Research Report

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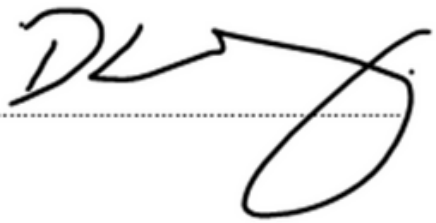

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01. Introduction

Its estimated that 1 in 6 of the UK adult population suffer from some sort of hearing loss, making it the second most common disability in the UK [1]. Many of those affected by hearing loss are taking advantage of the ever improving assistive auditory technologies currently available, although statistics show that a considerable amount of those affected do not use assistive auditory technologies and could benefit from them.

The initial step in this research report was to identify the market of people who are hard of hearing, seeking to understand the demographic of people that embrace the technology as well as the those who reject the technology. Once these demographics are highlighted, further research into the problems people face because of this tech will be undertaken.

Existing technologies will be explored to understand function, form, pricing, and improvement strategies. Alongside this exploration, the necessary patent and standard technicalities associated with designing a product in the hearing sector will also be highlighted.

Perhaps most importantly, using people based research, this report will uncover in depth the reasons why there is such a resistance to auditory assistive technology in the twenty first century, and how this resistance can be changed through the use of intuitive design.

02. Market Research

2.1 Existing Products

The sector of assistive auditory devices can be split into subsections; hearing aids and their accessories to enhance the hearing experience. The development of these accessories is a far smaller market and more room for design exploration Below is a diagram of existing hearing aid forms.

Figure 1. completely in the canal (A), in the canal (B), in the ear (C), behind the ear (D), receiver in canal or receiver in the ear (E), and open fit (F). [2]

These forms all serve different functions, with BTE models being the most common for various reasons. They are easy to take in and out and they often have a longer battery life and can provide additional amplification due to their larger form. The BTE form also allows for more features including directional microphones and Bluetooth technology. One perceived negative of using BTE models is that they are visible, but many user preferences are tending towards this visible model. To empower the user and create a product that normalises hearing loss as a disability, it was deemed important that the hearing aid is visible to others [3].

Below are a range of different accessories associated with hearing aids, expanding their function and enabling the user.

Figure 2. Charging case - A Charger, drying kit and protective hard case all in one. [4].

Figure 3. Roger Select™ is a versatile microphone ideal for stationary situations where background noise is present. When placed on a table, it discreetly and automatically selects the person who is talking and seamlessly switches from one talker to another. When multiple conversations take place, the listener can manually select whom to listen to. It can also transmit the sound of multimedia devices e.g. T.V. [5].

Figure 4. The PerfectClean Hearing Aid Cleaning System has been designed to clean, disinfect, and dry your hearing aids with the touch of a button. [6]

Figure 5. The JOIN® Hearing kit is a ready to wear rechargeable hearing aid unit, this aids claim to bring clearer fuller and richer sound in no time. Join connects easily to smartphones where you can stream sounds including music video and calls. [7]

Figure 6. The Starkey remote microphone and the Starkey mini remote microphone allow users to enjoy one-on-one conversations in noisy environments and easily stream from a variety of audio sources. The unique functions of these devices is the long distance range that these products offer in terms of streaming audio directly to Starkey hearing aids, [8]

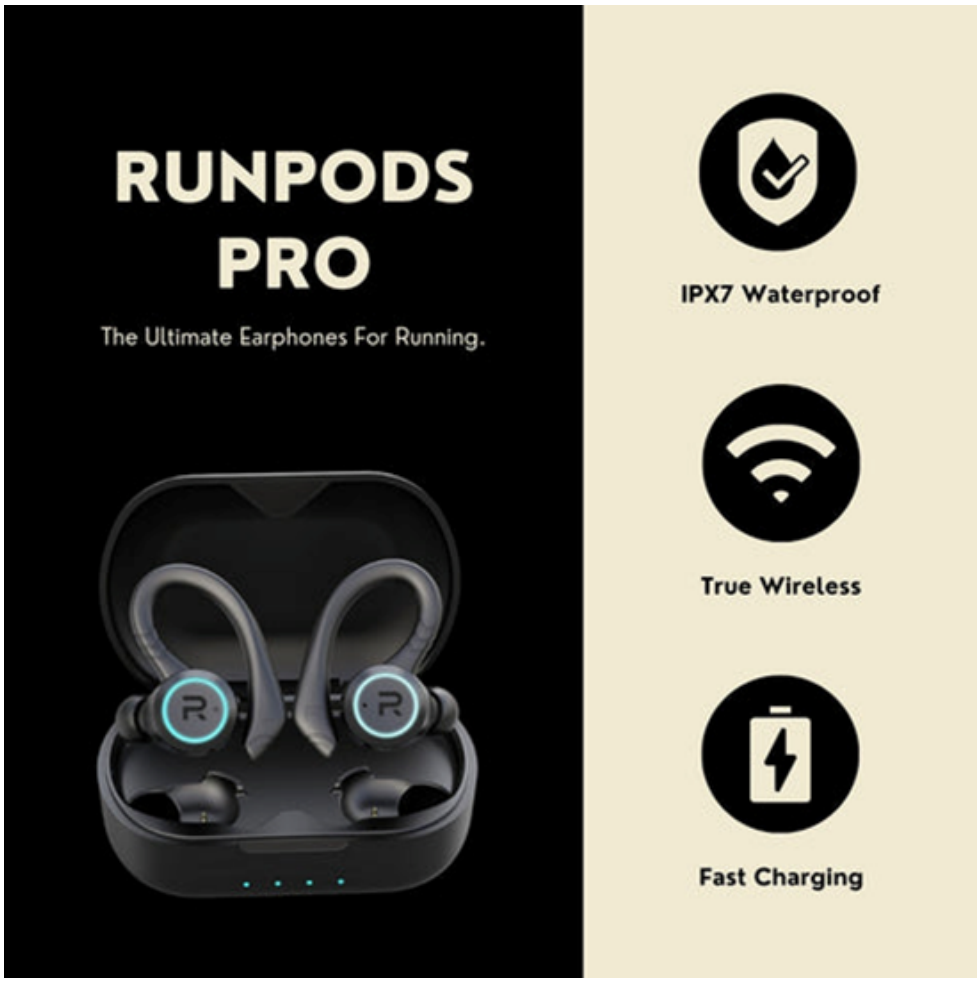


Figure 7. RunPods pro are a set of headphones that claim to never fall out of the ears and are IPX7 waterproof, making them perfect for sport and any weather. Although they are not assistive auditory units for use, insight can be taken from the form, case fitting and the design solution to produce the IP rating. [9]

2.2 Current trends

Behind the Ear (BTE) Hearing Aids are the most traditional form of aid, yet are still at the forefront of modern hearing aid technology [10].

In terms of hearing aid design, the BTE segment is expected to grow at a good rate over the next five years. These models are also widely considered to be ideal for most people with hearing problems. Due to COVID19 However this segment has had a decrease in growth rate, estimated to be due to the fact that wearing a mask decreases comfort greatly for these users [11]. Despite this current mask issue, BTE aids have been shown to be popular for those with limited dexterity and are the most universal models currently on the market [12].

2.3 Market Segmentation

It has been established that there is a considerable amount of the population who suffer from hearing loss. 2 million people in the UK are hearing aid users, an additional 6.7 million could benefit from using one [13]. Within this current statistic of two million hearing aid users, 20% of those use the private sector to help their hearing, with the remainder relying on the NHS for hearing aids.[14]

The NHS aims to supply as many people as possible with the hearing technology they require, often meaning that the options given are more limited in terms of technology, function, and form. In contrast the private sector is a further developed and more advanced area with great room for design exploration.

2.4 Target Market

33 per cent of the 50+ population living in the UK, (or 6.6 million) report hearing difficulties. Of these 6.6 million, which is made up from 56% men and 44% women. Of these, its estimated that there are 2.5 million people aged between 50 and 65 of working age with hearing difficulties [15]. With this in mind, its clear that the demographic for a product in this area is for an ageing population.

Evidence suggests that people wait on average 10 years before seeking help for their hearing loss and that when they do, GPs fail to refer 30–45% to NHS audiology services [16]. So its possible that the demographic for a product in the auditory technology sector will have a larger and slightly younger market than current research suggests.

2.5 Price Ranges

Prices for a hearing aid units in the UK private sector ranges greatly depending on function. The cheapest BTE models retail for around £80 for one ear and have extremely basic function. This goes up to state of the art products such as the Signia Active Pro which is priced at £2795. JOIN Hearing kit seen previously which has a chargeable case and retails for around £799 for both units. Accessories such as the Phonak wireless microphone units range in price from around £250-£800.[17]

2.6 Research Outcomes

Overall, there are a great deal of hearing aids and accessories that can be utilised to improve hearing for users in problematic settings. Current trends suggest that BTE units are compatible for the most users and are the easiest to fit functionality inside. The market contains a majority of people over fifty, with many of those close to fifty getting hearing aids late, after living with prolonged periods of bad hearing. Prices for hearing aids and assistive technology range greatly, and creating a product that combines these technologies would allow for a reduction in overall price, compared to purchasing multiple technologies independently.

03. Relevant Technologies

3.1 Hearing Aid Wearable Models

There are four main components of all hearing aids currently available on the market:

1. A microphone which picks up the sounds from your environment and then converts them into electrical impulses. These electrical impulses—or signals—are then sent to the amplifier, which is a computer chip dedicated to sound, in a modern hearing aid.
2. The amplifier boosts the volume of these electrical signals, making it easier to hear. In the devices with the top hearing aid features, the amplifier also cleans up the signal, removing noise and improving speech. The amplified and cleaned signals are then sent to the receiver and speaker after the digital processed signal is converted back to electrical impulses.
3. The receiver or speaker inside of hearing aids converts the amplified electrical signals back into sounds and then sends them directly to the ear where the natural hearing process takes over and the brain receives the impulses.
4. To keep this process working, a battery is needed inside of the hearing aids. This can be a little replaceable battery cell or a built-in rechargeable battery for some hearing aids. [18]

Below is a complex BTE hearing aid showing the main components, as well as additional extras that are available.

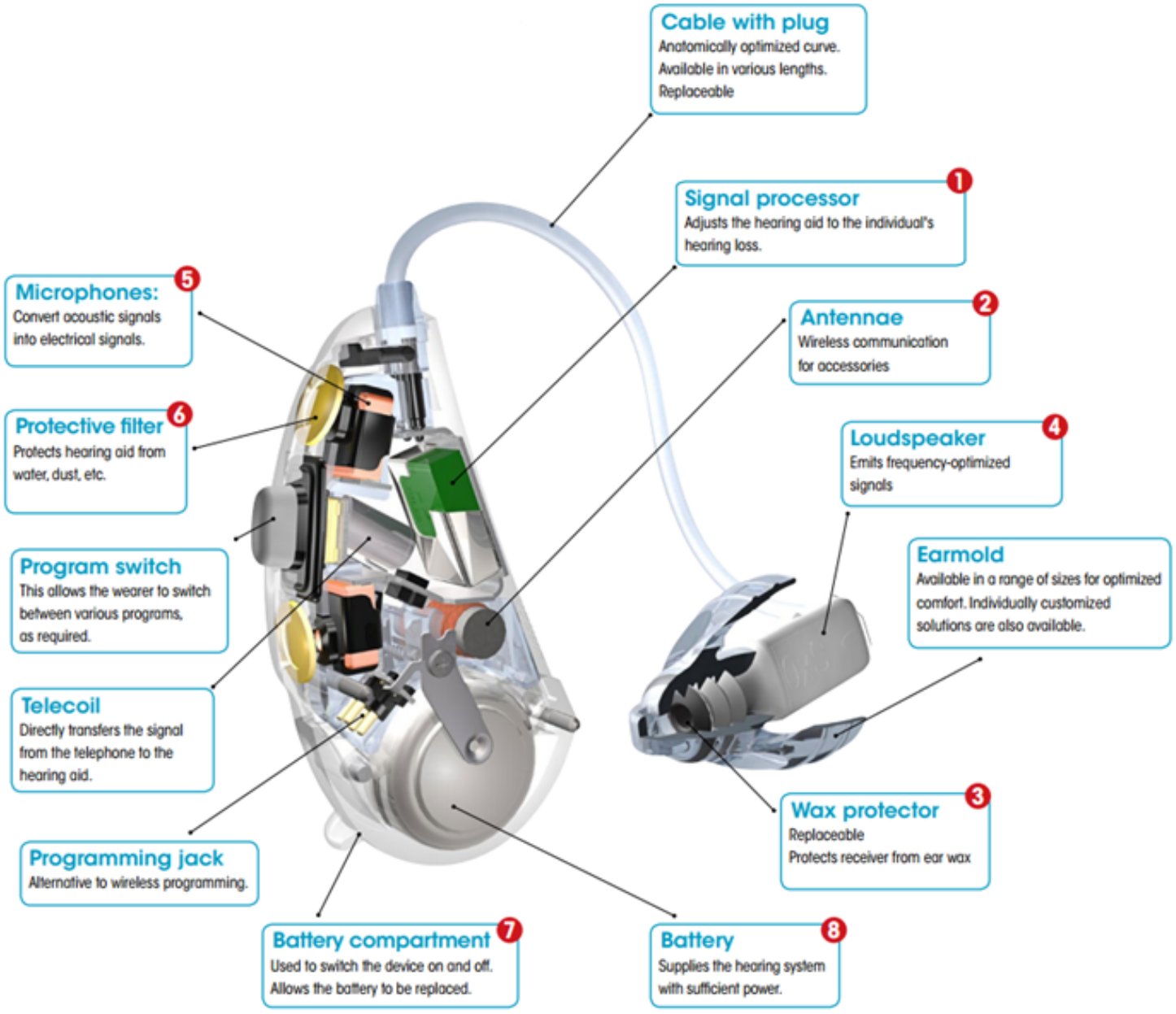


Figure 8 [19]

3.2 Bluetooth Technology

One advancement that has been introduced to hearing aids in recent years is Bluetooth Technology for various functions:

1. Bluetooth Low Energy can be used to programme hearing aids and is what is used to make wireless adjustments to devices through remote apps. This technology has revolutionised the hearing industry and uses far less energy than classic Bluetooth.
2. Bluetooth Classic. This allows hearing aids to connect to android phones as well as iPhone and can be broken down into two subsections. HFP- Hands-Free Protocol allows phone conversation without having to talk directly into the phone. A2DP- Advanced Audio Distribution Profile gives the best Stereo-Audio connection for music listening and streaming.
3. BVST. Binaural Voice Stream Technology allows for hearing aids to communicate back and forth with each other and allows for more improved hearing in areas with a lot of background noise.

Products such as the Roger 2.4 GHZ wireless model shown in figure 3 utilises Bluetooth technology and allow communication between a device and a hearing aid at some distance, whilst simultaneously cutting through background noise and recognising speech substantially better. [20][21]

3.3 Casing and Charging

Existing earpieces use either rechargeable or replaceable batteries. The act of replacing batteries has been deemed expensive, time consuming and difficult for those with limited dexterity or vision, so more and more models are being adapted to be rechargeable.

Non rechargeable hearing aid batteries can last anywhere from 5 to 14 days, based on a 16-hour day of wear. This is dependent upon the size of the battery and power needed by the hearing aid. This equates to replacing the batteries anywhere between 25-70 times a year, which also has a negative and avoidable impact on the environment. [22]

Current Rechargeable models use lithium ion batteries, which can hold a charge for up to 30 hours and last approximately five years before they need to be replaced [23]. Instead of a battery door, typically two electrodes exist on the bottom of the models which charge the battery through the case.

Cases for hearing aids exist with dehydration discs inside to remove moisture from the models, with some cases also containing UV light to destroy bacteria. Universal cases for hearing aids also do exist but these typically only act as a protective casing and have no additional functionality, so the most popular cases act as charging stations for the hearing aids they are paired with.

3.4 Calibration

Calibration to ensure those who are hard of hearing have the correct prescription is traditionally done by an audiologist but new technology is enabling users to calibrate their hearing aids at home once they have had their first fitting.

The calibration methods typically exist in the form of Mobile Apps to help users further understand their hearing aid settings and adjust their aid accordingly to enable improvements in user settings. As it currently stands, the improvements that can be made using these apps are relatively primitive compared to the in depth technological calibration carries out by audiologists. [24]

This is not entirely unintentional. Programming of hearing aids is extremely complex and requires a great deal of knowledge which is why audiologists have such an in depth education. Hearing is not as simple as a plus or minus prescription seen in glasses, instead no two peoples hearing is exactly the same and hearing aids are tweaked with tiny increments in many different ways. Because of this any app interface that controls calibration must be extremely complex in ability and simultaneously must simple enough for those who have no education in audiology to control their hearing aid, so a great deal of development is still to come.

The apps such as ReSound, Hearing Remote, and myPhonak enable users to turn their hearing aids on and off, independently change the volume of audio in each ear, and alter the sensitivity of noise reception. Some apps and models have the ability to reduce background noise, contain noise cancelling abilities and more.

Year on year users are gaining more control over their hearing aid abilities, but it’s clear that interfaces and technology needed for full on calibration by the user has some way to go.

04. Technical Information

4.1 Requirements

All hearing aids must contain the technology outlined in section 3.1 for the hearing aid to function. In order for a high end product to enter the market, at least Bluetooth technology and control over system functions also need to be present.

Currently most hearing aids are made to be water resistant not waterproof, since 2016 most hearing aids have a rating of IP68 which means that they can withstand dust, dirt and sand and being submerged in water to a maximum depth of 1.5 metres for 30 minutes and will continue to work [25].

Reports of allergic contact dermatitis have been found in patients when using certain materials for hearing aids. The cases are most commonly caused by ‘in the ear’ hearing aids but have been seen with Behind the Ear models as well as glasses [26]. It’s not a legal requirement but because of this risk, and since the ear models are handled and worn with bare skin, manufacturers make hearing aids using hypo-allergenic materials [27].

4.2 Standards

Most Standards from the BSI refer to the ability of the hearing aid, and the relevant methods of measurement associated with the fitting and maintenance of the internal technologies. There are no current standards associated with the external shell, aesthetics or form of hearing aids on the market.

One relevant standard for hearing aids according to the British Standard Institution comes from BS6083 - 1986 – Hearing Aids. Almost all parts of this standard have since been withdrawn. Part 11 specifies which symbols and other markings should be used within the design of hearing aids so although no longer a requirement, this may aid in the design of future auditory technology.[28]

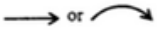
	Control		Function	Marking or symbol	Remarks
4.1	Various controls (adjustable in steps as well as continuously)	1	Indicating less/more		Increasing height of triangle or eyebrow-like strip indicates "more"
		2			For controls adjusting the output level "more" shall indicate a higher output SPL
		3			As above, with reference points
		4			Direction of arrow indicates "more"
		5			A higher number indicates "more" A lower number indicates "more"
		6		1, 2, 3, etc.	
4.2	Battery switch	1	Off	O	
4.3	Input selector	1	Microphone	M	
		2	Induction pick-up coil	T	
		3	Combination of microphone and induction pick-up coil	MT	
		4	Infra-red reception	IR	
		5	Radio reception	R	
		6	External electrical input	E or 	

Figure 9 is taken from BS6083 – Part 11 shows one example from of symbols used on hearing aids.

4.2 Patents

In a similar way to the standards, the majority of patents refer to the internal capabilities of the hearing aid units and the transmission of the audio data during use.

One of these patents detailed a method for tuning a hearing aid worn by a wearer, and involves automatically determining change to current hearing-aid audio setting based on wearer feedback and programmatically adjusting current hearing-aid audio settings [28]. The existence of this patent is an indication that audio technology is being driven in the direction of self-calibrating systems, giving more control to the end user.

4.3 Danger points

Parts, particularly in ear pieces must be securely attached to the main body of the wearable pieces, ensuring that nothing gets isolated within patients ears. Hearing aids, their cases and all accessories must also be made with no sharp edges to potentially harm users.

05. Human Based Research

5.1 People Based Research

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