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Research Note

Use and Mediating Effect of Interactive Design Features in Audiology Rehabilitation and Self-Management Internet-Based Interventions

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Purpose: The purpose of this study is to explore the presence of key interactive design features across Internet-based audiology rehabilitation and self-management interventions, and whether there is evidence of them mediating effects of the intervention.
Method: Adult audiology interventions relevant to this review were identified through a literature search in Google Scholar and a hand search of key journals. Four key interactive design features that have been proposed to mediate the effects of Internet-based health interventions were reported for each intervention: social context and support, contacts with the intervention, tailoring, and self-management.
Results: Five interventions were identified as representative examples of work in the field. Social context and support and contacts with the intervention were provided in most interventions, mainly through clinician guidance. Only 1 intervention utilized tailoring to personalize intervention content to individual users, but use was minimal. Self-management features were also used in all interventions but the precise nature of these features was poorly reported.
Conclusion: Future studies should assess the optimal dose and combinations of intervention features for maximizing efficacy in audiology intervention. To be specific, the role of tailoring should be explored, which has been identified as a potential mediator of intervention outcome in the wider e-health literature.

The Internet provides a vast array of health information and, in terms of audiology, offers a platform for research, rehabilitation, and self-management programs. In general, there is evidence to suggest that interventions delivered via the Internet can lead to improvements in health behavior, disease control, and psychological distress (Beatty & Lambert, 2013; Nyenhuis, Golm, & Kröner-Herwig, 2013; Webb, Joseph, Yardley, & Michie, 2010). In audiology, Internet-based interventions have the potential to reach a substantial proportion of older adults with hearing-related difficulties who may not have access to hearing services (Swanepoel et al., 2010). Applications to date have included hearing aid fitting and verification, cochlear implant programming, hearing counselling, and tinnitus psychological therapy, and have demonstrated to be reliable and effective, compared to conventional face-to-face methods (Swanepoel & Hall, 2010). Interventions might include asynchronous clinician contact, interactive homework, text, video, and audio (Vlaescu, Carlbring, Lunner, & Andersson, 2015).

To maximize the effectiveness of these audiological interventions, it is important to understand the intervention's underlying mechanisms—that is, how do the intervention's components, and a user's interactions with them, lead to the desired changes in outcome (Moore et al., 2014)? There is an emerging body of work that has aimed to define and assess the value of an intervention's content (e.g., behavior change techniques; Greenwell, Sereda, Coulson, El Refaie, & Hoare, 2016; Michie et al., 2013). However, there is less research and guidance on the best way to deliver this content.

Using critical interpretive synthesis, Morrison, Yardley, Powell, and Michie (2012) identified four interactive design features that may mediate the effects of Internet-based health interventions on the outcome of those interventions. These are described by the authors as social context

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and support, contacts with the intervention, tailoring, and self-management.

To narrow our focus, we chose to use these four features to provide a framework for this review. Morrison et al.'s (2012) synthesis was limited to fully automated interventions, but we have expanded the scope of their conceptual definitions to also include clinician-guided interventions to explore the full extent of the features used in the available interventions. *Social context and support* encompasses features that facilitate perceptions of social context and support, such as simulated or direct person-to-person interaction, online forums or chat rooms, and provision of information about other users. In our definition, social support may come from clinicians or other users. *Contacts with intervention* includes features that allow direct (e.g., telephone) or computer-mediated (e.g., video chat, instant messaging) contact with the intervention or clinicians who are responsible for the intervention. Contacts can be automated (e.g., emails) or clinician- or user-initiated and may include additional intervention content (e.g., feedback, answering user queries) or promote intervention usage (e.g., motivational or reminder emails).

Tailoring is the provision of individualized information based on certain characteristics (e.g., demographics, behavior, or theoretical constructs). *Self-management* features support the management of treatment (e.g., hearing aids) and the physical and psychosocial impact of their hearing difficulty. Such features encourage people to monitor their health and/or health-related behaviors, and adjust their knowledge, attitudes, behavior, and emotional responses accordingly, in order to maximize quality of life (Barlow, Wright, Sheasby, Turner, & Hainsworth, 2002). This may include self-monitoring of health and/or behavior, activity or action planning, or self-assessments of learning. These features may or may not include feedback from the intervention or clinician.

The purpose of this review is to explore examples where these design features have or have not been implemented in Internet-based audiology rehabilitation and self-management interventions, and whether there is evidence of them mediating effects of the intervention. This will help guide those developing Internet-based audiology interventions on the most important features that should be included. By using Morrison et al.'s (2012) framework, this review will also identify any core design features that have been underutilized in audiology research.

Method

Example adult audiology interventions relevant to this review were identified through literature searches in Google Scholar (no date limitation) searching for "online audiology intervention self management" and "online audiology intervention rehabilitation." Peer-reviewed records were selected if they reported a hearing-related Internet-based intervention for patients, either in the context of a trial, protocol, or intervention description. Each database search was stopped after three consecutive results pages gave no new hits. Database searches were supplemented with a hand search of articles published in the last 12 months in key journals including the *American Journal of Audiology*, *Ear and Hearing*, *International Journal of Audiology*, *Journal of the American Academy of Audiology*, and the *Journal of Medical Internet Research*. The reference list of a recent Cochrane review on hearing aid use (Barker, Mackenzie, Elliot, Jones, & de Lusignan, 2014) and a systematic review on self-help interventions for tinnitus (Greenwell et al., 2016) was also searched.

The aim of the study selection process was to choose publications to represent the diversity of the interventions in the field. Intervention publications were excluded if they did not cover a sufficiently different therapeutic approach, hearing-related condition, or delivery method than the interventions already included in the review. The second author (DH) carried out the searches and study selection and then the two authors independently extracted data from the publications on the four design features and key findings. Disagreements were resolved through discussion.

Results

Five interventions were selected: (a) Internet-based cognitive behavior therapy (CBT)/acceptance and commitment therapy (ACT) for tinnitus (Hesser et al., 2012); (b) Internet-based self-management for tinnitus (Greenwell, Featherstone, & Hoare, 2015); (c) Internet-based CBT/ACT for hearing problems (Molander et al., 2015); (d) multimedia education for first-time hearing aid users (Ferguson, Brandreth, Brassington, Leighton, & Wharrad, 2016); and (e) online rehabilitation for adult hearing aid users (Thorén, Öberg, Wänström, Andersson, & Lunner, 2014; see also Thorén et al., 2011). Hesser et al. (2012), Ferguson et al. (2016), and Thorén et al. (2014) reported intervention trials. Greenwell et al. (2015) reported an intervention description and Molander et al. (2015) reported a trial protocol. Use of the four interactive design features in these interventions is presented in Table 1.

Social Context and Support

Social support was provided through direct clinician contact in four of the five interventions. The intervention described by Ferguson et al. (2016) did not provide any interaction with peers or clinicians but did encourage participants to use the intervention alongside friends and family. They also provided testimonials from hearing aid users and their relatives about their experiences. Greenwell et al. (2015) and Thorén et al. (2014) used peer-to-peer discussion forums as part of the interventions. Discussions on the forums were either user-initiated (Greenwell et al., 2015) or initiated by the intervention through predetermined discussion topics (Thorén et al., 2014). In contrast, Hesser et al. (2012) used an online discussion forum as their control condition when trialing their CBT and ACT interventions for tinnitus. In fact, this group showed a moderate within-group clinical effect size (d = 0.68), although only half of

Table 1. Use of interactive design features in Internet-based audiology interventions.

Intervention (reference)	Social context and support	Contacts with the intervention	Tailoring	Self-management
CBT/ACT for tinnitus (Hesser et al., 2012)	Asynchronous therapist contact.	User-initiated contact with therapist via messages on a secure webpage; two reminder emails followed by a phone contact to remind user to contact the therapist.	Not used.	Users asked to complete exercises and assignments and report on outcomes from homework assignments; users encouraged to develop individualized plans to maintain skills learned during the intervention; therapist gave feedback.
Tinnitus E-Programme (Greenwell et al., 2015)	Optional asynchronous therapist contact; professional and lay-moderated online discussion forum.	Optional therapist contact via email.	Not used.	Users asked to complete and self-score a clinical tinnitus questionnaire measure before and after the intervention; daily relaxation goals were recommended by the intervention and defined in terms of frequency (i.e., daily) and duration (i.e., 30 min).
CBT/ACT for hearing problems (Molander et al., 2015)	Asynchronous therapist contact.	Contact with therapist via messaging on a secure platform; users encouraged to log onto the platform weekly; therapist contact prompted by users' completion of a set of open-response questions at the end of each module.	Not used.	Users asked to report on outcomes from homework assignments (some of which was user-assigned); reviewed by therapist and feedback and encouragement given; strategies for maintaining intervention gains developed.
Multimedia educational program for first-time hearing aid users (Ferguson et al., 2016)	Testimonials from hearing aid users and their relatives; encouragement to use intervention with family and friends.	Not used.	Brief tailoring of content based on type of hearing aid ear mold.	Multiple-choice quiz with automated feedback after each module to assess learning.
Internet-based educational program for adult experienced hearing aid users (Thorén et al., 2014)	Asynchronous audiologist contact; peer-to-peer online discussion forum.	Weekly email exchange with an audiologist; user submitted homework and prepared questions for the audiologist; audiologist gave email feedback and advice.	Not used.	Short quiz with immediate feedback after each module to assess learning; users given weekly homework in which they had to complete four to six different training tasks and were asked to reflect on their experiences.

Note. CBT = cognitive behavior therapy; ACT = acceptance and commitment therapy. The information in this table was taken from the intervention descriptions provided in the publications; therefore, additional information on the content or delivery of particular design features was not always available.

their participants were actively contributing to the discussion. Hesser et al. (2012) hypothesized that this positive effect was associated with factors such as attention and emotional and social support. In a proof of concept study of their Internet-based educational program for hearing aid users, Thorén et al. (2011) also used an online discussion forum as their control condition. According to their primary outcome, the educational program led to a reduction in hearing handicap in terms of both social and emotional consequences of hearing aid use, whereas for the discussion forum group there were reductions in emotional consequences only. This positive outcome in the control group was not predicted and was attributed to the unexpected "high level of activity and constructive help" (Thorén et al., 2011, p. 282) observed within the forum, making for more of an active rather than passive control condition.

The presence of clinician support and peer-to-peer interaction may explain some of the difference in clinical effectiveness observed between the two hearing aid studies included in this review. Although Ferguson et al. (2016) reported that participants had significantly improved practical hearing aid skills in their multimedia education program group versus a waiting list control group, changes on the Glasgow Hearing Aid Benefit Profile (Gatehouse, 1999)

did not differ significantly between groups. The authors did, however, observe a significant difference between groups for suboptimal users. Thorén et al. (2014) reported a significant improvement in their intervention group compared to a waiting list control on their primary clinical outcome measures, the Hearing Handicap Inventory for the Elderly (Lichtenstein, Bess, & Logan, 1988; Ventry & Weinstein, 1982), postintervention and at follow-up. As demonstrated in their proof of concept study (Thorén et al., 2011), online discussion forums can in themselves affect a significant reduction in handicap and so contribute to the overall educational program intervention effect seen by Thorén et al. (2014). Furthermore, audiologist contact in Thorén et al. (2014) went beyond mere social support to facilitate the utilization of some additional self-management techniques (i.e., activity planning, feedback on homework assignments) that were not present in Ferguson et al.'s (2016) intervention. However, as these studies also have other differences (e.g., hearing aid group targeted), the precise explanation for these differences is difficult to conclude.

Contacts With the Intervention

Contacts with the intervention was mainly through contact with a clinician, which was either mandatory (Hesser et al. 2012; Molander et al. 2015; Thorén et al., 2014) or optional (Greenwell et al., 2015). Contact was primarily user-initiated via online messaging (Hesser et al., 2012; Molander et al., 2015) or email exchange (Greenwell et al., 2015; Thorén et al., 2014) between clinician and user. Hesser et al. (2012) reportedly sent up to two email reminders and then contacted participants by phone to promote compliance with the intervention. Contacts with the intervention may explain some of the variance in attrition. This was associated with an intervention group attrition of 5%, which was lower than that in Thorén et al. (2014), who did not report using reminders (16% attrition), and in Ferguson et al. (2016), where no clinician contact or automated contact with the intervention was used (21% attrition). Little detail was provided in these studies regarding the content of these interactions.

Tailoring

The only explicit use of tailoring was seen in Ferguson et al. (2016); however, the use of this feature was minimal. One element of the intervention content could be personalized according to the type of hearing aid ear mold (custom or open) the user had. Hesser et al. (2012), Molander et al. (2015), and Thorén et al. (2014) all regulated progression of participants through successive modules. Although this provides clear structure to the intervention, it may restrict user autonomy, which is believed to help motivate and empower users (Deci & Ryan, 2000; Yardley, Morrison, Bradbury, & Muller, 2015). Thorén et al. (2014), for example, had reports that the intervention was too demanding and suggested future research to consider methods to "tailor the program to individual needs and desires of the hearing aid users to achieve self-empowerment by the individual" (p. 460). It is likely that the clinicians tailored their communications to the user based on individual need; however, this use of tailoring was not reported.

Self-Management

Most interventions required participants to either self-assess or report on the outcomes of their activities. For example, Ferguson et al. (2016) used an interactive quiz at the end of each module to allow self-assessment of learning. Eighty-eight percent of participants reported this was a valuable component for showing them what they had learned from the intervention. Advice and feedback messages were also given where the participants selected an incorrect response, and 91% of participants agreed these messages were clear.

Only Greenwell et al. (2015) reported using a validated clinical questionnaire as part of the intervention. In the Tinnitus E-Programme, participants are asked to complete and self-score the Tinnitus Handicap Inventory (Newman, Jacobson, & Spitzer, 1996) before and after the intervention, and to submit their score to the clinician toward assessing the effectiveness of the intervention. This use of self-monitoring allows users to develop a better understanding of how tinnitus affects their lives and evaluate how much benefit they have gained from the program.

Greenwell et al. (2015) was the only study to use reliable and systematic methods to report on the self-management components, behavior change techniques, and delivery methods included in their intervention. In contrast, the other reports provided little detail on the self-management components (e.g., the nature and goals of the homework, activity planning, and clinician feedback) they used.

Discussion

Internet-based interventions have the potential to reach a substantial proportion of older adults with hearing-related difficulties who may not have access to hearing services (Swanepoel et al., 2010). To maximize the effectiveness of these interventions, we need to better understand how these interventions work and identify the key features that are essential for success (Moore et al., 2014). There is an increasing body of research focusing on the content of Internet-based interventions (i.e., *what* is delivered), whereas our understanding on the design features of these interventions (i.e., *how* this content is delivered) remains relatively limited (Morrison et al., 2012). Here we have reviewed whether contemporary audiology interventions incorporate such design features. Although limited to five interventions, some thoughts emerge. Social contact and support and contacts with the intervention appear particularly important to audiology interventions. In all but one intervention, these features were delivered through a therapist or audiologist. It would be interesting to explore whether these design features would be as effective if automated—that

is, delivered without clinician contact. Morrison et al. (2012) focused only on automated interventions and hypothesized that those interventions that provide automated dialogue components, information about other real users, peer-to-peer mediated communication, and contacts with the interventions that incorporate additional behavior change techniques will be associated with more positive outcomes. Tailoring is also associated with more effective interventions (Morrison et al., 2012). However, this design feature was underutilized in the audiology interventions selected for this review.

Future research could manipulate the interventions to test the interactive design features individually and examine any incremental benefit they alone are responsible for. Collins, Murphy, Nair, and Strecher (2005) provided a useful strategy for optimizing interventions in which randomized experiments are used to determine the optimal dosage level and combinations of intervention features to maximize intervention efficacy. For the development of such complex interventions we recommend turning to the Medical Research Council (Craig et al., 2008) guidance and to be mindful of the framework proposed by Morrison et al. (2012) for the design of effective e-health interventions.

Similar to Morrison et al. (2012), we also found that the intervention publications did not always include the necessary detail to identify the exact nature of the design features, especially regarding self-management features. Intervention studies should provide comprehensive descriptions of the design features, as well as the intervention content, to facilitate study replication and develop a better understanding of how individual features might mediate intervention outcomes (Michie & Abraham, 2004).

This review aimed to provide a snapshot of interventions that were representative of the audiological field, rather than a comprehensive review of the field. As such, it is possible that some alternative interventions may have been missed, which may affect our understanding of these particular design features. A full scoping review is indicated.

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