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Research Article

A Study of the Perception, Level of Satisfaction and Control Requirements of a Self-Fitting Hearing Aid (A Qualitative Study)

Abstract

Background: Is a 'science knows best' approach the best option for hearing care, or do patients want more control; and if so, how much control do they want? The aim of this study is to assess what the thoughts and opinions of hearing aid users are towards a hearing aid they can programme themselves and investigate what control they require.

Methods: Semi-structured interviews were conducted with 11 hearing aid users (6 females and 5 males). Each participant was interviewed using a self-written 24-item questionnaire; validated using the content validity ratio method. Specially designed user interfaces (UI) to demonstrate how a SFHA might be controlled were shown to participants. Two versions were designed, an A-B selection version and a fader controlled version.

Results: 100% of participants exhibited a positive response to the SFHA concept. The fader software version was preferred by 100% of participants, with greater control ability being the primary reason. Using thematic analysis, four themes were identified; (1) perception and expectations of a SFHA; (2) using the software as a control mechanism; (3) this is how you can make the software better; and (4) the care of an audiologist vs. a SFHA.

Conclusions: The want and need for control is apparent within the data, demonstrating that a 'science knows best' approach may not be working within audiology clinics. Hearing aids users want the additional control to give them a more natural sound to their hearing aid and greater ownership of their hearing. There is some fear of making mistakes and becoming obsessed with finding the correct setting. However, with training and repetition, perceived self-efficacy is high.

Introduction

Would the idea of a self-fitting hearing aid (SFHA) interest hearing aid users and do they perceive themselves achieving satisfaction, or would they prefer a 'science knows best' approach to hearing aid care?

SFHAs are a relatively new conception; the research regarding use of SFHAs dates back to 2006 with a trainable hearing aid [1]. The trainable hearing aid is a device that the wearer can train to adapt to different environments. The theory is that it will generate more optimal settings for that user. The concept of the SFHA dates back further to 1984, when it was subject to a United States patent application. The inventors had the idea of a hearing aid that could test hearing in-situ

and adapt to changes in a user's hearing characteristics over time. However, due to a lack of advancements in technology, the designs were never realized [2]. In more recent times an Australian company called Blamey Saunders has developed a SFHA where the user has total control over every aspect of its functionality [3]. No research has been identified into the success rates of this product. Attempts were made to source research direct from Blamey Saunders, however this was unsuccessful as no further contact was established.

There is a gap in the knowledge of hearing aid users control requirements for a SFHA. Research has been conducted into the reliability of hearing aid users and hearing impaired individuals to make gain adjustments and more complex adjustments like sound quality (Bass, middle, treble & tone) and noise reduction

[4–8], but not in relation to a SFHA. Furthermore, only one study investigating the perceptions of a SFHA was identified. This study was investigating the reasons for achieving benefit from the device and advantages and disadvantages of the device. Convery et al. [9], found that participants generally favored the idea but had some reservations regarding cost, self-efficacy and lack of professional assistance, amongst others. This lack of literature into the perceptions of the SFHA highlights the need for more research to be done into perceptions and control requirements of a hearing aid. This present research aims to build on these findings by assessing hearing aid users' perceptions of a SFHA, their control requirements and perceived satisfaction levels, using qualitative methods. Without knowing the needs of hearing aid users, it would be challenging to develop a useful user interface (UI) and a hearing aid that brings them satisfaction. This study aims to assess hearing aid users' needs for control and how they want to instigate it by giving them two methods to choose from. The concept of control has been researched in terms of material possessions [10]. This present study hopes to link this knowledge to SFHAs. Having the ability to control a hearing aid at your own convenience is already possible; hearing aid companies such as Phonak, Siemens and Starkey have released a mobile phone application that allows a user to adjust volume levels and change programmes [11–13].

Aims and objectives

This present study, and the research by Convery et al. [9], are similar in that both use the concept and a description of a SFHA, rather than a physical device, to assess the thoughts of the participants. This study aims to begin to fill the gap in knowledge of the control requirements, perceptions and satisfaction levels of a SFHA. This will assist in further developments of SFHAs by giving programmers and signal processors an understanding of what features need to be included on the device and any UI. Assessing the need for the device will help to build an understanding of the reasons why the device is required. This could be important for advancements in audiological care; it may be possible that current audiological care has an impact on the decisions of current hearing aid users.

Methods

Ethical approval

This research study was granted ethical and risk assessment approval by the University of Southampton (UoS) ethics, research and governance online committee on 09/06/2016.

Participants

11 hearing aid users (6 Female and 5 Males), with an age range of 50–78 years old and a mean age of 67.9 years old were recruited from a UoS database of volunteers. Age and gender details of each participant can be found in Table 1. Each prospective participant was contacted by email. They were sent a participant information sheet and asked to respond if they wished to take part. To qualify for participation, each participant had to fit the following inclusion criteria:

Table 1: Age and gender characteristics of the eleven participants in this study.

Participant number	Gender	Age
1	Male	78
2	Male	62
3	Female	77
4	Female	65
5	Female	50
6	Female	65
7	Female	69
8	Male	72
9	Male	72
10	Male	72
11	Female	65
	Mean age	67.9

1. Aged 18 or over
2. A current hearing aid user
3. Good visual ability

Fourteen individuals responded to the email invitation; three were excluded from the study due to availability, poor visual ability and non-use of a hearing aid, respectively. The eleven remaining respondents were recruited for the study. Each participant was offered reimbursement of travel costs.

Participant preparation

Participants were asked to attend an interview session at the University of Southampton Auditory Implant Centre. On arrival, they were asked to sign a consent form and advised that the interview was being recorded on a laptop for transcription purposes, as a Dictaphone was not available. They were also informed of the structure of the session.

Procedure

Semi-structured interviews were conducted using the validated self-written questionnaire. The questions were used as a guide and if a participant discussed something of importance or significance, as deemed by the researcher, this was explored in more detail (Cohen & Crabtree, 2006).

For the first part of the interview section of the session, eleven questions were asked; these questioned assessed; (1) thoughts about current hearing aids; (2) perceptions of the SFHA concept; and (3) opinions of audiological care.

The first interview was followed by a demonstration by the researcher of both UIs. The participants were required to observe the software and make comments at any point if they wished. This portion of the session took on average 15–20 minutes and any questions were answered.

Following the software viewing session, the participants were asked the final twelve questions. These questions assessed; (1) thoughts and preferences on the UIs; (2) confidence levels

for software usability and self-adjustment self-efficacy; (3) satisfaction levels; (4) any other information they would like to add. In total, each interview lasted approximately 1 hour.

Software design

Two versions were designed in Microsoft PowerPoint; a fader controlled version and an A-B¹ selection version (Figure 1). These two designs were chosen as they represent two potential methods of adapting the hearing aid settings to achieve a tailored hearing configuration and allow the participants to choose a preferred design. Each screen is very plain and only contains button labels and very brief descriptions of what the user needs to do to set their hearing aid correctly.

Questionnaire design

The main instrument in this study is a self-written 24-item questionnaire. This questionnaire was based on three separate questionnaires; The PSSUQ, a 19-item quantitative questionnaire designed to assess usability of software interfaces and user satisfaction with the software interface; the South African Psychological Ownership Questionnaire (SAPOS) devised by Olckers [14]. This 83-item questionnaire was created to assess the perceptions of job ownership within the workplace. As with the PSSUQ, this questionnaire relied on quantitative data generated from a 6 and 7 point Likert scale, depending on the question being asked. The questions relied heavily on words and phrases such as ‘I am confident’, ‘I feel...’, ‘I have the freedom’ and ‘responsibility’. Finally, the untitled questionnaire used in the Convery et al. [9], study.

Questionnaire validation

As the questionnaire in this study was self-written it was decided that some form of validation should take place. To do this the content validity ratio (CVR) method was used. The CVR is a number between -1 and +1 and is calculated using a mathematical formula that takes into account the essential or non-essential nature of each question, based on the views of a group of validators (equation 1) [15,16].

Equation 1 – Content Validity Ration calculation; where *ne* = number of validators who rated a question essential and *N* = number of validators.

$$CVR = \frac{ne - \frac{N}{2}}{\frac{N}{2}}$$

For the validation process, each validator was asked to rate every question essential or non-essential to the questionnaire. The researcher had previously explained the study aims and objectives to them. These ratings were then used to calculate the CVR using equation 1. All questions that fell below the threshold of <0.54 were to be labelled for rejection. In total, 13 MSc Audiology students were recruited and each one completed a validation form. The results of this CVR process indicated that two questions be removed from the questionnaire (Table 2).



Figure 1: Main themes and subthemes identified by thematic analysis.

Results

The aim of this study was to assess the perception, level of satisfaction and control requirements for a SFHAs. A self-written questionnaire was designed, along with two UIs, to use in conjunction with semi-structured interviews with 11 hearing aid users. This section will describe the results found from the deductive thematic analysis. Main themes and sub-themes will be identified and described with supporting extracts from the data. Data analysis was conducted using Nvivo 11 and Microsoft Excel.

Statistical overview of results

Table 3 gives a brief overview of how many participants answered 'yes' to subjects measured by the questionnaire. It should be noted that not every 'yes' response was accompanied by a reason and of those who responded.

Analysis

The Themes: The following four main themes were identified in the data gathered from the 11 interviews; (1);

Table 2: Questions marked for removal from original questionnaire because of a low CVR threshold.

Question	CVR
5. Do you think you would benefit from a hearing aid you could control yourself?	0.38
6. Do you agree that a patient controlling their hearing aid is a good idea?	-0.23

Table 3: Proportion of participants who indicated a 'yes' answer to various outcomes assessed by the questionnaire.

Question subject	Number of participants answering yes (n/11)
Liked the concept of a SFHA	11
Discussed wanting control	11
SFHA will be beneficial in social situations	4
SFHA will be beneficial for music	4
SFHA will be beneficial in employment	1
Safety concerns	3
Preference for fader controlled version	11
Preference for A-B selection version	0
The software was easy to navigate	11
The software layout was acceptable	11
The sound manipulation options were adequate	10
Were there control parameters or software features missing?	9
Would you find satisfaction with this device?	10 (one participant said they would have to try it first)
Would you need assistance in using this device?	9
Confident in making self-adjustments with fader version	5
SFHA could be a substitute to audiologists	8 (3 were not asked as they gave positive reviews of their audiological care)
Would try a SFHA	9 (one was unsure)

“Perception and expectation of a SFHA” (2) “Using software as a control mechanism”; (3) “This is how you can make the software better” and; (4) “The care of an audiologist vs. a SFHA”. Within these main themes multiple sub-themes were also identified and will be discussed accordingly. Themes 1, 2 and 3 directly relate to the research question; theme 4 (the care of an audiologist vs. a SFHA) was identified as an apparent causal link in some cases for participants wanting to try a SFHA. Figure 2 shows the four main themes and their sub-themes in mind map form.

Theme 1: 'perception and expectation of a SFHA'

This theme describes what hearing aid users think about the idea of a SFHA, in addition to their perceived ability to use the device to enrich their lives.

Three sub-themes were developed for this theme: 'It's all about sound quality', 'is it safe?' and 'things can only get better'. The themes were derived by 'coding' the data for concepts relating to the research question. Interconnected codes were then assigned groups and these groups were given names that described the relationship between the codes; a so-called 'theme'. Where the codes could be further differentiated within the main theme, these were assigned 'sub-themes'.

Sub-theme: It's all about the sound quality: All 11 participants were asked how they would want their hearing aid to sound in an ideal world. The answers described hopes for a more natural or normal sound from their hearing aids, along with crispness and clarity.

Sub-theme: Things can only get better: The sub-theme 'things can only get better' draws together the responses from participants relating to how they believe the SFHA will help them in life. Life in this context is defined as social, entertainment, employment, and miscellaneous experience. For the purposes of structure, each life affect will be described separately, these are not additional sub-themes.

Social events and society

Four of the 11 participants discussed the potential for the SFHA being beneficial in social or societal situations. One participant showed an interest in how it would help in background noise; another participant believed that having the SFHA might help her get back into attending social situations as she would more control over how the HA would sound.

Employment

Nine out of the 11 participants interviewed were retired so employment was very underrepresented in the data. However, as the participants were able to talk retrospectively, it was included in the analysis. One participant, a nurse, described how the SFHA could assist her in the constantly changing environments of working on the ward.

Entertainment

Music was an important aspect for four of the participants. They believed the SFHA would bring them some benefit to



Figure 2: Screenshots from the two UIs designed for this research: (1), adjustment selection screen (used to select choice of control parameters) used across both fader and A-B selection versions; (2), A-B selection method with stimuli presentation buttons; (3) noise reduction fader from fader UI; (4), programme selection screen used on both UI versions; (5), bass, middle, treble, bass enhancement and brightness fader controls.

music. They spoke about the fader controls being useful for it and being able to tailor the settings to music.

Miscellaneous experiences

For the purposes of this study, miscellaneous experience refers to interaction with medical professionals and achieving goals.

Participant 6 discusses how the SFHA will cause a reduction in the need to rely on other people to get things done:

‘It would just be nice to have control over it, instead of being reliant on someone else having total control’ – P6

Participants 6 and 8 refer to the notion of achieving goals:

‘Oh yes, definitely. I think my hearing might be a nicer experience and maybe I wouldn’t have to concentrate quite as hard, maybe it would go more towards a natural hearing because it’s what I want to hear, how to hear. It could be very good’ – P6

‘I think a self-fitting one... I guess you’d only have yourself to question if it didn’t quite do what you were hoping it to do...And with

a bit of luck it would more accurately reflect what I was trying to achieve’ – P8.

Sub-theme: Is it safe?: This sub-theme refers to the safety concerns with the SFHA raised by participants during the interviews. In total, four of the participants discussed safety concerns; these were different sound setting for different environments, overloading the hearing aid and damaging the hearing aid itself.

Theme 2: ‘This is how you can make the software better’

As part of the interviews, the participants were asked to make comments on the UI and suggest control options and interface features they felt were missing. A variety of suggestions were identified. These have been grouped into sub-themes; ‘control parameters’ and ‘software features’. These suggestions were a mobile phone application, feedback controls, a setting back-up system, multiple example stimuli to set the set the hearing aid with and a linking facility for bilateral aids.

Theme 3: ‘Using software as a control mechanism’

The theme ‘using software as a control mechanism’

encompasses the views of the participants towards the UI they were shown in the interviews. Six sub-themes were developed for this main theme: 'I'd be happy and satisfied'; 'am I confident using the software and making adjustments?'; 'fader control is better'; 'I like control and I like choice'; 'age & technology'; and 'it's one of the easiest software interfaces I've seen'.

Sub-theme: I'd be happy and satisfied: Satisfaction is an important part of this project. It is important to understand if participants perceive a more satisfying experience with the SFHA. If they do, this could lead the way for further developments in the technology. Participants in this study were asked: 'Do you think you would have more satisfaction from your hearing experience with this UI and the self-fitting hearing aid?'

The results showed that 10 out of 11 participants (91%) believed they would achieve a more satisfying experience from their hearing with the SFHA; using words such as 'I know what I want', 'flexibility' and 'satisfaction'.

Sub-theme: Am I confident using the software and making adjustments?: This sub-theme covers the participants' assessment of their ability to make effective adjustments to the SFHA that bring positive change and their perceived confidence in using the UI. It has been spilt into two sections for the purpose of clarity; 'software confidence' and 'making adjustments'.

Software confidence: Participants in this study were asked: 'How confident do you feel with this software interface?'. The results of this questions.

The results show that the majority of the participants (63%) felt confident or very confident in their abilities. Participants used words such as; 'can't see what's difficult about it' and 'when I've got it, I've got it'.

Making adjustments: Four of the 11 participants demonstrated a feeling of confidence in their ability to make positive changes with the SFHA. Some participants, however, exhibited a lack of confidence. Participants expressed feelings of worry, needing practice and requiring assistance in the form of instructional guidance.

Sub-theme: I like control and choice: A number of participants were quick to discuss the importance of control and the affect it has on a person. They highlighted how control was appealing and ideal, better than not being in control and how it can lead to a more satisfying hearing experience.

Sub-theme: Fader control is better: Two versions of the UI were shown to all 11 participants; the A-B selection (2AFC) and the fader versions. Following this demonstration, each participant was asked to choose a software preference. All 11 participants preferred the fader version of the interfaces.

Sub-theme: It's one of the easiest software interfaces I've seen: As part of the questionnaire, the participants were asked whether they thought the layout of the software was clear

and if it was easy to navigate. All 11 participants believed the interface was well laid out and easy to navigate.

Theme 4: 'The care of an audiologist vs. a SFHA'

The participants were asked to give their opinions of the audiological care they currently receive. It was made clear to everyone that the provider of that care was of no relevance. Some participants mentioned their provider (private or NHS); however, this was not taken into account during the analysis. The data indicated strong positive and negative opinions of their most recent audiological care. The period for seeing the last audiologist was within the last 5 years. Two sub-themes were formed under this main theme; 'patient-centred care' and 'clinician-centred care'.

Sub-theme: Patient-centred care: A small number of the participants talked about positive experiences with audiologists. They all felt that the audiology department had provided them with a good overall experience.

Sub-theme: Clinician-centred care: The remaining eight participants all expressed negative feelings towards their audiologist or their audiological care as a whole. They used words and phrases such as: disrespect, obsession, lack of care and understanding and the impression of knowing what is best for the patient.

Discussion

Perception & expectation of a SFHA

The SFHA concept has had a positive response and expectations are high. It is important that as the technology is developed further, these expectations are met. If they are not met, this could cause discontinued use of the device [17]. However, there was an expectation of sound quality and wanting a more natural sound; however, due to limits in technology, this is unlikely to be met. There is a strong belief the SFHA will bring huge benefit to their lives. Employment, socialising and entertainment, for example, were all important to the participants. Obsession by the user was identified, however it was not widespread; leading the researcher to believe it is not a big problem for hearing aid users and may only be a concern of those who have other obsessive or perfectionist tendencies. Care must also be taken to ensure the device is safe, to avoid noise induced hearing loss. A maximum power output limiter may be suitable in this situation. It should be noted that no participants mentioned being detracted from using the device for any reason, safety, for example. Perhaps this might have been apparent if more hearing aid users were interviewed.

Using software as a control mechanism

Two UIs were shown to participants; a fader controlled version and an A-B selection (2AFC) version. The fader version was unanimously preferred by participants, citing more control capabilities as the primary reason. The A-B version was seen as too restrictive. The layout of both versions was praised for its layout and ease of navigation. Of all the 11 participants, only one had reservations about the interface, citing "it's

horrendously complicated". Her reasoning stemmed from a feeling of IT illiteracy of 'technophobia'. This was not surprising considering technophobia is common amongst the older generations; females in particular [18,19].

Having control was important to the participants and, perhaps unsurprisingly, was considered preferable over not having control; they considered it to be a brilliant idea and would give them power over the hearing aid, supporting research by Collaunt, Johnson, McClelland & Burnham and Paschke et al. [20–23]. According to one participant, having this control will reduce the need to articulate preferences for settings to an audiologist, whom he relies on to interpret them. The feeling of confidence, or lack of confidence, to make adjustments to the SFHA with the software could be influenced by three factors; (1), viewing the hearing aid as a material possession; (2), the amount of assistance available; and (3) age and gender.

Finally, 91% of the participants believed they could make satisfying changes to hearing aid with the software; suggesting they have high expectations for the software and the SFHA; these findings opposes the research by Dreschler et al. [24], that found the opposite was true.

This is how you make the software better

The participants have offered many suggestions for the UI, all of which were positive. There was no mention of needing to remove anything and they were happy with the bass, middle, treble, brightness and bass enhancement controls. Some of the suggested software features already exist, the phone app and the adjustable NR algorithm, for example [6,7, 11,13]. It is clear the participants are aware of what is missing, suggesting they know what they want out of the software and the SFHA. There may be too much expectation for the environmental stimuli as to the best of the authors knowledge having relevant environmental stimuli in a hearing aid has not been well researched. The back-up feature would be hugely beneficial to users; especially considering some participants believed they could conduct the self-adjustments incorrectly:

'[I'm] worried I'll mess it up' – P1

'The main concern I have about controlling my own hearing aid is.... That I didn't damage it I suppose... Overload it or press the wrong button and do the wrong thing' – P10.

The care of an audiologist vs. a SFHA

There is a clear disconnection between audiologists and patients. Although it is not widespread in the sample, it is clearly apparent from eight of the participants in this study. This disconnection stems from a feeling of disrespect and ignorance to the wishes of the patients. Explanations for this include appointments times, obsessive tendencies and clinic guidelines & protocols. It could be argued the SFHA could go some way to solving these issues as the reliance on a medical profession is not required.

Validity of results

One needs to be careful when extrapolating to the wider population. The number of participants in this study ($n = 11$) is only a small sample of hearing aid users. Furthermore, all 11 participants were volunteers and not selected randomly; they were selected from a UoS database based on the inclusion criteria for this study.

In addition, the age range of the sample (50–78 years) is not representative of the all hearing aid users.

Overall summary

The perception of the SFHA concept amongst hearing aid users was unanimously positive; confirming and outperforming the existing knowledge from Convery et al., [9]. The participants demonstrated a liking to the idea and the vast majority (91%) spoke about a willingness to try one if it were available, with one being unsure. This validates the viability of the SFHA. With further research in the UK, it could be possible that the SFHA becomes available in the future. The participants also believed the SFHA would help to overcome issues they have with their current audiological care; including their reliance on the service. This again confirms the knowledge from the Convery et al. [9], research.

It was evident from the results that the participants were in favour of more control and more choice of what they could control and they believed they could generate satisfactory results. The fader interface and bass, middle and treble controls proved the most popular; however, there were positive comments for the brightness and bass enhancement controls also, albeit fewer of them. The preference for bass and treble controls is not surprising as the results of the Dreschler et al. [24], demonstrated similar findings. However, this is new knowledge in the field of SFHAs. These findings were also interesting considering the Boymans & Dreschler (2012) research that found hearing aid users preferred audiologist adjusted gain; suggesting that satisfactory results may be a high expectation.

It was surprising that the A-B selection versions was not favoured by more participants; it was assumed that the A-B selection version would have been preferable to the hearing aid users due to its simplicity and ease of use. However, the participants felt the selection of pre-determined settings took away some of the control and individuality of the system.

The additional feature suggestions were also not surprising, the back-up system and mobile phone applications being a particular interest; hearing aid companies are already providing mobile phone applications for their new generation hearing aids. These typically allow the adjustment of volume and programmes [12,13]. Where the SFHA differs is there would be the opportunity to have control over all aspects of the sound quality, including noise reduction. To the best of the authors' knowledge, this would be unique in hearing aid research. A feedback reduction would also be beneficial, particularly when the users are becoming accustomed to making adjustments.

Further research is required into the reliability of using environmental stimuli so further comments cannot be made.

Finally, by stating that the SFHA would be better than what they currently have and having more control would allow less reliance on others, indicates a high level of satisfaction [10,25,26].

Conclusions

(1) The want and need for control is apparent, demonstrating that a 'science knows best' approach may not be working within audiology clinics. The participants believe the device will bring greater satisfaction and reduce reliance on audiologists; (2), there is an apparent distrust of audiologists, they are believed to be obsessive and do not listen to patient needs; (3), a fader controlled adjustment system is required, as identified by 100% of participants; (4), assistance using the software would be initially required. However, with training and repetition, perceived self-efficacy would be high; (5) the risk of causing noise induced hearing loss was not discussed by many participants; (6), additional features for the software were recommended: feedback reduction, multiple fitting stimuli, linking two hearing aids and a back-up system; (7), a mobile phone application is required for real-time adjustments; and (8), expectation may be too high, due to technological limitations and user ability.

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Appendices

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