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Perceptions of the Design of Voice Output Communication Aids

Abstract

Aims

Voice output communication aids (VOCAs) are a key form of aided communication within the field of Augmentative and Alternative Communication (AAC). The aim of this research was to explore the perceptions of communication aid design from the perspective of end users and AAC professionals, with the objective being to inform and influence the design of future devices.

Methods

A two-part study was conducted: interviews were undertaken with people who use VOCAs, and questionnaires were distributed to both people who use aided communication and AAC professionals.

Analysis of the interview data was carried out using a qualitative method based on Framework Analysis whilst descriptive statistics were generated from the questionnaire data.

Interview participants were an opportunity sample of VOCA users within a defined region of the UK. Those recruited were over the age of 12 and able to engage in the interview process; they were identified through the caseloads of local Speech and Language Therapists specialising in AAC.

The questionnaire was marketed to the AAC community throughout the UK. Respondents were self selecting as those using aided communication, their carers, and AAC professionals.
Results

18 people participated in the interviews. Questionnaires were completed by 43 people who use aided communication and 68 AAC professionals. The data suggest that current devices are considered neither reliable nor durable by users and professionals. Although features given a higher importance ranking are more likely to be perceived as available, a number of important design deficits are identified by users and/or professionals. Simplicity of design (and use) and the desire for devices which support communication that is as fast and spontaneous as possible also emerge as key requirements.

Synthesis of the data produced a framework with three main themes covering the range of issues which influence the successful use of a VOCA: specific aspects of the design of a device; the consideration of the wider picture around the person; and, the personal context in which someone uses their device.

Conclusions

Although the original aim of the project was to establish the user requirements of VOCA design, the data indicate that the characteristics of the device cannot be considered in isolation. Those factors uncovered highlight questions about whether the design of communication aids is truly effective in meeting the needs of the people who use them. Based on this data, an initial specification for future device design is proposed.

Keywords

user-centred design; augmentative and alternative communication; voice output communication aids.

What this paper adds
Previous research relating to voice output communication aids has mainly focused on their development, rather than on what the people who use them think about such devices. This study investigated perceptions of communication aid design from the perspectives of both the people who use AAC and the professionals who work with AAC.

The findings suggest that VOCAs fall short of meeting the needs of people who use them; it also suggests that the design of these devices cannot be seen in isolation from the personal context in which they are used and the wider picture around the person using them. The data from this project provides the basis for an initial specification for the design of future devices.
**Background**

Communication is recognised by the United Nations as a fundamental right (United Nations 2006) and Augmentative and Alternative Communication (AAC) techniques can enable people to communicate who would be unable to do so otherwise. AAC techniques include the use of signing, picture boards, alphabet charts, communication books, and also voice output communication aids (VOCAs).

In the past 10 to 15 years, rapid developments in technology have resulted in a tremendous expansion in the range and number of VOCAs available commercially. This effect has been particularly emphasised by the recent advent of smartphone platforms and the accompanying growth in communication applications (AAC-RERC 2011). However, despite the apparent increase in device availability and choice, a recent systematic literature review suggests that factors influencing the barriers and facilitators to successful use of these devices appear to be under-researched (Baxter et al. 2012).

The issue of abandonment of assistive technology is well recognised and VOCAs are not immune to this phenomenon; indeed, a number of authors, for example Sutherland et al. (2005), describe VOCA abandonment as problematic. Newell et al. (2011) discuss how user-centred design (UCD) can be applied to the development of assistive technologies whilst Waller et al. (2005) describe the advantages of applying this method to VOCAs, drawing on evidence from workshops with people who use AAC and practitioners. However, in her thesis, Prior (2011) concludes that there has been limited application of UCD and user-involvement to the design of VOCAs, either in the literature or in industry.

The link between device abandonment, the user requirements of devices, and device design is discussed by some authors, although there appears to be little work directly investigating this. Dawe (2006) argues that simplicity of design is key to reducing abandonment in electronic...
assistive technology, including VOCAs. Similarly, other authors also highlight the complexity and poor usability of some communication aids (Murphy 2004; Salminen et al. 2004). Light & Drager (2002) review the design requirements of AAC systems for young children, but this is not derived from primary user data. O’Keefe et al. (2007) report on focus groups with people who use AAC and their facilitators, and identify six themes where further research was agreed by the groups as being important. Two of these relate to the development of VOCAs: “improve the performance of existing VOCAs”; and, “improve the design of new VOCAs and low-tech aids”. Murphy et al. appear to have carried out the largest body of work in this area, including a study involving 93 people who use VOCAs (McCall et al. 1997; Murphy et al. 1996). However, this study looked at the obstacles to effective VOCA use from the perspective of communicative interactions, rather than focusing on the user requirements of VOCAs as devices.

Objectives

Funded through the Devices for Dignity (D4D)\(^1\) programme, this project was designed as the foundation for a stream of research aiming to define more precisely the user requirements of VOCAs, in order to improve the suitability of devices and thus reduce abandonment. The project aimed to involve people who use VOCAs in the process of defining device requirements. A previous study by one of the authors (Judge et al. 2009) suggests that gathering qualitative data from people who use assistive technology devices can highlight a range of factors relating to both successful and unsuccessful device use. Therefore, it was hypothesised that data would emerge from this project which could be used to inform and influence the design of future devices.

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\(^1\) D4D is one of two pilot Healthcare Technology Co-operatives in England, funded by the Dept of Health. It is a collaboration between clinicians, patients, academia and industry, and addresses issues of dignity and independence through its focus on the design, development and evaluation of medical devices to improve healthcare quality and well-being for patients with long term conditions. [http://www.devicesfordignity.org.uk/](http://www.devicesfordignity.org.uk/)
The specific research objectives for the study were to establish (i) what people who use VOCAs want from their devices, and (ii) which factors contribute to the perceived success and dignity of use of these devices.

**Method**

A two-staged approach was taken to the study, utilising two well established methodologies (interviewing and surveying), in an attempt to extract detailed data whilst also involving as large a population as possible. Ethical approval for the project was granted by the South Yorkshire Research Ethics Committee.

**Stage One: Interviews**

Interviews were undertaken with a range of people who use VOCAs in two neighbouring regions of northern England. The interviews were designed to explore in depth the experiences of people who use VOCAs, their perceptions of their communication aids, and any issues they identified around the design and use of these devices.

**Participant Inclusion Criteria and Recruitment:**

Criteria were designed to select participants who would be able to engage in the interview and express opinions about their use of their communication aid. This was an opportunity sample of participants and the sample size was determined by saturation of the data. The inclusion criteria for the sample were defined as:

- current users of medium or high tech VOCAs
- those with the ability to produce more than 20 utterances and, ideally, the ability to produce novel utterances
- secondary school age and above
Potential participants were recruited through local Speech and Language Therapists specialising in AAC in the identified regions. The AAC specialists were sent the project information and asked to identify and contact people who use VOCAs meeting the inclusion criteria. The specialists then asked each user for verbal consent to their name and contact details being passed to the research team. All possible participants identified by local specialists were sent a project information sheet and consent form, and were given at least seven days to decide whether they wished to participate in the research. The information sheet was followed up by a phone call from a member of the research team. Verbal consent to participate was requested over the phone and formal consent was taken at the time of the interview visit. If potential participants were not able to sign a consent form because of the nature of their disability they were asked to indicate consent on an audio recording; where the participant was considered vulnerable this took place in the presence of the carer.

**Interview Format:**

Interviews took place in each participant’s home or preferred location (for example, school or day centre) and were conducted by members of the research team who had no prior clinical contact with the participants. Participants were encouraged to use their preferred means of communication during the interviews, with support from carers and family members where preferred or needed. The interviews were audio-recorded.

The approach to the interviews drew on a range of techniques described in the literature to facilitate discussion with participants who would, by the nature of their inclusion in the project, have speech, language or communication difficulties. The design of interview resources considered the potential need for structured vocabulary and ‘communicative scaffolding’, whilst also balancing the potential for participants to communicate open responses using their VOCAs or other communication methods.
Obtaining high quality and wide-ranging qualitative data from participants with communication difficulties is generally acknowledged to be challenging. With regard to interviews, particular challenges are associated with supporting participants’ communication whilst not constraining or leading their responses. ‘Talking Mats’ is often cited as a method for including people with communication difficulties in research interviews (Murphy et al. 2005), with other methods including the use of cue cards and vocabulary lists. An excellent review of such methods can be found in Nind (2009).

The interview resources which were developed for this study drew strongly on the Talking Mats approach, whilst retaining options for more flexible and creative use; their design was also influenced by existing frameworks for assistive technology and by preliminary work conducted by one of the research team (Townend 2007). The resources included a pre-interview preparation guide, an interview topic guide, and interview prompt sheets. All resources covered the domains of design recognised in existing assistive technology frameworks, namely those of ‘context’, ‘individual’, ‘activity’ and ‘technology’.

The pre-interview guide was sent to participants after initial consent to take part in the interview was obtained. The aim of the guide was to allow participants to consider the topics of the interview and to pre-prepare any relevant vocabulary or messages on their communication aid (if possible or relevant).

The interview topic guide was designed for use by the researcher during the interview; it provided a set of main topics to be discussed and some possible open questions that could be used to stimulate conversation around these topics. The main headings of both the pre-interview guide and the interview topic guide reflected the prompt sheets.

The prompt sheets were designed to be used by the participant independently or in conjunction with the researcher or communication partner. Each prompt sheet contained up to
24 vocabulary items which covered a range of points of view relating to each topic and sub-topic. The prompt sheet headings were: about myself; communication environments and situations; reasons for communicating; topics; physical environment; ease of use; build quality; speech; access and control; performance; language system; options; cost, security and safety; training and support; and ideas for the future. In addition, there was a prompt sheet of words describing levels of ‘importance’ and also one of more general ‘descriptive words’. Prompt sheets were differentiated for the individual participants’ communication needs and were produced in a range of text and symbolised forms. They were designed to be used in a number of different ways including eye pointing, gesturing, or partner assisted scanning. An example of a prompt sheet is shown in Error! Reference source not found..

Interview Analysis:

The interviews were transcribed and the transcriptions pseudonomised, with participants represented by numbers rather than initials. Qualitative analysis of the data was undertaken, based on a Framework Analysis methodology (Ritchie & Lewis 2003), using NVivo 8 as the analysis tool. The analysis was undertaken by two researchers to reduce potential for coding bias: a sample of transcripts was initially coded by each researcher and the codings collaboratively merged and consolidated into an initial framework; the remaining transcripts were then coded according to this framework (whilst retaining scope for coding to additional themes/sub-themes) by each researcher; the codings were again merged and consolidated into a final framework, which was reviewed and agreed upon by both researchers.

Stage Two: Questionnaire

A questionnaire was designed in order to gather data from a wider geographical population of people who use VOCAs, those using other forms of AAC, and also from AAC professionals.
The questionnaire was distributed after the first interview stage of the project had been completed.

**Inclusion Criteria for Questionnaire Respondents:**

The potential population of people using aided communication in the UK is relatively small and, therefore, the questionnaire was intended to appeal to, and be accessible to, as wide a section of this interest group as possible. Inclusion criteria were thus set more broadly than for the interviews, as:

- current users of *any form of aided communication* (high tech or low tech), or people who have done so in the past, and who
  - have an opinion about communication aids and are able to answer a questionnaire with or without support from a carer
  - are of any age, medical diagnosis, language level, and physical ability
- carers of clients who use or have used aided communication
- professionals with experience of working with clients who use aided communication

**Questionnaire Design and Distribution:**

A first draft of the questionnaire was designed to replicate the overarching thematic structure of the interview resources. An initial analysis of the interview data was then used to validate that these themes were of relevance to respondents before the questionnaire was finalised, i.e. that the chosen themes were indeed emerging from the interview data. Each page of the questionnaire addressed one theme, with 4 or 5 statements about features related to that theme. For example: the theme “*Ease Of Use: What would make your ideal device easy to use?*” included the statements: “*It would… get my message across quickly with minimum*
“effort (efficient)”; “be set up just as I need it to be (suitable)”; “be adaptable as my needs and abilities change (adjustable)”; “work well without frequent breakdowns or problems (reliable)”. Each statement was accompanied by:

- a 3-point likert scale where respondents could rate how important each feature was to them in an ideal device (definitely, maybe, not at all);

- a rank order scale asking respondents to rank the importance of the feature as compared to the other features on that page (sharing the same theme);

- a binary tick box for respondents to identify if the feature was currently available on their device.

Each theme/page included a space for ‘free text’ qualitative answers. An example of a questionnaire page is shown in Error! Reference source not found..

<< INSERT FIGURE HERE >>

The themes within the questionnaire were divided into three sections. These were:

**Section One: About your ideal communication aid:**

- **Ease Of Use:** What would make your ideal device easy to use?

- **How A Device Is Made:** What physical characteristics would be important for your ideal device?

- **Speech Output:** Would the way your ideal device speaks be important to you?

- **Controlling A Device:** What features of access and control would be important in your ideal device?

- **Performance:** How would you like your ideal device to perform?
Design And Layout: Would the page design, screen layout and organisation of vocabulary on your ideal device make a difference to you?

Overall, thinking about your ideal communication aid - can you think of anything else about a communication aid that could affect how you would use it? Think about things that could make it easier or things that would make it harder to use.

Section Two: About Your Environment

Physical Environment And Transport: How much would your physical surroundings and moving between different places affect the way you use your ideal communication aid?

Training: Would receiving training to use your ideal communication aid make a difference?

Support: What help and support would be important to your use of your ideal communication aid?

Overall, thinking about your environment - can you think of anything else about the environment or routine that could affect how you would use a communication aid? Think about things that could make it easier or things that would make it harder to use.

Section Three: More About Your Priorities

In this section, respondents were asked to rank each of the main features (listed above) against each other through a tabulated list of likert and rank order scales.
Section Four: About You

- Information about the respondent’s aided communication and VOCA use;
  - demographic and medical information.

The questionnaires were offered in a number of formats: standard text, large text, and symbolised\(^2\) (versions utilising WLS and PCS symbol sets were distributed; other symbolised versions were created but not distributed due to licensing difficulties) and via a range of media: paper copies, an online web-page (standard text – created using the LimeSurvey\(^3\) software) or downloadable PDF (standard text and symbolised versions). The questionnaire was also released with two versions – one for people who use aided communication and their carers, and one for AAC professionals. The only difference in these versions was the phrasing of the questions and the final section where demographic or caseload data was obtained respectively.

The questionnaire was available for a four-month period in 2009, and was advertised through UK AAC networks – for example, the Communication Matters\(^4\) website, email list and annual conference; the Royal College of Speech and Language Therapists ‘Bulletin’; the Speech and Language Therapy in Practice journal and website; mailshots to AAC Assessment Centres and AAC professionals, and to support organisations and charities whose membership included potential respondents (e.g. SCOPE, Motor Neurone Disease Association, etc). Paper copies of any of the formats of questionnaire could be requested from the research office; these were posted with a self-addressed envelope to encourage their return. The online format was accessible through the D4D website.

\(^2\) Permission to use the symbols was granted by Widgit Literacy Symbols and Dynavox Mayer-Johnson.
\(^3\) LimeSurvey survey software: [http://www.limesurvey.org](http://www.limesurvey.org)
\(^4\) the UK Chapter of ISAAC: [http://www.communicationmatters.org.uk](http://www.communicationmatters.org.uk)
Questionnaire Analysis:

The questionnaire data collected from the paper-copy returns and the online software was collated into a statistics package (SPSS) for quantitative analysis. Descriptive statistics were extracted for each theme of the survey. Chi-Square tests were performed on the ‘importance’ and ‘availability’ responses to assess the significance of any associations within each theme. On the likert ‘importance’ scale any responses of ‘not at all important’ and ‘maybe important’ were pooled, since these cases often had zero values without pooling. Values of the ‘importance’ ranking were set between 1 (highest ranking) and 4 or 5 (lowest ranking) and reported as mean values.

Each questionnaire section was collated into a single bar graph with the main data series being the ‘availability’ responses for each feature and each group on the y axis. The totalled rank order scores for each group and feature were also added to the y axis, and the features were displayed according to the rank order scores of the user group. The data from the likert scale was omitted from the graph in order to reduce complexity and because the correlation between this measure and the ranking measure was good. Examples of such graphs can be seen in Figure 6 and Figure 7.

Results

Participants

Interview Participants:

Interviews were conducted with 18 people who use VOCAs (summarised in Table 1). Participants had a variety of conditions: the majority were congenital, with the most common condition being cerebral palsy. Since this was an opportunity sample, the participants had
not been selected specifically to balance conditions or age. The resulting sample, however, did include a range of conditions and ages.

**Questionnaire Respondents:**

164 paper questionnaires were sent out and the online questionnaire was marketed widely. 33 professionals filled out the paper version of the questionnaire, and 35 filled out the questionnaire online (total n=68). 28 people who use AAC filled out the paper questionnaire and 15 filled out the online version (total n=43). The overall return rate is impossible to calculate because of the nature of the marketing of the survey. However, the return rate of the paper copies was 37%.

**Respondents who use AAC (Error! Reference source not found.):**

All but one of the respondents reported that they currently use, or have used, a voice output communication aid; the majority of respondents were people who use a communication aid themselves, with eight respondents being family members/carers of someone who uses a communication aid. The majority of respondents reported that they live with family (75%), 11% were living alone, 8% in supported accommodation, and 6% in a residential care home. Most were between the ages of 12 and 18, with no respondent being over the age of 66. The majority of the respondents had Cerebral Palsy (62%), with Learning Disability and Progressive Acquired Conditions being the next most reported (9% each). This epidemiology is similar to the participants in the interview stage.

<< INSERT FIGURE HERE >>

**Professional Respondents (Figure 4):**

The majority of respondents were Speech and Language Therapist (46%, or 69% including Specialist Therapists); all other professions were significantly less well represented, with
Speech and Language Therapy Assistants (2), Specialist Teachers (2) and Technician (2) being the other professions represented by more than one respondent.

There was large variation within the reported caseload sizes. The mean ‘aided communication’ caseload size was 70, whilst the mean value for ‘voice output communication aids’ caseloads was 43. Both of these statistics had large standard deviations (276 and 165) and ranges (1999 and 1200) suggesting skewed data. The median values for the caseloads were 25 for ‘aided communication’ and 10 for ‘voice output communication aids’.

The mean length of time professionals had been working with voice output communication aids was 10 years (standard deviation 7 years). A large standard deviation was again evident in the reporting of the number of clients on professionals’ caseloads using different types of communication aids, with ‘large high tech’ communication aids representing the biggest group by mean (mean=38, median=4, std.dev=157) followed by ‘low tech’ communication aids (mean=30, median=14, std.dev=39).

More professionals worked with clients in the age range of 12-18 years than any other (matching the profile of the respondents who use AAC) and, in general, respondents worked more with children (under 18) than adults. People with Cerebral Palsy were most commonly reported as being on the professionals’ caseloads (84% of respondents), with Learning Disabilities (82%) and Autistic Spectrum (70%) also common. Professionals most often reported seeing clients in educational settings (77%), with home environments the second most frequently reported (63%).
Device Design Framework

The results from the qualitative interview data and quantitative questionnaire data were collated and synthesised into a framework consisting of three main themes, each having between five and eleven sub-themes. This framework (see Figure 5) represents a conceptual model of the perceptions of communication aid design as experienced by people who use VOCAs.

Summaries of the data within each sub-theme (in bold italics) are presented below with sample qualitative and quantitative data (the full data being too lengthy to present here). Chi-squared test results are reported where significant trends are suggested (p<.05).

Device Design:

The majority of respondents to the questionnaire in both user (88%) and professional (94%) groups reported that all features of ease of use were important (professional respondents: $x^2=13.7$, df=3, p =0.003). ‘Efficiency’ and ‘reliability’ emerged as the most important features ranked by both groups (mean rankings of 1.7 | 1.8 and 2.2 | 2.4 respectively for users|professionals). However, as shown in Figure 6, respondents in both groups were also more likely to feel that current devices were not ‘reliable’ (61% of user and 62% of professional respondents, with professional respondents $x_2=26.7$, df=3, p=0.000).

Reliability also emerged as a separate sub-theme on analysis of the interview data. A number of issues relating to device reliability were raised which affected interviewees’ confidence in using their devices. For example, devices making ‘unexpected noises’; ‘breaking down’; and, ‘taking a long time to repair’. Sometimes ongoing, unsolved problems were reported.
Interviewees and their carers reported feelings of frustration, anger and panic when they were unable to rely on their device working well, or were left for long periods of time without a working device. In a number of cases this led to a lack of motivation to use the device. In contrast, however, some interviewees were happy and satisfied that their device was reliable.

**Quote 1: Sample extract from ‘reliability’ sub-theme.**

All features of *device performance* were rated as ‘very important’ by the majority of users and professionals (users $x^2=10.2$, df=3, $p=0.017$; professionals $x^2=40.4$, df=3, $p=0.000$). Users rated all features as not being currently available, with ‘having a battery that lasts a long time’ being chosen most often as not available (73%). Professionals gave mixed responses: ‘ready quickly’ (57%) and ‘rechargeable while using’ (57%) were rated as currently available by a marginal majority of professional respondents whereas ‘it would be easy to look after’ (72%) and ‘have a battery that lasts a long time’ (66%) were rated as not currently available (user $x^2=9.1$, df=3, $p=0.028$; professional $x^2=43.9$, df=3, $p=0.000$). Both
user and professionals respondents ranked the features in the same order with ‘being ready quickly’ and ‘a battery that lasts a long time’ being ranked most highly (mean ranking of 1.74 and 1.89 for users).

When considering the effects of good and bad design interviewees demonstrated a strong association between a device being easy to use, being well designed, and being ‘simple’. Conversely, there was a clear association between interviewees’ perceptions of poor design and the cognitive load that they felt the machine placed on them to use it, both in operation and configuration/setup.

Questionnaire data around how a device is made indicated that a significant majority of both user (90%) and professional (81%) respondents felt that there were no ‘durable’ devices currently on the market (users $x^2=15.39$, df=3, $p=0.002$; professionals $x^2=50.46$, df=3, $p=0.000$). All features of how a device is made were considered important to the majority of both groups (an average of 90% of user and 84% of professional respondents) and the most important feature rated by both groups was having a device that was portable (mean ranking of 1.9 by user and 1.7 by professional respondents).

Many different aspects were reported during the interviews which related to a broad range of physical characteristics and thus this sub-theme was further sub-divided into nine areas of concern to interviewees: batteries; design and aesthetics; display; mounting; ruggedness; size; weight; transporting; use outdoors. In each of these areas interviewees highlighted examples where these characteristics exert a significant, and generally negative, impact on their use of a device.

An average of 63% of user and 52% of professional questionnaire-respondents rated most features connected with use of a device in the physical environment and transport as not currently available (professional $x^2=16.2$, df=3, $p=0.001$). Although none of the features
provoked strong responses, this was an un-characteristic response for professional respondents as the majority typically regarded most features as currently available.

The majority of user (85%) and professional (78%) respondents considered all features of design and layout to be important except ‘integrating additional features in one device’ where the majority (68%) of professional respondents rated this as not important (user \(x^2=15.1, df=3, p=0.002\); professional \(x^2=112.2, df=3, p=0.000\)). Both user and professional groups also gave ‘integrate additional features in one device’ a low ranking (mean rankings of 2.89 by user and 3.84 by professional respondents). Both groups of respondents rated ‘being able to find words and messages easily’ as the most important feature (mean rankings of 1.1 by user and 1.5 by professional respondents). The majority of user respondents felt that devices did not offer any features of design and layout except ‘producing spontaneous messages’ where 56% of respondents felt that this was available (user \(x^2=7.98, df=3, p=0.046\)).

When considering device configuration during the interviews, there was variation between interviewees around whether they or their carers were able, and felt confident, to modify or programme their devices. However, the value of personalising a device in terms of vocabulary, pictures, and layout, and how it impacted on interviewees’ use of the devices, was a recurrent theme throughout the interviews.

Three main aspects were reported during the interviews around interviewees’ perceptions of the voice output of their devices: personalisation, quality and volume.

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<th>Would you change the accent?</th>
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<tr>
<td>I</td>
<td>You would.</td>
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CP Would you make it Scottish? No? You would, would you make it Scottish? No. What would you do? Would you make a more regional accent from
Yorkshire? Do you think she should sound like she’s from Yorkshire, (X), your communication aid? You do.

[laughing] I didn’t know that. You’ve surprised me! [laughing]

I Do you want it to sound more like (Support Worker)?

CP Would you like it to sound more like (Support Worker) or more like me or anybody else?

CP Like me? You don’t want to listen to me all the time! [laughing]

Quote 2: Sample extract from ‘voice output – personalisation’ sub-theme.

Professionals responding to the questionnaire rated a ‘range of voices to choose from’ more highly (mean ranking 2.25) than users (mean ranking 2.8) who rated this as least important of the voice output features. 65% of users felt that there was not currently a choice of voices available to them. Having ‘an alternative way of sharing a message’ was given a low ranking (users mean ranking of 2.8, professionals 3.3). The majority of users (80%) and professionals (75%) agreed that devices should be ‘quick to speak’ and gave this a high ranking (mean ranking by users of 1.7 and professionals of 2.1).

Wider Picture

Interviewees reported that using a communication aid was a slower means of communicating than would be experienced in naturalistic spoken conversation. This effect of slowed speed of communication was a great cause of frustration for some interviewees, particularly where they had previous experience of communicating verbally.

Regarding the impact of training and learning, interviewees reported mixed experiences of initial training upon receiving a device, as well as of longer-term encouragement to practice and to learn how to use it. In some cases interviewees felt they were very much left to find their own way around the device; this was perceived as a poor introduction by some but as a
preferred option by others. Some interviewees were of the opinion that very practical training, being shown how to do something on a device, had been of benefit to them initially, and some had benefitted from intensive practise with a communication partner, perhaps on a daily basis.

Complexity of device and the cognitive load this imposed were highlighted as factors in learning how to use a device successfully. The majority of users (80%) and professionals (87%) responding to the questionnaire rated training in general as important (professional $x^2=15.2$, df=3, $p=0.002$). User and professional respondents both ranked ‘training for the user’ as most important (mean ranking of 1.56 by user and 1.57 by professional respondents) followed by ‘training for the family’ and ‘training for the carers’. However, examination of the ranking of the percentage of responses rated ‘very important’ by professionals provides a slightly different view, with ‘training for carers’ and ‘training for the family’ ranked more highly than ‘training for the user’. Training for ‘a wider group of people’ was agreed to be the least important type of training (mean ranking scores of 2.9 by user and 3.36 by professional respondents) but there was also majority agreement (76% of user and 60% of professional respondents) that this did not currently exist (professionals $x^2=24.9$, df=3, $p=0.000$).

An average of 82% of user and 88% of professional respondents felt that help and support was important. Both groups ranked ‘ongoing help and support from professionals’ most highly (mean ranking of 2.0 by user and 2.0 by professional respondents) although 61% of users felt this did not currently exist, in contrast to 37% of professionals (users $x^2=10.6$, df=4, $p=0.032$; professionals $x^2=18.9$, df=4, $p=0.001$). ‘Regular reviews’ were given a low ranking (mean ranking of 3.4 by user and 3.6 by professional respondents), and 89% of user and 68% of professional respondents felt that these were not currently carried out. 67% of user
respondents felt that there was not currently ‘help and support from carers’, compared with 50% of professionals (users $x^2=15.1$, df=4, $p=0.005$; professionals $x^2=15.67$, df=4, $p=0.004$).

The influence of service delivery was a strong theme in the interview data. Some interviewees reported that they had been able to look at or try out a range of devices before selecting their current device, whereas others had no knowledge of devices beyond the one they had been given and had played no part in the decision to select that particular device. Interviewees were aware of current developments in communication aids to widely varying degrees. Provision of ongoing AAC support was also discussed in the interviews. Interviewees reported that they usually knew who to contact when there was a problem with the device, but otherwise they did not have regular contact with AAC professionals once their device had been supplied and set-up. This situation was universal but was perceived differently by different interviewees; some were satisfied that someone was at the end of a phone and could be called upon when needed, others expressed frustration that they did not receive more regular support.

Strong evidence from the interview data emerged around interviewees’ restricted use of their communication aid. During the interviews some interviewees did not use their device but preferred to communicate verbally even thought this did not make for easy conversation (this was often where the text and symbol resource materials prepared for the interviews were of particular benefit). Interviewees reported that they did not use their communication aids in all environments or in all situations. In general, they reported that they did not use their devices outdoors and limited their use to key environments such as home, school, college, day centre or respite care.

1 1 OK. You said that you use your DEVICE at home and at school and at (respite care). Do you ever use it when you’re outside?
Feeling that there were people who could support aided communication within their immediate environments appeared to relate closely to how confident interviewees were in using their communication aids. However, there was widely reported variation in the range of people who were able to fulfil this role. Some interviewees benefitted from well-defined AAC support teams who offered the potential for daily or weekly contact in a school/college/day-care environment; others relied on close family members for day to day support.

Context

There were a number of occasions when the benefit of using a communication aid to clarify a misunderstanding was clearly demonstrated during the interviews. Sometimes interviewees reached spontaneously for their device when a verbal misunderstanding arose; at other times they were prompted to do so. In addition, interviewees quoted examples of occasions when they addressed communication breakdown through communication aid use.

When discussing their motivation and reasoning around the use of aided communication, interviewees gave reasons that ranged from simple statements of fact, such as ‘to talk’ or ‘say some words’; through practical reasons such as ‘people are not always able to read my writing’; to core reasons for communicating, such as ‘socialising’, ‘expressing thoughts and feelings’, ‘chatting and gossiping’; ‘making friends and furthering relationships’; ‘making choices and requests’; and ‘giving instructions to unfamiliar carers’.

Quote 3: Sample extract from the 'restricted use of communication aid' theme.
When asked to describe their current means of communication, interviewees described the **context of their current use of aided communication**. Interviewees reported use of the full range of aided and unaided communication, for example: *facial expression and body language; pointing, gestures and signing; vocalisation or spoken words; alphabet boards; pen and paper; texting on mobile phones; and writing on a computer*. For many interviewees the use of a VOCA was as a minority communication tool within this spectrum of methods.

Whether interviewees had **experience of any other forms of technology**, and other communication technologies, prior to their current device, was influenced by factors such as their underlying aetiology and the length of time they had experienced communication difficulties. Some interviewees reported previous familiarity with typewriters and computers, which had helped them in understanding and using their communication aid; for others the concept of high-tech devices had been a new challenge prompted by necessity and to some extent may have dictated the type of device they used. Not all interviewees were comfortable with the complexities of high-tech equipment.

The **environments** in which interviewees used their devices varied according to personal needs, preferences and perceived limitations. For some users it was vital that they used their device in common daily settings, for others they were used in broader settings such as when out shopping, at the pub or on work experience.

One of the elements which influenced the type of device that interviewees used was the way in which they were able to physically access or **control** a device. For some users their physical skills were unchanging, meaning that once the decision on most appropriate access method had been made their longer term need had been catered for; for others their physical skills were changing (in some cases this meant aiming for an increase in physical ability, in others an inevitable deterioration) and they needed to be able to adapt and change their access
method, and sometimes device, over time. Not all interviewees felt they had the most appropriate or easiest method for them set up at the current time. Some interviewees expressed the feeling that their own perfect solution was not yet clear, and some felt it would not easily be met by the ‘inhuman’ side of technology.

Both user and professional respondents to the questionnaire felt that having a device that was ‘easy to charge up’ was of low priority (mean ranking of 2.8 by user and 3.6 by professional respondents), and 73% of users and 79% of professionals described this feature as not currently existing (users $x^2=9.09, df=3, p=0.028$; professionals $x^2=43.89, df=3, p=0.000$). 96% of users and 60% of professionals responded that devices did not currently exist that were ‘easy to move between a range of places’ although this feature was ranked highly by user respondents when looking at the ranking of responses rated ‘very important’ (users $x^2=10.20, df=3, p=0.017$; professionals $x^2=40.41, df=3, p=0.000$). Having the ability to ‘turn a device on and off independently’ and having the ‘right access method’ were both highly rated (mean ranking of 2.08 | 2.48 and 2.08 | 1.33 for user | professional respondents respectively – see Figure 7).

**Availability and ranking correlations**

A moderate correlation was seen between ranking and availability – i.e. the more highly a feature was ranked the more highly it was rated as ‘currently available’. For users ($r=0.023$) this correlation was weaker than for professionals ($r=0.44$).

**Discussion**

The *Devices for Dignity* programme aims “to deliver innovative medical devices which .... place the needs of their users at the centre of the design and development process”(D4D Co-operative 2007). In order to fulfil this aim D4D has established four ‘Dignity Tests’ which all devices delivered by the programme must pass. These have been extracted from the ten
dignity challenges set out by the *Dignity in Care Campaign* (Cass et al. 2009). The *Devices for Dignity Tests* are:

- The device should enable independence, choice and control;
- The device should assist people to maintain confidence and self esteem;
- The device should act to alleviate loneliness and isolation;
- To enable a personalised service to be offered, use of the device should be customised easily.

Voice output communication aids have the potential to meet all of these tests and be devices that promote dignity and independence. The aim of this project, rather than designing new devices, was to investigate the user requirements and perceptions of current devices and to establish whether they are meeting these dignity tests.

The data suggest that current devices are considered neither reliable nor durable by users and professionals alike, with the implication that such basic design requirements impact significantly on perceptions of successful use of a device, and contribute to the limited environments in which users reported using their devices. Interviewees frequently referred to the design of current devices in negative terms and the questionnaire respondents also highlighted a number of failings of device design.

A large number of specific design issues emerged from the data which could constitute a useful specification for a communication aid; devices were not perceived to be easy to look after and their lack of reliability was sub-divided into very specific problems. These features of device design included: battery life; aesthetics; display options; mounting; ruggedness; size; weight; transportation; and use outdoors.
Simplicity of use emerged strongly as a theme and was perceived to be related to reliability and to speed of communication. It was both an aspiration (for users who felt their current devices were not simple) and a positive experience (for users who felt their current devices were simple and easy to use). Ease of use was the most highly ranked, and therefore most highly valued, section in the questionnaire. Conversely, ‘integration of additional features’ was perceived as adding to device complexity, and therefore unimportant, despite being available.

Another strong theme emerging through the data was the effect of the slow speed of communication. This slowed communication rate was again closely linked to the perceived success and dignity of use of devices. Both users and professionals felt strongly that VOCAs should enable communication to be as speedy and spontaneous as possible. The effect of slowed access to a device was acknowledged by users, but with the implication that better access methods should be found and customised systems developed to allow for faster, more spontaneous communication.

The correlation between ranking of features and availability (features rated more highly by users and professionals were slightly more likely to be rated as available) suggests that the design of current communication aids is considering some of the needs of users. However, the fact that it is only a weak correlation also indicates a lack of user involvement in the design of these devices. In this respect, as well as in the design failings outlined above, current devices would appear to fall short of the Devices for Dignity tests.

From the analysis of this data, the authors are proposing a framework of VOCA design and suggest that this fills a gap in the characterisation of VOCAs. A number of models of assistive technology already exist that describe the factors influencing technology usage, and provide frameworks for decision making within the context of selecting devices. These
include the ‘Matching Person and Technology’ model (Scherer & Craddock 2002), the ‘Human Activity Assistive Technology’ model (Cook & Polgar 2007), and a usability framework for assistive technology created by Arthanat et al. (2007). However, none of these are specific to the user requirements when considering communication aids nor do they provide an explicit framework for device design.

The framework proposed (Figure 5) by this research offers three ‘pillars’ or domains - in addition to ‘device design’ the framework recognises the contribution of the ‘wider picture’ and the personal ‘context’ to the use of communication aids. It acknowledges that a number of aspects relevant to these domains may contribute towards an individual’s successful use of a device (for example, a supportive environment). These aspects will be discussed at more length in other papers. However, their prominence in the data suggests that they should be regarded equally when designing communication aids (Figure 8), and that neglect of any of these aspects could also be seen as a failing in device design.

Limitations

The sampling of interview participants was not designed to balance across device, diagnostic, demographic or other characteristics; sampling was also limited to a single geographical region of the UK. However, the diagnostic balance of the interview participants did reflect the balance of the questionnaire respondents, participants did use a range of devices, and saturation of the data did occur.

The sample size of questionnaire respondents was self-selecting and could be biased. Although the sample was sufficient to provide statistical significance for some trends within themes (particularly among professional respondents) it was not sufficient to generate
significant results across all themes. The survey could be considered to be a pilot and a repeat of the survey should aim for a greater sample size.

The design of the questionnaire may have been too complex for some respondents; the strong correlation between the two ‘importance’ measures indicates that the design of the questionnaire could be simplified by eliminating one of these measures. Having completed the synthesis of the data following the close of the survey, it became evident that the questionnaire covered more in the ‘device design’ domain than the other two domains of ‘wider picture’ and ‘personal context’. The potential for re-designing the questionnaire based on these results, and its possible use as a decision support tool, will be discussed elsewhere.

The qualitative data from the questionnaire has not yet been analysed; neither has it been incorporated into the framework, as an initial overview of the data indicated that it would not add substantially to the already saturated qualitative data collected in the interviews.

A number of the features identified could be considered to be contradictory, which could be regarded as a further limitation of the study. For example, questionnaire respondents report that current devices are ‘useable for spontaneous messages’, but at other points in the survey they highlight this as a challenge. The authors suggest, however, that these points of conflict should be regarded as points of interest, and serve to demonstrate the complexity of the challenge of VOCA design.

Conclusions

This study provides an extensive investigation into the features of communication aid design as perceived by users of these devices and professionals who provide them to users. A framework was developed which describes the user requirements of a VOCA in terms of three ‘pillars’: device design; the wider picture; and the personal context. It is interesting to
note that although the study was focused on device design the additional two aspects emerged as equally important to users’ device usage.

All three pillars of the proposed framework present challenges for device design. The data highlights the complexity of the user requirements of VOCA devices and the need to involve end users in their design. With regard to the implications for device design, the data suggest that efforts should be channelled into designing devices that are perceived to offer a high speed of communication and that are reliable, simple and portable.

**Declaration of Interest**

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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<table>
<thead>
<tr>
<th>Communication Aid</th>
<th>Ease of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective</td>
<td>Simple</td>
</tr>
<tr>
<td>Easy</td>
<td>Tiring</td>
</tr>
<tr>
<td>Poor</td>
<td>Ineffective</td>
</tr>
<tr>
<td>Good</td>
<td>Helpful</td>
</tr>
<tr>
<td>Sets Message Across</td>
<td>Reliable</td>
</tr>
<tr>
<td>Flexible</td>
<td>OK</td>
</tr>
<tr>
<td>Unreliable</td>
<td>Variable</td>
</tr>
<tr>
<td>Adaptable</td>
<td>Not flexible</td>
</tr>
</tbody>
</table>

Figure 1: Example Prompt Sheet
## Section One: About Your Ideal Communication Aid

**Ease Of Use: What would make your ideal device easy to use?**

<table>
<thead>
<tr>
<th>It would ...</th>
<th>Definitely</th>
<th>Maybe</th>
<th>Not at all</th>
<th>Order of priority for me (1=highest)</th>
<th>My device does this at the moment (✓=yes)</th>
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</thead>
<tbody>
<tr>
<td>get my message across quickly with minimum effort <em>(efficient)</em></td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>be set up just as I need it to be <em>(suitable)</em></td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>be adaptable as my needs and abilities change <em>(adjustable)</em></td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>work well without frequent breakdowns or problems <em>(reliable)</em></td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

*Is anything else important to do with how easy a device is to use? Please write it here:*
Figure 3: VOCA User Respondents Profile
Figure 4: Professional Respondents Profile

Figure 5: The Three Domains of Communication Aid Use
It would get the user's message across quickly with minimum effort (efficient)
It would work well without frequent breakdowns or problems (reliable)
It would be set up just as the user needs it to be (suitable)
It would be adaptable as the user's needs and abilities change (adjustable)

Currently Available | Not Currently Available

Figure 6: Device Design Questionnaire Theme

It would be easy for the user to turn on and off him/herself
It would offer the right access method for the user
It would be moved easily between a range of positions to suit the user
It would be easy for the user to charge up or change the batteries him/herself

Currently Available | Not Currently Available

Figure 7: Device Control Questionnaire Theme
Figure 8: The Three Domains of Successful Device Usage
<table>
<thead>
<tr>
<th>ID</th>
<th>Current VOCA</th>
<th>Age</th>
<th>Acquired/ Congenital Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Liberator 14</td>
<td>12-18</td>
<td>Congenital</td>
</tr>
<tr>
<td>2</td>
<td>Pathfinder</td>
<td>12-18</td>
<td>Congenital</td>
</tr>
<tr>
<td>3</td>
<td>Communication Board. &amp; Tablet PC</td>
<td></td>
<td>Congenital</td>
</tr>
<tr>
<td>4</td>
<td>Liberator 14</td>
<td>12-18</td>
<td>Congenital</td>
</tr>
<tr>
<td>5</td>
<td>Lightwriter</td>
<td>66+</td>
<td>Acquired</td>
</tr>
<tr>
<td>6</td>
<td>DV4</td>
<td>19-40</td>
<td>Congenital</td>
</tr>
<tr>
<td>7</td>
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<td>40-65</td>
<td>Acquired</td>
</tr>
<tr>
<td>8</td>
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<td>12-18</td>
<td>Congenital</td>
</tr>
<tr>
<td>9</td>
<td>Lightwriter</td>
<td>40-65</td>
<td>Acquired</td>
</tr>
<tr>
<td>10</td>
<td>Powerbox 3</td>
<td>19-40</td>
<td>Congenital</td>
</tr>
<tr>
<td>11</td>
<td>Vantage</td>
<td>12-18</td>
<td>Congenital</td>
</tr>
<tr>
<td>12</td>
<td>Say-It-Sam</td>
<td>12-18</td>
<td>Congenital</td>
</tr>
<tr>
<td>13</td>
<td>Lightwriter</td>
<td>40-65</td>
<td>Acquired</td>
</tr>
<tr>
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<td>Vantage</td>
<td>40-65</td>
<td>Congenital</td>
</tr>
<tr>
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<td>Pathfinder</td>
<td>19-40</td>
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<td>Lightwriter</td>
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</tr>
<tr>
<td>18</td>
<td>Lightwriter</td>
<td>40-65</td>
<td>Acquired</td>
</tr>
</tbody>
</table>

Table 1: Interview Participants