INVESTIGATING THE EFFECTIVENESS OF THE I-PLAN INTERVENTION TO PROMOTE HEARING AID USE AND BENEFIT IN ADULT FIRST-TIME HEARING AID USERS

A thesis submitted to The University of Manchester for the degree of Doctor of Philosophy in the Faculty of Biology Medicine and Health

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<td>APHAB</td>
<td>Abbreviated Profile of Hearing Aid Benefit</td>
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<tr>
<td>APEASE</td>
<td>Affordability, Practicality, Effectiveness/Cost-Effectiveness, Acceptability, Side Effects/ Safety and Equity</td>
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<tr>
<td>BCTTv1</td>
<td>Behaviour Change Techniques Taxonomy version 1</td>
</tr>
<tr>
<td>CCAT</td>
<td>Crowe Critical Appraisal Tool</td>
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<tr>
<td>CINAHL</td>
<td>Cumulative Index to Nursing and Allied Literature</td>
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<td>COM-B</td>
<td>Capabilities, Opportunities, Motivation - Behaviour</td>
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<td>COSI</td>
<td>Client Oriented Scale of Improvement</td>
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<td>dBHL</td>
<td>Decibel Hearing Level</td>
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<td>HAPQ</td>
<td>Hearing Aid Performance Questionnaire</td>
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<td>HHI</td>
<td>Hearing Handicap Inventory</td>
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<tr>
<td>HHIE-S</td>
<td>Hearing Handicap Inventory for the Elderly – Screening</td>
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<tr>
<td>IOI-HA</td>
<td>International Outcome Inventory for Hearing Aid</td>
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<td>IOI-HA-SO</td>
<td>International Outcome Inventory for Hearing Aid for the Significant Other</td>
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<tr>
<td>GHABP</td>
<td>Glasgow Hearing Aid Benefit Profile</td>
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<tr>
<td>RCT</td>
<td>Randomised Controlled Trial</td>
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<tr>
<td>SADL</td>
<td>Satisfaction with Amplification in Daily Life</td>
</tr>
<tr>
<td>SC</td>
<td>Standard Care</td>
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<tr>
<td>SRBAI</td>
<td>Self-Report Behavioural Automaticity Index</td>
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<td>UK</td>
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LIST OF SYMBOLS

≤  Less than or equal to
≥  Greater than or equal to
%  Percent
α  Significance level
B  Unstandardized beta
β  Standardized beta
CI  Confidence Interval
M  Mean
n  Sample size
N  Population size
Dp²  Partial eta squared: Effect size
p  Probability value (p-value)
SD  Standard Deviation
X²  Chi-Squared
d  Cohen’s effect size
b  Meta-regression coefficient
R²  Adjusted proportion of between study variance explained by predictors
ABSTRACT

It is well established that hearing aids provide benefit to people with hearing loss, yet 5% to 24% of hearing aid users do not use their hearing aids at all and 40% use them only occasionally. Non- and under-use of hearing aids imply waste of hearing health care resources and unmet communication need for people with hearing loss. Various interventions have been attempted to promote hearing aid use, but none has been effective. Hearing aid fitting appointments provide an opportunity to deliver interventions to promote hearing aid use. The I-PLAN intervention was developed based on a health-psychology behaviour change framework, the behaviour change wheel, to fill the need for interventions to promote hearing aid use. This thesis examined the effectiveness of the I-PLAN to promote hearing aid use and benefit. The first study was a systematic review aimed to identify the behaviours of hearing healthcare professionals and to examine which behaviours promote hearing aid use and benefit during hearing aid discussions. The findings revealed that audiologists typically focus on provision of information related to technical aspects of hearing aid(s) during clinical interactions. There was evidence from two pilot intervention studies that ‘motivational interviewing’ provided by audiologists may promote hearing aid use. The second study was a quasi-randomised controlled trial. The aim was to examine the effectiveness of the complete I-PLAN intervention delivered face-to-face by audiologists during hearing aid fitting consultations with participants allocated to either; (i) I-PLAN intervention in addition to standard care (n = 80) or (ii) standard care only (n = 80). The third study was a 2 x 2 factorial randomised controlled trial to examine the prompt and plan components of the I-PLAN, delivered in sealed envelopes at the end of the fitting consultation without direct involvement of the audiologists. Participants were randomly allocated into four groups: (i) Info only (n = 60); (ii) Info + Prompt (n = 60); (iii) Info + Plan (n = 60); and (iv) Info + Prompt + Plan (n = 60). In both studies, the primary outcome was self-reported proportion of time hearing aids were used in difficult listening situations. Secondary outcomes were hearing aid use derived from hearing aid data logging, self-reported hearing aid benefit, self-reported self-regulation and habit formation. The self-regulation and habit formation were used to measure the potential mechanisms of action of the I-PLAN intervention and its components. Outcomes were measured at six weeks post-fitting. The findings of the second study showed that the complete I-PLAN intervention, delivered by audiologists, did not promote greater hearing aid use, benefit, self-regulation or habit formation. In the third study examining the individual components of the I-PLAN, the prompt component reduced hearing aid use and self-regulation. The plan component promoted greater hearing aid use and habit formation. The combination of prompt and plan components reduced data-logged hearing aid use. The adverse effect of the prompt on hearing aid use might be mediated by reduced self-regulation. The positive effect of the plan might be mediated by formation of hearing aid use habit. In conclusion, this thesis demonstrated the effects of the I-PLAN and its components on hearing aid use via controlled trial studies for the first-time in a clinical setting. The thesis provides robust evidence for the impact of a health psychology-based intervention to promote hearing aid use that is of use to clinicians and researchers. The plan component of the I-PLAN could be delivered during hearing aid fitting appointments to promote hearing aid use and habit formation. Perhaps this is the time for research in audiology to shift attention from technology-based solutions to behaviour change strategies in order to promote greater hearing aid use and benefit.
DECLARATION

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DEDICATION

I dedicate this thesis to my incredible parents, Zainudah Binti Samat and Ismail Bin Hamat, and to my beloved husband and daughter, Khairul Hasrol Bin Abdul Razak and Irdina Qaisara Binti Khairul Hasrol.

Thank you for everything you have done for me. ♥♥♥
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CHAPTER 1
OVERVIEW OF THESIS
CHAPTER 1

OVERVIEW OF THESIS

Hearing aids are effective in improving hearing-related quality of life for adults with hearing loss (Chisolm et al., 2007; Ferguson, Kitterick, Chong, Barker, & Hoare, 2017), yet up to 24% of hearing aid users do not use their hearing aids at all (Hartley, Rochtchina, Newall, Golding, & Mitchell, 2010) and up to 40% of new hearing aid users under-use their hearing aids (hearing aid use of fewer than 4 hours per day; Aazh, Prasher, Nanchahal, & Moore, 2015). Non-use and under-use of hearing aids indicate that a substantial proportion of people may not be getting appropriate benefit from hearing aids. In the UK, hearing aids are funded by the UK health system known as the National Health Service (NHS). Under the NHS, hearing aids are funded through taxation and are free at the point of use. Therefore, non-use and under-use also represent waste of resources for socially subsidized NHS hearing aids. Various interventions have attempted to promote hearing aid use, but none of these interventions resulted in improvements in hearing aid use (Barker, Mackenzie, Elliott, Jones, & de Lusignan, 2016). Effective interventions to promote hearing aid use and benefit are needed.

Interactions of adult patients with their audiologist during hearing aid fitting consultations may offer a critical opportunity for audiologists to introduce strategies that may facilitate hearing aid use and benefit (Vestergaard Knudsen, Öberg, Nielsen, Naylor, & Kramer, 2010). The interaction between audiologists and adult patients during hearing aid fitting appointments is not well understood in terms of the content or the relationship with hearing aid outcomes (Barker, Mackenzie, & de Lusignan, 2016; Vestergaard Knudsen et al., 2010). There is an important gap in the literature...
on how interaction with audiologists during hearing aid fitting appointments could help to promote greater hearing aid use and benefit among adult patients with hearing loss. This thesis aimed to test the effectiveness of a health psychology-based intervention called the I-PLAN to promote hearing aid use and benefit among first-time adult hearing aid users.

The first step of the PhD was to systematically identify and summarise the behaviours of hearing healthcare professionals during clinical consultations. The aims of the systematic review were to identify the behaviours of hearing healthcare professionals during hearing aid discussions that might promote hearing aid use and benefit and to examine the behaviours that were effective to promote hearing aid use and benefit. The findings of the systematic review revealed audiologists mainly delivered information to adult patients during hearing aid consultations. There was evidence from two small scale pilot studies that motivational interviewing by audiologists may promote hearing aid use (Aazh, 2016a; Solheim, Gay, Lerdal, Hickson, & Kvaerner, 2018). The review also identified a need for controlled studies of clinical behaviour to test the impact of specific audiologist behaviours on patient hearing aid use and benefit.

Given the lack of evidence for the positive impact of interventions to promote hearing aid use (Barker, Mackenzie, Elliott, et al., 2016) and indications from our systematic review that the clinical interaction might offer an opportunity to impact patient outcomes, a controlled trial study was designed to investigate the effectiveness of the I-PLAN intervention. The I-PLAN intervention was developed to support audiologists during hearing aid fitting appointments to promote hearing aid use in adult patients.
(Barker, de Lusignan, & Cooke, 2016). The I-PLAN comprises three components: (i) information on the consequences of hearing aid use and non-use; (ii) a prompt to use the hearing aids; and (iii) a behavioural plan for hearing aid use (Barker, de Lusignan, & Cooke, 2016). Hearing aid use, benefit and potential mechanisms of action of the I-PLAN; habit formation and self-regulation were measured. The results showed that I-PLAN intervention delivered face-to-face by audiologists did not promote greater hearing aid use, benefit, self-regulation or habit formation as compared to standard care. Given the three components of the I-PLAN were provided together to participants in the I-PLAN group and interactions between components may reduce the effectiveness of the I-PLAN intervention, a factorial experimental study was designed to test the impact of the individual components of the I-PLAN on hearing aid use and benefit. Therefore, for the third study, we focused on testing the prompt and plan I-PLAN components compared to without prompt and plan components on hearing aid use and benefit as well as on the potential mechanisms of action (self-regulation and habit formation). In the study, the I-PLAN was delivered in written format without audiologists’ direct involvement. The I-PLAN components were provided to participants in a sealed envelope at the end of their hearing aid fitting consultation. The results revealed that the plan component promoted greater hearing aid use \( [p = 0.01; d = 0.34] \) and habit formation \( [p = 0.02; d = 0.30] \) than no plan component and the prompt component reduced hearing aid use \( [p = 0.03; d = 0.24] \) and self-regulation \( [p = 0.04; d = 0.28] \) than without the prompt component. The results of the prompt component were unexpected. Provided both the prompt and plan components together reduced data-logged hearing aid use; mean use for prompt + plan was 6.9 (± 4.92) hours/day, compared to 8.5 (± 5.66) hours/day for the prompt only
and 8.5 (± 5.20) hours/day for the plan only. The effect of the plan and prompt might be mediated by formation of hearing aid use habit and self-regulation.

1.1 Format of the thesis

The academic journal or “alternative format” was used to present the novel and publishable findings of the thesis. The alternative format was considered appropriate to demonstrate the writing skills of scientific papers that have been developed throughout the candidate’s PhD training. Overall, the thesis comprised six chapters.

Chapter 2 is a literature review which provides the background to the issues addressed in this thesis. Chapter 3 to 5 present the main works of the thesis. Chapter 3 is a systematic review of behaviours of hearing healthcare professionals during hearing aid consultations with adult patients with hearing loss. This chapter has been published in the *International Journal of Audiology*, January 2019. Therefore, this chapter is presented according to the published format of the *International Journal of Audiology*.

Chapter 4 and Chapter 5 focus on investigating the effectiveness of the I-PLAN intervention and its components. In Chapter 4, the I-PLAN intervention was delivered face-to-face by audiologists during hearing aid fitting consultations to promote hearing aid use and benefit among first-time adult hearing aid users. In Chapter 5, we tested the prompt and plan components of the I-PLAN in relation to hearing aid use and benefit outcomes. Each study was conducted in a different NHS audiology clinic in Manchester and involved 400 new adult patients (160 patients for study in Chapter 4 and 240 patients for the study in Chapter 5). Both chapters have been submitted for
CHAPTER 1: OVERVIEW

publication in audiology peer-reviewed journals; *Trends in Hearing* for Chapter 4 and *Ear and Hearing* for Chapter 5. Therefore, the format of *Trends in Hearing* is used in Chapter 4 and the format of *Ear and Hearing* in Chapter 5. Finally, an integrated discussion of the findings from the three individual studies as well as a discussion of this PhD work is presented in Chapter 6. Recommendations for future directions is also provided in Chapter 6.

The first author of each paper is the author of this thesis. The co-authors, Piers Dawes, Kevin Munro and Chris Armitage suggested the main aim of the studies and advised on the design of the studies. The first author then took the lead role to refine the research questions, designed the methods, collected all of the data, conducted the analyses, interpreted the data and wrote the manuscripts. The co-authors advised on analyses, interpretation of results and revised manuscripts. A co-author, Antonia Marsden, contributed to the analysis and interpretation of the results of the experimental studies.
CHAPTER 2

BACKGROUND

This chapter gives an overview of hearing loss and the management of hearing loss in adults in the UK. It also describes development of the I-PLAN intervention to promote hearing aid use among adult patients with hearing loss. This chapter is divided into four sections. In the first section, an overview of: (i) hearing loss; (ii) the provision of hearing aids in the UK; (iii) the benefits of hearing aid use; (iv) prevalence of hearing aid non- and under-use; (v) previous intervention studies on promoting hearing aid use; and (vi) patient-related factors, as well as hearing healthcare professional-related factors that might influence hearing aid use. In the second section, an introduction to: (i) health psychological behaviour change techniques; (ii) the behaviour change wheel; and (iii) the COM-B model (Capability, Opportunity, Motivation-Behaviour). In the third section, an outline of: (i) the development of a behaviour change intervention to promote hearing aid use (the I-PLAN); and (ii) mechanisms of action. Finally, in the fourth section, the gap in knowledge and research questions for this research project are presented.

Section One

2.1 Hearing loss and its management

Hearing loss affects approximately 11 million adults in the UK (Action on Hearing Loss, 2015). Due to population ageing, this number will reach 16 million by 2035 (Action on Hearing Loss, 2015). Similar increases in numbers of people with hearing loss are expected internationally (World Health Organization, 2018).
Untreated hearing loss is associated with poor quality of life (Chia et al., 2007; Dalton et al., 2003; Gopinath et al., 2012), communication difficulties (Dalton et al., 2003), social isolation (Pronk, Deeg, & Kramer, 2013), low educational achievement and unemployment (Emmett & Francis, 2015), and declines in physical and cognitive functioning (Arlinger, 2003; Chia et al., 2007; Dalton et al., 2003; Gopinath et al., 2012; Lupsakko, Kautiainen, & Sulkava, 2005). Hearing loss may also affect the family and friends of individuals with hearing loss (Pronk et al., 2013; Scarinci, Worrall, & Hickson, 2008; Vas, Akeroyd, & Hall, 2017).

Hearing aids are the primary management option for adult patients with hearing loss (Grenness, Hickson, Laplante-Levesque, Meyer, & Davidson, 2015; Laplante-Levesque, Hickson, & Worrall, 2010; Pryce, Hall, Laplante-Lévesque, & Clark, 2016). A hearing aid does not restore normal hearing. Hearing aids compensate for hearing loss by selectively amplifying sounds according to individual frequency-specific patterns of hearing loss (Dillon, 2001). The goal of hearing aids is to reduce participation limitations and activity limitations of people with hearing loss (Boothroyd, 2007)

In the UK, 82% of adults with hearing loss obtain their hearing aid(s) from National Health Service (NHS) audiology clinics (Davis, Smith, Ferguson, Stephens, & Gianopoulos, 2007). Once adult patients are diagnosed with hearing loss at a hearing assessment appointment, they will be offered hearing aid(s) by their audiologist. Hearing aids are provided either at the hearing assessment or at a hearing aid fitting appointment (Department of Health, 2012). Behind-the-ear hearing aids are provided at no cost to the patient at the point of service provision (NHS, 2019). The advantage
to the patient of using the NHS hearing aids is the free provision of hearing aids as well as free post-fit services and free hearing aid batteries (NHS, 2019). In the NHS, the cost of the hearing assessment and hearing aid provision for each individual adult patient is £294 (for one hearing aid) and £388 (for two hearing aids) (NHS England, 2016). The direct cost to the NHS of managing hearing loss is estimated up to £450 million a year (Powell & Adcock, 2016). Behind-the-ear as well as other types of hearing aids (e.g., in-the-ear and completely-in-the-canal hearing aids) can also be purchased by adult patients directly from private hearing aid providers (e.g., Specsavers) (The Ear Foundation, 2011). Depending on the types, brand (e.g., Phonak or Oticon) and technology features (e.g., digital noise reduction or directional microphone) of the hearing aids, the costs for privately purchased hearing aids ranges from £500 to more than £3500 for one hearing aid (NHS, 2019). The cost of hearing aid(s) is therefore high regardless of whether the hearing aid(s) were obtained from the NHS or bought privately. Non- or under-use of hearing aids represents financial waste, as well as lost opportunity to improve communication and quality of life for people with hearing loss.

2.2 The benefits of hearing aid use

The benefits of hearing aid use in improving hearing-specific and general quality of life are well recognised. Chisolm et al. (2007) conducted a systematic review of hearing aid use on general health- and hearing-related quality of life in adults. Chisolm and colleagues identified 16 studies including two randomised controlled trial studies published up to August 2004. They found that hearing aid use has a very large positive effect on hearing-related quality of life (Cohen’s $d = 2.1; \text{95\% CI} = 0.5 \text{ to } 3.6$) measured using disease-specific questionnaires (e.g., Hearing Handicap Inventory for
the Elderly, HHIE questionnaire; Ventry & Weinstein, 1982). Chisolm and colleagues concluded that hearing aids reduce adverse psychological, social and emotional effects of hearing loss. A limitation of the review was that were only two randomised controlled trials available up to August 2004. Given that randomised controlled trials provide the stronger clinical evidence than other research designs, one may dispute the strength of the conclusions of the review. However, a more recent Cochrane systematic review of the effect of hearing aid use on hearing-related quality of life in adult patients with mild to moderate hearing loss, which included several more randomised controlled trials, revealed similar findings. Ferguson et al. (2017) included five randomised controlled trials that were published from 1987 up to 2017. They also found that hearing aid use is associated with a large effect on the hearing-related quality of life (the mean difference in HHIE score with and without hearing aids = -26.47; 95% CI = -42.16 to -10.77. The lower score indicates better hearing-related quality of life. Based on the calculation of average standard deviations across studies, the mean difference represents approximately Cohen’s $d = 1.8$).

There is therefore strong evidence that hearing aids are effective in improving the hearing-related quality of life of adult hearing aid patients regardless the severity of the hearing loss (e.g., mild to severe level) (Chisolm et al., 2007; Ferguson et al., 2017). Although hearing aids are effective in improving hearing-related quality of life, it takes an average of 10 years for adults with hearing loss to obtain hearing aid(s) following the onset of hearing difficulties (Davis et al., 2007). Among those that do obtain hearing aids, a significant minority either do not use or under-use their hearing aids (Aazh et al., 2015; Hartley et al., 2010; Hougaard & Ruf, 2011; Solheim & Hickson, 2017).
2.3 *The prevalence of hearing aid non- and under-use*

The percentage of hearing aid non-use reported in previous studies in the UK, USA, France, Germany, Norway and Australia ranged from 5% to 24% (Aazh et al., 2015; Hartley et al., 2010; Hougaard & Ruf, 2011; Solheim & Hickson, 2017) (Table 1).
Table 1: Hearing aid use reported in previous studies

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Country</th>
<th>Participants</th>
<th>Hearing aid use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Age (years)</td>
<td>Sample</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n</td>
<td></td>
</tr>
<tr>
<td>Solheim &amp; Hickson (2017)</td>
<td>Norway</td>
<td>60 to 100</td>
<td>181</td>
</tr>
<tr>
<td>Aazh et al. (2015)</td>
<td>UK</td>
<td>17 to 105</td>
<td>1012</td>
</tr>
<tr>
<td>Hougaard &amp; Ruf (2011)</td>
<td>Germany, UK, France, USA</td>
<td>Not stated</td>
<td>503 513 501 2953</td>
</tr>
<tr>
<td>Hartley et al. (2010)</td>
<td>Australia</td>
<td>49 to 99</td>
<td>307</td>
</tr>
</tbody>
</table>

*Never/ None = Hearing aid use was reported as 'not at all/ never'. **None = Hearing aid is kept in a drawer. ^IOI-HA = International Outcome Inventory for Hearing Aid.
Aazh et al. (2015) found 40% of new adult hearing aid users from a UK NHS audiology clinic were non-regular hearing aid users (defined as hearing aid use fewer than 4 hours/day). However, due to the absence of consensus or empirical evidence for what constitutes ‘optimal’ hearing aid use, it is difficult to say whether the criterion of ‘fewer than 4 hours a day’ represents a meaningful threshold of non-regular hearing aid use (Perez & Edmonds, 2012).

The studies summarised in Table 1 used arbitrary categories of hearing aid use which were based on the average hours of hearing aid use each day (e.g., 1 to 4 hours/day), but there is little or no evidence for the validity of any particular category of hearing aid use with respect to optimal use. Hearing aid use tends to be reported in terms of hours of use, with the assumption of ‘the more the better’. Arguably, there is a need for all day hearing aid use in all situations to ensure personal safety (e.g., hearing smoke alarms and when crossing a busy road). Consistent hearing aid use may also facilitate acclimatisation to hearing aids and increase hearing aid benefit. Dawes and Munro (2017) found that consistent hearing aid use (of at least 6 hours/day) facilitated acclimatisation to hearing aids, increased tolerance of background noise and improved speech recognition in noise.

However, the assumption that more hearing aid use is better may not be true for some hearing aid users. Some people may decide to use their hearing aids only in specific situations where they most need the hearing aids, for example, in a church, while watching TV or at meetings. Two studies identified optimal hearing aid use as a combination of at least some regular hearing aid use combined with self-reported benefit from hearing aids, particularly in situations in which the individual most
needed to hear better (Hickson, Meyer, Lovelock, Lampert, & Khan, 2014; Laplante-Lévesque, Jensen, Dawes, & Nielsen, 2013). By this definition, optimal hearing aid use could involve few hours of daily use, provided the individual used and benefited from hearing aids in critical listening situations. Therefore, measuring hours of hearing aid use (or proportion of time used) in specific listening situations (according to patients’ need) together with hearing aid benefit (using disease-specific questionnaires, e.g., the Hearing Handicap Inventory for the Elderly questionnaire; Ventry & Weinstein, 1982) are probably the best measures of optimal hearing aid use in addition to absolute hours of hearing aid use.

Leaving aside the issue of defining optimal hearing aid use, the studies summarised in Table 1 suggest that a significant minority of hearing aid owners either do not use their hearing aids at all or use them only occasionally. Besides wasting clinical resources, non-use of hearing aids could mean that the adverse effects of hearing loss are not being effectively addressed. Various interventions to promote hearing aid use have been devised and evaluated as follows.

### 2.4 Interventions to promote hearing aid use

Barker, Mackenzie, Elliott, Jones, and de Lusignan conducted a 2014 Cochrane review on intervention studies to promote hearing aid use. The review was updated in 2016 with 37 randomised controlled and quasi-randomised trials included in the review. The review included any intervention studies to promote hearing aid use in adult patients that measured outcomes at short (≤ 12 weeks), medium (12 to 52 weeks) and long term (> one year). Out of the 37 studies, 33 studies were focused on the provision of information concerning the management of adult patients’ hearing
CHAPTER 2: BACKGROUND

...aid(s) or hearing loss. Barker, Mackenzie, Elliott, et al. (2016) did not identify any interventions that had a positive impact on hearing aid use.

In another review of interventions to improve hearing aid use, Aazh and Moore (2017) reported seven randomised controlled trial studies published between the year 2000 and January 2016. All seven studies were focused on educating adult patients about the management of hearing loss and the use of hearing aids. Similar to Barker, Mackenzie, Elliott, et al.’s (2016) review, Aazh and Moore (2017) did not find any evidence for the effectiveness of educational rehabilitative programmes on hearing aid use.

Given that none of the intervention studies reviewed by Barker, Mackenzie, Elliott, et al. (2016) and Aazh and Moore (2017) improved hearing aid use, effective interventions to promote hearing aid use are required. Interventions should include other strategies in addition to provision of information. Examining factors that hinder or facilitate hearing aid use may help identify targets for successful interventions to promote hearing aid use.

2.5 Barriers and facilitators to hearing aid use

Three reviews examined the factors that are linked to hearing aid use and non-use among adult patients with hearing loss.

In chronological order, Vestergaard Knudsen et al. (2010) examined the determinants of hearing aid outcomes including hearing aid use in studies published between January 1980 and January 2009. The review revealed that three factors which positively correlated with hearing aid use were: (i) positive attitudes towards hearing
aids (e.g., Wilson & Stephens, 2003); (ii) positive attitudes / acceptance of hearing loss (e.g., Brooks, 1989) and (iii) self-perceived hearing difficulties (e.g., Cox, Alexander, & Gray, 2007; Hosford-Dunn & Halpern, 2001).

McCormack and Fortnum (2013) summarised the reasons for hearing aid non-use from 10 studies published from the year 2000 up to 2012. The three common reasons for hearing aid non-use were related to: (i) lack of self-perceived hearing aid benefit (e.g., hearing aid does not help, Hartley et al., 2010), (ii) issues with poor hearing aid fit and comfort (e.g., Tomita, Mann, & Welch, 2001) and (iii) problems with hearing aid care and maintenance (e.g., problems managing the hearing aid, Öberg, Marcusson, Ngga, & Wressle, 2012). Forgetting to use hearing aids was also reported as one of the reasons for adult patients not using their hearing aids (McCormack & Fortnum, 2013).

In 2015, Ng and Loke identified audiological and non-audiological factors that correlated with hearing aid uptake and use among adults with hearing loss, in studies published between 2000 and 2014. Similar to Vestergaard Knudsen et al.’s (2010) review, Ng and Loke (2015) found that self-perceived hearing difficulty (e.g., Mizutari et al., 2013) was the most important non-audiological factor for hearing aid use.

A large body of research supports the conclusion that use of hearing aids is not simply dependent on technical aspects of hearing aids or the nature of the patient’s hearing loss (McCormack & Fortnum, 2013; Ng & Loke, 2015; Vestergaard Knudsen et al., 2010). Hearing aid use is also dependent on the thoughts and attitudes of people with
hearing loss (e.g., self-perceived hearing aid benefit and attitudes towards hearing aids).

Recent studies found that patients who presented at UK NHS audiology clinics were highly motivated to use their hearing aid and confident in their ability to use hearing aids (Armitage, Lees, Lewis, & Munro, 2017; Sawyer, Munro, Dawes, O’Driscoll, & Armitage, 2019), but there was a gap between patients’ motivation and actual hearing aid use (Sawyer et al., 2019). Sawyer et al. (2019) suggested that intervention studies should target ‘volitional processes’ (that translate motivation to use hearing aids into action) to increase hearing aid use among adult.

Although the main factors for hearing aid use or non-use identified in the three systematic reviews described above were related to the thoughts and attitudes of adult patients with hearing aids, all three reviews also highlighted the potential role of hearing healthcare professionals in impacting motivation and translating motivation to use hearing aids into action (McCormack & Fortnum, 2013; Ng & Loke, 2015; Vestergaard Knudsen et al., 2010).

2.6 Roles of hearing healthcare professionals in promoting hearing aid use

Besides thoughts and attitudes of people with hearing loss (e.g., self-perceived hearing aid benefit and attitudes towards hearing aid), hearing aid use may be partly dependent on a range of behaviour of other people, including significant others, friends and hearing healthcare professionals (e.g., audiologists; Barker, Atkins, & de Lusignan, 2016). During hearing aid fitting appointments, audiologists in NHS audiology departments typically would: (i) programme the hearing aid(s); (ii) perform real ear
measurements (REMs) to tune the hearing aid as appropriate; (iii) advise patients on realistic expectations (e.g., hearing aids do not restore normal hearing), communication tactics and habituation to hearing aids (e.g., use the hearing aid all the time or as much as you can); (iv) provide demonstration and instruction on hearing aid operation; (v) provide explanation on services provided (access battery and repair service); (vi) provide patients with batteries, a hearing aid box and written information about specific hearing aid fitting; (vii) provide explanation about follow-up appointments (e.g., further tuning of hearing aid as appropriate); and (viii) schedule a hearing aid follow-up appointment in six to ten weeks after fitting. The follow-up appointment can be either face-to-face or via the telephone. Audiological clinical interactions during hearing aid fitting appointment offers a platform for audiologists to introduce strategies that may promote greater hearing aid use.

The importance of audiologists in supporting and counselling patients to promote hearing aid use has been highlighted in several qualitative studies (Aazh, 2016b; Barker, Munro, & De Lusignan, 2015; Bennett, Laplante-Lévesque, Meyer, & Eikelboom, 2018; Dawes, Maslin, & Munro, 2014; Laplante-Lévesque et al., 2013). Barker et al. (2015) conducted a survey among adult patients with hearing loss, researchers and hearing healthcare professionals (e.g., audiologists, hearing therapist and hearing aid dispensers) to identify behaviours of hearing healthcare professionals that might help adult patients self-manage their hearing loss. Barker and colleagues found 16 behaviours of hearing healthcare professionals, for example, building a good rapport, using lay terms and being a good listener, that might help adult patients manage their hearing loss.
Aazh (2016b) explored the external factors that promoted hearing aid use in 34 participants taking part in a study of motivational interviewing to promote hearing aid use (Aazh, 2016a). Participants reported that the education, advice and counselling they received from their audiologist influenced their hearing aid use (Aazh, 2016b).

Hearing healthcare professional-related factors may therefore influence patient use of hearing aids. However, little attention has been given to the potentially very important role of clinicians in supporting and counselling patients to promote hearing aid outcomes during hearing aid fitting appointments (Vestergaard Knudsen et al., 2010). Interventions that include behaviour change strategies (i.e., behaviour change techniques) delivered by hearing healthcare professionals during hearing aid fitting appointments may assist in boosting hearing aid use by adult patients.

**Section Two**

**2.7 Behaviour change techniques**

A behaviour change technique refers to a specific strategy used in an intervention to promote health behaviour change (Webb, Sniehotta, & Michie, 2010). Behaviour change techniques are defined as the ‘observable, replicable, and irreducible’ content (or ‘active ingredients’) of interventions to change behaviour (Michie, Atkins, & West, 2014, p. 145). Behaviour change techniques are used to change one or several behavioural determinants of an individual (Michie et al., 2014).

There are 16 main categories comprised of 93 behaviour change techniques in the Behaviour Change Techniques Taxonomy version 1 (BCTTv1; Michie et al., 2013). The 93 behaviour change techniques were identified from the main components (or
‘active ingredients’) of previous intervention studies in health psychology by behaviour change experts (Michie et al., 2013). A behaviour change technique can be delivered as a single stand-alone technique or in combination with other behaviour change techniques (Michie et al., 2014). The behaviour change techniques can also be self-delivered or delivered by an interventionist (Michie et al., 2014).

According to Michie et al. (2013), there are five advantages of using the behaviour change technique taxonomy version 1 as a systematic way of describing behavioural intervention content. Firstly, a standardised taxonomy for description facilitates replication of behaviour change interventions that are found to be effective. Second, a standardised taxonomy facilitates implementation of behaviour change techniques. Third, a standardised taxonomy allows for systematic synthesis of effective interventions to inform future studies. Fourth, a standardised taxonomy facilitates design of behavioural interventions with well-defined content. Lastly, linking well-defined behaviour change techniques with theories of behaviour change allows for investigations of the underlying mechanisms of action.

Behaviour change techniques have been widely used especially in promotion of physical activity (Olander et al., 2013) and healthy eating (Cradock et al., 2017; McDermott, Oliver, Iverson, & Sharma, 2016; Samdal, Eide, Barth, Williams, & Meland, 2017). However, the evidence concerning which behaviour change techniques lead to better outcomes is still unclear. For example, in a meta-analysis, Samdal et al. (2017) reported that goal setting ($b = 0.48, 95\% \ CI = 0.26 \ to \ 0.71, \ p < 0.001, \ Adjusted \ R^2 = 49.2\%$) and self-monitoring of behaviour ($b = 0.40, 95\% \ CI = 0.16 \ to \ 0.63, \ p = 0.001, \ Adjusted \ R^2 = 35.3\%$) were associated with positive impacts.
on physical activity and healthy eating. On the other hand, in another review McDermott et al. (2016) found no associations between behaviour change techniques and physical activity and healthy eating. One of the potential reasons for the discrepancy between the two reviews is because of the variation in target populations: Sambal et al.’s review (2017) focused on overweight and obese adults only while McDermott et al.’s (2016) review included any study that measured intention to change physical activity and healthy eating behaviour among adults. The findings from these two reviews also indicate that, besides appropriate behaviour change techniques, appropriate populations should be targeted.

Behavioural change techniques have started to receive attention in audiology. In a cross-sectional observational study, Barker, Mackenzie, and de Lusignan (2016), described the behaviour change techniques used by nine NHS audiologists during hearing aid fitting consultations in the UK. Eleven behaviour change techniques were used, with the three most common being instruction on using hearing aids, provision of information related to social and environmental impacts of hearing use and demonstration of hearing aids (Barker, Mackenzie, & de Lusignan, 2016). The study contributed to the knowledge concerning which behaviour change techniques are used by UK audiologists with adult hearing aid patients, but Barker and colleagues did not attempt to make any link between the use of the behaviour change techniques and hearing aid outcomes. We are not aware of any study to date that has attempted to link audiologists’ behaviour change techniques to adult patient outcomes. There is therefore a gap in knowledge concerning which behaviour change techniques improve patient outcomes.
2.8 The behaviour change wheel and the COM-B model

Although it is desirable to identify which behaviour change techniques promote hearing aid use and benefit, there are dozens of potential behaviour change techniques that may be effective (e.g., Michie et al., 2013). According to Armitage et al. (2017), one of the possible reasons that intervention studies reviewed in the Barker, Mackenzie, Elliott, et al.’s review (2016) did not yield any improvements in hearing aid use is may be because of the absence of a robust theoretical basis for previous interventions.

The use of theoretical frameworks and an evidence-based approach are recommended in the Medical Research Council guidance for intervention development (Craig et al., 2008). The benefits of using theory in intervention design are that theory can: (i) provide a framework to assist in synthesizing of evidence; (ii) permit communication across research groups by using a common language; (iii) be used as a starting point for intervention design to identify what needs to shift in order for behaviour to change; and (iv) be used in the evaluation of interventions by identifying how an intervention is working (i.e., mechanism of action; Atkins & Michie, 2015). A theory- and evidence-based approach is therefore crucial in designing and developing a successful behaviour change intervention.

One theoretical basis for developing a behaviour change intervention is the behaviour change wheel (Michie et al., 2014). The behaviour change wheel is a comprehensive framework for designing behaviour change interventions and was developed based on a systematic review and a synthesis of 19 multiple frameworks of behaviour change.
(Michie et al., 2014). The application of the behaviour change wheel in designing and developing behaviour change interventions is illustrated in Figure 1.

**Figure 1**: The stages of intervention development according to the behaviour change wheel (Michie et al., 2014).

The behaviour change wheel allows for a systematic approach to identify behaviour change techniques that may be effective in promoting hearing aid use. A wide range of the possible 93 different behaviour change techniques may be appropriate in addressing problems of capabilities, opportunities or motivation of adult hearing aid patients. Application of the APEASE (Affordability, Practicality, Effectiveness/Cost-Effectiveness, Acceptability, Side Effects/ Safety and Equity; Michie et al., 2014) assists in selecting behaviour change techniques used in the intervention that are the most appropriate in terms of the APEASE dimensions.

Central to the behaviour change wheel is the COM-B model (capabilities (C), opportunities (O), motivation (M) and behaviour (B); Michie et al., 2014). According to the COM-B model, people need to be physically (e.g., skills) and psychologically (e.g., knowledgeable) capable (C), use social and physical opportunities (O) with reflective (e.g., self-conscious intentions) and automatic motivation (e.g., desires,
wants and needs) (M) in order to perform a behaviour (B) (Michie et al., 2014). The COM-B model identifies the determinants of the behaviour that need to shift for behaviour to change (e.g., capabilities, opportunities or/and motivation; Michie et al., 2014).

**Section Three**

**2.9 The I-PLAN intervention**

The behaviour change wheel, COM-B model and behaviour change techniques were used for the first-time in audiology to develop an intervention to promote hearing aid use and benefit in adult patients (the I-PLAN; Barker, de Lusignan, et al., 2016). Barker, de Lusignan, et al. (2016) conducted series of studies to develop the I-PLAN intervention: (i) a Cochrane systematic review of interventions to promote hearing aid use; (ii) a Delphi review with adult patients, audiologists and researchers; (iii) interviews with audiologists; and (iv) observation of audiologists’ usual clinical practice (Barker, Atkins, & de Lusignan, 2016; Barker, Mackenzie, & de Lusignan, 2016; Barker, Mackenzie, Elliott, et al., 2016; Barker et al., 2015). Barker, de Lusignan, and Cooke (2016) proposed three main components of the I-PLAN intervention to be delivered by audiologists during hearing aid fitting consultations to promote hearing aid use among adult patients.

The three main components of the I-PLAN intervention were: (i) provision of information related to the benefits and disadvantages of using and not using a hearing aid; (ii) use of physical prompts as reminders for hearing aid use; and (iii) creation of a behavioural plan for hearing aid use (e.g. when and where to wear their hearing aids) (Barker, de Lusignan, & Cooke, 2016). Both of the prompt and plan components of
the I-PLAN required audiologists to engage their adult patients to self-manage their hearing loss. For example, adult patients need to decide where to put their physical prompt and to create a behavioural plan for their hearing aid use (e.g. when and where to wear their hearing aids). Given the components of the I-PLAN depend on adult patients to create plans to use their prompt and plan, the intervention was named as the I-PLAN (Barker, de Lusignan, & Cooke, 2016). The three components of the I-PLAN were mapped according to the Behaviour Change Techniques Taxonomy version 1 (BCTTv1) and based on the APEASE criteria (Michie et al., 2013) (Table 2).
Table 2: Active ingredients of the I-PLAN intervention (Barker, de Lusignan, & Cooke, 2016)

<table>
<thead>
<tr>
<th>Components of the I-PLAN</th>
<th>Behaviour change technique</th>
<th>Definition (from BCTTv1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of information related to consequences of hearing aid use and non-use</td>
<td>5.1 Information about health consequences</td>
<td>Provide information (e.g., written, verbal, visual) about health consequences of performing the behaviour</td>
</tr>
<tr>
<td></td>
<td>5.3 Information about social and environmental consequences</td>
<td>Provide information (e.g., written, verbal, visual) about social and environmental consequences of performing the behaviour.</td>
</tr>
<tr>
<td>Provision of a prompt to remind patients to use their hearing aids</td>
<td>7.1 Prompts/cues</td>
<td>Introduce or define environmental or social stimulus with the purpose of prompting or curing the behaviour. The prompt or cue would normally occur at the time or place of performance.</td>
</tr>
<tr>
<td></td>
<td>12.5 Adding objects to the environment</td>
<td>Add objects to the environment in order to facilitate performance of the behaviour.</td>
</tr>
<tr>
<td></td>
<td>1.4 Action planning</td>
<td>Prompt detailed planning of performance of the behaviour (must include one of context, frequency, duration and intensity). Context may be environmental or internal.</td>
</tr>
<tr>
<td>Creation of a behavioural plan for hearing aid use</td>
<td>1.1 Goal setting (behaviour)</td>
<td>Set or agree a goal defined in terms of the behaviour to be achieved.</td>
</tr>
<tr>
<td></td>
<td>1.2 Problem solving</td>
<td>Analyse or prompt the person to analyse factors influencing the behaviour and generate or select strategies that include overcoming barriers and/or increasing facilitators.</td>
</tr>
<tr>
<td></td>
<td>1.4 Action planning</td>
<td>Prompt detailed planning of performance of the behaviour (must include one of context, frequency, duration and intensity). Context may be environmental or internal.</td>
</tr>
</tbody>
</table>
The I-PLAN intervention has not been implemented or evaluated to our knowledge. The I-PLAN is theoretically a promising behaviour change intervention to promote hearing aid use and benefit for the following reasons. First, the I-PLAN was developed using the behaviour change wheel (Michie et al., 2014) and includes available evidence concerning audiologist’s clinical practice, as recommended in the Medical Research Council (MRC) guidance on intervention development (Craig et al., 2008). Second, given that high motivation to use hearing aids (Sawyer et al., 2019) is not necessarily translated into hearing aid use (i.e., 'intention-behaviour gap'; Sheeran, 2002), the I-PLAN targets motivation of adult patients through provision of information (e.g., information of negative and positive consequences of using a hearing aid) as well as volitional processes (via a behavioural plan to use the hearing aid and a physical reminder to use the hearing aid). Third, some of the behaviour change techniques of the I-PLAN have been proven effective to promote behaviour change outside of audiology. For example, in a systematic review to evaluate the effectiveness of interventions to promote physical activity among healthy inactive adults, interventions that used behaviour change techniques including ‘action planning’ and ‘prompts’ were effective in maintaining engagement of participants in physical activity (Howlett, Trivedi, Troop, & Chater, 2019).

Although the I-PLAN is a promising intervention to promote hearing aid use, there is no information about the effectiveness of the I-PLAN in promoting hearing aid use and benefit in adult patients. Systematic evaluation of the I-PLAN intervention is required. Additionally, evaluating which I-PLAN components (i.e., behaviour change techniques) are the most effective in behaviour change (i.e., hearing aid use) is also important as recommended by the National Institute for Health and Care Excellence.
CHAPTER 2: BACKGROUND

(NICE, 2014). Establishing which components are effective in promoting hearing aid use and benefit would provide an evidence base, motivate audiologists to integrate the component(s) of the I-PLAN in clinic and maximize the efficiency of the I-PLAN intervention.

2.10 Mechanisms of action

There is a need to identify, understand and explain the specific ways an intervention works (i.e., the mechanism of action), as recommended in the Medical Research Council guidance on intervention evaluation (Moore et al., 2015) because understanding the mechanism of action allows interventions to be optimized (Bauman, Sallis, Dzewaltowski, & Owen, 2002; Michie et al., 2014; Moore et al., 2015). The importance of understanding the mechanism of action is also highlighted in the behaviour change wheel (Michie et al., 2014). Mechanisms of action are defined as ‘the processes through which a behaviour change technique affects behaviour’ (Michie et al., 2018, p. 502). Mechanisms of action are operationalized in intervention studies as mediators. Mediators refer to third variables that explain how two independent and dependent variables are related for the intervention to produce its effects (MacKinnon, 2012).

Although the behaviour change techniques taxonomy version 1 provides a detailed description of behaviour change techniques, the taxonomy does not specify which mechanism of actions of these behaviour change techniques target. How to link each behaviour change technique to their respective mechanism of action is unclear. At the time this PhD work was proposed, there was ongoing work to link behaviour change techniques with mechanisms of action (Michie et al., 2018). In this PhD work, we
proposed two potential mediators that might explain the mechanism of action of the I-PLAN intervention: self-regulation and habit formation. Details of each potential mediator, self-regulation and habit formation are explained as follows.

Self-regulation

Self-regulation is defined as ‘any efforts undertaken to alter one’s behavior’ (Sniehotta et al., 2005, p. 245). According to Sniehotta, Nagy, Scholz, and Schwarzer (2006), there are three action control constructs that play major roles in self-regulation: (i) awareness of standards, (ii) self-monitoring, and (iii) self-regulatory effort. For example, in adult patients fitted with hearing aid(s), self-regulation begins with adult patients setting their own standard (i.e., goal) related to hearing aid use (e.g., “I have to use my hearing aid for 8 hours every day”), monitoring their hearing aid use (self-monitoring) to attain the standard (e.g., “Today, I have used my hearing aid only for five hours instead of eight hours”) and adjusting the discrepancy between their current performance and the standard they set to compensate the difference (self-regulatory effort). Self-regulation therefore can be described as a personal process that involves monitoring, evaluating and readjusting one’s own behaviour in order to reach a behavioural goal (e.g., using a hearing aid).

Sniehotta et al. (2006) examined the three constructs of self-regulation in physical activity (i.e., awareness of standards, self-monitoring and self-regulatory effort). Participants were 122 adult cardiac patients who were highly motivated to engage in physical activity after being discharged from rehabilitation centre. Participants were required to complete a self-regulation questionnaire on a weekly basis for six-weeks; changes in the three constructs were measured. Results indicated that the three self-
regulation constructs were involved in supporting participants to engage in physical activity. Sniehotta and colleagues concluded that self-regulation assists adult patients in translating their motivation into actual physical activity. Given that the goal of the I-PLAN is to support adult patients to translate their motivation to use hearing aids into actual use, it is plausible to test self-regulation as a mechanism of action.

Habit formation

Habit is ‘a process by which a stimulus generates an impulse to act as a result of a learned stimulus-response association’ (Gardner, 2015, p. 277). When behaviour is repeated consistently in a consistent context (i.e., performed in the same situation every day repeatedly), habit is likely to be formed (Gardner, Abraham, Lally, & Bruijin, 2012; Lally, Jaarsveld, Potts, & Wardle, 2010). People who are encouraged to perform a healthy behaviour (e.g., eating fruit, drinking water, performing physical activity) regularly in consistent contexts report increases in habit (Lally et al., 2010). Lally et al. (2010) found that formation of a habit takes 66 days on average, with a range of 18 to 254 days.

Hearing aid use may become habitual. Two components of the I-PLAN, the prompt and the behavioural plan, may facilitate development of habit by providing opportunity for patients to use their hearing aids in a similar way and context every day. Therefore, habit formation may offer a potent mediating variable for hearing aid use. Additionally, given that habits mediate the effects of behavioural plans (i.e., action plans) on smoking cessation (Armitage, 2016), it would be logical to examine habit formation as a potential mediator of behavioural plans in relation to hearing aid use.
Section Four

2.11 Gap in knowledge

A systematic review of determinants of hearing aid use highlighted the need for researchers to shift their attention to the human dynamics of the interactions between patients and hearing healthcare professionals in order to facilitate improved patient outcomes during hearing aid fitting appointments (Vestergaard Knudsen et al., 2010). Although several previous studies have highlighted the potential of audiologists to promote hearing aid use (Aazh, 2016b; Bennett et al., 2018; Dawes et al., 2014; Laplante-Lévesque et al., 2013), the behaviours of audiologists during hearing aid fitting appointments with adult patients and the effectiveness of any specific behaviour in promoting hearing aid use and benefit are unclear. Research to identify which behaviours of hearing healthcare professionals promote hearing aid use and benefit among adult patients is necessary. Systematic evaluation of the I-PLAN intervention may provide some insight into which audiologist-delivered behaviour change strategies do promote hearing and use and benefit outcomes.

The aim of the thesis was to examine: i) whether audiologists can promote greater hearing aid use and benefit among first-time adult hearing aid users using the I-PLAN intervention; ii) which components of the I-PLAN intervention are effective and iii) what the mechanism(s) of action are. It was hypothesised that; (i) participants who receive all the I-PLAN components would show greater hearing aid use, benefit, self-regulation and habit formation of hearing aid use compared to participants who receive standard care; (ii) there would be greater hearing aid use, benefit, self-regulation and habit formation among participants who receive the prompt component compared to those who do not receive the prompt; (iii) the plan group would show
greater hearing aid use, benefit, self-regulation and habit formation than those who do not receive the plan; (iv) there would be greatest hearing aid use, benefit, self-regulation and habit formation in participants who receive both prompt and plan components; and (v) self-regulation and habit formation would mediate the effect of prompt and/or plan components on hearing aid use and benefit. Establishing effectiveness of the I-PLAN intervention would assist adult patients in gaining more benefit from their hearing aids, facilitate development of audiological education and training programs and provide an evidence base for clinical guidelines.

2.12 Research questions

This PhD work addressed the following research questions:

1. What are the behaviours of hearing healthcare professionals during hearing aid fitting consultations?

2. Which behaviours of hearing healthcare professionals are effective in promoting hearing aid use and benefit?

3. What is the effect of the I-PLAN intervention delivered face-to-face by audiologists on hearing aid use and benefit?

4. Which components of the I-PLAN intervention are effective at promoting hearing aid use and benefit?

5. How do the I-PLAN components work to promote hearing aid use and benefit (i.e., what are the mechanisms of action)?

The summary of the studies conducted in this PhD project is shown in Table 3.
Table 3: Summary of each study in this thesis, including a description of research question, hypothesis, and methodology

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>RESEARCH QUESTION</th>
<th>HYPOTHESIS</th>
<th>METHODOLOGY</th>
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<tbody>
<tr>
<td>3</td>
<td>i) What are hearing healthcare professionals’ behaviours during hearing aid consultations?</td>
<td>-</td>
<td>Systematic review i) Hearing healthcare professionals including ENT specialists, audiologists and hearing aid providers ii) Adult patients aged 18 years old and above</td>
</tr>
<tr>
<td></td>
<td>ii) Which behaviours lead to greater hearing aid use and benefit by adult patients?</td>
<td>-</td>
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</table>
| 4       | i) What is the effect of the I-PLAN intervention compared to standard care? | The I-PLAN intervention promotes greater hearing aid use, hearing aid benefit, habit formation and self-regulation with respect to hearing aid use in participants, compared to participants receiving standard care | Quasi-experimental i) Adult patients aged 18 years old and above ii) First-time hearing aid users | Primary outcome: Self-reported proportion of time hearing aids were used Secondary outcome: Hearing aid use measured via data-logging. Self-reported hearing aid benefit measured using IOI-HA* and HHIE-S** questionnaires. Potential mechanism of action measured using self-regulation and habit formation questionnaires. (SRBAI***)
|         | - | - | - | - |
| 5       | i) Which component of the I-PLAN intervention promotes greater hearing aid use and benefit? | Participants who receive the prompt or plan components of the I-PLAN would report/show greater improvement in hearing aid use, benefit, self-regulation and habit formation than participants who do not receive prompt or plan component of the I-PLAN. There would be greatest hearing aid use, benefit, self-regulation and habit formation in participants who receive both prompt and plan components. Self-regulation and/or habit formation would mediate the effect of prompt and/or plan component. | Randomised controlled trial | 240 | - | - |

*IOI-HA= International outcome inventory for hearing aids; **HHIE-S = Hearing Handicap Inventory for the Elderly and for Adults – Screening; ***SRBAI = Self-Report Behavioural Automaticity Index
CHAPTER 3
WHAT DO HEARING HEALTHCARE PROFESSIONALS DO TO PROMOTE HEARING AID USE AND BENEFIT AMONG ADULTS? A SYSTEMATIC REVIEW

Journal: International Journal of Audiology
Submission Status: Published (DOI: 10.1080/14992027.2018.1531154)
Authors: Afzarini H. Ismail, Kevin J. Munro, Christopher J. Armitage & Piers D. Dawes

Note: The format of International Journal of Audiology is used in this chapter. References and appendices are placed at the end of this chapter.
What Do Hearing Healthcare Professionals Do to Promote Hearing Aid Use and Benefit Among Adults? A Systematic Review

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\textsuperscript{5}NIHR Greater Manchester Patient Safety Translational Research Centre

**Abbreviations:**

- APHAB: Abbreviated profile of hearing aid benefit
- COSI: Client Oriented Scale of Improvement
- GHABP: Glasgow Hearing Aid Benefit Profile
- HHI: Hearing Handicap Inventory
- IOI-HA: International outcome Inventory for hearing aids
- IOI-HA-SO: International Outcome Inventory for Hearing Aid for the Significant Other
- SADL: The Satisfaction with Amplification in Daily Life.

**Correspondence:** Afzarini Ismail, Manchester Centre for Audiology and Deafness, School of Health Sciences, A 3.8 Ellen Wilkinson Building, University of Manchester, Oxford Road, Manchester, M13 9PL. Tel: +441612758568. E-mail: afzarini@iium.edu.my
Abstract

Objective: To conduct a systematic review of the evidence in relation to what hearing healthcare professionals do during hearing aid consultations and identifying which behaviours promote hearing aid use and benefit among adult patients.

Design: Searches were performed in electronic databases MEDLINE, EMBASE, CINAHL, PsycInfo, Web of Science, PubMed and Google Scholar. The Crowe Critical Appraisal Tool and Melnyk Levels of Evidence were used to assess quality and level of evidence of eligible studies. Behaviours of hearing healthcare professionals were summarised descriptively.

Study Sample: 17 studies met the inclusion criteria.

Results: Twelve studies described behaviours of audiologists and five studies were intervention studies. Audiologists were typically task- or technically-oriented and/or dominated the interaction during hearing aid consultations. Two intervention studies suggested that use of motivational interviewing techniques by audiologists may increase hearing aid use in patients.

Conclusions: Most studies of clinicians’ behaviours were descriptive, with very little research linking clinician behaviour to patient outcomes. The present review sets the research agenda for better-controlled intervention studies to identify which clinician behaviours better promote patient hearing aid outcomes and develop an evidence base for best clinical practice.
CHAPTER 3: SYSTEMATIC REVIEW

Introduction

The World Health Organization estimates that 328 million adults globally have a hearing loss greater than 40dBHL in the better ear (WHO 2012). Hearing aids are the primary treatment for hearing loss (Laplante-Lévesque, Hickson, and Worrall 2010), yet 24% of people given a hearing aid(s) do not use them (Hartley et al. 2010). Besides waste of resources, non-use of hearing aids could impact on people with hearing loss and their families and friends in terms of unaddressed difficulties in communication, social isolation and reduced mental well-being (Pronk, Deeg, and Kramer 2013; Scarinci, Worrall, and Hickson 2008; Vas, Akeroyd, and Hall 2017).

McCormack and Fortnum (2013), identified various reasons for non-use, including hearing aids being uncomfortable, difficulty handling hearing aids and patients’ attitudes towards hearing loss and hearing aids (for example; not recognising a need for a hearing aid or stigma of hearing aids). McCormack and Fortnum (2013) also highlighted the important role of audiologists in supporting and counselling patients to promote hearing aid use.

An emerging body of evidence supports McCormack and Fortnum’s (2013) assertion that hearing healthcare professionals can exert an important impact on patient outcomes. Kochkin (2000) found that patients who did not use their hearing aids cited hearing healthcare professional-related factors including “poor services provided” and “oversold expectation”. A 2010 MarkeTrack survey found that characteristics of the hearing healthcare professional (including knowledge, professionalism, empathy, creation of realistic expectations and explanations about maintenance of hearing aids) and patient ratings of the quality of the fitting process were positively correlated with patients’ hearing aid use, benefit and satisfaction (Kochkin et al. 2010). Qualitative studies reported that patients value interaction with
their audiologists and that interactions with audiologists may help patients get used to using hearing aids (Dawes, Maslin, and Munro 2014) and motivated patients to use their hearing aids (Aazh 2016b). A systematic review of determinants of hearing aid outcomes highlighted the need to explore the dynamics of the patient-hearing healthcare professionals clinical interactions to facilitate patient outcomes (Vestergaard Knudsen et al. 2010).

Despite indications that the clinical interaction may be an important factor in promoting hearing aid use and benefit, a Cochrane review of interventions to improve hearing aid use by Barker et al. (2014) found no effect of self-management support and/or service delivery interventions on hearing aid use in adult patients. However, this review included only randomised controlled trials and quasi-randomised trials up to 2013. More recently, Aazh and Moore (2017) described the key content of seven intervention studies to improve hearing aid use between 2000 and 2016. Aazh and Moore (2017) found the interventions were focused on education of patients about hearing aid use and communication strategies. Aazh and Moore (2017) did not find any effect of educational interventions on hearing aid use. However, as with Barker et al.’s review, Aazh and Moore (2017) included only randomised trials. Although randomised controlled trials are the ‘gold standard’ in clinical trials, difficulty with some aspects of design (for example; randomization may not be feasible), may make research designs other than randomised controlled trials the only practical option to provide an evidence base for clinical guidelines.

Following their 2014 Cochrane review, Barker, Munro, and de Lusignan (2015) surveyed adult patients with hearing loss, researchers and hearing healthcare professionals to identify behaviours of hearing healthcare professionals that might help people manage hearing loss. The patients, researchers and clinicians in this study
identified 16 hearing healthcare professional-related behaviours, including using open-ended questions, using lay-terms, being empathetic and addressing the individual needs of patients. The efficacy of these behaviours in promoting hearing aid use and benefit remains to be tested.

Although little is known about the link between behaviours of hearing healthcare professionals and hearing aid outcomes, there is evidence outside audiology showing that healthcare professionals’ behaviours positively impact on patient outcomes. In their meta-analysis of studies investigating the association between healthcare providers’ communication behaviours and patient treatment adherence, Zolnierek and DiMatteo (2009) found that the risk of non-adherence was 19% higher in patients of healthcare providers with poor communication behaviours. Shay and Lafata (2015) similarly found that 54% of the studies they included in their review reported positive effects of shared decision making on patient-reported outcomes including satisfaction. The associations between communication behaviours with positive patient outcomes could be extrapolated to hearing aid use and benefit.

Identifying particular behaviours of hearing health care professionals that facilitate hearing aid outcomes is important to promote effective management of hearing problems in adult patients, minimise waste of resources and support development of evidence-based audiological education and training programs. Therefore, the purpose of this systematic review was to identify, summarise and assess the quality of evidence; describing behaviours of hearing healthcare professionals during hearing aid consultations with adult patients, and identifying which behaviours promote hearing aid use and benefit by adult patients.
Methods

Search strategy

A search of databases MEDLINE, EMBASE, Cumulative Index to Nursing and Allied Literature (CINAHL), PsycInfo, Web of Science, PubMed and Google Scholar was conducted. The search was performed from the earliest possible date up to and including August 2018. Databases were searched without restriction on language or location. Searches were performed using free text terms. The free text terms were categorised in three blocks based on the research questions; “behaviour” (block 1), “hearing healthcare professional” (block 2) and “hearing aid” (block 3) (see Table 1). To ensure all the possible words were included in this review, experienced research librarians assisted with preparation of the word lists. Reference lists from shortlisted papers were searched for additional potentially eligible articles.
### Table 1: Search terms and Boolean operator used

**Group terms combine by ‘AND’**

<table>
<thead>
<tr>
<th>Key concept</th>
<th>Group 1:</th>
<th>Group 2:</th>
<th>Group 3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviour</td>
<td>Hearing Healthcare</td>
<td>Hearing Aid</td>
<td></td>
</tr>
<tr>
<td><strong>Combine by ‘OR’</strong></td>
<td>Professional</td>
<td><strong>Combine by ‘OR’</strong></td>
<td>‘OR’</td>
</tr>
<tr>
<td>Communication</td>
<td>Hearing healthcare profession</td>
<td>Hearing aid</td>
<td></td>
</tr>
<tr>
<td>Conversation</td>
<td>Ear, nose and throat specialist</td>
<td>Amplification</td>
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<tr>
<td>Interaction</td>
<td>ENT</td>
<td>Ear mold</td>
<td></td>
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<tr>
<td>Discussion</td>
<td>Otolaryngologist</td>
<td>Earmould</td>
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<tr>
<td>Counseling</td>
<td>Otorhinolaryngologist</td>
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<tr>
<td>Approach</td>
<td>Rhinolaryngologist</td>
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<tr>
<td>Consultation</td>
<td>Audiologist</td>
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<td>Aural Rehabilitation</td>
<td>Hearing specialist</td>
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<td>Education</td>
<td>Hearing therapist</td>
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<td>Audiometrician</td>
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<td>Audiometrist</td>
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<td>Hearing aid specialist</td>
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<td>Hearing aid dispenser</td>
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<td>Hearing aid practitioner</td>
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<tr>
<td>Hearing aid provider</td>
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</table>
**Participants and setting**

Studies were included if they described clinical consultations involving patients aged 18 years or above with hearing healthcare professionals including otolaryngologists, audiologists or hearing aid providers who prescribe and dispense hearing aids in any practice setting. The various types of hearing healthcare professionals were included to capture the range of professionals involved in delivery of hearing services in different countries. Studies conducted with children or involving parents were excluded.

**Study characteristics**

Descriptive studies were included if they included direct observations of consultations between hearing healthcare professionals and adult patients. Only consultations that involved a discussion of hearing rehabilitation options were included. This included a discussion of hearing rehabilitation options following hearing assessment appointments, including fitting appointments or post-fitting appointments. Studies that described the behaviours of hearing healthcare professionals during history-taking or during describing hearing assessment results were excluded. Hearing healthcare professionals’ behaviours were defined as ‘anything a person does in response to internal or external events’ (Michie, Atkins, and West 2014, page 234). This included anything that hearing healthcare professionals did in terms of their verbal and/or non-verbal communication behaviours. Studies describing the use of web-based or other remote forms of communication, implantable devices, student clinicians or simulated patients were excluded. Studies of consultations between hearing healthcare professionals and family and friends of patients were also excluded.
Randomised controlled trials (RCTs) and single group design studies that evaluated the effect of interventions that involved face-to-face hearing healthcare professional-patient clinical consultations and measured patient hearing aid outcomes were included. Outcomes of interest included hearing aid use and benefit. Hearing aid use included either data logged hours of hearing aid use or self-reported hearing aid use. Measures of subjective hearing aid benefit included patient self-report measures of hearing aid benefit, satisfaction and hearing handicap reduction. Studies that measured outcomes related to patients’ recall of information pertaining to hearing test results or measures of aided speech recognition were excluded. Other outcomes, for example, mental and psychosocial well-being, were not reported in the present review. Intervention studies that measured hearing healthcare professional-related outcomes only (including intervention fidelity, satisfaction or attitude of hearing healthcare professionals) were excluded.

Studies describing rehabilitation for tinnitus, balance or cochlear implantation were excluded. Editorials, expert opinions or study protocols were excluded. Studies that were not published in peer-reviewed journals were also excluded.

**Review procedure**

The first author reviewed all the article titles to exclude those that were clearly ineligible. Full text versions of articles were obtained when the abstract reported research involving clinician-patient consultations. All the potentially relevant full-text articles were reviewed independently by the co-author (Dawes). Any disagreement between the two reviewers was resolved by discussion with other authors (Munro and Armitage). The process of review and selection of articles for inclusion was recorded.
and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al. 2009).

**Data extraction**

The first author carried out data extraction using a structured table. The reliability of data extraction was checked by the co-author (Dawes) with discrepancies resolved through discussion with the co-authors (Munro and Armitage). The data extraction table included key information as follows: author, year of publication, country, study design, participants and the key behaviours of hearing healthcare professionals that were identified in each respective study. The key behaviours reported in the present review were reported using the terminology used by the respective authors of each study to describe the behaviours that they had identified. For intervention studies, additional data on the effect size of each intervention on hearing aid use and benefit outcomes were also extracted.

**Quality assessment and level of evidence**

The Crowe Critical Appraisal Tool (CCAT) (Crowe and Sheppard 2011) was used to assess the methodological quality of eligible studies. The Crowe Critical Appraisal Tool was selected because it was developed as a structured tool for evaluation of health research, can be used to appraise studies of various designs and has established validity and reliability (Crowe and Sheppard 2011; Crowe, Sheppard, and Campbell 2011). It consists of eight categories including; 1) Preliminaries (title, abstract and text), 2) Introduction, 3) Design, 4) Sampling, 5) Data collection, 6) Ethical matters, 7) Results and 8) Discussion. Each category was scored on a scale from 0 to 5 based on appropriateness of methodology and reporting. The total score for each study was
considered as ‘poor quality’ (<50%), ‘moderate quality’ (51% – 74%) and ‘high quality’ (>74%) based on criteria from a previous study with the Crowe Critical Appraisal Tool (Sznitman and Taubman 2016).

The level of evidence of each study was also assessed using the Melnyk Levels of Evidence (Melnyk and Fineout-Overholt 2011). Level I is the strongest level of evidence on which to base treatment decisions and includes systematic reviews or meta-analyses of RCTs. Level II evidence includes RCTs. Level III refers to controlled trials without randomization. Level IV includes well-designed case-control and cohort-studies. Level V includes systematic reviews of descriptive or qualitative studies. Level VI includes single descriptive or qualitative studies, and level VII includes expert opinion or reports of expert committees.

The risk of bias was assessed using the Cochrane Back and Neck Group risk of bias criteria (Furlan et al. 2015). The Cochrane Back and Neck Group risk of bias criteria consist of 13 criteria with each criterion scored as ‘yes’, ‘unclear’, or ‘no’. A ‘yes’ indicates low risk of bias (Furlan et al. 2009). A study would be rated as having a low risk of bias when at least 50% of Cochrane Back and Neck Group risk of bias criteria are met, and the study has no serious flaws (for example, a high participant drop-out rate) (Furlan et al. 2009). The Crowe Critical Appraisal Tool, level of evidence and risk of bias ratings were undertaken independently by two reviewers (Ismail and Dawes) with disagreements being resolved through discussion.
Data analysis

The behaviours of hearing healthcare professionals identified in the present review were summarised descriptively. Heterogeneity across studies in study designs prevented quantitative meta-analysis of results from the intervention studies. Therefore, the results of the intervention studies were reported descriptively.

Results

Study selection

Two thousand nine hundred seventeen potential articles were identified through database searching. 1219 duplicates were identified and removed. The abstracts of 1698 studies were screened, and 1665 articles were discarded due to not meeting the inclusion criteria, leaving 33 potential articles that were assessed for eligibility. Five potential articles were identified by manual searching of the reference list of included articles. One potential article was identified by one of the co-authors (Munro). The full text versions of 39 potential eligible articles were retrieved and evaluated for inclusion. 17 of the 39 studies were included in this review. The flow of the literature search and identification process is presented in Figure 1.
Figure 1: PRISMA flowchart of the systematic search
**Study characteristics**

All 17 studies were set in audiology clinics with seven studies (44%) conducted in Australia (Doyle 1994; Ekberg, Barr, and Hickson 2017a; Ekberg, Grenness, and Hickson 2014; Ekberg, Hickson, and Grenness 2017b; Grenness et al. 2015; Meyer et al. 2017; Sciacca et al. 2017), four (25%) in the United Kingdom (Aazh 2016a; Barker, Mackenzie, and de Lusignan 2016; Ferguson et al. 2016; Pryce et al. 2016), three (19%) in the United States (Dockens et al. 2017; Nair and Cienkowski 2010; Saunders and Forsline 2012), one (6%) in Sweden (Naylor et al. 2015), one (6%) in Denmark (Hindhede 2010) and one (6%) in Norway (Solheim et al. 2018). 12 studies observed and described audiologists’ behaviours during discussions about a hearing aid (Barker, Mackenzie, and de Lusignan 2016; Dockens et al. 2017; Doyle 1994; Ekberg, Barr, and Hickson 2017a; Ekberg, Grenness, and Hickson 2014; Ekberg, Hickson, and Grenness 2017b; Grenness et al. 2015; Hindhede 2010; Meyer et al. 2017; Nair and Cienkowski 2010; Pryce et al. 2016; Sciacca et al. 2017). The remaining five studies were intervention studies that involved face-to-face audiologist-patient clinical consultations and measured patient hearing aid outcomes (Aazh 2016a; Ferguson et al. 2016; Naylor et al. 2015; Saunders and Forsline 2012; Solheim et al. 2018). The characteristics of all studies are summarised in Table 2 and 3 (descriptive and intervention studies, respectively).
<table>
<thead>
<tr>
<th>Author, year, (country)</th>
<th>Objective</th>
<th>Methodology</th>
<th>Participant</th>
<th>Results</th>
<th>CCAT score (X/40 (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dockens et al. (2017) (USA)</td>
<td>To examine audiologist-patient interactions.</td>
<td>Descriptive, observational study (VI)</td>
<td>Post-testing</td>
<td>1 audiologist, 6 adults</td>
<td>The audiologist was the dominant communication partner and produced on average of 43 words per turn compared with patient’s 15 words per turn during hearing aid consultations.</td>
</tr>
<tr>
<td>Ekberg, Barr, and Hickson (2017a) (Australia)</td>
<td>To examine audiologist-patient interactions during discussions about hearing aid cost</td>
<td>Descriptive, observational study (VI)</td>
<td>Post-testing</td>
<td>26 audiologists, 62 adults</td>
<td>Audiologists offered a single hearing aid cost option to patients in 76% of appointments leading to rejection of hearing aids by patients due to the cost. Additional consequences included longer appointment times and disconnected audiologist-patient interactions. Patients’ concerns about cost were mostly not addressed. Some audiologists offered a range of cost options which facilitated smoother interactions; acceptance of patient decisions by audiologists and fewer negative emotional reactions by patients.</td>
</tr>
<tr>
<td>Ekberg, Hickson, and Grenness (2017b) (Australia)</td>
<td>To examine conversation repair strategies used in audiologist-patient interactions</td>
<td>Descriptive, observational study (VI)</td>
<td>During and/or post-testing</td>
<td>26 audiologists, 63 adults</td>
<td>A lack of mutual gaze occurred between audiologists and patients in 76% of consultations (mostly when audiologists were talking with patients while performing other tasks).</td>
</tr>
</tbody>
</table>
Table 2. Continued

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Design</th>
<th>Setting</th>
<th>Sample Size</th>
<th>Outcome</th>
<th>Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meyer et al. (2017) (Australia)</td>
<td>To describe content of audiologist-patient communication</td>
<td>Descriptive, observational study (VI)</td>
<td>Post-testing</td>
<td>26 audiologists, 56 adults</td>
<td>Audiologist-patient communications were described as ‘expanded biomedical’ in 45 appointments and ‘narrowly biomedical’ (i.e., focus on biomedical information) with little discussion of psychosocial issues in 11 appointments (n = 56). Longer duration of appointments was associated with an ‘expanded biomedical’ interactions.</td>
<td>35/40</td>
</tr>
<tr>
<td>Sciacca et al. (2017) (Australia)</td>
<td>To describe complexity of language used by audiologists</td>
<td>Descriptive, observational study (VI)</td>
<td>Post-testing</td>
<td>26 audiologists, 62 adults</td>
<td>The complexity of audiologists’ language was estimated at grade 5 reading level. At least 3 jargon words (e.g., ‘low frequency’) were used by audiologists on average in each consultation, but the meaning of jargon words was usually not explained.</td>
<td>35/40</td>
</tr>
<tr>
<td>Barker, Mackenzie, and de Lusignan (2016) (UK)</td>
<td>To describe behaviour change techniques used by audiologists</td>
<td>Descriptive, observational study (VI)</td>
<td>Fitting</td>
<td>9 audiologists, 9 adults</td>
<td>Audiologists were observed using 11 behaviour change techniques including: providing instruction on hearing aid use, practical instruction on how to use hearing aids, instruction on cleaning and operating hearing aids and providing information about social support availability and benefits of hearing-aid use.</td>
<td>38/40</td>
</tr>
<tr>
<td>Pryce et al. (2016) (UK)</td>
<td>To examine the decision-making process during audiologist-patient consultations</td>
<td>Qualitative, observational study (VI)</td>
<td>Post-testing</td>
<td>5 audiologists, 5 adults</td>
<td>Audiologists led the decision-making process by giving advice and prescribing hearing aids. No alternative rehabilitation options were offered. Advice provided about hearing aids was general without relating the information to patients’ problems and preferences.</td>
<td>35/40</td>
</tr>
</tbody>
</table>
### Table 2. Continued

<table>
<thead>
<tr>
<th>Study Authors</th>
<th>Study Overview</th>
<th>Study Design</th>
<th>Sample Size</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grenness et al. (2015) (Australia)</td>
<td>To describe verbal communication between audiologists and patients/companions</td>
<td>Descriptive, observational study (VI)</td>
<td>Post-testing 26 audiologists, 62 adults</td>
<td>Audiologists spent on average 29 (± 18.6) minutes in discussion including 4 (± 4.1) minutes discussing the patient’s hearing loss. Audiologists were the dominant communicative partner and produced on average 421 utterances during a consultation compared to 261 utterances by patients. 48% of the content of audiologists’ discussion was categorised as ‘education and counselling’, which focused on technical aspects of the hearing aid. A hearing aid was recommended to all patients with hearing loss. Alternative hearing rehabilitation options were only provided when patients rejected hearing aids.</td>
</tr>
<tr>
<td>Ekberg, Grenness, and Hickson (2014) (Australia)</td>
<td>To examine how patients’ concerns about hearing aid are addressed by audiologists.</td>
<td>Descriptive, observational study (VI)</td>
<td>Post-testing 26 audiologists, 63 adults</td>
<td>Audiologists did not adequately attend to patients’ concerns about hearing aids during hearing aid discussions. Audiologists focused on informing patients about their hearing loss and then moved directly into a discussion of the technical aspects of hearing aids. As a result, patients re-raise their concerns about hearing aids and lengthen the appointment time. At the end of the consultation, patients either gave a weak agreement to try a hearing aid or left the appointment without a hearing aid.</td>
</tr>
<tr>
<td>Hindhede (2010) (Denmark)</td>
<td>To examine the audiologist-patient interactions</td>
<td>Qualitative, observational study (VI)</td>
<td>Fitting 8 audiologists, 41 adults</td>
<td>Consultations were described as ‘information giving sessions. The content of information provided by audiologists was similar across all audiologist-patient consultations. The content of the information related to acclimatisation to hearing aids and technical aspects of hearing aids rather than discussing the patients’ communicative needs. Audiologists did not address the concerns of patients about hearing aids and focused instead on adjusting the hearing aid.</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Design</td>
<td>Fitting</td>
<td>Health Literacy</td>
</tr>
<tr>
<td>-------</td>
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</tr>
<tr>
<td>Nair and Cienkowski (2010) (USA)</td>
<td>To investigate the grade level of patient health literacy, language used by audiologists and hearing aid written materials.</td>
<td>Descriptive, observational study (VI)</td>
<td>3 audiologists, 12 adults</td>
<td>Average patient health literacy was below a third-grade reading level (based on Flesch-Kincaid reading level). The complexity language used by audiologists was significantly higher than that of patients. However, the language used by audiologists was significantly less complex than in written materials. Audiologists did not adjust the complexity of language according to the demographic of patients.</td>
</tr>
<tr>
<td>Doyle (1994) (Australia)</td>
<td>To describe features of audiologist-patient interactions</td>
<td>Descriptive, observational study (VI)</td>
<td>10 audiologists, 50 adults</td>
<td>Audiologists were the dominant communication partner; did 66% of the talking on average and asked three times more questions than patients. Audiologists spent on average 6 (± 2.8) minutes to discussing the patient’s hearing loss and hearing aids. 43% of questions asked by audiologists were related to symptoms and causes of hearing loss. 49% of questions asked by patients related to the hearing aid, with 31% of patients’ questions being about hearing aid use and benefit.</td>
</tr>
</tbody>
</table>
Table 3: Details of intervention studies

<table>
<thead>
<tr>
<th>Author, year, (country)</th>
<th>Objective</th>
<th>Study design (level of evidence)</th>
<th>Appoint. phase</th>
<th>Participant</th>
<th>Intervention</th>
<th>Measurements</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solheim et al. (2018)</td>
<td>To investigate effectiveness of motivational interviewing (Miller and Rollnick 2012) on hearing aid use in adult patients who used their hearing aid fewer than 90 minutes per day.</td>
<td>Pre- and post-test (IV)</td>
<td>Fitting follow-up</td>
<td>47 adults (all participants received the motivational interviewing for 30 minutes).</td>
<td>Motivational Interview (Miller and Rollnick 2013)</td>
<td>Hearing aid use was measured via data logging at 6 months post-fitting (baseline) and at 3 months post-intervention. Hearing aid benefit was measured based on informal patient reports of perceived benefit or contentment with hearing aid (increased or not increased)</td>
<td>There is significant increase in hearing aid use according to data logging at 3 months post-intervention. 37 of 47 adults had increased hearing aid use from 21 minutes per day on average (SD = 29 minutes) at baseline (6-month post-fitting) to 1 hour and 52 minutes per day on average (SD = 1 hour and 40 minutes) at 3-month post-intervention. 21 of the 37 (57%) adults reported increased benefit or contentment with hearing aid at 3 months post-intervention.</td>
</tr>
</tbody>
</table>
Table 3. Continued

| Ferguson et al. (2016) (UK) | To evaluate the feasibility of incorporating the Motivation Tools (Clark 2010) into routine clinical practice and to test the impact of motivational engagement on hearing aid use and benefit in new hearing aid users. | Quasi-randomised controlled trial (III) | Fitting 5 audiologists, 68 adults (n = 32) received motivational engagement using motivational tools by the Ida Institute; and n = 36 received motivational engagement using the Line, Box and Circle (Clark 2010) | Motivational engagement | Hearing aid use was measured via data logging and self-report questionnaires. Hearing aid benefit and satisfaction were measured using self-reported questionnaires; 1. Glasgow Hearing Aid Benefit Profile (GHABP; Gatehouse 1999) and 2. The Satisfaction with Amplification in Daily Life (SADL; Cox and Alexander 2001). Outcomes were measured at hearing assessment, hearing aid fitting and/or at 10 weeks post-fitting. | There was no significant difference between intervention and control groups in hearing aid use measured via data logging, self-reported hearing aid use, benefit or satisfaction measured at follow up. | 37/40 (93%); High quality |
| Aazh (2016a) (UK) | To evaluate the feasibility of a full-scale randomised controlled trial to investigate effectiveness of motivational interviewing (Miller and Rollnick 2012) on hearing aid use in adult patients who used their hearing aid fewer than four hours per day. | Randomised control trial (II) | Fitting follow-up | 2 audiologists, 37 adults (n = 20 received ‘motivational interviewing’ and n = 17 received standard care) | Motivational Interview (Miller and Rollnick 2012) | Hearing aid use was measured via data logging. Self-report questionnaires used; 1. International Outcome Inventory for Hearing Aids (IOI-HA; Cox and Alexander 2002), 2. International Outcome Inventory for Hearing Aid for the Significant Other (IOI-HA-SO; Noble 2002), 3. Client Oriented Scale of Improvement (COSI; Dillon, James, and Ginis 1997) and 4. Glasgow Hearing Aid Benefit Profile (GHABP; Gatehouse 1999). Outcomes were measured at baseline and at one month after the intervention. | The intervention group had greater hearing aid use (7 ± 3.7 hours per day) compared to the control group (4 ± 3.6 hours per day according to data logging at follow up (Cohen’s $d = 0.82$). There was no significant difference in IOI-HA, IOI-HA-SO, COSI and GHABP questionnaire scores in both groups at one-month post intervention. | 40/40 (100%); High quality |
Table 3. Continued

| Naylor et al. (2015) (Sweden) | To test effects of two types of interactions (termed ‘narratives’) on hearing aid benefit in experienced and first-time hearing aid users. The acoustical setting of the hearing aid was identical for all patients. | Randomised controlled crossover trial (II) | Fitting 2 | Interactive (I) and Diagnostic (D) Narrative. All patients were randomized either to ‘I’ or ‘D’ group. All participants then received the alternative interaction after two weeks. | Self-reported hearing aid benefit was measured using the Hearing Handicap Inventory for the Elderly (HHIE; Ventry and Weinstein 1982), International Outcome Inventory for Hearing Aids (IOI-HA; Cox and Alexander 2002) and Hearing Aid Performance Questionnaire (HAPQ; Gatehouse, Naylor, and Elberling 2006). Outcomes were measured two weeks post-intervention. | Experienced hearing aid users (n = 24): 20 of the 24 experienced users preferred either the interactive narrative or the diagnostic narrative. There was greater hearing aid benefit and lower hearing disability according to self-reported questionnaire scores (Cohen’s $d = 0.48$ (HAPQ; Gatehouse et al. 2006), $d = 0.43$ (HHIE; Ventry & Weinstein 1982), and $d = 0.68$ (IOI-HA; Cox et al. 2000)) for the preferred versus the non-preferred narrative. First-time hearing aid users (n = 16): 14 of the 16 users preferred either the interactive narrative or the diagnostic narrative. There was greater hearing aid benefit and lower hearing disability according to self-reported questionnaire scores (Cohen’s $d = 0.30$ (HAPQ; Gatehouse et al. 2006), $d = 0.45$ (HHIE; Ventry and Weinstein 1982)) for the preferred versus the non-preferred narrative. There was no difference in IOI-HA scores between narratives. |
Table 3. Continued

| Saunders and Forsline (USA) | To compare informational and performance perceptual counselling (Saunders and Forsline, 2012) on hearing aid use and benefit in adult patients who were dissatisfied with their hearing aids. | Randomised controlled trial (II) | Fitting follow-up | 1 audiologist, 69 adults (n = 35 received IC and n = 34 received PPC) | Informational and performance perceptual counselling (Saunders and Forsline, 2012) | Self-reported hearing aid use- and benefit-related questionnaires were completed before the counselling session (Session 1) and 8 to 10 weeks after the counselling session (Session 2). Hearing aid use and benefit were measured using Hearing Handicap Inventory (HHI; Ventry and Weinstein 1982; Newman et al. 1990), Abbreviated Profile of Hearing Aid Benefit (APHAB; Cox and Alexander, 1995) and IOI-HA (Cox and Alexander 2002) questionnaires. | No significant differences on the HHI, APHAB or IOI-HA in both groups at follow-up. | 31/40 (78%); High quality |
Descriptive studies

Nine of the 12 descriptive studies involved audio- or video-recorded post-hearing assessment discussions (Dockens et al. 2017; Doyle 1994; Ekberg, Barr, and Hickson 2017a; Ekberg, Grenness, and Hickson 2014; Ekberg, Hickson, and Grenness 2017b; Grenness et al. 2015; Meyer et al. 2017; Pryce et al. 2016; Sciacca et al. 2017). Three studies video-recorded hearing aid fitting appointments (Barker, Mackenzie, and de Lusignan 2016; Hindhede 2010; Nair and Cienkowski 2010). Two studies were rated as “moderate quality” (Crowe Critical Appraisal Tool, score of 58%). The remaining 10 studies were “high quality” (scores from 78 to 95% (Table 2)). All studies were rated as level VI according to the Melnyk Levels of Evidence (Melnyk and Fineout-Overholt 2011).

Intervention studies

Three of the five intervention studies examined interventions delivered by audiologists targeted at current hearing aid users who under-used and/or reported little benefit from the hearing aid (Aazh 2016a; Saunders and Forsline 2012; Solheim et al. 2018). In the fourth study, new hearing aid users were the population of interest (Ferguson et al. 2016). In the remaining study, the effects of audiologist interactions were studied among both experienced and new hearing aid users (Naylor et al. 2015).

The Crowe Critical Appraisal Tool scores for quality of methodology ranged from 75 to 100%, all “high quality” (Table 3). Four of the studies were rated as having a low risk of bias except for one study according to the Cochrane Back and Neck Group criteria (Furlan et al. 2015). The levels of evidence of the intervention studies were Level II, III and IV, according to the Melnyk Levels of Evidence (Melnyk and Fineout-Overholt 2011). Three studies were randomised controlled trials (level II),
one was a quasi-randomised controlled study (level III) and one was one group pre- and post-test study (level IV).

**Hearing healthcare professionals’ behaviours during a hearing aid consultation**

Regardless of whether the discussion about a hearing aid followed hearing assessment or hearing aid fitting appointments, audiologists in all 12 descriptive studies were task- or technically-oriented and/or took a dominant role during the clinical consultations (Barker, Mackenzie, and de Lusignan 2016; Dockens et al. 2017; Doyle 1994; Ekberg, Barr, and Hickson 2017a; Ekberg, Grenness, and Hickson 2014; Ekberg, Hickson, and Grenness 2017b; Grenness et al. 2015; Hindhede 2010; Meyer et al. 2017; Nair and Cienkowski 2010; Pryce et al. 2016; Sciacca et al. 2017). Audiologists were reported to have done most of the talking during clinical interactions (Dockens et al. 2017; Doyle 1994; Grenness et al. 2015). Audiologists were also interpreted as typically being directive in decision making, in that they offered hearing aids and no other hearing rehabilitation options (for example, assistive listening devices or communication training program) (Pryce et al. 2016) or offered a limited range of hearing aid cost options (Ekberg, Barr, and Hickson 2017a). Rehabilitation options other than hearing aids were only presented when patients rejected hearing aids (Grenness et al. 2015).

Examples of task- or technically-oriented behaviour during post-hearing assessment appointments included focusing on introducing the hearing aid with little time discussing patients’ hearing diagnoses (Doyle 1994; Ekberg, Grenness, and Hickson 2014; Grenness et al. 2015), hearing aids being prescribed as a default management option for hearing loss (Doyle 1994; Grenness et al. 2015; Pryce et al. 2016), the content of audiologists’ talk being predominantly about the technical
aspects of hearing aids (Doyle 1994; Ekberg, Grenness, and Hickson 2014; Grenness et al. 2015; Meyer et al. 2017) with no or limited talk concerning the lifestyle and communication needs of the patient (Ekberg, Grenness, and Hickson 2014; Grenness et al. 2015; Meyer et al. 2017). Audiologists used medical jargon without explaining its meaning (Sciacca et al. 2017) and used language that was beyond the literacy level of patients (Nair and Cienkowski 2010). Audiologists also performed other tasks while talking to patients (Ekberg, Hickson, and Grenness 2017b).

During hearing aid fitting appointments, audiologists’ interactions were also described as task- or technically-oriented. The advice and information about hearing aid use provided by audiologists was general (Barker, Mackenzie, and de Lusignan 2016; Hindhede 2010), with little or no input from the patient (Barker, Mackenzie, and de Lusignan 2016). The content of information provided by audiologists was similar across hearing aid fitting consultations (Barker, Mackenzie, and de Lusignan 2016; Hindhede 2010). The information that audiologists provided related to acclimatisation to hearing aids and technical aspects of hearing aids (Hindhede 2010).

**Behaviours of hearing healthcare professionals and hearing aid outcomes**

Five studies were identified that included interventions employing: motivational engagement (Ferguson et al. 2016), motivational interviewing (Aazh 2016a; Solheim et al. 2018), diagnostic and interactive narratives (Naylor et al. 2015), and performance perceptual counselling (Saunders and Forsline 2012) in relation to hearing aid use and benefit outcomes.

In chronological order, Saunders and Forsline (2012) examined effectiveness of informational counselling only versus informational plus performance perceptual counselling on hearing aid use and benefit in 69 adult patients who were dissatisfied
with their hearing aids (Saunders and Forsline 2012). In informational counselling, patients were counselled about their hearing loss, hearing aids and communication strategies. Performance perceptual counselling involved providing information related to the performance perceptual discrepancy (PPDIS) score of patients (the difference between measured and patient judgement of their ability to understand speech in noise). Patients who scored negatively on the PPDIS were defined as under-estimating their hearing ability; patients with positive PPDIS scores were judged as over-estimating their hearing ability. It was hypothesized that those who either underestimated or over-estimated their hearing ability could benefit from performance perceptual counselling. Saunders and Forsline (2012) analysed self-reported hearing aid use and benefit questionnaires. There was no significant change in hearing aid use or benefit in either the informational or performance perceptual counselling groups at 8 or 10 weeks post-fitting.

Naylor et al. (2015) evaluated the effect of audiologists’ interactions on patients’ hearing aid use and benefit. Naylor et al. described the clinical interaction as embodying a ‘narrative’ that may impact on patient outcomes. Adult patients (24 experienced and 16 new hearing aid users) were randomized to an ‘interactive’ narrative or a ‘diagnostic’ narrative alternately. In the interactive narrative, patients were involved in decision making with their audiologists and were led to believe that their hearing aid was set-up to their preferences. In the diagnostic narrative, patients were passive, and no input or response was required from them. In both conditions, hearing aids were adjusted based on each patient’s hearing thresholds so that the hearing aids were acoustically identical across both narratives. Hearing aid benefit was measured at two weeks post-intervention using self-report questionnaires. Results were reported in terms of the patient’s ‘preferred’ interaction (diagnostic or
interactive). 20 of the 24 experienced and 14 of the 16 new hearing aid users preferred either the interactive narrative or the diagnostic narrative. Patients without a preference were excluded from analysis. Among experienced hearing aid users, there were better ratings of hearing aid benefit and reduced hearing disability (Cohen’s $d = 0.48$; Hearing Aid Performance Questionnaire (HAPQ) (Gatehouse, Naylor, and Elberling 2006), $d = 0.43$; Hearing Handicap Inventory for the Elderly (HHIE) (Ventry and Weinstein 1982), and $d = 0.68$; International Outcome Inventory for Hearing Aids (IOI-HA) (Cox and Alexander 2002)) in the preferred versus the non-preferred narrative. In the smaller group of new hearing aid users, there were higher ratings of hearing aid benefit and reduced hearing disability for the preferred versus the non-preferred narrative (Cohen’s $d = 0.30$; HAPQ (Gatehouse, Naylor, and Elberling 2006), $d = 0.45$; HHIE (Ventry and Weinstein 1982)), but no difference between narratives for the IOI-HA (Cox and Alexander 2002).

Ferguson et al. (2016) trained two out of five study audiologists to deliver ‘Line, Box and Circle’ motivational tools. The ‘Line, Box and Circle’ was developed by the Ida Institute to be used by audiologists to encourage patients to engage with their own audiological management (Clark 2010). For example, patients were asked questions related to their motivation to improve hearing. The motivational tools were delivered during fitting consultations to first-time hearing aid patients. Ferguson et al. found that although adult patients who received the motivational tools reported greater self-efficacy in managing their hearing aid following hearing assessment and greater engagement with their audiologist during hearing aid fitting, there was no significant difference between intervention and control groups in hearing aid use measured via data logging, self-reported hearing aid use, benefit or satisfaction at 10 weeks follow-up.
Aazh (2016a) explored the feasibility of a full-scale randomised controlled trial of motivational interviewing on hearing aid use. This feasibility study was conducted with 37 adult hearing aid users who used their hearing aid fewer than four hours per day (Aazh 2016a). Patients were randomized into two groups; standard consultation from an audiologist (standard care) or a combination of standard consultation and motivational interviewing (motivational interviewing group). In the motivational interviewing group, the audiologist discussed personal motivation to use hearing aids with the patient based on motivational interviewing principles (Miller and Rollnick 2012). Adult patients who received motivational interviewing (n = 20) showed greater hearing aid use (7 ± 3.7 hours per day) compared to the standard care group (4 ± 3.6 hours per day; large effect size Cohen’s d = 0.82) according to the hearing aid data logging. There was no significant difference in hearing aid questionnaire scores IOI-HA (Cox and Alexander 2002), International Outcome Inventory for Hearing Aid for the Significant Other (IOI-HA-SO)(Noble 2002), Client Oriented Scale of Improvement (COSI) (Dillon, James, and Ginis 1997) or Glasgow Hearing Aid Benefit Profile (GHABP) (Gatehouse 1999) at one month post-intervention.

In 2018, Solheim et al. investigated the effectiveness of motivational interviewing provided by an audiologist to 47 adult patients who attended six-month follow-up appointment and used their hearing aid(s) fewer than 90 minutes per day (measured using data logging). Based on motivational interviewing principles (Miller and Rollnick 2013), adult patients’ experiences and personal obstacles to hearing aid use were discussed for 30 minutes. Hearing aid use was measured using data logging at three months post-intervention. Hearing aid benefit was measured based on informal patient reports of perceived benefit at three months post-intervention.
Solheim et al. found that hearing aid use increased from 21 minutes per day on average (standard deviation ± 29 minutes) at baseline (6 months post-fitting) to 1 hour and 52 minutes per day on average (standard deviation ± 1 hour and 40 minutes) at three months post-intervention. Moreover, 21 of 37 (57%) adult patients reported an increase in hearing aid benefit at three months post-intervention.

Discussion

This review sought to understand and clarify the impact of hearing healthcare professionals’ behaviours on patient hearing aid use and benefit. We identified twelve descriptive observational studies and five intervention studies of the impact of changing audiologist-patient interactions on hearing aid use and benefit. Audiologists displayed a limited range of behaviours that did not include any of the behaviours recommended by Barker, Munro, and de Lusignan (2015) including using open-ended questions, using lay-terms, being empathetic and addressing the individual needs of patients. Implications for future interventions and clinical practice are discussed below.

The behaviours of hearing healthcare professionals with adult hearing aid patients during a hearing aid consultation.

A limited range of behaviours is employed by audiologists. The behaviours of audiologists reported in the 12 studies above were characterised by being task- or technically-oriented and/or being led by the audiologist (Barker, Mackenzie, and de Lusignan 2016; Dockens et al. 2017; Doyle 1994; Ekberg, Barr, and Hickson 2017a; Ekberg, Grenness, and Hickson 2014; Ekberg, Hickson, and Grenness 2017b; Grenness et al. 2015; Hindhede 2010; Meyer et al. 2017; Nair and Cienkowski 2010;
Pryce et al. 2016; Sciacca et al. 2017). Although clinical guidelines and researchers recommend that audiologists should engage in shared-decision making, address patients’ individual needs, and engage in patient-centred practice (British Society of Audiology 2016; Grenness et al. 2015), these behaviours have not typically been reported in relation to audiological practice. Audiologists’ behaviours are consistent with a traditional medical model of impairment that focuses on diagnosis and treatment of disease or impairment rather than addressing the person with the health problem in a more holistic fashion (Bauman, Fardy, and Harris 2003). Not attending to the individual psychosocial needs of a patient was identified as a barrier to the development of an effective audiologist-patient relationship (Grenness et al. 2014). Failure to attend to individual psychosocial needs may result in failure to impact patients’ attitudes and thoughts concerning hearing aid use and benefit.

It was striking that the behaviours reported by Doyle in 1994 were similar to those reported in studies in 2000s (for example Ekberg, Grenness, and Hickson (2014) and Grenness et al. (2015)). The behaviours of audiologists have apparently remained similar over the last 20 years. Perhaps the lack of improvement in rates of hearing aid use and benefit over this time period despite advances in hearing aid technology might be partially attributable to persistent use of ineffective behaviour change strategies during audiological consultations. There is a scope to employ additional or alternative behaviour change strategies that might promote hearing aid use and benefit (Barker, Mackenzie, and de Lusignan 2016).

The quality and level of evidence of descriptive studies of audiologists’ behaviours included in the present review was moderate or good. A descriptive observational design was appropriate for the aim of describing audiologists’ practice, so the moderate level of evidence is not necessarily a limitation. However, in the
CHAPTER 3: SYSTEMATIC REVIEW

The majority of the studies there were limitations regarding methodological quality in relation to sampling. Most studies used convenience sampling to recruit audiologists, which may have resulted in sampling bias. Perhaps selecting audiologists who were willing to be involved in research resulted in selection of audiologists with more progressive professional development and practice than is usual.

**Behaviours that lead to better hearing aid use and benefit by adult patients**

The intervention studies were the only studies that allowed any inference to be made about causal links between audiologist behaviours and outcomes. The present review identified five intervention studies that investigated the effects of interventions provided during audiologist-patient interactions on patient hearing aid outcomes. These interventions included performance perceptual counselling (Saunders and Forsline 2012), diagnostic and interactive narratives (Naylor et al. 2015), motivational tools (Ferguson et al. 2016) and motivational interviewing (Aazh 2016a; Solheim et al. 2018). Three of five intervention studies reported a significant effect of the intervention on hearing aid use and benefit. Aazh (2016a) and Solheim et al. (2018) reported a positive impact of the motivational interviewing on hearing aid use measured via data-logging at one-month post-intervention (Aazh 2016a) and at three-month post-intervention (Solheim et al. 2018) on adult patients who under-used their hearing aids. Naylor et al. (2015) found differences in self-reported hearing aid benefit between preferred and non-preferred narratives in experienced and first-time hearing aid users.

Aazh (2016a) and Solheim et al. (2018) suggested that incorporating an individualised approach to motivate hearing aid use into routine clinical interactions might promote hearing aid use and benefit. However, there were several limitations
in both studies. Aazh’s study was a feasibility study rather than a fully powered randomised controlled trial. Solheim et al.’s study was a pre- and post-test study without a control group. The small sample size in both studies raises uncertainty about the precision and reliability of the results. The lack of a control group in Solheim et al.’s study makes it difficult to draw conclusions about the impact of the motivational intervention. Hearing aid outcomes were limited to one-month and three-month post-intervention with no long-term outcomes were assessed, so it is unknown whether the benefits of intervention persist.

Naylor et al. (2015) suggested that clinical ‘narratives’ provided by audiologists influence hearing aid benefit. According to Naylor et al., each hearing aid user had his or her own preference for the style of clinical interaction during hearing aid fitting and that preference impacted upon hearing aid outcomes. However, Naylor et al.’s (2015) study also involved a small sample size and short-term outcome measures two weeks after each intervention. Additional clinical trials testing the effectiveness of motivational interviewing, clinical narratives and other potential audiologist behaviours that may promote hearing aid outcomes are needed.

Clinical guidelines and researchers recommend particular behaviours and interactional styles (British Society of Audiology 2016; Grenness et al. 2015), including shared-decision making and patient-centred practice. However, without controlled experimental studies looking at the impact of these behaviours on patient hearing aid outcomes, it would be premature to draw the conclusion that behaviours of audiologists promote hearing aid use and benefit. Current clinical recommendations appear to be based only on expert opinion, which is the weakest level of evidence (Melnyk and Fineout-Overholt 2011). Exactly how audiologists can best promote hearing aid use and benefit in adult patients via their clinical interactions has yet to be
established. This represents a yawning gap in knowledge that is not unique to audiology (Shay and Lafata 2015; Zolnierek and DiMatteo 2009).

Given that previous review found that the non-use of hearing aids is partly dependent on the thoughts and attitudes of people with hearing loss (McCormack and Fortnum 2013), it is important to test whether clinical interactions with audiologists could change the thoughts and attitudes of patients and promote hearing aid use and benefit. While knowledge (about hearing aid care and its maintenance) may be necessary (Aazh and Moore 2017), knowledge alone may not be sufficient to achieve the behaviour change required to sustain hearing aid use and benefit. Creating a behavioural plan for hearing aid use (i.e., an ‘action plan’) may be important to translate motivation to use a hearing aid into consistent hearing aid use (Sawyer et al. in press); evidence suggests that patients are already highly motivated to wear a hearing aid when they present in audiology clinics (e.g., Armitage et al. 2017; Sawyer et al. in press). The challenge is translating good intentions into behaviour. Future behaviour change-based interventions for audiologists to promote the use of behaviour change strategies targeting ‘volitional processes’ (i.e., those that translate motivation into action) in adult patients are needed.

In future research to supply the evidence to support clinical practice, interventions to change practice of audiologists in clinic should be clearly described in a way that would allow interpretation and replication. Use of standard methods of describing the content of interventions, for example, the Behaviour Change Techniques Taxonomy version 1 (BCTTv1; Michie et al. 2013) alongside standard outcome measures including objective measures of hearing aid use and validated self-reported hearing aid questionnaires would facilitate comparison of results across studies and populations. Intervention studies would provide an ideal paradigm for
testing which behaviours are most effective in promoting hearing aid use and establishing the utility of skills training programs for audiologists.

Intervention studies should be robustly designed (e.g., by including active control groups to minimise the impact of research participation effects and double-blind assessment of outcomes to minimise bias). Intervention studies should also include a process evaluation in order to understand contextual factors that impact the effectiveness of the intervention (Moore et al. 2015). For example, Aazh (2016b) conducted interviews with participants to understand factors that may influence outcomes in a study of motivational interviewing to promote hearing aid use.

**Strengths and limitations of the literature and the present review**

The findings of this review were limited by the quality of study design of the available studies. Most literature was descriptive, and no inferences about which behaviours are effective in promoting outcomes were possible on the basis of these studies. Secondly, because audiologists were the only hearing healthcare professional group found in this review, we cannot infer whether the same behaviours are employed by other hearing healthcare professionals.

The average age of patients involved in the majority of studies was around 70 years (Aazh 2016a; Doyle 1994; Ekberg, Barr, and Hickson 2017a; Ekberg, Grenness, and Hickson 2014; Ferguson et al. 2016; Grenness et al. 2015; Meyer et al. 2017; Nair and Cienkowski 2010; Sciacca et al. 2017; Solheim et al. 2018) which is typical of first-time adult hearing aid users. Findings of these studies may therefore be generalizable. The behaviours of audiologists in Australia, the United Kingdom, the United States and Denmark were reported to be similar across studies. However, it is notable that most studies were carried out in the West and it may be that different
CHAPTER 3: SYSTEMATIC REVIEW

Audiologist behaviours are appropriate for particular cultures and models of hearing health service provision in each country. More international studies of the behaviours of audiologists are needed.

Although hearing aid use was the main outcome measured in the present review and Aazh and Moore’s review, our review question was differed from Aazh and Moore. Aazh and Moore (2017) investigated audiological rehabilitation programs that were delivered in a variety of settings (e.g., individual or group session). Our review was restricted to the effect of interventions delivered face-to-face between the hearing healthcare professional and the patient in a clinical setting. Identifying which interventions promote hearing aid use and benefit are important if they are to be integrated into clinical practice.

Despite using six major databases and extensive key terms, a manual search of reference lists of included papers identified five studies that were not identified in the database search. Manual searches are therefore recommended for reviews in audiology, in line with practice in other fields (dermatology, for example (Vassar, Atakpo, and Kash 2016)). One paper included in the present review (Naylor et al. 2015) was identified by a co-author but was not identified in either the database search or the manual search. This paper may have been missed due to use of idiosyncratic terminology (‘embodied narrative’). Future systematic reviews might survey clinical and research leaders to identify a broader range of potentially relevant search terms.

Conclusions
The conclusions of the present systematic review are, first, audiologists typically employ a limited range of behaviours that are mostly task- or technically-oriented. Second, there is some evidence from good quality studies that audiologists’ behaviour
does impact hearing aid outcomes in adult patients, although the small number of studies precludes identification of which behaviour(s) these include. There is scope to trial additional or alternative behaviours that might promote hearing aid use and benefit. Such behaviours could be tested via well-designed controlled trials, contributing to an evidence base for clinical practice and education. A renewed focus on the impact of human interactions in clinical management of hearing loss may be beneficial in a clinical practice paradigm that has been dominated by technological advancement.

Declaration of interest
No potential conflict of interest was reported by the authors.

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CHAPTER 4
CONTROLLED TRIAL OF THE I-PLAN INTERVENTION TO PROMOTE HEARING AID USE AMONG FIRST-TIME ADULT HEARING AID USERS

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Note: The format of Trends in Hearing is used in this chapter. References and appendices are placed at the end of this chapter.
CONTROLLED TRIAL OF THE I-PLAN INTERVENTION TO PROMOTE 
HEARING AID USE AMONG FIRST-TIME ADULT HEARING AID USERS 

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Abstract

Suboptimal hearing aid use negatively impacts health and well-being. The aim of the present study was to conduct the first controlled trial of a theory-based behavior change intervention to promote hearing aid use. This study was a quasi-randomized controlled trial with two arms. 160 first-time hearing aid users were recruited at the hearing aid fitting appointment. The control arm received standard care. In addition to standard care, the intervention arm received I-PLAN, which comprised: (i) information from audiologists about the consequences of hearing aid use/non-use; (ii) reminder prompt to use the hearing aids; and (iii) behavioral plan. The primary outcome, measured at six weeks, was self-reported hearing aid use in difficult listening situations. Secondary outcomes were data logged hearing aid use, self-reported hearing aid benefit, self-regulation and habit formation. The results showed that the proportion of time the hearing aids were used in difficult listening situations was similar in both groups \([\text{Mean}_{\text{intervention}} = 81.0\% \ (\pm 25.9) \ of \ the \ time \ versus \ \text{Mean}_{\text{control}} = 79.6\% \ (\pm 29.4) \ of \ the \ time]\). There were no statistically significant differences between groups in any other outcome measure including data logged hearing aid use. High levels of hearing aid use across all research participants limited the potential for the intervention to impact on hearing aid use. The intervention materials proved acceptable and deliverable. Future intervention trials should target suboptimal hearing aid users.

Keywords: hearing aids, intervention, audiologists, adult patients
CHAPTER 4: CONTROLLED TRIAL

Introduction

The negative impact of hearing loss not only affects the individual (Pronk, Deeg, & Kramer, 2013) but also their significant others (Scarinci, Worrall, & Hickson, 2008; Vas, Akeroyd, & Hall, 2017). Hearing aids are the main treatment for hearing loss (Grenness, Hickson, Laplante-Lévesque, Meyer, & Davidson, 2015; Pryce, Hall, Laplante-Lévesque, & Clark, 2016) and are effective in improving hearing-related quality of life (Chisolm et al., 2007; Ferguson, Kitterick, Chong, Barker, & Hoare, 2017). Despite this, studies find that 5% to 24% of hearing aid owners do not use their hearing aids (Aazh, Prasher, Nanchahal, & Moore, 2015; Hartley, Rochtchina, Newall, Golding, & Mitchell, 2010; Hougaard & Ruf, 2011; Solheim & Hickson, 2017) and 40% of new adult patients use their hearing aids fewer than four hours per day (Aazh et al., 2015). Some of the main reasons for non-use or under-use of hearing aids include poor fit and comfort of hearing aids, perceptions that hearing aids are of limited benefit and poor service from hearing aid dispensers and/or dispensers overselling the benefits of hearing aids (Aazh et al., 2015; McCormack & Fortnum, 2013). Relatively little is known about factors related to the fitting process and hearing aid use and benefit (Vestergaard Knudsen, Öberg, Nielsen, Naylor, & Kramer, 2010).

The purpose of the present study is to evaluate an intervention delivered during the hearing aid fitting to promote hearing aid use.

A Cochrane systematic review found that none of the included 37 trials improved hearing aid use (Barker, Mackenzie, Elliott, Jones, & de Lusignan, 2016), perhaps because none were based on behavior change theory and evidence (Armitage, Lees, Lewis, & Munro, 2017), for example the behaviour change wheel (Michie, Atkins, & West, 2014). Previous intervention studies in the review included education-,
counselling and auditory training-based interventions (Barker, Mackenzie, Elliott, et al., 2016). Previous interventions were therefore all based on educational principles and focused on providing information relating to communication techniques to reduce negative impact of hearing loss and/or information concerning management and use of hearing aids. For example, Ferguson, Brandreth, Brassington, Leighton, and Wharrad (2016) developed a series of short interactive instructional videos that were based on educational design principles. A recent study reported that adult patients were highly motivated to use their hearing aids but had difficulty translating motivation to use hearing aids into action (‘volitional process’; Sawyer, Munro, Dawes, O’Driscoll, & Armitage, 2019). Sawyer et al. (2019) suggested interventions to promote hearing aids should target ‘volitional processes’ (e.g., action planning) to increase hearing aid use among adult patients.

Based on their systematic review and associated work, Barker, de Lusignan, and Cooke (2016), developed the ‘I-PLAN’ intervention, using the behaviour change wheel (Michie et al., 2014). The I-PLAN intervention aims to support audiologists during hearing aid fitting appointments to support adult patients in using their hearing aids and comprises three components: (i) provision of information related to the benefits and disadvantages of using and not using a hearing aid; (ii) provision of prompts as a reminder for hearing aid use; and (iii) creation of a behavioral plan for hearing aid use (Barker, de Lusignan, & Cooke, 2016) (see Table 1). The I-PLAN intervention could be a promising intervention to promote hearing aid use as the components of the I-PLAN may target both motivation (via provision of information) and volitional process (via provision of prompt and plan) of adult patients. To date, the effectiveness of the I-PLAN intervention has not been tested. In addition, given
that little is known about which audiologist behaviors may facilitate patient hearing aid use outcomes, intervention studies are needed to provide an evidence base for clinical practice (Ismail, Munro, Armitage, & Dawes, 2019).

Table 1: Active ingredients of the I-PLAN intervention (Barker, de Lusignan, & Cooke, 2016)

<table>
<thead>
<tr>
<th>Components of the I-PLAN</th>
<th>Behavior change technique</th>
<th>Definition (from BCTTv1; Michie et al., 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of information related to consequences of hearing aid use and non-use</td>
<td>5.1 Information about health consequences</td>
<td>Provide information (e.g., written, verbal, visual) about health consequences of performing the behavior.</td>
</tr>
<tr>
<td>Provision of a prompt to remind patients to use their hearing aids</td>
<td>5.3 Information about social and environmental consequences</td>
<td>Provide information (e.g., written, verbal, visual) about social and environmental consequences of performing the behavior.</td>
</tr>
<tr>
<td>Creation of a behavioral plan for hearing aid use</td>
<td>7.1 Prompts/cues</td>
<td>Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behavior. The prompt or cue would normally occur at the time or place of performance.</td>
</tr>
<tr>
<td></td>
<td>12.5 Adding objects to the environment</td>
<td>Add objects to the environment in order to facilitate performance of the behavior.</td>
</tr>
<tr>
<td></td>
<td>1.4 Action planning</td>
<td>Prompt detailed planning of performance of the behavior (must include one of context, frequency, duration and intensity). Context may be environmental (physical or social) or internal (physical, emotional or cognitive).</td>
</tr>
<tr>
<td></td>
<td>1.1 Goal setting (behavior)</td>
<td>Set or agree a goal defined in terms of the behavior to be achieved.</td>
</tr>
<tr>
<td></td>
<td>1.2 Problem solving</td>
<td>Analyse or prompt the person to analyse factors influencing the behavior and generate or select strategies that include overcoming barriers and/or increasing facilitators.</td>
</tr>
<tr>
<td></td>
<td>1.4 Action planning</td>
<td>Prompt detailed planning of performance of the behavior (must include one of context, frequency, duration and intensity). Context may be environmental (physical or social) or internal (physical, emotional or cognitive).</td>
</tr>
</tbody>
</table>
In addition to testing the I-PLAN intervention, we wanted to understand the potential mechanisms of action thereby allowing the intervention to be optimised (Bauman, Sallis, Dzewaltowski, & Owen, 2002) and considered two potential avenues. First, given that the intervention is designed to enhance self-regulation (defined as ‘any efforts undertaken to alter one’s behavior’; Sniehotta et al., 2005, p. 245), we assessed awareness of standards for action, self-monitoring, and self-regulatory effort as potential mediators of any effect (Sniehotta, Nagy, Scholz, & Schwarzer, 2006). Second, behavioral plans (e.g., action plans) specified in the “when-then” format (as in the present study) have been shown to change behavior via habits (Armitage, 2016) and repeated successful performance of behaviors leads to habit formation (Gardner, Abraham, Lally, & de Bruijin, 2012), so we additionally assessed habit as a potential mediator.

**Aim and hypotheses**

We aimed to evaluate the effectiveness of I-PLAN delivered face-to-face by audiologists during hearing aid fitting appointments in promoting hearing aid use and benefit compared to standard care among first-time adult hearing aid users. In this study, we aimed to test five hypotheses: (i) participants who received I-PLAN would report higher hearing aid use operationalised as the proportion of time during which hearing aids were used in difficult listening situations compared to the Standard Care group; (ii) participants who received I-PLAN would show greater hearing aid use measured via data-logging; (iii) participants who received I-PLAN would report higher hearing aid benefits compared to the Standard Care group; (iv) participants who received I-PLAN would report higher self-regulation and habit formation relative to the Standard Care group; and (v) enhanced self-regulation and better habit
formation would mediate the effect of the I-PLAN intervention on hearing aid use and benefit.

Methods

Study design
This was a quasi-randomized study design with two arms. Adult patients were allocated to I-PLAN (n = 80) or Standard Care group (n = 80). Participants in the I-PLAN group received the I-PLAN intervention at the time of hearing aid fitting. Outcome assessments were taken at six weeks post-intervention. This study received NHS ethical approval from the North West - Greater Manchester East Research Ethics Committee and from the University of Manchester Ethics Committee (REC reference 17/NW/0406). This study was registered in the clinical trials database (ClinicalTrials.gov identifier is NCT04017416).

Setting
This study was conducted in a single-centre audiology service in Manchester, UK. The study was conducted from January to December 2018.

Outcome measures
The primary outcome, assessed six weeks post-intervention, was self-reported use of hearing aids in difficult listening situations. The self-reported was used as a primary outcome given that the aim of the I-PLAN intervention was to promote hearing aid use in listening situations based on individual needs. The secondary outcomes were hearing aid use measured via data-logging, self-report of hearing aid benefit, self-regulation and habit formation. The six weeks period between intervention and
outcome assessments was chosen because it is a routine practice in UK National Health Service audiology clinics for patients to be followed up at six weeks after hearing aid being fitted. The outcome measures were:

**Hearing aid use in situations that cause hearing difficulty unaided:** A question adapted from the Glasgow Hearing Aid Benefit Profile (GHABP) (Gatehouse, 1999) was used to assess hearing aid use in difficult situations: ‘*In a typical situation where you have hearing difficulty, what proportion of time do you wear your hearing aid?*, with five response options; never/not all (0% of time), about ¼ of the time (25% of the time), ½ of the time (50% of the time), ¾ of the time (75% of the time), or all the time (100% of the time). Proportion of time hearing aids were used in difficult listening situations was measured because the aim of the I-PLAN intervention was to promote hearing aid use in listening situations based on individual needs (as specified in the “when-then” format. In the ““when-then” format, participants were required to complete a behavioral plan on when to use their hearing aids). Additionally, hearing aid use in the most critical listening situations based on individual needs is a good index of ‘optimal’ hearing aid use (Laplante-Lévesque, Jensen, Dawes, & Nielsen, 2013). Higher percentage indicates higher proportion of time hearing aids were used in difficult listening situations.

**Hearing aid use:** An objective measure of hearing aid use was generated automatically by the hearing aid(s) data logging feature. Hearing aid use data were reported in terms of mean hours/day. The mean of the right and left hearing aid was used for participants with two hearing aids.
International Outcome Inventory for Hearing Aids (IOI-HA): The IOI-HA was used to capture self-reported hearing aid benefit (Cox & Alexander, 2002). The IOI-HA is widely used to measure hearing aid outcomes (Perez & Edmonds, 2012), and comprises seven questions; hearing aid use, hearing aid benefit, residual activity limitations, satisfaction, residual participation restrictions, impact on others, and quality of life. Five response options are provided for each question with a score from 1 to 5 (total score 7-35). Higher scores indicate better outcomes.

Hearing Handicap Inventory for the Elderly and for Adults – Screening version (HHIE-S): The HHIE-S (Ventry & Weinstein, 1983) measures self-perceived hearing handicap. The HHIE-S consists of 10 questions and assesses the effect of hearing loss on emotional and social domains. For example; ‘do you feel handicapped by a hearing problem?’ (emotional domain) and ‘does a hearing problem cause you difficulty when visiting friends, relatives, or neighbours?’ (social domain). Response options are yes (4 points), sometimes (2 points) or no (0 points). Higher scores indicate greater perceived hearing handicap.

Self-regulation: Three components of self-regulation: awareness of standards for action, self-monitoring and self-regulatory effort were assessed. Self-regulation questions were adapted from a self-regulation questionnaire on physical activity by Sniehotta et al. (2006). There are six items (2 items/component) with a seven-point Likert scale (1 strongly disagree to 7 strongly agree). All the items began with a statement ‘During the last six weeks, I….and followed by statements relating to self-regulation. For example; ‘…often had the intention to use my hearing aid(s) on my mind’ (awareness of standards) or ‘…tried hard to use my hearing aid regularly’ (self-
regulatory effort). Higher scores indicate greater self-regulation. The scale showed good internal consistency with a Cronbach’s alpha of 0.77 in the present study.

**Self-Report Behavioral Automaticity Index (SRBAI):** Habit formation in relation to hearing aid use was measured using the four items of the SRBAI (Gardner et al., 2012). All the questions began with a phrase ‘Using hearing aid(s) is something...’ ‘...I do automatically’, ‘...I do without thinking’, ‘...I do without having to consciously remember to use them’ and ‘...I start doing before I realize I am doing it’. The four items were answered on seven-point Likert scale (1 strongly disagree to 7 strongly agree). Higher the scores indicate stronger habit. The scale showed good internal consistency with a Cronbach’s alpha of 0.93 in the present study.

**The I-PLAN written materials**

Barker, de Lusignan, and Cooke (2016) did not specify the exact form of the I-PLAN components, so we developed I-PLAN materials that would be used by audiologists to deliver the three I-PLAN components to their patients during hearing aid fitting consultations. We chose to develop written I-PLAN materials because they will: (i) minimize effort needed by audiologists to remember the content of the I-PLAN; (ii) maximize participant’s recall of the I-PLAN information (Reese & Hnath-Chisolm, 2005); and (iii) make it possible to replicate the intervention for future research or clinical implementation. In addition, I-PLAN written materials also would serve as a checklist to monitor fidelity of the I-PLAN (Supplemental Material 1). The I-PLAN written materials were:

**Information on consequences of using and not using a hearing aid:** We reviewed literature related to the negative impact of hearing loss (e.g., Scarinci et al., 2008; Vas
et al., 2017) in order to identify commonly reported consequences of using/not using a hearing aid. To ensure that consequences included in the I-PLAN would be of relevance to patients and audiologists, we consulted three adult patients with hearing loss aged between 50 and 70 years, two significant others and two audiologists. All were asked to rank lists of consequences of hearing aid use/non-use in order of importance (1 = most important; 5 = least important). To determine which consequences of hearing aid use/non-use would be included in the I-PLAN written materials, we used the Modified Borda Count method (www.mindtools.com). Based on the Modified Borda Count method, each participant preferred options were assigned weights (1 = 5 points; 5 = 1 point). Then, the scores were added and averaged to identify the top three preferred options across participants. The Borda Count method was used in a previous study that developed venous thromboembolism educational materials for patients and their significant others (Popoola et al., 2016). The top three positive and negative consequences were included in the I-PLAN written material (BCTTv1 5.3: Information about social and environmental consequences; Michie et al., 2013).

**A prompt for hearing aid use:** In standard care, a hearing aid box is provided free to the patients for safekeeping of hearing aid when not in use (BCTTv1 12.5: Adding objects to the environment; Michie et al., 2013). For example, study audiologists may say ‘two boxes here are to put the hearing aids in’ to their patients when fitted with hearing aids. In the I-PLAN intervention, the hearing aid box would be explicitly identified to patients by audiologists as a physical prompt to remind patients to use their hearing aid. A written instruction provided with the box were ‘Please use your hearing aid box as a reminder to wear your hearing aid(s). For example, you could
put your hearing aid box next to the bathroom mirror last thing at night to remind you to wear your hearing aid(s) in the morning’ (BCTTv1 7.1: prompts/cues; Michie et al., 2013).

**A written behavioral plan for hearing aid use:** In standard care, patients are advised to use their hearing aids (e.g., to use the hearing aid all the time; BCTTv1 1.1: Goal setting (behavior); Michie et al., 2013). In the I-PLAN intervention, audiologists were asked to collaborate with their patients to produce a specific plan on ‘where’ and ‘when’ to use their hearing aids (BCTTv1 1.4: Action planning; Michie et al., 2013). Instructions and an example were provided; ‘Please plan where and when to wear your hearing aid(s). You can choose any place and time but please write your plan in as much detail as possible. Please write your plan in the space provided. Example: ‘When I have finished brushing my teeth in the morning, then I will wear my hearing aid(s)’. The instruction was adapted from ‘volitional help sheets’, used previously to promote smoking cessation (Armitage, 2008), physical activity (Armitage & Arden, 2010) and to reduce alcohol intake (Armitage & Arden, 2012). In the present study, we did not operationalise ‘problem solving’ (BCTTv1 1.2; Michie et al., 2013), because we judged that first-time hearing aid users may have difficulty identifying barriers to using hearing aids as they have not yet had any experience with hearing aids. The I-PLAN intervention written materials are in Table 2.
**Table 2: The details of the I-PLAN intervention written materials**

<table>
<thead>
<tr>
<th>Components of the I-PLAN</th>
<th>Behavior Change Technique</th>
<th>Written Materials of I-PLAN</th>
</tr>
</thead>
</table>
| Provision of information related to consequences of hearing aid use and non-use | 5.3 Information about social and environmental consequences | Hearing aid use will improve:  
  - your ability to hear others  
  - your social interactions  
  - the lives of those around you by making it easier for them to communicate with you.  
  **Not using a hearing aid will:**  
  - reduce your ability to hear your family and friends  
  - lead you to withdraw from social activities  
  - cause stress and increase burden on those around you by making it harder for them to communicate with you. |
| Provision of a prompt to remind patients to use their hearing aids | 7.1 Prompts/cues | My hearing aid reminder  
Please use your hearing aid box as a reminder to wear your hearing aid(s). For example, you could put your hearing aid box next to the bathroom mirror last thing at night to remind you to wear your hearing aid(s) in the morning. |
| Creation of a behavioral plan for hearing aid use | 1.4 Action planning | My hearing aid(s)  
Please plan where and when to wear your hearing aid(s).  
You can choose any place and time but please write your plan in as much detail as possible. Please write your plan in the space provided on the next page.  
**Example:** ‘When I have finished brushing my teeth in the morning, then I will wear my hearing aid(s)’  
**Please write your plan in the space provided in the format in the example.**  
When I ……………., then I will wear my hearing aid(s).  
Use the space below if you want to write more than one plan. |
Participants

The sample size calculation using G-power software (Faul, Erdfelder, Lang & Buchner, 2007), suggested that 128 adult patients (64 participants per group) would provide 80% statistical power to detect a significant difference in the proportion of time hearing aids were used (the primary outcome measure) between the groups with a medium sized effect of Cohen’s f squared ($f^2 = 0.0625$) using a MANOVA ($\alpha = 0.05$). However, to allow for attrition and to provide some statistical leeway, we aimed to recruit 80 participants in each group ($n = 160$ participants).

Adult patients who were scheduled for initial hearing aid fitting appointments were approached to participate in this study. Patients were recruited by reviewing clinic schedules of study audiologists to identify potentially eligible participants. Adults were eligible if they: (i) had no previous personal experience of using a hearing aid; (ii) were aged 18 years old or above; (iii) attended initial hearing aid fitting appointment with study audiologists; (iv) were native English speakers or had good understanding of English; and (v) had sufficient mental capacity to provide informed consent based on audiologist’s opinion were eligible to take part in this study. The exclusion criteria were: (i) inability to complete the questionnaires due to age-related problems (for example; dementia) based on audiologist’s opinion; and (ii) presence of medical contraindications for hearing aids as described by the British Academy of Audiology (BAA, 2007).

For each patient, an invitation letter, participant information sheet, consent form, and baseline questionnaire were posted at least two days prior to their hearing aid fitting appointment. No incentives were offered for participation. Adult patients were
provided written informed consent and were told that they were free to choose whether or not to participate and that they could withdraw themselves or their data at any time without consequence. If patients decided to take part in the study, they were asked to sign the consent form, complete the questionnaire at home and return the completed documents to their audiologist at the hearing aid fitting appointment.

**Group allocation**

Allocation of participants to condition was based on: (i) when participants were able to attend their hearing aid fitting appointments; and (ii) the clinic schedules of study audiologists. Neither the study audiologists nor the authors had any role in allocation of participants to the two groups. Participants scheduling was carried out by clinical administrative staff. Allocation of participants to the study audiologists in both groups was designed to be as close as possible to the clinic procedures to minimize the demands on the participating audiological clinic. Participants were blinded to group allocation as they did not know which audiologists were delivering the I-PLAN or Standard Care when they attended their hearing aid fitting appointments. It was not possible to blind study audiologists to group allocation.

**Study audiologists**

Following a meeting with all audiologists (n = 7) in the participating UK National Health Service audiology clinic, four audiologists (n = 4) volunteered to help in this study. Audiologists who volunteered to help but were not interested in delivering the I-PLAN were assigned to the Standard Care group (n = 2). Audiologists who were interested in delivering the I-PLAN intervention were allocated to the I-PLAN group.
and attended the I-PLAN training session (n = 2). All four study audiologists were working full-time with adult patients in the audiology department (Table 3).

### Table 3: Characteristics of study audiologists

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>I-PLAN</th>
<th>SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>48</td>
</tr>
<tr>
<td>Working experience (years)</td>
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<td>3.5</td>
</tr>
<tr>
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<td>24</td>
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</tbody>
</table>

Two hearing aid fitting consultations each were video recorded for all four study audiologists prior to the commencement of the study in order to: (i) establish that usual clinical practice was different to the I-PLAN intervention; and (ii) provide a baseline description of clinical interactions of the study audiologists. Videos were independently reviewed by the first (Ismail) and one co-author (Dawes). Both of the authors recorded the audiologists’ clinical practice in a checklist form (Supplemental Material 2) that was developed based on the description and examples of UK audiologists’ practice observed in Barker, Mackenzie, and de Lusignan’s (2016) study. The form was completed independently by the authors. Any disagreements were resolved through a discussion. Analysis of the video-recorded clinical consultations confirmed that the clinical practice of all study audiologists was similar to that observed in Barker, Mackenzie, and de Lusignan’s description of the clinical practice of UK audiologists (see Barker, Mackenzie, & de Lusignan, 2016). Clinical practice of the study audiologists did not differ between the audiologists who would later deliver the I-PLAN intervention versus those who would deliver standard care.
only. Comparability of I-PLAN and standard care audiologists prior to training was confirmed by showing no differences in the clinical and demographic characteristics and hearing aid use (data logged hours of hearing aid use) of patients seen by each study audiologist in the three months before the study commenced (Supplemental Material 3).

**I-PLAN training**

At the commencement of the study, two audiologists attended an I-PLAN training session with the first author (Ismail). The I-PLAN training session included an explanation of the development and components of the I-PLAN. Training also included a practical session using the I-PLAN where audiologists practiced delivering the I-PLAN on each other via a role play exercise. The training lasted for about one hour.

Following the training session, the two I-PLAN audiologists practiced delivering the I-PLAN to three first-time hearing aid patients each (n = 6, in total). This was to ensure that the I-PLAN components were delivered as specified in the I-PLAN written materials. The practice consultations were video recorded after written informed consent was obtained from the patients. The first author attended the clinic on the day of the consultations to set up the filming equipment but was not present during the consultations. The videos were viewed independently by the two authors (Ismail and Dawes). The audiologists’ verbal statements were also checked by the authors using the I-PLAN fidelity checklist (Supplemental Material 1). The fidelity checklist was developed based on the content of the I-PLAN written materials. The two audiologists
were observed to deliver the I-PLAN intervention according to the I-PLAN written materials.

**Fidelity to the I-PLAN intervention**

Three months after the study had commenced, hearing aid fitting consultations were video recorded again for all study audiologists. In the I-PLAN group, four audiologist-patient consultations selected at random (n = 4; 2 patients for an audiologist), were video recorded to monitor fidelity of delivery of the I-PLAN intervention by the study audiologists. The audiologists’ verbal statements were independently checked by the first (Ismail) and one co-author (Dawes) using a checklist for the content of the I-PLAN (Supplemental Material 1). In the Standard Care group, two audiologist-patient consultations were also selected at random (n = 2; 1 patient, 1 audiologist) and video recorded to monitor the consistency of the behavior of standard care audiologists during the research study. Videos of the clinical consultations of audiologists at three months after the I-PLAN audiologists received I-PLAN training showed that the I-PLAN audiologists delivered the I-PLAN components as prescribed in the I-PLAN written materials (Supplemental Material 1). The clinical interactions of the standard care audiologists three months after commencement of the study were consistent with observations of clinical interactions before the commencement of the study.

**Hearing aid fitting appointment**

**Standard Care Group**

Audiologists in the Standard Care group were instructed to manage the participants in the same way as they would do in their routine clinics. All the procedures conducted in the routine clinical practice were in accordance with national practice guidelines.
and were typical of National Healthcare Services (NHS) audiology departments across the UK. Specifically, standard care fitting appointments involved: (i) programming of hearing aid(s); (ii) performing real ear measurements (REMs); (iii) advising patients on realistic expectations (e.g., hearing aid does not restore normal hearing), communication tactics and habituation to a hearing aid; (iv) providing demonstration and instruction to operate a hearing aid; (v) explanation on services provided (access battery and repair service); (vi) providing patients with batteries, hearing aid box and written information about specific hearing aid fitting; (vii) explanation about what to expect at the follow-up appointment; and (viii) booking for hearing aid follow-up appointment in six weeks’ time. The hearing aid fitting consultation lasted up to 45 minutes.

**I-PLAN Group**

Participants in the I-PLAN group received a consultation from one of the two study audiologists trained to deliver I-PLAN. The study audiologists were instructed to deliver the I-PLAN in addition to standard care at the hearing aid fitting consultation. The study audiologists were also instructed to integrate the I-PLAN into their 45-minute routine hearing aid fitting consultation. At the end of the consultation, participants were given their I-PLAN cards to take with them.

**Follow-up appointment**

All participants across the groups received a six-week face-to-face hearing aid follow-up appointment per usual clinical care. Approximately two days before the six weeks follow-up appointment, a questionnaire was posted to the participants. Participants were asked to bring the completed questionnaire with them to the appointment. At the
follow-up appointment, the audiologist discussed the particular difficulties participants were having with their hearing aid(s) and provided further education, practice, advice, and hearing-aid adjustment as required. Data on hearing aid usage (averaged across the whole six weeks) were also downloaded from the hearing aids. When participants did not attend their follow-up appointment, they were sent a postage-paid addressed envelope and were asked to return the questionnaire to the researcher.

_Statistical analysis_

Descriptive statistics summarize the characteristics of participants. To assess the success of the quasi-randomization procedures, multivariate analysis of variance (MANOVA) was used to compare the characteristics of the I-PLAN and Standard Care groups on continuous baseline variables, and chi-square for categorical variables.

To investigate the effectiveness of the I-PLAN intervention on the outcome measures, two analyses were conducted. The first analysis was MANOVA to determine if the mean difference was significant. Second, multivariate analysis of covariance (MANCOVA) was performed in order to control for differences in any baseline characteristics (for example; age, gender, audiometric hearing thresholds and self-reported hearing handicap, HHIE-S (unaided)) between the I-PLAN and Standard Care groups that may impact outcomes.

To investigate the effect of the I-PLAN intervention on potential mediators, self-regulation and habit formation, we planned to conduct bootstrapping procedures as
outlined by Preacher and Hayes (2008) to test for the multiple mediating effects. The bootstrapping procedures would be conducted if there was a significant difference between the groups on self-regulation or habit formation or any of hearing aid outcome measure.

**Results**

**Recruitment and retention**

Flow of study participants for the present study is illustrated in Figure 1. Prior to a hearing aid fitting appointment, 288 patients were invited to participate in the study by mail. At the hearing aid fitting appointment, 160 (55.5%) agreed to participate in this study and were allocated to the I-PLAN group (n = 80) or Standard Care group (n = 80). Twelve participants (7.5%; 6 from each group) did not attend (DNA) the six-week hearing aid follow-up.

Of 148 participants who attended the follow-up appointments, eight participants (n = 8) did not return their follow-up questionnaire (5.4%; 4 from each group). Six additional follow-up questionnaires, however, were received from the six out of 12 participants who did not attend their follow-up appointment. Five participants from the I-PLAN group and one participant from the Standard Care group. The data therefore were included in the analysis that involved participants who returned the follow-up questionnaire (I-PLAN group, n = 75 and SC group, n = 71).
Clinical and demographic characteristics of participants

Table 4 shows the characteristics of the participants recruited to the study and allocated to the I-PLAN group and Standard Care group at the hearing aid fitting appointment. Consistent with the sampling frame, all participants recruited to the present study were first-time hearing aid users. The mean age of all participants was 72 years (SD = 10.7, range 41-91 years). Approximately half (52%) were male. All the participants across the groups were fitted with behind-the-ear hearing aid(s). 62% (99 out of 160) of the participants were fitted bilaterally. The mean score of the self-perceived hearing handicap based on the Hearing Handicap Inventory for the Elderly (HHIE)-Screening, HHIE-S (unaided) questionnaire was 20.5 (SD = 9.6) which indicates a mild-moderate hearing handicap.
At the hearing aid fitting appointment, based on MANOVA, there was a significant difference between I-PLAN group and Standard Care group in baseline characteristics (age, pure tone average and HHIE-S (unaided)), $F(3, 156) = 2.81; p = 0.04$; Pillai’s trace $V = 0.05$; Partial $\eta^2 = 0.05$. Decomposition of this effect using univariate ANOVAs showed there was a borderline significant difference in age ($p = 0.06$) between the two groups. Participants in the I-PLAN group were older than participants in the Standard Care group. There were no significant differences in pure tone average ($p = 0.56$) and HHIE-S (unaided) ($p = 0.14$) between the two groups. There were no significant differences between I-PLAN and Standard Care groups in gender ($p = 0.87$) and fitted ear ($p = 0.63$) based on Chi-Square tests.

There was also no significant difference in baseline characteristics between those who did and did not attend the six-week follow-up appointment (Supplemental Material 4).
Table 4: Clinical and demographic characteristics of participants recruited to this study and allocated to the I-PLAN or Standard Care (SC) group at the hearing aid fitting appointment

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>I-PLAN (n = 80)</th>
<th>SC (n = 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Age (years)</td>
<td>73.7</td>
<td>9.4</td>
</tr>
<tr>
<td>Age range (years)</td>
<td>41-91</td>
<td></td>
</tr>
<tr>
<td>Hearing loss (dBHL)*</td>
<td>34.7</td>
<td>11.9</td>
</tr>
<tr>
<td>HHIE-S (unaided)</td>
<td>21.6</td>
<td>9.5</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>41</td>
<td>51.2</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>48.8</td>
</tr>
<tr>
<td>Fitted Ear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>32</td>
<td>40.0</td>
</tr>
<tr>
<td>Bilateral</td>
<td>48</td>
<td>60.0</td>
</tr>
</tbody>
</table>

* = Average of hearing thresholds at .5, 1, 2 and 4 kHz in the better ear.
Hearing aid use

Self-reported hearing aid use in situations that caused hearing difficulty unaided

Out of 146 participants who returned their follow-up questionnaire, the mean proportion of time the hearing aids were used in situations that caused hearing difficulty unaided was 81.0% (SD = 25.9) of the time for the I-PLAN group (n = 75) and 79.6% (SD = 29.4) of the time for the Standard Care group (n = 71). Four participants (2.7%) reported that they used their hearing aids ‘never/not at all of the time’ in situations where they had hearing difficulty. All of these participants were in the Standard Care group. Across both groups, 11 participants (7.5%) reported using their hearing aids for ‘¼ of the time’, 19 (13%) for ‘½ of the time’, 28 (19.2%) for ‘¾ of the time and 84 (57.5%) for ‘all the time’.

Objective hearing aid use measured via data-logging

Overall, average hearing aid use as measured via data logging by all participants (n = 148) at the six-week follow-up appointment was 9.3 (SD = 5.2) hours per day. Mean hearing aid use in the I-PLAN group (n = 74) was 9.7 (SD = 4.9) hours per day. Mean hearing aid use in the Standard Care group (n = 74) was 8.8 (SD = 5.6) hours per day. Figure 2 shows the distribution of hearing aid use for the I-PLAN and Standard Care groups. Among participants who attended the six-week follow-up appointment but did not return the follow-up questionnaire (n = 8), the mean hearing aid use was 6.5 (SD = 5.0) hours per day.

Out of 148 participants, 16.9% (25 out of 148) used their hearing aid fewer than four hours per day (‘non-regular hearing aid use’, according to criteria used by Aazh et al. (2015)). Of the 25 participants, 15 (20.3%) of the participants were in the Standard
Care group (n = 74) and 10 (13.5%) were in the I-PLAN group (n = 74). There were no significant differences between regular and non-regular hearing aid users in age, gender, fitted ear, pure tone average or self-perceived hearing handicap score (based on HHIE-S (unaided)) at hearing aid fitting appointment (Supplemental Material 5).

Figure 2: The distribution of hearing aid use measured via data-logging (hours per day) according to groups. The middle line in the boxplot represents the median.

**Effects of the I-PLAN intervention**

As shown in Table 5, the I-PLAN intervention had no impact on hearing aid use (proportion of time of hearing aid use or data-logging, benefit (IOI-HA or HHIE-S (aided)) and potential mediators (self-regulation or habit formation). The MANOVA, $F (6, 133) = 0.46; p = 0.83$; Pillai’s trace $V = 0.02$ Partial $\eta^2 = 0.02$, as well as the univariate ANOVAs showed there were no significant differences in all measures between the I-PLAN and Standard Care groups. This result remained non-significant
after adjusting for age, gender, pure tone average and self-reported hearing handicap, HHIE-S (unaided) using the MANCOVA, $F (6, 129) = 0.47; p = 0.83$; Pillai’s trace $V = 0.02$; Partial $\eta^2 = 0.02$ and univariate ANCOVAs.

Given there were no differences between groups in any of the potential mediators or hearing aid outcome measure, mediator analysis was not conducted.

Table 5: Outcome measures for the I-PLAN and Standard Care (SC) groups at six-week follow-up appointment

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>I-PLAN (n = 70)</th>
<th>SC (n = 70)</th>
<th>Mean difference (95% CI)</th>
<th>$d$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Proportion of time (%)</td>
<td>81.4</td>
<td>25.4</td>
<td>80.0</td>
<td>29.4</td>
</tr>
<tr>
<td>Data logging (hours/day)</td>
<td>9.8</td>
<td>5.0</td>
<td>9.1</td>
<td>5.5</td>
</tr>
<tr>
<td>IOI-HA</td>
<td>28.5</td>
<td>4.0</td>
<td>28.3</td>
<td>4.3</td>
</tr>
<tr>
<td>HHIE-S (aided)</td>
<td>14.6</td>
<td>9.4</td>
<td>12.6</td>
<td>9.2</td>
</tr>
<tr>
<td>Self-regulation</td>
<td>5.1</td>
<td>0.9</td>
<td>5.0</td>
<td>1.1</td>
</tr>
<tr>
<td>SRBAI</td>
<td>4.6</td>
<td>1.5</td>
<td>4.6</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Notes:
1. The reported mean and standard deviations values are “raw” and not adjusted for baseline characteristics. The analyses were based on data obtained in participants who attended the six-week follow-up appointment and returned the follow-up questionnaire [I-PLAN, n = 70 and Standard Care, n = 70].
2. a = unadjusted values are from the ANOVAs. b = adjusted values are from the ANCOVAs with the covariates: (i) age; (ii) gender; (iii) pure tone average and; (iv) self-reported hearing handicap, HHIE-S (unaided).
3. IOI-HA= International outcome inventory for hearing aids; HHIE-S = Hearing Handicap Inventory for the Elderly and for Adults – Screening version; SRBAI = Self-Report Behavioral Automaticity Index.
4. Second analyses (MANOVA, MANCOVA and univariate) for self-reported outcomes were also conducted. The analyses were based on data obtained in participants who returned their follow-up questionnaire [I-PLAN, n = 75 and Standard Care, n = 71]. The results remained non-significant.
Outcome measures across study audiologists

MANCOVA was performed to explore whether there were differences in participant outcomes between the four study audiologists. Study audiologist was coded as an independent variable, with outcome measures at the six-week follow-up appointment as the dependent variables and age, gender, audiometric hearing thresholds and self-reported hearing handicap, HHIE-S (unaided) of participants as covariates. The MANCOVA, $F(18, 387) = 0.64; p = 0.87$; Pillai’s trace $V = 0.09$, Partial $\eta^2 = 0.03$, and the univariate ANOVAs showed there were no significant differences in all measures between the study audiologists (Supplemental Material 6).

Clinical and demographic characteristics of adult patients seen by study audiologists at three months pre-intervention

In order to explore whether hearing aid use in participants recruited to the study was different compared to hearing aid use among adult patients in the host audiology clinic prior to the commencement of the study, we compared hearing aid use between adult patients seen by study audiologists in the three months before the study commenced (n = 75) with those who were recruited to the study and attended their hearing aid follow-up appointment (n = 148). There was no difference in data logged hearing aid use in between participants recruited to this study (n = 148; Mean = 9.3 hours per day; SD = 5.2) and adult patients who attended the audiology clinic in the three months prior to the start of the study (n = 75; Mean = 8.5 hours per day; SD = 4.8); ANCOVA with age, gender and audiometric hearing thresholds as covariates, $F(1, 218) = 1.2, p = 0.28$ (Supplemental Material 7).
Discussion

As far as we are aware, this is the first study to investigate the effects of I-PLAN, a theory-based behavior change intervention delivered face-to-face by audiologists to promote hearing aid use and benefit among adult first-time hearing aid users. There was no significant difference between the I-PLAN and Standard Care groups on hearing aid use measured by self-reported proportion of time hearing aids used in difficult listening situations or data logged hearing aid use, hearing aid benefit, IOI-HA, HHIE-S (aided) or potential mediators self-regulation and habit formation.

Although the I-PLAN was found not to be effective to promote hearing aid use and benefit in this study, it may be premature to conclude that the I-PLAN is ineffective in promoting hearing aid use. Average hearing aid use as shown by data-logging by the participants in this study (n = 148) at the six-week follow-up appointment was at 9.3 hours per day. There may therefore be limited potential to increase hearing aid use among the first-time hearing aid users in this present study. As participants were required to give informed written consent to participate, the sample recruited to the study may have been biased in favour of those who were motivated to help with hearing research, and so may also be more likely to use their hearing aid(s) than those who declined to participate. It may be desirable to target those at high risk of not using or under using their hearing aids for interventions to promote hearing aid use, rather than delivering interventions to those who use hearing aids regularly.

Those who did not return to the six-week follow-up appointment or did not complete the follow-up questionnaire, for example, may have been more likely not to use their hearing aids and could perhaps have benefited from the I-PLAN intervention. In the
present study, eight participants did not complete the follow-up questionnaire at the six-week outcome assessment. Across the eight who did not complete the follow-up questionnaire, data logged hearing aid use was only 6.5 (SD = 5.0) hours per day, lower than the main group mean (Mean_{148} = 9.3 hours; SD = 5.2). Therefore, perhaps participants who did not complete the questionnaire or did not attend the follow-up appointment were likely not to use or under use their hearing aids.

Additionally, 16.9% (25 out of 148) of participants were non-regular hearing aid users (hearing aid use fewer than four hours per day; Aazh et al., 2015); much lower than the 40% non-regular users reported by Aazh et al. (2015) in a sample of new hearing aid users from another UK National Health Service audiology clinic. There were no significant differences between non-regular and regular hearing aid users in other baseline characteristics in the present study, but previous studies showed that adult patients who had a lower income (Lupsakko, Kautiainen, & Sulkava, 2005) and who did not perceive a need for a hearing aid (Lupsakko et al., 2005; Solheim, Gay, & Hickson, 2018) were more likely not to use or under use their hearing aids. Other factors that might predict low hearing aid use, for example, personality traits and coping strategies (Cox, Alexander, & Gray, 2005) or post-motivational variables (e.g., action planning) (Sawyer et al., 2019). Combinations of demographic and/or psychological variables could be used to identify those who are likely not to use hearing aids and may benefit from interventions to promote hearing aid use.

It is possible that the behavior change techniques in the I-PLAN might interact with each other to reduce effectiveness (Michie, West, Sheals, & Godinho, 2018). The I-PLAN intervention involved a combination of several behavior change techniques and
it was not possible to disentangle the independent contributions of individual behavior change techniques in the I-PLAN. Factorial study designs could isolate and investigate how individual behavior change techniques relate to hearing aid use (e.g., Ismail, Armitage, Munro, Marsden, & Dawes, 2019). Alternatively, there were dozens of potential behavior change techniques that were not incorporated in I-PLAN that could be tested in the future. In addition, given that participants may have received information concerning the consequences of using and not using a hearing aid at the hearing aid fitting appointment as part of standard care (e.g., Barker, Mackenzie, & de Lusignan, 2016), it is also possible that some of the behavior change techniques specified in the I-PLAN, for example the information about social and environmental consequences (BCTTv1 5.3; Michie et al., 2013), were also delivered by study audiologists in the Standard Care group. However, based on our video observations of clinical interactions in the Standard Care group, none of the information about social and environmental consequences as stated in the I-PLAN materials was delivered by the study audiologists. The video observations of the study audiologists were also in line with a systematic review which concluded that audiologists typically focus on provision of information concerning technical aspects of hearing aids during hearing aid consultations (Ismail, Munro, et al., 2019).

The effectiveness of the I-PLAN may also depend how behavior change techniques are delivered (Michie et al., 2018). Although the style of delivery of the behavior change techniques was beyond the scope of this study, it is possible that individual consultation styles of audiologists could add noise to the outcome data. For example, audiologists with better communication skills may promote better patient adherence to the audiologist’s recommendations (see Zolnierek & DiMatteo, 2009). But as there
was no difference in participant outcomes between study audiologists at the six-week outcome assessment, it is unlikely that differences in interaction styles between audiologists had an appreciable impact on patient outcomes. Studies could investigate different modes of delivery of the I-PLAN components. For example, I-PLAN components could be provided in a written format without audiologists’ involvement (Ismail, Armitage, et al., 2019), which may be easily implemented in the clinical routine. The I-PLAN components also could be provided on-line in video format (e.g., Ferguson et al., 2016). In addition, studies should ideally measure longer-term outcomes than the six-week follow-up in this study. Hearing aid use declines over longer durations (e.g., Humes, Wilson, Barlow, Garner, & Amos, 2002) and useful interventions should support hearing aid use in the long term.

**Limitations of the study**

First, there may have been contamination of the intervention across I-PLAN and standard care study audiologists given they were working in the same clinic. However, based on our video recordings, the clinical interactions of the standard care audiologists were consistent between observations prior to commencement of the study and three months after the commencement. A cluster randomized design using different clinical sites would eliminate the possibility of contamination in future studies. Second, participants were not randomized to group. In this study, randomization was not feasible. The procedures of the present study were designed to be as close to routine clinic procedure in order to avoid additional burden on the clinic that was hosting the study.
Conclusions

To our knowledge, this was the first controlled trial of the I-PLAN intervention to promote hearing aid use and benefit among first-time adult hearing aid users. There were no statistically significant differences in any outcome measure. However, a trend for higher hearing aid hours of use in present study sample, may limit the scope to promote better hearing aid use in the present study. Interventions to promote hearing aid use should seek to identify and target those who are at risk of not using their hearing aid.

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Disclosure statement

No potential conflict of interest was reported by the authors.
Funding

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investigation of decision making during help-seeking for adult hearing loss. 


Solheim, J., & Hickson, L. (2017). Hearing aid use in the elderly as measured by


SUPPLEMENTAL MATERIALS

Supplemental Material 1: Fidelity checklist of the I-PLAN intervention at three months after the I-PLAN training


| Components of the I-PLAN | Written Materials of I-PLAN | Fidelity  
(√ = present,  
  x = absent) |
|--------------------------|-----------------------------|-------------|
| Provide information (e.g. written and verbal) about **positive** social and environmental consequences of performing the behaviour | Hearing aid use will improve:  
• your ability to hear others  
• your social interactions  
• the lives of those around you by making it easier for them to communicate with you. |  |
| Provide information (e.g. written and verbal) about **negative** social and environmental consequences of performing the behaviour | Not using a hearing aid will:  
• reduce your ability to hear your family and friends  
• lead you to withdraw from social activities  
• cause stress and increase burden on those around you by making it harder for them to communicate with you. |  |
| Introduce or define environmental stimulus with the purpose of prompting or curing the behaviour. The prompt or cue would normally occur at the time or place of performance | My hearing aid reminder  
Please use your hearing aid box as a reminder to wear your hearing aid(s). For example, you could put your hearing aid box next to the bathroom mirror last thing at night to remind you to wear your hearing aid(s) in the morning. |  |
| Prompt detailed planning of performance of the behaviour  
(must include one of context, frequency, duration and intensity). | My hearing aid(s)  
Please plan where and when to wear your hearing aid(s). You can choose any place and time but please write your plan in as much detail as possible. Please write your plan in the space provided on the next page.  
Example: ‘When I have finished brushing my teeth in the morning, then I will wear my hearing aid(s)’  
Please write your plan in the space provided in the format in the example. When I ………., then I will wear my hearing aid(s).  
Use the space below if you want to write more than one plan. |  |
Supplemental Material 2: The checklist of usual clinical procedure of study audiologists based on the study conducted by Barker, Mackenzie, and de Lusignan (2016)

<table>
<thead>
<tr>
<th>BCTTv1</th>
<th>Definition (Michie et al., 2013)</th>
<th>Example from Barker Mackenzie, and de Lusignan (2016)</th>
<th>Present study ($\checkmark = \text{present}$, $\times = \text{absent}$)</th>
</tr>
</thead>
</table>
| 1.1    | Goal - setting (behaviour)      | • Set or agree a goal in terms of the behaviour to be achieved. | • ‘wear it all the time’  
• ‘wear it throughout the day every day’ |
<p>| 1.4    | Action-planning                 | • Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration, and intensity) | • ‘what I would like you to do is you get up in the morning, you’ve had a wash, you’ve got dressed, put your hearing aid in, try and leave it there all day and then take it out before you go to bed’ |
| 3.2    | Social support (practical)      | • Advise on, arrange or provide practical help for performance of the behaviour | • ‘If you have any problems at all, let us know’ |
| 4.1    | Instruction on how to perform a behaviour | • Advise on or agree on how to perform the behaviour | • - |
| 5.1    | Information about health consequences | • Provide information about health consequences of performing the behaviour | • ‘obviously because of the tinnitus hopefully it will help bring in the sounds in from around you to dull that down’ |
| 5.3    | Information about social and environmental consequences | • Provide information about social and environmental consequences of performing the behaviour | • ‘certain things might sound a bit sharper and more obtrusive than you’d normally think’ |</p>
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.6</td>
<td>Information about emotional consequences</td>
<td>• Provide information about emotional consequences of performing the behaviour • No example provided</td>
</tr>
<tr>
<td>6.1</td>
<td>Demonstration of the behaviour</td>
<td>• Provide an observable sample of the performance of the behaviour • -</td>
</tr>
<tr>
<td>8.1</td>
<td>Behavioural practice or rehearsal</td>
<td>• Prompt practice or rehearsal of the performance of the behaviour one or more times in a context or at a time when the performance may not be necessary in order to increase habit and skill. • -</td>
</tr>
<tr>
<td>8.7</td>
<td>Graded tasks</td>
<td>• Set easy-to-perform tasks, making them increasingly difficult, but achievable until behaviour is performed • ‘to start with wear them for a few hours a day in a quiet situation... then gradually introduce more sounds and wear them for a bit longer’</td>
</tr>
<tr>
<td>12.5</td>
<td>Adding objects to the environment</td>
<td>• Add objects to the environment in order to facilitate performance of the behaviour • Provided spare batteries; cleaning equipment</td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**Supplemental Material 3**: Clinical and demographic characteristics of adult patients seen by study audiologists during the three months before the study commenced

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>I-PLAN (n = 35)</th>
<th>SC (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td><strong>SD</strong></td>
<td><strong>Mean</strong></td>
</tr>
<tr>
<td>Age (years)</td>
<td>70.4</td>
<td>15.4</td>
</tr>
<tr>
<td>Age range (years)</td>
<td>32-89</td>
<td></td>
</tr>
<tr>
<td>Pure Tone Average (dBHL)*</td>
<td>35.6</td>
<td>13.8</td>
</tr>
<tr>
<td>Gender</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>16</td>
<td>45.7</td>
</tr>
<tr>
<td>Patient outcomes^X</td>
<td><strong>Mean</strong></td>
<td><strong>SD</strong></td>
</tr>
<tr>
<td>Data logging (hours/day)</td>
<td>7.9</td>
<td>4.8</td>
</tr>
</tbody>
</table>

* = Average of hearing thresholds at .5, 1, 2 and 4 kHz in the better ear.

^X = Hearing aid use of patients seen by study audiologists during the three months before the study commenced.
**Supplemental Material 4:** Clinical and demographic characteristics of participants attended and did not attend (DNA) at six-week follow-up appointment

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>I-PLAN (n = 74)</th>
<th>SC (n = 74)</th>
<th>Attended (n = 148)</th>
<th>DNA (n = 12)</th>
<th>p&lt;sup&gt;a&lt;/sup&gt;</th>
<th>p&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Age (years)</td>
<td>73.6</td>
<td>9.7</td>
<td>70.9</td>
<td>11.6</td>
<td>0.13&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.34&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Age range (years)</td>
<td>41-91</td>
<td>42-91</td>
<td>41-91</td>
<td>43-78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing loss (dBHL)&lt;sup&gt;*&lt;/sup&gt;</td>
<td>34.7</td>
<td>11.8</td>
<td>33.9</td>
<td>13.7</td>
<td>0.71&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.65&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>HHIE-S (unaided)</td>
<td>21.9</td>
<td>9.5</td>
<td>19.6</td>
<td>9.5</td>
<td>0.15&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.29&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>39</td>
<td>52.7</td>
<td>39</td>
<td>52.7</td>
<td>78</td>
<td>52.7</td>
</tr>
<tr>
<td></td>
<td>1.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>35</td>
<td>47.3</td>
<td>35</td>
<td>47.3</td>
<td>70</td>
<td>47.3</td>
</tr>
<tr>
<td>Fitted Ear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Monaural</strong></td>
<td>31</td>
<td>41.9</td>
<td>27</td>
<td>36.5</td>
<td>58</td>
<td>39.2</td>
</tr>
<tr>
<td></td>
<td>0.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bilateral</strong></td>
<td>43</td>
<td>58.1</td>
<td>47</td>
<td>63.5</td>
<td>90</td>
<td>60.8</td>
</tr>
</tbody>
</table>

<sup>a</sup> = p-values from the univariate ANOVAs (b) or chi-square test (c) or continuity correction (d).

<sup>*</sup> = Average of hearing thresholds at .5, 1, 2 and 4 kHz in the better ear.
Supplemental Material 5: Clinical and demographic characteristics of regular and non-regular hearing aid (HA) users

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Regular HA users</th>
<th>Non-regular HA users</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 123)</td>
<td>(n = 25)</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Age (years)</td>
<td>72.4</td>
<td>10.5</td>
<td>71.8</td>
</tr>
<tr>
<td>Age range (years)</td>
<td>41-91</td>
<td>45-86</td>
<td></td>
</tr>
<tr>
<td>Hearing loss (dBHL)*</td>
<td>34.6</td>
<td>12.5</td>
<td>32.8</td>
</tr>
<tr>
<td>HHIE-S (unaided)</td>
<td>20.7</td>
<td>9.5</td>
<td>21.0</td>
</tr>
<tr>
<td>Gender</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Female</td>
<td>56</td>
<td>45.5</td>
<td>14</td>
</tr>
<tr>
<td>Monaural</td>
<td>49</td>
<td>39.8</td>
<td>9</td>
</tr>
<tr>
<td>Bilateral</td>
<td>74</td>
<td>60.2</td>
<td>16</td>
</tr>
</tbody>
</table>

\[ a = \text{p-values are from the univariate ANOVAs (b) or chi-square test (c).} \]

\[ * = \text{Average of hearing thresholds at .5, 1, 2 and 4 kHz in the better ear.} \]
**Supplemental Material 6:** Outcome measures at six-week follow-up appointment across study audiologists

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>I-PLAN (n = 70)</th>
<th>SC (n = 70)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audiologist 1</td>
<td>Audiologist 2</td>
</tr>
<tr>
<td></td>
<td>(n = 43)</td>
<td>(n = 27)</td>
</tr>
<tr>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>SD</td>
<td>SD</td>
</tr>
<tr>
<td>Proportion of time (%)</td>
<td>82.6</td>
<td>79.6</td>
</tr>
<tr>
<td></td>
<td>24.1</td>
<td>27.8</td>
</tr>
<tr>
<td>Data logging (hours/day)</td>
<td>9.2</td>
<td>10.8</td>
</tr>
<tr>
<td></td>
<td>4.4</td>
<td>5.7</td>
</tr>
<tr>
<td>IOI-HA</td>
<td>28.8</td>
<td>28.1</td>
</tr>
<tr>
<td></td>
<td>4.3</td>
<td>3.6</td>
</tr>
<tr>
<td>HHIE-S (aided)</td>
<td>13.6</td>
<td>16.2</td>
</tr>
<tr>
<td></td>
<td>8.0</td>
<td>11.3</td>
</tr>
<tr>
<td>Self-regulation</td>
<td>5.1</td>
<td>5.2</td>
</tr>
<tr>
<td></td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>SRBAI</td>
<td>4.6</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>1.4</td>
</tr>
</tbody>
</table>

**Notes:**
1. The reported mean and standard deviations values are “raw” and not adjusted for baseline characteristics. The analyses were based on data obtained in participants who attended the six weeks follow-up appointment and returned the follow-up questionnaire [I-PLAN, n = 70 and Standard Care, n = 70].
2. IOI-HA= International outcome inventory for hearing aids; HHIE-S = Hearing Handicap Inventory for the Elderly and for Adults – Screening version; SRBAI = Self-Report Behavioural Automaticity Index.
**Supplemental Material 7:** Clinical and demographic characteristics of adult patients seen by study audiologists during the three months before the study commenced (n = 75) and participants recruited to this present study and attended the six-week follow-up appointment (n = 148)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>3 months pre-intervention (Based retrospective data)</th>
<th>Present study&lt;sup&gt;X&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 75</td>
<td>n = 148</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Age (years)</td>
<td>72.6</td>
<td>14.7</td>
</tr>
<tr>
<td>Age range (years)</td>
<td>32-94</td>
<td></td>
</tr>
<tr>
<td>Pure Tone Average (dBHL)&lt;sup&gt;*&lt;/sup&gt;</td>
<td>37.0</td>
<td>14.1</td>
</tr>
<tr>
<td>Gender</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>37</td>
<td>49.3</td>
</tr>
<tr>
<td>Female</td>
<td>38</td>
<td>50.7</td>
</tr>
<tr>
<td>Patient outcomes</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Data logging (hours/day)</td>
<td>8.5</td>
<td>4.8</td>
</tr>
</tbody>
</table>

<sup>*</sup> = Average of hearing thresholds at .5, 1, 2 and 4 kHz in the better ear.

<sup>X</sup> = The analyses were based on data obtained in participants who were recruited to this study and attended the six-week follow-up appointment.
CHAPTER 5
EVALUATION OF THE I-PLAN INTERVENTION TO PROMOTE HEARING AID USE IN NEW ADULT USERS: A RANDOMIZED CONTROLLED TRIAL

Journal: Ear and Hearing
Submission Status: Under review
Authors: Afzarini H. Ismail, Kevin J. Munro, Christopher J. Armitage, Antonia Marsden & Piers D. Dawes

Note: The format of Ear and Hearing is used in this chapter. References and appendices are placed at the end of this chapter.
Evaluation of the I-PLAN Intervention to Promote Hearing Aid Use in New Adult Users: A Randomized Controlled Trial

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Abstract

Objective: The I-PLAN is a theory-based intervention that is designed to promote hearing aid use in adults. It consists of a prompt, a behavioral plan and provision of information. Provision of information is already part of standard care and may not be sufficient to promote hearing aid use. The objective was to test the effectiveness of the I-PLAN prompt and plan components in promoting hearing aid use and benefit. Hypotheses were: there would be greater hearing aid use, benefit, self-regulation and habit formation among participants who received the prompt or plan component, compared to no prompt or no plan component, and the effect would be greatest in participants who received both prompt and plan; and self-regulation and habit formation would mediate the effect of prompt and/or plan components on hearing aid use and benefit.

Design: A 2 x 2 factorial randomized controlled trial design. 240 new adult patients (60 in each group) were randomized to: information (Info) only; Info + Prompt; Info + Plan; or Info + Prompt + Plan. All participants received treatment as usual, including information, by their audiologist in addition to I-PLAN components which were provided in a sealed envelope at the end of the hearing aid fitting consultation. Participants in the prompt group were instructed to use their hearing aid box as a physical prompt. Participants in the plan group were instructed to write a ‘when-then’ plan. Participants, audiologists and researchers were blinded to group allocation. The primary outcome was self-reported proportion of time hearing aids were used in difficult listening situations. Secondary outcomes were hearing aid use derived from data logging, self-reported hearing aid benefit, self-reported self-regulation and habit formation. Outcomes were measured at six-week post-fitting.
Results: Contrary to predictions, participants who received the prompt component reported using their hearing aid less than participants without the prompt \([p = 0.03; d = 0.24]\). Participants who received the plan component reported using their hearing aids more frequently than those who did not receive the plan \([p = 0.01; d = 0.34]\). Receiving both prompt and plan components did not change self-reported proportion of time hearing aids were used but data-logging hearing aid use was significantly reduced when participants received both prompt and plan components together. The prompt reduced self-regulation of hearing aid use compared to the no prompt \([p = 0.04; d = 0.28]\), while the plan promoted stronger formation of hearing aid use habits than the no plan group \([p = 0.02; d = 0.30]\).

Conclusions: Audiologists should consider using ‘when-then’ plans to promote hearing aid use. Using the hearing aid box as a physical prompt may have adversely impacted hearing aid use by undermining self-regulation. Participants may have delegated responsibility for hearing aid use to the prompt. The hearing aid box may also have unintentionally provided a stigmatising reminder of age-related physical decline. Subsequent studies should evaluate different prompts and test the long-term benefit of the plan and habit formation.
Introduction

Hearing aids are the first line of intervention for adults with hearing loss (Laplante-Lévesque et al. 2010; Grenness et al. 2015; Pryce et al. 2016) and are effective in improving hearing-related quality of life (Chisolm et al. 2007; Ferguson et al. 2017). However, studies estimate that 5% to 24% of adult hearing aid users do not use their hearing aid (Hartley et al. 2010; Hougaard & Ruf 2011; Aazh et al. 2015; Solheim & Hickson 2017) and up to 40% of adult new hearing aid users use their hearing aids for fewer than four hours/day (Aazh et al. 2015). There is therefore a need for strategies to promote hearing aid use among adults with hearing loss.

A Cochrane systematic review of intervention studies to promote hearing aid use found no self-management support or/and service delivery interventions in audiology that were effective in promoting hearing aid use in adults (Barker et al. 2016c). One of the reasons the intervention studies may fail to promote hearing aid use is because of limited use of behavior change theory to inform intervention development (Armitage et al. 2017). It is therefore imperative to develop theory-based interventions to maximize hearing aid use, promote quality of life and reduce waste of hearing health care resources.

The I-PLAN was the first theory-based intervention designed to promote hearing aid use (Barker et al. 2016a). The I-PLAN intervention was based on the behaviour change wheel, a framework for designing and developing a behavior change intervention (Michie et al. 2014). At the centre of the behaviour change wheel is the COM-B model. The COM-B model proposes that people need sufficient capabilities (C), opportunities (O), and motivation (M) to engage in behavior (B) (Michie et al. 2014). Development of the I-PLAN intervention involved working with adult patients and audiologists in: (i) understanding the problems surrounding non-
use of hearing aids; (ii) identifying target behaviors of audiologists that could promote hearing aid use in adult patients; and (iii) mapping the intervention components on to behavior change techniques using the Behavior Change Technique Taxonomy version 1 (BCTTv1; Michie et al. 2013). The behavior change techniques are the ‘active ingredients’ of behavior change interventions (Michie et al. 2013). Behavior change techniques can be delivered as stand-alone techniques or in combination with other behavior change techniques and can be provided by an interventionist or self-delivered (Michie et al. 2014). The three main components of the I-PLAN are: (i) provision of information related to consequences of hearing aid use and non-use (“info”); (ii) provision of a prompt to remind patients to use their hearing aids (“prompt”); and (iii) creation of a behavioral plan for hearing aid use (“plan”) (Barker et al. 2016a).

One of the I-PLAN components involve provision of information to adult patients on positive and negative consequences of using and not using a hearing aid (Barker et al. 2016a). Based on the COM-B model, provision of information on positive and negative consequences of hearing aid use would target adult patients’ psychological capability (e.g., knowledge) and hence influence adult patients’ motivation to use a hearing aid (Michie et al. 2014). In terms of behavior change techniques, provision of information on consequences of using and not using a hearing aid could be delivered as providing ‘information about health consequences’ (BCTTv1 5.1; Michie et al. 2013) and ‘information about social and environmental consequences’ (BCTTv1 5.3; Michie et al. 2013). Although provision of this information may improve adult patients’ knowledge and influence their motivation, a recent study has shown that adult patients attending an audiology clinic were already highly motivated to use their hearing aid (Sawyer et al. 2019). However, there was a
gap between adult patients’ motivation and actual hearing aid use (Sawyer et al. 2019). High motivation does not necessarily lead to the desired action (Sheeran 2002). Intervention studies should instead target ‘volitional processes’ (that translate motivation to use hearing aids into action) to increase hearing aid use among adult patients (Sawyer et al. 2019). The conclusion that hearing aid support interventions should target volitional processes may explain why previous intervention studies reviewed by Barker et al. (2016c) were not effective in promoting hearing aid use (Sawyer et al. 2019). The studies reviewed by Barker et al. (2016c) focused mainly on promoting hearing aid use through providing educational materials and/or information related to aural rehabilitation. Providing patients with information alone may not be sufficient to promote hearing aid use (Kelly & Barker 2016). Provision of information may need to be supplemented by other strategies that might facilitate the translation of adult patients’ motivation into hearing aid use.

There is evidence that the behavior change techniques embedded in the I-PHAN are effective in promoting positive health behavioral outcomes outside of audiology. For example, in a systematic review to evaluate the effectiveness of interventions to promote physical activity among healthy inactive adults, Howlett et al. (2019) found interventions that used behavior change techniques including ‘action planning’ and ‘prompts’ were effective in maintaining engagement of participants in physical activity. In a systematic review related to physical activity and healthy eating, the behavior change technique, ‘provide information on the consequences of behavior’ was associated with a positive change in intention only, but not on behavior (McDermott et al. 2016).

Forgetting to use hearing aids has been reported as one of the reasons for hearing aid non-use among adult patients (McCormack & Fortnum 2013). Even if
adult patients are highly motivated to use their hearing aids, they might forget to use them; failing to translate motivation into hearing aid use. Provision of a prompt as a reminder to use hearing aids and behavioral plan might therefore represent a promising strategy to supplement provision of information. In terms of the COM-B model, the provision of a prompt would target physical opportunity to use hearing aids (BCTTv1 7.1: ‘prompt’; Michie et al. 2013).

In addition, planning is a key self-regulation strategy that may assist in translation of motivation into action (Schwarzer 2016; Sniehotta et al. 2006; Sniehotta et al. 2005). There are two different types of planning; ‘coping planning’ deals with anticipated barriers to perform a new behavior and ‘action planning’ refers to the process of linking specific environmental cues (‘when and where’) to behavioral response (‘how to act’) (Hagger & Luszczynska 2014; Sniehotta et al. 2005). For example, ‘being at home when watching television’ could be a cue and ‘use a hearing aid’ is the appropriate behavioral response. In term of behavior change techniques, ‘action planning’ (BCTTv1 1.4; Michie et al. 2013) and coping planning (part of ‘problem solving’ BCTTv1 1.2; Michie et al. 2013) are grouped under goal and planning techniques in the BCTTv1 (Michie et al. 2013). Planning interventions are effective in promoting various health-behaviors, for example in physical activity (Bélanger-Gravel et al. 2013), smoking cessation (Armitage & Arden 2008) and to reduce alcohol consumption (Armitage & Arden 2012). Planning (e.g., action planning) interventions have not yet been evaluated in relation to hearing aid use.

The I-PLAN intervention proposed by Barker et al. (2016a) involves audiologists delivering the I-PLAN components to adult hearing aid patients during hearing aid fitting consultations. The effectiveness of the I-PLAN intervention with audiologists’ involvement has already been tested using a quasi-randomized
controlled trial with two arms (Ismail et al. 2019). Participants in the I-PLAN group received all three components of the I-PLAN face-to-face from their audiologist during hearing aid fitting consultations. Ismail et al. (2019) found no significant difference in hearing aid use or benefit among adult patients in the I-PLAN group compared to the Standard Care group. This may have occurred because some components of the I-PLAN (e.g., prompt and plan) might interact with each other to reduce the effectiveness of the intervention (Michie et al. 2018). However, which components of the I-PLAN might reduce the effectiveness of other components is unclear. A study with a factorial design that could separate and examine effects of each component on hearing aid use is needed. Moreover, the National Institute for Health and Care Excellence (NICE 2014) recommends that researchers examine which intervention components (i.e., behavior change techniques) are effective in behavior change. Establishing which components are effective in promoting hearing aid use would provide an evidence base and motivate audiologists to include the component(s) of the I-PLAN in clinics as well as maximizing the efficiency of the intervention.

In order to understand the mechanism or process by which an intervention produces its effects, there is a need to identify the potential mechanisms of action so that interventions may be optimised (Bauman et al. 2002; Michie et al. 2014; Moore et al. 2015). Given the goal of the I-PLAN is to support adult patients in translating their motivation to use hearing aids into actual use, the present study seeks to test a potential mediator that relates to translating motivation into behavior; self-regulation (which includes awareness of standards, self-monitoring, and self-regulatory effort; Sniehotta et al. 2006). In addition, given that habits have been shown to mediate the effects of plans (i.e., action plans) on smoking cessation (Armitage 2016), and habit
is likely to be formed when behavior was repeated consistently in a consistent context (Gardner et al. 2012), we aimed to assess habit formation as a second potential mediator.

**Aim and hypotheses**

We aimed to examine the effectiveness of the prompt and plan components of the I-PLAN intervention to promote hearing aid use, measured via self-reported proportion of time hearing aids were used at six weeks post-fitting in new adult hearing aid users in a UK National Health Service (NHS) audiology clinic. Data-logged hearing aid use and hearing aid benefit (measured by self-reported questionnaires) were secondary outcomes. We also aimed to explore whether self-regulation and habit formation might mediate the effect of the I-PLAN prompt and plan components on hearing aid use and benefit. In this study, we used a 2 x 2 factorial design with prompt and plan as factors. We hypothesized that:

i. participants who received the prompt component would report and show greater improvements in outcome measures (e.g., hearing aid use and benefit and potential mediators; self-regulation and habit formation) than those with no prompt;

ii. participants who received the plan component would report and show greater improvements in outcome measures (e.g., hearing aid use and benefit and potential mediators; self-regulation and habit formation) than those with no plan;

iii. participants who received both the plan and prompt would report and show greater improvements in outcome measures (e.g., hearing aid use and benefit and potential mediators; self-regulation and habit formation) than prompt and plan alone; and
self-regulation and habit formation might mediate the effect of the I-PLAN intervention on hearing aid use and benefit.

Materials and Methods

Trial design

This was a randomized controlled trial with a 2 x 2 factorial design. Participants were randomized to receive one of four possible combinations of the I-PLAN, namely: (i) information (info) only; (ii) info + prompt; (iii) info + plan; or (iv) info + prompt + plan. The first between-subjects factor was prompt, which had two levels: (i) prompt, in which participants were from the Info + Prompt and Info + Prompt + Plan groups; and (ii) no prompt, in which participants were from the Info only and Info + Plan groups (Table 1). The second factor was plan, which also had two levels: (i) plan, in which participants were from the Info + Plan and Info + Prompt + Plan groups; and (ii) no plan, in which participants were from the Info only and Info + Prompt groups.

Table 1: The between-subject factors

<table>
<thead>
<tr>
<th>Groups</th>
<th>No Prompt (n = 120)</th>
<th>Prompt (n = 120)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Plan (n = 120)</td>
<td>(i) Info only</td>
<td>(ii) Info + Prompt</td>
</tr>
<tr>
<td></td>
<td>(n = 60)</td>
<td>(n = 60)</td>
</tr>
<tr>
<td>Plan (n = 120)</td>
<td>(iii) Info + Plan</td>
<td>(iv) Info + Prompt + Plan</td>
</tr>
<tr>
<td></td>
<td>(n = 60)</td>
<td>(n = 60)</td>
</tr>
</tbody>
</table>

Each of the four intervention combinations were delivered at the hearing aid fitting appointment. All four groups received treatment as usual provided by audiologists. Outcome assessments occurred at six-week post-intervention. This study was approved by the NRES Committees - West of Scotland (Ref: 17/WS/0253). This
study was registered in the clinical trials database (ClinicalTrials.gov Identifier: NCT03742609).

Setting and location

The study took place in an audiology department in a single National Health Services (NHS) hospital in the north of England, UK. The study was conducted from February to December 2018.

Participants

The number of adult patients required for this study was calculated using the G-power software (Faul, Erdfelder, Lang, & Buchner, 2007). The sample size calculation suggested that 180 adult patients (with 45 participants per group) would provide 80% statistical power to detect a significant difference in hearing aid use between the groups ($\alpha = 0.05$) with a medium-sized effect, 0.25, and four covariates (age, gender, audiometric hearing thresholds and self-reported hearing handicap) using ANCOVA. However, to allow for 30% of attrition and to provide some statistical leeway, we aimed to recruit 60 participants to each group. Therefore, in total 240 participants were recruited to this study.

New adult hearing aid users were invited to participate in the study. Adult patients who: (i) were aged 18 years old or above; (ii) never used a hearing aid before; (iii) had a good understanding of English; and (iv) had sufficient mental capacity to provide informed consent based on the audiologist’s opinion were included. Adult patients who were unable to complete the questionnaires (e.g., due to dementia), based on the audiologist’s opinion, and / or presence of medical contraindications for hearing aids, as described by the British Academy of Audiology (BAA 2007) were
excluded. No incentive to participate was offered, and all hearing aids and aftercare appointments were provided free of charge consistent with standard UK National Health Service (NHS) practice.

**Outcome Measures**

Outcome measures were taken at six-week post-intervention. The six-week post-intervention period was chosen because it is standard practice in UK National Health Service audiology clinics for patients to be followed up six weeks after hearing aid fitting. Similar outcome measures were used in a previous study that examined the effectiveness of the I-PLAN delivered by audiologists (Ismail et al. 2019). The outcome measures were:

**Hearing aid use in difficult situations (unaided)** • We adapted one question from the Glasgow Hearing Aid Benefit Profile (GHABP) (Gatehouse 1999). The GHABP consists of 25 questions that asked related to the proportion of time hearing aids were used in situations that patients experienced hearing difficulty; ‘In a typical situation where you have hearing difficulty, what proportion of time do you wear your hearing aid?’ The proportion of time hearing aid use in challenging listening situations was measured because: (i) the I-PLAN intervention aimed to promote hearing aid use in the specific situation identified by participants (as in the ‘when’ and ‘where’ plan); and (ii) hearing aid use according to the patients’ individual needs based on the identified listening situations reflect the ‘optimal hearing aid use’ (Laplante-lévesque et al. 2013). Answers were provided according to five response options; never/not all (0% of the time), about ¼ of the time (25% of the time), ½ of the time (50% of the time), ¾ of the time (75% of the time) or all the time (100% of the time).
**Hearing aid use** • Hearing aid use, defined as hours of use per day, was generated automatically from the data logging feature in the hearing aids. The average hours between right and left hearing aids was used for participants fitted with two hearing aids.

**International outcome inventory for hearing aids (IOI-HA)** • The IOI-HA (Cox & Alexander 2002) is a self-report measure of hearing aid use and benefit that is commonly used in audiology studies (Perez & Edmonds 2012). The IOI-HA consists of seven questions indexing aspects of hearing aid outcomes: (i) hearing aid use; (ii) hearing aid benefit; (iii) residual activity limitations; (iv) satisfaction; (v) residual participation restrictions; (vi) impact on others; and (vii) quality of life. In each question, five response options are provided with a score from 1 to 5 (total score 7-35). Higher scores indicate better outcomes.

**Hearing Handicap Inventory for the Elderly and for Adults – Screening version (HHIE-S)** • The HHIE-S (Ventry & Weinstein 1983) is an index self-perceived hearing handicap due to the hearing loss. The HHIE-S is a 10-item questionnaire that assesses the effect of hearing impairment on social and emotional factors. For example; ‘does a hearing problem cause you to feel embarrassed when meeting new people?’ (emotional factor) and ‘does a hearing problem cause you difficulty when listening to TV or radio?’ (social factor). Questions are scored as yes (4 points), sometimes (2 points) or no (0 points). Higher scores indicate greater perceived hearing handicap.

**Self-regulation** • Self-regulation for hearing aid use was measured using an adapted version of the self-regulation questionnaire on physical activity by Sniehotta et al. (2006). It measures three components of self-regulation: (i) awareness of standards; (ii) self-monitoring; and (iii) self-regulatory effort. In total, there are six items (two
items for each component), each with a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree). All the items began with a statement ‘During the last six weeks, I… and followed by each of the component. For example; ‘During the last six weeks, I often had the intention to use my hearing aid(s) on my mind’ (awareness of standards), ‘During the last six weeks, I consistently checked myself to see if I was using my hearing aid(s) often enough’ (self-monitoring) and ‘During the last six weeks, I tried hard to use my hearing aid regularly’ (self-regulatory effort). Higher scores indicate greater self-regulation of hearing aid use. The scale showed good internal consistency with a Cronbach alpha of 0.78.

**Self-Report Behavioral Automaticity Index (SRBAI)** • The SRBAI is four-item measure of automaticity (the main components of habit on behavior) (Gardner et al. 2012). Habit formation in relation to hearing aid use was measured using the four items that began with a phrase ‘Using hearing aid(s) is something...’ ‘I do automatically’, ‘...I do without thinking’, ‘...I do without having to consciously remember to use them’ and ‘...I start doing before I realize I am doing it’. The four items were answered on a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree). The higher scores indicating stronger habit. The scale showed good internal consistency with a Cronbach alpha of 0.94.

**Fidelity to the interventions** • All participants in this study were asked ‘have you read the information on the card in the white envelope you were given at the hearing aid fitting appointment?’ in the follow-up questionnaire.

**The I-PLAN written materials**

In the present study, we developed the I-PLAN written materials as Barker et al. (2016a) did not specify the exact form of the I-PLAN components. We chose to test
I-PLAN prompt and plan components via a set of written materials (Table 2) because provision of the I-PLAN as a set of written materials: (i) standardized the intervention across study audiologists; and (ii) made it easier for audiologists to incorporate the I-PLAN into clinical practice (written materials allow for patients to self-complete the intervention, minimizing audiologist time required to deliver the intervention). The written materials were provided by audiologists to new hearing aid users at their hearing aid fitting consultation. The details of the I-PLAN written materials were as follows:

**Information related to pros and cons consequences of hearing aid use and non-use**

- In terms of behavior change techniques, information about hearing aid use/non-use is delivered as ‘information about social and environmental consequences’ (BCTTv1 5.3; Michie et al. 2013). For example; ‘hearing aid use will improve your ability to hear others’ (positive consequence) and ‘not using a hearing aid will reduce your ability to hear your family and friends’ (negative consequence). To identify information related to the social and environmental consequences of hearing aid use, current literature on the impact of untreated hearing loss on significant others (e.g., Scarinci et al. 2008; Vas et al. 2017) was used, based on a literature review by the first author. However, given the long list of consequences identified from the literature, three adult patients with hearing loss aged between 50 and 70 years, two significant others and two audiologists with over 10 years of clinical experience each were consulted in order to identify the three most salient consequences to be included in the I-PLAN.

*A prompt to remind patients to use their hearing aids* • The second component of the I-PLAN was a ‘prompt or cue’ (BCTTv1 7.1; Michie et al. 2013). Adult patients were explicitly instructed to use their hearing aid box as a reminder to hearing aid use.
Instructions with an example were given; ‘Please use your hearing aid box as a reminder to wear your hearing aid(s). For example, you could put your hearing aid box next to the bathroom mirror last thing at night to remind you to wear your hearing aid(s) in the morning’.

A written plan for hearing aid use • The third component of the I-PLAN was ‘action planning’ (BCTTv1 1.4; Michie et al. 2013). Participants were asked to create at least one written plan by themselves concerning ‘where’ and ‘when’ to use their hearing aid(s). Participants were asked to complete the ‘when-then’ statement provided on the I-PLAN written material. An example on how to complete the ‘when-then’ statement was also provided in the material. The ‘when-then’ instruction was adapted from the ‘if-then’ instructions of ‘volitional help sheets’ used previously to promote smoking cessation (Armitage 2008). Such ‘if-then’ plans have been applied across various health behaviors (e.g., to reduce self-harm among patients who have attempted suicide, O’Connor et al. 2017, and to prevent emotional eating, Armitage 2015). One advantage of the approach is that it can be self-completed and does not require a healthcare professional to be present (Armitage, 2008). Crucially, the Germanic origins of “if-then” plans mean there is no linguistic difference between “if-then” plans and “when-then” plans, and among English-speaking participants, there has been shown to be no difference in terms of changing people’s behavior (Armitage 2016). In this study, ‘action planning’ is referred as ‘plan’ throughout the manuscript. The details of the I-PLAN intervention written materials are in Table 2. The I-PLAN written materials were the same as those used in our previous study (Ismail et al. 2019).
Table 2: The details of the I-PLAN intervention materials (Barker et al. 2016a), as implemented by Ismail et al. (2019)

<table>
<thead>
<tr>
<th>Components of the I-PLAN</th>
<th>Behavior Change Technique</th>
<th>Written Materials of I-PLAN</th>
</tr>
</thead>
</table>
| Provision of information related to consequences of hearing aid use and non-use | 5.3 Information about social and environmental consequences | Hearing aid use will improve:  
• your ability to hear others  
• your social interactions  
• the lives of those around you by making it easier for them to communicate with you.  
Not using a hearing aid will:  
• reduce your ability to hear your family and friends  
• lead you to withdraw from social activities  
• cause stress and increase burden on those around you by making it harder for them to communicate with you. |
| Provision of a prompt to remind patients to use their hearing aids | 7.1 Prompts/cues | My hearing aid reminder  
Please use your hearing aid box as a reminder to wear your hearing aid(s). For example, you could put your hearing aid box next to the bathroom mirror last thing at night to remind you to wear your hearing aid(s) in the morning. |
| Creation of a behavioral plan for hearing aid use | 1.4 Action planning | My hearing aid(s)  
Please plan where and when to wear your hearing aid(s).  
You can choose any place and time but please write your plan in as much detail as possible. Please write your plan in the space provided on the next page.  
Example: ‘When I have finished brushing my teeth in the morning, then I will wear my hearing aid(s)’  
Please write your plan in the space provided in the format in the example.  
When I ……………., then I will wear my hearing aid(s).  
Use the space below if you want to write more than one plan. |
**Group allocation**

All four groups received the information about the pros and cons of use and non-use of a hearing aid. The information was provided to all participants based on the assumption that: (i) information alone may not be sufficient to lead adult patients to actual hearing aid use (Kelly & Barker 2016); and (ii) patients may have received information about the pros and cons of using a hearing aid at the standard hearing aid fitting appointment (Barker et al. 2016b). All participants were treated similarly across the groups so that the impact of research participation effects (McCambridge et al. 2014) could be minimized.

The first group was the (i) information (info) only group. Adult patients allocated in this group received information alone. In the remaining three groups, adult patients were assigned to receive either: (ii) prompt; (iii) plan; or (iv) prompt and plan, in addition to information.

**Procedure**

**Before hearing aid fitting appointment**  
Invitation letters, participant information sheets, consent forms, along with baseline questionnaires were posted to adult patients who were scheduled for initial hearing aid fitting appointments. Adult patients were informed that the aim of the study was to discover which parts of the I-PLAN are most helpful in promoting hearing aid use and benefit for people with hearing problems. Patients were also given a general description of the I-PLAN intervention (e.g., ‘the I-PLAN includes information about the benefits of hearing aid use and the disadvantages of not using a hearing aid and involves making a short plan about the times and places that you will use your hearing aid’) in the participant information sheet. A general description of the I-PLAN intervention was provided so that
participants were blinded to the specific contents of the I-PLAN components in order
to minimize the risk of bias.

All these documents were posted at least two days prior to each patient’s
appointment. Adult patients who decided to take part in the study were asked to sign
the consent form, complete the questionnaire (for baseline characteristics and self-
reported hearing handicap, HHIE-S) at home and return the completed documents at
the hearing aid fitting appointment.

At hearing aid fitting appointment • Participants who consented to participate in the
study had their National Health Service (NHS) behind-the-ear hearing aid(s) fitted by
their audiologist and received treatment as usual provided by audiologists. Treatment
as usual included: (i) programming the hearing aid(s); (ii) performing real ear
measurements (REMs) to fine-tune the hearing aid(s); (iii) advising patients on
realistic expectations (e.g., hearing aid does not restore normal hearing),
communication strategies with hearing aid and acclimatization to a hearing aid; (iv)
demonstrating and providing instruction on hearing aid management (e.g., to on and
off the hearing aid); (v) explaining post-fit services (e.g., battery and repair services);
(vi) providing patients with spare batteries, a hearing aid box and written information
about specific hearing aid fitting; (vii) providing a brief explanation about follow-up
appointments (e.g., discussion of issues related to hearing aid use and management);
and (viii) scheduling a face-to-face follow-up appointment in six weeks after fitting.

The participants were randomly allocated to receive one of the four possible
combinations of the I-PLAN materials. The four possible combinations of the I-PLAN
materials were sealed in numbered opaque white envelopes. The numbered opaque
white envelopes then were randomized by one of the authors using a random number
generator (https://www.random.org/integers/). The random number generator was
used to determine the order in which the white envelopes were piled. The envelopes were placed in a paper tray at the clinic. Once participants had consented to take part in the study, audiologists took one of the envelopes containing one of the four sets of I-PLAN materials for the participant. The I-PLAN materials were given to the participants at the end of their consultation. In order to minimize any bias, audiologists did not deliver the I-PLAN intervention. Participants were asked to review and/or complete the I-PLAN material(s) by themselves in the consultation room prior to leaving the clinic. Once completed, participants were asked to take the I-PLAN materials with them. All participants were scheduled for a routine face-to-face six-week hearing aid follow-up appointment. Clinical reception staff managed scheduling of patients for hearing aid fitting and follow-up appointments. In summary, the individual components of the I-PLAN were not discussed with the participants and treatment allocation was concealed from the audiologists and researchers.

**Post-hearing aid fitting appointment** • Participants were posted a questionnaire prior to their six-week hearing aid follow-up. The questionnaire included all five self-reported outcome measures (e.g., hearing aid use in difficult situations, IOI-HA, HHIE-S, self-regulation and habit formation). Participants were asked to complete the questionnaire and return the completed questionnaire at their follow up appointment to the first author in a sealed envelope. Data on hearing aid usage were downloaded from patients’ hearing aids by their audiologist at the follow-up appointment. Therefore, outcome data were extracted with the research team being blind to group allocation. If participants did not attend their hearing aid follow-up appointment, the follow-up questionnaire was posted again to them. Participants were asked to return the questionnaire directly to the first author.
Statistical analysis

Descriptive statistics were reported to summarize the baseline clinical and demographic characteristics of participants. No formal statistical analysis comparing the baseline clinical and demographic characteristics of participants was performed as recommended by CONSORT guidelines (2010).

Two analyses were conducted to examine the effectiveness of I-PLAN prompt and plan components on the outcome measures. Initially, a descriptive analysis by randomized group (Info only, Info + Prompt, Info + Plan and Info + Prompt + Plan) was performed to investigate the possibility of interaction effects of the prompt and plan on each outcome measured across groups. Then, 2 x 2 ANCOVAs were conducted to examine the interaction and main effects of the I-PLAN prompt and plan components on each outcome measure while controlling for clinical and demographic characteristics of participants that may impact outcomes (e.g., age, gender, audiometric hearing thresholds and self-reported hearing handicap, HHIE-S (unaided). Analyses controlled for the baseline clinical and demographic characteristics of participants to increase precision of estimated intervention effects (Lingsma et al. 2010).

We investigated whether the effect of the plan or prompt on hearing aid use (proportion of time or data logging) and hearing aid benefit (IOI-HA or HHIE-S (aided) may be mediated through self-regulation or habit formation. Where there was evidence of an effect of the prompt/plan on both a potential mediator (self-regulation or habit formation) and hearing aid outcomes, direct effects and indirect effects of the plan/prompt on the relevant outcome were estimated using the bootstrapping method (Preacher & Hayes 2008) in PROCESS macro version 3.3 for SPSS (Hayes 2012). The bootstrapping method is a procedure that involves multiple resampling of the data.
to estimate indirect effect and confidence interval of the indirect effect (Preacher & Hayes 2008). The 95% of the confidence interval of the indirect effects was obtained with 5000 bootstrap samples (Preacher & Hayes 2008).

Results

Recruitment

Figure 1 presents the flow of study participants. Of the 351 adult patients who were scheduled for a hearing aid fitting appointment, 52 (14.8%) declined to participate. A further 59 (16.8%) were excluded as they did not attend the hearing aid fitting appointment (n = 37), had cognitive or memory difficulties (n = 3), had a poor understanding of English (n = 5) or had previous experience with a hearing aid (n = 14).

In total, 240 (68.4%) first-time hearing aid adult patients were consented to participate in this study. They were randomly allocated to one of the four groups: (i) Info (n = 60); (ii) Info + Prompt (n = 60); (iii) Info + Plan (n = 60); and (iv) Info + Prompt + Plan (n = 60).
CHAPTER 5: RCT

**Figure 1**: CONSORT diagram showing flow of participants through the trial for main outcome measure, the self-reported hearing aid use (n = 207).

**Clinical and demographic characteristics of participants**

Table 3 shows the clinical and demographic characteristics of the patients allocated randomly to the four groups at the hearing aid fitting appointment. All the participants across the groups were first-time hearing aid users and were fitted with the NHS behind-the-ear hearing aid(s). The mean age of participants across the groups was 67.6 years (SD = 13.35; Range = 22 to 94 years). On average, participants across the groups showed a mild to moderate hearing handicap based on the mean score of the Hearing Handicap Inventory for the Elderly (HHIE)-Screening, HHIE-S (unaided) questionnaire; 21.7 (SD = 9.52).

Based on the descriptive analysis, the mean age and the mean HHIE-S of participants were similar across groups. The mean pure tone average was higher in
the Info + Plan group and lower in the Info + Plan + Prompt group. The proportion of males was higher in the Info only group compared to the other groups.

**Table 3**: Baseline characteristics of the participants at the hearing aid fitting appointment (n = 240).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Info (n = 60)</th>
<th>Info+ Prompt (n = 60)</th>
<th>Info + Plan (n = 60)</th>
<th>Info+Prompt+ Plan (n = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Age</td>
<td>67.2</td>
<td>12.02</td>
<td>67.8</td>
<td>13.64</td>
</tr>
<tr>
<td>Pure tone Average</td>
<td>35.0</td>
<td>13.02</td>
<td>33.0</td>
<td>12.40</td>
</tr>
<tr>
<td>HHIE-S (unaided)</td>
<td>20.9</td>
<td>9.48</td>
<td>21.8</td>
<td>9.23</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>32</td>
<td>53.3</td>
<td>28</td>
<td>46.7</td>
</tr>
<tr>
<td>Female</td>
<td>28</td>
<td>46.7</td>
<td>32</td>
<td>53.3</td>
</tr>
</tbody>
</table>

Pure tone average = Average of hearing thresholds at 0.5, 1, 2 and 4 kHz in the better ear. HHIE-S = Hearing Handicap Inventory for the Elderly and for Adults – Screening version (Ventry & Weinstein, 1983).
Attrition analyses and missing values

In total, 29 out of 240 participants (12.1%) failed to attend their six-week follow-up appointment. The follow-up data were missing completely at random based on Little's Missing Completely at Random (MCAR) Test \(X^2 (6) = 4.36, p = 0.63\).

Of 211 participants who attended the six-week follow-up appointment, seven participants (3.3%) did not return the follow-up questionnaire (Figure 1). Three additional questionnaires were received from three out of 29 (10.3%) participants who did not attend the follow-up. In total 207 follow-up questionnaires were obtained from participants across the four groups.

Compliance with Interventions

All participants in this study reported that they had read the I-PLAN cards based on the question asked, ‘Have you read the information on the card in the white envelope you were given at the hearing aid fitting appointment?’ in the follow-up questionnaire.

Effects of the I-PLAN prompt and plan components

The means and standard deviations of outcome measures by randomized group (Info only, Info + Prompt, Info + Plan and Info + Prompt + Plan) are shown in Table 4. Table 5 summarizes the means and standard deviations of outcome measures as well as adjusted mean and standard errors for each between-subjects factor (Prompt vs No Prompt and Plan vs No Plan).
Table 4: The outcome measures at six-week post-intervention across the four randomization groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Info only (n = 49)</th>
<th>Info + Prompt (n = 53)</th>
<th>Info + Plan (n = 49)</th>
<th>Info + Prompt + Plan (n = 56)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of time (%)</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>IOI-HA</td>
<td>27.4</td>
<td>4.24</td>
<td>26.9</td>
<td>5.16</td>
</tr>
<tr>
<td>HHIE-S (aided)</td>
<td>14.3</td>
<td>9.64</td>
<td>15.9</td>
<td>10.52</td>
</tr>
<tr>
<td>Self-regulation</td>
<td>5.0</td>
<td>0.98</td>
<td>4.7</td>
<td>1.22</td>
</tr>
<tr>
<td>SRBAI</td>
<td>4.1</td>
<td>1.77</td>
<td>4.1</td>
<td>1.63</td>
</tr>
<tr>
<td>Data logging (hours/day)</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>(n = 49)</td>
<td>7.0</td>
<td>4.75</td>
<td>8.5</td>
<td>5.66</td>
</tr>
<tr>
<td>(n = 54)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n = 52)</td>
<td></td>
<td></td>
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<tr>
<td>(n = 56)</td>
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</tr>
</tbody>
</table>

Notes:
1. The reported values are “raw” and not adjusted for baseline characteristics.
2. IOI-HA = International outcome inventory for hearing aids; HHIE-S = Hearing Handicap Inventory for the Elderly and for Adults – Screening version; SRBAI = Self-Report Behavioral Automaticity Index

The effects of the I-PLAN prompt and plan components on outcome measures as follows:

**Hearing aid use in difficult situations (unaided)** • Of 207 participants who completed their follow-up questionnaire, the mean proportion of time hearing aids were used in difficult listening situations was 76.5% of the time (SD = 27.06). Of the 207 participants, 46.9% (97 out of 207) reported that they used their hearing aids in difficult listening situations for ‘all the time’ since hearing aids were fitted, 24.6% for ‘¾ of the time’, 17.9% for ‘½ of the time’, 8.7% for ‘¼ of the time’ and only 1.9% ‘never/ not at all’ used their hearing aids. Of those who reported never having used their hearing aids, three of the participants were in the Info + Prompt group (n = 3) and one in the Info group (n = 1).
The mean proportion of time hearing aids were used was higher in the Info + Plan group \([\text{Mean}_{\text{plan}} = 86.7\% \text{ of the time, } \text{SD} = 18.47]\) and Info + Prompt + Plan group \([\text{Mean}_{\text{info+prompt+plan}} = 75.9\% \text{ of the time, } \text{SD} = 27.37]\) compared to the Info only group \([\text{Mean}_{\text{info}} = 73.0\% \text{ of the time, } \text{SD} = 26.44]\). The mean proportion of time hearing aids were used was lower in the Info + Prompt only group \([\text{Mean}_{\text{prompt}} = 70.8\% \text{ of the time, } \text{SD} = 31.67]\) than the Info only group.

Based on 2 X 2 ANCOVA, there was no statistically significant interaction effect of the prompt and plan on proportion of time hearing aids were used. However, there was a main effect of the prompt on the proportion of time hearing aids were used \([F(1, 199) = 4.65; p = 0.03; \text{Partial } \eta^2 = 0.02, d = 0.24]\). Participants in the prompt only group reported a lower proportion of time hearing aids were used. There was also a significant main effect of the plan on the proportion of time of hearing aids were used \([F(1, 199) = 7.40; p = 0.01; \text{Partial } \eta^2 = 0.04, d = 0.34]\). Participants in the plan group reported a higher proportion of time hearing aids were used (Table 5).

**Data-logged hearing aid use** • For data logging, the mean hearing aid use averaged over six weeks across participants who attended the follow up appointment \((n = 211)\) was 7.7 (SD = 5.17) hours per day. The mean hearing aid use was higher in the Info + Plan \([\text{Mean}_{\text{plan}} = 8.5 \text{ hours/day, SD} = 5.20]\) and Info + Prompt \([\text{Mean}_{\text{prompt}} = 8.5 \text{ hours/day, SD} = 5.66]\) groups compared to the Info only group \([\text{Mean}_{\text{info}} = 7.0 \text{ hours/day, SD} = 4.75]\). However, the mean data-logged hearing aid use for the Info + Plan + Prompt \([\text{Mean}_{\text{info+prompt+plan}} = 6.9 \text{ hours/day, SD} = 4.92]\) was similar to the Info only group, suggesting an interaction between plan and prompt on data-logged hearing aid use.
Based on the data-logging, 154 of 211 participants (73.0%) used their hearing aid more than four hours per day and were considered as ‘regular hearing aid users’ (Aazh et al. 2015). Based on MANOVA (for age, pure tone average and HHIE-S (unaided)), there was a significant difference between regular and non-regular hearing aid users \([F (3, 207) = 3.05; \ p = 0.03; \ Pillai\’s \ trace \ V = 0.04; \ Partial \ \eta^2 = 0.04]\). Participants who used their hearing aid(s) regularly reported higher self-perceived hearing handicap score than participants who used their hearing aid(s) non-regularly (HHIE-S Score (unaided); regular hearing aid users, Mean\(_{\text{regular}}\) = 22.5, SD = 9.38, non-regular hearing aid users, Mean\(_{\text{non-regular}}\) = 18.4, SD = 9.36; \(p = 0.01\)) (Supplemental Material 1).

There was a statistically significant interaction between prompt and plan components of the I-PLAN on hearing aid use measured via data-logging \([F (1, 203) = 5.13; \ p = 0.03; \ Partial \ \eta^2 = 0.03]\) while controlling for clinical and demographic characteristics of participants (age, gender, audiometric hearing thresholds and self-reported hearing handicap, HHIE-S (unaided)). Participants who received both the prompt and plan components of the I-PLAN had reduced hearing aid use measured via data-logging compared to participants who received the prompt or plan only (Table 4). There was no significant main effect of the prompt or plan on data-logged hearing aid use.

**Hearing aid benefit based on IOI-HA and HHIE-S (aided)** The mean hearing aid benefit based on IOI-HA and HHIE-S (aided) were similar across all randomization groups. However, in the Info + Plan group, mean HHIE-S (aided) was lower compared to other groups. There were no statistically significant interaction effects of the prompt and plan components on hearing aid benefit; IOI-HA \([F (1, 199) = 1.10; \ p = 0.30; \ Partial \ \eta^2 = 0.01]\) or HHIE-S (aided) \([F (1, 199) = 0.21; \ p = 0.65; \ Partial \ \eta^2 = 0.00]\).
< 0.01]. There were also no significant main effects of the prompt or plan on hearing aid benefit (Table 5).

_Potential mechanism of action; self-regulation and habit formation_ • The mean self-regulation and habit formation of hearing aid use (based on SRBAI) were similar across the four randomization groups. However, the mean habit formation was higher in the Info + Plan group compared to other groups. There were no statistically significant interaction effects of the prompt and plan components on self-reported self-regulation \[ F(1, 199) = 0.01; p = 0.92; \text{Partial } \eta^2 = 0.00] and habit formation \[ F(1, 199) = 2.20; p = 0.14; \text{Partial } \eta^2 = 0.01], after controlling for clinical and demographic characteristics of participants. Analysis with 2 X 2 ANCOVA however, showed there was a main effect of the prompt on self-regulation score \[ F(1, 199) = 4.40; p = 0.04; \text{Partial } \eta^2 = 0.02, d = 0.28]. Participants in prompt group reported lower self-regulation hearing aid use compared to the participants in no prompt group (Table 5). There was also a significant main effect of the plan on habit formation of hearing aid use \[ F(1, 199) = 6.07; p = 0.02; \text{Partial } \eta^2 = 0.03, d = 0.30]. Participants in the plan group reported higher habit formation scores compared to no plan group (Table 5).
Table 5: Main effects of the I-PLAN plan and prompt components on hearing aid outcomes, self-regulation and habit formation at the six-week outcome assessment

<table>
<thead>
<tr>
<th>Variables</th>
<th>Prompt (n = 109)</th>
<th>No Prompt (n = 98)</th>
<th>p-value</th>
<th>Plan (n = 105)</th>
<th>No Plan (n = 102)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proportion of time (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>73.4 (29.52)</td>
<td>79.9 (23.72)</td>
<td>0.03*</td>
<td>81.0 (24.15)</td>
<td>71.8 (29.15)</td>
<td>0.01*</td>
</tr>
<tr>
<td>Mean_{adj} (SE)</td>
<td>72.8 (2.43)</td>
<td>80.5 (2.57)</td>
<td></td>
<td>81.4 (2.47)</td>
<td>71.8 (2.51)</td>
<td></td>
</tr>
<tr>
<td><strong>IOI-HA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>27.0 (5.25)</td>
<td>28.0 (4.38)</td>
<td>0.13</td>
<td>27.9 (5.03)</td>
<td>27.2 (4.72)</td>
<td>0.22</td>
</tr>
<tr>
<td>Mean_{adj} (SE)</td>
<td>27.0 (0.46)</td>
<td>28.0 (0.49)</td>
<td></td>
<td>27.9 (0.47)</td>
<td>27.1 (0.47)</td>
<td></td>
</tr>
<tr>
<td><strong>HHIE-S (aided)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>15.9 (9.81)</td>
<td>13.6 (9.67)</td>
<td>0.06</td>
<td>14.5 (9.52)</td>
<td>15.1 (10.09)</td>
<td>0.57</td>
</tr>
<tr>
<td>Mean_{adj} (SE)</td>
<td>15.9 (0.80)</td>
<td>13.7 (0.85)</td>
<td></td>
<td>14.4 (0.82)</td>
<td>15.1 (0.83)</td>
<td></td>
</tr>
<tr>
<td><strong>Self-regulation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>4.8 (1.18)</td>
<td>5.1 (1.01)</td>
<td>0.04*</td>
<td>5.0 (1.10)</td>
<td>4.9 (1.12)</td>
<td>0.35</td>
</tr>
<tr>
<td>Mean_{adj} (SE)</td>
<td>4.8 (0.10)</td>
<td>5.1 (0.11)</td>
<td></td>
<td>5.0 (0.10)</td>
<td>4.9 (0.11)</td>
<td></td>
</tr>
<tr>
<td><strong>SRBAI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>4.2 (1.70)</td>
<td>4.5 (1.70)</td>
<td>0.29</td>
<td>4.6 (1.69)</td>
<td>4.1 (1.69)</td>
<td>0.02*</td>
</tr>
<tr>
<td>Mean_{adj} (SE)</td>
<td>4.2 (0.16)</td>
<td>4.5 (0.16)</td>
<td></td>
<td>4.6 (0.16)</td>
<td>4.2 (0.16)</td>
<td></td>
</tr>
<tr>
<td><strong>Data-logging (hours/day)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>7.7 (5.33)</td>
<td>7.8 (5.03)</td>
<td>0.91</td>
<td>7.7 (5.10)</td>
<td>7.8 (5.28)</td>
<td>0.97</td>
</tr>
<tr>
<td>Mean_{adj} (SE)</td>
<td>7.7 (0.48)</td>
<td>7.8 (0.50)</td>
<td></td>
<td>7.8 (0.48)</td>
<td>7.7 (0.49)</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. The mean (SD) values are derived from the descriptive table and are not adjusted for covariates.
2. Mean_{adj} (SE) values are derived from estimated marginal means tables and adjusted for age, gender, audiometric hearing thresholds and self-reported hearing handicap, HHIE-S (unaided).
3. IOI-HA = International outcome inventory for hearing aids; HHIE-S = Hearing Handicap Inventory for the Elderly and for Adults – Screening version; SRBAI = Self-Report Behavioral Automaticity Index.
4. *p < 0.05
Potential mediating effects

Given there were statistically significant effects of: (i) prompt on the proportion of time hearing aids were used and self-regulation score; and (ii) plan on the proportion of time of hearing aids were used and habit formation score, mediation analyses were conducted. The aims were to test whether: (i) self-regulation may mediate the effect of prompt on the proportion of time hearing aids were used; and (ii) habit formation may mediate the effect of plan on the proportion of time hearing aids were used (Figure 2).

The independent variables were groups; prompt (dummy-coded as 0 = no prompt, 1 = prompt) and plan (dummy-coded as 0 = no plan, 1 = plan). The mediators were self-regulation and habit formation (SRBAI) of hearing aid use. The dependent variable was proportion of time hearing aids were used. The covariates, age, gender, audiometric hearing thresholds and self-reported hearing handicap, HHIE-S (unaided), were included in the analysis.

The results showed the confidence intervals associated with the indirect effects of self-regulation and habit formation did not contain zero. The results suggested that: (i) self-regulation mediated the effect of prompt on the proportion of time hearing aids were used [95% CI = -5.46 to -0.11]; and (ii) habit formation mediated the effect of plan on the proportion of time hearing aids were used [95% CI = 0.78 to 7.67] (Figure 2). The results therefore indicated that: (i) the prompt undermined self-regulation of hearing aid use and (ii) the plan promoted formation of hearing aid use habits.
Figure 2: Direct and indirect effect of prompt on proportion of time hearing aids were used through self-regulation (above) and plan on proportion of time hearing aids were used through hearing aid habit formation. Notes: *p < 0.05, **p < 0.01, ***p < 0.001.
Discussion

This is the first randomized controlled trial to investigate the effectiveness of the prompt and plan components of the I-PLAN health behavior change intervention to promote hearing aid use and benefit in new adult patients fitted with hearing aids. There are five key findings:

i. the proportion of time hearing aids were used in specific, difficult listening situations was lower in participants who received the prompt compared to no prompt;

ii. participants who received the plan reported greater hearing aid use compared to no plan;

iii. data-logged hearing aid use was reduced when participants received both prompt and plan;

iv. the prompt reduced self-regulation of hearing aid use; and

v. the plan promoted formation of hearing aid use habits.

Contrary to predictions, the proportion of time hearing aids were used was lower in the prompt group compared to the no prompt group [73.39% versus 79.85% of the time; $d = 0.24$]. Those who received the prompt also reported lower self-regulation scores. Results suggest that the prompt adversely affected hearing aid use by undermining self-regulation. It is possible that the physical prompt caused participants to delegate the responsibility for hearing aid use to the prompt rather than having to intrinsically monitor, evaluate and adjust their hearing aid use. However as self-regulation and hearing aid use were measured at the same point, we cannot be certain that the reduced self-regulation impacted hearing aid use. Longitudinal data at more time points would be needed to investigate whether reduced self-regulation preceded reduced hearing aid use (Lee et al. 2019, Sniehotta et al. 2006). In addition, given
stigma associated with age may adversely impact hearing aid use (Wallhagen 2010), perhaps the physical prompt chosen in this study (i.e., the hearing aid box) was perceived by participants as an aversive reminder of ageing. Participants in the prompt group may have used their hearing aid less as a strategy to avoid a psychological threat associated with ageing. Those who received the physical prompt therefore tended to avoid using their hearing aid and were less likely to self-regulate of their hearing aid use. The unexpected adverse negative impact of the physical prompt suggests caution is warranted before delivering physical prompt behavior change interventions in hearing as well as in relation to other health behaviors. The negative impact of the specific physical prompt chosen in this study suggests that not just any object could serve as a physical prompt. Rather, researchers should identify physical prompts that are relevant to participants and do not have any negative associations to ensure that the physical prompt does not have adverse effects on desired health behavior.

Consistent with our hypothesis, participants who wrote hearing aid use plans reported a greater proportion of time hearing aids were used in difficult situations compared to participants who did not receive the plan component [80.95% versus 71.81%; \( d = 0.34 \)], at six weeks post-fitting. The positive impact of the plan on hearing aid use is in line with research outside audiology on the impact of plan interventions on health-behavior change (for example; physical activity (Bélanger-Gravel et al. 2013), smoking cessation (Armitage & Arden 2008) and to reduce alcohol consumption (Armitage & Arden 2012). Based on the mediation analysis, the effect of the plan component on hearing aid use may be attributable to formation of a hearing aid use habit. Previous research similarly showed that habit mediated the effects of an action plan on smoking cessation (Armitage 2016). Writing and using a specific plan for how and when to use hearing aids may facilitate development of hearing aid use
habits, which were observable at six weeks (42 days) post-fitting as in the present study. Humes et al. (2009) suggested self-reported measures stabilize three to six months post-fitting. Note that previous research outside audiology indicated that habits take on average 66 days to form (Lally et al. 2010). The time course of habit formation in relation to hearing aids may warrant further investigation; understanding of the time course and dynamics of habit formation in relation to hearing aid use may help identify opportunities for intervention to facilitate habit formation and promote hearing aid use.

In addition, the effect size of the plan component was ‘small to medium’ ($d = 0.34$) according to Cohen’s (1992) criteria. Whether the result represents a clinically significant change is unclear. Future research would need to work with patients to establish a minimal clinically important difference in the proportion of time hearing aids are used in challenging listening environments that is relevant to hearing aid users (Armijo-Olivo 2018). The small to medium effect size found in this study may also indicate the complex nature of hearing aid use and the limits of a single behavior change strategy in promoting hearing aid use. Participants may experience a variety of difficulties that could impact hearing aid use (e.g., comfort, changing batteries; McCormack & Fortnum 2013). Interventions to promote hearing aid use likely need to include plan behavior change elements along with strategies to identify and manage other psychological and practical factors that may limit hearing aid use (e.g., the COM-B model; Michie et al. 2014). One might also increase the effectiveness of the plan component by asking participants to create a plan that contains more than two elements (e.g., when and where). A previous review study found plans that contain four or five components (e.g., with whom, frequency, intensity and duration) may be
more effective in promoting health behaviors than plans containing two components (Carraro & Gaudreau 2013).

We found that the behavior change techniques (‘action planning’ (BCTTv1 1.4) and ‘prompt’ (BCTTv1 7.1)) in the I-PLAN intervention interacted with each other in reducing the effectiveness of the I-PLAN intervention in promoting hearing aid use measured via data-logging. The result is in line with Ismail et al.’s (2019) finding that providing all the I-PLAN components together did not result in greater hearing aid use or benefit than standard care. Given that prompt reduced hearing aid use and plan increased hearing aid use, it is possible that the effect of making specific plans was undermined by providing prompts. This possibility could be explored by asking participants to describe their experience of the intervention in detail.

**Strengths and limitations of the study**

The first strength of this study is that the participants were randomized to the intervention. A second strength is that the details of the individual I-PLAN components were not shared with the participants in the participants information sheet or with audiologists and treatment allocation was concealed from the researchers and audiologists. This study also had sufficient sample size to detect small to medium effects of the I-PLAN intervention components on hearing aid use, and the age of the sample was representative of the majority of first-time hearing aid users in the UK (Action on Hearing Loss 2015).

Potential limitations were first, the plan created by adult patients was not examined at the six-week follow up. Therefore, we cannot ascertain whether participants had carried out their plans. However, given the results of the present study revealed that there was a significant difference between participants in the plan group compared to no plan group on the proportion of time of hearing aids were used in
challenging listening situations, it seems reasonable that participants in the plan group used their hearing aids as they had planned. Qualitative interviews with participants may provide understanding of the plans created and used by participants to promote hearing aid use. Qualitative interview with participants who received the prompt component also may give us insight about how participants had perceived their hearing aid box (e.g., positive prompt or negative prompt). Second, short-term (i.e., six weeks) outcomes were measured. It would be valuable to examine whether the effect of the plan persists in the long-term (e.g., three, six and/ or 12 months). Third, due to time constraints, an additional standard care group (receive none of the I-PLAN component) was not included as it would have added to the number of participants needed and have extended the period of data collection beyond feasible time limits. As a result, we were unable to quantify whether the outcomes for each I-PLAN group were different to those for standard care. Future research should consider including a standard care control group. Fourth, as the mediator and the outcomes were measured at the same point, we cannot be certain that the mediator causes the outcome. Data at more time points would be needed to investigate this further (Lee et al. 2019).

Conclusions

This is the first randomized controlled trial of an intervention to promote hearing aid use based on a theoretical model of behavior change. Provision of a hearing aid box as a physical prompt reduced hearing aid use and self-regulation. It is important to identify a physical prompt with positive connotations to facilitate effective hearing aid use. Planning, a volitional strategy, did promote hearing aid use in listening situations that users find most challenging and promote formation of hearing aid use habit. Audiologists should identify other volitional behavior change
strategies that might promote hearing aid outcomes. Behavior change strategies that promote patient hearing aid outcomes could be included in audiological education and training programs and provide an evidence base for clinical guidelines.

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References


of Sport and Exercise, 14(2), 228–248.


**SUPPLEMENTAL MATERIAL**

**Supplemental Material 1:** Clinical and demographic characteristics of regular and non-regular hearing aid (HA) users.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Regular HA users (n = 154)</th>
<th>Non-regular HA users (n = 57)</th>
<th>Statistical value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Age (years)</td>
<td>68.6</td>
<td>13.57</td>
<td>67.5</td>
</tr>
<tr>
<td>Pure tone Average (dBHL)*</td>
<td>33.7</td>
<td>11.76</td>
<td>32.7</td>
</tr>
<tr>
<td>HHIE-S (unaided)</td>
<td>22.5</td>
<td>9.38</td>
<td>18.4</td>
</tr>
<tr>
<td>Gender</td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Male</td>
<td>76</td>
<td>49.4</td>
<td>24</td>
</tr>
<tr>
<td>Female</td>
<td>78</td>
<td>50.6</td>
<td>33</td>
</tr>
</tbody>
</table>

*Pure tone average = Average of hearing thresholds at 0.5, 1, 2 and 4 kHz in the better ear. HHIE-S = Hearing Handicap Inventory for the Elderly and for Adults – Screening version (Ventry & Weinstein, 1983). a = p-values are from the univariate ANOVAs (F) or chi-square test (X<sup>2</sup>). All comparisons are non-significant except for the HHIE-S score, p<0.05**.
CHAPTER 6
GENERAL DISCUSSION & FUTURE DIRECTIONS
CHAPTER 6

GENERAL DISCUSSION & FUTURE DIRECTIONS

This thesis addressed the need for interventions to promote hearing aid use and benefit in adult patients fitted with hearing aid(s) for the first-time. The aims of this thesis were to:

(i) systematically identify the behaviours of hearing healthcare professionals during hearing aid consultations and the available evidence concerning the impact of the behaviours of hearing healthcare professionals on hearing aid use and benefit patient outcomes (Chapter 3);

(ii) assess the effectiveness of I-PLAN intervention delivered face-to-face by audiologists during hearing aid fitting consultations through a controlled trial study (Chapter 4);

(iii) examine the prompt and plan components of the I-PLAN intervention to promote hearing aid use and benefit among first-time adult hearing aid users through a randomised controlled trial study (Chapter 5); and

(iv) examine the mechanisms of action of the I-PLAN intervention to promote hearing aid use and benefit via self-regulation and habit formation as potential mediators (Chapter 5).

A contribution of each study to the research and the implications of findings to the audiology practice and future research are discussed in the next section. The strengths and limitations of the thesis as well as future directions are provided at the end of this chapter.
6.1 General discussion

The findings of our systematic review study provide a characterisation of the clinical interactions between audiologists and adult patients during hearing aid consultations. Audiological practice was found to be remarkably consistent across time (since Doyle, (1994) to the present), across public versus private health care settings and across countries. Audiologists use a small range of behaviour change strategies, mostly centred around giving information on technical aspects of hearing aids. Our findings therefore justify the importance of considering additional alternative behaviour change strategies to promote hearing aid use and benefit.

Although the findings of our review imply that motivational interviewing (Aazh, 2016a; Solheim et al., 2018) could be applied by audiologists during their consultations with patients to promote hearing aid use, recent studies found that patients who presented at UK NHS audiology clinics were generally highly motivated to use their hearing aid (Sawyer et al., 2019), but there was a gap between patients’ motivation to use hearing aids and actual hearing aid use, suggesting that motivation may not translate to behaviour (Sawyer et al., 2019). Intervention studies should therefore target ‘volitional processes’ (that translate motivation to use hearing aids into action) to increase hearing aid use among adult patients (Sawyer et al., 2019). A need for intervention studies that include other strategies in addition to provision of information to promote hearing aid use was also highlighted by previous review studies, Barker, Mackenzie, Elliott, et al. (2016) and Aazh and Moore (2016).

Given that the I-PLAN intervention is a systematically developed behaviour change intervention and consists of three behaviour change techniques, the I-PLAN
intervention may well be effective in promoting hearing aid use. The findings in Chapter 4 established the effects of the I-PLAN intervention for the first-time in a clinical setting. There were no differences in any outcome measures between the I-PLAN group and the Standard Care group when the I-PLAN was delivered face-to-face by audiologists. However, the findings in Chapter 4 need to be interpreted with caution. This is because high levels of hearing aid use (e.g., more than 8 hours/day) among participants could possibly limit the potential for the I-PLAN intervention to impact on hearing aid use and benefit. There may be also have been an interaction between the I-PLAN plan and prompt components, reducing the effectiveness of the intervention.

The study in Chapter 5 established the effects of the prompt and plan components of the I-PLAN on hearing aid use and potential mechanisms of action (self-regulation and habit formation) for the first-time in a clinical setting. The findings in Chapter 5 indicate that the plan component could be provided to promote hearing aid use in adult hearing aid patients, in addition to provision of information that characterises standard care. The finding that the plan component of I-PLAN boosted hearing aid use when it was delivered in paper format without being completed with the audiologist suggested that delivery of health behaviour interventions to promote hearing aid use could be adaptable. Interventions need not be delivered by an audiologist and take precious time in a clinical consultation. Effective interventions could be delivered independent of audiologists in written format, or perhaps on-line (e.g., Ferguson, Brandreth, et al., 2016).
Using self-completed interventions to promote hearing aid use is consistent with a self-management paradigm in relation to hearing loss. Management of hearing loss is typically based on a medical model of intervention for an acute condition. Researchers have argued that self-management is a more appropriate and likely more effective model of care in relation to hearing loss (Convery, Keidser, Hickson, & Meyer, 2016). Adult patients may feel empowered to manage and use their hearing aid when they received the plan component. Extensive involvement of adult patients in their own audiological rehabilitation decision has also been highlighted in a previous study to improve audiological rehabilitation outcomes (Grenness, Hickson, Laplante-Lévesque, & Davidson, 2014).

The surprising finding that the prompt component reduced the proportion of time hearing aids were used in specific listening situations indicates that well-intentioned behaviour change interventions may have unintended adverse consequences. In this study, we explicitly asked participants to use the storage box as a physical prompt to remind participants to use their hearing aid(s). Hearing aid boxes are typically given to patients for safekeeping of their hearing aid when not in use. One advantage of using the storage box as the prompt is that no additional resources would be needed to provide the prompt. Unfortunately, using the hearing aid box as a physical prompt did more harm than good, reducing hearing aid use and self-regulation for hearing aid use. Given the negative effect of the prompt, it is possible that the prompt undermined the positive effect of the plan when the prompt and plan components were provided together (Chapter 4 and Chapter 5).
CHAPTER 6: DISCUSSION & FUTURE DIRECTIONS

Taken together, both studies (Chapter 4 and Chapter 5) raise questions about the role of the audiologist in promoting hearing aid use. Although a difference between the studies in Chapter 4 and 5 was the mode of delivery of the I-PLAN (audiologists delivery versus in the envelope), we cannot come to any conclusion concerning the relative impact of the mode of delivery and the role of the audiologist. There seem to be no substantial differences in the proportion of hearing aid use between the audiologist-delivered I-PLAN and the I-PLAN delivered in paper format. For example, for the audiologist-delivered I-PLAN (Chapter 4), the mean proportion of hearing aid use was 81.0% (SD = 25.9) of the time for the I-PLAN group versus 79.6% (SD = 29.4) of the time for Standard Care group. For the I-PLAN delivered in paper format, the mean proportion of hearing aid use was 75.9% (SD = 27) of the time for the ‘Info + Prompt + Plan’ group versus 73.0% (SD = 26) for the ‘Information only’ group. Direct comparison of the audiologist-delivered versus the paper I-PLAN is problematic because of the different study designs (quasi-experimental versus randomised controlled trial), different audiologists (with different demographics and experience) and different study samples for each study. Future research could test the impact of audiologist involvement by directly comparing the audiologist-delivered with the self-completed I-PLAN. There is one randomised controlled trial that indicated a similar amount of benefit when hearing aid(s) were self-fitted without audiologists’ involvement versus audiologist-fitted hearing aids (Humes et al., 2017). An important outstanding question is the value that consultation with a professional audiologist brings to hearing health care.
6.2 Strengths and limitations of current research

Several strengths and weaknesses were identified and considered in this PhD project. One strength is that the positive effect of the plan component is generalisable to UK NHS first-time hearing aid users. Generalisation is possible because: i) the study in Chapter 5 was a fully powered randomised controlled trial; ii) participants were representative of typical first-time adult hearing aid users in the UK; and iii) the study was done in NHS hearing aid clinics and involved NHS audiologists. Findings may not be generalisable to experienced hearing aid users or those from different countries with different models of hearing health service provision.

One key limitation is that we do not know if the positive effect of the plan component persists for more than six weeks. Humes et al. (2009) concluded the self-reported hearing aid outcomes stabilise at three to six months after fitting. Our six-week outcome measures, therefore, may not represent reliable self-reported outcomes. The six-week follow-up was chosen because it capitalised on the usual follow-up time for the audiology clinics that hosted our studies. The six-week follow-up may also be an appropriate moment to assess how adult patients are getting used to their hearing aids (Dillon, 2001), and six-week follow-up may also provide a critical indication of likely hearing aid use in the long term (Humes, 2018).

Another strength of this thesis is the strong level of evidence provided by the two controlled trials (randomised controlled trial and quasi-experimental study). An additional strength is the large sample size of the two fully powered intervention trials (N = 160, N = 240). These large studies compare favourably with the smaller previous intervention studies found in our review (Solheim et al., 2018, N = 47; Ferguson,
Maidment, et al., 2016, N = 68; Aazh, 2016a, N = 37; Naylor et al., 2015, N = 40; and Sauders & Forsline, 2012, N = 69). We also measured hypothesised mechanisms of action underlying the I-PLAN intervention in promoting hearing aid use and benefit. In addition, the I-PLAN written materials were developed in consultation with patients and audiologists and based on materials that have been proven effective in health behaviour change (e.g., ‘volitional help sheets’; Armitage, 2008). A further strength of this thesis is the use of the behaviour change techniques as a language to describe our main components (i.e., active ingredients). Using the behaviour change techniques makes it possible to share the application of the I-PLAN components using a common language (e.g., action plan) and assist in synthesising the evidence found in our studies in a systematic manner. Finally, a strength of this thesis is the methods used in our study to minimise risk of bias, for example, the used of envelopes to deliver the I-PLAN components to participants.

6.3 Future directions

The studies presented in this thesis suggest an agenda for further research as follows:

**Optimal hearing aid use**

Given there is no consensus for what constitutes optimal hearing aid use, future work should identify criteria for optimal or successful hearing aid use. Identifying ‘optimal’ use criteria would provide a standard for identifying under-use and/or unsuccessful hearing aid users and provide a target for interventions to promote hearing aid use to strive for. Laplante-Lévesque et al. (2013) identified one definition of optimal hearing aid use as according to the patients’ individual needs based on the key listening situations, but their study was qualitative and offered a low level of evidence. More
rigorous identification of ‘optimal’ use would involve investigating various levels of hearing aid used and its association with hearing aid benefit (e.g., hearing-specific and general quality of life). A prediction is that, ‘optimal’ use relates primarily to use in situations of greatest communication need rather than to absolute hours of use.

*Patient experience of the I-PLAN*
Analysis of the experience of adult patients using the I-PLAN components could elucidate the reasons for certain findings, for example, the adverse impact of the prompt on hearing aid use, understand reasons for the interaction of the prompt and plan components as well as identify any barriers or facilitators to completing the intervention. The patient’s experience of the intervention could be investigated using qualitative methods (e.g., face-to-face interviews or focus groups with patients). The data obtained from the interview could also be analysed against the COM-B model in order to understand the capabilities, opportunities and motivation that influence implementation of the I-PLAN intervention.

*Identifying high risk populations for I-PLAN intervention*
The impact of the I-PLAN was either non-existent (for complete I-PLAN components in Chapter 4) or small (for the plan component in Chapter 5). One of the possible reasons for the limited effects of the I-PLAN observed in this thesis may be because average hearing aid use at the six-week follow-up appointment was high in these study samples. There may therefore have been limited the scope to improve hearing aid use among participants in this PhD work. Those who did not consent to participate in the studies (Chapter 4 and Chapter 5) may have been more likely not to use their hearing aids and could perhaps have benefited from the I-PLAN intervention. Future research
could concentrate on reliably identifying new hearing aid users who are at risk for low/non-use and selectively target them for interventions to promote hearing aid use and benefit. Post-hoc analysis suggested that people who used their hearing aids fewer than four hours/day reported lower hearing handicap score than people who used their hearing aid(s) regularly. Accuracy of prediction could be improved by using multiple health psychological correlates of hearing aid use (e.g., post-motivational variables, action planning and coping planning). Future research could also include experienced hearing aid users that under-use or do not use their hearing aids.

Additional behaviour change techniques

In this PhD work, only three behaviour change techniques were tested to promote hearing aid use and benefit. There are numerous other behaviour change techniques in the taxonomy (BCTTv1; Michie et al., 2013) that may be effective in promoting hearing aid use and benefit. For example, self-incentive techniques are positively associated with behaviour change across various health behaviour domains (e.g., weight loss and quit smoking; Brown, Smith, Epton, & Armitage, 2017) and may also be effective in promoting hearing aid use. Future study should identify and test additional behaviour change techniques that potentially promote hearing aid use and benefit.

Physical prompts and self-regulation

Given the unexpected adverse impact of the physical prompt component of the I-PLAN on hearing aid use, future study should aim to understand the negative impact of physical prompt on hearing aid use and benefit. Comparing one specific physical prompt with other types of prompts (e.g., phone messaging reminder or verbal
reminder from significant others) will inform understanding of how environmental cues relate to health behaviour change in general and to hearing aid use in particular. In addition, understanding the relationship between environmental cues and self-regulation is of particular importance given the suggestion that environmental cues may adversely impact hearing aid use by undermining self-regulation.

**Time course of health behavioural psychology of hearing aid use**

Chapter 5 suggested that the plan component may promote hearing aid use via supporting development of the habit of hearing aid use. Short-term follow-up and only one observation (e.g., outcome measured only at six-week follow-up) meant that we did not have information concerning the interplay of psychological factors (e.g., coping planning, self-efficacy) that may support habit formation. Establishing hearing aid use as a habit may be key to ensuring long term use. Longitudinal studies with regular observations of habit, hearing aid use and relevant psychological factors could be used to understand the determinants and time course of habit formation and identify critical periods for intervention to promote hearing aid use habit formation (e.g., using a cross-lagged panel study design; van Bree et al., 2017).

**6.4 Final remarks**

Evaluation of the I-PLAN intervention and its components help to fill a need for evidence-based interventions to promote hearing aid use and benefit. Testing the I-PLAN intervention also allowed us to demonstrate that it is possible to apply a health psychology-based intervention to clinical audiology. Clinical audiology is ripe for health psychology-based approaches because hearing aid use does not rely solely on technical aspects of hearing aids or nature of hearing loss. There are important
psychological factors that need to be considered. In particular, 'volitional' psychological factors that may be critical in translating new hearing aid users’ motivation to use hearing aids into consistent use. This PhD provided evidence that a volitional strategy delivered during hearing aid fitting appointments boosted hearing aid use. This PhD also found that researchers should be alert to the possibility of unintended adverse effects of behaviour change interventions. Addressing the psychological factors associated with hearing aid use may help foster genuine behaviour change and long-term hearing aid use. Perhaps this is the time for research in audiology to shift attention to behaviour change strategies to facilitate greater hearing aid use and benefit, rather than focusing on technological fixes grounded in a medical model of addressing hearing loss that is the usual focus of audiology.
REFERENCES


Armitage, C. J., Lees, D., Lewis, K., & Munro, K. J. (2017). Preliminary support for a brief psychological intervention to improve first-time hearing aid use among


REFERENCES


207


REFERENCES


APPENDICES : CHAPTER 4

Appendix 1: Participant information sheet

PARTICIPANT INFORMATION SHEET

HOW CAN AUDIOLOGISTS HELP PEOPLE GET MORE BENEFIT FROM THEIR HEARING AIDS?

You are being invited to take part in a research to understand how audiologists can help people more effectively. The research project is part of a PhD degree project at the University of Manchester.

Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

Who will conduct the research?

Mrs. Noor Afzarini Hasnita Ismail and Dr Piers Dawes. Manchester Centre for Audiology and Deafness (ManCAD), School of Health Sciences, Faculty of Biological, Medical and Health Sciences, Ellen Wilkinson Building, University of Manchester, Manchester, M13 9PL, United Kingdom.

This research is being organised by The University of Manchester as a research governance sponsor.

What is the aim of the research?

The aim of this research is to discover whether a new counselling strategy the ‘I-PLAN’ is effective in promoting hearing aid use and benefit for people with hearing problems. In this study, we will compare the I-PLAN with the usual way of counselling people who are getting hearing aids for the first time and see which is the most helpful.
Why have I been chosen?
You have been invited to take part as you are someone who has been offered hearing aid(s).

What would I be asked to do if I took part?

1. **During the hearing aid fitting appointment,**
   - Additional information about your age, gender and hearing that is relevant to the research will be recorded from your audiology patient notes.
   - We will ask you to complete a questionnaire asks about your hearing in daily life.
   - We plan to video-record a small sample of hearing aid fitting appointments with your audiologist. If your appointment is selected to be video-recorded, your audiologist will ask if it would be ok to video-record the appointment.

2. **6 weeks after the hearing aid fitting appointment,**
   - We would record information about how often you use your hearing aid(s). This information is logged automatically by your hearing aid and will be downloaded by your audiologist during your appointment.
   - We will ask you to complete a questionnaire during your audiology appointment visit. The questionnaire asks about how much you use your hearing aid use and your hearing in daily life. The questionnaire will take around 10-15 minutes.

3. **3 and 6 months after you received your hearing aid,**
   - We will send you the same questionnaire via free post or via email, whichever you prefer and will ask you to complete the questionnaire. The questionnaire asks about how much you use your hearing aid use and your hearing in daily life. The questionnaire will take around 10-15 minutes.

What are the possible advantages, disadvantages and risks of taking part?

There are no direct benefits to you from taking part in this study but, the information we get for this study could help improve the quality of service for people with hearing loss.
What happens to the data collected?
All the data collected from this study will be analysed and presented at scientific conferences and reported in scientific papers. The video recording will be used for analysis only and will not be included when presenting or publishing the study. The data will be anonymous, meaning that your identity will be confidential. The data collected also will be used to support other research in the future, and may be shared anonymously with other researchers.

How is confidentiality maintained?
All information which is collected about you will be kept strictly confidential.

- The data obtained will be treated anonymously using assigned code number rather than your name.
- All the video recording will be deleted as soon as after analysis.
- All the video-recordings, electronic and paper copies of the research data will be transferred from the audiology department to the University of Manchester and will be securely stored at the University of Manchester.
- The data collected as part of this study will be accessed by the research team only. Individuals from the University of Manchester, NHS Trust or regulatory authorities may need to look at the data collected for this study to make sure the project is being carried out as planned. This may involve looking at your identifiable data and records, but all individuals involved in auditing and monitoring the study will have a strict duty of confidentiality to you as a research participant.
- All the information will be securely stored at the University of Manchester for 5 years following completion of the study, after which it will be disposed of securely.
- Personal data (postal address, telephone number, email address) will be kept for 12 months after the end of the study so that we are able to contact you to let you know about the findings of the study (if you wish).
What happens if I do not want to take part or if I change my mind?
No, you do not need to take part. If you decline to take part, your clinical care will be not be affected in any way.

Will I be paid for participating in the research?
You will not be paid for taking part in this study.

What is the duration of the research?
The total duration of this research will be approximately 1 hour;
1. **During the hearing aid fitting appointment** = 10 minutes for answering the questionnaire.
2. **6 weeks after the hearing aid fitting appointment** = 15 minutes for answering the questionnaire.
3. **3 months after the hearing aid fitting appointment** = 15 minutes for answering the questionnaire.
4. **6 months after the hearing aid fitting appointment** = 15 minutes for answering the questionnaire.

Will the outcomes of the research be published?
We will publish the results in a scientific journal and present them at scientific meetings. We can send you a short report about our findings, if you wish.

Who has reviewed the research project?
The study has been reviewed and approved by 17/NM/0405 Research Ethics Committee.

What if something goes wrong?
It is highly unlikely that you will be harmed in any way. If you have a concern about any aspect of this study, you should ask to speak to the researcher who will do her best to answer your questions.
• **Minor complaints**
  If you have a minor complaint then you need to contact the researcher(s) in the first instance:

  **AFZARINI**

  E-mail: noor.ismail-postgrad.manchester.ac.uk
  Tel: 0161 275 8567

  However, if you would prefer not to discuss with the researcher, please contact her supervisor:

  **DR PIERS DAWES, PhD, SENIOR LECTURER IN AUDIOLOGY**

  E-mail: Piers.Dawes@manchester.ac.uk
  Tel: 01613061758

• **Formal Complaints:**
  If you wish to make a formal complaint or if you are not satisfied with the response you have gained from the researchers in the first instance then please contact the Research Governance and Integrity Manager, Research Office, Christie Building, University of Manchester, Oxford Road, Manchester, M13 9PL, by emailing: research.complaints@manchester.ac.uk or by telephoning 0161 275 2674 or 275 2046.

  In the event that something does go wrong and you are harmed during the research you may have grounds for a legal action for compensation against the University of Manchester or NHS Trust, but you may have to pay your legal costs. The normal National Health Service complaints mechanisms will still be available to you.

  **Contact for further information**

  Please contact;

  Afzarini: 0161 275 8567 or email: noor.ismail-postgrad.manchester.ac.uk
Appendix 2: Participant consent form

PARTICIPANT CONSENT FORM

HOW CAN AUDIOLOGISTS HELP PEOPLE GET MORE BENEFIT FROM THEIR HEARING AIDS?

If you are happy to participate please complete and sign the consent form below

Please initial box

1. I confirm that I have read the information sheet (version 3, dated [03/07/2017]) for the above research study and have had the opportunity to consider the information and ask questions and had these answered satisfactorily.

2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving a reason and without detriment to any treatment/service.

3. I understand that my initial hearing aid fitting appointment session with audiologist may be video recorded.

4. I understand that additional information that is relevant to the study will be recorded from my patient records. This information will include the age, gender, type of hearing loss and any hearing conditions that are relevant to the research.

5. I understand that relevant sections of my medical notes and data collected during the study may be looked at by individuals from the University of Manchester, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.
6. I understand that the information collected about me will be used to support other research in the future and may be shared anonymously with other researchers. This information will include the age, gender, type of hearing loss, any hearing conditions that are relevant to the research and hearing aid(s) usage.

7. OPTIONAL: I would like to receive a summary of the main findings at the end of the study. I understand that the research team will keep my contact details to send the summary.

8. I agree to take part in the above project.

Name of participant: __________________________
Signature: ___________________ Date: ________________

Name of person taking consent: __________________________
Signature: ___________________ Date: ________________

Mrs Afzarini Ismail, Researcher
Signature: ___________________ Date: ________________

The study has been reviewed and approved by 17/NM/0405 Research Ethics Committee
Appendix 3: Invitation letter

Evaluation of the I-PLAN to promote hearing aid use and benefit by adults with hearing impairment  
IRAS ID: 228054

Audiology Department,  
Trafford Hospitals  
Moorside Road,  
Manchester M41 5SL  
Tel: 0161 746 2304  
audiology.trafford@cmft.nhs.uk

Dear xxx

Re: Invitation to Take Part in a Research Study “How Can Audiologists Help People Get More Benefit from Their Hearing Aids?”

Researchers at Manchester University and I are doing research to discover whether a new counselling strategy the ‘I-PLAN’ is effective in promoting hearing aid use and benefit for people with hearing problems. This study may help to improve the quality of care for people with hearing problems. We would like to invite you to take part in this study.

Details of the study are described in the information sheet that comes with this letter. Your help would be appreciated, but it is completely up to you if you decide to take part or not. If you have any questions, please feel free to contact either myself at Trafford Hospital or Mrs Afzarini at the University of Manchester (contact details below).

If you would like to take part, please contact Mrs. Afzarini directly or complete the 1) consent form, 2) initial hearing aid fitting questionnaire and 3) contact details form that come with this letter. Please return all the complete documents to your audiologist at your initial hearing aid fitting appointment. Thank you very much.

Yours sincerely,

Dr Greg Nassar (Head of Audiology Services)  
Trafford Hospitals, Moorside Road  
Manchester, M41 5SL. Tel: 0161 746 2306

Mrs. Noor Afzarini Hasnita Ismail (Researcher)  
Manchester Centre for Audiology and Deafness (ManCAD),  
School of Health Sciences, Faculty of Biology, Medicine and Health  
A3.08, Ellen Wilkinson Building, University of Manchester, Manchester, M13 9PL  
Tel: +44 161 275 8568  Email: noor.ismail-2@postgrad.manchester.ac.uk
Appendix 4: Initial hearing aid appointment questionnaire

QUESTIONNAIRE: PARTICIPANT (INITIAL HEARING AID APPOINTMENT)

HOW CAN AUDIOLOGISTS HELP PEOPLE GET MORE BENEFIT FROM THEIR HEARING AIDS?

To ensure the confidentiality of your personal data, please write your code in the boxes below.

<table>
<thead>
<tr>
<th>The first two letters of your mother’s first name</th>
<th>Day of your birthday (a number between 01 and 31)</th>
<th>The first letter of your surname</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Example: SA if the name is Sarah</td>
<td>*Example: 02 if your date of birth was the 02/12/1950</td>
<td>*Example: S if your name is David Smith</td>
</tr>
</tbody>
</table>

Please answer all the questions by tick (V) for each question.

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<thead>
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<tbody>
<tr>
<td>1</td>
<td>Does a hearing problem cause you to feel embarrassed when meeting new people?</td>
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<td></td>
<td>Yes</td>
<td>Sometimes</td>
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<tr>
<td>2</td>
<td>Does a hearing problem cause you to feel frustrated when talking to members of your family?</td>
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<td></td>
<td>Yes</td>
<td>Sometimes</td>
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<td></td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>3</td>
<td>Do you have difficulty hearing when someone speaks in a whisper?</td>
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<tr>
<td></td>
<td>Yes</td>
<td>Sometimes</td>
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<td>☐</td>
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<tr>
<td>4</td>
<td>Do you feel handicapped by a hearing problem?</td>
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<td></td>
<td>Yes</td>
<td>Sometimes</td>
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<tr>
<td>5</td>
<td>Does a hearing problem cause you difficulty when visiting friends, relatives, or neighbours?</td>
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<td></td>
<td>Yes</td>
<td>Sometimes</td>
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<td></td>
<td>Does a hearing problem cause you to attend movies or theatre or religious services less often than you would like?</td>
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<td>6</td>
<td>Yes</td>
<td>Sometimes</td>
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<th></th>
<th>Does a hearing problem cause you to have arguments with family members?</th>
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<tr>
<td>7</td>
<td>Yes</td>
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<td></td>
<td>☐</td>
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<th></th>
<th>Does a hearing problem cause you difficulty when listening to TV or radio?</th>
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<tbody>
<tr>
<td>8</td>
<td>Yes</td>
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<tr>
<td></td>
<td>☐</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Do you feel that any difficulty with your hearing limits or hampers your personal or social life?</th>
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<tbody>
<tr>
<td>9</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>☐</td>
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<table>
<thead>
<tr>
<th></th>
<th>Does a hearing problem cause you difficulty when in a restaurant with relatives or friends?</th>
</tr>
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<tbody>
<tr>
<td>10</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>☐</td>
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</table>

THANK YOU FOR YOUR TIME
Appendix 5: Follow-up hearing aid questionnaire

**QUESTIONNAIRE: PARTICIPANT (6 WEEKS)**

**HOW CAN AUDIOLOGISTS HELP PEOPLE GET MORE BENEFIT FROM THEIR HEARING AIDS?**

Dear Sir / Madam,

We would greatly appreciate it if you could fill in this questionnaire. This questionnaire asks about your hearing in daily life. The questionnaire should take less than 10 minutes.

Completing this questionnaire is voluntary. If you decline to take part, your clinical care will be not be affected in any way.

The information you provide will be treated as strictly confidential and will be used anonymously. To protect the anonymity of provided information, we will ask you to write an anonymous code in the boxes on the next page. When you have finished the questionnaire, please put the questionnaire in the white envelope. Then give the white envelope to your audiologist before you leave the clinic.

Thank you very much for giving your time to help with this study. Your participation will help improve the quality of service for people with hearing problems. If you have any questions about the questionnaire or the research study, please contact Mrs. Afzarini on 01612758568 at the University of Manchester.
QUESTIONNAIRE: PARTICIPANT (6 WEEKS)

HOW CAN AUDIOLOGISTS HELP PEOPLE GET MORE BENEFIT FROM THEIR HEARING AIDS?

To ensure the confidentiality of your personal data, please write your code in the boxes below.

<table>
<thead>
<tr>
<th>The first two letters of your mother’s first name *Example: SA if the name is Sarah</th>
<th>Day of your birthday (a number between 01 and 31) *Example: 02 if your date of birth was the 02/12/1950</th>
<th>The first letter of your surname *Example: S if your name is David Smith</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Please answer all the questions by selecting the most appropriate option.

1. Think about how much you used your present hearing aid(s) over the past two weeks. On an average day, how many hours did you use the aid(s)? (a number between 0 and 24): ___________ (hour(s) a day)

2. Think about the situation where you most wanted to hear better, before you got your present hearing aid(s). Over the past two weeks, how much has the hearing aid helped in that situation?

<table>
<thead>
<tr>
<th>helped not at all</th>
<th>helped slightly</th>
<th>helped moderately</th>
<th>helped quite a lot</th>
<th>helped very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
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</tr>
</tbody>
</table>

3. In a typical situation where you have hearing difficulty, what proportion of the time do you wear your hearing aids?

<table>
<thead>
<tr>
<th>never/not at all</th>
<th>about ¼ of the time</th>
<th>about ½ of the time</th>
<th>About ¾ of the time</th>
<th>all the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
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</tr>
</tbody>
</table>

4. Think again about the situation where you most wanted to hear better. When you use your present hearing aid(s), how much difficulty do you STILL have in that situation?

<table>
<thead>
<tr>
<th>very much difficulty</th>
<th>quite a lot of difficulty</th>
<th>moderate difficulty</th>
<th>slight difficulty</th>
<th>no difficulty</th>
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<tr>
<td>□</td>
<td>□</td>
<td>□</td>
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<td></td>
<td>Considering everything, do you think your present hearing aid(s) is worth the trouble</td>
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<tr>
<td>5</td>
<td>not at all worth it</td>
<td>slightly worth it</td>
<td>moderately worth it</td>
<td>quite a lot worth it</td>
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<thead>
<tr>
<th></th>
<th>Over the past two weeks, with your present hearing aid(s), how much have your hearing difficulties affected the things you can do?</th>
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<tr>
<td>6</td>
<td>affected very much</td>
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<td>□</td>
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<table>
<thead>
<tr>
<th></th>
<th>Over the past two weeks, with your present hearing aid(s), how much do you think other people were bothered by your hearing difficulties?</th>
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<tbody>
<tr>
<td>7</td>
<td>bothered very much</td>
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<td></td>
<td>□</td>
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<thead>
<tr>
<th></th>
<th>Considering everything, how much has your present hearing aid(s) changed your enjoyment of life?</th>
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<tbody>
<tr>
<td>8</td>
<td>worse</td>
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<th></th>
<th>Does a hearing problem cause you to feel embarrassed when meeting new people?</th>
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<tr>
<td>9</td>
<td>Yes</td>
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<table>
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<tr>
<th></th>
<th>Does a hearing problem cause you to feel frustrated when talking to members of your family?</th>
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<tr>
<td>10</td>
<td>Yes</td>
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<tr>
<td></td>
<td>□</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Do you have difficulty hearing when someone speaks in a whisper?</th>
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<tbody>
<tr>
<td>11</td>
<td>Yes</td>
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<tr>
<td></td>
<td>□</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Do you feel handicapped by a hearing problem?</th>
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<tr>
<td>12</td>
<td>Yes</td>
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<td></td>
<td>□</td>
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</tbody>
</table>
13 | Does a hearing problem cause you difficulty when visiting friends, relatives, or neighbours?  
---|---|---
| Yes | Sometimes | No |
| ☐ | ☐ | ☐ |

14 | Does a hearing problem cause you to attend movies or theatre or religious services less often than you would like?  
---|---|---
| Yes | Sometimes | No |
| ☐ | ☐ | ☐ |

15 | Does a hearing problem cause you to have arguments with family members?  
---|---|---
| Yes | Sometimes | No |
| ☐ | ☐ | ☐ |

16 | Does a hearing problem cause you difficulty when listening to TV or radio?  
---|---|---
| Yes | Sometimes | No |
| ☐ | ☐ | ☐ |

17 | Do you feel that any difficulty with your hearing limits or hampers your personal or social life?  
---|---|---
| Yes | Sometimes | No |
| ☐ | ☐ | ☐ |

18 | Does a hearing problem cause you difficulty when in a restaurant with relatives or friends?  
---|---|---
| Yes | Sometimes | No |
| ☐ | ☐ | ☐ |

19 | Using hearing aid(s) is something I do automatically’  
---|---|---|---|---|---|---
| Strongly disagree | Disagree | Disagree somewhat | Undecided | Agree somewhat | Agree | Strongly agree |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

20 | Using hearing aid(s) is something I do without thinking  
---|---|---|---|---|---|---
| Strongly disagree | Disagree | Disagree somewhat | Undecided | Agree somewhat | Agree | Strongly agree |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

21 | Using hearing aid(s) is something I do without having to consciously remember to use them  
---|---|---|---|---|---|---
<p>| Strongly disagree | Disagree | Disagree somewhat | Undecided | Agree somewhat | Agree | Strongly agree |
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Using hearing aid(s) is something I start doing before I realize I’m doing it</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Disagree somewhat</td>
<td>Undecided</td>
<td>Agree somewhat</td>
<td>Agree</td>
</tr>
<tr>
<td>23</td>
<td>During the last 6 weeks, I often had the intention to use my hearing aid(s) on my mind</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Disagree somewhat</td>
<td>Undecided</td>
<td>Agree somewhat</td>
<td>Agree</td>
</tr>
<tr>
<td>24</td>
<td>During the last 6 weeks, I have always been aware of using my hearing aid(s)</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Disagree somewhat</td>
<td>Undecided</td>
<td>Agree somewhat</td>
<td>Agree</td>
</tr>
<tr>
<td>25</td>
<td>During the last 6 weeks, I consistently checked myself to see if I was using my hearing aid(s) often enough</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Disagree somewhat</td>
<td>Undecided</td>
<td>Agree somewhat</td>
<td>Agree</td>
</tr>
<tr>
<td>26</td>
<td>During the last 6 weeks, I took care to use my hearing aid</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Disagree somewhat</td>
<td>Undecided</td>
<td>Agree somewhat</td>
<td>Agree</td>
</tr>
<tr>
<td>27</td>
<td>During the last 6 weeks, I tried hard to use my hearing aid regularly</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Disagree somewhat</td>
<td>Undecided</td>
<td>Agree somewhat</td>
<td>Agree</td>
</tr>
<tr>
<td>28</td>
<td>During the last 6 weeks, I did my best to act consistently with what my audiologist told me regarding hearing aid use</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Disagree somewhat</td>
<td>Undecided</td>
<td>Agree somewhat</td>
<td>Agree</td>
</tr>
</tbody>
</table>

THANK YOU FOR YOUR TIME
**Appendix 6: Participant information sheet (pre-training)**

**PARTICIPANT INFORMATION SHEET**

**HOW CAN AUDIOLOGISTS HELP PEOPLE GET MORE BENEFIT FROM THEIR HEARING AIDS?**

You are being invited to take part in a research to understand how audiologists can help people more effectively. The research project is part of a PhD degree project at the University of Manchester. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

**Who will conduct the research?**

Mrs. Noor Afzarini Hasnita Ismail and Dr Piers Dawes. Manchester Centre for Audiology and Deafness (ManCAD), School of Health Sciences, Faculty of Biological, Medical and Health Sciences, Ellen Wilkinson Building, University of Manchester, Manchester, M13 9PL, United Kingdom.

This research is being organised by The University of Manchester as a research governance sponsor.

**What is the aim of the research?**

The aim of this research is to discover whether a new counselling strategy the ‘I-PLAN’ is effective in promoting hearing aid use and benefit for people with hearing problems. In this study, we will compare the I-PLAN with the usual way of counselling people who are getting hearing aids for the first time and see which is the most helpful.

**Why have I been chosen?**

You have been invited to take part as you are someone who has been given a hearing aid(s) OR offered hearing aid(s).
What would I be asked to do if I took part?

- If you are someone who has **been given hearing aid(s):**
  - You do not need to do anything. Information about your age, gender and hearing that is relevant to the research and how often you use your hearing aid(s) will be recorded from your audiology patient notes.

- If you are someone who has been **offered hearing aid(s):**
  - We would video-record of your hearing aid fitting appointment with your audiologist. Your audiologist will ask if it would be ok to video-record the appointment. Additional information about your age, gender and hearing that is relevant to the research will be recorded from your audiology patient notes.

What are the possible advantages, disadvantages and risks of taking part?

There are no direct benefits to you from taking part in this study but, the information we get for this study could help improve the quality of service for people with hearing loss.

What happens to the data collected?

All the data collected from this study will be analysed and presented at scientific conferences and reported in scientific papers. The video recording will be used for analysis only and will not be included when presenting or publishing the study. The data will be anonymous, meaning that your identity will be confidential. The data collected also will be used to support other research in the future and may be shared anonymously with other researchers.

How is confidentiality maintained?

All information which is collected about you will be kept strictly confidential.

- The data obtained will be treated anonymously using assigned code number rather than your name.

- All the video recording will be deleted as soon as after analysis.
• All the video-recordings, electronic and paper copies of the research data will be transferred from the audiology department to the University of Manchester and will be securely stored at the University of Manchester.

• The data collected as part of this study will be accessed by the research team only. Individuals from the University of Manchester, NHS Trust or regulatory authorities may need to look at the data collected for this study to make sure the project is being carried out as planned. This may involve looking at your identifiable data and records, but all individuals involved in auditing and monitoring the study will have a strict duty of confidentiality to you as a research participant.

• All the information will be securely stored at the University of Manchester for 5 years following completion of the study, after which it will be disposed of securely.

• Personal data (postal address, telephone number, email address) will be kept for 12 months after the end of the study so that we are able to contact you to let you know about the findings of the study (if you wish).

What happens if I do not want to take part or if I change my mind?
No, you do not need to take part. If you decline to take part, your clinical care will be not be affected in any way.

Will I be paid for participating in the research?
You will not be paid for taking part in this study.

Will the outcomes of the research be published?
We will publish the results in a scientific journal and present them at scientific meetings. We can send you a short report about our findings, if you wish.

Who has reviewed the research project?
The study has been reviewed and approved by 17/NM/0405 Research Ethics Committee.
What if something goes wrong?
It is highly unlikely that you will be harmed in any way. If you have a concern about any aspect of this study, you should ask to speak to the researcher who will do her best to answer your questions.

• **Minor complaints**
  If you have a minor complaint then you need to contact the researcher(s) in the first instance:

  **AFZARINI**
  
  E-mail: noor.ismail-@postgrad.manchester.ac.uk  
  Tel: 0161 275 8567

  However, if you would prefer not to discuss with the researcher, please contact her supervisor:

  **DR PIERS DAWES, PhD, SENIOR LECTURER IN AUDIOLOGY**
  
  E-mail: Piers.Dawes@manchester.ac.uk  
  Tel: 01613061758

• **Formal Complaints:**
If you wish to make a formal complaint or if you are not satisfied with the response you have gained from the researchers in the first instance then please contact the Research Governance and Integrity Manager, Research Office, Christie Building, University of Manchester, Oxford Road, Manchester, M13 9PL, by emailing: research.complaints@manchester.ac.uk or by telephoning 0161 275 2674 or 275 2046.

In the event that something does go wrong and you are harmed during the research you may have grounds for a legal action for compensation against the University of Manchester or NHS Trust, but you may have to pay your legal costs. The normal National Health Service complaints mechanisms will still be available to you.

**Contact for further information**

Please contact;

Afzarini: 0161 275 8567 or email: noor.ismail-@postgrad.manchester.ac.uk
Appendix 7: Participant consent form (pre-training)

PARTICIPANT CONSENT FORM

HOW CAN AUDIOLOGISTS HELP PEOPLE GET MORE BENEFIT FROM THEIR HEARING AIDS?

If you are happy to participate please complete and sign the consent form below.

1. I confirm that I have read the information sheet (version 1, dated [03/07/2017]) for the above research study and have had the opportunity to consider the information and ask questions and had these answered satisfactorily.

2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving a reason and without detriment to any treatment/service.

3. I understand that additional information that is relevant to the study will be recorded from my patient records. This information will include the age, gender, type of hearing loss, any hearing conditions that are relevant to the research and how often I use my hearing aid(s).

4. I understand that my initial hearing aid fitting appointment session with audiologist will be video recorded (if applicable).

5. I understand that relevant sections of my medical notes and data collected during the study may be looked at by individuals from the University of Manchester, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.
6. I understand that the information collected about me will be used to support other research in the future and may be shared anonymously with other researchers. This information will include the age, gender, type of hearing loss, any hearing conditions that are relevant to the research and my hearing aid(s) use.

7. OPTIONAL: I would like to receive a summary of the main findings at the end of the study. I understand that the research team will keep my contact details to send the summary.

8. I agree to take part in the above project.

Name of participant: _______________________
Signature: _______________________
Date: __________________

Name of person taking consent: _______________________
Signature: _______________________
Date: __________________

Mrs Afzarini Ismail, Researcher
Date: __________________

The study has been reviewed and approved by 17/NM/0405 Research Ethics Committee.
Appendix 8: Invitation letter (pre-training)

Evaluation of the I-PLAN to promote hearing aid use and benefit by adults with hearing impairment
IRAS ID: 228054

Dear xxx,

Re: Invitation to Take Part in a Research Study “How Can Audiologists Help People Get More Benefit from Their Hearing Aids?”

Researchers at Manchester University and I are doing research to discover whether a new counselling strategy the ‘I-PLAN’ is effective in promoting hearing aid use and benefit for people with hearing problems. This study may help to improve the quality of care for people with hearing problems. We would like to invite you to take part in this study.

Details of the study are described in the information sheet that comes with this letter. Your help would be appreciated, but it is completely up to you if you decide to take part or not. If you have any questions, please feel free to contact either myself at Trafford Hospital or Mrs Afzarini at the University of Manchester (contact details below).

If you would like to take part, please contact Mrs. Afzarini directly or complete the consent form that come with this letter. Please return the consent form to your audiologist at your initial hearing aid fitting appointment. Thank you very much.

Yours sincerely,

Dr Greg Nassar (Head of Audiology Services)
Trafford Hospitals, Moorside Road, Manchester, M41 5SL. Tel: 0161 746 2306

Mrs. Noor Afzarini Hasnita Ismail (Researcher)
Manchester Centre for Audiology and Deafness (ManCAD),
School of Health Sciences, Faculty of Biology, Medicine and Health
A3.08, Ellen Wilkinson Building, University of Manchester, Oxford Road, M13 9PL
Tel: +44 161 275 8568 Email: noor.ismail-2@postgrad.manchester.ac.uk
Appendix 9: Audiologist information sheet

AUDIOLOGIST INFORMATION SHEET

HOW CAN AUDIOLOGISTS HELP PEOPLE GET MORE BENEFIT FROM THEIR HEARING AIDS?

You are being invited to take part in a research study to discover whether a new counselling strategy, the ‘I-PLAN’ is effective in promoting hearing aid use and benefit for people with hearing problems. The research will be used to improve clinical practice and patient benefit. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Who will conduct the research?
Mrs. Noor Afzarini Hasnita Ismail and Dr Piers Dawes. Manchester Centre for Audiology and Deafness (ManCAD), School of Health Sciences, Faculty of Biological, Medical and Health Sciences, Ellen Wilkinson Building, University of Manchester, Manchester, M13 9PL, United Kingdom.

This research is being organised by The University of Manchester as a research governance sponsor

What is the aim of the research?
The aim of this study is to evaluate the effectiveness of the ‘I-PLAN’ to promote hearing aid use and hearing-related quality of life. Audiologists and their adult patients will be divided into two groups; the standard care and the I-PLAN program groups. The groups for audiologists are based on your own interest whether or not you would like to attend training in the I-PLAN. Adult patients will be assigned into the groups based on the audiologist that they are working with.

Why have I been chosen?
You have been invited to take part because you are an audiologist working with adult hearing aid patients.
What would I be asked to do if I took part?
Depending on your preference, you will be assigned to the; i) standard care group or ii) I-PLAN group.

i. STANDARD CARE GROUP
   1. Prior to the start of the study,
      - We will ask you to anonymously record age, gender, duration and nature of hearing loss and average hearing aid use outcome from clinical records of the adult patients that you have seen in the 3 months duration.
      - We would video-record your initial hearing aid fitting appointment with three adult patients at 3 weeks before the study starts.
   2. During the hearing aid fitting appointment,
      - We will ask you to fill out a questionnaire about your gender, working experience and training background.
      - We would video-record* your initial hearing aid fitting appointment with a small sample (n=8) of your adult patients; 6 weeks, 3 months and 6 months after the start of the study.
   3. 6 weeks after the hearing aid fitting appointment,
      - We will ask you to record information regarding your patients’ hearing aid use based on your patients’ hearing aid data logging feature during your follow-up appointment (40 patients/audiologist).

ii. I-PLAN GROUP
   1. Prior to the start of the study,
      - We will ask you to anonymously record age, gender, duration and nature of hearing loss and average hearing aid use outcome from clinical records of the adult patients that you have seen in the 3 months.
      - We would video-record your initial hearing aid fitting appointment with three adult patients at 3 weeks before the study starts.
2. **45 minute I-PLAN training session**
   
   - We will invite you to attend our 45 minute I-PLAN training session which includes; i) provision of written information regarding the advantages and disadvantages of planning, ii) provision of a prompt for the making a behaviour plan and iii) creation of a written behavioural plan.

3. **During the hearing aid fitting appointment,**
   
   - We will ask you to fill out a questionnaire about your gender, working experience and training background.
   
   - We would video-record* your initial hearing aid fitting appointment with a small sample (n=8) of your adult patients; **6 weeks, 3months and 6 months after the start of the study** *Recordings are completely confidential, will be kept securely and deleted after analysis.*

   *All data will be strictly confidential and anonymous as it will not be possible to link any information to any individual audiologist or patient.

4. **6 weeks after the hearing aid fitting appointment,**
   
   - We will ask you to record information regarding your patients’ hearing aid use based on your patients’ hearing aid data logging feature during your follow-up appointment (40 patients/audiologist).

**What are the possible advantages, disadvantages and risks of taking part?**

There are no direct benefits to you from taking part in this study but, the information we get for this study could help improve the quality of care for people with hearing problems.

**What happens to the data collected?**

All the data collected from this study will be analysed and presented at scientific conferences and reported in scientific papers. The video recording will be used for analysis only and will not be included when presenting or publishing the study. The data will be anonymous, meaning that your identity will be confidential.
How is confidentiality maintained?
All information which is collected about you will be kept strictly confidential.

- The data obtained will be treated anonymously using assigned code number rather than your name.
- All the video recording will be deleted as soon as after analysis.
- All the video-recordings, electronic and paper copies of the research data will be transferred from the audiology department to the University of Manchester and will be securely stored at the University of Manchester.
- The data collected as part of this study will be accessed by the research team only. Individuals from the University of Manchester, NHS Trust or regulatory authorities may need to look at the data collected for this study to make sure the project is being carried out as planned. This may involve looking at your identifiable data and records, but all individuals involved in auditing and monitoring the study will have a strict duty of confidentiality to you as a research participant.
- All the information will be securely stored at the University of Manchester for 5 years following completion of the study, after which it will be disposed of securely.
- Personal data (email address, telephone number) will be kept for 12 months after the end of the study so that we are able to contact you about the findings of the study.

What happens if I do not want to take part or if I change my mind?
It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and the researcher would ask you to sign a consent form. If you decide to take part you are still free to withdraw at any time without giving a reason and without detriment to yourself. We will ask your permission to retain any non-identifying anonymised data obtained until the point of your withdrawal in the consent form.

Will I be paid for participating in the research?
You will not be paid for taking part in this study
What is the duration of the research?
The study will not involve any additional work or extension to the duration of a standard clinical consultation. We estimated that the total number of 40 adult new hearing aid patients required for the study could be seen over eight months (approximately 5 patients/month).

Will the outcomes of the research be published?
We will publish the results in a scientific journal and present them at scientific meetings. We can send you a short report about our findings, if you wish.

Who has reviewed the research project?
The study has been reviewed and approved by 17/NM/0405 Research Ethics Committee

What if something goes wrong?
It is highly unlikely that you will be harmed in any way. If you have a concern about any aspect of this study, you should ask to speak to the researcher who will do her best to answer your questions.

- Minor complaints
  If you have a minor complaint then you need to contact the researcher(s) in the first instance:
  
  **AFZARINI ISMAIL**
  
  E-mail: noor.ismail-postgrad.manchester.ac.uk  Tel: 0161 275 8567

  However, if you would prefer not to discuss with the researcher, please contact her supervisor:

  **DR PIERS DAWES, PhD, SENIOR LECTURER IN AUDIOLOGY**
  
  E-mail: Piers.Dawes@manchester.ac.uk  Tel: 01613061758
• **Formal Complaints:**

If you wish to make a formal complaint or if you are not satisfied with the response you have gained from the researchers in the first instance then please contact the Research Governance and Integrity Manager, Research Office, Christie Building, University of Manchester, Oxford Road, Manchester, M13 9PL, by emailing: research.complaints@manchester.ac.uk or by telephoning 0161 275 2674 or 275 2046. In the event that something does go wrong and you are harmed during the research you may have grounds for a legal action for compensation against the University of Manchester or NHS Trust, but you may have to pay your legal costs. The normal National Health Service complaints mechanisms will still be available to you.

Contact for further information

Afzarini Ismail : 0161 275 8567 or email: noor.ismail-2@postgrad.manchester.ac.uk
Appendix 10: Audiologist consent form

AUDIOLOGIST CONSENT FORM

HOW CAN AUDIOLOGISTS HELP PEOPLE GET MORE BENEFIT FROM THEIR HEARING AIDS?

If you are happy to participate please complete and sign the consent form below

1. I confirm that I have read the information sheet (version 1, dated [24/04/2017]) for the above research study and have had the opportunity to consider the information and ask questions and had these answered satisfactorily.

2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving a reason.

3. I understand that my hearing aid fitting appointments with my adult patients will be video recorded for research purposes.

4. I understand that data collected during the study may be looked at by individuals from the University of Manchester, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my data.

5. I understand that the information collected about me will be used to support other research in the future and may be shared anonymously with other researchers.

6. OPTIONAL: I would like to receive a summary of the main findings at the end of the study. I understand that the research team will keep my contact details to send the summary.

7. I agree to take part in the above project.

Name of participant: ____________________________________________

Signature: ___________________ Date: ____________

Name of person taking consent: ________________________________

Signature: ___________________ Date: ____________

Mrs Noor Afzarini Ismail, Researcher

The study has been reviewed and approved by 17/NM/0405 Research Ethics Committee
Appendix 11: Demographic form for audiologist

Evaluation of the I-PLAN to promote hearing aid use and benefit by adults with hearing impairment
IRAS ID: 228054

音频评估表

<table>
<thead>
<tr>
<th>The first two letters of your mother’s forename</th>
<th>Day of your birthday (a number between 01 and 31)</th>
<th>The first two letters of the city you were born in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Example: SA if the name is Sarah</td>
<td>*Example: 02 if your DOB was the 02/12/1950</td>
<td>*Example: MA if the city is Manchester</td>
</tr>
</tbody>
</table>

**AUDIOLOGIST’S INFORMATION**

<table>
<thead>
<tr>
<th>GENDER</th>
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</tr>
</thead>
<tbody>
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<td></td>
</tr>
<tr>
<td>PROFESSIONAL GRADE</td>
<td></td>
</tr>
<tr>
<td>YEARS OF EXPERIENCE</td>
<td></td>
</tr>
<tr>
<td>YEARS OF TRAINING</td>
<td></td>
</tr>
</tbody>
</table>
APPENDICES : CHAPTER 5

Appendix 12: Participant information sheet

A self-management tool for people with hearing difficulties to promote hearing aid use and benefit
IRAS ID: 234737

PARTICIPANT INFORMATION SHEET

A SELF-MANAGEMENT TOOL FOR PEOPLE WITH HEARING DIFFICULTIES TO PROMOTE HEARING AID USE AND BENEFIT.

You are being invited to take part in a research project to understand how we can help people with hearing difficulties more effectively. The research project is part of a PhD degree research project at the University of Manchester.

Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Who will conduct the research?

Mrs. Noor Afzarini Hasnita Ismail and Dr Piers Dawes. Manchester Centre for Audiology and Deafness (ManCAD), School of Health Sciences, Faculty of Biological, Medical and Health Sciences, Ellen Wilkinson Building, University of Manchester, Manchester, M13 9PL, United Kingdom.

This research is being organised by The University of Manchester as a research governance sponsor.

What is the aim of the research?

The aim of this research is to discover which of parts of the ‘I-PLAN’ are most helpful in promoting hearing aid use and benefit for people with hearing problems.
What is the ‘I-PLAN’?

The I-PLAN is a set of written materials that are given to new hearing aid users. The materials include information about the benefits of hearing aid use and the disadvantages of not using a hearing aid. The I-PLAN also involves making a short plan about the times and places that you will use your hearing aid. It takes about 5 minutes to read and complete the I-PLAN.

Why have I been chosen?

You have been invited to take part as you are someone who has been offered new hearing aid(s).

What would I be asked to do if I took part?

We will ask you to complete two questionnaires at; 1) Hearing aid fitting appointment and 2) six weeks after the hearing aid fitting appointment.

- **Hearing aid fitting appointment**
  - During this appointment, we will ask you to complete a questionnaire about your age, gender, experience with hearing aids and hearing in daily life. This questionnaire will take around 5 minutes.
  - You then will receive one or more parts of the I-PLAN in a white envelope provided by your audiologist to take home. Different parts of the I-PLAN are randomly allocated to each person in the study. Please read and/or complete the materials provided before you leave the clinic.
  - Additional information about your hearing aid prescription that is relevant to the research will be recorded from your audiology patient notes.

- **6 weeks after the hearing aid fitting appointment.**
  - We will ask you to complete the second questionnaire. The questionnaire asks about how much you use your hearing aid and your hearing in daily life. This questionnaire will take around 10 to 15 minutes.
• We would record information about how often you use your hearing aid(s). This information is logged automatically by your hearing aid and will be downloaded by your audiologist during your appointment.

What are the possible advantages, disadvantages and risks of taking part?
There are no direct benefits to you from taking part in this study but, the information we get for this study could help improve the quality of service for other people with hearing difficulties.

What happens to the data collected?
All the data collected from this study will be analysed and presented at scientific conferences and reported in scientific papers. The data will be anonymous, meaning that your identity will be confidential.

How is confidentiality maintained?
All information which is collected about you will be kept strictly confidential. The data obtained will be treated anonymously using assigned code number rather than your name. The data collected as part of this study will be accessed by the research team only. Individuals from the University of Manchester, NHS Trust or regulatory authorities may need to look at the data collected for this study to make sure the project is being carried out as planned. This may involve looking at your identifiable data and records, but all individuals involved in auditing and monitoring the study will have a strict duty of confidentiality to you as a research participant. All the information will be securely stored at the University of Manchester for 5 years following completion of the study, after which it will be disposed of securely.

What happens if I do not want to take part or if I change my mind?
You do not need to take part. If you decline to take part, your clinical care will be not be affected in any way.
Will I be paid for participating in the research?
You will not be paid for taking part in this study.

What is the duration of the research?
The total duration of this research will be approximately **25 minutes, over 2 visits**;
5. **During the hearing aid fitting appointment = 10 minutes** for answering the questionnaire, read and/or complete the I-PLAN materials.
6. **6 weeks after the hearing aid fitting appointment = 15 minutes** for answering the questionnaire.

Will the outcomes of the research be published?
We will publish the results in a scientific journal and present them at scientific meetings using anonymous data, meaning that your identity will be confidential. We can send you a short report about our findings, if you wish.

Who has reviewed the research project?
The study has been reviewed and approved by West of Scotland REC 5 Research Ethics Committee

What if something goes wrong?
If you have a concern about any aspect of this study, you should ask to speak to the researcher who will do her best to answer your questions.

Minor complaints
If you have a minor complaint then you need to contact the researcher(s) in the first instance:

**Mrs Noor Ismail.**  
E-mail: noor.ismail@postgrad.manchester.ac.uk  
Tel: 01612758568
However, if you would prefer not to discuss with the researcher, please contact her supervisor:

Dr Piers Dawes, PhD, Senior Lecturer in Audiology.
E-mail: Piers.Dawes@manchester.ac.uk
Tel: 01613061758

Formal Complaints:
If you wish to make a formal complaint or if you are not satisfied with the response you have gained from the researchers in the first instance then please contact the Research Governance and Integrity Manager, Research Office, Christie Building, University of Manchester, Oxford Road, Manchester, M13 9PL, by emailing: research.complaints@manchester.ac.uk or by telephoning 0161 275 2674 or 275 2046. In the event that something does go wrong and you are harmed during the research you may have grounds for a legal action for compensation against the University of Manchester or NHS Trust, but you may have to pay your legal costs. The normal National Health Service complaints mechanisms will still be available to you.

Contact for further information
Please contact;
Afzarini Ismail : 0161 275 8567 or email: noor.ismail-2@postgrad.manchester.ac.uk
Appendix 13: Participant consent form

A self-management tool for people with hearing difficulties to promote hearing aid use and benefit
IRAS ID: 234737

PARTICIPANT CONSENT FORM
A SELF-MANAGEMENT TOOL FOR PEOPLE WITH HEARING DIFFICULTIES TO PROMOTE HEARING AID USE AND BENEFIT.

If you are happy to participate please complete and sign the consent form below. Please return this form at your hearing aid fitting appointment.

Please initial box

1. I confirm that I have read the information sheet (version 2, dated [07/12/2017]) for the above research study and have had the opportunity to consider the information and ask questions and had these answered satisfactorily.

2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving a reason and without detriment to any treatment/service.

3. I understand that additional information that is relevant to the study will be recorded from my patient records and hearing aid(s). This information will include the type of hearing loss, any hearing conditions that are relevant to the research and my hearing aid(s) usage.

4. I understand that relevant sections of my medical notes and data collected during the study may be looked at by individuals from the University of Manchester, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.
5. I understand that the information collected about me will be used to support other research in the future and may be shared anonymously with other researchers. This information will include the age, gender, type of hearing loss, any hearing conditions that are relevant to the research and hearing aid(s) usage.

6. OPTIONAL: I would like to receive a summary of the main findings at the end of the study. I understand that the research team will keep my contact details to send the summary.

7. I agree to take part in the above project.

Name of participant: ____________________________

Signature: ____________________________

Date: __________________

Name of person taking consent: Mrs Afzarini Ismail, Researcher

Signature: ____________________________

Date: __________________

* 1 original consent form – for the study file
** 1 copy of consent form to participant

The study has been reviewed and approved by West of Scotland REC 5 Research Ethics Committee.
Appendix 14: Invitation letter

Dear xxx

Re: Invitation to take part in a research study “A self-management tool for people with hearing difficulties to promote hearing aid use and benefit”.

Researchers at Manchester University and I are doing research to discover whether a new tool called the ‘I-PLAN’ is effective in promoting hearing aid use and benefit for people with hearing difficulties. This study may help to improve the quality of care for people with hearing difficulties. We would like to invite you to take part in this study.

Details of the study are described in the information sheet that comes with this letter. Your help would be appreciated, but it is completely up to you if you decide to take part or not. If you have any questions, please feel free to contact either myself at Withington Community Hospital or Mrs Noor Ismail at the University of Manchester (contact details below).

If you would like to take part, please contact Mrs. Noor Ismail directly to discuss the study in more detail or complete the 1) consent form and 2) initial hearing aid fitting questionnaire that come with this letter. Please return all the complete documents at your initial hearing aid fitting appointment. Thank you very much.

Yours sincerely,

K.M. Lewis

Kathryn Lewis (Head of Audiology)
University Hospitals of South Manchester NHS Foundation Trust,
Withington Community Hospital, Nell Lane,
West Didsbury, Manchester, M20 2LR. Tel: 0161 217 3206

Mrs. Noor Ismail (Researcher)
Manchester Centre for Audiology and Deafness (ManCAD),
School of Health Sciences, Faculty of Biology, Medicine and Health
A3.08, Ellen Wilkinson Building, University of Manchester, M13 9PL
Tel: +44 161 275 8568 Email: noor.ismail-2@postgrad.manchester.ac.uk
Appendix 15: Initial hearing aid appointment questionnaire

INITIAL HEARING AID APPOINTMENT QUESTIONNAIRE
A SELF-MANAGEMENT TOOL FOR PEOPLE WITH HEARING DIFFICULTIES TO PROMOTE HEARING AID USE AND BENEFIT.

Dear Sir or Madam,

We would greatly appreciate it if you could fill in this questionnaire. This questionnaire asks about your age, gender, experience with hearing aids and hearing in daily life. The questionnaire should take less than 10 minutes. Completing this questionnaire is voluntary. If you decline to take part, your clinical care will be not be affected in any way.

If you would like to participate in this study, you will receive reading materials about hearing aid use from your audiologist to take home. Please read and/or complete the materials before you leave the clinic.

The information you provide will be treated as strictly confidential and will be used anonymously. To protect the anonymity of provided information, we will ask you to write an anonymous code in the boxes on the next page.

When you have finished the questionnaire, please put the questionnaire in the white envelope. Then give the white envelope to the audiologist at your hearing aid fitting appointment. Additional information about envelope number that you will receive from your audiologist and your hearing aid prescription will be recorded on the last page of this questionnaire.

Thank you very much for giving your time to help with this study. Your participation will help improve of the quality of service for people with hearing problems. If you have any questions about the questionnaire or the research study, please contact Mrs. Noor Ismail on 0161 2758568 at the University of Manchester.
INITIAL HEARING AID APPOINTMENT QUESTIONNAIRE

A SELF-MANAGEMENT TOOL FOR PEOPLE WITH HEARING DIFFICULTIES TO PROMOTE HEARING AID USE AND BENEFIT.

Please write a code in the boxes below. We use this code instead of your name to make sure that your responses to the questionnaire are anonymous.

<table>
<thead>
<tr>
<th>The first two letters of your mother’s first name. *Example: SA if the name is Sarah</th>
<th>Day of your birthday (a number between 01 and 31) *Example: 02 if your date of birth was the 02/12/1950)</th>
<th>The first letter of your surname. *Example: S if the name is David Smith.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please answer all the questions.

1. Age: _________________ years

2. Gender: _________________

3. Have you had a hearing aid before?  
   Yes □ (Please go to question 4)  
   No □ (Please skip the question 4)

4. Do you currently wear a hearing aid?  
   Yes □  
   No □

5. Does a hearing problem cause you to feel embarrassed when meeting new people?  
   Yes □  
   Sometimes □  
   No □

6. Does a hearing problem cause you to feel frustrated when talking to members of your family?  
   Yes □  
   Sometimes □  
   No □

7. Do you have difficulty hearing when someone speaks in a whisper?  
   Yes □  
   Sometimes □  
   No □
Do you feel handicapped by a hearing problem?

<table>
<thead>
<tr>
<th></th>
<th>Yes ☐</th>
<th>Sometimes ☐</th>
<th>No ☐</th>
</tr>
</thead>
</table>

Does a hearing problem cause you difficulty when visiting friends, relatives, or neighbours?

<table>
<thead>
<tr>
<th></th>
<th>Yes ☐</th>
<th>Sometimes ☐</th>
<th>No ☐</th>
</tr>
</thead>
</table>

Does a hearing problem cause you to attend movies or theatre or religious services less often than you would like?

<table>
<thead>
<tr>
<th></th>
<th>Yes ☐</th>
<th>Sometimes ☐</th>
<th>No ☐</th>
</tr>
</thead>
</table>

Does a hearing problem cause you to have arguments with family members?

<table>
<thead>
<tr>
<th></th>
<th>Yes ☐</th>
<th>Sometimes ☐</th>
<th>No ☐</th>
</tr>
</thead>
</table>

Does a hearing problem cause you difficulty when listening to TV or radio?

<table>
<thead>
<tr>
<th></th>
<th>Yes ☐</th>
<th>Sometimes ☐</th>
<th>No ☐</th>
</tr>
</thead>
</table>

Do you feel that any difficulty with your hearing limits or hampers your personal or social life?

<table>
<thead>
<tr>
<th></th>
<th>Yes ☐</th>
<th>Sometimes ☐</th>
<th>No ☐</th>
</tr>
</thead>
</table>

Does a hearing problem cause you difficulty when in a restaurant with relatives or friends?

<table>
<thead>
<tr>
<th></th>
<th>Yes ☐</th>
<th>Sometimes ☐</th>
<th>No ☐</th>
</tr>
</thead>
</table>

THANK YOU FOR YOUR TIME.

-------------------------------------------------------------------------------------------------------------------------

Envelope number: _____________________________

Hearing aid prescription:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>250 Hz</th>
<th>500 Hz</th>
<th>1000 Hz</th>
<th>2000 Hz</th>
<th>4000 Hz</th>
<th>8000Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right ear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left ear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 16: Follow-up hearing aid appointment questionnaire

FOLLOW-UP HEARING AID APPOINTMENT QUESTIONNAIRE
A SELF-MANAGEMENT TOOL FOR PEOPLE WITH HEARING DIFFICULTIES TO PROMOTE HEARING AID USE AND BENEFIT

Dear Sir or Madam,

We would like to invite you to complete a hearing aid questionnaire. This questionnaire is about how much you use your hearing aid use and your hearing in daily life. The questionnaire will take around 10-15 minutes.

Completing this questionnaire is voluntary. If you decline to take part, your clinical care will not be affected in any way.

The information you provide will be treated as strictly confidential and will be used anonymously. To protect the anonymity of provided information, we will ask you to write an anonymous code in the boxes on the next page.

Please complete the questionnaire as complete as possible. When you are finished completed the questionnaire, please place the questionnaire in the white envelope provided. Then please give the white envelope to Mrs. Noor Ismail at your hearing aid follow-up appointment or return it in the postage-paid return addressed envelope (if applicable).

Thank you very much for your cooperation.

The University of Manchester
Please write a code in the boxes below. We use this code instead of your name to make sure that your responses to the questionnaire are anonymous.

<table>
<thead>
<tr>
<th>The first two letters of your mother’s first name. *Example: SA if the name is Sarah</th>
<th>Day of your birthday (a number between 01 and 31) *Example: 02 if your date of birth was the 02/12/1950)</th>
<th>The first letter of your surname. *Example: S if the name is David Smith.</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Please answer all the questions by selecting the most appropriate option.

1. Have you read the information on the card in the white envelope you were given at the hearing aid fitting appointment?
   - Yes ☐
   - No ☐

2. What did you do with the materials in the white envelope provided to you at the hearing aid fitting appointment?
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

3. Think about how much you used your present hearing aid(s) over the past two weeks. On an average day, how many hours did you use the aid(s)?
   (a number between 0 and 24): ___________ (hour(s) a day)

4. Think about the situation where you most wanted to hear better, before you got your present hearing aid(s). Over the past two weeks, how much has the hearing aid helped in that situation?
   - helped not at all ☐
   - helped slightly ☐
   - helped moderately ☐
   - helped quite a lot ☐
   - helped very much ☐

5. In a typical situation where you have hearing difficulty, what proportion of the time do you wear your hearing aids?
   - never/not at all ☐
   - about ¼ of the time ☐
   - about ½ of the time ☐
   - About ¾ of the time ☐
   - all the time ☐
6. Think again about the situation where you most wanted to hear better. When you use your present hearing aid(s), how much difficulty do you STILL have in that situation?

<table>
<thead>
<tr>
<th></th>
<th>very much difficulty</th>
<th>quite a lot of difficulty</th>
<th>moderate difficulty</th>
<th>slight difficulty</th>
<th>no difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

7. Considering everything, do you think your present hearing aid(s) is worth the trouble?

<table>
<thead>
<tr>
<th></th>
<th>not at all worth it</th>
<th>slightly worth it</th>
<th>moderately worth it</th>
<th>quite a lot worth it</th>
<th>very much worth it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

8. Over the past two weeks, with your present hearing aid(s), how much have your hearing difficulties affected the things you can do?

<table>
<thead>
<tr>
<th></th>
<th>affected very much</th>
<th>affected quite a lot</th>
<th>affected moderately</th>
<th>affected slightly</th>
<th>affected not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

9. Over the past two weeks, with your present hearing aid(s), how much do you think other people were bothered by your hearing difficulties?

<table>
<thead>
<tr>
<th></th>
<th>bothered very much</th>
<th>bothered quite a lot</th>
<th>bothered moderately</th>
<th>bothered slightly</th>
<th>bothered not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

10. Considering everything, how much has your present hearing aid(s) changed your enjoyment of life?

<table>
<thead>
<tr>
<th></th>
<th>Worse</th>
<th>No change</th>
<th>slightly better</th>
<th>quite a lot better</th>
<th>very much better</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

11. Does a hearing problem cause you to feel embarrassed when meeting new people?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>Sometimes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

12. Does a hearing problem cause you to feel frustrated when talking to members of your family?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>Sometimes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

13. Do you have difficulty hearing when someone speaks in a whisper?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>Sometimes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
14. Do you feel handicapped by a hearing problem?

<table>
<thead>
<tr>
<th></th>
<th>Yes □</th>
<th>Sometimes □</th>
<th>No □</th>
</tr>
</thead>
</table>

15. Does a hearing problem cause you difficulty when visiting friends, relatives, or neighbours?

<table>
<thead>
<tr>
<th></th>
<th>Yes □</th>
<th>Sometimes □</th>
<th>No □</th>
</tr>
</thead>
</table>

16. Does a hearing problem cause you to attend movies or theatre or religious services less often than you would like?

<table>
<thead>
<tr>
<th></th>
<th>Yes □</th>
<th>Sometimes □</th>
<th>No □</th>
</tr>
</thead>
</table>

17. Does a hearing problem cause you to have arguments with family members?

<table>
<thead>
<tr>
<th></th>
<th>Yes □</th>
<th>Sometimes □</th>
<th>No □</th>
</tr>
</thead>
</table>

18. Does a hearing problem cause you difficulty when listening to TV or radio?

<table>
<thead>
<tr>
<th></th>
<th>Yes □</th>
<th>Sometimes □</th>
<th>No □</th>
</tr>
</thead>
</table>

19. Do you feel that any difficulty with your hearing limits or hampers your personal or social life?

<table>
<thead>
<tr>
<th></th>
<th>Yes □</th>
<th>Sometimes □</th>
<th>No □</th>
</tr>
</thead>
</table>

20. Does a hearing problem cause you difficulty when in a restaurant with relatives or friends?

<table>
<thead>
<tr>
<th></th>
<th>Yes □</th>
<th>Sometimes □</th>
<th>No □</th>
</tr>
</thead>
</table>

21. Using hearing aid(s) is something I do automatically

|   | Strongly disagree □ | Disagree □ | Disagree somewhat □ | Undecided □ | Agree somewhat □ | Agree □ | Strongly agree □ |

22. Using hearing aid(s) is something I do without thinking

|   | Strongly disagree □ | Disagree □ | Disagree somewhat □ | Undecided □ | Agree somewhat □ | Agree □ | Strongly agree □ |

23. Using hearing aid(s) is something I do without having to consciously remember to use them

|   | Strongly disagree □ | Disagree □ | Disagree somewhat □ | Undecided □ | Agree somewhat □ | Agree □ | Strongly agree □ |

24. Using hearing aid(s) is something I start doing before I realize I’m doing it

<p>|   | Strongly disagree □ | Disagree □ | Disagree somewhat □ | Undecided □ | Agree somewhat □ | Agree □ | Strongly agree □ |</p>
<table>
<thead>
<tr>
<th></th>
<th>During the last 6 weeks, I often had the intention to use my hearing aid(s) on my mind</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Disagree somewhat</th>
<th>Undecided</th>
<th>Agree somewhat</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td></td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td></td>
<td>During the last 6 weeks, I have always been aware of using my hearing aid(s)</td>
<td>Strongly disagree</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td></td>
<td>During the last 6 weeks, I consistently checked myself to see if I was using my hearing aid(s) often enough</td>
<td>Strongly disagree</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td></td>
<td>During the last 6 weeks, I took care to use my hearing aid</td>
<td>Strongly disagree</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td></td>
<td>During the last 6 weeks, I tried hard to use my hearing aid</td>
<td>Strongly disagree</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td></td>
<td>During the last 6 weeks, I did my best to act consistently with what my audiologist told me regarding hearing aid use</td>
<td>Strongly disagree</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

THANK YOU FOR YOUR TIME.
Appendix 17: I-PLAN written materials

**Hearing aid use will improve...**

- your ability to hear others
- your social interactions
- the lives of those around you by making it easier for them to communicate with you

**Not using a hearing aid will...**

- reduce your ability to hear your family and friends
- lead you to withdraw from social activities
- cause stress and increase burden on those around you by making it harder for them to communicate with you
My hearing aid reminder

Please use your hearing aid box as a reminder to wear your hearing aid(s).

For example, you could put your hearing aid box next to the bathroom mirror last thing at night to remind you to wear your hearing aid(s) in the morning.

My hearing aid(s)

Please plan where and when to wear your hearing aid(s).

You can choose any place and time, but please write your plan in as much detail as possible. Please write your plan in the space provided on the next page.
Example:

- ‘When I have finished brushing my teeth in the morning, then I will wear my hearing aid(s).’

Please write your plan in the space provided, following the format in the example.

When I .................................................................................................................................
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