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Discovering the unmet needs of people with difficulties understanding speech in noise and a normal or near-normal audiogram

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Abstract

Purpose: A proportion of people with a normal audiogram or mild hearing loss (NA-MHL) experience greater than expected difficulty hearing speech in noise. This preliminary exploratory study employed a design thinking approach to better understand the clinical pathway and treatment options experienced by this population.

Method: Exploratory survey data was analysed from 233 people with NA-MHL who had consulted a clinician and 47 clinicians. Qualitative analysis was performed on interview data from 21 people with NA-MHL and 7 clinicians.

Results: Results revealed that noisy environments, such as restaurants, were where many people experienced listening difficulties. Most people with NA-MHL were not offered a treatment option at their audiology appointment and their satisfaction with the appointment was diverse. Many clients reported frustration at being told that their hearing was “normal”. Data from clinicians showed that there is no standard test protocol for this population, and most felt that they did not have adequate training or resources to help NA-MHL clients.

Conclusions: This study discusses the research needs regarding the experience of those with NA-MHL, their help-seeking behaviours, and treatment options. Understanding these needs is the first step to designing projects to improve the quality of life of this population.

Introduction

The most common and widely used test of hearing thresholds is pure tone audiometry. However, the audiogram does not always reflect a client's real-world listening abilities. There is a proportion of people who, despite having an audiogram showing normal hearing or mild hearing loss (NA-MHL), experience greater than expected difficulty hearing speech in noise and have unmet needs regarding the clinical pathway and treatment options (Zhao & Stephens, 2007). Spankovich et al. (2018) found that 15% of adults with four frequency average audiometric thresholds ≤ 25 dB HL in each ear had self-reported hearing difficulties. Similarly, Tremblay et al. (2015) found 12% of adults with normal hearing (defined as thresholds < 20 dB HL at 0.5, 1.0, 2.0, 3.0, 4.0, 6.0, and 8.0 kHz) had self-reported hearing difficulties. In other studies, Kumar et al. (2007) reported 10% of people with normal hearing at their clinic complained of hearing loss; Saunders and Haggard (1992) reported an unpublished study by R.R.A. Coles showing that 5% of adults referred to ear, nose, and throat clinics have normal hearing; and Hind et al. (2011) found that 5.1% of children and 0.9% of adults referred to audiology clinics had normal hearing (defined as thresholds < 20 dB HL at 0.5, 1.0, 2.0, and 4.0 kHz).

Cases of people who have difficulty hearing speech in noise, despite having normal or near-normal audiograms, have been documented since the mid-1900s by King (1954) and Kopetzky (1948) and since 1992 the disorder has been referred to as King-Kopetzky Syndrome (Hinchcliffe, 1992). Because normal audiometric results do not explain a client's hearing difficulties, clinicians are often at a loss as to how to manage patients (Zhao & Stephens, 2007). As a result, clients in the past have been reassured that they do not have a hearing problem, or are told their issues are psychological (Zhao & Stephens, 2007).

Much of current audiology practice follows a bio-medical model of detecting, measuring, and remediating biologically based impairments, rather than a bio-psychosocial

model (Pryce & Wainwright, 2008). The bio-psychosocial model takes into account the social, psychological, and behavioural components of an illness (Engel, 1977) and has a focus on understanding the client's subjective experience and how that can help diagnosis and outcomes (Borrell-Carrio, Suchman, & Epstein, 2004). Instead of following the bio-medical model, Pryce (2006) and Pryce and Wainwright (2008) took a qualitative approach investigating these clients' clinical experiences and coping strategies. Pryce (2006) investigated coping strategies used by people with NA-MHL and reported that proactive coping strategies included directing speakers to adjust their behaviour, changing the environment, disclosure, and humour. Reactive coping strategies included concentrating to piece together the communicative message, bluffing, avoiding communication, asking for repeats, and lip-reading. Pryce (2006) found that what determined whether a clinical encounter was positive or not was whether an explanation that accounted for the symptoms the client was experiencing was provided by the clinician. Coping ability was more positive and successful in reducing emotional stress when the clinicians explained the disorder so clients gained a better understanding of it. Reassuring a client that their hearing was not impaired did not reduce distress, but instead increased emotional distress and fear, and came across as dismissive. Clients were more likely to use strategies that reduce distress when they felt that the problems discussed with the clinician had been acknowledged and given some explanation.

Pryce and Wainwright (2008) further explored the clinical encounter of people with NA-MHL. They found that positive encounters were characterised by the client feeling that their problems had been taken seriously, and that the clinician had satisfactorily explained the symptoms. Negative encounters were characterised by the clinician being dismissive, the client being concerned that they had wasted the clinician's time, confusion about the purpose and legitimacy of the diagnostic tests, questioning of test results, and increased anxiety about

alternative causes for the symptoms such as dementia or mental health problems. The authors concluded that effective communication between client and clinician and acknowledging the legitimacy of their disorder are key in determining the success of the clinical encounter.

Rehabilitation for people with NA-MHL is very varied, and there is no universal management program for these clients (Zhao et al., 2008). Generally, a simple hearing aid fitting will not help and a rehabilitative strategy is needed to help minimise participation restriction (Zhao et al., 2008). Zhao et al. (2008) suggest that counselling and using hearing tactics are the most relevant approaches for rehabilitation management for people with NA-MHL. Counselling can help the client come to terms with their hearing difficulty and the clinician can be a valuable support in helping the client adapt and manage their hearing difficulties. Clients benefit most when the clinician assists them in developing coping strategies rather than merely diagnosing a problem. Hearing tactics such as changing social interaction and the physical environment, and observing the speaker can help the client hear better in a noisy environment. The most important tactic for these clients is to improve the signal-to-noise ratio and avoid reverberant conditions.

Another possible remediation strategy for people with NA-MHL but greater-than-expected difficulty listening in noise is using a hearable. A hearable is a device that "fits in or on an ear that contains a wireless link, whether that's for audio, or remote control of audio augmentation" (Hunn, 2016). Recently hearables have been rapidly growing in popularity. Hearables can automatically improve the hearing experience of the listener by filtering out background noise, and as they are less complex than hearing aids offer a cheaper option than purchasing a traditional hearing aid. Nuheara (Nuheara Ltd., Perth, Australia) is an Australian company that has developed IQbuds, which are earbuds that filter out noise. Hunn (2016) reports that Nuheara are making the point that because the world is becoming increasingly noisy, even those whose hearing is fine need help having conversations. Nuheara, like several

other hearables companies are not targeting traditional assisted hearing but instead a new market of augmented hearing, which could become very popular (Hunn, 2016).

The aim of the current study was to conduct preliminary exploratory research to better understand the experiences of people with NA-MHL and greater than expected difficulty listening in noise, in regard to the clinical pathway and treatment. This differs from much of the previous research that focuses on the bio-medical model of detecting, measuring, and remediating biologically based impairments in clients, rather than understanding their needs and experiences. Understanding the needs of someone with NA-MHL is the first step to designing effective projects that may eventually improve the quality of life for this population. In order to do this, a design thinking approach was taken (see Yock et al., 2015). The design thinking process involves three phases: identify, invent, and implement. This paper focuses on the need finding aspect of the identify phase. Need exploration involves understanding aspects of a problem, via direct communication with those involved, that a new solution can address (Yock et al., 2015). For example, observations and interviews can be used to define the core problem, the population affected by the problem, and the desired outcome, which combined create a needs statement (Yock et al., 2015). In the current study we explored the perspectives of people with NA-MHL and clinicians through exploratory surveys and interviews in order to identify the needs for these groups.

Method

Ethics

Approval for the study was granted from the Australian Hearing Human Research Ethics Committee (AHHHREC2018-34), and complied with the National Statement on Ethical Conduct in Human Research.

Design Thinking

A design thinking approach was adopted in order to focus directly on the experiences of the individuals suffering with the issue – in this case difficulty understanding speech in noise. According to Yock et al., 2015, the needs finding stage of the design thinking identify phase involves three activities: strategic focus, needs exploration, and need statement development. The strategic focus of this study was to improve the listening-in-noise difficulties experienced by people with NA-MHL and greater than normal difficulty hearing speech in noise and assist clinicians who see this population. The needs exploration activity aimed to identify the specific problems that require attention for these groups through exploratory surveys, so results from a large number of participants could be collected, and empathy interviews, so that people's insights could be explored further in a smaller number of participants. Exploratory surveys rather than validated questionnaires were used in this preliminary investigation so that the questions could be tailored to this group and open ended questions could allow participants to expand more on their insights. Empathy interviews were conducted to understand the person's thoughts, feelings, and motivations, so their behaviours and needs could be better understood. The needs arising from the findings of the exploration phase are presented in the discussion as ways to address problems in the population that would provide a positive outcome.

Participants

Survey results were obtained from 1213 adults. Of these 1213, 1164 were from the NA-MHL population and 49 were from clinicians. An information section at the beginning of the survey assured the participant that their personal information and any data collected as part of the research project would be treated as strictly confidential. At the end of the survey participants had the option to sign up for an interview. Interviews were conducted either via phone or in person, and were audio recorded and transcribed for later analysis. Participants were read the National Acoustic Laboratories (NAL) privacy policy and gave either verbal or

written consent to the interview and having it recorded and transcribed. Links to the surveys for the NA-MHL group and clinicians were circulated via social media, online forums, and audiology newsletters. Nuheara participants were recruited separately via an email sent out to all Nuheara clients worldwide. Interviews were requested with senior staff in hearing aid and audio technology companies, as well as hearable startups. There were no incentives for the participants to take part other than helping us with our research and being given the opportunity to have their say.

NA-MHL Group

Exploratory Survey

As well as completing the survey, the criteria for inclusion in the NA-MHL group survey data was that they had to be an adult who self-reported in the survey as having 1) a normal audiogram or mild hearing loss, 2) difficulty hearing speech in noise, and 3) previously seen a clinician about their hearing difficulties. This left 233 NA-MHL participants (78 females). Sixty-seven were from the general population, and 166 were recruited from the database of Nuheara.

Interviews

Interviews were conducted with a subset of 21 people (6 female) with NA-MHL.

Clinicians

Exploratory Survey

The inclusion criteria was that the participants had to be clinicians practicing clinically with adult clients. Forty-nine clinicians completed the online survey but two were excluded from the final sample as they worked solely with paediatric clients. The results of the remaining 47 clinicians (36 female), aged 23-63 years are reported, although the number of responses varied between items (minimum n = 39).

Interviews

Interviews were conducted with seven clinicians (4 female) whose main motivation for participating was to advance the field and contribute toward future clinical developments.

Exploratory Surveys

The exploratory surveys were developed by the authors with questions selected to specifically understand the experiences and needs of this population. The questionnaires were not designed to be used as a validated survey tool, rather, they were designed solely for the purpose of this exploratory study.

NA-MHL Group

The survey for the NA-MHL group is shown in Appendix A. It was divided into four parts: about you; your hearing; your hearing test appointment; and following your hearing test appointment. Questions in the 'about you' section included demographic questions and filter questions to ensure the participant had a normal audiogram or mild hearing loss, had difficulty hearing speech in noise, and had seen a clinician about their hearing difficulties. Questions in the 'your hearing' section further characterised the participants' hearing problems, for example, if they asked people to repeat themselves when conversing in noisy places. The 'your hearing test appointment' section included questions about the tests conducted in the appointment and the participants satisfaction with the appointment and treatment options. Finally, the 'following your hearing test appointment' section included questions about the willingness of the participant to trial different treatment options, questions about hearables, and a question asking about ideal solution/s.

Clinicians

The survey for the hearing health professionals (hereafter called clinicians) who see NA-MHL clients in clinical practice is shown in Appendix B. It divided into four parts: about you; about your NA-MHL clients; appointment/ rehabilitation process; and the future of NA-MHL. The 'about you' section asked about the clinician's gender, location, years of

experience, areas of clinical work and how they would describe the typical characteristics of this group. The section ‘about your NA-MHL clients’ explored how many they see, what ages, referral paths, their perception of clients’ difficulties including situations and environments, their reasons for presenting, and how they describe their difficulties. ‘The appointment/rehabilitation process’ section asked which assessment tools the clinician uses, how the results are used to discuss treatment, treatment uptake, whether clients receive aural rehabilitation and if not why not, which treatment options clients receive and effectiveness of treatments, influences of clients’ decision to pursue or not pursue treatment, whether the clinician recommends hearables, what outcomes are measured, clinician’s confidence in recommending treatment, what form of rehabilitation would they prefer to provide, whether they feel they have sufficient training to help this group, what is needed to better help this group, barriers to rehabilitation services, and further comments about their experience with NA-MHL clients. The final section, ‘the future of MHL’ elicits their view on NA-MHL clients’ underlying problem, and asks for suggestions about the type of research they’d like to see about issues for NA-MHL clients.

NA-MHL Group

The interview script for the NA-MHL group is shown in Appendix C. It was divided into four parts: characterising your hearing difficulties; perceptions of yourself; the pathway to the clinic; and rehabilitation. For the ‘characterising your hearing difficulties’ section, participants were encouraged to share a story about a situation that they had experienced difficulty hearing speech in noise, and were prompted about what they did, how they felt, and what the impact was. For the ‘perceptions of yourself’ section, participants were asked if their family and friends knew about their difficulties and if they had adapted their behaviour. The ‘pathway to the clinic’ section asked the participant to describe their visit to the clinic and comment on both how the results were explained and their feelings about them. The

'rehabilitation' section asked if the participant had been offered any treatment options and what their experience with the treatment was like. This section also explored what people thought about traditional hearing aids, hearables, a remote microphone, and communication training as possible treatment options.

Clinicians

The interview script for clinicians who saw clients with speech-in-noise difficulties with NA-MHL is shown in Appendix D. It was divided into six parts: about you as a clinician; your experiences with NA-MHL clients; the assessment; treatment options; clinical insights; and further comments. The 'about you' section asked about their motivation to do the interview, years as an audiologist and their current role. The 'your experiences' section asked how frequently they saw NA-MHL clients, an example of a clinical experience with one of them, and other appointments where things went differently. The 'assessment' section explored the sorts of assessment tools they use to understand their NA-MHL clients' difficulties, how helpful these tools are, the clinician's confidence in making decisions, and communicating the results. The 'treatment' question asked what rehabilitation tools they offer and how comfortable they feel with these. It then sought their thoughts on four treatment options (traditional hearing aids, hearables, remote microphones, and communication training). The 'clinical insights' section asked for thoughts on the importance of the problem and how well understood it is. Clinicians also had the opportunity to provide additional comments or ask questions about the study which the interviewer would answer at the end of the interview.

Data Analysis

Exploratory Surveys

Descriptive statistics were calculated using Excel 2016 (Microsoft Inc., Redmond, WA) and MATLAB (Natick, Massachusetts: The MathWorks Inc.). Open-ended questions were coded for key themes.

Interviews

A content analysis was used for interpreting the interview data with a focus on finding quotes that identified the unmet needs of the study groups as per the design thinking method (Yock et al., 2015).

Results

Participant Demographics – NA-MHL Group and Clinicians

Exploratory Surveys – NA-MHL Group

The ages of the 233 NA-MHL participants are shown in Table 1. Most participants (56%) were based in Australia or the United States of America (29%). The overall self-reported health of the participants was either 'good', 'very good', or 'excellent' (97%).

Table 1: Age distribution of NA-MHL group participants.

Age	Percentage of Participants
18-34	15%
35-64	67%
65+	18%

Exploratory Surveys – Clinicians

The majority of clinicians were based in Australia (74%), and the others in the United Kingdom (22%) and the United States of America (4%). Most of the clinicians' main workplace was located in an urban setting (70%), while the others worked in regional (24%) and rural/remote area (6%). Table 2 shows the clinical experience of the clinicians. More than

half the clinicians worked exclusively in assessment and rehabilitation with adults (60%), and the others with a mixed paediatric and adult caseload (40%). Table 2 also shows the number of NA-MHL clients clinicians report seeing per month. Clinicians identified self-referral (79%), and the GP (66%), as the two main client referral pathways to a hearing clinic appointment. Referral via Ear Nose and Throat specialists (19%), nurses (6%) and workplaces (6%), were less frequent; other sources included speech pathologists, psychologists and the Department of Veterans' Affairs.

Table 2: Clinical experience of the participating clinicians and number of NA-MHL clients clinicians report seeing per month.

		Percentage of Clinicians
Clinicians' clinical experience	Inexperienced (≤ 5 years)	26%
	Experienced (6-20 years)	40%
	Very experienced (> 20 years)	34%
Number of NA-MHL clients clinicians report seeing per month	0-1	32%
	2-5	45%
	6-10	21%
	10+	2%

Interviews – NA-MHL Group

All participants who took part in the interviews for the NA-MHL group were adults from Australia who self-reported speech-in-noise difficulties despite having a normal audiogram or mild hearing loss, and had seen a clinician for their hearing difficulties.

Interviews – Clinicians

All clinicians who took part in the interviews were also from Australia. Six of the seven clinicians who took part in the interviews had worked in the hearing field for 11-20 years in various roles including paediatric and/or adult diagnosis, assessment and rehabilitation, higher education and research. Eighty-six percent estimated that they saw five or less clients with NA-MHL per month, and 14% saw six to ten per month.

Exploratory Survey Results – NA-MHL Group and Clinicians

The Experience of NA-MHL

Typical Characteristics of NA-MHL Group

Clinicians typically described these clients as having normal audiograms or mild high-frequency sensorineural hearing loss (61%), speech-in-noise difficulties (38%) and associated issues including anxiety, fatigue and social withdrawal (30%). They also, but less frequently, described them as presenting with a mismatch between subjective and objective test results (13%); being less aware of their own hearing problem than others e.g., family members (9%); and working in noisy environments (9%).

Situations Related to NA-MHL Difficulties

When clinicians were asked to rank seven common hearing difficulties reported by clients with NA-MHL, situations involving listening to speech in background noise and multiple talkers received the highest ranking. When asked to describe difficult communication situations, clinician's and NA-MHL participants' responses referred to features of both the environment and speaker. In most cases these descriptions of environments specified physical locations (e.g., restaurants/cafes [27% of NA-MHL; 68% of clinicians], shopping centres [3%; 15%], and bars/pubs [10%; 23%]) (see Figure 1). Clinicians also described clients having difficulty in offices, especially when the design was open plan (11%). The NA-MHL group also described more general features of the

environment that contributed to their difficulties (e.g., reverberant venues like classrooms [4%] and windy places [2%]).

[Insert Figure 1 here]

Both groups made reference to social environments that were problematic. Thirty-three percent of the NA-MHL group and 79% of clinicians described listening environments with multi-speaker situations (including parties and groups) as difficult, with a number mentioning family gatherings specifically.

Difficult situations were also described as resulting from features of the speaker. In terms of speaker location, distance was noted by both groups (4% of the NA-MHL group and 8% of the clinicians), and speaker not facing the listener was an issue noted by 8% of the NA-MHL group. The NA-MHL group also described difficulties relating to voice quality (e.g., soft voice [6%], strong accents [3%], and unclear speech [3%]).

Situations including amplified speech was also noted as a problem for those with NA-MHL. Both groups noticed difficulties with the TV (11% of NA-MHL group and 8% of clinicians). Some NA-MHL group participants also mentioned listening on the phone (3%) as well as loudspeakers in open spaces such as airports or train stations (1%).

Reported Impacts of NA-MHL

Impacts reported by clinicians and the NA-MHL group included both emotional and social/behavioural impacts. Clinicians reported that clients described the biggest emotional impact of hearing difficulty as experiencing frustration (48%), but also said it caused them embarrassment (21%), anxiety/depression (14%), and stress and annoyance (11%). They reported that the main functional (day-to-day) impact clients described was social (41%) including isolation, reduced enjoyment, and feeling left out.

Experiences of Seeking Help

There were a number of reasons why people with NA-MHL were reported to have had their hearing assessed. Two of the most common motivations for seeking a hearing test described by both the NA-MHL group and clinicians were self-perception of hearing difficulty (24%; 32%) and family pressure (14%; 43%).

Other reasons given by NA-MHL group participants included, employment/routine health checks (21%), or for other hearing issues (e.g. surfers' ear, middle ear infection, surgery; tinnitus; or family incidence of hearing difficulty). Approximately 4% of NA-MHL group participants noted hearing assessment was opportunistic (e.g. a free hearing test in a shopping centre).

Clinicians also reported work as a motivator for NA-MHL clients with 32% describing visits resulting from difficulties clients were facing at work, and others noting clients concerns that hearing difficulties would negatively impact their job security (e.g., police officer, bar worker). Clinicians also reported motivators of social isolation experiences (27%), frustration (11%), and tinnitus (5%) by their NA-MHL clients.

Assessment Tools

Figure 2 shows the clinical tools clinicians find useful with NA-MHL clients; some answers focused on diagnostics and some on treatment and rehabilitation options. This figure shows that clinicians find speech-in-noise testing (44%), pure tone audiometry (37%) and discussion of communication strategies and tactics (28%) the most useful clinical tools.

For NA-MHL group participants, nearly all reported recalling having an audiogram (94%). However, fewer participants recalled speech-in-quiet testing (33%), and speech-in-noise testing (22%). When asked whether the tests results explained their hearing difficulties, 37% of participants reported "yes-fully". The most common feedback received by participants reporting partial-satisfaction (33%) or no-satisfaction (29%) was that 1) they did not accept being told that their hearing was normal or normal for their age, and 2) the tests

were incomplete and not representative of their difficulty, particularly when a speech-in-noise test was not conducted.

[Insert Figure 2 here]

A large proportion of NA-MHL participants (79%) reported that they were not offered a follow-up appointment. Some participants recalled being told that follow-up was not needed as there was little that could be done for their normal or (near-to-normal) hearing. Other NA-MHL participants reported they believed that their disinterest in buying a hearing aid influenced theirclinician's decision to not offer a follow up.

Some follow-up appointments reported by the participants were due to reasons unrelated to their NA-MHL experiences (e.g. wax removal, hearing aid fitting, yearly review/work assessment.) A small number of participants did report follow-ups to track their hearing performance over time to detect potential deterioration, and/or reported feeling that the clinician was concerned for their welfare.

Discussing Results

Clinicians reported that they do not use the above mentioned tools to discuss hearing and treatment options with their clients in a uniform or standardized way. When asked how they used results to discuss hearing and treatment options with their NA-MHL clients, the most common response was use of counselling about hearing and communication tactics (60%) and stress and anxiety (7%). Some clinicians discussed either the potential effectiveness of hearing aid/s, offered hearing aid trials (19%), or recommended ALDs (12%), while others reassured their clients that their hearing was 'OK' (12%). Several clinicians indicated that they refer clients for central auditory processing disorder (CAPD) assessment (5%) or auditory training (2%). Ten clinicians mentioned that they explain the

measured results (e.g., speech test) and use these to lead into discussion related to the issues the client reports and possible rehabilitation options.

Satisfaction with Appointments

Just over a quarter of NA-MHL group participants (26%) reported that they were 'very satisfied' with their hearing appointment. A further 46% reported being 'partially satisfied', and 26% reported being 'not satisfied'. Reasons for satisfaction included the belief that results accurately reflected hearing difficulties. For some, the lack of diagnosable loss was itself viewed as a positive outcome and cause for satisfaction, particularly where the assessment was work-related. Others reported that a 'mild loss' result provided a possible explanation for their difficulties and was therefore positive.

In contrast, positive results were a reason for dissatisfaction for some participants. They reported disappointment at the failure for their "good" results to account for their 'real-life' difficulties, and the resultant lack of opportunities for recommended treatments. Participants felt the options provided were limited and/or insufficient to solve their problems. Some felt that the clinician pushed to sell hearing aids, and some mentioned that the cost of hearing aids was prohibitive.

Participants also described concerns that testing was not comprehensive. Comments included suggestions that testing was not sufficient to describe their difficulty or seemed biased by theclinician's interpretation.

Experiences of Treatment

Treatments Offered

Less than a quarter of participants recalled receiving any offer of treatment from theclinician. Of these, the majority of recommendations (80%) were for a hearing aid.

Figure 3 shows participants' willingness to use different options that may help improve their communication experience. This figure shows that 1) the number of

participants ‘ready & willing’ to use hearables was significantly higher than those willing to use hearing aids (62% vs. 32%); 2) a large number of participants (60%) were willing to try a smartphone app used with earphones aiming to improve their communication experience in noisy scenarios; and 3) the most popular options for willingness to use in the future was hearing aids (46%) and an online communication training course (36%).

[Insert Figure 3 here]

When asked about their preferred solutions for improving their communication experience, NA-MHL group participants often used words such as discreet, unobtrusive, invisible, inexpensive, and easy-to-pair with smartphones. One participant described the ideal solution as *“a very small device that is barely noticeable and is very comfortable to wear (i.e. doesn’t block the ear canal). Blocks/cancels background noise, but not speech and allows phone calls in noise. Low cost < $1000”*.

Treatment and aural rehabilitation options and uptake

When asked whether, in their experience, NA-MHL clients typically receive any form of aural rehabilitation approximately one third (30%) of the clinicians answered “no”, two thirds (61%) answered “yes”, and the rest indicated they “don’t know”. Figure 4 shows the reasons clinicians selected to explain why some clients do not receive any aural rehabilitation. The top three were that clients were either not interested (31%) e.g., one clinician wrote “*clients are reluctant to use devices ….they want a cure not a partial solution that still relies on them having to use a device*”, not eligible (29%), or the clinician thought that appropriate rehabilitation options were not available for this population (19%). A further 5% of clinicians indicated that affordability also affected whether clients received rehabilitation and 14% answered they “don’t know”.

[Insert Figure 4 here]

Figure 5 shows the clinicians' estimate of the percentage of NA-MHL clients that they see who do choose treatment (if offered). Fifty-one percent of the clinicians surveyed estimated that ≤ 10% of the clients that come to see them choose treatment for their speech-in-noise difficulties. Clinicians suggested that cost (54%), self-perceived difficulty (30%) and motivation (26%) were the main factors influencing the clients' decision to pursue treatment; they also suggested that, to a lesser degree, the utility (5%) and appearance (7%) of devices, client age (5%) and clinician recommendation/s (5%) played a role.

Clinicians estimated that clients choosing rehabilitation typically received one or more of the following: counselling (79%), individual (49%) or group (9%) communication training, hearing aid/s (49%) or other hearing devices such as ALDs (51%), remote microphones (26%), hearables (19%) or referral to another service (23%). They also responded that other rehabilitation included speech pathology, central auditory processing disorder intervention, and internet and app 'training'.

[Insert Figure 5 here]

Hearables

Just over half (53%) of the clinicians who responded indicated that they never recommend hearables to their NA-MHL clients and a further 24% rarely did. The proportion of clinicians who sometimes, or often recommended hearables for these clients was comparatively low (22%). One clinician disclosed that *"I was really excited about hearables …. they are just so big I think they are unusable although there is a need for them."*

Treatment Outcomes

For NA-MHL group participants using hearing aids, satisfaction was diffuse (see Figure 6). Both satisfied and dissatisfied users reported some negatives associated with their

use (e.g. the cost-benefit was considered too low, practical difficulties of wearing devices such as incompatibility with headphones/Bluetooth devices).

[Insert Figure 6 here]

Figure 7 illustrates clinicians' opinion about how effectively seven potential treatment options (hearing aids, other hearing devices, counselling, individual or group communication training, hearables and remote microphone) address the speech-in-noise difficulties experienced by people with NA-MHL. Overall, the majority of clinicians rated hearing aids, other hearing devices, counselling and individual communication training as either 'a little' or somewhat effective' but were 'unsure' about the effectiveness of group communication and hearables. Remote microphones were most frequently rated as either 'somewhat' or 'very effective'.

[Insert Figure 7 here]

Measurement of Rehabilitation Outcomes/Success

Clinicians measured the outcomes or 'success' by measuring client satisfaction (74%), Client Oriented Scale of Improvement (COSI; National Acoustic Laboratories) goals (55%), family member feedback (53%), questionnaire (30%) and speech tests (26%). One clinician indicated that they do not measure outcomes, another that they do not hear back from clients, and another that none of their clients had accepted treatment.

Figure 8 shows the level of confidence clinicians felt that their recommended treatment options address NA-MHL client concerns. Thirty-three percent and 31% respectively fell in the middle quartiles, while 25% fell in the bottom quartile (least confident) and only 13% fell in the top quartile (most confident).

[Insert Figure 8 here]

Approximately one third (32%) of the clinicians indicated that ideally, of seven potential treatment options (none, hearing aids, other hearing devices, counselling, individual or group communication training, referral), they would prefer to provide other hearing devices to this population. The remaining clinicians preferred counselling (18%) and individual communication training (16%) and a further 11% selected hearing aids. None of the clinicians surveyed considered no treatment as an ideal option and 16% said that they did not know what treatment they would prefer to provide.

Clinical Services

Training and resources

Only a small proportion of clinicians (18%) felt that they had appropriate training and resources to assist NA-MHL clients, and many clinicians (44%) indicated that both their training and resources were inadequate. Others felt either their training (4%) or resources (45%) were inadequate, and the remainder were unsure (9%).

When asked for their ideas about what underlies NA-MHL clients' speech-in-noise difficulties, clinicians suggested numerous potential aetiologies. The most common were auditory processing (49%), extended high frequency hearing threshold levels (2%), cochlear synaptopathy or neural pathway deficits (17%), cognition (22%) and psychosocial issues e.g., motivation, anxiety or stress, expectations (10%). Other miscellaneous suggestions included mild hearing loss, other health conditions, poor communication tactics and distracting technology and the surrounding listening environment.

Clinician needs and barriers to providing rehabilitation services

In order to better help NA-MHL clients, clinicians said they needed evidence-based clinical tools and guidelines (including ecologically valid speech-in-noise tests) (46%), further training and education (34%) about NA-MHL, access to the latest devices and

technology (including online training options), improved counselling skills (22%) and resources such as information handouts/leaflets (17%) to give their clients.

Clinicians reported that the main barriers they encountered to providing rehabilitation services to NA-MHL clients related to eligibility, funding, and costs (51%). Other barriers included their own clinical inexperience with and lack of knowledge of NA-MHL (22%), lack of evidence based tests and solutions (12%) and the clients motivation to undergo rehabilitation (12%).

Future research suggestions

Clinicians suggested a number of avenues for future research including the development of speech-in-noise assessment tools and advanced hearing aid options, random control trials assessing the effectiveness of different treatment options and outcomes for this population. For example, one clinician surveyed answered that "*it would be useful to have research that could lead to an evidence-based test battery, guidelines for management, and effective rehabilitation programs*".

Interview Results – NA-MHL Group and Clinicians

The Experience of NA-MHL

In interviews, participants discussed the emotional impact of NA-MHL in relation to their quality of life. Participants described the additional effort required to navigate conversations, including the need to ask for repeats, which could lead to anxiety and less enjoyment of conversations. For example, one participant said *"I find myself concerned if I know I'm going to be going to an event where this sort of situation is likely to arise. Not agitated, but more feeling like I have to put my armour on a bit and go, okay, well you gotta prepare yourself, this is going to happen, and steel myself. And it does take some of the pleasure of being around people*".

One participant noted that they took on the responsibility and effort of navigating the communication rather than acknowledging difficulties or tasking the speaker with lengthy repeats: *"I don't say to people that I can't hear or I'm having difficulty hearing. In a crowded situation it usually ends up me just saying, "would you mind repeating that, I missed that bit". Whereas I could have missed the whole conversation. But I generally try to find a way of picking up bits and pieces interpolating what the rest of it must have been".*

As reported by one participant, missing information in conversations provoked frustration, and anxiety about potential misinterpretation/s of their reactions: *"Often the partner is the only one who can be brutally honest with you – saying didn't you hear them? They were talking to you and you're just completely ignoring them. I wasn't aware of a conversation or someone asking the question, and I was horrified to think that I was completely rude"*

As a consequence, NA-MHL participants reported making changes in their behaviour, preferences, or daily routines: 1) *"It just makes me feel disinclined to go out, and when I do go I tend to avoid restaurants and cafes and anything which is likely to be a crowd of people, unfortunately", 2) "And there's this huge crowd of people in the place and I pretty much I gave up trying to hold a conversation with anyone because there's just so much background noise that it's, you know, I have difficulty making out what people are saying or holding an intelligent conversation".*

Experiences of Seeking Help

Interviews with the NA-MHL group revealed that the current test battery does not reflect the real-world problems they are having. One participant remarked *"Because I was being tested in the environment that's just like a clinic, basically, there was no background noise … it's not the same as being in a noisy bar and be able to make an actual conversation."*

Interviews with clinicians further highlighted that there is no evidence-based appointment test protocol or guidelines available and clinicians provide different explanations and advice based on similar test results. For example, one clinician said *"...there is an issue that people have, where they have normal hearing, but still can't cope well, and it's a bit sad, there isn't really a test that we have available for clinicians to use to show whether someone has an abnormally high difficulty with noise compared to other people*". Another said *"I try to help them understand the way the hearing system works, how noise works in the world and why they absolutely could be experiencing this and I suppose also that it is very personal. I let them know that I could have five people with the same test results and they are all going to have a very individual experience*."

In the survey results reported previously, only a small number of participants reported follow-up appointments with their clinicians. However, in the interviews one clinician did say *"I always recommend they come in for a free screening every twelve months. It gives an opportunity to monitor hearing and let them know if any new technology has come on the market".*

Experiences of Treatment

Clinicians felt that they did not have rehabilitation options that they were confident in. An interview with one clinician revealed "*I quite often feel that I am not doing a really good job because they (clients) come in wanting an answer and I can't give it to them."* Another said "*I guess not that confident, I think you do kind of feel helpless with this population because you don't know what's going to help them, or why they're having greater difficulties than they necessarily should be having."*

Interviews with the NA-MHL group also revealed that there is a lack of treatment options for this population, and in particular that clinicians said that hearing aids were not needed as their hearing loss was not great enough. One participant said, referring to their

clinician, *"She said basically there's nothing needed. Because [the hearing loss] was only in a couple of minor frequencies, she said you'd hardly even notice it. It's not at the stage where we're looking at devices or anything to deal with it because she said even if you got fitted with the hearing aid or something you probably wouldn't even notice the difference, it's that minor."* Another participant remarked that *"At that stage, it wasn't at a point where the audiologist thought you really need hearing aids, it was more you will need them at some point, or you will find them beneficial at some point, but it's touch and go as to whether you need from now."*

Additional Experiences

Participants from the NA-MHL group highlighted the need for increasing public awareness of their hearing difficulties, improving the design of public venues, as well as promoting healthy hearing habits that would prevent hearing deterioration. As reported by different NA-MHL participants: 1) *"One thing that has occurred to me is like, why there's just not more public education and public awareness of the difficulty of some people unable to hear in really noisy places; and why it's necessary for venues to have the music turned not so loud. You know, for cafes as well… it just feels very the trend in, you know, public bars and restaurants and stuff like that, it's just not enough consideration given how noisy a place is when you fill it with hundreds of people, and live music, and whatever, you know, like chairs that make lots of noise."*; and 2) *"It's almost like no thought at all is given to the auditory experience and being in a public space these days."*

Future research suggestions

Similar avenues for future research were identified in the interviews as the surveys, for example, one clinician reflected in an interview that "*it would be useful for clinicians if we had an assessment tool to figure out if someone has poorer than normal speech in noise".*

Discussion

We explored the perspectives of people with NA-MHL and greater than expected difficulty listening in noise and clinicians in order to better understand their experiences of the clinical pathway and treatment. We found that the clinicians' insights resonate with the NA-MHL group lived experiences. Through a design thinking approach, using exploratory surveys and interviews, we identified a number of research needs which would inform clients and clinicians dealing with NA-MHL. We grouped these into three main areas: the experience of NA-MHL, help-seeking behaviours, and treatment. Some of the needs relate to basic research (in terms of describing and understanding the underlying processes), while others are linked to more practical, applied research (particularly in relation to assessment and treatment).

The Experience of NA-MHL

This study found that clients and clinicians described features of difficult listening environments, and the lived experience and impact of NA-MHL, similarly. These features relate to the physical characteristics of the environment itself, and more general attributes of the speaker. Background noise involving conversation with other talkers was a primary source of listening difficulty, a finding consistent with Pang et al. (2019) and with laboratory-based investigations reporting poorer speech-in-noise test performances when target speech was masked by other speech sounds relative to speech-shaped noise (Hornsby et al., 2006; Desjardin & Doherty, 2013). Our NA-MHL group also indicated that general features in the physical design of difficult listening environments (for example reverberant and open-plan spaces), and the inherent nature of social events (which generally features substantial speech-based background noise) are problematic (see also Hall III et al., 2002; Hornsby et al., 2006; Mattys et al., 2012). Collectively, this informs the need to encourage the design and building of public spaces in such a way that communication is optimised. Additionally, there appears

to be a need to characterise the acoustic environment and ease-of-communication in crowded public venues such as restaurants and clubs in order to provide adults with speech-in-noise difficulties (and the broader community) with an indicator of their potential hearing experience in those places.

Characteristics

In asking participants and clinicians about their experiences, the authors attempted to form an understanding of NA-MHL and its impact. The experiences described by the NA-MHL group and clinicians provide important insights about needs requiring attention in both the help-seeking and treatment stages.

The experiences also inform the need for defining the group, not just in relation to behavioural test findings (such as audiograms, speech-in-noise test results), but also psychosocial characteristics. Both clients and clinicians were clear that a discrepancy exists between behavioural test results and self-reported hearing difficulties, which is consistent with findings of several other researchers (Alicea & Doherty, 2017; Spankovich et al., 2018). This emphasises the importance of conducting basic research to form a consensus, and develop accurate criteria for defining and characterising the NA-MHL population in order to promote effective communication between clients and clinicians, leading to appropriate treatment/remedial measures.

Impacts

Reduced enjoyment of social activities, frustration, anxiety, and withdrawal and isolation are some of the emotional and social impacts reported by our NA-MHL group, which in some cases resulted in changes to social behaviour and preferences. These emotional and social impacts are also reflected in previous studies of those with normal hearing thresholds but difficulties listening in noise (Alicea & Doherty, 2017; Hornsby & Kipp, 2016). However, in practice, little has been done to address this and appointments are

often clinician-centred, with a substantial amount of time spent providing technological solutions to hearing difficulties rather than addressing the psychosocial needs of clients (Meyer et al., 2017; Grenness et al., 2014). Increasingly, the importance of understanding and addressing the psychosocial impacts of hearing difficulties is being acknowledged and integrated into more holistic models of hearing health care in order to improve clinical outcomes for those with hearing difficulties (Heffernan et al., 2016; Ekberg et al., 2014).

The Experiences of Help Seeking for NA-MHL

It is noteworthy that the two main motivations for seeking hearing assessment in our NA-MHL group were self-referral (24%), and family pressure (14%). Other reasons for seeking help included employment requirements, other auditory complaints, and unplanned opportunities to get a hearing assessment e.g. a free hearing test in a shopping centre. Given that self-assessment and help-seeking behaviour is one of the most robust predictors of intervention uptake, an opportunity exists to implement more effective strategies that would motivate the remaining 72% of those receiving assessment for reasons other than self-referral or an opportunistic test. This has additional implications for client-clinician engagement, and the potential to influence intervention decisions and hearing health outcomes (Laplante-Levesque et al., 2011; Poost-Foroosh et al., 2011; Pryce et al., 2016). Furthermore, clients' readiness to seek help for hearing difficulties should not be misconstrued as readiness to engage in treatment (Claesen & Pryce, 2012).

Assessment Tools

Our results indicated that at the very least clinicians and clients require improved assessment procedures and ideally the development of standardised clinical assessment protocols. In order to be effective, these need to take into account the NA-MHL group's functional difficulties in addition to their objective listening performance results. Such an approach would enable more effective monitoring and provide justification for follow-up

appointments. Better quality methods would likely also improve the NA-MHL group's confidence in hearing assessment procedures, although this should not preclude assessing hearing difficulties from the clients' perspectives, including their motivation and reasons for seeking help (Claesen & Pryce, 2012). For many years, researchers have sought to investigate NA-MHL within the context of a bio-medical model, but have yet to reach a consensus regarding the underlying nature and experience of the hearing difficulty. Future research efforts may be better directed towards the importance of managing the symptoms and addressing the functional impacts of this population (Pryce & Wainwright, 2008; Bramhall et al., 2019; Convery et al., 2019).

Satisfaction with Appointments

The majority of our NA-MHL group expressed dissatisfaction with the outcomes of the assessment appointment, which for some, resulted in limited recommended treatment options. In part, this stemmed from the belief that the current test battery is unable to fully account for the difficulties the clients present, and that there is heterogeneity of advice based on similar test results. A converging pattern of responses was observed in a study by Pryce and Wainwright (2008) who investigated help-seeking for medically unexplained hearing difficulties. They reported that confusion (with respect to reason for testing), questioning of test results (on the basis of validity and sensitivity of the assessment tool), and dismissal (the notion that symptoms are not recognised or accepted as legitimate) were some of the salient characteristics of 'negative consultations', which are also seen as barriers to the coping process for clients. Moreover, when discussion of test results are clinician-led rather than client-focused, clients' preferences were not heard (resulting in lack of shared decision-making), and expectations not met. Therefore, an opportunity exists to develop better guidelines for explaining results to the NA-MHL group, and to enhance clinicians communication and empathic listening skills as a means of validating and addressing clients'

concerns thus facilitating client-clinician interactions (Pryce & Wainwright, 2008; Laplante-Levesque et al., 2011; Ekberg et al., 2014; Pryce, 2015; Convery et al., 2019).

The Experience of Treatment

Perhaps unsurprisingly, many clinicians do not feel confident recommending treatment, as there is very little research on the efficacy of remedial options for this population (Pryce, 2015). This informs the need to gather evidence about the effectiveness of different treatment options to increase clinician confidence in addressing clients presenting concerns.

Treatment Offered

Clients reported a diverse range of satisfaction with treatment options offered, and that these were in contrast to their own treatment preferences. This may reflect a lack of client-clinician engagement in our NA-MHL group, as it is known this relationship directly influences the level of agreement about treatment plans, irrespective of clients' willingness to use it (Adams et al., 2012; Convery et al., 2019). Additionally, clinicians from our study felt that their recommendations played a minor role in clients' decision making, which contradicts what we know from this research.

Less than a quarter of participants recalled receiving any offer of treatment from theclinician. Of those that were offered treatment, the majority (80%) of recommendations for this group involved hearing aids. This occurred even though there is currently limited evidence supporting the benefit of hearing aids for those with NA-MHL (Roup et al., 2018) and despite the body of literature indicating that providing this population with informational counselling, and personalised communication strategies to reduce communication disruption, particularly in environments where listening difficulties occur, is proven to be helpful (Borg & Stephens, 2003; Claesen & Pryce, 2012).

The NA-MHL group's preferred treatment often takes into consideration factors such as costs, appearance, and compatibility with smartphones, which is in contrast to clinicians' impression that the main factors that influence treatment uptake are motivation, self-perceived difficulty and costs. This mismatched perception of personal factors that contribute to the decision making process for treatment acceptance may be a barrier to successful treatment. Furthermore, clinicians revealed that uptake of treatment is very low for the NA-MHL population due to number of reasons that includes disinterest, reluctance, lack of suitable treatment options, and affordability. For clinicians, this signals the need to modify their approach to identifying treatment needs from the clients' perspective in order to encourage a more co-operative relationship and facilitate compliance to treatment.

Treatment Outcomes

Only 13% of clinicians felt confident that their recommended treatment options address NA-MHL client concerns. Clinicians commented that they feel unsure about what is going to help a client with these difficulties. This is not just true for clinicians; Pang et al. (2019) found that 43% of people experiencing difficulties hearing speech in noise indicated a lack of awareness of remediation tools available. Therefore there is a need to evaluate treatment options to provide an evidence base of what interventions may help this population. To date there has not been much research in this area except Roup et al. (2018) who recently investigated mild-gain hearing aids as a treatment option for adults with a normal audiogram but self-reported hearing difficulties in complex listening situations. Roup et al. (2018) found significant improvements in the participants' self-reported hearing difficulties and their speech-in-noise performance when using the device. This study recognised, however, that it did not include a placebo control group, so we are now conducting a study to assess if there is a placebo effect.

Hearing aids are not the only potential solution for people with NA-MHL. Clinicians also noted other hearing devices, counselling, and communication training as options for this population. In fact, approximately one third of the clinicians indicated that they would prefer to provide other hearing devices to this population. Therefore more research is needed to assess if other hearing devices such as hearables can benefit people with NA-MHL. Interestingly, Pang et al. (2019) found this population actually preferred the idea of communication training over devices as a remediation option, so future research into the efficacy of training is also needed.

There is also a need to understand why some options may work better for some clients than others, and characterise what aspects affect a particular client's success from the treatment. This will help predict which option a client may benefit from most. Furthermore, there is a need to evaluate individuals' desire to use treatment and their acceptability of technological solutions. Many NA-MHL participants commented that they wanted a discreet option, so it is important that this is taken into consideration by the clinicians so they are suggesting options that the client would be comfortable using. There is also a need to develop better training/support for clinicians to work with clients through their treatment pathway.

The Design Thinking Approach

Using a design thinking approach differs from much of the current research in the field. Most research focuses on the bio-medical model of detecting, measuring, and remediating biologically based impairments, rather than understanding the needs and experiences of the individual. The advantage of using a design thinking approach is that it allows researchers to understand aspects of a problem via direct communication with those involved. This is the first step to finding new solutions that can address the problem (Yock et al., 2015). The design thinking approach in the current study provided insight into the daily lives of those experiencing speech-in-noise difficulties and the clinicians who see these

people. This allowed us to identify the needs to address these issues as discussed above. Understanding this population's needs is the first step to designing effective projects that may eventually improve their quality of life.

Limitations

While design thinking provides helpful insight into the issues that need to be addressed from the people experiencing the problem, it has its limitations. For example, it deals with the symptoms that people are experiencing rather than addressing the underlying mechanisms that are causing the problem. Therefore, using a design thinking approach along with a bio-medical model approach is important so that both aspects of the problem are addressed. This study also had other limitations. We surveyed two different NA-MHL groups: sixty-seven of the participants were from the general population, but 166 were recruited from the database of Nuheara, a hearables company. The responses between the two groups were similar, but it is important to note the selection bias as the Nuheara group are a unique population. Most of the Nuheara participants were male (84%) and middle-aged, so caution is required when generalising the results to the general population. This group also had a bias of experiencing a specific product and its marketing. Another limitation is the use of self-reported surveys. Self-report studies have validity issues as they rely on people's accurate judgement and memory of events. This is also an issue in using interview data as participants might either exaggerate or understate their symptoms, or misremember situations. Ecological momentary assessments where a person fills out a survey on their phone while they are in the event is one way of minimising this issue which could be used in the future. Additionally, the surveys were not piloted or validated as this is not part of the exploratory design thinking process. It may therefore be useful to conduct a follow-up study with that includes the assessment of validity and reliability of the questionnaires. Further, this study had a focus on hearables as potential interventions for this population as hearables are

becoming more popular on the market. It would be beneficial for future studies to also explore other potential interventions including other devices and auditory or communication training.

Future Directions

The design thinking process involves three phases: identify, invent, and implement. This paper focused on the need finding aspect of the identify phase by utilising observations and interviews to define the core problem, the population affected by the problem, and the desired outcome (Yock et al., 2015). Future research is needed now to take these needs and develop projects to address them. The purpose of the invent phase is to "devise solutions to one or more defined needs, taking advantage of creative ideation techniques, prototyping and testing methods and a filtering process that is based on objective risk criteria" (Yock et al., 2015). These solutions can then be implemented in the final phase of the design thinking process. Completion of the full design thinking process may help to improve the quality of life for this population. Additionally, a design thinking approach could be used to identify the needs of other populations such as those with hearing loss, whose needs may overlap to some degree with those identified in this study.

Conclusions

This study employed a design thinking approach to identify and better understand the experiences of people with NA-MHL and greater than expected difficulty hearing speech-in-noise. Both clients and clinicians identified a discrepancy between behavioural test results and self-reported hearing difficulties. There is therefore a need for evidence based, standardised clinical assessment protocols that are ecological to addresses these issues. The findings of this study also demonstrated a lack of an evidence base to direct clinicians' prescription of treatment and to advise clients what is most likely to be successful for their

individual situation. Consequently, there is a need to evaluate different treatment options for different individuals to determine which option a client may benefit from most. Addressing these needs and those discussed in the paper may help improve the quality of life of people with NA-MHL and help clinicians diagnose, support, and provide appropriate rehabilitation strategies for the population.

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Data Accessibility Statement

Data will be made available upon reasonable request.

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Figures

Figure 1. Listening environments clients report most difficulty in according to clinicians.

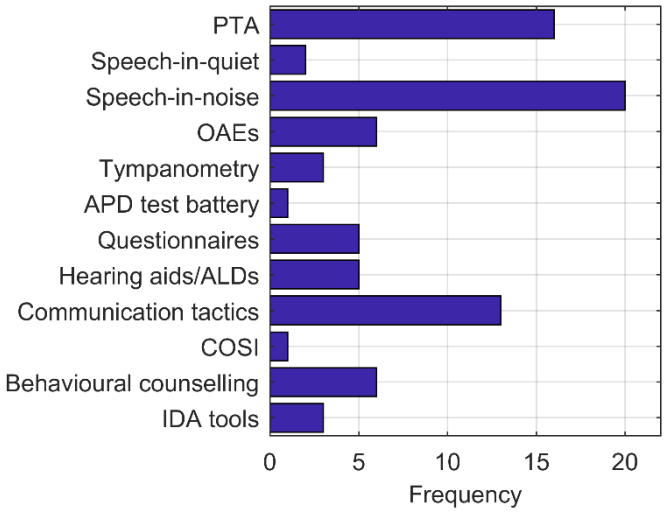

Figure 2. The clinical tools clinicians find useful with clients with a normal audiogram or mild hearing loss (NA-MHL) clients. ALDs, assistive listening device; APD, auditory processing disorder; COSI, Client Oriented Scale of Improvement (National Acoustic Laboratories); IDA, Idainstitute; OAEs, otoacoustic emissions; PTA, pure tone audiometry.

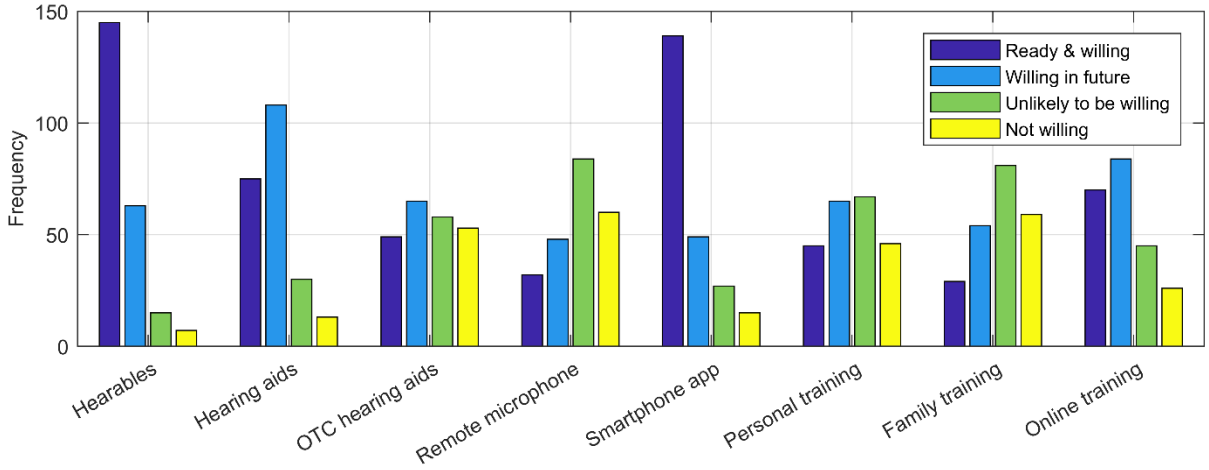

Figure 3. Number of participants willing to use different options that aim to improve their communication experience. OTC, over the counter.

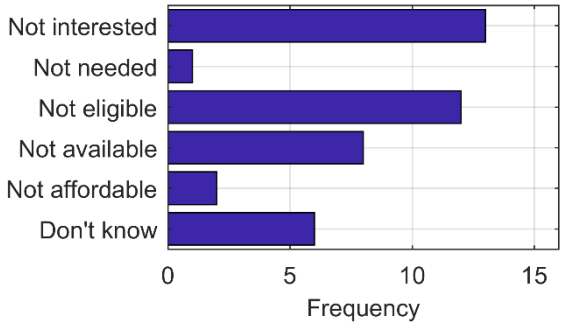

Figure 4. Number of clinicians reporting different reasons that explain why clients with a normal audiogram or mild hearing loss (NA-MHL) do not receive aural rehabilitation.

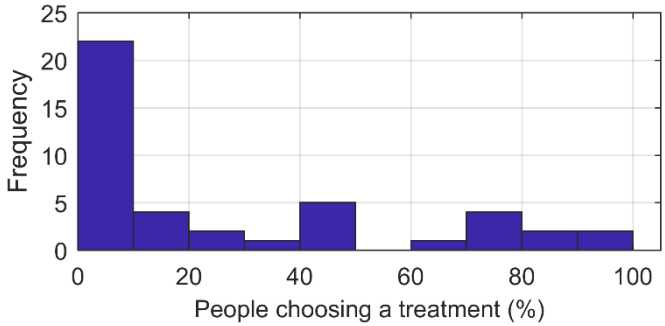

Figure 5. Number of clinicians reporting the percentage of clients with a normal audiogram or mild hearing loss (NA-MHL) who, if offered, choose treatment.

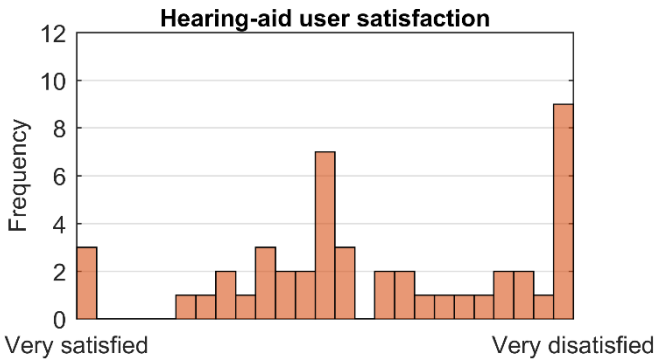

Figure 6. Number of participants reporting different levels of hearing aid satisfaction.

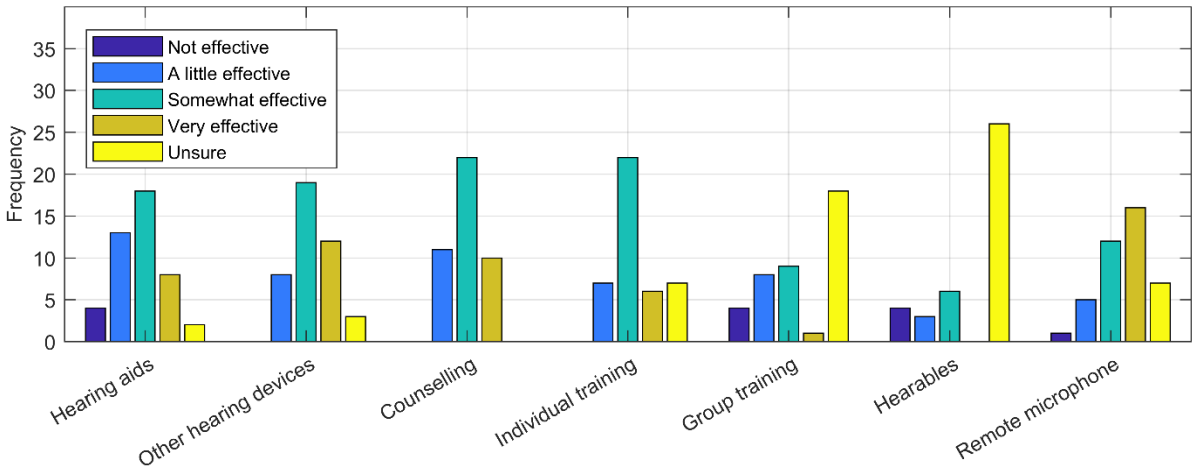

Figure 7. Clinicians estimate of effectiveness of treatment options for clients with a normal audiogram or mild hearing loss (NA-MHL) and speech-in-noise difficulties.

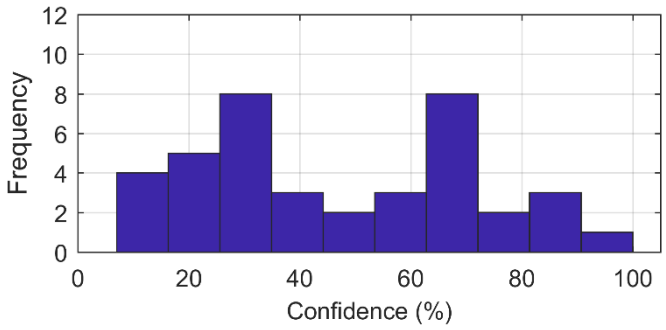

Figure 8. Clinicians' confidence that treatment options address concerns of clients with a normal audiogram or mild hearing loss (NA-MHL).

Appendix A – NA-MHL Group Survey

1) Do you have difficulty understanding speech in noisy environments?
( ) Yes
( ) No

2) Have you had a hearing test before?
( ) Yes
( ) No

3) How did your audiologist/clinician describe your hearing test result?

	Normal	Mild	Moderate	Severe/Profound	Unsure
Left Ear	( )	( )	( )	( )	( )
Right Ear	( )	( )	( )	( )	( )

4) Are you:
( ) Female
( ) Male
( ) Indeterminate/intersex/unspecified

5) How old are you?
( ) 18-34 years
( ) 35-64 years
( ) 65 or over

6) Do you speak a language other than English?*
( ) No, English only
( ) Yes, Italian
( ) Yes, Greek
( ) Yes, Cantonese
( ) Yes, Arabic
( ) Yes, Vietnamese
( ) Yes, Mandarin
( ) Yes, other (please specify):: _____

7) What country do you live in? (if in Australia, please enter your postcode)
_____

8) Select the option that best describes your current job
( ) Community/personal worker
( ) Clerical/administrative worker
( ) Labourer
( ) Machinery operator/driver
( ) Manager
( ) Professional
( ) Sales worker
( ) Technician/trade worker
( ) Student
( ) Full time home duties
( ) Retired
( ) Currently not working
( ) Other - Write In: _____

9) In general, would you say your health is
( ) Excellent
( ) Very good
( ) Good
( ) Fair
( ) Poor

10) When you have free time, do you:
( ) almost always prefer to do something with others
( ) usually prefer to do something with others
( ) sometimes like to be with others but also enjoy spending time by yourself
( ) usually prefer to spend time alone
( ) almost always prefer to spend time alone

11) Do you, or other people notice any problems with your hearing?
( ) Yes, please describe: _____
( ) No
( ) I don't know

12) Do you mishear and confuse similar sounding words (e.g. "fifty" and "fifteen", "thirsty" and "Thursday", "ships" and "chips". etc.) in quiet places?
( ) Never
( ) Rarely
( ) Sometimes
( ) Often
( ) Almost always

13) Do you ask people to repeat themselves when conversing in noisy places?
( ) Never

( ) Rarely
( ) Sometimes
( ) Often
( ) Almost always

14) Are you able to focus easily when doing non-listening tasks (e.g. reading, chores)?
( ) Never
( ) Rarely
( ) Sometimes
( ) Often
( ) Almost always

15) Tinnitus is defined as any sound that a person can hear internally that is not present externally. It may be heard as a buzzing, ringing, whistling, hissing or pulsing sound. Have you ever experienced tinnitus?
( ) Never
( ) Occasionally
( ) Sometimes
( ) Frequently
( ) Almost always
( ) Unsure

16) Where do you hear the tinnitus?
( ) Left ear only
( ) Right ear only
( ) Both ears
( ) In my head
( ) Other - please describe: _____

17) Who prompted you to seek hearing assessment or treatment?
_____
_____
_____
_____

18) Can you describe the situations in which you experience your listening difficulties?
_____
_____
_____
_____

19) What tests were conducted in your appointment? Please select all that applies
( ) Hearing tone test ('press the button when you hear a beep/tone')
( ) Speech-in-quiet test (test repeating words or sentences without background noise)

( ) Speech-in-noise test (test repeating words or sentences in noise)
( ) Other - Write In: _____
( ) Unsure

20) Do you feel that the information the audiologist/clinician gave you about your hearing test results adequately explained your hearing difficulties?
( ) Yes - fully
( ) Yes - partially
( ) No

21) Why?
_____
_____
_____
_____

22) Were you offered a device or treatment option(s)?
( ) Yes
( ) No

23) What does it involve?
_____
_____
_____
_____

24) Are you satisfied with the treatment plan?
0 _____[__]_____ 100

25) At the end of your hearing test appointment, were you satisfied with the outcome?
( ) Yes, very
( ) Yes, somewhat
( ) No

26) Why?
_____
_____
_____
_____

27) Did your audiologist suggest a follow up appointment (in relation to things discussed in the hearing test appointment)?
( ) Yes
( ) No

28) Why?

_____
_____
_____
_____

29) Which of the following options would you consider using to assist with your listening difficulties?

	Ready & willing	Willing in future	Unlikely to be willing	Not willing
Smartphone App: An app used with earphones which provides different settings for different situations to amplify a speaker's voice or a specific sound source over background noise.	( )	( )	( )	( )
Personalised Hearing Aids: On-ear or in-ear devices fitted by a professional; may also include additional features to assist in hearing	( )	( )	( )	( )

in different situations.				
Store-bought Hearing Aids: On-ear or in-ear devices that are purchased online or in non-specialist stores without individual fitting. These would be cheaper than professionally fitted hearing aids and might be limited in features.	( )	( )	( )	( )
Hearables: Earphones that automatically improve the hearing experience of the listener by filtering out background noise.	( )	( )	( )	( )
Remote Microphone with Earphones: A microphone device worn by the speaker that transmits speech to the	( )	( )	( )	( )

listener's earphones.				
Personal Communication Training Course: Run by a professional, the course would provide opportunity to discuss communication issues and practice listening strategies.	( )	( )	( )	( )
Family Communication Training Course: Run by a professional, the training course would help you and your partner and/or family/friends to discuss communication difficulties and practice strategies.	( )	( )	( )	( )
Online Communication Training Course: An online training course, completed at	( )	( )	( )	( )

your own pace that provides tips and information for communicating and listening in difficult situations.				

30) Please rank how important (from most to least) the following factors are when choosing a treatment option:
_____Cost
_____Efficacy of treatment
_____Appearance/stigma
_____Ease of use

31) Are there other treatment/remediation options you would be willing to try?
_____
_____
_____
_____

32) Before today, did you know what a hearable was?
( ) Yes
( ) No

33) Do you know where you can purchase a hearable?
( ) Yes
( ) No

34) Please list down all the places you could use a hearable to improve listening to speech in noisy situations:
_____
_____
_____
_____

35) Please list down all the places you could purchase a hearable from:
_____
_____
_____
_____

36) Would you use a hearable if it made it easier to listen to speech in noisy situations?
( ) Yes
( ) No
( ) Unsure

37) Why not? Please check all that applies
( ) I am not interested in rehabilitation
( ) I do not think I need rehabilitation
( ) I am not eligible for rehabilitation services
( ) I do not think the rehabilitation options are appropriate for me
( ) Affordability
( ) Don't know
( ) Other - please explain:: _____

38) What is your ideal solution to your listening difficulties?
_____
_____
_____
_____

39) How did you find out about our survey?
( ) Facebook
( ) Twitter
( ) LinkedIn
( ) Reddit
( ) Email
( ) A friend
( ) 1 in 6 Newsletter
( ) Hearing Matters Magazine
( ) Other - Write In: _____

Thank You!

Appendix B – Clinician Survey

1) A little about you
Gender
( ) Male
( ) Female
( ) Indeterminate/unspecified/other

Age: _____

Where do you mainly work?
( ) Australia
( ) Other: _____*

Where is your main workplace located?
( ) City/urban area
( ) Regional
( ) Rural/Remote

How many years' experience do you have as an audiologist?
( ) Less than 2 years
( ) 3-5 years
( ) 6-10 years
( ) 11-20 years
( ) More than 20 years

Which of the following best describes your clinical work?
( ) Paediatric assessment and/or rehabilitation
( ) Adult assessment and/or rehabilitation
( ) Both paediatric and adult diagnostic assessment and/or rehabilitation
( ) Diagnostic vestibular work

2) How would YOU describe the typical characteristics of this group?
If it helps, think about what descriptions you would use to help a new audiologist identify people who might be part of this NH-MHL group. e.g., The shape of their audiogram? Their results on other tests? In addition to speech-in-noise issues, what are their common complaints?

_____
_____
_____
_____

3) How many clients do you see each month who would meet this NH-MHL definition?
( ) 1 or less

( ) 2-5
( ) 6-10
( ) Over 10

4) Overall, what is the approximate proportion (in %) of NH-MHL clients you see in each age range below?
_____Under 12 years
_____13-17 years
_____18-34 years
_____35-64 years
_____65 or over

5) What are the main referral paths for your NH-MHL clients? *(Tick all that apply)*
( ) Client self-referred
( ) Ear Nose Throat Specialist
( ) Doctor/General Pracitioner
( ) Nurse
( ) Workplace/Employer
( ) Other - Write In: _____

6) What listening environments do these clients report having most difficulty in? (i.e., physical spaces that are frequently described as difficult)
_____
_____
_____
_____

7) In what listening situations do these clients report experiencing most difficulty? (e.g., location/number of conversation partners or sound source)
_____
_____
_____
_____

8) Are there any other common reasons that these clients give for making an appointment to see you? (e.g. need for better communication experience at work)
_____
_____
_____
_____

9) How do NH-MHL clients describe the functional (day-to-day) and emotional impact that their hearing difficulties have on them?
_____

_____
_____
_____

10) Out of the following categories, what are the most common hearing difficulties NH-MHL clients report having? (*rank from most to least frequent*)
_____Speech in one-on-one conversation
_____Speech over distance
_____Speech without visual cues (e.g. conversing while driving)
_____Other - Write In
_____Speech in background noise
_____Multiple talkers
_____Listening to music
_____Talking on the phone

11) What clinical tools do you find useful with NH-MHL clients?
_____
_____
_____
_____

12) How do you use these results to discuss NH-MHL clients' hearing and discuss treatment options with them?
_____
_____
_____
_____

13) What percentage of people with NH-MHL that come to see you, choose treatment (if any treatment is offered)?
_____

14) In your experience do these clients typically receive any form of aural rehabilitation?
( ) No
( ) Yes
( ) Don't know

15) If NH-MHL clients do not receive any aural rehabilitation is this due to:
( ) Client is not interested in rehabilitation
( ) Client does not need rehabilitation
( ) Client is not eligible for rehabilitation services
( ) Appropriate rehabilitation options are not available for this population
( ) Affordability
( ) I'm not aware of treatment options available for this population

( ) Other - Write In: _____
( ) Don't know

16) If they do receive rehabilitation, what type of rehabilitation do they typically receive? *(tick all that apply)*

Hearables: A hearable is a wireless in-ear computational earpiece. Essentially it is a micro computer that fits in the ear canal and utilises wireless technology to supplement and enhance the listening experience.
( ) Hearing aids
( ) Other hearing devices (e.g. ALDs)
( ) Counselling
( ) Individual communication training
( ) Group communication training
( ) Referral to another service
( ) Hearables
( ) Remote microphone
( ) Other - Write In: _____

17) In your opinion, how effective are the following treatments for addressing speech-in-noise difficulties experienced by people with NH-MHL?

	1. Not at all effective	2. A little effective	3. Somewhat effective	4. Very effective	Unsure
Hearing aids	( )	( )	( )	( )	( )
Other hearing devices (e.g. ALDs)	( )	( )	( )	( )	( )
Counselling	( )	( )	( )	( )	( )
Individual communication training	( )	( )	( )	( )	( )
Group communication training	( )	( )	( )	( )	( )
Hearables	( )	( )	( )	( )	( )

Remote microphone	( )	( )	( )	( )	( )

18) What influences NH-MHL clients' decisions to pursue (or not to pursue) treatment?
_____
_____
_____
_____

19) Do you generally recommend hearables to your NH-MHL clients?
( ) Never
( ) Yes - Rarely
( ) Yes - Sometimes
( ) Yes - Often

20) If NH-MHL clients do receive rehabilitation, how do you measure outcomes/success? (*Tick all that apply*)
( ) Speech testing
( ) Questionnaire
( ) COSI goals
( ) Client's satisfaction
( ) Family member feedback.
( ) Other - Write In: _____

21) How confident do you feel that your recommended treatment options address your NH-MHL clients' concerns?
0 _____[__]_____ 100

22) Ideally, what form of rehabiliation would you prefer to provide NH-MHL clients?
( ) None
( ) Hearing aids
( ) Other hearing devices
( ) Counselling
( ) Individual communication training
( ) Group communication training
( ) Referral
( ) Other
( ) Don't know

23) Do you feel that you have appropriate training and resources to help NH-MHL clients?
( ) Yes
( ) No - Inadequate training
( ) No - Inadequate resources

( ) No - Inadequate training & resources
( ) Not sure

24) What do you think clinicians need to better help NH-MHL clients? (e.g. clinical tools, devices)

_____
_____
_____
_____

25) Are there any particular barriers you experience providing rehabilitation services towards NH-MHL clients?

_____
_____
_____
_____

26) Do you have any further comments about your experiences with NH-MHL clients?

_____
_____
_____
_____

The Future of NH-MHL

27) Do you have any ideas about what underlies the speech-in-noise difficulties of NH-MHL clients?

_____
_____
_____
_____

28) Do you have any suggestions about the type of research would you like to see conducted about issues for clients with NH-MHL?

_____
_____
_____
_____

29) How did you find out about our survey?
( ) Facebook
( ) Twitter
( ) LinkedIn
( ) Reddit
( ) Email

( ) A friend
( ) 1 in 6 Newsletter
( ) Hearing Matters Magazine
( ) Other - Write In: _____

Thank You!

Appendix C – NA-MHL Group Interview Script

1. What motivated you to do this interview?

Characterising your hearing difficulties
2. Can you describe to me a situation in which you experienced difficulty hearing speech in noise?
- ➔ What did you do?
- ➔ How did you feel?
- ➔ When was the first time you noticed your difficulties?
- ➔ How long ago was this?
- ➔ What is the impact of the difficulty (if any)?

Yourself
3. Do your family and friends know about your difficulties?
- ➔ **Yes:** Can you expand on this?
- ➔ **No:** how do you think they would respond?

4. Have they adapted their behaviour to assist you with your difficulties?
- ➔ **Yes:** in what ways?
- ➔ **No:** what would be helpful?

Pathway to the clinic
5. What motivated you to seek an appointment/advice with an audiologist/clinician?

6. Please describe your visit/s to the clinic

7. What were the results of the testing?

8. How were the results explained/described to you? How did you feel about this?

Rehabilitation
9. Were you offered any treatment options?
- ➔ **Yes:** what options did you try? Why/why not?
- ➔ What was your experience of starting the treatment?
- ➔ Tell me what situations you tried it in, and how effective it was?
- ➔ Will you continue to use it?
- ➔ Is there anything else you would like to try?
- ➔ **No:** Would you like to have been offered something?

There is a number of possible treatment options that might be available. We're interested in what you think about the following options: (we're just exploring what people think about them)

- Traditional hearing aid? (On-ear or in-ear devices fitted by a professional; may also include additional features to assist in hearing in different situations).

- Hearable? (Earphones that automatically improve the hearing experience of the listener by filtering out background noise).

- Remote microphone? (A microphone device worn by the speaker that transmits speech to the listener's earphones).

- Communication training (personal or online)? (A course that provides tips and information for communicating and listening in difficult situations).

Further comments

Do you have any further comments?

Thank you for your participation, we appreciate your time in doing this interview with us.

Appendix D – Clinician Interview Script

1. What motivated you to do this interview?

2. How long have you been an audiologist?

3. What is your role? Could you describe what that role involves?

4. How long have you been in your current role?

> ***We're interested in adults who have difficulty hearing speech in noise, but when tested have a normal or mild hearing loss.***

5. Roughly how many clients do you see per month that would fit this description?

(NOTE: If they don't see these clients, check whether they discuss these cases with any colleagues. If no experience at all, thank them for their time and terminate interview)

6. Take a moment to think about the clients you've seen with speech-in-noise difficulties, can you describe your clinical experiences seeing one of these clients.
   - ➔ How did they describe their problem?
   - ➔ How did you feel during the appointment?
   - ➔ Were there any solutions that you recommended? Did you think they'd be helpful? Is that what you'd usually do?
   - ➔ Did you have any further follow-ups with the client?

7. Are there other appointments where things have gone differently? How?

Assessment

8. What sort of tools do you use to understand the difficulties this population is having?
   - ➔ Why
   - ➔ How helpful are they in the decision making process?

9. Generally, how confident do you feel about making decisions for this population?

10. How do you describe the results to the clients?

11. How do clients respond to your advice?

12. Is that a common response?

Treatment

13. What types of rehabilitation tools do you usually offer?

14. How successful or comfortable do you feel with these treatment options?

15. What do you think about the following treatment options:

- ➔ Traditional hearing aid? (On-ear or in-ear devices fitted by a professional; may also include additional features to assist in hearing in different situations). Pro and con? Would you recommend it?

- ➔ Hearable? (Direct to consumer earphones that automatically improve the hearing experience of the listener by filtering out background noise). Pro and con? Would you recommend it?

- ➔ Remote microphone? (A microphone device worn by the speaker that transmits speech to the listener's earphones). Pro and con? Would you recommend it?

- ➔ Communication training (personal or online)? (A course that provides tips and information for communicating and listening in difficult situations). Pro and con? Would you recommend it?

Clinical Insights

16. In the broader context of hearing health care, where does this problem (of speech-in-noise difficulties) fit in?
i.e.
- ➔ Is it a big or small issue?
- ➔ Is it well understood or poorly understood?

17. How much effort/resources/research do you think should be put into helping these people?

Comments

18. Do you have any questions or further comments?

Thank you for your participation. We appreciate you taking the time to share your insights with us.