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1 **Information retention and overload in first-time hearing aid users: an interactive**
2 **multimedia educational solution**

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31 **Abstract**

32 Purpose: To assess the effect of an educational intervention, based on the concept of reusable
33 learning objects (RLOs), on knowledge of hearing aids and communication in first-time
34 hearing aid users.

35 Method: A randomized controlled trial of hearing aid users, where one arm received the
36 educational intervention and the other arm acted as a control group. RLOs were delivered
37 through DVD for TV and PC, and online. Knowledge of both practical and psychosocial
38 aspects of hearing aids and communication was assessed using a free-recall method at six-
39 weeks post-fitting.

40 Results: Knowledge of both practical and psychosocial knowledge was significantly higher in
41 those who received the RLOs compared to the control group. Large effect sizes indicated
42 these differences are clinically significant.

43 Conclusion: An educational intervention to supplement clinical practice results in improved
44 knowledge in first-time hearing aid users.

45

46 **Introduction**

47 If you are an audiologist reading this, how confident are you that all the information and
48 advice that you offer your first-time hearing aid patients is understood, absorbed and then
49 acted upon once they leave the comfort of your clinic room?

50 It has been reported that around half (51%) of first-time hearing aid users have difficulties
51 using their hearing aids (AoHL, 2011). For example, between 60-80% of first-time hearing
52 aid users do not know how to use the telephone with their hearing aids and need further
53 instruction (Goggins & Day, 2009; Vuorialho, Karinen, & Sorri, 2006). This is reflected in a
54 statement from a typical first-time hearing aid user: “You get a lot of information...by the
55 time you get home you’ve forgotten most of it” (AoHL, 2011). The problem of information
56 overload and retention is not unique to hearing aid users. It has been suggested that between
57 40-80% of information given verbally in clinical appointments is forgotten afterwards
58 (Kessels, 2003). A study of hearing aid users showed that of the information delivered at the
59 hearing aid fitting appointment, a more optimistic figure of 25% is forgotten one month later
60 (Reese & Smith, 2006). However, this study used a multiple-choice method of assessment
61 that may have artificially inflated the amount of information recalled. Using a free-recall
62 method of assessment El-Molla et al. (2012) showed that around half (49.6%) of the
63 information delivered was recalled in first-time hearing aid users (62.9% of practical and
64 34.3% of psychosocial information).

65 To address this problem, delivery of high quality written information is recommended as
66 good clinical practice (AoHL, 2011; NHS Scotland, 2009). It is common for hearing aid users
67 to receive a hearing aid-specific manufacturer’s user guide, however, two studies have
68 reported that these user guides are not optimal in terms of content, design and readability
69 (Brooke, Isherwood, Herbert, Raynor, & Knapp, 2012; Caposecco, Hickson, & Meyer, 2014).
70 Furthermore, it is important to recognize that delivery of information from audiologist to

71 patient is not the same as educating the patient and increasing their knowledge base
72 (Boothroyd, 2007). Constructivist learning theory suggests that interaction with learning
73 materials promotes learning, and the greater the interactivity, the greater the learning (Zhang,
74 Zhou, Briggs, & Nunamaker, 2006). Studies of education in hearing aid users as part of their
75 (re)habilitation include communication programmes delivered in group or individual settings
76 (Beynon, Thornton, & Poole, 1997; Hickson, Worrall, & Scarinci, 2007), remote programmes
77 home-delivered by videotapes (Kramer, Allesie, Dondorp, Zekveld, & Kapteyn, 2005),
78 written materials supported by telephone follow-up calls (Lundberg, Andersson, & Lunner,
79 2011) and online educational and rehabilitation programmes (Thorén, Öberg, Wänström,
80 Andersson, & Lunner, 2013).

81 **Development of the educational intervention**

82 The concept of reusable learning objects (RLOs) have been used in elearning environments.
83 RLOs are short, highly visual, chunks of interactive multimedia learning that illustrate
84 concepts to support a specific learning goal, enable engagement with the learning materials
85 by activities, can be replayed as often as is required, and include a self-assessment element
86 that enables test of mastery of the content (Windle, McCormick, Dandrea, & Wharrad, 2010).
87 We have developed an educational programme underpinned by pedagogical principles and
88 learning theory and consisting of RLOs for first-time hearing aid users (Ferguson, Brandreth,
89 Leighton, Brassington, & Wharrad, in review). Each RLO has specific learning outcomes,
90 includes reinforcement of good behaviours and explains the consequences of poor
91 behaviours, with an interactive multiple-choice quiz at the end. The RLOs include video
92 clips, illustrations, animations, photos, sounds and testimonials, and all are subtitled.

93 Seven RLOs were designed using a participatory approach including audiologists and hearing
94 aid users (Brandreth, Leighton, Wharrad, & Ferguson, 2013) to ensure the RLOs met the
95 users' needs (duration shown in brackets):

- 96 1) Getting to know your hearing aids (embed video link here) (9m 33s)
- 97 2) How to insert hearing aids (embed video link here) (4m 34s)
- 98 3) What to expect when wearing hearing aids (embed video link here) (6m 48s)
- 99 4) Adapting to wearing hearing aids (embed video link here) (9m 35s)
- 100 5) Communication tactics (embed video link here) (11m 52s)
- 101 6) Using the phone and other devices (embed video link here) (5m 36s)
- 102 7) Hearing aid care and troubleshooting (embed video link here) (7m 55s)

103 There was also a short introduction (2m 52s), and the total duration of the RLOs was 58.7
104 minutes.

105 The aim of this paper was to assess the effect of the RLOs on knowledge of hearing aids and
106 communication in first-time hearing aid users, six weeks post-fitting.

107 **Evaluation of RLOs**

108 The effectiveness of the RLOs were investigated in a randomized controlled trial (RCT) of
109 203 first-time hearing aid users. These were recruited from Nottingham Audiology Services
110 as part of their standard clinical management, which comprised hearing aid fitting to the
111 NAL-NL1 prescription, verification with probe tube measurements, then hearing aid
112 orientation including provision of the manufacturer’s fitting guide and counselling. Outcome
113 measures included hearing aid benefit, practical hearing aid skills, participation restrictions,
114 well-being, and feedback on the RLOs assessed six-weeks post-hearing aid fitting (see
115 Ferguson et al., in review). The study was approved by the Nottingham Research Ethics
116 Committee and Nottingham University Hospital’s Trust Research and Development
117 department.

118 The single centre, prospective RCT had two arms: (i) the intervention group received the
119 RLOs as part of their standard clinical management at the hearing aid fitting (RLO+, n=103),
120 (ii) the control group received standard clinical management only (RLO-, n=100).
121 (Participants in the intervention group chose one of four RLO delivery methods: (i)
122 interactive DVD for television (50.6%), (ii) interactive DVD for PC (15.2%), (iii) interactive
123 RLOs via the internet (32.9%, (iv) autoplay DVD for television with no interactivity for
124 participants who did not have remote controls (1.3%). Standard clinical management
125 included hearing aid fitting including probe-tube microphone verification, hearing aid
126 orientation, issue of hearing aid manufacturer's guide, and counselling.

127 The 20-item, free recall hearing aid and communication knowledge questionnaire (El-Molla,
128 et al., 2012) assessed knowledge of practical (n=12) and psychosocial (n=8) aspects of
129 hearing aids and communication in 141 participants (see Table 1 for demographics). ..The
130 reduced number was due to non-attenders at evaluation (n=32) and a delay in starting to use
131 the knowledge questionnaire due to early piloting (n=30). Composite scores were calculated
132 as the mean of the practical items and psychosocial items. For each item there was a range of
133 possible answers with one mark for each correct answer (max=2 or 3) resulting in a
134 percentage score. For example, the question "How frequently, and when, does the tubing
135 need to be replaced in the earmould?" had the answers (1) every 4-6 months, and (2) when the
136 tubing becomes worn or damaged (e.g. yellow, hard, or split). One point was given for each
137 correct answer. Effect sizes (Cohen's *d*), categorized as small (0.2), moderate (0.5) and large
138 (0.8), were 0.94, 0.88, and 0.65 for total score and composite scores for practical and
139 psychosocial scales respectively.

140 Composite scores were significantly better in the RLO+ group ($p < 0.001$), with generally
141 large effect size (Table 2))The range of responses was large, and each item ranged between 0-

142 100%. There was no difference in age, hearing threshold or gender between the groups
143 ($p>0.05$). ANOVA showed no significant effects of age, gender or hearing threshold on the
144 composite scores ($p>0.05$).

145 A multivariate analysis of variance (Wilks' Lamda, λ) of the items showed the RLO+ group
146 had significantly better scores ($p<.001$). Table 2 shows the post hoc t-tests for the 14 items
147 with a between-group difference $>3\%$, which included both practical ($n=8/12$) and
148 psychosocial ($n=6/8$) items.

149 **Benefits of RLOs for first-time hearing aid users**

150 Knowledge about hearing aids and communication was suboptimal in first-time users, and
151 poorer for the psychosocial compared to practical composite scores. There was, however,
152 significantly higher practical and psychosocial knowledge in the intervention group compared
153 to the control group. The effect sizes for the composite scores were generally large,
154 suggesting the improvements were clinically significant. It is not clear whether (i) the RLOs
155 provided additional information that the audiologist did not have time to deliver in the one-
156 hour fitting appointment, (ii) the information was delivered and the RLOs served as reminder
157 to participants who might have otherwise have experienced poor information recall or
158 information overload, or (iii) a combination of both. However, the results suggest that the
159 knowledge showing the largest gains from RLO use is that which is not always given by the
160 audiologist due to time constraints and the requirement to ensure the basics are addressed.
161 For the absolute essentials (e.g. how to use the battery, where to go to get advice, and the
162 need to acclimatise to the hearing aid), there was almost no difference ($<3\%$) between the two
163 groups. Similar results were seen for basic hearing aid handling skills (hearing aid/battery
164 insertion and removal), which were generally good with no group difference (Ferguson et al.,
165 in review). Interestingly, knowledge of limitations of hearing aids was higher in the RLO+

166 group whereas there was no group difference for hearing aid benefits, suggesting that
167 audiologists may focus more on the benefits rather than the limitations of hearing aids.

168 But does this improvement in knowledge transfer to improved outcome measures? Results
169 from the current study presented elsewhere suggest that RLOs do provide benefits to hearing
170 aid users (Ferguson, et al., in review). In the RLO+ group, practical earmould cleaning and
171 telephone skills were significantly better, and hearing aid use was significantly greater in
172 challenging listening situations, such as having a conversation in a group as well as in
173 suboptimal users. The vast majority of users reported the RLOs were highly useful, improved
174 their confidence to discuss hearing aids and communicate with others, and were preferable to
175 written materials. Importantly, around half the users watched the RLOs 2+ times and 20%
176 watched them 3+ times, with some watching the RLOs as many as seven times, suggesting
177 the RLOs were used to manage their hearing loss, hearing aids and communication. This was
178 supported by post-evaluation focus groups.

179 It should be noted that the participants in this research were younger and had less hearing loss
180 than typical hearing aid users from this clinic. It is possible that the impact of the RLOs on a
181 typical older, more impaired population would be different. Finally, the RLOs have
182 undergone further improvement based on participant feedback, are now branded as C2Hear,
183 and have been commercially available since November 2014. Further development and
184 evaluation is planned to tailor C2Hear to individuals using mobile technologies for hearing
185 aid users, as well as develop and evaluate RLOs for communication partners and non-
186 audiological healthcare professionals.

187 There is clearly a gap in adult (re)habilitation for an effective intervention to enhance
188 knowledge and educate hearing aid users. It remains to be seen whether audiologists will

189 adopt this educational intervention to supplement their clinical practice, as this was the
190 ultimate goal of this research.

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202

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Table 2. Mean age and better ear average hearing thresholds (octave frequencies between 0.25-4 kHz), gender and hearing aid fits for the intervention (RLO+; n=62) and control groups (RLO-; n=77) who completed the knowledge questionnaire

| | RLO+ | RLO- |
|--|-----------------|-----------------|
| Mean age (SD) years | 68.1 (7.4) | 67.3 (9.3) |
| Mean better ear average _(0.25-4 kHz) (SD) dB HL | 32.7 (7.6) | 31.4 (9.3) |
| Gender (male: female) % | 41:21 (66%:34%) | 49:30 (62%:38%) |
| Hearing aid fits(bilateral / unilateral) % | 47:15 (76%:24%) | 56:23 (71%:29%) |

Table 1. Mean percentage knowledge scores for the composite and individual items for the intervention (RLO+) and control (RLO-) groups, the mean difference between groups and effect size (Cohen's *d*). *indicates 'practical' questions.

| Composite scores and items | Mean knowledge score (%) | | Group Difference % | Effect size (<i>d</i>) | Sig (<i>p</i>) |
|--|--------------------------|------|--------------------|--------------------------|------------------|
| | RLO+ | RLO- | | | |
| <i>Composite scores</i> | | | | | |
| Total | 57.4 | 48.2 | 9.2 | .93 | <.001 |
| Practical | 62.7 | 52.9 | 9.8 | .86 | <.001 |
| Psychosocial | 49.9 | 41.6 | 8.3 | .68 | <.001 |
| <i>Individual items</i> | | | | | |
| *How frequently and when does the tubing need to be replaced in the earmould? | 65.3 | 29.7 | 35.6 | .97 | <.001 |
| When you are wearing your hearing aids, can you name three important ways to improve one-to-one communication? | 66.1 | 40.1 | 26.0 | .74 | <.001 |
| *How would you use the telephone with hearing aid(s)? | 41.5 | 27.1 | 14.4 | .57 | .004 |
| *What should you not do with your hearing aid(s)? | 53.7 | 45.1 | 8.6 | .52 | .037 |
| *What do you check if your hearing aid starts to whistle? | 27.9 | 12.6 | 15.3 | .49 | .001 |
| *How do you clean the earmould? And the tube? | 79.4 | 67.4 | 12.0 | .46 | .007 |
| What are the benefits of persevering with hearing aid(s)? | 55.4 | 43.1 | 12.3 | .42 | .014 |
| How do you tell which aid is the left and which is the right? | 95.8 | 87.3 | 8.6 | .37 | .06 |
| *What would you check if your hearing aid sounds softer than usual or begins to crackle and buzz? | 43.8 | 36.5 | 7.3 | .28 | .097 |
| What are the limitations of hearing aid(s)? | 26.3 | 21.1 | 5.3 | .26 | .11 |
| How long do you think it takes to get used to new hearing aid(s)? | 37.1 | 30.4 | 6.7 | .21 | .10 |
| What situations would help you experience and adapt to your hearing aid(s)? | 30.1 | 22.2 | 7.9 | .19 | .10 |
| *How do you know when your batteries are about to run out? | 77.4 | 72.1 | 5.3 | .18 | .29 |
| Do you expect your hearing aid(s) will restore normal hearing? | 92.0 | 87.2 | 4.8 | 0.15 | .40 |

Questions that showed minimal (<3%) difference: Explain how to replace your battery (2.8%); When the hearing aid is not in use, how do you prevent the battery from running out? (2.1%); If you have a problem or query, where do you go to get advice? (0.7%); Where and how would you use the loop programme? (8.8%); What is the best way to get used to your hearing aid? (1.4%); What benefits might you get from wearing hearing aids? (11.3%). The number in brackets is the percentage of people who scored 0.

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