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Rachel Gomez & Melanie Ferguson

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## Improving self-efficacy for hearing aid self-management: the early delivery of a multimedia-based education programme in first-time hearing aid users

Rachel Gomez<sup>a,b,c</sup>  and Melanie Ferguson<sup>a,b,d,e</sup> 

<sup>a</sup>Nottingham Audiology Services, Nottingham University Hospitals NHS Trust, Nottingham, UK; <sup>b</sup>NIHR Nottingham Biomedical Research Centre, Nottingham University Hospitals NHS Trust, Nottingham, UK; <sup>c</sup>Life and Health Sciences, Aston University, Birmingham, UK; <sup>d</sup>Hearing Sciences, School of Medicine, University of Nottingham, Nottingham, UK; <sup>e</sup>National Acoustic Laboratories, Sydney, Australia

### ABSTRACT

**Objectives:** This study examined the effect of a multimedia educational programme for first-time hearing aid users (C2Hear reusable learning objects, RLOs), delivered at the hearing assessment on (1) self-efficacy for hearing aids (primary outcome), and (2) readiness for hearing rehabilitation and hearing aid knowledge (secondary outcomes).

**Design:** A single-centre, prospective, pre-post, randomised controlled trial with two arms. The intervention group ( $n = 24$ ) received RLOs, and the waitlist control group ( $n = 23$ ) received a printed booklet on hearing aids. Outcomes were measured at the hearing assessment and hearing aid fitting appointments.

**Study sample:** Fifty-six adult first-time hearing aid users attending a publicly funded audiology service.

**Results:** The RLO group showed significantly greater improvement in self-efficacy and knowledge of hearing aids than the control group. A borderline effect of readiness for hearing rehabilitation was also found. Potential links between hearing aid self-efficacy and knowledge were identified.

**Conclusions:** Early delivery of the RLOs results in greater hearing aid self-efficacy and knowledge at the hearing aid fitting appointment, with indications that RLOs increase readiness for hearing rehabilitation. As knowledge, self-efficacy and readiness are cornerstones of self-management, the C2Hear RLOs can prime first-time hearing aid users to better self-manage their hearing aids before they receive them.

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Hearing self-management; self-efficacy; knowledge; ehealth; readiness; hearing aids; hearing loss

### Introduction

Hearing loss is most commonly managed through the fitting of hearing aids, which have been shown to significantly improve listening ability, hearing-related and general health-related quality of life (Ferguson et al. 2017). Hearing aids have also been reported to increase cognition (Dawes et al. 2015), reduce depression (Castiglione et al. 2016) and social isolation (Weinstein, Sirow, and Moser 2016). Despite the benefits of using hearing aids, maladaptive health behaviours still occur. For example, hearing aid non-use in adults is estimated to range between 3% and 24% (Lupsakko, Kautiainen, and Sulkava 2005; Bertoli et al. 2009), with more recent studies reporting between 10% (Aazh et al. 2015) and 15.5% (Solheim and Hickson 2017).

Self-management focuses on behaviours related to a specific health condition. There is evidence from other chronic, long-term health conditions (LTCs), such as diabetes and asthma, that those who play an active role in the day-to-day self-management of their condition are more likely to adopt better health behaviours that lead to better patient outcomes (Mosen et al. 2007). A meta-review has identified five distinct components of self-management (Taylor et al. 2014), which includes provision of education about the LTC, strategies to support adherence to treatments, practical support tailored to the LTC, psychological strategies to support adjustment to the LTC and social support.

Within the audiology literature there is relatively little on self-management of hearing loss. Recently, Convery et al. (2018a) conducted a factor analysis that revealed three cornerstones of successful hearing self-management, (i) knowledge; individuals have knowledge regarding hearing loss and management options, (ii) actions; individuals adopt and sustain behaviours adherent with the management option(s), (e.g. hearing aid use), and (iii) psychosocial behaviours; whereby individuals adopt and sustain positive mental well-being and social behaviours linked to positive coping. Some variables were predictive of improved self-management, such as gender and years of previous hearing healthcare experience. These are fixed factors and cannot be enabled by the audiologist. However, two factors (knowledge and self-efficacy) were both directly associated with improved self-management and have the potential to be modified by both audiologists and patients, leading to action (i.e. self-management behaviours). Across all domains of self-management, experience of hearing healthcare was the most common predictor of hearing self-management, featuring in the overall, actions and knowledge domains. This implies that the knowledge gained through experience is central in equipping individuals to self-manage. Furthermore, increased hearing aid self-efficacy was associated with increased action.

Self-efficacy for hearing aids refers to the confidence a patient has in their ability to use, care for, and manage all that hearing aid ownership encompasses. According to Bandura (1977), self-efficacy is modifiable and is influenced by a hierarchy of

sources. First, and most importantly, by the individual performing the task (mastery experience); second by observing someone similar performing the task (vicarious experience); third by receiving feedback on how an individual performed a task (verbal persuasion); and lastly the individual's physical and affective state. Previous studies within audiology identified that increased self-efficacy for hearing aids is associated with a greater likelihood of help-seeking and increased hearing aid adoption, increased hearing aid satisfaction and successful hearing aid use (Hickson et al. 2014; Meyer, Hickson, and Fletcher 2014; Meyer, Hickson, Lovelock, et al. 2014; Ferguson et al. 2016b). Thus, self-efficacy for hearing aids is a crucial factor across the rehabilitation pathway.

A Cochrane review of self-management to improve the use of hearing aids (Barker et al. 2016) identified several remote, home-delivered interventions that targeted self-management skills. These included interactive multimedia videos or reusable learning objects (RLOs) delivered online or via DVD (Ferguson et al. 2016a), videotapes (Kramer et al. 2005), internet delivered modules with audiologist support (Thoren et al. 2011), and later with peer support (Thoren et al. 2014). Compared with standard care, the interventions increased adherence of hearing aids, practical handling skills, knowledge of hearing aids and communication (Ferguson et al. 2016a), and reduced hearing-related participation restrictions (Kramer et al. 2005; Thoren et al. 2011, 2014).

In audiology clinics, hearing aid information and skills are primarily delivered verbally, and may be supported by manufacturers' hearing aid guides and other written instructional materials. Basic hearing aid skills, such as insertion, are consistently high in both new and experienced hearing aid owners (Desjardins and Doherty 2009; Doherty and Desjardins 2012; Ferguson et al. 2016a; Saunders et al. 2018). Yet skills such as cleaning, programme manipulation, telephone use and expectations of hearing aids are consistently poorer (Ferguson et al. 2016a; Saunders et al. 2018). This mismatch in skill level may reflect audiologists' prioritisation of immediate skills over long-term maintenance skills or the setting of realistic expectations (Ferguson et al. 2015). This is consistent with the dominance of technical discussion over a patient-centred approach (Grenness et al. 2015), and compared to patients, audiologists under-emphasise the value of advanced hearing aid skills, such as programme manipulation (Bennett et al. 2018).

This mismatch is also reflected in patients' views of hearing rehabilitation. Qualitative research reveals that existing hearing aid users have a desire for additional information (Laplante-Levesque et al. 2013), and new hearing aid owners report they receive insufficient education prior to and after hearing aid fitting (Kelly et al. 2013). By supplying high-quality information audiologists can stem this mismatch, empowering patients to self-manage and take an active role in shared decision-making (Laplante-Levesque, Hickson, and Worrall 2010).

A large randomised controlled trial (RCT) demonstrated that the RLOs, now known as C2Hear, significantly increased practical and psychosocial knowledge of hearing aids and communication, practical hearing aid handling skills, and increased hearing aid use in those who did not wear them all the time, compared to a passive waitlist control group at six weeks post-hearing aid fitting (Ferguson et al. 2016a). Re-use of the RLOs by hearing aid users was high with over half watching the RLOs two or more times, suggesting self-management of hearing aids and hearing loss. The C2Hear RLOs contain chunks of interactive multimedia education on the practical and psychosocial components of hearing aid ownership, displayed in a visual

format using videos, images, self-assessment and patient testimonials, underpinned by pedagogical learning principles (Ferguson et al. 2016a). The RLOs were co-produced using a participatory approach involving hearing aid users and hearing healthcare professionals to ensure they were aligned to the endusers needs (Ferguson et al. 2018).

A process evaluation of the outcomes from the C2Hear RCT indicates that self-efficacy for hearing aids, based on a single question from the Hearing Healthcare Intervention Readiness (Weinstein 2012), is also modified by the RLOs (Ferguson 2019). A potential explanation is that the RLOs targeted hearing aid users' vicarious experience (Bandura 1977; Smith and West 2006), thus increasing their self-efficacy for hearing aids. In addition, the short chunks and self-initiated format of the RLOs allows individuals to select their own learning and practice at their own pace, targeting mastery experience (Smith and West 2006). Given these are the two strongest sources of self-efficacy (Bandura 1977), we propose that increasing knowledge and self-efficacy of hearing aids in turn leads to action. Thus, the C2Hear RLO intervention supports the three modifiable constructs of hearing self-management described by Convery et al. (2018a); knowledge, self-efficacy and readiness (action) for hearing rehabilitation. Our previous research showed that C2Hear RLOs improve knowledge but we have not examined self-efficacy for hearing aids fully, nor readiness to take action.

Currently, there is no evidence on any optimum window for enabling hearing self-management interventions. Within audiology, most self-management interventions, including the C2Hear RLOs, are introduced at hearing aid fitting (Barker et al. 2016). This is in contrast to other chronic health conditions, such as diabetes, where clinical guidance mandates self-management is integral from diagnosis onwards (NICE 2015). A study on the use of motivational engagement tools showed significant changes in hearing health behaviours, including hearing aid self-efficacy and readiness for rehabilitation, can be influenced between hearing assessment and fitting appointment (Ferguson et al. 2016b). Therefore, there is value in earlier delivery of the RLOs at the hearing assessment appointment. This can prime the patient with knowledge of hearing loss, hearing aids and communication to support shared discussions between the patient and audiologist, as well as shared decision-making, at hearing aid fitting (Laplante-Levesque, Hickson, and Worrall 2010).

The primary aim of this study was to evaluate the effects of early delivery of the C2Hear RLOs on hearing aid self-efficacy, in comparison to an active control using a detailed printed booklet on hearing loss, hearing aids and communication. Secondary aims were to compare (i) readiness for hearing rehabilitation and (ii) hearing-related knowledge in those receiving RLOs versus standard audiology care.

## Methods

The study is reported in accordance with the CONSORT statement (Schulz, Altman, and Moher 2010).

## Participants

Adult first-time hearing aid users were referred by their family doctor for hearing assessment at the Nottingham Audiology Services (NAS), Nottingham University Hospitals NHS Trust between November and December 2016. Of the 279 patients who attended assessment appointments during that period,

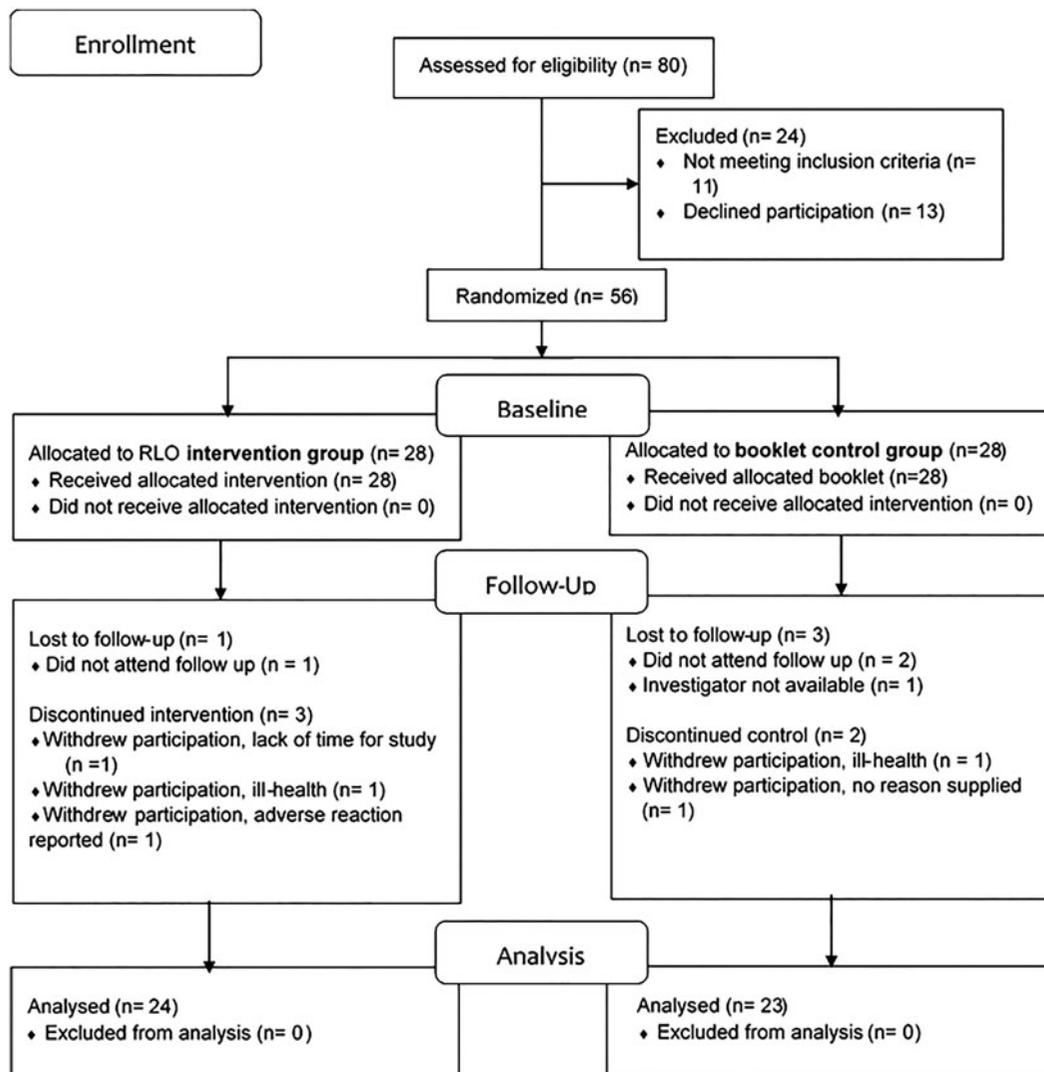


Figure 1. CONSORT flow chart.

80 patients (28.7%) discussed their eligibility for the study with the primary author (RG). Inclusion criteria were (1) adults aged  $\geq 18$  years, (2) first-time hearing aid users (defined as no hearing aid use in the last two years) and (3) English as their spoken language or good understanding of English. Exclusion criteria were those unable to complete study questionnaires due to age-related problems (e.g. cognitive decline). The inclusion criteria were met by 56 patients who were then randomised into groups (Figure 1).

### Study design and procedures

The study was a prospective, single-centre RCT with two arms. The intervention group was given access to RLOs alongside standard clinical care. The active waitlist control group received standard clinical care and the hearing aid instruction booklet that is offered routinely to all new hearing aid users. The intervention group did not receive a copy of the hearing aid instruction booklet until the end of the study. Study information was mailed to all patients due to attend for hearing assessment during the study period prior to their appointment. Clinic audiologists conducted the hearing assessment as per clinic protocol, and on completion offered all patients the opportunity to meet with the study audiologist (RG) to discuss the study. When

eligibility and interest were confirmed, written informed consent was obtained. Checks of eligibility and recruitment ceased once 56 participants had consented to take part in the study.

Randomisation was carried out using sealed and sequentially numbered envelopes, which had been randomly arranged (Higgins and Green 2011) by an individual who was independent to participant recruitment. Sequentially arranged envelopes were then opened by RG in the order of consent. The study audiologist was not blinded to intervention allocation as it was essential that instructions on access and use of the RLOs and booklet, and completion of the diary, were clearly explained.

Participants attended the evaluation session immediately prior to the hearing aid fitting, approximately 4–6 weeks post-hearing assessment. Outcomes were obtained by RG. At the end of the evaluation session, participants in the booklet group were offered the RLOs in whatever format they preferred, although no further evaluation was conducted.

The primary outcome measure was the Measure of Audiologic Rehabilitation Self-efficacy for Hearing Aids (MARS-HA; (West and Smith 2007). An *a priori* power calculation, based on the standard deviation of the MARS-HA in first-time hearing aid users (Ferguson et al. 2016a) and detection of a 10% change in self-efficacy at a power of 80% and type II error rate of 5%, indicated that 25 participants were required for each

group. To account for 10% attrition, a total sample of 56 participants was planned.

The study was approved by the Derby Research Ethics Committee, the Health Research Authority, Aston University and Nottingham University Hospitals NHS Trust Research & Development department.

## Interventions

### RLOs

The RLOs were originally developed with 32 hearing aid users and 33 audiologists, and evaluated in a large RCT (Ferguson et al. 2016a). They were subsequently modified based on patient feedback and are freely available online via YouTube ([www.youtube.com/C2HearOnline](http://www.youtube.com/C2HearOnline)) and more recently on a dedicated stand-alone website ([C2hearonline.com](http://C2hearonline.com)). RLO titles were (i) getting to know hearing aids, (ii) insertion of hearing aids, (iii) what to expect from hearing aids, (iv) acclimatisation, (v) communication tactics, (vi) troubleshooting, (vii) using the telephone and other devices, (viii) other assistive devices and (ix) hearing aid re-tubing (custom coupling only). The RLOs contained information relating to both practical and psychosocial aspects of rehabilitation. They included video clips, illustrations, animations, photos, sounds, all subtitled and developed using pedagogical principles (Windle et al. 2011). The content of RLOs was specific to the type of hearing aid coupling (i.e. open fit,  $n = 8$ ; custom,  $n = 9$ ), alongside an introductory RLO and user testimonials ( $n = 5$ ). Each RLO finished with a short, optional interactive quiz with 2–3 multiple-choice questions covering content from the RLO, with feedback on the responses. Total duration was 46 min for custom earmould RLOs and 42 min and 25 s for open fit RLOs.

The RLO intervention group was asked to express their preference for either (1) an interactive DVD for PC or TV, or (2) interactive RLOs delivered via the internet. Participants were asked to watch all RLOs specific to their hearing aid coupling. To prevent the risk of information overload (Poost-Foroosh et al. 2011), participants in the intervention group were advised not to watch more than 2–3 RLOs at any one time, the same as for the previous RCT (Ferguson et al. 2016a). Appropriate instructions were given on how to use the RLOs.

### Booklet

Participants in the active control Booklet group received a 32-page A5 colour booklet, designed and written by NAS staff, which is given to all prospective hearing aid users as standard care. An online copy of the booklet is available online (DOI link: <https://bit.ly/2EoHltz>). Booklet topics include (i) introduction to hearing aids, (ii) insertion and hearing aid care, (iii) expectations and adapting to hearing aids, (iv) troubleshooting, (v) communication tactics and (vi) assistive listening devices. The same booklet is used irrespective of hearing aid style, with the user identifying the relevant section for custom earmould versus open fit. All content is conveyed passively, via text and supporting pictures.

The Booklet group was advised to read no more than 2–3 topics at any one time, in keeping with the advised amount for the RLO group.

## Audiological measures

Pure-tone air-conduction thresholds at octave frequencies (0.25–8 kHz) were measured for each ear alongside bone-conduction, as required (0.5–4 kHz), in accordance with the UK national recommended procedure (The British Society of Audiology 2011), using Otometrics Aurical audiometer (Otometrics UK & Ireland, Brackley, UK) with TDH39 headphones and B71 bone conductor.

## Outcome measures

### Self-report questionnaires

All questionnaires were completed at baseline (assessment) and evaluation (immediately prior to hearing aid fitting, typically 4–6 weeks later), unless otherwise specified.

The MARS-HA (West and Smith 2007) assesses hearing aid self-efficacy across four subscales; basic (7 items) and advanced hearing aid handling (5 items), adjustment to hearing aids (3 items) and aided listening (9 items). Each item is scored using an 11-point percentage scale (0–100%) with a mean score across all items giving a global self-efficacy score.

Secondary outcome measures included The *Ida Motivational Line tools* (Ida Institute 2013), which assesses readiness for hearing rehabilitation (Line question 1; *How important is it for you to improve your hearing right now?*) and self-efficacy for hearing aids (Line question 2; *How much do you believe in your ability to use hearing aids?*). The tools use an unmarked visual analogue scale between 0 (not important/lowest belief) to 10 (greatest importance/highest belief). Participants were asked to mark their thoughts on the scale and record the number indicated.

An additional secondary outcome measure was the *Hearing and Communication Knowledge* questionnaire (HACK) (Ferguson et al. 2015). This is a 20-item open-ended questionnaire targeting free recall of practical ( $n = 12$ ) and psychosocial ( $n = 8$ ) factors relating to hearing aid use and communication. A pre-defined marking scheme, identical to Ferguson et al. (2016a) was used to allocate one point for every correct response, with the maximum number of responses capped based on the scoring from the RCT, resulting in a percentage correct score for each question. Composite scores were then computed for the practical (max score = 32 points) and psychosocial (max score = 22 points) subscales, which were summed to give an overall global score for hearing and communication knowledge. In contrast to the MARS-HA (West and Smith 2007) that asks individuals to predict their confidence with hearing aids, the HACK questionnaire assesses factual knowledge relating to hearing aids. Therefore, the HACK was completed at the evaluation session only, as it was anticipated that many participants would have significant difficulties answering these questions at the baseline session, because they were likely to have had no or limited exposure to hearing aids.

Further demographic outcomes included the Montreal Cognitive Assessment version 7.1 (MoCA) (Nazreddine et al. 2005), a cognitive screening tool using an 8 domain, 13-item questionnaire. The MoCA was delivered at baseline only, with a maximum score of 30 correct responses. Scores were used to determine participant characteristics. PC literacy was also assessed using a validated three-point scale of “Never used”, “Beginner” and “Competent” (Henshaw et al. 2012). Finally, highest education level obtained was recorded using a self-report three-point scale of “GCE/GCSE” (Secondary education),

“A Level/Diploma or equivalent” (post-Secondary) and “Degree level or above”.

### Participant feedback

The RLO group received a video diary, identical to that used in Ferguson et al. (2016a). The Booklet group received a diary based on identical design but with headings amended to reflect booklet content. For both groups, participants were asked to record the date and number of times the materials (RLOs or booklet) were viewed or read. This was collected at evaluation.

The Booklet group was asked a two-item disclaimer (“have watched/have not watched RLOs”) at evaluation to establish whether the participant had or had not accessed the freely available RLOs during the study.

### Analysis of outcome measures

The distribution of scores for each outcome was visually and statistically inspected for normality using Kolmogorov-Smirnov test ( $p \leq .05$ ). The mean and standard deviations of the outcome measures were used to determine (i) within-participant change scores for outcomes measured at baseline and evaluation and (ii) between-group scores for outcomes measured at evaluation only. Planned statistical analysis included independent  $t$ -test or Mann Whitney test. Significant results were factored into an analysis of co-variance (ANCOVA), using the baseline MARS-HA subscales and Ida line scores as covariates, alongside age, sex, better-ear average (BEA) hearing threshold (across octave frequencies 0.25–4 kHz), PC literacy and MoCA score as fixed factors to give baseline adjusted mean difference scores. Effect sizes were based on either on Cohen’s  $d$  (Cohen 1988) with small (0.2), moderate (0.5) and large (0.8) for  $t$ -tests, or small (0.0099), moderate (0.0588) and large (0.1379) for ANCOVA analysis. Significance was set at  $p \leq .05$  for all. Multiple testing was corrected by using Bonferroni correction.

## Results

### Participants

Demographic and clinical characteristics for the groups are shown in Table 1. There were no significant group differences for age, BEA, the number of bilateral hearing aid fittings, internet competency and the MoCA score. There was a significant effect of gender between the two groups ( $p < .05$ ), with more males randomly assigned to the RLO than Booklet group at baseline (82%, 46%, respectively). There was no significant difference between those attending only baseline and those attending both visits for age, gender, BEA, Internet competency and the MoCA score ( $p > .05$ ).

### Access, take-up and adherence

Out of 279 patients who attended their assessment during the study period, 80 patients (28.7%) discussed eligibility (RG), with 56 patients (70%) meeting eligibility criteria and consenting to participate, as shown in Figure 1. Reasons for exclusion were declined participation,  $n = 13$  (16.3%), hearing aid use in the last 2 years,  $n = 6$  (7.5%), not eligible for hearing aid fitting,  $n = 3$  (3.8%) and diagnosed with memory impairment,  $n = 2$  (2.5%).

**Table 1.** Demographic and clinical characteristics of the intervention (RLO) and control (Booklet) groups at baseline (hearing assessment) and follow-up (immediately prior to hearing aid fitting).

	Baseline		Evaluation	
	RLO ( $n = 28$ )	Booklet ( $n = 28$ )	RLO ( $n = 24$ )	Booklet ( $n = 23$ )
Mean age (years)	71.2 (7.1)	69.8 (9.8)	71.4 (5.8)	69.7 (9.6)
Age range (years)	58–83	50–88	58–83	50–84
Gender, male (%)	24 (82)	13 (46)	23 (96)	10 (43)
Mean BEA hearing threshold <sub>0.25–4 kHz</sub> (dB HL) (SD)	29.7 (7.0)	30.0 (9.9)	30.6 (7.1)	30.6 (9.4)
No. at education level (%)				
GCE/GCSE	12 (43)	12 (43)	10 (42)	8 (35)
A Level/Diploma or equivalent	5 (18)	13 (46)	5 (21)	12 (52)
Degree level or above	10 (36)	3 (11)	8 (33)	3 (13)
No. at occupational status (%)				
Employed	2 (7)	7 (25)	2 (8)	5 (22)
Retired	26 (93)	21 (75)	22 (92)	18 (78)
No. at PC literacy (%)				
Never used	1 (4)	5 (18)	1 (4)	4 (17)
Beginner	4 (14)	4 (14)	3 (13)	2 (7)
Competent	22 (79)	19 (68)	20 (83)	17 (74)
Not known	1 (4)	0 (0)	0 (0)	0 (0)
No. of bilateral hearing aid fittings (%)	28 (50)	28 (50)	9 (38)	9 (39)
Mean time between baseline and evaluation (days)	n/a	n/a	35.5 (8.6)	30.6 (11.5)
Mean MoCA score (SD)	25.5 (2.8)	25.5 (3.1)	25.2 (3.3)	25.7 (3.3)

MoCA: Montreal Cognitive Assessment. Numbers in brackets are SD or percentages.

A total of 47 participants (84%) attended both visits of the study (RLO = 24; Booklet = 23). One participant in the RLO group was lost to follow-up (3.6%) and three participants in the booklet group were lost to follow-up (10.7%) (Figure 1). Two participants in the Booklet group attended evaluation but withdrew prior to completing outcome measures (7.1%), compared with three in the RLO group (10.7%). One of the withdrawals in the RLO group was the result of an adverse reaction, stemming from recognition of a member of the public who volunteered in an RLO.

Of the RLO viewing options, DVD for PC was the most commonly used (37.5%), followed by equal numbers watching RLOs online (29.2%) and DVD for TV (29.2%). Data on RLO viewing were missing for one participant.

Self-report diaries were returned by all 24 (100%) of the RLO group at the evaluation session. Of those returning the diary, adherence to the RLOs was high, with 20 participants (83.3%) watching all RLOs at least once (Table 2). Of those who did not watch all the RLOs, one was able to watch two RLOs before their DVD player stopped working, one watched six of the RLOs but stopped due to lack of time, and the final participant failed to watch any RLOs due to lack of time. The average number of views per participant was 12.9 (SD = 12.4, maximum = 58). On average, over two-fifths (42.9%) of participants watched the RLOs at least twice, and a quarter (28.4%) watched the RLOs three or more times. Re-use of the RLOs was high across most topics, with some watching up to 13 times (Table 2).

Booklet diaries were returned by 19 (79%) of the group who attended the evaluation session (Table 2). Adherence to the booklet was moderately high, with 14 participants (73.6%) reading the entire booklet at least once. Of those who did not read the entire booklet, one read four (out of eight) sections and another read five of the sections, although reasons for non-completion are unknown. Two participants (10.5%) failed to read any section of the booklet due to lack of time. The average number of reads per participant was 1.5 (SD = 0.82, maximum

= 5). On average, almost half (47.4%) of the participants read the booklet at least twice and 13.8% read the booklet three or more times. Re-use of the booklet was high across topics, although the maximum number of reads was consistently lower for all sections (range = 3–5) compared with all RLOs (range = 4–13). Of note, all 23 (100%) participants from the Booklet group who attended the evaluation reported they did not view the freely available RLOs.

### Outcome measures

Table 3 shows the outcome measures at baseline and evaluation for each group. An ANCOVA for the primary outcome measure (MARS-HA Global), showed the RLO group had a statistically significant improvement in self-efficacy for hearing aids compared to the Booklet group, with a large effect size [ $F(1, 44) = 16.72, p = <.001, \eta^2 = 0.275$ ]. The baseline adjusted mean difference between intervention and control was 21.02 (95% confidence intervals = 10.65, 31.37). For each individual subscale, there was a statistically significant improvement ( $p < 0.05$ ) for

**Table 2.** Self-report diary use for the RLO ( $n = 24$ ; 100%) and Booklet ( $n = 19$ ; 79%) groups.

RLO title	% Watched	% Watched	% Watched	Times watched (Max)
	1+	2+	3+	
Introduction	91.3	30.4	13	7
Getting to know HA	91.3	52.2	30.4	13
Insertion of HA	91.3	43.5	39.1	11
Expectations	87.0	52.2	34.8	7
Acclimatisation	91.3	43.5	26.1	5
Communication	91.3	47.8	26.1	5
Troubleshooting	91.3	39.1	34.8	8
Phone and ALDs	87.0	34.8	17.4	4
Testimonials	65.2	8.7	4.3	6

Booklet title	% Read	% Read	% Read	Times Read (Max)
	1+	2+	3+	
Introduction	89.5	42.1	15.8	3
Expectations	84.2	47.4	15.8	3
Communication	89.5	52.6	15.8	3
Phones	78.9	42.1	10.5	3
Care & maintenance	84.2	52.6	15.8	5
Acclimatisation	84.2	47.4	10.5	3
Troubleshooting	84.2	52.6	15.8	5
ALDs	78.9	42.1	10.5	3

Note: For the Booklet group, information on "Getting to know hearing aids" and "insertion" were found in the "Introduction".  
HA: hearing iAid; ALDs: assistive listening devices.

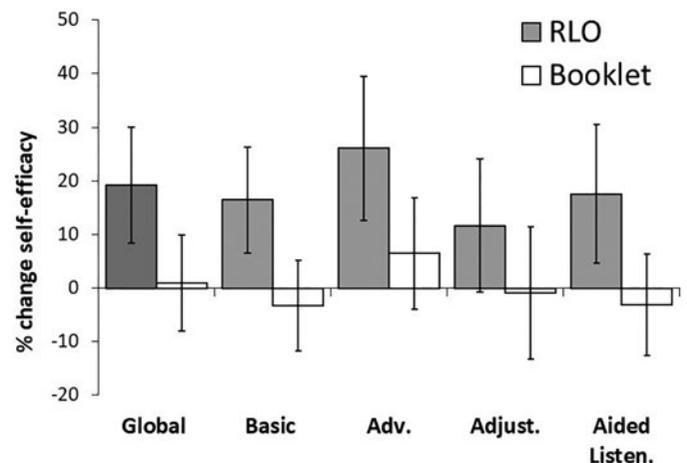
**Table 3.** Mean and standard deviations (<sup>a</sup>or median and interquartile range) for the Measure of Audiologic Rehabilitation for Hearing Aid (MARS-HA) score and Ida line tool questions.

	RLO		Booklet		ANCOVA			
	Baseline	Follow-up	Baseline	Follow-up	Baseline adjusted mean difference (95% CI)	F	p Value	$\eta^2$
MARS-HA								
Global (%)	66.87 (28.95)	85.27 (11.82)	60.41 (25.48)	61.14 (28.64)	21.02 (10.65, 31.37)	16.72	<0.001	0.275
Basic (%)	72.61 (31.12)	92.28 (8.27)	67.57 (31.70)	66.96 (31.05)	22.39 (12.73, 32.05)	21.82	<0.001	0.332
Advanced (%)	50.89 (36.56)	79.70 (18.73)	41.25 (31.06)	48.5 (32.18)	25.84 (12.62, 39.05)	15.55	<0.001	0.266
Adjustment (%)	67.56 (33.53)	85.30 (18.42)	64.32 (26.98)	64.06 (31.78)	18.93 (4.04, 33.81)	6.60	0.014	–
Aided listening (%)	69.15 (31.13)	82.17 (16.77)	66.91 (30.20)	65.05 (29.43)	19.78 (8.07, 31.48)	11.64	0.004	0.221
Ida line tools								
LQ1 (all) <sup>a</sup>	8.00 (3.00)	9.00 (2.00)	10.00 (2.00)	10.00 (2.00)	0.19 (0.41, 0.81)	0.41	0.53	–
LQ1 (<8) <sup>a</sup>	6.50 (2.00)	7.53 (3.75)	6.50 (3.25)	6.50 (2.50)	0.55 (1.98, 3.08)	0.24	0.64	–
LQ2 (all) <sup>a</sup>	9.00 (3.50)	9.00 (1.88)	8.00 (2.00)	9.00 (4.00)	0.29 (0.87, 1.45)	0.25	0.62	–
LQ2 (<8) <sup>a</sup>	5.00 (2.25)	9.00 (1.50)	6.50 (2.00)	6.00 (4.00)	3.26 (1.46, 5.06)	15.40	0.002	0.542

F values show between-group effects. LQ1: Ida Line Question 1 (readiness); LQ2: Ida Line Question 2 (self-efficacy). LQ1 (<8) and LQ2 (<8): analysis where only baseline LQ1/2 scores less than 8 were included in analysis. Bolded values are those significant after Bonferroni correction,  $\eta^2$  = Partial Eta squared effect size.

the RLO group, with moderate to large effect sizes. These all remained statistically significant after accounting for multiple testing, with the exception of the Adjustment scale, [ $F(1, 40) = 6.60, p = .014$ ], which after applying Bonferroni correction would have required a  $p < 0.0125$  to remain significant. A significant group effect for gender was found for the MARS-HA Global [ $F(1, 44) = 8.29, p = .006$ ] and Advanced Handling subscales [ $F(1, 41) = 8.39, p = .006$ ], with males in RLO group showing greater change than females. No group interactions were identified after accounting for age, PC literacy and MoCA score. Figure 2 shows the change scores between baseline to evaluation for each group.

Where the secondary self-efficacy outcome was measured using the Ida Line Tool question 2, ANCOVA revealed borderline statistically significant group difference [ $F(1, 44) = 0.25, p = .062$ ]. Due to the large proportion of respondents scoring the maximal score of 10 at baseline ( $n = 17, 30.0%$ ), sensitivity analysis was performed to determine whether groups differed when those with maximal self-efficacy at baseline ( $\geq 8$ ) were excluded. After exclusion of scorers between 8 and 10 (total  $n = 36$ ), a statistically significant group difference for self-efficacy using Ida Line Question 2 [ $F(1, 13) = 15.40, p = .002, \eta^2 = 0.542$ ] was found, for the RLO group compared to the booklet group. This significant effect continued after exclusion of scores between  $< 7$



**Figure 2.** Within-group change across baseline to follow-up for Measure of Audiologic Rehabilitation for Hearing Aid (MARS-HA) score. Mean  $\pm$  95% confidence interval for the intervention (RLO;  $n = 24$ ) and control (Booklet;  $n = 23$ ) groups.

**Table 4.** HACK score at follow-up.

	RLO	Booklet	<i>p</i>	<i>d</i>
HACK score				
Global (%)	65.51 (16.9)	42.21 (16.9)	<0.001	1.38
Practical (%)	77.29 (19.15)	45.35 (20.4)	<0.001	1.61
Psychosocial (%)	57.66 (18.72)	40.17 (17.5)	0.002	0.97

Mean and standard deviations (SD) for the intervention (RLO; *n* = 24) and control (Booklet; *n* = 23) groups. Groups compared using independent *t*-test. *d* = Cohens *d*.

and <5 in 1-point step sizes, and remained after accounting for age, sex, BEA, PC literacy and MoCA score.

For the Ida Line Tool question 1 (readiness), there was a borderline between-group difference in readiness for hearing rehabilitation [ $F(1, 44) = 0.41, p = .053$ ], with neither group demonstrating significant change in readiness between visits. As for self-efficacy (LQ2), the proportion of respondents scoring the maximal score of 10 at baseline was high (*n* = 26, 46.4%), and sensitivity analysis was performed to determine whether difference scores varied significantly between groups when those with maximal readiness at baseline were excluded. Exclusion of baseline scores between 8 and 10 (total *n* = 43) revealed no statistically significant group difference for readiness using Ida Line Question [ $F(1, 19) = 0.24, p = .064$ ], although significance remained borderline.

For the secondary outcome measure of hearing aid and psychosocial knowledge (HACK) (Table 4), the RLO group compared to booklet group showed statistically significantly greater knowledge than the booklet group for the overall score ( $t(45) = -4.7, p = <.001, d = 1.38$ ), and both the practical ( $t(45) = -5.5, p = <.001, d = 1.61$ ) and psychosocial ( $t(45) = -3.3, p = .002, d = 0.97$ ) subscale scores, with large effect sizes. Of note, the knowledge scores were consistently better in both groups for the practical scores than the psychosocial scores.

## Discussion

The present study investigated the effects of early delivery of the C2Hear RLOs on hearing aid self-efficacy, knowledge and readiness in comparison to a printed booklet in a sample of prospective first-time hearing aid owners.

### Evaluation of the RLOs

Self-efficacy for hearing aids at the fitting appointment improved significantly for both measures (MARS-HA and LQ2) as a result of the RLOs. These findings suggest that it would be beneficial for first-time hearing aid users to be given the C2Hear RLOs at the hearing assessment in order to prime patients about hearing aids, and increase their self-efficacy for hearing aids before they even receive them. According to Bandura's Social Cognitive Theory (1977) self-efficacy is strongly influenced by vicarious experience and verbal persuasion, both of which feature in the RLOs and could explain the improvements shown for self-efficacy in the RLO group compared to the 'passive' booklet. Therefore, we can explain the increase in self-efficacy by the use of visual illustrations, demonstration of hearing aid functions, opportunities for interactivity and self-assessment, and testimonials from hearing aid users that are integral to the RLOs (Ferguson et al. 2018).

An additional explanation for the success of the RLOs in increasing self-efficacy compared to the booklet is likely to be related to the improvement in hearing aid knowledge as the

RLO group had significantly better overall, practical and psychosocial knowledge of hearing aids compared to the booklet group. Successful hearing self-management requires three elements: knowledge, self-efficacy and cues to action (Convery et al. 2018a). We propose that the improved acquisition of knowledge on hearing aids and communication in those that used the RLOs acts as a catalyst to improve hearing aid self-efficacy. This is supported by qualitative research, which has indicated that there appears to be a self-fulfilling prophecy whereby obtaining hearing knowledge results in greater confidence, which fuels application of this knowledge in daily life (Malmberg et al. 2018). In a previous study of online support programmes, hearing aid users reported sufficient knowledge prior to trial enrolment (Brannstrom et al. 2016). This could explain why these authors failed to measure statistically significant improvements in hearing aid self-efficacy following use of their online support programme, as no additional knowledge was gained. Furthermore, a process evaluation of data from Ferguson et al. (2016a) study has shown that the greater knowledge obtained by the RLO group predicts general health self-management (Ferguson 2019). Therefore, we propose that knowledge is a key mediator for increasing hearing aid self-efficacy, and this can be an effective mediator even before the hearing aids have been fitted.

This study also supports the contention that hearing aid self-efficacy is a modifiable factor in hearing rehabilitation, as proposed by Convery et al. (2018a). The relevance of this, and why this is important, is that improved hearing aid self-efficacy is linked with a range of positive factors, including increased hearing aid self-management (Convery et al. 2018a) and increased hearing aid satisfaction and use (Hickson et al. 2014; Meyer, Hickson, and Fletcher 2014; Meyer et al. 2014). It is proposed that this early increase in self-efficacy may support early application of hearing self-management (Malmberg et al. 2018) and shared decision-making at hearing aid fitting (Laplante-Levesque, Hickson, and Worrall 2010).

RLOs were originally designed in the education field and they have been developed and assessed in educating healthcare professionals. For example, they have been shown to significantly increase students self-efficacy for wound care (Redmond et al. 2018). In contrast, other RLOs have not demonstrated increases in the self-efficacy of nurses caring for children who self-harm (Manning et al. 2017) or student nurses' self-efficacy of mathematical principles (Maag 2004). It remains unclear as to why RLOs have had mixed success in increasing the self-efficacy of healthcare professionals, especially given that they all featured self-assessment and tailoring, both known to support an individual's self-efficacy (Roberts et al. 2017). Further research is necessary to define the components of RLOs likely to exert influence over domain specific self-efficacy.

It was notable that the practical and psychosocial hearing aid knowledge in the RLO group in the present study was higher than that reported by Ferguson et al. (2016a), where outcomes were measured at six-weeks post-hearing aid fitting. It is unclear whether knowledge levels in the present study were sustained at six weeks post-fitting as the study did not include a follow-up, due to the time limitations of this student project. Despite this, the results suggest patients are able to acquire high levels of hearing aid knowledge prior to receiving hearing aids. This suggests that early enablement of knowledge is both possible and beneficial to those who have opted to take-up hearing aids. The enablement is consistent with patient perspectives, where qualitative research identified that patients who had their hearing assessed reported a desire for additional and ongoing

information regarding hearing aids (Poost-Foroosh et al. 2011; Poost-Foroosh, Jennings, and Cheesman 2015). This was also consistent with that reported by long-term hearing aid users (Kelly et al. 2013).

It should be noted both in the present and previous studies (Ferguson et al. 2016a) that poorer scores were reported for psychosocial knowledge compared to practical hearing aid knowledge. This suggests either understanding or recall of practical knowledge is superior to psychosocial knowledge or that practical information can be enabled more readily. Regardless, results suggest a potential knowledge gap where audiologists should consider spending time addressing the psychosocial knowledge needed for hearing aid use, as this appears more difficult for patients to remotely acquire or recall. This is consistent with other research that has indicated a paucity of attention on psychosocial aspects of rehabilitation and failure to address unmet needs relating to psychosocial aspects of hearing loss (Grenness et al. 2015; Convery et al. 2018b).

The borderline significant difference in readiness for hearing rehabilitation suggests that the RLOs have potential to improve readiness in those waiting to be fitted with hearing aids. We propose two explanations as to the lack of significant group effect. First, that the study was powered using the MARS-HA hearing aid self-efficacy questionnaire as the primary outcome measure, and a larger sample size is needed to show a significant effect for this readiness measure. Second, exploration of scores at assessment suggests that readiness was already high amongst both groups (RLO Group (>8) = 67%; Booklet Group (>8) = 83%), resulting in a ceiling effect for a substantial number of patients, also seen elsewhere (Ferguson et al. 2016b, Ferguson, Woolley, and Munro 2016). This likely reflects the study design, whereby participants in the present and previous studies had already agreed to take-up hearing aid(s) prior to being recruited onto the studies (Ferguson et al. 2016b, Ferguson, Woolley, and Munro 2016). Therefore, it is likely that participants in the current study had greater readiness scores than those who attended hearing assessment but declined rehabilitation, reflective of where they were in their behaviour change cycle (Ekberg, Grenness, and Hickson 2016). Qualitative video analysis (Ekberg, Grenness, and Hickson 2016) may be useful to understand the impact of RLOs on patient readiness.

### Adherence

The analysis of self-report diaries revealed that use of educational materials between assessment and fitting was high. Of those returning the self-report diaries, 73.6% of the Booklet group reported to having read the entire booklet at least once. For the RLO group this was even higher, with 83.3% reporting to have watched all RLOs at least once. Further analysis revealed that on average, each RLO was viewed 3 or more times by a quarter (25.1%) of the RLO group, compared with just over a 10th (13.8%) of the Booklet group re-reading sections three or more times. Whilst the numbers watching the RLOs at least once was lower than previous evaluation (97%, Ferguson et al. (2016a), the data suggest that patients were more likely to use and re-use the RLOs than printed materials prior to hearing aid fitting, supporting the early delivery of the RLOs. The adherence data for RLOs in the present study is consistent with that reported in other studies utilising RLOs for research purposes (Maag 2004; Manning et al. 2017; Redmond et al. 2018). It is acknowledged that participation in the study likely influenced the high adherence rates seen here and more generally in clinical trials of

patient education. As a result, it is not possible to speculate on the adherence levels of a clinic population that was not participating in a clinical trial. Despite this, it could be argued that as the RLOs were designed with first-time hearing aid users in mind, that both adherence to, and re-use of, the RLOs might diminish with time, reflecting that individuals may have mastered the education contained within them. Studies utilising long-term follow-up, including measures of adherence and use, would be beneficial.

### Limitations

One of the study limitations was that neither the study audiologist nor patients were blinded to the group allocation. This was because instructions on the use of the RLOs, Booklet and self-report diaries were important to ensure the patients knew what to do. In addition, the RLO group did not receive the hearing aid booklet until the end of the study, in contrast to routine clinical care at the time. As the study audiologist was not involved in their hearing assessment it is possible some participants were supplied this printed hearing aid booklet at assessment. To overcome this lack of blinding and avoid changing routine practice, future evaluations should use routine care plus a double-blind trial, using an active control not specific to hearing loss (e.g. general health self-management).

Finally, the study lacked both short-, medium- and long-term follow-up of the RLO versus Booklet groups, reflecting the pragmatic approach and time constraints of data collection. Future research that repeated this study while obtaining outcomes post-fitting, would address this limitation. Finally, a lack of long-term follow-up has been identified as a priority for future research in how best to support hearing aid use in adults (Barker et al. 2016).

### Conclusions

This study showed an increase in hearing aid self-efficacy and knowledge when standard care was supplemented by C2Hear RLO multimedia, even before hearing aids were fitted. Coupled with the greater adherence for RLOs compared to the booklet, these results suggest that early provision of C2Hear RLOs at hearing assessment leads to favourable outcomes, and is acceptable to adults with hearing loss who have opted for hearing aids. Evidence for the interdependency between knowledge, self-efficacy and readiness to action for hearing self-management has been indicated, suggesting measurement of these three domains could be considered as key factors in future research.

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## ORCID

Rachel Gomez  <http://orcid.org/0000-0002-8935-9997>

Melanie Ferguson  <http://orcid.org/0000-0002-8096-869X>

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