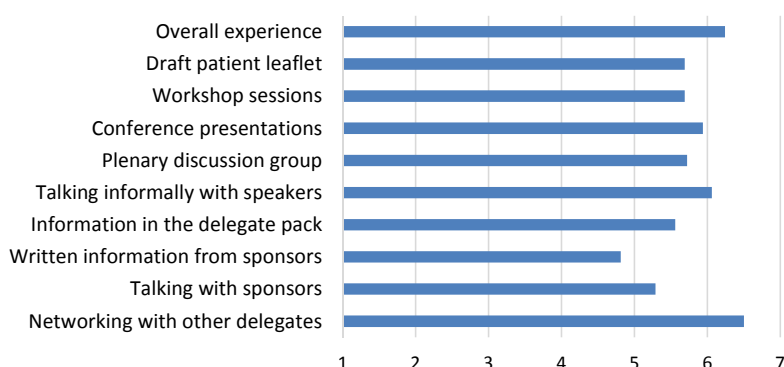


Figure 7. Average 'usefulness' rating of conference elements (1 'Not useful' to 7 'Useful').

“ I have used the skills that I learnt at the conference to advise musically inclined hearing aid users clinically and have shared my notes and experiences with my audiology colleagues. My hospital has also signed up to advertise the Hearing Aids for Music project to our patients as a result of my attendance at the conference. ”

“ In observing the developing interest of researchers and manufacturers in this important field, it was good to see progress being made, giving hope for the future. The performance of the FORTE ensemble whilst truly inspirational at face value, contained such powerful messages for us all. ”

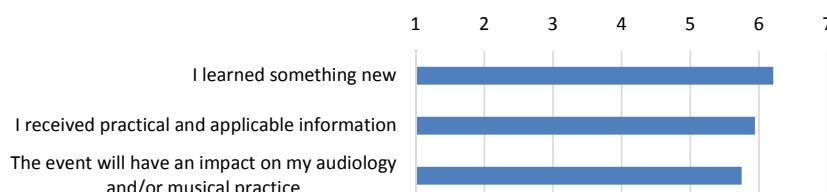


Figure 8. Average 'agreement' ratings with statements (1 'Not at all' to 7 'Very much').

Research outputs

Clinical and industry publications

Leaflet for hearing aid users

We have developed a leaflet for hearing aid users, *Music listening with hearing aids*, based upon the experiences of those taking part in our research. Feedback from hearing aid users about this leaflet has been positive, and audiologists attending our conference reported that they would recommend this resource widely.

Leaflets for audiologists

We have also developed two leaflets for audiologists. These are titled *Music Counselling and Fitting: A guide for audiologists* and Quickstart clinic guide: *Starting out with a music program*. It is hoped that these evidence-based recommendations will improve fitting of hearing aids for music listening and will increase levels of confidence and expertise among audiologists.

Industry publications

We continue to write articles for a wide range of industry magazines to raise awareness of the project and disseminate findings. Recent publications include *Audacity* (the magazine of the British Academy of Audiology), *Acoustic Bulletin* (Institute of Acoustics), *Action on Hearing Loss*, and *The Psychologist*.



Academic publications (forthcoming)

Article 1 'Hearing aids are designed for speech and not music: Patient and practitioner perspectives on listening to music with a hearing aid'. This article details findings from the clinical survey and audiologists' survey.

Article 2 'Acclimatising to music with hearing aids: An in-depth study of musicians and non-musicians with different levels of hearing impairment'. This article explores findings from the in-depth interview study, comparing musicians and non-musicians.

Article 3 'Outcomes of a large-scale online survey of listening to music with hearing aids'. This article outlines the survey findings, focusing on differences in how hearing aids help and difficulties experienced according to different levels of hearing loss.

Events

Academic conferences

We have presented project findings in academic conferences, both nationally and internationally.



British Academy of Audiology (BAA)



British Association of Teachers of the Deaf (BATOD)



The British Psychological Society (BPS)



British Society of Hearing Aid Audiologists



European Society for the Cognitive Sciences of Music (ESCOM)



International Conference for Music Perception and Cognition (ICMPC)



Timbre 2018 McGill Music Conference



2018 Joint ICMPC/ESCOM Conference

Research seminars

We have presented project findings to industrial networks (in person and online) and in several university research seminar series across the UK.



Association of Adult Musicians with Hearing Loss



British Society of Audiology



Institute of Acoustics



Society for Education, Music and Psychology Research



Public engagement events

We have taken part in a number of public engagement events and have additionally been invited to participate in dissemination events of other related projects.



Be Curious, University of Leeds



Frequentise, Music and the Deaf Huddersfield



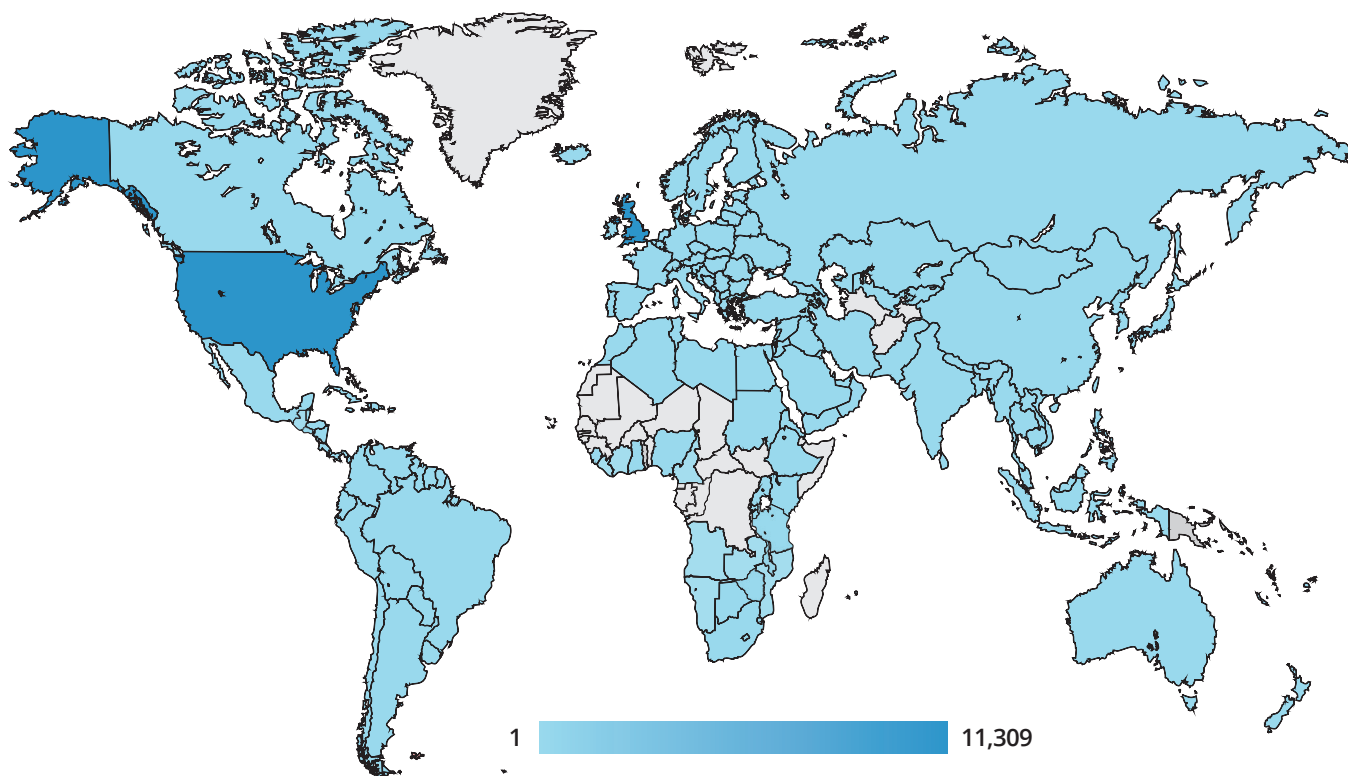
Listening Experience Database Open University



3D-Tune-In Hearing Futures

Global reach

Since setting up our website in July 2015 it has been viewed over 32 thousand times. The majority of visitors are based in the UK (35%) and in northern America (31%), with the remaining visitors spread globally across 148 different countries.



The HAFM website has funding to be maintained for the next ten years. The website will continue to provide updates on our research findings and will serve as a major information resource for stakeholders, hearing aid users, manufacturers and academics. It will continue to host our conference presentations, research opportunities that arise, and our glossary of relevant terms (developed in direct response to networking and feedback from our international conference) which aims to assist hearing aid users, musicians and audiologists to communicate clearly in clinics. In addition, regular blogposts will continue to provide a wide range of views and personal experiences.

Read more at www.musicandhearingaids.org and follow news updates on our Twitter feed @musicndeafness.

Recommendations

Our project engaged many stakeholders to get a true picture of music listening with hearing aids in everyday life. Based on our findings, we make the following recommendations for our key stakeholder groups.

Hearing aid users

We have the following recommendations for hearing aid users:

- Understanding your own hearing and hearing aids will help you to use both to their full potential.
 - Understand your pattern of loss (high/low frequency loss, and how this may affect your ability to hear different musical instruments/voices).
 - Understand the capabilities of your hearing aids.
- Talk to your audiologist and work together on solutions for music listening.
 - Discuss musical styles, instruments and contexts you engage with.
 - Ask for a volume control for each aid that you wear.
 - Ask for a music program and make sure you understand how to use it.
- Engage in listening practice.
 - Be patient and accept that acclimatising to hearing aids can take time.
 - Identify situations where hearing aids are helpful or challenging for music.
 - Try the listening suggestions in our *Music listening with hearing aids* leaflet which includes listening to familiar music, different styles, and music with lyrics.
- Consider whether Assistive Listening Devices (ALDs) might be helpful.

Our leaflet *Music listening with hearing aids* details these recommendations more fully. It can be downloaded from the resources section of our website.

Top tips for music listening:

- Reduce the volume of the music, and let your hearing aids amplify the sound.
- For recorded music, turn down the volume on your music player.
- For live music, move further away from the musicians and/or loudspeakers.
- Use the hearing aid volume control to reduce the input level.
- Try different listening programs on your hearing aid.
- Try wearing noise-cancelling headphones as well as your hearing aids.
- If you have a mild loss, it might be best to take your hearing aids out altogether.
- For mild to moderate hearing loss or high-frequency hearing loss: if you have two aids sometimes a more natural sound can be achieved by wearing only one aid.

Top tips for musicians:

- Tell your audiologist you are a musician.
- Discuss your musical expertise and typical musical environments (instruments played, performance settings) as well as difficulties experienced.
- Ask your audiologist to include a volume control and music program.
- Work with your audiologist.
 - Audiologists are not routinely trained in music, and so may not understand technical musical terms – consider using resources from our website in your clinical appointment (e.g. pitch to frequency chart, glossary of relevant terms).
- Explore the use of Assistive Listening Devices (ALDs) in performance settings.
 - E.g. try a remote mic in an orchestral setting to help hear the conductor as well as other performers; try a hearing aid with Bluetooth/phone application to enable real-time adjustment (e.g. volume control, equalisation).

Audiologists

Our work has shown that the initial discussion when patients receive their first hearing aids is crucial in managing their expectations about the implications of hearing loss, and about what hearing aids might do for their music listening. Time spent discussing options and tailoring hearing aids for music were linked with positive valued outcomes.

We have used our project findings to develop a number of resources for audiologists which are freely available on our website.

These include:

- A leaflet *Music listening with hearing aids* to give your patients.
- Two leaflets for audiologists:
 - *Starting out with a music program: Quickstart clinic guide*
 - *Music counselling and fitting: A guide for audiologists*
- A glossary mapping musical and audiological terms for sound.

Further, since audiologists are not usually trained in the perception of music through hearing aids nor in the specific components of music (e.g. instrument frequency ranges, and the combined listening and playing demands of rehearsals) we also provide some useful visual charts and illustrations on the resources section on our website.

We have the following recommendations for audiologists:

History and initial counselling

- Ask about the role of music in their lives.
 - Ensure you have a history of what, when and where they listen or play/sing.
- Find out whether they use volume control, music program, and ALDs.
- Ask what problems they experience with different musical styles and venues – there may need to be different solutions for different situations.
 - Ask how their experiences differ with recorded versus live music settings.
- Check whether they understand their degree of loss and frequencies affected.
 - Use a music chart which can help show what is missing without aids, and what sounds might be competing when trying to hear music with multiple instruments.
- Check whether they understand all the controls and programs on their aid.
- For musicians, compare their hearing loss profile with the frequency range of their instrument/voice.
 - Try the 'instrument range' and 'pitch to frequency' charts on our website.

Strategies for fitting hearing aids for music

- Use our leaflet on *Starting out with a music program: Quickstart clinic guide* which provides advice on general settings to apply to the hearing aid, and specifics to adapt the music program.

Training and resources

- Use HAFM resources developed to assist in clinic.
- Keep up to date with the HAFM website at www.musicandhearingaids.org
- Consider doing some introductory musical training.
 - Free course: Open University Introduction to Music Theory (8 hours).
 - Free course: Open University Sound for Music Technology (20 hours).

Top tips for programming hearing aids for music:

General settings:

- Mould selection – keep open if possible.
- Give a volume control, allowing the widest range possible.
- Keep volume control separate for left and right aids.
- Offer a mute button for control of loudness in live settings/performing.
- Verify fitting with Real Ear Measurement as accurately as possible to target.
- Try manufacturer's music program with the tips below.

Setting the music program

- Disable feedback manager and frequency transposition/compression.
- Disable noise management and wind-noise management.
- Disable microphone adaptive directionality.
- Base gain on everyday listening program.
- Increase Maximal Power Output if possible – then check loudness comfort.
- Look at compression ratios – keep compression ratios as low as possible within your fit to target.
- Select slow-acting compression.

“

The music program added to my hearing aid has made all the difference to my enjoyment of live music and participation in choral singing. Previously, with even high specification hearing aids without the music program I usually had to take the aids out because of the distortion. Now with the music program, individual instruments are clearly distinguished and the sound quality is excellent.

”

Hearing aid manufacturers

Our research demonstrates unequivocally that hearing aid users want solutions for music listening and for music performance. Although advances in hearing aid technology for music (e.g. music programs) are helpful for a large proportion of hearing aid users, they are not yet helpful for everyone.

We have the following recommendations for hearing aid manufacturers:

- Work alongside academics, researchers and clinicians to document and share hearing aid users' listening experiences in everyday settings to foster a culture of awareness in industry and to help with experimental design for music listening with hearing aids in the future.
- Consider adding advice on music listening and using a music program as standard within hearing aid instruction leaflets.
- Provide advice on using your range of aids for music listening.
- Ensure the ability to select separate volume controls for each ear is maintained across hearing aid ranges.
- Consider providing specific microphone covers to reduce the input level for louder music.
- Optimise and ease the ability to switch quickly from music to speech settings.
- Develop strategies to deal with simultaneous speech and music signals to help listeners at concerts and to facilitate full participation in rehearsals and performances for musicians.
- Report music-related research and technical developments within annual publications and/or at annual UK meetings of the British Irish Hearing Instrument Manufacturers Association (BIHIMA), British Academy of Audiology (BAA), British Society of Audiology (BSA), and British Society of Hearing Aid Audiologists (BSHAA).
- Ensure music is represented within stakeholder engagement activities and specifically detailed within longer term research and development strategies.
- Share your company's long-term research and development strategy on music listening with clinicians, academic researchers and hearing aid users.
- Reveal more technical data regarding your music programs so that hearing aid users and audiologists can assess whether they are achieving the best possible outcomes from the technology you provide.
- Consider more fully the nuanced demands of musicians.

Researchers

Our research has shown that music is important to people with all levels of deafness (including severe/profound), yet very few studies of musical behaviour have asked about or accounted for levels of hearing loss. Ensure that you give the opportunity for deaf people to participate in your studies, and think through the needs of this particular group.

We have the following recommendations for researchers:

- Include individuals with expertise in deaf education on your team or advisory board who can advise on aspects relating to deaf culture and accessibility.
- Think about accessibility at all stages of the research project.
 - Sign language translation of study information, consent processes, questions.
 - Costings of assistive equipment such as T-loop, sign interpretation, palantype for events.
- Think through how you will measure degree and/or type of hearing loss.
 - E.g. Pure Tone Audiometry (in clinic, or self-administered), subjective descriptors.
- Ensure appropriateness of methods and tasks.
 - Provide paper alternatives to online surveys.
 - Shorter surveys will elicit more complete responses.
- Include participant talks at conferences relating to hearing loss, hearing technology and music.
- Plan time for answering general queries from interested parties.

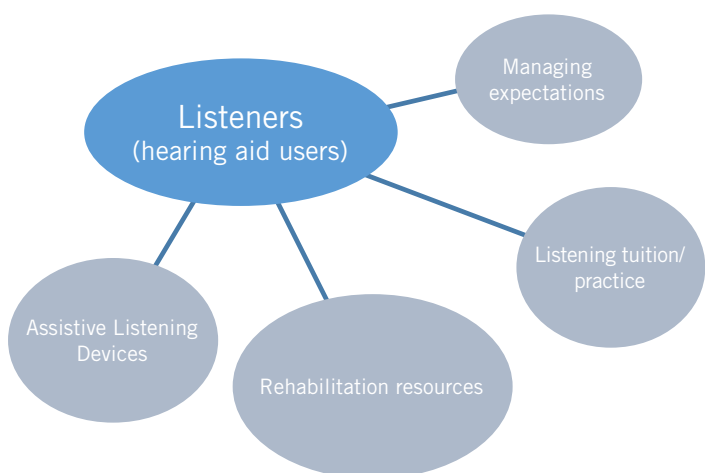
In addition to these recommendations, we offer some suggestions for future research below.

Future directions

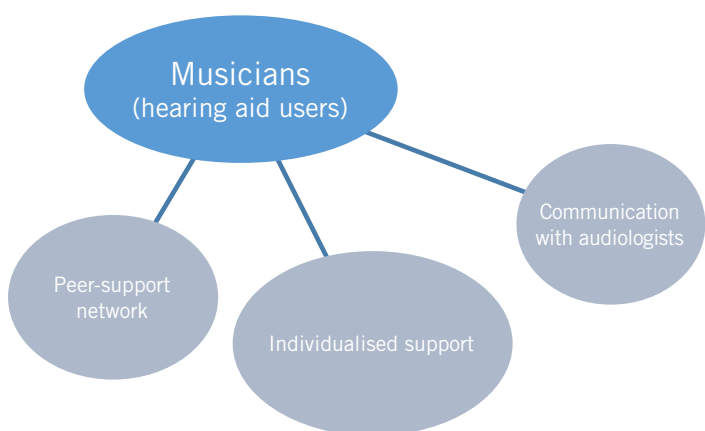
This section draws on our own research intuitions, the wide-ranging discussion occurring during the plenary session of our conference, and further exploration of these ideas in meetings with our advisory board and key stakeholders. Possible areas for future research have been summarised schematically, grouped into four main areas spanning the concerns of those groups involved: clinical partners, manufacturers, researchers and of course hearing aid users themselves.

As a team, we have strong expertise in clinical audiology, music psychology, and computer science, and are supported by experts in auditory perception, deaf education and hearing therapy. We have made links with researchers, audiologists, manufacturers, and musicians throughout the course of the project, and there is significant potential to develop future partnerships. If you would like to collaborate with us in any of the areas outlined below, please get in touch.

With hearing aid users

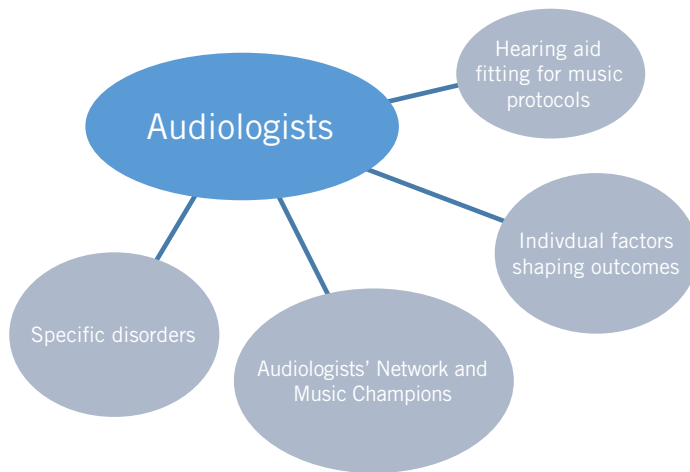


- Explore hearing aid users' expectations of music listening with hearing loss, and map how listening outcomes are shaped by:
 - Psychological attributes (e.g. personality).
 - External factors (e.g. listening practice).
- Understand the effects of listening tuition/practice on acclimatisation.
 - e.g. Listening through headphones, loudspeakers, and in live contexts.
- Assess the impact of rehabilitation resources on listening behaviour over time.
 - e.g. HAFM project leaflets and online materials, creative workshops.
- Monitor the use and effectiveness of ALDs in different musical settings.



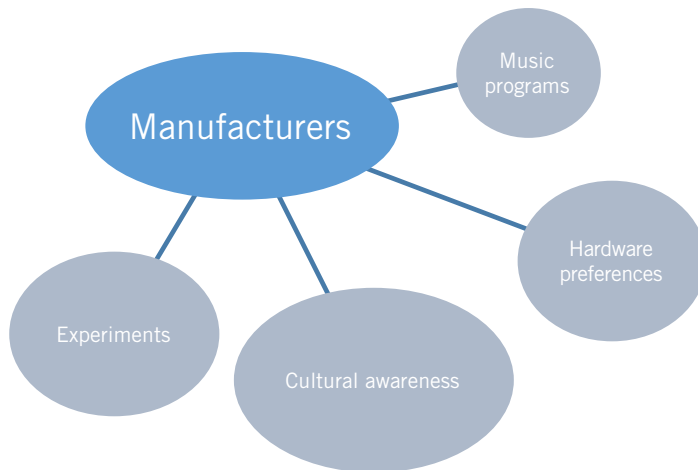
- Investigate and improve communication with audiology professionals.
 - e.g. How expectations are managed, developing a shared terminology, improving support for professional issues, and monitoring progress of aural rehabilitation.
- Evidence the importance of individualised support.
 - e.g. By hearing level, instrument-specific concerns, workplace-specific concerns, rehabilitation resources.
- Explore the possibility of a network for musicians (much the same as the Association of Adult Musicians with Hearing Loss in the US) to provide peer-support.

With audiologists



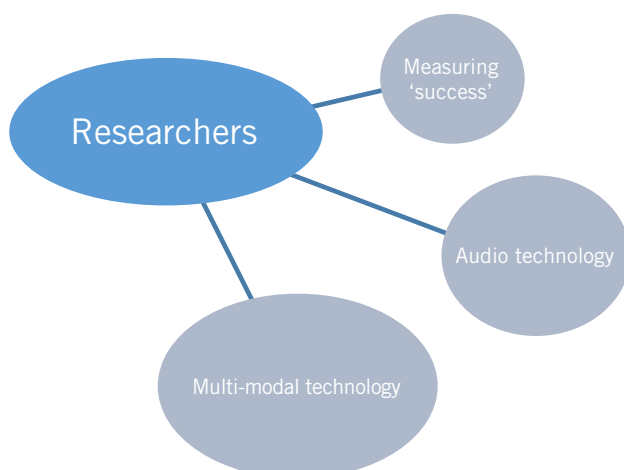
- Examine how audiologists fit hearing aids for music.
 - e.g. Qualitative and observational techniques, practical documentation, case studies.
- Design a series of experiments to test the role of individual difference factors on listening outcomes.
 - e.g. Personality and satisfaction ratings, perceived impact on quality of life, levels of experienced fatigue, variation in levels of musical training.
- Explore the perception of music among hearing aid users with specific disorders.
 - e.g. Meniere's Disease, tinnitus.
- Explore the possibility of audiology 'music champions' across the UK, in both the public and private sector, who could act as local contacts for expertise and further signposting.

With hearing aid manufacturers



- Work with audiologists to increase understanding of the technical specifications of music programs.
 - e.g. Transparency of strategies, music programs for performers, extended frequency range and changing dynamic input level.
- Investigate hearing aid user preferences for hardware.
 - e.g. Increased device size for musicians to enable enhanced processing.
- Increase cultural awareness of the challenges experienced with music.
 - e.g. Accounting for perspectives of hearing aid users, audiologists, hearing therapists.
- Design experiments to test the contribution of various factors to listening outcomes.
 - e.g. Influence of ear moulds, venue/room acoustics, input dynamic range.

With researchers



- Critically discuss how to measure the 'success' of music listening outcomes with all parties (e.g. hearing aid users, audiologists, manufacturers).
 - Develop terminology to describe appropriate musical concerns and define musical tasks (e.g. instrument recognition, pitch perception, clarity, quality), measurement of musical engagement and training, assess influences of different musical styles and different influences on satisfaction.
- Map the adoption of audio technology.
 - e.g. Awareness of resources, understanding of benefits, use of ALDs, phone apps, streaming.
- Map the development of audio technology and the implications for listeners and performers.
 - e.g. Self-programming, and integration of hearing aids with ear protection, dosimeters or other health monitoring functions.
- Explore the potential for multimodal technology in enhancing listening outcomes for hearing impaired listeners.
 - e.g. Sensory substitution/augmentation, visual enhancement (e.g. video, image, text), virtual reality.

Our networks

Support across the professional, commercial, academic and hearing aid user communities has begun to create a strong national and international network to continue research in hearing aids and music listening.

We would like to thank the following in particular for their contributions to the project and conference.



3D-Tune-In
www.3d-tune-in.eu



AI Media
www.ai-media.tv



Connevens Limited
www.connevens.co.uk



Ewing Foundation
ewing-foundation.org.uk



FrontRow
www.gofrontrow.com



Help Musicians UK
www.helpmusicians.org.uk



Oticon
www.oticon.com



Phonak
www.phonak.com



Reactify
www.reactifymusic.com



Sivantos
www.sivantos.com



Starkey
www.starkey.com



Widex
www.widex.co.uk

References

- Action on Hearing Loss (2015). *Hearing Matters*. Available for download here:
www.actiononhearingloss.org.uk/how-we-help/information-and-resources/publications/research-reports/hearing-matters-report/
- Archbold, S., Lamb, B., O'Neill, C. & Atkins, J. (2014). The Real Cost of Adult Hearing Loss. *The Ear Foundation*. Available for download here:
<https://www.earfoundation.org.uk/files/download/869>
- Chasin, M. & Russo, F. A. (2004). Hearing aids and music. *Trends in Amplification*, 8(2), 35-47.
- Department of Health (2015). Action Plan on Hearing Loss. Retrieved from: www.england.nhs.uk/wp-content/uploads/2015/03/act-plan-hearing-loss-upd.pdf
- Fulford, R. J. (2013). *Interactive Performance for Musicians with a Hearing Impairment*. Unpublished doctoral thesis. RNCM, UK.
- MacDonald, R. A. R., Kreutz, G. & Mitchell, L. A. (2012). *Music, Health and Wellbeing*. Oxford: Oxford University Press.
- Madsen, S. M. & Moore, B. C. (2014). Music and hearing aids. *Trends in Hearing*, 18, doi:10.1177/2331216514558271
- Plack, C. J. (2014). *The Sense of Hearing*. (2nd Ed). London: Psychology Press.

Greasley, A. E., Crook, H. & Beeston, A. V. (2019). Hearing Aids for Music: *Findings and recommendations for hearing aid users, audiologists, manufacturers and researchers*. Final report of the AHRC-funded Hearing Aids for Music Project. 25 April 2019.

Cover image: FORTE Ensemble performing at our project conference, September 2017 [DSCN0848]
R L Salter Photography.

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Funded by the **Arts and Humanities Research Council (UK)**



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