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Technological Advancements in the Hearing Aid Industry

Assessing the effect of technological advancements on the adoption of hearing aids for people with mild-moderate hearing loss

Master's thesis in Industrial Engineering and Management

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Abstract

Hearing loss affects about half a billion people around the world, and the number keeps increasing. However, the adoption rate of hearing aids is still low. In the US, only 14% of the 25.4M people with mild hearing loss, and 37% of the 10.4M people with moderate hearing loss use hearing aids. Technological advancements introduce new performance metrics that allow new actors to meet the needs of the mild-moderate hearing loss segment. The purpose of this thesis is to understand how technological advancements could affect the adoption of hearing devices for the mild-moderate hearing loss segment, and how this could affect the hearing aid industry.

This study has been conducted through a qualitative literature review of adoption barriers and technology advancements, which has been complemented with quantitative data from the Hearing Industry Association. This has brought insights into the barriers that hinder people from adopting hearing aids. The examined adoption barriers in this study are denial, product value, effort, and stigma.

We have found that technological advancements enable new entrants to reduce the involvement of hearing care professionals and provide direct-to-consumer (DTC) hearing aids. We argue that DTC hearing aids reduce the adoption barriers of effort and stigma since they lead to increased patient control, less effort, and lower self-stigma for the consumer. Further, the product value can be increased through a change of focus to non-auditory needs and a reduction of price.

On an industry level, we conclude that the growth of DTC devices from consumer electronics manufacturers and new hearing aid manufacturers are threatening the key competitive advantages of the traditional hearing aid manufacturers. New entrants have great potential to thrive in the DTC market which will increase the competition and lead to price pressure on hearing devices. Traditional hearing aid manufacturers might struggle to compete in the DTC channel, but we argue that they will benefit from the increased spread of hearing devices. Ultimately, the establishment of DTC hearing aids has the potential to provide better user outcomes and increase the uptake of hearing devices for people with mild-moderate hearing loss.

Keywords: *Adoption Barriers, Technological Advancements, Hearing Aids, Denial, Stigma, Emotional Effort, Over-the-counter, Direct-to-consumer, Self-fitting, Artificial Intelligence*

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1

Introduction

This section presents the background to the hearing aid industry and the problems associated with the low uptake of hearing aids in the mild-moderate hearingloss segment. Further, the purpose, research questions, and scope of the report are presented.

1.1. Background

Hearing loss affects about 466 million people around the world (WHO, 2020). The prevalence of hearing loss is increasing, and if untreated it can have detrimental effects on the individual. Hearing loss is most prevalent among older age segments, but is increasing among young people, because of increased exposure to loud volumes via listening devices (Le Clercq, van Ingen, Ruytjens & van Schroeff, 2016).

If the hearing loss is untreated it might have an impact on the person's social interactions, feelings, mental health, and lifestyle (Barnett et al, 2016). People with hearing loss are more likely to be depressed, have anxiety issues, and a poor quality of life. They have difficulties participating in conversations as they cannot hear, or might even avoid joining social situations where the hearing loss is at risk of being exposed (Bouton, 2016). Hence, the result of an untreated hearing loss is an increased risk of social isolation, depression, cognitive decline, and dementia.

Although hearing loss is a widespread issue, WHO estimates that only 17% of those who could benefit from a hearing aid use one (WHO, 2020). There is a higher degree of untreated hearing loss in lower-income countries (WHO, 2020), but the adoption rate also differs between high-income countries. In Japan, only 15% of hearing-impaired individuals have hearing aids (Egger, Ruf & Zimmer, 2018a), whereas it reaches 33% in the US (HIA, 2019) and 49% in Norway (Egger, Ruf & Zimmer, 2019).

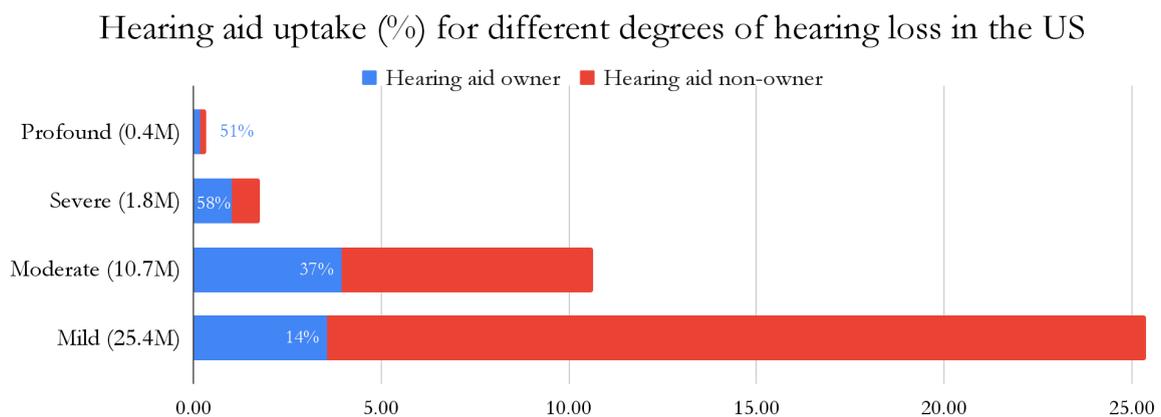


Figure 1. Hearing aid uptake in the US. Adapted based on the number of people with hearing loss by degree (Goman & Lin, 2016) and hearing aid adoption rate (HIA, 2019).

In the US, the adoption rate of hearing aids differs between the hearing loss segments (see figure 1). For people with severe and profound hearing loss, 58% and 51% respectively use a hearing aid (HIA, 2019).

However, there is a lower uptake for less severe hearing losses, where just 37% of people with moderate hearing loss use a hearing aid, and only 14% of people with mild hearing loss have a hearing aid (HIA, 2019).

As a treatment option, hearing aids are suitable to assist people with sensorineural hearing loss to improve their hearing (John Hopkins, 2021). In many cases, this condition is caused by ageing, loud noises, diseases, or injuries. The hearing loss affects the individual differently depending on the degree, which ranges from mild hearing loss at 26-40 dB to profound hearing loss at 80+ dB (Goman & Lin, 2016). As a reference, people with normal hearing can hear sounds below 25 dB (Asha, 2021a).

Mild hearing loss ranges between 26 and 40 dB and causes difficulties to hear in noisy situations (Clason, 2020), such as in a restaurant or a crowded place. Moderate hearing loss ranges between 41 and 60 dB (Goman & Lin, 2016), and makes it difficult for the affected person to hear clearly in conversations and might require the person to ask others to repeat themselves (Clason, 2020). Severe hearing loss ranges between 61 and 80 dB (Goman & Lin, 2016), and makes it difficult to hear speech and people might need to rely on lip-reading to manage conversations. People with profound hearing loss can only hear loud sounds above 80 dB (Goman & Lin, 2016), such as an aeroplane or a fire alarm (Hearing Health Foundation, 2021). Of the 38.2 million hearing-impaired individuals in the US, mild hearing loss is the most common one at 67%, followed by moderate at 28%, severe at 5%, and lastly profound at 1% (Goman & Lin, 2016).

Hearing aids are classified as medical devices and are controlled by medical device regulations to protect users. In the past, most hearing aids had to be sold through professionals that provide services to facilitate the journey (for more detail see appendix B). In the traditional consumer journey, the first two visits are conducted by clinicians, an initial hearing screening with a general practitioner (GP), and a second clinical screening with an ear-nose-throat doctor (ENT) to exclude any medical or surgical condition. Then, the person is referred to a **hearing care professional (HCP)**, who are licensed professionals that are allowed by the FDA to sell and adjust hearing aids for people with hearing loss (FDA, 2020). The term HCP includes audiologists and hearing aid dispensers. Audiologists are, apart from selling hearing aids, able to provide services to assess, diagnose, and care for hearing and balance issues. Of the audiologist services, a hearing aid dispenser can perform the fitting, servicing and adjustment of features of the hearing aid. In the US, it has become optional to visit a clinician, but the current FDA regulations still require that hearing aids are sold by HCPs.

There is a range of physical distribution channels where patients can visit and buy their hearing aid; public or hospitals such as the US military's Veterans Affairs, independent stores owned by HCPs, hearing aid wholesalers, hearing aid retail chains, pharmacies, special retailers such as opticians, or big-box retailers such as Costco (Demant, 2016). There are also online sales channels where consumers can get remote consultation by HCPs.

Hearing aids need to last for a full day, as people tend to use their hearing aids about 12-16 hours per day and on average 13 hours (Bailey, 2019e). Developers of hearing aids are faced with a tradeoff decision to optimize the sound and functionality of the hearing aid and retain long battery life, while simultaneously minimizing the size (Onsemi, 2014). When developing hearing aids, manufacturers work to improve the computational capability and sound quality of the device, while reducing the power consumption and physical size. This is a factor that creates great technical difficulty in optimizing the hardware that runs the device.

Company	Sonova	Demant	WS Audiology	GN Group	Starkey
Country (HQ)	Switzerland	Denmark	Denmark	Denmark	US
Hearing aid brands	Phonak, Unitron, Hansaton	Oticon, Bernafon, Sonic, Phillips	Signia, Widex	Resound, Beltone, Intertone	Starkey
Cochlear & Baha implants	Advanced Bionics	Oticon	-	-	-
Consumer electronics brands	Sennheiser	-	-	Jabra	-
Revenue Billion Euro (€) 18/19 [excluding consumer electronics]	€2.56	€2.00	€1.60	€0.86	€0.15

Table 1. Overview of traditional hearing aid manufacturers. Data from 2020 Annual Report, Sonova, Demant, WS Audiology, and GN Group (2020). Starkey data from (Miller, 2020)

There are five **traditional hearing aid manufacturers (THMs)** that produce a majority of the world's hearing aids (see table 1). Audiologists have a strong brand preference and on average 71.4% of the devices they sell are from the same brand (Johnson, Mueller & Ricketts, 2009), which requires manufacturers to market their hearing aids to these channels to ensure that they are the preferred brand. There are also high costs involved in developing the hearing aid as they need to be small, energy-efficient, and have high functionality (Onsemi, 2014). The large costs of R&D and marketing premier large economies of scale. As a consequence, since the merger between Widex and Sivantos into WS Audiology in 2019 (WSA, 2019), the hearing aid industry is dominated by the five hearing aid manufacturers: Sonova, Demant, WS Audiology, GN Hearing, and Starkey (Strom, 2018a). Together these companies account for over 90% of the global hearing aid industry in terms of revenue (Grand View Research, 2019). The THMs are present in several areas and offer hearing aids, hearing accessories, applications, and fitting software that help professionals to adjust the hearing aids (Demant, 2016). The two largest actors, Sonova and Demant, offer hearing implants and have their own distribution networks through physical stores. Further, WS Audiology owns the online channels audibene and hear.com. Additionally, GN Group and Sonova provide consumer electronics products through their respective brands Jabra and Sennheiser.

The competitive advantage of THMs originates from their ability to develop and sell hearing aids through HCPs to the end-user. This translates into three key competitive advantages. Firstly, the THMs have close relationships and brand preferability with HCPs that provide them with access to end-users. Secondly, they can sustain this relationship and retain their brand image by utilising economies of scale to create clinical evidence, marketing, and advertising. Thirdly, they can use economies of scale for their R&D to create a small hearing aid with advanced features and power to last throughout the day.

“[...] traditional hearing aids are a bit discriminatory. They are really only purchased and bought by people who have really high levels of hearing loss. At least that is how it was five, six years ago. And so folks would not buy hearing aids until they really reached a threshold that it was a must-have”

Davis, Bellavia & Kemp (2021, 05:20)

Hearing aids are expensive and some actors try to make them more accessible in the US. The average pair of hearing aids costs \$4 672 (Bailey, 2021), and the overall low uptake of hearing aids are starting to put more pressure on changing the dynamics of the industry. Especially, the low uptake in the mild-moderate hearing loss segment has been put in focus. In the US, issues with high prices and a perceived lack of competition in the industry have led to a proposition of a new product category of over-the-counter (OTC) hearing aids, that can be sold without the involvement of an HCP (American Academy of

Audiology, 2018). The guideline states that this will allow for the introduction of new medical-grade devices for mild-moderate hearing loss that will have lower requirements than the traditional hearing aid classification.

Although the OTC classification has not been put into place yet, companies have already started to develop and launch **direct-to-consumer (DTC)** hearing aids. These changes allow companies to bypass the HCPs and reach consumers directly in the mild-moderate hearing loss segment. Furthermore, technological advancements allow for new technical aspects that could change the hearing aid product offering. For THMs this results in new competition from two fronts that target the mild-moderate consumer, from diversification of **consumer electronics manufacturers (CEMs)** and **new hearing aid manufacturers (NHMs)**.

Several actors are developing hearing devices to enter the industry. From the consumer electronics side, the most prominent actor is Bose that launched a hearing aid in May 2021, which is sold DTC and can be self-fitted by the user without the need of an HCP (Bose, 2021). Moreover, Samsung, Apple, Sennheiser, and Jabra all have elements of hearing enhancement in their hearables devices (GlobalData, 2019). The strength of CEMs lies in their ability to develop new technological features in fast cycles. They also have strong brands and can maintain this through extensive marketing and advertising that attract B2C customers. Moreover, they can utilize large economies of scale to provide products at a lower price for the consumer. On the contrary, NHMs such as Eargo can create a product that is adapted to the needs of people with mild-moderate hearing loss. The NHMs can create products at low cost that have a similar experienced performance as hearing aids from THMs, and support these with services that are similar to those that are currently provided by HCPs.

Currently, many changes take place in the industry, but there is a limited understanding about which group of companies that is best suited to reach the mild-moderate hearing loss segment. Moreover, there is a lack of understanding of what keeps people who might benefit from hearing aids from acquiring them. Hence, to increase the adoption of hearing aids for people with mild-moderate hearing loss, there is a need to investigate which barriers that are currently hindering people with mild-moderate hearing loss from acquiring hearing aids. Moreover, there is a need to understand how technological advancements could play a role in reducing these barriers to adoption. Finally, by viewing this from a larger industry perspective, this report will investigate which groups of companies that are best positioned to reduce the barriers to adoption, as well as how the THMs would be affected by the changes.

1.2. Purpose & Research Questions

The purpose of this report is to understand how technological advancements could affect the adoption of hearing devices for the mild-moderate hearing loss segment, and how this could affect the hearing aid industry. The purpose will be fulfilled by answering the following research questions:

1. What hinders people with mild-moderate hearing loss from acquiring hearing aids?
2. How could technological advancements affect the technology ecosystem for hearing aids?
3. How could technological advancements affect adoption of hearing aids for people with mild-moderate hearing loss?
4. How could technological advancements affect the traditional hearing aid manufacturers?

The report is structured in four sections to answer each research question respectively. The section “Barriers to Adoption” examines the primary factors that hinder people from acquiring hearing aids.

Thereafter, the section “Advancements of Technology Ecosystem” presents technological changes in the industry and the effects on products, components, and complements. Then, the section “Effect on Adoption” describes how these technological advancements could reduce barriers to adoption. Finally, the section “Effect on industry” discusses how the technological advancements and increase in adoption might influence the competitive dynamics of the industry.

1.3. Scope & Limitations

The customer segment of 45-65-year-olds with mild-moderate hearing loss has the highest potential to increase adoption. Hence, this is the consumer scope of this report. The mild-moderate hearing loss segment is the largest in terms of the number of people, with the lowest hearing aid adoption at 14% for mild hearing loss and 37% for moderate hearing loss in the US. Since the purpose of the report is to investigate the increase in adoption, non-owners in these hearing loss segments are relevant. Additionally, most technological advancements and new entrants in the hearing aid industry are mainly targeting people with mild-moderate hearing loss.

The age group of 45-65 consists mainly of working people with other communication needs than those above 65. Additionally, the age group 45-65 is more technically experienced than the 65+ age group, making them more suitable for a self-managed hearing device. In terms of geographical area, the report will focus on the US market since the ongoing changes in regulations for over-the-counter sales of hearing aids will take place in the US, and are intended for people with mild-moderate hearing loss. Hence, the investigation of 45-65-year-old individuals with mild-moderate hearing loss in the US is based on the high potential for increased adoption.

The scope of the adoption barriers will cover the barriers of product value, consumer journey, stigma, and denial. Additional potential reasons for low adoption have been encountered during the literature review, such as lack of awareness and lack of knowledge, but these have been excluded from this report. The report focuses on the barriers that hinder people from purchasing a hearing aid, despite being aware of their hearing loss and having knowledge about how to get care. Barriers that are not included in this, are outside of the scope of this report.

The scope of the technology ecosystem includes components, complements, and products of hearing aids. For products, the hearing improvements allowed by artificial intelligence are covered, since this is the main technological advancement that improves the product performance. For components, the chipset technology is covered since this will have the biggest impact on the accessibility of hearing devices. For complements, the technology ecosystem chapter will focus on technologies that change aspects of the audiologist services. The focus will be on the effect and the functionality that is enabled by technological advancements, rather than to describe how the technologies work. There are other changes in the technology that might affect the hearing aid, such as the software interface or hearing assistive technologies. However, these are excluded from the report as the changes in the role of the audiologist and the chipset technology has the greatest potential to threaten the traditional hearing aid manufacturers (THMs) and increase adoption.

The industry perspective will focus on the THMs, consumer electronics manufacturers (CEMs), and new hearing aid manufacturers (NHMs). The THMs include the five large hearing aid manufacturers in the established hearing aid industry. CEMs are defined as companies that sell in-ear headphones with hearing enhancing features, so-called hearables, or have begun to develop hearing solutions. Lastly, NHMs include companies that manufacturers DTC hearing devices for mild-moderate consumers. Some of the DTC

products are currently labelled as PSAPs, or hearing aids, but are still intended for DTC sales. These will also be included in the DTC products in this paper. Moreover, some of the companies that sell DTC devices use misleading marketing or provide insufficient hearing amplification for the person with hearing loss. These companies are excluded from this report.

A limitation of the report is that it lacks first-hand information from actual people with hearing loss. Because of the ongoing situation of covid-19 to find and set up meetings with people in the target group in the US. However, MarkeTrak 10 includes individual responses to relevant questions within the scope of this report. Also, there is an extensive amount of literature that covers the experiences of individual barriers for people with hearing loss. Articles such as “The Stigma of Hearing Loss“ by Wallhagen (2010) and “Hearing Loss Denial“ by Rawool (2018) present in-depth understandings of the influence of stigma and denial on the consumer. However, few articles manage to describe the overall barriers to accessing hearing devices and the intersection between denial, product value, effort, and stigma. This report aims to add to this knowledge by providing actionable insights that can help companies to address non-treated hearing loss, and motivate more people to acquire a hearing device. The backbone of the report is based on clinical research on hearing loss and hearing aids and consists of a literature study that highlights the barriers that hinder patients with hearing loss from acquiring a device. Lastly, by using a large set of data from different companies, products, and customers, we were able to draw conclusions that are representative of the scope of the report.

2

Method

This study has been conducted in three stages. A first stage of a primary and comprehensive literature search to assess the adoption barriers of hearing aids. Thereafter, we conducted a literature search with a focus on uncovering the technological advancements. Lastly, we conducted an analysis and discussion on the collected information to answer our purpose based on conversations with Company H¹, background literature, and the collected secondary data.

We have made an extensive literature search to understand and verify the barriers to hearing aids adoption. This search was guided by the MarkeTrak 10 report and discussions with Company H. A research design should be conducted in an iterative approach where activities are happening simultaneously and have an influence on each other (Maxwell, 2005). Hence, we have remained in contact with company H to ensure that the content remains relevant and stays grounded in the practical environment while continuing to search for literature that could question our hypotheses.

Qualitative research is suitable when the subject requires deep understanding (Patel & Davidson, 2003). Hence, the research has been conducted through primarily an inductive qualitative data analysis of the collected literature to understand the underlying reasons why people with mild-moderate hearing loss are not acquiring hearing aids. There are large amounts of data available on hearing loss and the adoption of hearing aids. However, there is a lack of common understanding of the influence of the consumer journey on the adoption barriers. When there is an existing body of literature it might be difficult to only rely on a qualitative study to describe concepts from new perspectives (Edmondson & Mcmanus, 2007). Rather, complementing the research with quantitative data could add credibility to the study by providing support for the relative relationships between concepts. Hence, the qualitative research has been complemented with quantitative data from MarkeTrak 10 (HIA, 2019) to verify the relative importance of the barriers. Since 1989, the Hearing Industry Association (HIA) has conducted the MarkeTrak study in the US to understand the satisfaction, needs, and uptake of hearing devices for people with hearing loss. MarkeTrak includes data from both owners and non-owners of hearing aids and has been used as a foundational source to define the barriers that hinder potential consumers from purchasing hearing aids.

Based on discussions with company H and data in the MarkeTrak report, we have chosen to focus on denial, product value, effort, and stigma as the barriers to adoption, since these were the most prominent reasons for the low uptake. The barriers are separated into these categories, but in many cases, they influence each other. For instance, “too expensive” is a mentioned reason to not purchase hearing aids, where denial, price, and emotional effort might all make the person perceive that the product is too expensive. However, the separation of the barriers assists in understanding the impact of the respective barriers on individuals who fail to acquire hearing aids.

To understand what is already discovered and known on the subject, reviewing the existing literature of the subject assists in evaluating the findings of the study (Easterby-Smith, Thorpe, Jackson & Jaspersen, 2018). Hence, the data from MarkeTrak 10 was complemented by a comprehensive literature search. The search terms include hearing loss (hearing loss, hearing-impairment, hearing difficulty etc.), hearing

¹ Company H is an actor in the hearing industry and has asked to remain anonymous for confidentiality reasons.

devices (hearing aids, over-the-counter hearing aids, hearing enhancements, personal sound amplification products etc.), and barriers (adoption, barriers, hinders, uptake etc.). These initial searches were made to verify the barriers and were later complemented with more specific search words for each barrier. The more specific search words include search terms for technical performance (sound performance, speech in noise, hearing assessment, fitting software etc.), price (cost, margin, markup etc.), effort (inconvenience, time, emotional effort, denial etc.), and stigma (stereotypes, negative perception, ageism etc.). This literature search was complemented by discussions with key people at Company H to better understand the barriers that consumers experience in their care journey. A replication of the study with an identical scope is likely to produce the same reasons for the low uptake since a variety of well-cited articles and journals were used to confirm the barriers to adoption.

For the second literature search, we included aspects on technological advancements (technological improvements, technological improvement, emerging technology etc.) in combination with the specific areas of the technology ecosystem (hearing aids, chipsets, components, assessment, fitting, counselling, human interaction etc.) to understand the technological changes. The search was initially made in a broader area to understand the technological changes that are happening in the industry, and together with Company H, the focus on hearing aids, HCPs, and chipsets was selected. The literature included academic articles, papers, and reports found on Google Scholar. These articles were complemented with material from central industry organizations (AAA, ASHA, HIA, Ehima, MayoClinic etc.), industry experts in industry journals, and company websites. Moreover, a primary source was transcriptions from the podcast futurear.co where the host Dave Kemp has interviewed industry experts and company representatives about hearing devices, hearing care, and hearables. To confirm our interpretations of the literature review, the findings from secondary sources were discussed with representatives at Company H.

For the analysis on how technological advancements could assist in reducing the barriers to adoption and the industry structure, the literature was chosen to reflect the changes regarding the performance and consumer utility of hearing aid devices. The barriers to adoption were cross-referenced with the technological advancements to break down how the changes could improve the uptake of hearing aids. The analysis was based on the collected data on barriers and technology advancements to understand which performance aspects that users might experience utility from. This resulted in an analysis into two areas, the change in the role of HCP and the change in product value, which represent the identified main changes caused by technological advancements.

Moreover, theories about technological transition and creative destruction were used to analyse the competitive situation and changes on an industry level. From interviews with company H we were provided with information on the key competitive advantages of the THMs, which was verified by external sources. By examining how technological advancements influence the competitive advantage of the THMs and comparing it with the theory, we were able to draw conclusions of how the industry might be affected.

3

Literature Background

The following section presents relevant literature to understand and assess the changes that technological advancements inflict on the hearing aid uptake and the hearing aid industry.

3.1. Technological Performance

Major innovations provide more opportunities and increase the marginal returns to technical development more than incremental innovations (Lindmark, 2006). The rate of change will increase as an innovation surpasses a technical barrier and breakthrough. At this point, the cost of development is also the lowest and the returns are the highest. However, initiating the change demands a lot of resources to overcome the technical difficulties. Similarly, the technical development will reach a point of diminishing returns where the progress slows down and the rate of performance improvements declines (Lindmark, 2006).

There are limits to the incremental improvements in one separate performance metric. The reason is that technical development explores technical opportunities based on an initial breakthrough innovation (Lindmark, 2006). In the beginning, there are plenty of unexplored ideas that can be put into practice. As the opportunities are tested and explored, there will eventually be fewer possible alternatives and it will demand more resources to try them out. Hence, the incremental innovations for one performance aspect will ultimately reach a limit. This limit can come in the technical feasibility of a solution, but also be limited by other aspects such as economic or legal restraints (Lindmark, 2006).

If one performance metric has reached a certain limit, the technical development often continues in another performance metric (Lindmark, 2006). By comparing two performance metrics, it can be possible to assess the trade-off of improving the performance in different dimensions. If one metric starts reaching techno-economical barriers to investment, it is crucial to redirect investments to the new performance metrics. Innovations are usually first sold in areas where they have an advantage in one performance metric compared to the traditional industry (Lindmark, 2006). Because of trade-offs in the technology, an increased performance in one parameter often results in poorer performance in another. To understand the changes in the techno-economic environment it might therefore be important to assess different performance metrics.

In this development, it is important to also relate performance to what consumers demand. Technology might not have reached diminishing returns in what is technologically possible, but it can still overshoot the expectations of what consumers demand (Sandström, 2020). The risk is then to fail to introduce new performance dimensions that consumers value. An example is that transistor radios were initially inferior in sound performance to analogue radios, but they were cheaper and portable. As technical development allowed for increased sound performance, analogue radios overshoot the consumer demands in sound quality while transistor radios reached a sufficient sound quality. This resulted in the demise of analogue radios (Sandström, 2020).

The utility of a technology is the perceived benefit and satisfaction that an individual finds from attending a situation, or from using goods or services (Lindmark, 2006). The utility is in turn determined by how an individual chooses between available solutions. Utility aspects can be linked to technical performance to determine the value of improving the performance aspects of the innovation to increase the marginal improvement (Lindmark, 2006).

Many of the performance improvements for technologies have relied on Moore's law of improvement of semiconductors. Gordon Moore predicted that the number of circuit elements of a chip would double every two years, and later reversed it to every 18 months (Schaller, 2006). The effect of the improvement has been that chipsets have become smaller, cheaper, higher performing, and require less power usage. Moore's law has fueled the development of digital technologies where chipsets have become better and allowed for increased functionality. However, this change has slowed down (Theis & Wong, 2017), and is expected to level off by 2025 as the creation of heat prevents future miniaturization of the silicon semiconductors (Shalf, 2020). The development of chipsets will continue, but not at the same rate as before.

3.2. Technology Ecosystem

Innovations are dependent on other technologies to provide value to the user. A technology exists in an ecosystem of other technologies that influence the performance of the product (Adnar & Kapoor, 2009), and to function properly a technology needs to be viewed in the context of other services and products that are used together with the technology (Lindmark, 2006). Hence, technology systems are dependent on the development of components to be able to succeed in the development of a new technology system (Adnar, 2006). An aspect that affects the performance of the technology system is the components that go into the product from suppliers (Adnar & Kapoor, 2009).

Moreover, the linkage to other technologies can be complementary or substitutive. Complements are technologies that can be bought in addition to each other, while substitutes are technologies that can be bought instead of each other (McAuley, Pandey & Leskovec, 2015). Complementary technological systems are sub-systems of technologies that are connected and combined to add value to an application (Lindmark, 2006). An example is that a printer is dependent on a network of computers, printer ink, and complementing software to function. There will be little value in the printer if these systems are not present. For complementary products, the cross-elasticity of demand is negative (Lindmark, 2006). If the price of printers decreases, the demand for printer ink will increase.

Instead, substituting technological systems are systems that are providing functionality by other means (Lindmark, 2006). If the value is improved sight, this can be provided by eyeglasses or lenses that act as substituting innovations to each other. Substitutionary goods have a positive cross elasticity of demand (Lindmark, 2006). If the price decreases for one technology, the demand for the other technology will decrease. Hence if the price for lenses decreases, the demand for glasses will decrease.

Other than price, technical performance can also be included as a metric for complementary and substitutionary systems (Lindmark, 2006). If quality becomes better for a complementary service it will increase the demand for the examined technology. Similarly, if the quality becomes better for a substituting technology it will lower the demand for the examined technology.

3.3. Market Entry Barriers and Substitutes

An industry that is dominated by a small concentration of firms is an oligopoly and often has significant barriers to enter the market (Grant, 2016). Market entry barriers limit the competition in the industry to a few actors and enable the industry to earn profits that are higher than what they would have been at a market-level competition. The effectiveness of the market barriers is dependent on the capabilities and resources that the companies have. Barriers that are proficient for new companies might not be effective towards established companies that enter through diversification (Grant, 2016).

According to Grant (2016), the primary sources of barriers to entry are scale economies, cost advantages, product differentiation, access to distribution channels, regulatory barriers, and the ability to retaliate. Economies of scale relate to the benefits of a company to spread out large costs on a large number of units and are usually applicable for large costs such as the development of new products or advertising. Moreover, product differentiation might act as a market entry barrier by keeping customers loyal to certain brands and products, which hinder them from switching to other brand offerings. For some industries, there is limited access to the distribution channel to the customers for reasons such as a limited shelf space or a limited capacity for the retailer to take on more products. Further, there could be legal barriers that govern the industry (2018). Examples of this are legal restrictions that provide licenses to companies to allow them to sell their products or intellectual property laws that protect certain types of knowledge.

Another threat to an industry is the availability of close substitutes to the products or services that the industry offers (Grant, 2016). If there are substitutes, customers might be willing to switch from the industry's offering if they are offered a better value in respect to the price. The level of substitutability of an offering depends on the tendency of consumers to switch to another similar product offering. An example is how e-commerce has substituted the value provided by traditional brick-and-mortar companies (Grant, 2016), such as in the travel industry where online booking sites have been able to substitute and outcompete physical travel agencies.

3.4. Creative Destruction

Technological transitions might cause a creative destruction of the incumbent technology. A technological regime is a prevailing boundary that determines how technology progresses and guides the trajectory for a certain technology (Kemp, 1994). It is usually dominated by incremental changes that are within the existing technological system. Breakthrough innovation might result in new technology systems emerging (Kemp, 1994). In the transition to another technology regime, there might be an event of creative destruction (Lindmark, 2006), where incumbents are unable to adapt to the change and lose market share to new actors (Spencer & Kirchoff, 2006). A common pattern of creative destruction in an industry is that incumbents are too focused on the existing technology regime and that they are slowed down in the transition to the new technology regime by investments in the old regime.

The process of creative destruction often begins with the incumbent not being able to fully explore new alternatives because of commitments in technology, strategy, or markets to a technological regime (Spencer & Kirchoff, 2006). New technology could then be introduced by a new or smaller player in the industry that is not bound by the constraints of the existing regime and that differentiates from the existing industry. Often this begins in a smaller niche in the industry. The new technology is ignored by incumbents as it is outside of the needs of the best customers, outside of their expertise, requires a commitment to investments in the new area, or might cannibalize on the sales of best-performing

products. In making the development, the new actor creates a significant position in a niche close to the incumbent market. Many times, the performance aspects of the new market are different from the incumbent industry. As the new technology develops, it improves on the incumbent's previous performance metric, while retaining the advantage in the new performance aspect (Spencer & Kirchoff, 2006). When the new technology reaches a similar performance level as the traditional technology, the new performance aspects become strategic advantages compared to the existing industry.

In developing new technologies, companies struggle to create innovations that are not demanded by their existing profitable market. An incumbent tends to be heavily invested in their primary market and existing customer base (Abernathy & Clark, 1985). Hence, they might lack incentives to invest in new technologies as this would result in them abandoning the current customers and investing less in the old technology. Existing consumers expect a level of performance in traditional performance aspects which demands most resources, rather than to lower the traditional performance to introduce new performance attributes. Incumbents then struggle to be mobile and create innovations that do not meet the needs of their existing large customers (Christensen & Rosenbloom, 1995). Hence, the advantage of new entrants lies in their ability to set a strategic direction to differentiate from the traditional industry and introduce new performance aspects that are currently not demanded by the existing industry.

Competence-destroying innovations could make existing knowledge of the technology base go obsolete. Technology tends to develop for a long time in incremental innovations that follow the previous trajectory in the industry (Tushman & Anderson, 1986). This continuous improvement can be challenged by a new technological breakthrough innovation that radically changes the technology in the industry, and introduces ambiguity and uncertainty in the new environment. Some of these are competence-enhancing innovations that arise from the existing industry and strengthen the existing know-how and knowledge. Other changes are instead competence-destroying as they are advancing innovation based on competencies that are inconsistent with previous knowledge, know-how, and abilities. These innovations tend to come from new actors that challenge the established firms (Tushman & Anderson, 1986).

New technology could make the complementary assets of the incumbent obsolete, paving way for new actors to enter the market. For some innovations, complementary assets are needed to gain an advantage in exploiting an innovation (Tripsas, 1997). More generic assets have many applications, while specialized assets are only valuable for a certain type of innovation. The specialized assets might be crucial for an incumbent technology, but a new technology system could destroy the value of these assets (Tripsas, 1997). An example is that for mechanical calculators the sales force and service were essential to the value of the product. However, as electronic calculators were more robust and could be sold in office stores, these assets lost their value. Diversifying companies could also have the necessary complementary assets to enter an industry, and could be more successful in the industry than existing companies that lack them (Tripsas, 1997).

An innovation might be incremental at one stage of the value chain but have more radical effects in other parts of it. Considering only the effect of a technology for the manufacturer or innovator it can seem as an innovation is incremental (Afuah & Bahram, 1993). However, having a broader view of the system might have a larger effect on the capabilities and resources of complementary innovators, suppliers, or customers. Not considering the larger scope can be detrimental, especially for technologies that are dependent on innovations in complementary technologies and rely on learning and have positive network externalities. For the old technology, there might be inertia in changing the complementary innovations to match newer technologies. In this change, incumbents could be challenged by new entrants that are free from this (Afuah & Bahram, 1993).

Incumbents might face issues with adjusting the organizational structure to face the threat of architectural innovations. The organization of incumbents is structured to be efficient in producing an innovation that follows the dominant design (Henderson & Clark, 1990). Hence, communication channels, information filters, and strategies are streamlined to continue developing the traditional technology. An architectural innovation would demand a new structure of the product that changes the interaction of the components. This would also challenge the existing organizational structure of the company. Incumbents are stuck in old patterns and are slowed down in making the necessary changes for the new technology. In contrast, new organizations lack these organizational linkages and are free to create an organizational structure that is better adapted to the new technology (Henderson & Clark, 1990).

4

Barriers to Adoption

There are several reasons behind the low adoption rate of hearing aids for the mild-moderate hearing loss segment. These barriers are causing people to delay or deny the need to seek treatment for the hearing loss, rather than to confront the issue and persist through the consumer journey. In this section, the barriers denial, product value, effort, and stigma are investigated to answer the research question: “What hinders people with mild-moderate hearing loss from acquiring hearing aids?”.

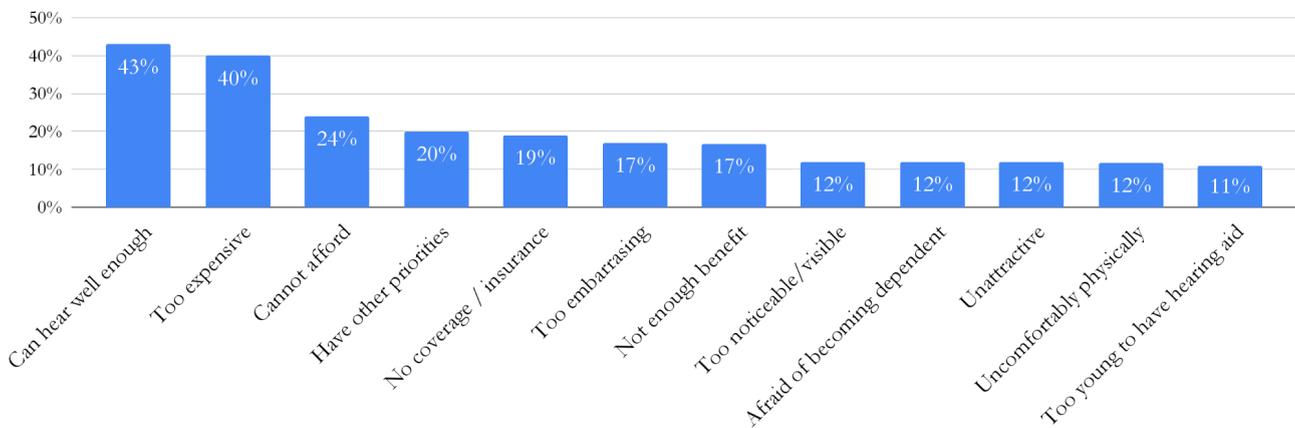


Figure 2. Reasons for non-owners of hearing aids to not progress on the consumer journey. Adapted from HIA (2019).

The experiences of candidates in the consumer journey are what primarily inhibit people from acquiring hearing aids (HIA, 2019). This includes arguments that the device is too expensive, that people cannot afford it, or that people lack coverage or insurance. Moreover, non-owners of hearing aids state that using hearing aids is too embarrassing, too noticeable or visible, unattractive or that they are too young to have hearing aids (HIA, 2019). People also state that they can hear well enough, have other priorities than their HA, and do not think there is enough benefit with hearing aids.

In the decision to purchase a hearing aid, consumers need to consider the product value. This includes the performance of the device and how much benefit that could be derived, as well as the monetary price of the device and its affordability. The stated reasons that the device is too expensive, that people can not afford it, or lack reimbursement implies that the price of the device hinders people from continuing in the consumer journey. However, considering that people rather discuss the perceived benefit of the device in comparison to the price (Strom, Cavitt & Kemp, 2020), the reasons that hearing aids are too expensive, that people have other priorities, or that there is not enough benefit with the device would rather relate to the product value and the product performance of the device. Moreover, as the functionality of the device is determined by the size, the product value also includes the reason that the device is too visible or that they are physically uncomfortable.

Moreover, people need to spend the necessary time and effort to get through the consumer journey. Not only is it difficult for people with hearing loss to understand and accept their problem, but it is also demanding to search for and find a solution to the problem. Based on a cohort of 3 132 hearing-impaired individuals, HIA (2019) presents in MarkeTrak 10 that out of people with perceived hearing difficulty, 78% meet with one or more **hearing care professionals (HCPs)**. Further, 60% end up speaking with an HCP, 52% get confirmation of their hearing loss, and 41% recommend an action from the HCP. Lastly, 34% of those who perceive themselves to be hearing-impaired choose to get hearing aids (HIA, 2019).

The responses that concern stigma are that the device is too visible, that it is too embarrassing, that people are afraid to become dependent, feel unattractive, or perceive themselves to be too young to have hearing aids (HIA, 2019). These factors are all indications that stigma is inhibiting people from continuing in the journey and acquiring hearing aids. The following chapter examines how the adoption barriers denial, product value, effort, and stigma inhibit people from acquiring hearing aids.

4.1. Denial

A contributing reason to people not progressing in the hearing aid journey is that they enter a state of denial of their hearing loss. The most frequently mentioned reason for not progressing in the journey in MarkeTrak 10, that people can hear well enough (HIA, 2019), is an indication that people are minimizing and denying the existence of their hearing loss (Rawool, 2018). This is also the main response from people with mild-moderate hearing loss, which inhibits them from progressing in the consumer journey (Rogin & Abrams, 2016). Denial can be both implicit as the person blames their lack of hearing on outside causes, or explicit by ignoring evidence of the hearing loss. Denial functions as a coping mechanism that allows the person to escape the anxiety, fear, and stress that is brought to them by the condition. Hence, it might be easier for a person to deny the existence of their issue than to accept their condition and the stigma it brings to them (Rawool, 2018).

There are different levels of denial. Some people deny the existence of their hearing loss and state that they do not have any issues with their hearing (Rawool, 2018). Some might deny the effects of their hearing loss or downplay their lack of hearing. Even if they have accepted their hearing loss, people can deny the need for hearing aids. The same lack of acceptance can take place in people who acquire hearing aids but choose not to use them (Rawool, 2018).

There are several reasons why people deny their hearing loss and there are often other underlying factors that drive the person into denial. Aspects such as people perceiving their hearing loss as not severe enough and minimizing the effect of their hearing loss (Rawool, 2018) primarily relate to the stigma of having hearing loss. Furthermore, people could be ambivalent about the actual effectiveness of hearing aids (Rawool, 2018). Relating to the product value, this translates into perceptions such as the price being too high or the performance being insufficient. Relating to the effort of the consumer journey, there is a lack of confidence among users to make the required changes to adapt to their hearing loss (Rawool, 2018), which makes people deny their needs. Moreover, there is a lack of trust in hearing health care providers, which relates to the perception that HCPs are biased towards selling hearing aids to the patients. Additionally, people go into denial as a measure to escape the perceived stigma of having hearing aids and the stereotypes that are associated with it.

4.2. Product Value

“If someone has a \$500 problem they should not have to pay for a \$5 000 solution”

Strom, Cavitt & Kemp (2020, 15:20)

The hearing aid provides value to the user by improving their hearing, but hearing performance is not the only factor that determines the product value. In value-based healthcare, the value is defined as the health outcomes of the patient in relation to the price (Xu et al., 2020). The value of the product is subjective to the individual needs and the desire to acquire the product, and reflects the price that the customer would be willing to pay (Neap & Celik, 1999). Product performance refers to how well the product improves and facilitates the hearing of the user. In other words, product attributes include aspects such as sound quality in quiet settings, performance in noise, feedback, and physical comfort (Bridges, Lataille, Buttorff, White & Niparko, 2012). The price represents the price of the hearing aid and often also includes the price of the additional services that are provided to a consumer by the HCP (Sjogblad & Abel, 2016).

The health outcomes, or utility, of hearing aids are dependent on the product performance (Cox, Johnson & Xu, 2014; HIA, 2019), the degree of hearing loss (Meister et al., 2015), the hearing needs, and the non-auditory needs (Valente et al., 2006). The potential consumer utility then becomes the difference between the consumer's desired hearing level, i.e. the hearing need, and the consumer's current hearing level, i.e. the hearing loss. The utility or aided improvement experienced by the consumer is in turn dependent on the product performance, non-auditory needs that influence the consumer, hearing loss, and hearing need. Both the product performance and the potential consumer utility affect the health outcomes of the consumer, since a better product performance increases the ability to make use of the potential hearing improvement.

To illustrate the potential health outcomes, a difference between the hearing need and the current hearing level indicates that the individual experiences a gap between what is wanted and what is currently possible in terms of their hearing. Performance that fulfills the hearing needs could arguably make the individual hear on a desired level. Sufficient product performance could also assist with meeting the non-auditory needs that influence the product, such as ease of use, appearance, and physical comfort. Hence, the hearing need, the non-auditory need, and the hearing loss play a part in understanding how much potential utility could be provided by a hearing device.

Potential Consumer Utility

A person's desired hearing improvement from a hearing device depends on three aspects, the hearing loss, the hearing need, and the non-auditory need. This is also represented by the three parts of an audiologist's hearing assessment (Valente et al., 2006). The hearing loss represents the difference between normal hearing and the current hearing level. The hearing need is based on the communication and social needs of the individual and the non-auditory need involves other personal needs, personality traits, and environmental factors that might influence the preferences of the individual (Valente et al., 2006).

Hearing loss

The greater hearing loss a person has, the greater benefit could be derived from a hearing aid. The hearing loss is measured by using objective auditory hearing assessments to understand the hearing threshold in different frequencies and the cause of the hearing loss (Valente et al., 2006). In case of a sensorineural hearing loss due to aging, loud noises, diseases, or injuries, hearing aids could assist people to regain some

hearing (John Hopkins, 2021). The level of hearing loss is relevant to take into account when considering the potential utility a consumer could experience from adopting hearing aids, since greater hearing loss is associated with greater benefit (Meister et al., 2015). Hence, a greater hearing loss results in patients being more willing or more likely to adopt hearing aids (Jenstad & Moon, 2011).

Hearing need

The perception of the hearing need is determined by the lifestyle and different listening environments of the individual (Valente et al., 2006). To illustrate this, a social salesperson who works in a difficult sound environment will have a larger need for more advanced hearing device features than a less social person who works in a library, even if they have the same level of hearing loss. Subjective hearing measurements can be used to understand the subjective perception of the individual's hearing aid benefit (Mendel, 2009). This includes understanding the perception of the communication needs of the individual based on statements from them and their partner or family member. These assessments aim to identify the social and emotional needs of the hearing aid user (Mendel, 2009). The HCP conducts this by asking questions about the hearing needs and the hearing environments that an individual spends time in to identify which hearing device would meet these needs (Olson, 2017). Moreover, the hearing need implies that a person does not need to suffer from a hearing loss to potentially benefit from a hearing device, since the hearing need could exceed what is possible with a normal hearing level.

A person's expectations play a role in determining the individual hearing need (Valente et al., 2006). New hearing aid users might have unrealistic expectations about the effect of getting hearing aids (Solheim, 2011). Hearing aids will not fully restore the hearing of the individual instantly (Mayo Clinic, 2020). Rather it is a process where the hearing level improves, but where there will still be situations when the hearing is limited. For some people, it might take time to get used to the amplified sound and the listening ability will gradually improve (Mayo Clinic, 2020).

Non-auditory need

The non-auditory need relates to the needs of the individual that are not related to their hearing and includes both the internal and external non-auditory aspects (Valente et al., 2006). Internal aspects include personal concerns such as personality characteristics, prior experience with hearing devices, and general health. External aspects include the environmental aspects such as occupational needs, lifestyle, and support systems that influence the individual's life (Valente et al., 2006). The non-auditory needs influence the experienced benefit from hearing aid features such as connectivity, ease of use, or device appearance. In conjunction with hearing needs, non-auditory needs influence the desired ability to communicate and engage in social settings (Valente et al., 2006).

Product Performance

“Actually, there is remarkably little published evidence to show that premium hearing aids give better real-world outcomes than basic hearing aids or personal sound amplification products”

Cox (2014, p5)

The product performance relates to the overall ability of a hearing aid to amplify sounds to compensate for the individual's hearing loss. The performance of a product indicates how well the hearing needs of the individual are met, and is a factor in predicting the utility for the consumers. Performance attributes of a hearing aid are, among others, product quality, ease of use, physical appearance, sound quality, and physical comfort (HIA, 2019). The audiologist recommends product aspects such as the type of hearing aid, the connectivity features, level of noise-cancelling, and directionality of microphones to meet the user

needs (Valente et al., 2006). The hearing performance is made possible by the functionality of the device, which in turn is dependent on limitations in the size and power usage of the device (Onsemi, 2014).

Hearing aid performance is necessary for the satisfaction and retention of hearing aid users, but it does not seem to be a major barrier to adoption. In MarkeTrak, hearing aid performance in terms of sound quality is stated as the primary driver for hearing aid satisfaction (HIA, 2019). Some of the aspects of sound that contribute to the satisfaction are the ability to tell direction, that there is a rich sound experience, and that it minimizes background noise. Furthermore, poor sound performance and comfortability are influencing factors that make people stop using hearing aids. A third of people that discontinued the use of hearing aids did so because of problems such as background noise, sound quality, or feedback noise (HIA, 2019). Further, about a sixth complained about the physical fit of the product, such as it being uncomfortable or falling out. Hence, product performance is important for the satisfaction and retention of users, rather than being a deciding factor for hearing aid adoption.

The same pattern of satisfaction and retention for hearing aids seems to be apparent for personal sound amplification products (PSAPs). Products in this category are not intended for people with hearing loss (FDA, 2020), but they are an attractive low-cost alternative to hearing aids since they amplify sounds of the environment (Cho et al., 2019). However, there is a very wide classification of products that currently is considered as a PSAP, where the price ranges from about \$10 to \$2 000 (HIA, 2019). This also influences the performance of the PSAP category where some devices are underperforming severely (Olsson, 2019), whilst others might be helpful (Olsson, 2020; Palus & Redd, 2020). Out of the price categories of PSAPs, 39% of consumers with PSAPs that cost below \$100 are dissatisfied with the performance, compared to 19% for devices that cost more than \$100 (HIA, 2019). Because of this wide difference in performance, there is a lower level of trust in the performance of PSAPs compared to hearing aids.

For the mild-moderate hearing loss segment, there is a negligible difference in the experienced performance between premium and basic devices. By examining the different aspects of basic and premium hearing aids, there is no significant difference between the two categories in terms of the user's perceived hearing performance (Cox, Johnson & Xu, 2016). In the study, the premium hearing aids were better in a controlled testing environment, but the increased price premium and sound processing power did not bring any changes in preference for people with mild-moderate hearing loss in real-world environments. Similarly, premium hearing aids offer more advanced noise reduction than basic hearing aids, but adults with mild-moderate hearing loss do not perceive the improved advantage that premium features provide (Wu et al, 2019). Ultimately, premium hearing aids cannot be assumed to produce better experienced benefits than basic hearing aids (Cox, Johnson & Xu, 2014). Rather, what is contributing more to the proficiency of the hearing aids is how well they are fitted to the individual's hearing needs (Johnson, Xu & Cox, 2016). Instead of spending money on more advanced hearing aids, consumers could save money by opting for a more basic level hearing aid, and ensuring that it is fitted properly (Taylor, 2018).

There are uncertainties in the field of the effect of PSAPs. However, studies point to the fact that the new hearing devices have reached similar performance to hearing aids (Laplante-Lévesque et al., 2017). Similarly, it seems that people with mild-moderate hearing loss could not differentiate between PSAPs, basic hearing aids, and premium hearing aids (Cho et al., 2019). About half of the test group even preferred PSAPs over hearing aids, because of the quicker fitting of the PSAP. However, premium hearing aids provided better results for higher degrees of hearing loss (Cho et al., 2019). Comparing self-fitted PSAPs and hearing aids fitted with best practice, hearing aids provide better speech recognition performance and lower listening efforts. However, PSAPs still provide a significant improvement in

speech recognition and reduced listening effort in comparison to not using a device (Brody, Wu & Stangle, 2018).

Price

“57.5% are unwilling to adopt hearing aids despite the fact that no cost is expected from the patient”

Valente & Amlani (2017, p647)

The price of hearing aids seems to be hindering people from acquiring a hearing device. From the interviews of non-owners of hearing aids in the MarkeTrak 10 survey, 40% of those who have taken no steps stated that hearing aids were too expensive, 24% that they could not afford them, and 19% that they did not have any reimbursement (HIA, 2019). Additionally, of non-owners that were recommended a hearing aid from an HCP, 42% stated that it would be too expensive, 26% that they could not afford it, and 21% mentioned a lack of reimbursement.

Hearing aids are in general expensive, and a majority of the price is attributed to HCPs. The average price is \$2 560 for a single hearing aid and \$4 672 for a pair of hearing aids (Bailey, 2021c). The lifespan of a hearing aid is only about 5 years and patients are expected to update the device after this. Moreover, the cost of batteries to supply a non-rechargeable hearing aid is \$100 per year (Humes et al, 2017), while the charging station for rechargeable devices comes at an additional cost of \$250-\$300 for the charging station (Clason, 2019). In total, approximately 70% of the markup of the price comes from the services provided by the retailers, such as salaries for HCPs, the cost of providing services, and the cost of the store (William Demant, 2016). About 25% comes from the manufacturer and includes the cost of R&D, marketing, manufacturing, and sales of the device. The final 5% is attributed to the suppliers of the hearing aid manufacturers (William Demant, 2016).

The reason for the high markup for retailers is that audiologists and dispensers need to cover the costs of their business while still making a profit. In terms of personnel, this includes the cost of staff in terms of salaries and benefits (AAA, 2012). There are also clinic expenses such as rent for the shop, advertising, equipment, and utilities. Moreover, they need to cover the cost of the goods sold and the estimated operational cost for each service (AAA, 2012). Further, audiologists have an eight year education which makes them accumulate a large amount of student debt, resulting in them having to sell many hearing aids to pay back the debt (Cardinal et al., 2021). Hence, clinics are also keen on setting an appropriate profit margin for their business.

A contributing reason to the high price of hearing aids is that audiologists charge a bundled price, which includes both the price of the device and the services provided by the audiologist (Cavitt, 2020). The types of prices that are bundled with the hearing aid include aspects such as a hearing assessment, dispensing fee, fitting fee, batteries, accessories, follow-up visits, and aural rehabilitation (Sjoblad & Abel, 2016). The bundled price for the consumers also includes follow-up service and warranty for the product (Asha, 2021b). If the product is bundled with the service, many patients will pay for services that they do not utilize or need (Cavitt, 2015).

It is possible for audiologists to provide unbundled services. In case the price is unbundled, the patient pays for the hearing aid, and is only charged additionally for the services the audiologists provide (Cavitt, 2015). This kind of model would make audiologists charge for the value they provide to the client, rather than to sell hearing aids to break even (Cavitt, 2015). This kind of business model is similar to the model that primary care units and dentists provide (Audiology Method, 2018). However, many clinics still bundle the product with the services, and a contributing factor is that unbundling the services will reduce the

revenue for the clinics in the short term (Cavitt, 2015). The reason is that the total income from each hearing aid will be spread out over a longer period of time, in comparison to a bundled service where the patient pays for the services in advance.

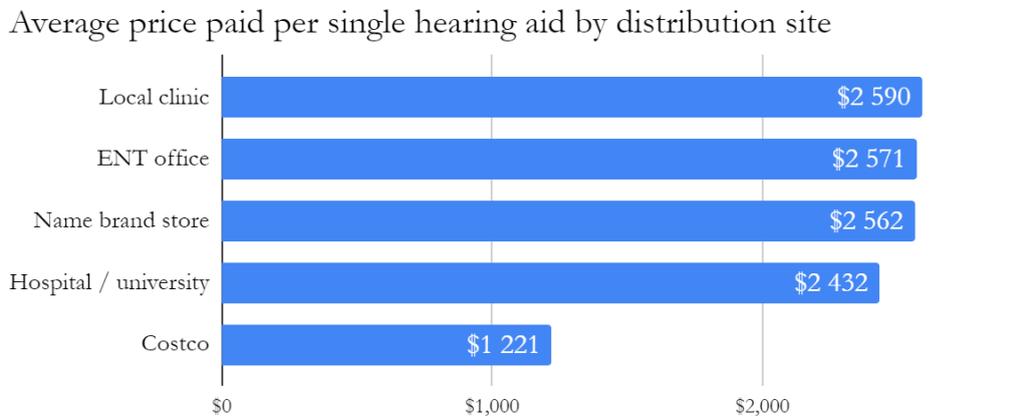


Figure 3. Average price paid per hearing aid by distribution site (Bailey, 2021c).

The price of hearing aids differs between channels, as the type of professional and level of service varies (figure 3). Comparing the average price per hearing aid, a local clinic, ENT office, or name brand store charges a similar price of \$2 590, \$2 571, and \$2 562 respectively (Bailey, 2021c). The average price from a hospital or university clinic is \$2 432. These channels provide the full service offerings for assessment, fitting, and consultation with a general practitioner, ear-nose-throat doctor, or an audiologist (Bailey, 2021c). The high cost of running audiologist practices has been challenged by large box office stores such as Costco. The average selling price at Costco is \$1 221, which is significantly lower than the other channels (Bailey, 2021c). Costco can keep down costs by utilising strength in purchasing power, an ability to share costs on overheads, and by purchasing previous generations or cheaper versions of hearing aids (Copithorne, 2021a). Moreover, by only employing hearing aid dispensers that have a lower level of education than audiologists, Costco can lower the cost of salaries

In both Norway and the UK, there is a low adoption rate of hearing aids for people with mild and moderate hearing loss, even though the price is a lot lower than in the US. Similar to MarkeTrak in the US (HIA, 2019), EuroTrak studies have been conducted in countries such as Norway (Egger C, Ruf S, & Zimmer S, 2019), where the government covers a majority or all of the cost of most hearing aids, apart from a few exceptions (EFHOH, 2018). Still, only 49% of the surveyed hearing-impaired individuals had acquired hearing aids (Egger C, Ruf S, & Zimmer S, 2019). Based on the hearing-impaired individuals in the survey, 81% had met an ENT or GP, 55% had discussed hearing loss with an audiologist or dispenser, and 47% had received a positive recommendation for a hearing aid after the discussion with the hearing professional. The data is similar for the UK where 48% of the surveyed hearing-impaired individuals use hearing aids (Egger C, Ruf S, & Zimmer S, 2018b), despite basic hearing aids being fully reimbursed by the public health organization NHS (EFHOH, 2018). In Norway, 29% of people with mild hearing loss and 54% with moderate hearing loss use hearing aids, compared to 64% for severe and profound (Egger C, Ruf S, & Zimmer S, 2019). Similarly, in the UK, 18% of people with mild hearing loss and 46% with moderate hearing loss use hearing aids, compared to 66% for people with severe and profound hearing loss (Egger C, Ruf S, & Zimmer S, 2018b).

Since adoption rates are low in countries that provide subsidised hearing aids, it seems that even if the price could be removed as a barrier, there are still other barriers that inhibit people with mild-moderate

hearing loss from acquiring hearing aids. In relation to this, Valente & Amlani (2017) conclude that if the price of hearing aids were lowered, it could increase the adoption in the US by about 10 percentage points. However, price is not a leading factor when choosing to get a hearing aid (Valente & Amlani, 2017).

4.3 Effort

*“We are asking them to take [...] an eight hour day, to go down the journey that we have set.
And really? Do we really have any evidence to show that it is the right journey?”*

Strom, Cavitt & Kemp (2020, 23:12)

Seeking treatment for hearing loss is a tedious process that demands both time and attention of the customer. Many seek treatment for their hearing loss, but do not complete the consumer journey or take action on the received hearing aid recommendations (Poost-Foroosh et al., 2011). In terms of adoption barriers, the time and effort that a person needs to spend might inhibit them from going through the consumer journey, and instead turn them into a state of denial. Additionally, the psychological burden and emotions from the traditional consumer journey affect the adoption and ability to adhere to hearing aids (Heffernan et al., 2015). Moreover, there is a lack of trust in the care provided by audiologists (Preminger, 2020) and clinicians (Rawool, 2008), which creates further friction in the care process. The effort of the consumer journey can be divided into physical and emotional effort (Knudsen, Nielsen, Kramer, Jones, Laplante-Lévesque, 2013).

Physical Effort

The traditional consumer journey is demanding for the patient as they will need to spend a lot of time and effort to get through the required stages to acquire a hearing device. Moreover, users are often faced with hinders across the consumer journey (Taylor & Manchaiah, 2019). The process of buying a device can be inconvenient, long, and disempowering for the consumers (Copithorne, 2021b), and the audiological pathway involves a significant level of friction for the user (Bellavia et al., 2020). This involves going through each stage of assessing the hearing loss, hearing aid fitting, programming the hearing device, adjusting the device, and maintenance of the device (Copithorne, 2021b).

For the client, each stage will include situations where the person needs to make a decision or action. This includes decisions such as choosing between different clinics and hearing aid functionalities (Taylor & Manchaiah, 2019), and actions such as booking meetings with professionals and getting in contact with the reimbursing organisation (Taylor & Mueller, 2020). The traditional consumer journey also requires several physical appointments with a professional (Copithorne, 2021b), which leads to inconvenient aspects such as time, travel-time, distance to the store, and ability to schedule a time (Barnett, 2016). As most people below 65 are working, it becomes even more inconvenient for them to put aside time to visit the clinic. Furthermore, consumers do not perceive the overall clinical pathway as a process towards a common goal, but rather as single isolated events that are separated from each other (Laplante-Lévesque, Hickson & Worrall, 2011). Therefore, each stage will require effort to initiate, as if it was a new event.

All the information that is being brought to the consumer by the audiologist might be overwhelming for the consumer (Poost-Foroosh et al., 2011). This includes information about the selection of different hearing aid styles, features, brands, and how it fits the client's needs. This also involves the information about the price of different devices, the trial period, and warranty (Poost-Foroosh et al., 2011). Many people end up getting lost in the information, particularly if it is only provided on a single occasion.

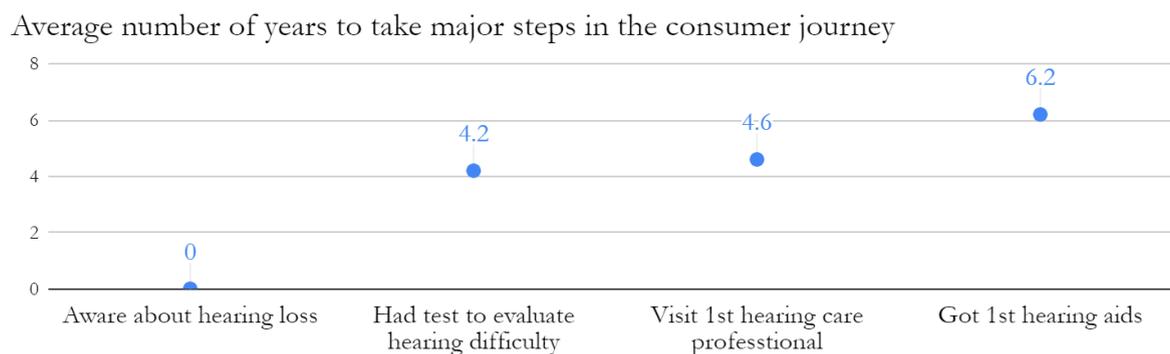


Figure 4. Time between becoming aware of getting 1st hearing aid (Adapted from HIA, 2019).

The process also requires the consumer to spend a lot of time to get through all the stages in the consumer journey. Respondents mentioned that the necessary time required to obtain a hearing aid is not weighed up by the perceived benefit of the product (HIA, 2019), indicating that time consumption in the consumer journey is an obstacle to overcome. The patient needs to physically visit the clinic (Strom, Cavitt & Kemp, 2020), search for information (Taylor & Mueller, 2020), evaluate the different options, and become emotionally ready to take the next step (Ekberg, Grennes & Hickson, 2015). It tends to take people 6.2 years between becoming aware of their hearing loss and purchasing hearing aids (HIA, 2019). The average time between becoming aware of the hearing loss and participating in an initial hearing test is 4.2 years. It then takes about 5 months until the first HCP visit and another 1.6 years until the person purchases hearing aids (HIA, 2019).

Emotional Effort

The realization of a hearing loss diagnosis could result in a strong emotional reaction for an individual. Adults who get diagnosed with hearing loss might have an identity crisis as their existing self-identity and personality is related to a hearing life (Kaland & Salvatore, 2002). Having to deal with the changes caused by the hearing loss can lead to anxiety and feelings of depression. Other feelings that people with hearing loss might encounter are frustration, embarrassment, and loneliness (Heffernan et al., 2015). In case a person is not in a stage of accepting their hearing loss while visiting the audiologist, they risk resisting the care and recommendation for hearing aids (Ekberg, Grennes & Hickson, 2015). Nevertheless, audiologists sometimes overlook the emotional concerns of patients, which reduces the likelihood that a patient will remain in the consumer journey (Heffernan et al., 2015). Moreover, professionals might not fully understand how patients reflect on their experiences in the consumer journey (Manchaiah, Sephens & Meredith, 2011).

Individuals need to be active in taking control of and self-managing their journey. Depending on an individual's locus of control (LOC) and self-efficacy, people will have different perceptions of their own level of control on outcomes in their life (Sternatsy & Dhar, 2021). People with an external LOC believe that they are not in control of their life outcomes and need motivation from the environment to take action about their condition. In contrast, people with an internal LOC would be self-motivated to change their situation and find a solution to their hearing loss. Consequently, people with an internal LOC are more likely to have hearing aids (Sternatsy & Dhar, 2021). Furthermore, the more involved a patient is in the care of their chronic condition and the better the care providers understand the patient's perspective, the better outcomes the individual will get (Grenness, Hickson, Laplante-Lévesque & Davidson, 2014).

“A physician informed one of our patients [...] that the only thing she needed to do was to stop worrying about buying a good stereo because of her inability to differentiate between a good and a bad stereo”

Rawool (2018, p16)

There is a risk that the clinical pathway hinders people from completing the consumer journey and acquiring a hearing device. Clinicians might contribute to dropouts in the consumer journey as they minimize the expressed hearing concerns or do not refer people to an HCP (Laplante-Lévesque et al., 2011). Moreover, clinicians may comment that a hearing loss is not serious enough, that people would not benefit from hearing aids, or that hearing aids would only worsen their condition (Rawool, 2018). Additionally, clinicians might have negative stereotypes that people would not prioritize their hearing, that they would not be able to afford, or get accustomed to hearing aids (Rawool, 2018). Overall, these comments from clinicians can make people go into denial and exit the consumer journey.

The clinical pathway might be unnecessary for people with mild-moderate hearing loss as they are less likely to have clinical conditions that require medical or surgical care. For people with mild-moderate hearing loss, there is a lower incidence rate of the more serious health conditions that clinicians screen for (AAA, 2018). These conditions are often associated with other symptoms such as pain, ear drainage, and tinnitus that motivate people to seek clinical care. As patients with mild-moderate hearing loss usually have a sensorineural hearing issue that originates from noise exposure or degenerative hearing, there is a lower need for clinical screening (AAA, 2018). Based on this argument, the national academies of science and medicine (NASEM) recommended the regulation of OTC devices (Strom, 2017), allowing people with mild-moderate hearing loss to purchase a hearing aid without the requirement of meeting with a clinician.

There is a low perceived level of trust with audiologists which might inhibit patients from accepting the advice they are given. Consumers need to select an audiologist and evaluate if they can trust the provided information (Taylor & Manchaiah, 2018). Moreover, patients need to make sure that audiologists can sufficiently take care of their needs. There are major differences in the service provision where some clinics might not provide a satisfactory level of service for the client (Hendricks, Dahlhaus-Booij & Plass, 2016). Of audiologists services, the greatest variability is in ensuring client participation, waiting times, and arranging appointments.

There is a perception in the US hearing industry that audiologists work to try to sell as many hearing aids as possible (Edwards et al., 2021). Moreover, consumers experience that they are only provided a service by audiologists so that they should purchase a hearing device (Laplante-Lévesque et al, 2011). Patients experience that they do not get an objective view on their hearing loss and that the focus is on onboarding them with a device, rather than caring for their hearing loss. A contributing factor to the lack of trust is that audiologists acquire a large amount of student debt during the eight year long education and need to sell many hearing aids to pay back their debt (Cardinal et al., 2021). Pressuring clients into purchasing a device that is too expensive or above their needs may cause them to not purchase a hearing aid (Poost-Foroosh et al., 2011).

Adding to this perception, audiologists choose a brand that they prefer for the user rather than providing an objective choice for the patient. Audiologists have a strong brand preference and on average 71.4% of the sold hearing aids come from the same manufacturer (Johnson, Mueller & Ricketts, 2009). Audiologists usually choose the technology they think is the best (Branda, Powers & Weber, 2019), and a majority of them prefer a brand from one of the large manufacturers (Johnson et al, 2009). The most important factors for an audiologist when choosing a product are the quality, reliability, and comfort of the product,

as well as the service and programming software from the manufacturer. Moreover, even though it is not rated as an important factor, some audiologists choose brands based on economic incentives or special contracts with manufacturers (Johnson et al, 2009). Furthermore, Russo, Confente, Gligor & Authy (2016) showed that some audiologists are loyal to brands simply out of habit or laziness, even if they were unsatisfied with the hearing aids, did not value the offering, or if there were low switching costs. The lack of consumer understanding about the hearing aid makes it difficult for them to influence the decision. This might result in patients ending up with a suboptimal solution since audiologists choose the hearing device based on subjective factors.

Audiologists prefer dealing with technical challenges rather than handling the individual's psychological difficulties. Patients primarily address concerns regarding their psychosocial environment, but these needs are not sufficiently addressed by the audiologist during appointments (Ekberg, Grenness & Hickson, 2014). Instead, audiologists are stated to control the discussion and 90% of the agenda of appointments (Grenness, Hickson, Laplante-Lévesque, Meyer & Davidson, 2015). If patients have a greater presence in the conversation, they feel more confident and capable to take action after their clinic visits, whereas a low conversational presence results in a low perception of their ability.

Further, there is a lack of emotional support from the audiologist, where a low amount of communication is spent on establishing an emotional relationship between the audiologist and the patient (Grenness et al., 2015). The lack of establishing an emotional relationship inhibits the feeling of trust between the audiologist and the patient, which is an important factor since it affects the devotion to adhering to the treatment (Muñoz et al., 2017). Moreover, about two-thirds of audiologists lack the confidence, or perceive that they do not have the skillset, to provide emotional support for hearing-impaired individuals (Bennett et al., 2020). Moreover, 56% of studied audiologists state that they do not have the competencies to provide emotional support and 30% stated that providing emotional support is not in the scope of the audiologist profession. Therefore, audiologists might not be best suited to provide emotional support to the patient.

4.4 Stigma

“My pictures of people who have [hearing aids] are either pictures of very old people ‘Aaye?’ or mentally retarded people, also that have hearing problems. It is not a pretty social image, the loss of hearing”

Partner to a person with hearing loss (Wallhagen, 2010, p69).

The stigmatization of hearing loss and hearing aids inhibit many people from seeking care. Concerning the barriers to adoption, stigma is one of the primary factors that hinder people from treating hearing loss (Bouton, 2016; HIA, 2019). Out of 3 000 individuals without hearing aids, 48% mentioned stigma as a reason to not purchase hearing aids (Kochkin, 2007). Stigma can be described as the relationship between the societal stereotypes of a characteristic and the people that share the characteristic (Lash & Helme, 2020). The American Psychological Association further defines stigma as “the negative social attitude attached to a characteristic of an individual that may be regarded as a mental, physical, or social deficiency”. Further, it is stated that “a stigma implies social disapproval and can lead unfairly to discrimination against and exclusion of the individual” (APA, 2020). Rather than accepting and treating a hearing loss, it is more common to deny, hide, ignore, or blame it on the environment (Southall, Gagné, & Jennings, 2010). These kinds of actions cause people to drop out of the consumer journey, rather than to search for assistance and deal with their problem. Therefore, it is of essence to understand how the stigmatization of hearing aids and hearing loss is a barrier to adoption.

Stigma as an adoption barrier gets highlighted even more when looking at how people describe their interpretation of hearing aids and the reasons for not acquiring a device. Among these reasons are the interpretations that hearing devices are unattractive and embarrassing to wear (HIA, 2019). Although the product might expose the hearing loss and trigger the underlying stigma of the person, HIA (2019) proposes that it is the underlying hearing loss that makes people feel old, rather than the hearing aid. Further, a common statement is that people see themselves as being too young to have hearing aids, highlighting the negative perception attributed to wearing and being in need of a hearing device.

Types of Stigma

Stigma arises from the values in the social sphere as structural stigma (see figure 5). This is then embodied by stigmatisers who communicate these values to individuals with the stigmatizing trait as public stigma (Corrigan & Fong, 2014). The stigmatized individual might also internalise the stigma onto themselves as self-stigma. Although they can be viewed separately, the three levels of stigma are interconnected and influence each other (Zhang, Wang, Toubiana & Greenwood, 2021).

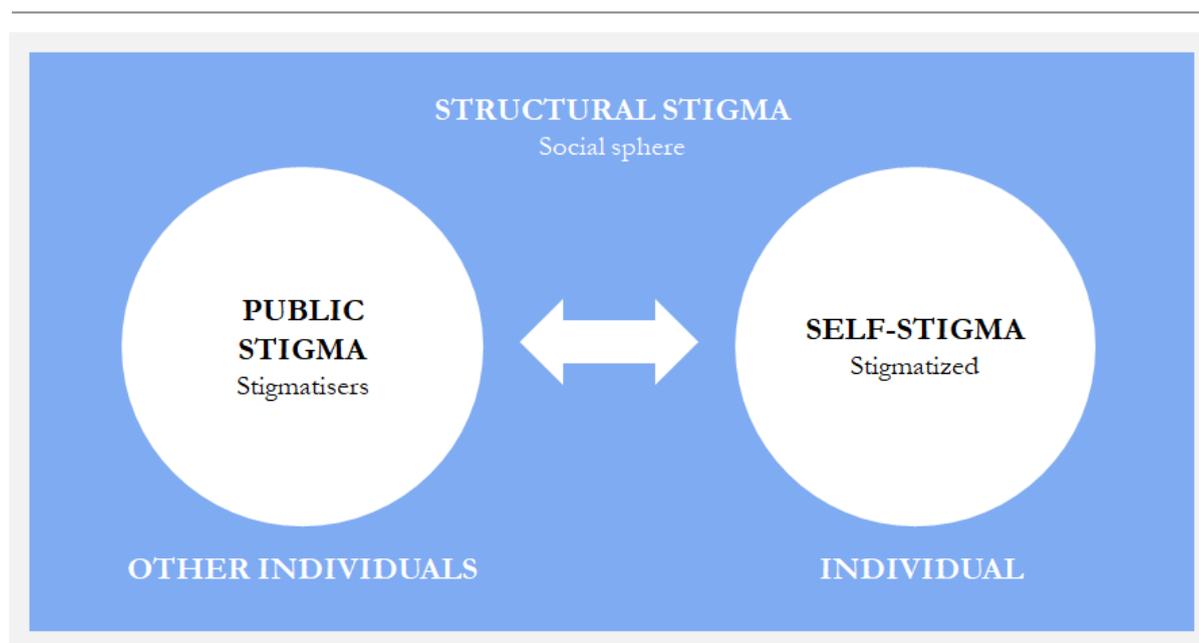


Figure 5: Overview of the relationship between the different types of stigma (Adapted from Corrigan & Fong, 2014).

Structural stigma takes place in the institutions in society (Corrigan & Fong, 2014). Institutions include both formal institutions, such as laws and policies, and informal institutions such as norms, morals, and cultures (North, 1991). For hearing loss, structural stigma is shaped by the cultural values that are imposed by society onto hearing loss and hearing aids (Hatzenbuehler, 2017). Structural stigma is not only present on an informal level, but hearing loss is also being treated differently on a legislative or policy level as hearing aids are usually not covered by insurance (Lash & Helme, 2020).

Moreover, the structural stigma influences the public stigma and self-stigma (Corrigan & Fong, 2014). The public stigma is expressed when someone embodies the structural stigma and displays a negative or discriminative view of a person with a stigmatising trait. The public stigma can either come from an outsider, i.e. a person without a hearing loss, or from an insider, i.e. a person with hearing loss, that reinforces the negative perception of the individual that is stigmatised (Corrigan & Fong, 2014). On an

internal level, people might display self-stigma, which refers to a negative perception of themselves because of their hearing loss (Gagné et al., 2011). They then assign attributes such as being old and unattractive to themselves which lowers their self-identity, self-esteem, and self-efficacy.

The Individual's Experiences of Stigma

Stigma makes people more cautious about seeking care for the hearing loss to not be associated with the negative views. Overall, stigma is a contributing barrier for people to engage in preventative health services, treatment, and support for those with health challenges (Thomson, Parrott & Nussbaum, 2011). Stigmatized individuals might experience shame and embarrassment (Lash & Helme, 2020). For instance, a majority of people without a hearing aid state to have some experience of feeling embarrassed because of their hearing loss and 30% experience it regularly or occasionally (HIAs, 2019). Moreover, someone with self-stigma might choose to not seek treatment against their stigmatized health condition to not be identified with the stigmatizing attribute (Gagné et al. 2011).

There are many stereotypes that people with hearing loss might encounter. People might experience ageism which is the stigma of being old or being perceived as old (Wallhagen, 2010). The attributed ageism might also make the public perceive that they cannot take care of themselves, that their health is deteriorating, or that hearing loss is a sign that they are ageing (Gagné, 2019). Humans have an inherent fear of mortality and ageism relates to how people try to distance themselves from ageing and being reminded about it (Wallhagen, 2010). Partners could contribute to this stigmatization by remarking on their age. Furthermore, people with hearing loss might be perceived as being unable to take care of themselves or having challenges with social situations (Gagné, Southall & Jennings, 2009a).

Moreover, people with hearing loss might feel less capable, disabled, or isolated because of their condition. People might feel that they have the ability to take control of their lives by having to accept that their hearing is declining (David & Warner, 2015). Some find that the feeling of pity is stigmatising because it views the person as burdened or functionally limited (Lash & Helme, 2020). Similarly, people do not want to be labeled as not being normal, and they do not want to be seen as different because of their stigmatising trait. They do not want to stand-out from the group and be different (Claesen & Pryce, 2012). Moreover, people might feel that they are becoming unattractive (Wallhagen, 2010), and that their appearance is negatively affected if they were to wear hearing aids (Rawool, 2018). From the perspective of the person with hearing loss, some perceive that others do not have the time to adapt to the individual with hearing loss (Lash & Helme, 2020). This is made evident as others might either avoid the person with hearing loss or make them have to repeat themselves. Another common way that people feel stigmatised is that they are perceived as being less physically and intellectually capable (Lash & Helme, 2020). People might then hide their hearing loss to not be perceived as being cognitively unable or being treated as being stupid.

Experiences of stigma make people feel less capable and excluded from common situations. When speaking with the individual, outsiders might be uncomfortable, anxious, or avoidant in the nonverbal communication, and patronizing in the verbal communication (Lash & Helme, 2020). Moreover, outsiders might avoid interacting with disabled people to not offend them. People might also have the stereotype that the person with hearing loss is deaf and unable to hear anything (Scharp & Barker, 2020).

Additionally, the fact that hearing loss is a non-visible condition strengthens the negative perception. For visible conditions, people are more diplomatic and try to be sensible about the stigma (Gagné, Southall & Jennings, 2009a). Instead, as people are not aware of the non-visible conditions, they might share their negative opinions about the attribute. People might then be perceived as rude or having a cognitive issue

when they ask others to repeat themselves or are not responding in conversations (Scharp & Barker, 2020). People do not feel like their condition is cared for and feel like they have to prove that they have a disabling condition (Lash & Helme, 2010). Since people tend to hide their hearing loss, it is also perceived as uncommon and has not become as socially accepted as more visible conditions (Lash & Helme, 2010). Moreover, a contributing reason for the structural stigma is that hearing loss is not spoken about and that people are unaware of the condition (Bouton 2016).

The experiences of stigma are reinforced by stigma from hearing care partners, professionals, and marketing material. Partners of hearing-impaired could both contribute to reinforcing the stigma or assisting with easing the issues of the person (Wallhagen, 2010). Moreover, GPs sometimes referred to it as being “just ageing” (Wallhagen & Pettengill, 2008). Hearing professionals assume that candidates want the smallest possible hearing aid, implying that hearing aids should be hidden and that they are stigmatised (Wallhagen, 2010). Similarly, marketing material promotes new hearing aids as being small devices that are tiny and can barely be seen. This perception affects individuals that are looking into purchasing options and contributes to the stigma (Wallhagen, 2010). In a study in the UK, some respondents mentioned that an enhanced visibility of hearing aids could help with reducing the stigma for the devices, as they felt that the current narrative reinforced the stigma (Rolfe & Gardner, 2016). People stated that even if the products are tiny and hidden they are noticeable. Instead, they would prefer to make products more attractive to reduce the medical and elderly look of the device (Rolfe & Gardner, 2016).

Self-stigma might threaten an individual’s confidence in themselves, which in turn discourages them from continuing in the consumer journey. Self-efficacy is mentioned as one of the key motivators to seek care for hearing loss, along with degree of hearing loss, level of family support, and the self-recognition of a need for hearing devices (Barnett et al, 2016). The degree of self-efficacy is related to the confidence a person has in their ability to receive care and is correlated with successful use of hearing aids. Moreover, the higher acceptance and self-recognition a patient has of their hearing loss, the more willing they are to progress with and use hearing aids (Barnett et al, 2016). Self-stigma causes people to become ashamed of themselves which diminishes self-esteem and self-efficacy of the individual (Gagné, Southall & Jennings, 2011). Hence, self-stigma becomes a strong contributor as a barrier to access care, since it prevents acceptance of hearing loss and lowers the self-esteem and self-efficacy of the patient.

It might be overwhelming for the individual to handle the threat to their self-identity. Accepting the hearing loss might result in a cognitive dissonance for the individual as they apply their own stereotypic views onto themselves, and realise that the pre-existing views of themselves as being healthy are false (Gagné, Southall & Jennings, 2009b). People then feel mental discomfort as the new realisations about themselves conflict with their existing perception of their self-identity. Alterations in self-perception could lead to feelings of no longer belonging in the contexts that they normally do, and requires the person to accept that their body has an altered functionality (Wallhagen, 2010). Many people do not want to change their understanding of their own identity. Instead this often triggers a coping mechanism for the individual, where they hide their hearing loss to not challenge their identity (David & Werner, 2016).

Coping Mechanisms

People tend to use coping strategies to handle the stress from the threat to their self-identity. Engaged coping mechanisms are ways to accept their hearing loss and use treatment options (Heffernan et al., 2016). In contrast, disengaged coping mechanisms are actions to avoid, deny, or ignore to deal with the hearing loss. As a measure to handle the effects of stigma, people might choose to use both physical and emotional coping mechanisms to handle the stimulus. People might withdraw from situations that make it difficult for them to hear. They then exclude themselves from social gatherings or their job because it is

becoming difficult with the hearing loss. Furthermore, people might choose to withdraw within situations by being present, but passive in social interactions. This can be particularly true for gathering in a larger group as it might become too difficult to engage in the conversation (Heffernan et al., 2016).

Individuals with hearing loss might use coping mechanisms to avoid being confronted by their hearing loss in conversations. People might cope with the stigma by trying to pretend that they are hearing or avoid speaking explicitly to not show their hearing loss (David & Werner, 2015). People can also try to dominate or set the direction of a conversation to limit the need for listening (Hass-Slavin, McColl & Pickett, 2005). Moreover, people might blame their situation on discrimination rather than that there is a problem with themselves (Gagné, Southall & Jennings, 2009a). Another reaction might be to deny aspects of their hearing loss to cope with the stigma (Rawool, 2018). Coming to terms with their hearing loss seems to be a large obstacle for many people.

Another coping strategy is to compartmentalize the hearing loss and only focus on the inability of hearing and not the disability. Concerning this, one person stated: *“I have said ‘I can’t hear you.’ And, which, for some reason, is more comfortable for me to say and it seems to relate to the moment, rather than to a general life condition”* (Wallhagen, 2010, p 69). This could make it easier for people to handle their hearing loss, as it might not inflict on their self-identity. Nevertheless, coping strategies might hinder people from recognizing the symptoms of their condition and seeking care (Rolfe & Gardner, 2016), as they limit their interactions in environments that make them understand their hearing loss.

Wallhagen (2010) proposes that there is a need to change the societal view of hearing loss, by increasing the acceptance and changing the perception of hearing loss on a holistic level. However, this demands changes in the cultural norms and stereotypes of society. Instead, many companies focus on making products smaller and nearly invisible (Wallhagen, 2010). This makes it easier for the individual to hide that they have a hearing loss and limit triggers, but does not deal properly with their self-stigma and the views that they impose onto themselves. Instead, coping mechanisms such as compartmentalizing the hearing loss might be more effective in minimizing the harmful threat that self-stigma poses to the self-identity.

5

Advancements of Technology Ecosystem

As technology progresses, it influences the product performance and the service delivery model for hearing devices. Historically, innovations in the hearing aid industry have mainly improved the performance of hearing aids, but in recent years this has expanded into services and business models (Edwards, 2020). Technological advancements are still improving the performance and capabilities of hearing aids, but through a change in the service delivery they are also raising the potential to improve the users' lifestyles (Wolfgang, 2019a).

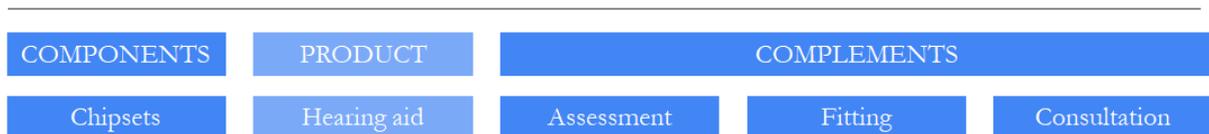


Figure 6. Overview of technology ecosystem for hearing aids.

Hearing aids exist in an ecosystem of technologies and services that are needed to help the patient with hearing loss. The hearing aid product consists of the device that the person has in their ear, but there are also components that are needed to make the hearing aid, such as the battery system and chipset technology. Further, the complementary services from audiologists and dispensers assist the user with assessing their hearing loss and needs, the selection of hearing device, and technical fitting, which ensures that the person is equipped with the right hearing aid and that it addresses their hearing need. Moreover, HCPs assist with consulting the user about how to use hearing aids and how to live with hearing loss. In each of these areas, there are technological advancements that are changing the current product or service offering. Hence, the purpose of this section is to describe the technological advancements in the areas of products, components, and complements, as well as the changes they bring to the current offering. This section aims at answering the research question: “How could technological advancements affect the technology ecosystem for hearing aids?”.

5.1. Complements

Several services in the traditional consumer journey of hearing aids are provided by HCPs. On a broad level, the main services provided by HCPs in the traditional consumer journey are assessment, fitting, and consultation (Valente, 2006). Technological advancements might change the complementary services for hearing aids primarily by understanding how assessment, fitting, and consultation could be substituted or eliminated by technological advancements.

Assessment

In the traditional consumer journey, audiologists conduct extensive assessments in the clinic to diagnose and assess the hearing loss, identify the hearing needs, and understand the non-auditory needs. Technological advancements can change the way these services are being delivered by making it possible to conduct remote care and in some cases substitute the services provided by the audiologist.

Teleaudiology is the delivery of audiological services through telecommunication technologies (Ballachanda, 2017). It is used to facilitate hearing healthcare remotely and ranges from more simple interactions, such as a phone call to ask for advice, to advanced interactions, such as remote fitting and counselling. Innovation in teleaudiology has facilitated remote hearing health interactions between HCPs and their clients, making hearing services more accessible (Edwards, 2020). The usage of teleaudiology is becoming more common in the hearing health care landscape (Convery, Heeris, Ferguson & Edwards, 2020), and following the need for social distancing during covid-19, it is now a common hearing care delivery method (Swanepoel et al., 2021).

HCP assessments could be conducted remotely with the patient through teleaudiology. One method of teleaudiology is live interaction between patients and professionals, which involves communicational technologies such as video and audio tools (Wolfgang, 2019b). The essential equipment of a physical clinical visit can be used to provide remote teleaudiology services as well, with some additional equipment to set up and enable the remote patient interactions. Remote care can provide easier access to hearing care services for those who live far from a clinic, have mobility difficulties, or a busy schedule (Swanepoel et al., 2021). Nearly all of the services that are traditionally provided in a physical meeting with an audiologist can be provided via teleaudiology (Wolfgang, 2019b), indicating that hearing and non-auditory needs assessment could be conducted remotely. For instance, Eargo offers remote professional assistance to work closely with the patient to understand the individual hearing situation (Eargo, 2021).

Technological advancements in teleaudiology make it possible for patients to conduct the initial hearing assessment online without an HCP. The use of teleaudiology in hearing health care allows for online hearing screenings, such as online hearing assessments that can be conducted by using an adaptive triple digit-in-noise test that identifies the potential hearing loss depending on the recorded signal-to-noise ratio (Ratanjee-Vanmali, Swanepoel & Laplante-Lévesque, 2019; 2020). Additionally, mobile apps offer at-home hearing tests, which allows the patient to detect their hearing loss on their own (Wolfgang, 2019b). For the mild-moderate hearing loss segment, a measurement of the hearing threshold conducted by an app is likely to be sufficient for making a diagnosis (Edwards, 2020). Moreover, using an online screening app increases the self-efficacy of clients compared to physical screenings (Amlani, 2015), which in turn increases the likelihood that people will continue to seek care.

Technological advancements might not only substitute the assessment of the hearing loss, but there are several ways to understand the hearing needs and non-auditory needs without human contact. By introducing questionnaires in the hearing assessment applications it can be possible for online screening to adjust to the specific hearing needs of the user (Ratanjee-Vanmali et al., 2020). Moreover, some applications ask the user to answer survey questions while in different environments to better quantify and adjust the device to the specific listening environment (Swanepoel et al., 2021). Collecting information via surveys makes it possible to adjust the hearing aid to the hearing needs and situational non-auditory needs for the patients.

Changes in regulations and technology have improved the access to online screenings. Although online hearing assessments have been around for over a decade, the validity has often violated FDA and state regulations (Hodsden, 2016). However, since a few years back, people can assess their hearing on their own with a hearing assessment approved by the FDA. For instance, the hearing test by iHear Medical is conducted from home without the involvement of a hearing professional, and works by connecting a personal computer to factory-calibrated earphones (Hodsden, 2016; Keidser & Convery, 2016). The patient downloads the required software and goes through all stages of the hearing exam to receive results of the hearing assessment, which complies with WHO recommendations to a degree of 96.4%.

Additional examples are the HearX group's hearing screen apps hearZA and hearWHO, where the purpose of the apps is to increase access to hearing care to people in lower and middle income countries (Kemp & Swanepoel, 2021). The app calibrates the person's headphones to the sound environment and allows the person to conduct a pure tone audiometry. Moreover, people will answer questions in a form to assess their hearing needs and their readiness to make a change (Kemp & Swanepoel, 2021). After the initial screening, people could then be contacted by audiologists through their smartphone. Hence, the audiologist services of hearing assessment and needs assessment could be substituted by teleaudiology in the form of online hearing screenings, home-tests, and remote live interactions.

Technological advancements might even reduce the need for a traditional hearing assessment. Self-fitting hearing technology could make it possible for people to get a hearing device without having conducted a thorough hearing assessment or having an audiogram of their hearing loss (Edwards, 2020; Strom, 2021a). It could be sufficient to have conducted a hearing screening to verify that they have a mild-moderate hearing loss. Further, self-fitting hearing aids can adapt and customize to the individual hearing needs of specific environments (Zhang et al., 2016). Self-fitting hearing aids customize the settings according to the specific environment by using AI, through GPS location and data logging (Wolfgang, 2019). Since the technology learns and adapts to the individual needs through usage, the necessity of a pre-made needs assessment might become redundant. An example of an elimination of the traditional hearing assessment is the hearing device provided by Bose that uses self-fitting (FDA, 2018). The self-fitting software does not require a hearing assessment or the assistance of a hearing professional, indicating that the technology might be fully capable of eliminating the need for a hearing assessment by a hearing professional. Hence, the technology of self-fitting hearing aids might eliminate the need for a traditional hearing assessment.

Fitting

Fitting and verification of the selected hearing aids are arguably one of the most important services provided by audiologists, since a patient could experience similar benefits from a basic and a premium hearing aid as long as the product is fitted properly. Traditionally, fitting of the hearing aid has been conducted in the audiological clinic, but can through technological advancements be conducted remotely. Moreover, by using machine learning systems it has become possible to create self-fitted hearing aids that do not need the intervention of an audiologist.

Artificial intelligence has made it possible to conduct remote hearing aid fittings. Technological advancements in teleaudiology have allowed advanced care such as hearing aid programming and ear-drum inspection to be provided remotely (Wolfgang, 2019b). With the addition of AI to teleaudiology, both fitting and follow-up fitting will be possible to conduct remotely (Wolfgang, 2019a). The remote fitting process via AI requires the audiologist to use simple fitting software, whereas the patient only needs a compatible cell phone to interact with the audiologist. It could then be possible for the user to get in contact with the audiologist when they are in a difficult sound environment, and the audiologist could remotely help the individual to adjust the settings to work in that specific environment (Wolfgang, 2019a). Hence, remote care via teleaudiology could substitute the need for physical audiologist meetings with remote live interactions between patients and hearing professionals.

Self-fitting hearing aids allow the user to optimize the hearing performance without the involvement of an HCP, to both the individual hearing loss and the individual hearing need. The fitting process of self-fitting hearing aids includes threshold measurements to understand the degree of hearing loss, prescribed gain settings to match the hearing loss, and personalized gain settings to customize and fine-tune the device to the individual (Keidser & Convery, 2016). Initially, self-fitting hearing aids were pre-programmed and allowed the user to make adjustments and manage the entire fitting process without professional

assistance. However, the pre-programming of the device required an audiogram obtained through a hearing professional to meet the regulations of the FDA. Technological advancements in supporting services, such as self-administered hearing tests and mobile applications, have led to fully self-fitting devices, meaning that they are capable of providing the entire fitting and fine-tuning process without the need for professional involvement (Keidser & Convery, 2016).

Furthermore, self-fitting hearing aids could remove the need for fitting conducted by HCPs. Originally, self-fitting hearing aids consisted of technologies such as fitting algorithms, training algorithms, and on-board tone-generators (Keidser & Convery, 2016), but the introduction of AI allows for improved continuous fitting via, for instance, data logging and environment customization (Wolfgang, 2019a). AI makes it possible for hearing devices to log user needs and preferences in different listening environments by monitoring the changes made by the user and detecting familiar environments via GPS location (Wolfgang, 2019a). Through data logging, the hearing device will analyze and recognize different listening environments and adjust the settings according to the previous preferences of the user. An example of this is AI-based Signia Assistant which can tailor the settings of the hearing device to the user's specific needs (Høydal, Fischer, Wolf, Branda & Aubreville, 2020). The AI of Signia Assistant uses the user's everyday listening environments as an extension of the traditional fitting procedure, moving from settings based on assumptions to settings based on data. More specifically, individualising the fitting to meet the individual's needs instead of fitting based on the in-clinic tests (Høydal et al., 2020). Since fitting will be possible to be provided directly by the product, without any involvement from a hearing professional, the service of fitting could become substituted by self-fitting hearing aids through AI.

Consultation

Consultation is a service that requires human interaction. It includes the orientation, counselling, and follow-up services that the audiologists provide to assist the user with their questions, emotional needs, and issues that arise with their hearing aid. An orientation provides onboarding of the patient by providing information about the device and helping the patient with adapting to living with hearing aids. Moreover, it includes effective communication during orientation visits and follow-up care to make the patient competent about both the device and their own hearing needs. Additionally, the services of counselling and follow-up help the patient to increase awareness and understand the effects of the hearing device. Based on the examined literature, technological advancements are not on their own capable of providing the service of emotional and human interaction that the patient needs to optimize the benefits of their hearing device. Hence, it seems that the necessary human interaction of HCP services during hearing aid orientation, counselling, and follow-up can not be directly substituted by technological advancements. However, technological advancements within teleaudiology allow audiologists to remotely provide follow-up services such as counselling and support (Edwards, 2020). Hence, the need for physical meetings could be substituted by remote orientation, counselling, and follow up.

Although the services of consultation might not be directly substituted by technology, it might become less important for the consumer. Since the self-fitting software based on AI can adjust the settings according to the preferences learned through usage, the technology might be capable of conducting the fitting process without the need of knowing the goals and needs of the patient. In the case of technological advancements allowing hearing aids to optimize performance according to user needs regardless of the competence of the user, the need for effective communication might become less important. Moreover, part of the follow-up service is to reassess the device settings and readjust the product if there is room for individual improvements. Self-fitting hearing aids that use continuous fitting might remove some of this need for follow-up, since they are capable of self-adjusting to specific

environments and learn which settings are optimal for the user. Hence, technological advancements might have the potential to reduce rather than substitute the services of consultation.

Direct-to-Consumer Hearing Devices

Direct-to-consumer (DTC) hearing devices include technology and software that allows the user to program and adjust their hearing aids completely on their own. The deregulation for over-the-counter devices in the US will open up for the sales of DTC hearing devices, but there are a few hearing aids that are already being sold direct-to-consumer. One example is the Bose Hearing Aid which is self-fitting, intended to compensate for mild-moderate hearing-impairment, and sold without the involvement of a hearing care professional (FDA, 2018). Further, Lexie is a hearing aid manufacturer that sells its products direct-to-consumer, where the journey involves online order, downloading the Lexie App, hearing assessment, settings optimization, and self-maintenance (Lexie, 2021). Although the customization of the hearing aids to the individual hearing profile is done without the involvement of a hearing professional, the service of remote interaction with a “hearing expert” is offered to optimize settings and listening experience. Lastly, Eargo is a hearing aid manufacturer with a DTC sales model (Eargo, 2021). The products are intended to compensate for mild-moderate hearing loss and the consumer journey includes taking a free online hearing test, online order, and a fitting process in close connection to a remote hearing professional.

In addition to the companies that are currently selling hearing aids direct-to-consumer, several DTC offerings are being developed. An example of a company that is developing a DTC strategy is hear.com. The goals of developing the DTC channel are to expand the sales supported by telehealth and eliminate physical appointments with hearing professionals (Bailey, 2021d). This service delivery model would serve consumers with mild hearing loss more directly and efficiently, by reducing the number of physical meetings, and lead to an alteration in the role of HCP for certain hearing aid sales channels (Bailey, 2021d). The teleaudiology solution called “Clinic-in-a-Box” by hear.com includes all the necessary equipment that allows the patient to conduct the HCP services, such as hearing test and fitting, on their own. All of the existing solutions and services will be offered to the consumer after the introduction of the DTC sales channel, apart from physical appointments with HCP which would no longer be essential (Bailey, 2021d).

5.2. Product

Artificial intelligence through machine learning and deep learning could improve the performance aspects of hearing aids are the most challenging. Although previous technical advancements have improved the patient satisfaction of hearing aids, the products are still facing several technical challenges, with improved speech recognition in noise and improved customization to the individual user being two of the main ones (Zhang, Mustiere & Micheyl, 2016). A major contributor to user frustration is that hearing aids have difficulties separating voices in noise (Wang, 2017), and it has been the most frequent target of complaints from patients (Wolfgang, 2019a). Technological advancements in the field of artificial intelligence have shown promising results to improve speech recognition in noisy environments and continuous customization to the individual’s hearing loss (Wang, 2017; Zhang, Mustiere & Micheyl, 2016). Technological advancements allow for superior sound quality (Wolfgang, 2019a), and the impact that machine learning can have on hearing aids is significant, leading to great potential for improved patient satisfaction (Zhang, Mustiere & Micheyl, 2016).

Customization to the individual user is an issue that could be solved by the introduction of artificial intelligence in the hearing aid industry. A hearing aid with AI is not only able to log the preferred user settings of different listening environments, but it is also capable of automatically adjusting the settings to the recorded user preference (Wolfgang, 2019a). Algorithms based on machine learning are being trained continuously during usage so that the performance can be optimized without patient involvement (Zhang, Mustiere & Micheyl, 2016). Technological algorithms allow for continuous improvement of hearing devices since they adapt to the hearing habits of the user over time, which could maximize the benefit for the user (Swanepoel et al., 2021).

Machine learning and deep learning have demonstrated their capabilities of potentially removing the issue of speech comprehension in noisy environments for hearing aids. With the introduction of AI, there will be an improved ability of hearing aids to recognize speech in noisy environments (Wolfgang, 2019a), which has already been demonstrated by using machine learning (Zhang, Mustiere & Micheyl, 2016). For instance, hearing aids using technological advancements of AI can recognize the voices that are most frequently occurring in the life of the user, to prioritize them in noisy environments (Hearsoundly, 2021). By remembering and enhancing individual voices, the user will be able to better hear the people they spend the most time with and engage socially.

Deep learning has come close to solving the widespread issue of speech separation in noisy environments, although the capabilities of deep learning have so far only been demonstrated in controlled hearing environments. Speech separation in noise using deep learning works by an initial breakdown of all the sounds that the hearing aid is being exposed to, including both speech and noise (Wang, 2017). All the sounds are then analyzed according to a large number of attributes connected to common speech, such as frequency and intensity of the sounds. After the separation and analysis of the individual sounds, the deep learning algorithm identifies speech and distinguishes it from noise to enhance the desired sounds and remove the rest. When testing the deep learning method, the hearing-impaired understood on average 82% of words in noise compared to 36% without hearing assistance (Wang, 2017). Even normal hearing people experienced a significant improvement, where 80% of words were understood on average compared to 37% without assistance. Although artificial intelligence in hearing aids is not yet widespread among manufacturers, a company that has already implemented artificial intelligence in its hearing aid is Whisper (Whisper, 2021). The hearing aid from Whisper is equipped with an artificial intelligence solution that processes the sounds from real life listening environments to optimize the individual sound performance.

5.3. Components

Technological advancements in the hearing aid rely on an increased computerization capability. To run the advanced algorithms of the new functions, there is an increased need to supply more power to the hearing aid and to have chipsets that use less power per chipsize (Gerlach, Payá-Vayá & Blume, 2021). The emerging company Whisper has solved the issue of power by providing an external power source that runs the advanced algorithms of the machine learning system (Strom, 2020a). An alternative would be to make larger devices that could house larger batteries (Onsemi, 2014). These are both possible solutions, but the external power source is cumbersome for the user to bring with them, and a larger hearing aid increases the public stigma and reduces the usability for the user.

In the past, new technological stages of hearing aids have been made available by new circuit and power capabilities (Strom, 2021b). Similarly, the development of hearing aids will depend on improvements in the chipset components of the hearing aid. The development of chipsets has lowered the required battery

power and increased the number of features per size unit (Widex, 2015). The chip itself has become smaller, but it has also reduced the need for larger batteries, which in turn reduces the size of the hearing aid.

A large part of the competitive advantage of hearing aids comes from the ability of hearing aid manufacturers to create small and low-power devices with a high degree of functionality. However, the main driver of the development of chipsets is the expansive growth of hearables in the consumer electronics industry. The covid-19 pandemic has increased the demand for hearables as people have had video conferences and started to care about how their headphones with chords would appear in the video calls (Hunn, Thomas & Kemp, 2020). The market has grown by 60% in one year, from 139 million units in 2019 to 233 million units in 2020 (Forrest & Pearce, 2020). Moreover, the reason why Apple was able to develop and launch the AirPods was that Apple had created a custom built chipset that powered the product (Hunn, Thomas & Kemp, 2020). Furthermore, the large volume of hearables creates the opportunity for better economies of scale for chipset manufacturers compared to the around four million hearing aid devices sold annually (Strom, 2020b). This makes it possible for chipset manufacturers to distribute the R&D costs over a larger volume of devices than hearing aid manufacturers, which makes it possible to create cheaper devices (Einhorn & Kemp, 2020).

The growth of hearables will continue to drive the performance of the underlying chip technology and enable improvements in the technology system. A current issue with hearables is the battery life, where hearing aids are currently better at providing sufficient power for a full 16 hour day with specific use chipsets (Davis, Kemp & Bellavia, 2021). However, there seems to be a change where the hearable industry is driving towards a better battery performance for general application chipsets. There are already cheap DTC hearing devices for mild-moderate hearing loss, that are built with the general application chipsets and have a battery life of 12-15 hours (Davis, Kemp & Bellavia, 2021).

As technology progresses, there is a development that more features will become standardized and integrated in the underlying chipsets and in that way become more accessible. A majority of the hearables run on either Qualcomm or Broadcom chipsets, excluding Apple that develops their own chipsets (Hunn, Thomas & Kemp, 2020). An example of standardisation is that Qualcomm made an integration of active noise-cancelling functionality on the chip level, which made noise cancellation cheaper and more accessible to hearable companies (Einhorn & Kemp, 2020).

Likewise, the development of chipset technology could make it possible for NHMs and consumer electronics manufacturers to provide hearing enhancement features. Qualcomm found that 40% of studied participants wanted hearing assistance, and partnered with Jacoti to offer hearing enhancement features in their chipsets for normal hearing and mild-moderate hearing loss (Qualcomm, 2020). The functionality of the hearing enhancement features will be integrated in the chipset technology, making them accessible to customers to Qualcomm. The chipset will work by allowing users to perform a hearing assessment on the Jacoti app to create a personalized sound profile. The profile can then be loaded onto the earbud which runs on Qualcomm's QC5100 chipsets, allowing for the adjusting of the frequency bands to the individual's hearing (Qualcomm, 2020). The inclusion of Jacoti will make hearing enhancement more accessible, which in turn will make it possible for companies to add features that build on this chipset to enable better functionality for people with mild-moderate hearing loss (Einhorn & Kemp, 2020). Relating to this, in a later report from futuresource, about 61% of consumers found hearing enhancement appealing for hearables (Pearce, Bellavia & Kemp, 2021). The hearing enhancing features would become an entry point where people could trial sound enhancing features and make them more aware about their hearing loss.

Similar to noise-cancelling and hearing enhancement features, there will be a continued integration of more features in the chipsets, where hearables will provide synergies for hearing aid development. Headphone users choose hearable devices primarily based on sound quality, price, comfort in ear, battery life, and ease of use (Qualcomm, 2020). Moreover, Chinese consumers expect a battery life of 18 hours per day and globally comfortability is a primary purchase barrier. Indicating that these aspects are where hearable device companies will try to improve the performance to become more competitive. This will in turn make it possible for hearing device manufacturers to utilise the chipset for hearables to create better hearing devices. Nuheara has for example been able to build their devices around the generic chipsets and have been able to integrate more advanced hearing functionality because of the developments in the hearables space (Davis, Kemp & Bellavia, 2021).

6

Analysis of Barriers to Adoption

In this section, we analyse how the changes in performance and service delivery, caused by technological advancements, can positively facilitate adoption of hearing aids for the mild-moderate hearing loss segment. We describe how the advancements in complementary technologies allow for direct-to-consumer (DTC) devices where the involvement of hearing care professionals (HCPs) is greatly reduced. The analysis includes the positive effects of increased patient involvement, reduced inconvenience, and reduced self-stigma, as well as potential risks with the self-managed service delivery model. In this section, we also describe how the technological advancements regarding products and components lead to an increased product value for the mild-moderate hearing loss segment. By cross-referencing the barriers to adoption with the technological advancements, this section aims at answering the research question: “How could technological advancements affect adoption of hearing aids for people with mild-moderate hearing loss?”.

6.1. Reduced Barriers in the Consumer Journey

The traditional consumer journey is a long and tedious process that includes several barriers to adoption for the consumer, such as required effort, time consumption, emotional concerns, and lack of trust with professionals. Physical meetings with hearing professionals contribute to the adoption barriers connected to the consumer journey, but complementary technologies such as online self-assessment, remote care, and self-fitting could substitute audiologist services to reduce friction in the consumer journey. Self-assessment could substitute the need to conduct an initial hearing assessment in the audiology office, and remote care can allow for more cost-efficient consultation to consider the emotional needs of the consumer. Further, self-fitting would substitute the need to visit the clinic and meet with an HCP to conduct the fitting of the device. Hence, the establishment of self-fitting DTC devices with remotely provided services can positively affect adoption by allowing people to purchase a hearing device via a consumer journey that is simpler, faster, and less costly. To illustrate the benefits of a DTC journey to reduce the barriers to adoption, 92% of patients reported in a survey that an online screening test was of positive assistance in terms of seeking treatment for their hearing loss (Ratanjee-Vanmali, Swanepoel & Laplante-Lévesque, 2020). The same authors reported that patients who conduct a remote fitting process experienced a high level of patient satisfaction.

Increased Patient Involvement

A DTC journey with self-fitting hearing aids requires the user to become more involved in the care process, which positively affects the likelihood of adoption. The technological advancements allow patients to become more independent than in the traditional consumer journey. Advancements in service delivery models, caused by improvements of hearing health care technologies, has moved technical control from the hearing professional to the consumer (Convery et al., 2020). This could be beneficial for the consumer since increased patient involvement in the care process improves the outcome for the individual. To further motivate the potential increase in consumer value from a more self-managed consumer journey, customers experience greater value from products that are self-made if the required labor results in a successful task, based on the IKEA effect (Norton, Mochon & Ariely, 2012). Thus, a

consumer journey with more user involvement and required self-management of the process has the potential of increasing the experienced value of the hearing device.

Consumers that purchase DTC hearing devices on their own will have control of the purchase decision, while the HCP will lose much of their influence. Currently, it is primarily the HCP that selects the hearing device based on the hearing needs of the client and the hearing performance of the device. However, as consumers have a lower understanding of their hearing loss and value other aspects of the device than hearing performance, there will be a shift in focus to the person's non-auditory needs. For DTC devices this will mean that other aspects than hearing performance will have a larger influence on the purchase decision. On the product level, these are aspects such as the visual appearance, the ease of use of the device, and supporting software interface. Furthermore, these new performance aspects include the services and support that is provided in addition to the device, and how convenient and effortless the consumer journey is.

Reduced Physical Effort

A DTC journey could alleviate the effects of the barriers of inconvenience, time, and effort in the consumer journey. By making it possible for a consumer to purchase and set up the hearing device on their own or with remote support, the need for several visits at physical clinics is reduced. In effect, this reduces much of the time and effort required by the consumer as they will not have to travel or make time to go to the clinic. Moreover, DTC devices could reduce the effort of the consumer journey since no prior assessments at a physical clinic would be necessary to purchase a device. An example of the effects of reduced effort is that remote services, which were initially intended for patients outside geographical reach, are often preferred out of convenience (Ratanjee-Vanmali et al., 2020). Further, in the DTC journey, the patient is in charge and can choose to collect information at a time that suits them, which reduces the risk of information overload.

The lack of audiologist trust might inhibit patients from accepting care, but could be reduced with a DTC journey since audiologists would have a less central role. The variability in service quality between HCP clinics could be lowered by an increased standardisation of the technology. The service quality could become more consistent and reduce dropout, as fewer consumers experience an insufficient quality. Additionally, the perception that audiologists are subjective, and biased could be reduced by a DTC journey since audiologists would mainly provide services that facilitate the use of hearing aids, while not being as involved in the sales of the product. This new service delivery model has the potential to separate the sales of the product from the hearing professionals, which would remove the obstacle of the low trust with HCPs as they would not be involved to the same extent.

Reduced Emotional Effort & Self-stigma

Although a large part of the inconvenience and physical effort could be reduced by DTC devices, the primary change with the DTC model is the reduction of the emotional effort triggered by the consumer journey and self-stigma. Moreover, a DTC journey improves the confidence and the self-efficacy of the patient, which in turn makes them more prone to search for a treatment option. Key motivators for people to seek treatment for their hearing loss are the degree of hearing loss, the level of self-efficacy of the individual, and the self-acceptance of their condition. The level of self-efficacy and self-acceptance could be improved by a consumer journey that requires less effort and involves less stigma for the individual.

Currently, there are many stages in the consumer journey that reminds people about their disability and the limitations of their hearing loss. Each stage threatens the self-identity of the individual and triggers self-stigma by implying that the client has a medical problem that cannot be resolved. As the individual needs to be persistent and self-manage their care, it might inhibit them from finalizing the consumer journey.

Going more into depth on the consumer journey, these discouraging triggers are present at each physical meeting with a professional. The clinical visit makes people feel disabled even if they might only have a minor hearing condition. The GP visit involves an initial assessment where the client is sent to a specialist if a hearing loss is found, implying that they might have a serious condition. The ENT assessment involves several tests to understand if the patient has a medical or surgical issue, which increases the patient’s perception that they are disabled. Similarly, visiting the HCP might bring further stress to the patient and reinforce the feeling that they are becoming disabled. Furthermore, the initial HCP screening involves an array of more tests that reinforce the medical perception of their problem. The client is then presented with a hard copy of their audiogram as evidence of their physical limitations. Lastly, the client is invited to a counselling session where they become overwhelmed by information as a preparation to make an expensive purchase decision to aid their hearing.

Because of these triggers, the traditional consumer journey might worsen the person’s perception of themselves and inhibit them from continuing to the next stage. It brings up many emotions for the person as they need to come to terms with the realisation that they have limitations because of their hearing. In the best-case scenario, this causes an increase in self-acceptance, but in most cases it leads to stress and negative emotions. If they also have some level of self-stigma, their self-identity will worsen as each meeting causes a trigger that confirms the perception of their hearing disability. In turn, this harms their self-esteem and self-efficacy, which reduces their motivation to advance to the next stage in the process. To handle the stress and manage their life, people instead resort to either denial or coping mechanisms to start rebuilding their self-identity.

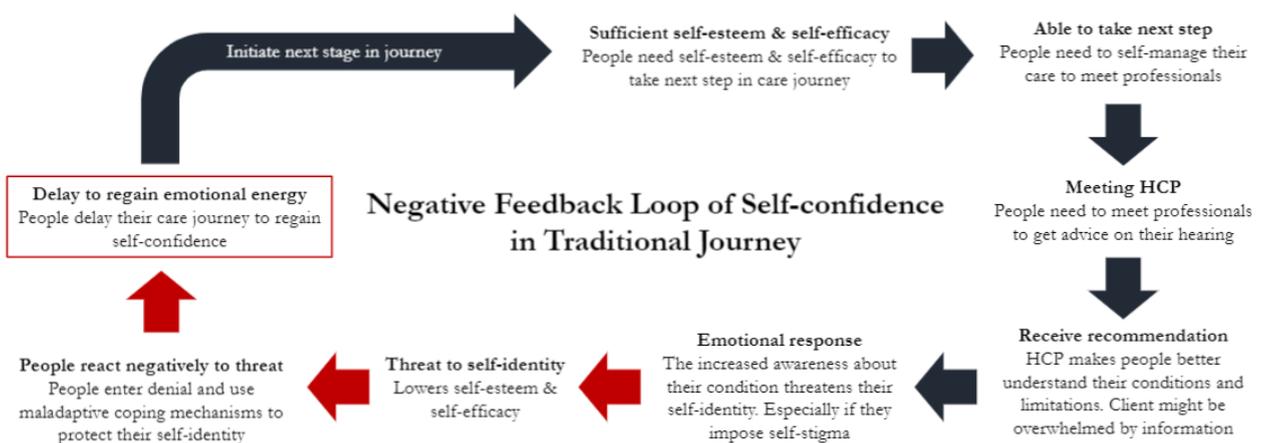


Figure 7. The negative feedback loop of self-confidence in the traditional consumer journey.

Each of these stages decreases the likelihood that a person will complete the consumer journey. It is causing the person to question themselves and reduces the self-confidence and self-efficacy that the person needs to get through the journey. Further, each stage increases the perceived magnitude of their disability, which increases the number of perceived limitations for the individual. The improved understanding of their limitations makes it more difficult for the individual to accept the limiting effect that the hearing loss has on them. Figure 7 illustrates the emotional process that the individual goes

through to take a step in the consumer journey, and shows how the threats to the individual's self-identity make them delay seeking care or inhibit them from completing the consumer journey.

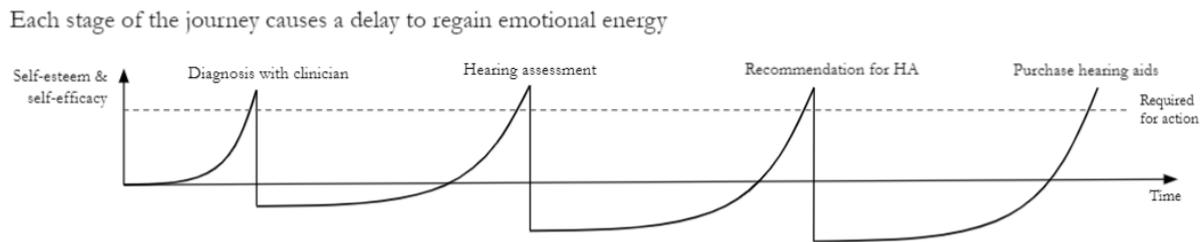


Figure 8. Overview of the change of self-esteem and self-efficacy over time. People will experience a decrease in both after the threat to their self-identity from visiting the professional.

If the delay following each professional appointment is shown over time, it can be seen that each stage might hinder people from continuing in the journey. In a successful journey, the person manages to recover from the threat to their self-identity and regain the lost self-esteem and self-efficacy (illustrated in figure 8). However, after each stage there is a risk for drop-out. Hence, the more visits a person makes before purchasing a device, the higher the risk of them exiting the journey without treatment. In that case, the individual might experience more value from avoiding the threat to their self-identity than the value of being able to hear better. This might lead people to drop out and not take the next step in the consumer journey. DTC devices could reduce a lot of this stress by making it possible for people to not meet clinicians or audiologists before they purchase the hearing device. Instead, they only have to go through the emotional preparation before they buy the device and before the hearing screening.

DTC could prevent the triggering of emotions by presenting an easier alternative to the traditional journey, which would make the person feel less incapable, limited, and disabled. Much of the emotional effort and self-stigma arises from the triggers that make the person with hearing loss realize that they have a limited functionality. The hearing loss might limit their ability to participate in some environments, but to a large extent they are still able to live an ordinary life despite their hearing loss. Therefore, it might be overwhelming for them to accept that they have limited functionality as they only have hearing issues in certain environments and might not perceive themselves as disabled.

From the individual's point of view, the issue is in many ways functional; that they have difficulties hearing. Hence, by focusing on the functional issue, DTC hearing aids can provide a way to cope with the hearing loss and reduce the triggering of self-stigmatising feelings of being old and disabled. A parallel can be drawn to people who need reading glasses for short distances, but can manage most situations without them. During the purchasing process of glasses, it is more common to discuss the functionality and the reduced vision than the clinical underlying reason or issue with the eye.

The involvement of physical visits with clinicians might be a contributing factor to the medical perception of the traditional consumer journey, due to negative comments, extensive health screenings, and lack of referral to HCPs. Hence, each meeting with a professional further strengthens the stigmatising perception of hearing loss. The patient would, via a DTC delivery model, not be exposed to either negative comments or extensive health screenings, and would not need to be referred to an HCP. Therefore, a consumer journey where the role of professionals is removed could reduce the obstacles currently caused by clinicians.

Manufacturers focus mainly on improving hearing. However, improving hearing through a hearing device does not necessarily solve the issue of feeling hearing disabled. The large focus on minimizing the size of

hearing aids can contribute to the self-stigma and make people feel that they have an issue to be ashamed of. Moreover, this narrative from hearing professionals, marketing, and advertisement might reinforce the perception that hearing aids and hearing loss are stigmatic and should be kept hidden. Instead, the adoption could be increased if the consumer journey only included stages that handle the functional issue of not being able to hear, rather than the medical issue of being hearing disabled.

A way to reduce the self-stigma is to compartmentalize the stigmatisation by reinforcing the perception that the person struggles to hear and has a functional rather than a medical issue. A DTC journey focuses on enhancing hearing or improving understanding of sound in difficult environments, rather than speaking about the actual cause or reason behind the hearing loss. Further, by putting pressure on limiting the exposure of the medical issue it would be possible to handle the hearing issue without bringing up too many negative emotions for the individual. This would make a person use coping mechanisms to minimize the size of their issue, but compartmentalizing the issue makes it easier for people to manage their feelings and gives them the energy to help them persist in finding a treatment.

Compartmentalization can, in conjunction with removing professional appointments, significantly reduce the experienced stigma of the individual. It would be easier to manage the care journey and the self-identity of people would not be challenged to the same extent, which would make it easier to find a solution to their problem. Moreover, the overall emotional effort from handling information would go down from the introduction of DTC devices.

Risks of Direct-to-consumer Devices

Despite there being benefits of increased patient involvement, it requires the consumer to have a level of technical expertise that is not necessary for the traditional consumer journey. There are risks attributed to the increase of responsibility since all care aspects of the audiologist-patient interaction cannot be fully replaced by technology. For instance, people interested in a DTC device are required to assess the different purchasing options of hearing devices by themselves. If they choose to receive treatment online, the product selection process includes creating an understanding of which product would be the most suited to their needs.

To further illustrate that all aspects of professional care interactions cannot be fully replaced by technology, there is a low ability of patients to complete the self-fitting process, with numbers such as 55% success rate in one study (Convery, Keidser, Seeto & McLelland, 2017) and 68% in a second study (Singh, 2020). Users can achieve satisfactory settings without the involvement of an HCP, but it requires the user to be technically capable of self-managing the device. Since not all users are capable of performing the required tasks, they might benefit from additional support to complete the self-fitting process, especially for more complex hearing devices (Singh, 2020). Additionally, only a small minority of the respondents feel very comfortable performing any of the tasks required, and less than half of respondents feel at least fairly comfortable assessing their own hearing loss and select a suitable hearing device that fits their individual needs (HIA, 2019). Therefore, there is a risk that DTC devices can be too difficult to use since a large proportion of hearing-impaired individuals are either uncomfortable or incapable of performing the tasks. It is not enough that products and services are accessible and affordable for the user to benefit from them, they must also be usable.

Although many are currently struggling with a self-fitting process, DTC devices are not fully established or normalized yet, meaning that guidelines and manuals for self-management are also in an early stage. As DTC products progress in their development, the usability and guidelines for self-management are likely to become more intuitive, allowing for high self-fitting success rates. Similarly, the users of DTC products

will become more technically experienced the more established the products get. Likewise, the success rate of self-managing the fitting process is correlated to previous technology experience of smartphones and hearing aids (Singh, 2020).

People in the 45-64 age segment are technically more experienced and capable than older age segments, mitigating the risk that they would not be able to complete the DTC journey. For instance, the age segment 35 to 64 are more confident than people 65-years-old and have better abilities to perform the tasks required by DTC devices (HIA, 2019). People between 45 and 65 are more comfortable in assessing their own hearing loss, selecting an appropriate device and using device features. The significant difference indicates that 45-64-year-olds will be more able to complete a DTC journey and adjust their self-fitting devices.

Technology cannot replace the human interaction aspects of personal consultation. Consultation is an important part of the customer process since it makes the patient well-informed, convinced, and confident about the usage of the product. The DTC journey removes the need for physical human interactions and places more control and responsibility in the hands of the patient. However, what is lacking with increased patient responsibility in terms of personal interaction could be alleviated with remote support. The DTC journey is not designed to require a hearing professional, but patients who are struggling with their hearing device could seek help from an expert to be guided through the process and raise the potential for success (Singh, 2020). For instance, current companies in the DTC market include remote support to complement the self-managed fitting process (Bose, 2021; Lexie, 2021; Eargo, 2021). The awareness of person-centred hearing care is becoming more prevalent and customer support is required for a successful outcome for the patient (Swanepoel et al., 2021). Support via teleaudiology, which is provided by the current DTC companies, are creating a foundation for hearing care that is more patient-based. Hence, the need for professional support would still be present in a DTC sales model, but it could be provided remotely to remove the negative aspects attributed to physical appointments.

Additionally, the services of remote support might not be required to be performed by HCPs, since they prefer dealing with technical challenges rather than understanding the individual's psychological difficulties. Audiologists or hearing dispensers could still assist with the servicing of the product, but they might not be best suited to provide emotional support or effective communication to the patient. The core competencies of hearing aid dispensers are measuring, fitting, and selling hearing aids (NHS, 2021). Moreover, as audiologists might not be best suited to deal with the psychosocial needs of the client it could be possible that people with a lower level of education could address these patient needs.

By introducing emotional customer service and specific technical support it could be possible to remove the need for HCPs in the consultation stage. Hence, the lack of audiologist interaction in the DTC journey might not impact the level of emotional support. Instead, professionals with lower education might be more suited to provide this service, which could lead to both lower prices and better emotional support. Since both Bose and Lexie provide remote support by a support staff that does not consist of HCPs indicates that the aspect of human interaction can be provided by staff with lower education. Bose and Lexie call their support staff "hearing experts" and "hearing products experts" respectively (Bose, 2021; Lexie, 2021), indicating that remote support staff does not need to be HCPs.

6.2. Increased Product Value

Technological advancements affect the product value for both the price and the performance. DTC hearing devices introduce new performance metrics and bypass many of the costs attributed to hearing

professionals in the traditional consumer journey. By focusing on other performance metrics than only hearing performance while reducing the price of the products, DTC hearing devices can better meet the needs of the mild-moderate hearing loss segment and increase the value of the products.

Traditionally, hearing aids have in many ways been one-dimensional in the focus on hearing performance. HCPs measure and test the hearing loss and the communication needs which has put an emphasis on the hearing performance. The other focus has been on reducing the hearing aid size, to diminish the public stigma. Hence, audiologists have based their decision on choosing a hearing aid primarily on the size and the improved hearing benefit that a user could get from acquiring a device. This has in turn made manufacturers focus on minimizing the size of the device, improving the hearing performance of the hearing aid, and developing the fitting software that professionals use to adapt the device to the client. Moreover, these performance aspects have become the means of competition in the industry. As a consequence, the non-auditory needs of the end-user have become deprioritized in this process. Additionally, the price of hearing aids is too high to motivate the benefits experienced by mild-moderate consumers, which has been one of the reasons for low adoption rates.

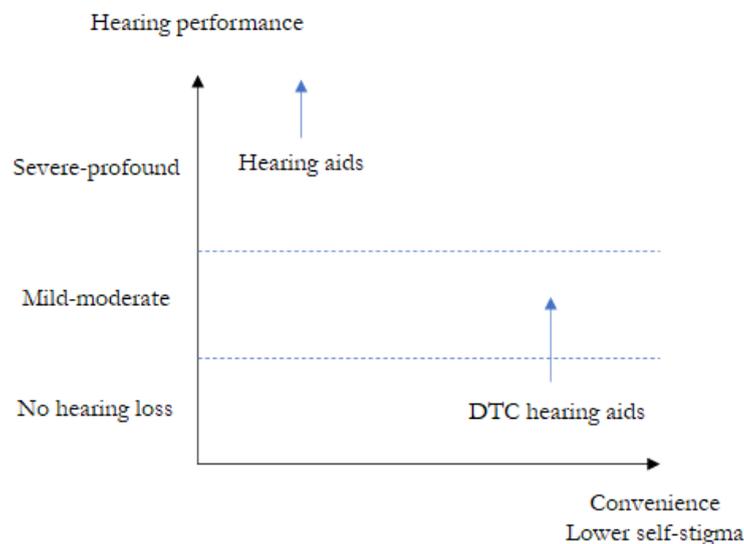


Figure 9. DTC hearing aids introduce new performance aspects, but have lower levels of hearing performance. Traditional hearing aids overshoot on the demanded hearing performance for the mild-moderate hearing loss segment. As the hearing performance increases because of technological advancements, DTC hearing aids will be better suited to meet these needs.

Most hearing aids are developed for people with severe-profound hearing loss who experience more utility from improved hearing than people with mild-moderate hearing loss. These consumers have a larger need for hearing aids, and the high price is motivated by the improved quality of life from purchasing a device. However, for people with mild-moderate hearing loss, many hearing aids are overshooting in terms of the demanded hearing performance by providing products that are equipped with overly advanced hearing features. The hearing performance of hearing aids is already sufficient to meet the hearing needs, resulting in a diminishing marginal utility of improved performance. Hence, the improvements in hearing performance will most likely not lead to increased adoption of hearing aids for people with mild-moderate hearing loss. Rather, the non-auditory aspects of the device are relatively more important for these consumers as the hearing loss only affects them in certain situations.

Based on the adoption barriers of inconvenience, emotional effort, and stigma, there are needs of the mild-moderate hearing loss segment that are not met by only hearing performance. DTC hearing devices

are in many ways able to introduce new performance aspects that can fulfil these unmet needs. The removal of the HCP and the increased patient involvement reduces the inconvenience, effort, and experienced self-stigma for the user. Hence, DTC hearing devices compete on performance metrics that are more suitable to meet the needs of the mild-moderate hearing loss segment.

Although DTC hearing devices introduce new performance metrics that fulfil the unmet needs of the mild-moderate hearing loss segment, a sufficient level of performance is required to benefit from the device. To illustrate this, 39% of people that bought their PSAP for less than \$100 were dissatisfied (HIA, 2019). Although some DTC products will lack in product performance, there are many reasons to believe that the general level of performance will be sufficient for the mild-moderate hearing loss segment. Primarily, devices classified as over-the-counter hearing aids will be approved by the FDA, meaning that they will need to comply with the federal regulations of being a well-functioning medical device. Secondly, since DTC hearing aids are in an early stage of their development, the performance of the devices will improve as more features become standardized on a chipset level. Lastly, as consumers get used to hearing enhancement features from hearables, the demand for improved hearing is likely to increase, putting pressure on consumer electronics manufacturers (CEMs) to provide a sufficient level of hearing performance. Hence, there is a low risk that DTC hearing aids will provide a less than sufficient level of product performance for the mild-moderate hearing loss segment.

If DTC hearing devices could ensure a sufficient performance level, they could become an attractive option for the mild-moderate hearing loss segment. It remains to see the effect of the Bose hearing aid, but it brings many aspects of a competitive product. The price is lower than traditional hearing aids, it can be bought without HCP involvement, it is self-fitting, and has available support services. It is unsure whether the performance is sufficient, and in case Bose fails to satisfy consumers it is just a matter of time before another company launches a device with sufficient performance. The developments in chipset technology from the hearables space will bring forward better and cheaper chipsets as the hearables industry continues to grow. There will most likely be synergies in the development of hearing aids and hearables that would make it easier for new entrants to provide products that reach a sufficient performance level. This puts traditional hearing aids at the risk of becoming redundant in the mild-moderate space since their main competitive edge in performance will be met to a sufficient level by DTC devices.

In a DTC journey, the patient would be more involved in the care process rather than having to pay for an audiologist to provide all the necessary services. The high price of hearing aids sold via the traditional consumer journey is to a large degree attributed to audiologists, since 70% of the markup of the price comes from retailers. A DTC journey would lead to a separation of payment of product and audiologist services, in contrast to the traditional journey where the product and services are bundled. The audiologist would no longer need to be selling the product or provide services such as assessment and fitting. This would lead to consumers only paying audiologists for the services they actually need, for instance, the initial hearing assessment and cleaning of the devices. Likewise, a consumer that only needs the product and no additional audiologist services would only need to pay for the product. Hence, DTC would reduce the cost for consumers that do not demand all of the services provided in the traditional consumer journey.

Additionally, customer support does not need to be provided by an audiologist, and remote care allows the services of human interaction to be provided without the need of a physical appointment. The cost of running the clinic is part of the reason for the high markup of the price attributed to retailers. Hence, if human interaction is provided remotely by professionals with lower education, the price of hearing devices could be significantly reduced.

In combination with reduced involvement of hearing professionals, CEMs could utilise economies of scale to lower the price of hearing devices. A major difference between CEMs and traditional hearing aid manufacturers is the scalability of their product offering. In comparison, 223 million hearables were sold in 2020, compared to four million hearing aids in 2019. Moreover, CEMs have synergies in the development of hearables and hearing aids, which makes it possible for them to benefit from the economies of scale to reduce the cost of developing and manufacturing hearing devices. They can also utilize their existing sales channels to sell the DTC devices to consumers. Supporting the argument that DTC products would cost less than traditional hearing aids, a pair of Lexie Lumen is currently priced at US \$799 (Lexie, 2021) and a pair of Bose SoundControlHearing Aid at US \$849 (Bose, 2021).

7

Implications on the Industry

Technological advancements allow for direct-to-consumer (DTC) hearing devices which is a new product category in the hearing aid industry. In this section, we investigate the implications of the DTC market on the hearing aid industry. We focus on the threats of increased competition from consumer electronics manufacturers (CEMs) and new hearing aid manufacturers (NHMs) for the traditional hearing aid manufacturers (THMs). The THMs consist of the five large hearing aid manufacturers Sonova, Demant, WS Audiology, GN Hearing, and Starkey. CEMs include large companies such as Apple and Bose, that produce hearables for consumer use and have begun to either develop hearing devices or implement hearing enhancement features in their hearables. Moreover, NHMs include new actors that are making DTC hearing devices targeted at people with mild-moderate hearing loss. The common factor is that these are new companies that are smaller than THMs and target the specific needs of the mild-moderate hearing loss user.

The main competitive advantages of THMs are the already established relationship with audiologist clinics, the marketing and advertising channels to maintain that relationship, and economies of scale for R&D. The impending changes that are reshaping the role of audiologists and increasing commoditization of performance will affect the value of these competitive advantages. In this section, we aim to answer the research question: “How could technological advancements affect the traditional hearing aid manufacturers?”. We address this by investigating how CEMs and NHMs could affect the main competitive advantages of THMs in the DTC market.

7.1. Reduced Importance of Audiologist Channel

The changes in the complementary technologies will affect the THMs, as the value of their exclusive access to this channel will be reduced. In this change, consumers will take charge of the purchasing decision and can bypass the inconvenience and price that arise from the traditional consumer journey. Hence, the relative advantage that THMs have for brand-preferability of audiological clinics will have a reduced importance in a DTC journey.

Rather than putting effort into getting the audiologists’ approval, it will be more important for companies to place resources into building complementary offerings that can help the patient get accustomed to their hearing aids. Many of the services provided by HCPs could be substituted by technology or staff with a lower educational level, which would lower the price and increase accessibility. Some of these technologies are currently in an inferior stage, where audiologists could provide a better service than the new technology offering. However, because of the high fee they charge, many consumers might question the marginal value of these services compared to purchasing a self-fitting device with a better value offering. Further, it might be difficult for HCPs to motivate the high markup of the bundled pricing model. These changes could motivate consumers to switch to DTC products, where they could get more value for their money. To be able to bypass the audiologist, manufacturers would need to develop and offer substitutes for assessment, fitting, and consultation. The technological development should focus on developing self-fitting algorithms and online assessments that ensure that the device is adjusted to the

user's hearing needs. Furthermore, it needs to be intuitive and easy for the patient to use, to minimize the need for consultation. Nevertheless, if they need further assistance with using the device there should be both emotional and technical support.

THMs have established their organizational structure to meet the needs of the audiologists. The focus of the competition between the THMs is hearing performance for premium hearing devices. Therefore, manufacturers have invested resources, accumulated knowledge, and arranged their organizational structures to continue to improve the performance of their devices in this segment. Most likely, they will also continue this development to retain their trust with existing important customers in the HCP channel or they risk losing sales to their competitors. If THMs would start selling DTC devices, they would either compete with their existing customer base of audiologists that sell hearing aids or cannibalise on their own sales of hearing aids. This might inhibit them from committing to a consumer journey that is free from HCPs.

On the contrary, new entrants would not be restricted by these connections and are incentivised to substitute the audiologist to reduce the existing advantages of THMs. By differentiating themselves, new entrants would be in a better position to compete. CEMs have a strong legacy of providing solutions that meet end-user needs. Additionally, they would be well-positioned to utilize their technical capabilities to create sufficiently performing self-fitting devices that are easy to use. They would also be able to invest sufficient resources in partnerships, acquisitions, and R&D to provide hearing assessment tools. Moreover, CEMs have sufficient economies of scale to set up the necessary customer service network to remotely provide emotional, technical, and if needed audiological support. To be able to compete in the industry, NHMs would need to provide sufficient complementary services to their DTC devices. Initially, this could be conducted through remote care (such as Eargo), but NHMs would be incentivised to create self-fitting software and provide online hearing assessments to exclude the reliance on HCPs. However, in comparison to CEMs, they might have difficulties providing the same level of service.

THMs would benefit from the increased diffusion of hearing devices, as DTC devices and hearables with hearing enhancement features will introduce people to hearing devices earlier than before. Having hearing enhancement features in their hearables will make it possible for people to experience that their hearing is below optimal and that there are ways to improve it. The increased ability to test hearing enhancing features is likely to lead to an overall increase in the adoption of hearing devices, both for DTC devices and traditional hearing aids.

Moreover, all consumers will not feel comfortable taking full control of their hearing care journey. They want to have the clinical experience and the professionalism of an audiologist and expect HCP support from either remote or physical clinics. For people with mild-moderate hearing loss, HCPs could provide the option to purchase a DTC device in their clinic. This could increase the uptake for THMs, as new entrants might struggle to build a strong brand in the clinics because of the inferior hearing performance.

Additionally, having the option to purchase a DTC device makes it possible for people to test and trial a cheaper and more accessible alternative to traditional hearing aids. In many ways, the DTC device can act as a gateway product to a more advanced hearing aid. People grow accustomed to hearing devices when they have a mild-moderate hearing loss, and as the hearing level deteriorates because of ageing, people that are used to a DTC device will be more likely to adopt more advanced hearing devices. THMs might then be able to increase their sales of the more advanced devices as more people will enter this channel. THMs will be able to protect the sales in this channel since the treatment of higher degrees of hearing losses requires professional support. Hence, an overall increase in penetration of hearing devices would

make it possible for more people to adopt a DTC device, to later upgrade to an advanced hearing device through an HCP.

7.2. Increased Focus on B2C Marketing

As consumers in a DTC journey will have a larger influence on the purchase decisions compared to the audiologist, there will be a shift in the companies' focus from B2B sales to B2C marketing directly to the consumer. The primary factor that HCPs evaluate a hearing aid on, is the hearing improvement that a client might derive from the product, which depends on the hearing loss, and the hearing needs of the person. Moreover, HCPs evaluate the hearing aid on how easy it is for them to adjust it via the fitting software. This results in HCPs primarily premiering technological advancements in hearing aids that will help the patient hear better.

However, in the change to a DTC model, the user's non-auditory needs should be taken into consideration. When patients start taking control of the purchasing in the DTC channel, these non-auditory needs will have a larger influence on the purchasing decision since they are not as prioritised by the HCP. For the consumer, this includes aspects such as the experienced inconvenience from purchasing the device, the perceived emotional toll that the journey evokes, and the usability of the product. Moreover, consumers in a DTC journey will have a lower ability to assess which device that meets their hearing needs and understand the hearing performance of the product, which makes it difficult for them to fully evaluate the hearing improvements of the product. Based on the concept of bounded rationality, people will simplify the aspects that they do not understand into concepts that they can comprehend (Khaneman, 2011). This means that people will base their purchase decision on the factors they know and understand. This, in turn, will mean that there will be a change from a primary B2B marketing focus on HCPs, to a B2C focus on the end-user.

As the general population have poor knowledge about hearing performance, they will rely on the brand image to understand the reliability and the quality of the product. Technical functionality is relevant for professionals, but the information becomes too detailed for the user. Instead, non-auditory factors will have a larger influence on the purchase decision of DTC devices as these are aspects that the consumer can comprehend. Consequently, the B2C brand of the manufacturer will have a larger influence on the consumer's decision than what it has today.

CEMs will leverage their existing brand image and strength in B2C marketing to attract consumers. These companies have a key capability in marketing and advertising to consumers. They are more proficient in understanding the end-user needs and how to build a brand for the larger population. The brand transferability to the hearing aid industry is particularly strong for the premium headphones and hearables segment. These companies have established a brand that is based on quality, convenience, and sound performance, and they could leverage this brand if they move into the hearing aid space. A contributing factor to Sonova's purchase of Sennheiser is to benefit from Sennheiser's strong consumer brand in premium headphones and hearing equipment. For traditional hearing aids, end-users have low brand recognizability and 56% of users are unaware of which brand of hearing aids they have (HIA, 2019). Since CEMs have better brand recognizability with end-users, the increased importance of brand in a DTC channel would benefit CEMs more than THMs.

NHMs will instead have the advantage of being able to create a new brand image, to serve the specific needs of the mild-moderate hearing loss segment. However, compared to CEMs or THMs, they will not have the same benefits in size and economies of scale. Therefore, NHMs will need to find a niche in the

market where they can establish a foothold, to later reach a larger group of customers. An example is Eargo that has focused on targeted online advertisements that draw people to their online store (Taboola, 2020). This has made it possible for Eargo to increase the traffic to their webpage and attract people with mild-moderate hearing loss to purchase their devices.

The difficulty for THMs will be to change the internal organizational structures to sell B2C while continuing to market their products for the B2B segment. The existing internal structures of THMs have been built to optimize the sales of hearing aids to HCPs and it is difficult to let go of the existing focus on hearing performance, particularly as severe-profound consumers have unmet hearing needs that need to be considered. They might also face difficulties in fully acknowledging that consumers with mild-moderate hearing loss have non-auditory needs that take precedence over their hearing needs.

7.3. Increased Commoditization of Performance

Improvements in chipsets will enable an increased competition from new actors. Synergies in the development of chipsets for hearables with hearing aids, such as hearing enhancement features and noise-cancelling, will make it cheaper for CEMs and NHMs to develop DTC hearing devices. The chipset development by Qualcomm and other chipset manufacturers will keep introducing new elements to the chipsets such as improved battery life, better sound processing, and hearing enhancement features. While more features will become easily accessible via commoditized chipsets, THMs will struggle to keep their lead in hearing performance technology. Developing the AI systems and underlying hardware to improve the hearing performance will require a lot of resources from these companies. However, the issue for THMs is that performance will become more easily available via chipsets, which makes it possible for the competition to emerge from a lower performance level and provide a similar performance level. By making these changes on a component level, it will allow for an increased competition since there will be fewer technical barriers to creating a hearing aid. As a consequence there are fewer aspects to develop, and new entrants will be faster to develop hearing devices that are cheaper than before.

The increased commoditization and economies of scale of chipset manufacturers and CEMs will lower the prices of hearing aids. Even if the competition arises from below the premium market, there will be a price competition that makes it more difficult to put a high markup on hearing devices. Further, new entrants will introduce devices that provide a sufficient level of performance at a lower price, which will further decrease the price of hearing devices. It might not directly influence the pricing for hearing aids, but it will become more difficult for HCPs to motivate their markup as there will be more alternatives to their services.

Improvements in hearables will spill over to the hearing aid industry, and new entrants to the hearing aid industry will have faster access to more features as technology continues to progress. Especially commoditization in comfortability, sound processing, and battery power will make it easier for new actors to enter the hearing aid industry in the DTC channel. THMs have an advantage in the knowledge base for premium features and will keep this position. However, as more features become accessible, CEMs and NHMs will become more competitive. The chipset manufacturers also have large economies of scale because of the large volume increase in hearables, which enables lower prices. Because of the increasing commoditization in component manufacturing, the benefits of the economies of scale in R&D development for THMs will decrease. There will also be an overall price competition that threatens the value proposition of hearing aids from THMs.

7.4. Effect of Increased Competition

The three key competitive advantages of the THMs will not be as competitive in the DTC market as they are in the traditional market. In the growth of the DTC market, THMs might get their share diluted by new entrants. The THMs will have difficulties competing in this product category because of the existing commitments to more severe hearing losses and profitable sales via HCPs. Instead, consumer electronics manufacturers and new hearing aid manufacturers will be able to grow in this segment by improving the consumer experience and the convenience of the journey. The new entrants are also not restricted by previous commitments in the hearing industry and have better capabilities in delivering value through the B2C channel. Hence, THMs might lose share to the new entrants in the DTC market for the mild-moderate hearing loss segment.

However, the overall effect on the hearing aid market from the growth of DTC would be that hearing devices would become more widespread. This would also mean that more people would become more aware of hearing aids, which would increase the number of visits to audiologist clinics. THMs will be able to retain the strength in the audiologist channel and will profit from this growth. Furthermore, the DTC devices might provide an entry point for people with mild-moderate hearing loss to start using hearing devices, which makes them convert to more advanced hearing aids as their hearing degrades. Hence, the THMs might experience increased competition, but will not cease to exist. In the case of glasses, reading glasses became a complement to prescription lenses and increased the referrals for prescription lenses, instead of acting as a substitute to them (Cavitt, 2016). Therefore, DTC devices could increase the competition in the mild-moderate hearing loss segment for people who do not want professional support, while simultaneously increasing the number of people who enter HCP clinics.

8

Conclusion

Technological advancements in the hearing aid industry allow for a **direct-to-consumer (DTC)** journey that reduces the inconvenience, emotional effort, and self-stigma for the consumer. We have found that the primary reason behind this is the reduced involvement of **hearing care professionals (HCPs)**, which leads to a more convenient purchasing process with increased patient involvement. Moreover, a change in focus to the functional lack of hearing, rather than the disabling effects of having a hearing loss, would arguably reduce the emotional triggers and the likelihood that people question their self-identity. In turn, this would prevent people from going into the destructive behavioural cycle of denying their hearing loss, isolating themselves, and dropping out of the consumer journey. Hence, we argue that DTC devices would reduce the barriers to adoption and lead to more people acquiring hearing aids.

Further, we have found that technological advancements allow for an increase of the product value for the mild-moderate hearing loss segment. Improved hearing performance will not in itself increase adoption as non-auditory needs are more important for the mild-moderate hearing loss segment. Instead, by focusing on non-auditory needs and a lower price, DTC devices will be able to compete on other performance metrics that provide more value to the mild-moderate hearing loss segment than hearing aids sold via the traditional consumer journey. Since DTC devices provide many opportunities to bypass the adoption barriers and increase the product value, we argue that they have great potential to increase the adoption of hearing aids in the mild-moderate hearing loss segment.

A prerequisite for DTC devices to provide these benefits is sufficient hearing performance, which will be achieved through synergies from hearables. As the hearables industry continues to grow, the development in chipset technology will bring better and cheaper chipsets that increase the accessibility for new entrants to device features that can be integrated into DTC devices. **Consumer electronics manufacturers (CEMs)** and **new hearing aid manufacturers (NHMs)** are, via their DTC devices, able to reduce the value of the main competitive advantages of **traditional hearing aid manufacturers (THMs)**. CEMs have already entered the DTC market and have advantageous capabilities to create products that provide value to the mild-moderate hearing loss segment. We argue that the brand recognizability, transferability of hearables features, and economies of scale of these companies put them in pole position to lead the growth of the DTC market. Further, NHMs are establishing themselves in the DTC market and are well-suited to reach the mild-moderate hearing loss segment. We expect numerous NHMs to emerge in niche markets as they can build their sales channel according to their specifically targeted customer segment. These changes will arguably reduce the entry barriers for the DTC market, allowing new entrants to grow and compete on new performance metrics.

Although new actors might have a higher potential to thrive in the DTC market, we argue that THMs will still derive benefit from the increased adoption of hearing devices in the mild-moderate hearing loss segment. One reason is that there will still be individuals who value professional support and prefer to purchase their DTC device through an HCP, which provides THMs with an advantage over new entrants. Another reason is that DTC devices can introduce hearing enhancement to people with mild-moderate hearing loss and serve as a gateway that funnels consumers to more advanced hearing aids. By providing entry-level DTC devices that increase adoption in the mild-moderate hearing loss segment, we suggest

that the awareness of the benefits of hearing enhancement will increase. Subsequently, people will turn to more advanced hearing devices from THMs when their hearing level deteriorates, growing the market for the severe and profound hearing loss segments.

Nevertheless, the entries of CEMs and NHMs will increase the competition in the industry. We expect that it will result in an overall increase in the size of the industry, where most of the growth will happen in the DTC channel, but where THMs can still retain or even grow their share in the clinic. The increased competition will eventually, when the new entrants provide sufficient performance levels, lead to price pressure on hearing devices. We argue that the primary change will be that the HCP distribution networks are affected negatively, while companies that can reach consumers directly could appropriate a larger share of the product value.

The actualisation of the over-the-counter (OTC) regulation for hearing aids is still pending, but there are currently many changes that are happening in the industry that drives the market for DTC devices. At the time that this thesis was written, Bose released their first self-fitting hearing aids and Sonova acquired Sennheiser to access the consumer electronics channel. Whether THMs, CEMs, or NHMs will succeed in the DTC market is still to be decided. Either way, this change would make it possible for more people with mild-moderate hearing loss to get access to hearing devices and in that way retain their social life and have an overall improved quality of life.

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