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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 people who use aided communication and to 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; they also suggest 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 provide the basis for an initial specification for the design of future devices.

Background

Communication is recognised in Article 21 of the United Nations Convention on the Rights of Persons with Disabilities as a fundamental right (United Nations, 2006). 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) . Despite the apparent increase in device availability and choice, however, 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, both in the literature and 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" (p94). 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 (Murphy et al., 1996; McCall et al., 1997). 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.

A number of well-established models of assistive technology (AT) exist that describe the factors influencing technology usage, and provide frameworks for decision making within the context of selecting assistive devices. These include the 'Matching Person and Technology' model (Scherer & Craddock, 2002) and the 'Human Activity Assistive Technology' model (Cook & Polgar, 2007). Other more recent work includes the usability framework for AT created by Arthanat et al. (2007) and a proposed framework of communication support factors relating to children's use of assistive communication technology by Griffiths and Price (2011).

The domains described in these frameworks appear to converge and could be described as 'context', 'individual', 'activity' and 'technology'. These frameworks do not appear to provide an explicit framework for AT device design and relate to the broad AT context rather than the specific user requirements relevant to VOCAs.

The Devices for Dignity[1] Healthcare Technology Co-operative is based within the NHS, and is a collaboration between clinicians, patients, academia and industry which acts as a focus for 'technology pull' into the NHS. It is within the context of this innovative programme that the current project is embedded.

Objectives

Funded through the Devices for Dignity (D4D) 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) suggested 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.

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.

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[1] D4D is one of two pilot Healthcare Technology Co-operatives in England. www.devicesfordignity.org.uk

Stage One: Interviews

Interviews were undertaken with a range of people who use VOCAs in two neighbouring counties 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 technology 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.

Obtaining high quality and wide-ranging qualitative data from participants with communication difficulties is generally acknowledged to be challenging. The approach to the interviews, therefore, needed to draw 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. 'Talking Mats' (Murphy et al., 2005) is frequently cited (for example: Rabiee et al., 2005; Nind, 2008) as one method for including people with communication difficulties in research interviews, whilst other methods include the use of cue cards and vocabulary lists. For an excellent review of such methods see Nind (2008).

The design of the interview resources drew strongly on both the Talking Mats approach and preliminary work conducted by one of the authors (Townend., 2007). The design aimed to balance participants' potential need for a structured focus and scaffolding of their communicative responses, with their potential to engage in creative and open interaction. The resources included a *pre-interview preparation guide*, an *interview topic guide*, and *interview*

prompt sheets, all of which were designed to cover the domains of design recognised in existing assistive technology frameworks.

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 in advance the topics to be addressed in the interview and to pre-prepare any relevant vocabulary or messages on their communication aid (if relevant and/or possible).

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 *prompt sheets* reflected both the *pre-interview guide* and the *interview topic guide* and were designed to be used by the participant independently or in conjunction with the researcher or communication partner during the interview. Thus, the basic design of the prompt sheets took the form of separate topic-based, vocabulary lists, each arranged in a grid format. Each prompt sheet contained up to 24 vocabulary items which covered a broad range of potential responses relating to each topic and sub-topic, representing both positive and negative points of view. 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;*
- *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 Figure 1.

<< INSERT FIGURE 1 HERE >>

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 across the UK 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; and
    - 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 concurrently with the interviews and followed the same topic structure as the interview resources. Initial analysis of the interview data was undertaken and used to confirm that the questionnaire was relevant – by ascertaining that themes were emerging from the interview data that related to the questionnaire topics.

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 indicate whether 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 Figure 2.

<< INSERT FIGURE 2 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?*

- *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?*

- *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 questionnaire was distributed in a number of formats: standard text, large text, and symbolised versions utilising Widgit Literacy Symbols and Picture Communication Symbols (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[2] software) or downloadable PDF (standard text and symbolised versions). The questionnaire was also released as two versions – one for people who use aided communication and their carers, and one for AAC professionals. The only differences between these two versions were in the instructions given and the demographic data requested. Professionals were asked to *"think about as broad a range of users' needs as possible"* and answer questions relating to *'an ideal device'*, whilst people who use aided communication were requested to think more specifically and personally about *'your ideal*

[2] LimeSurvey survey software: http://www.limesurvey.org

device'. The final section requested caseload data from professionals and demographic data from aided communication users.

The questionnaire was available for a four-month period in 2009, and was advertised through UK AAC networks – for example, the Communication Matters[3] 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.

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

[3] the UK Chapter of ISAAC; http://www.communicationmatters.org.uk

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, living in two northern counties of England. This was an opportunity sample and, although the majority of participants had a congenital condition (the most common being cerebral palsy), the resulting sample did include a range of conditions and ages (summarised in Table 1).

<< INSERT TABLE 1 HERE >>

Questionnaire Respondents:

164 paper questionnaires were sent out across the UK and the online questionnaire was marketed widely. 68 professionals responded to the questionnaire (33 using paper, 35 online) whilst 43 people who use AAC responded (28 using paper, 15 online). 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%.

All but one of the respondents who use AAC reported that they currently use, or have used, a voice output communication aid; eight respondents were family members/carers of someone who uses a communication aid. Most respondents lived with family (75%), with 11% 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 (see Figure 3).

<< INSERT FIGURE 3 HERE >>

The majority of professional respondents (see Table 2) were Speech and Language Therapist (46%, or 69% including Specialist Therapists); all other professions were less well represented.

<< INSERT TABLE 2 HERE >>

There was huge variation within the reported caseload sizes with large standard deviations (SD) and ranges in the data. The mean 'aided communication' caseload size was 70 (SD=276, median=25) and the mean value for size of 'voice output communication aids' caseload was 43 (SD=165, median=10).

The mean length of time professionals had been working with voice output communication aids was 10 years (SD= 7) whilst the group of devices most often used by clients on their caseload was 'large high tech.' communication aids (mean=38, SD=157, median=4), followed by 'low tech' communication aids (mean=30, SD=39, median=14).

More professionals worked with clients in the age range of 12-18 years. People with Cerebral Palsy were most commonly reported as being on the professionals' caseloads (84%), with Learning Disabilities and Autistic Spectrum next most reported (see Figure 4). Professionals most often reported seeing clients in educational settings (77%), and home environments (63%).

<< INSERT FIGURE 4 HERE >>

Device Design Framework

The results from the qualitative interview data and quantitative questionnaire data were collated and synthesised into an overall framework. This framework comprised three main themes or domains, each of which was further divided into a maximum of ten sub-themes. The resulting framework is shown in Figure 5 and represents a conceptual model of communication aid design and use according to the perceptions of people who use VOCAs.

<<INSERT FIGURE 5 HERE>>

Summaries of the data within each theme are offered below in the order in which their **sub-themes *(in bold italics)*** are represented in the framework (Figure 5); some of the results are illustrated with samples of the questionnaire data and some with extracts from the interview data (the full data being too lengthy to present here). Extracts of interview data use the key of I for interviewer, CP for a communication partner, M (male) or F (female) for a spoken utterance from the communication aid user and CA for an utterance formulated by the user and spoken with their communication aid. Chi-squared test results are reported where significant trends are suggested ($p<0.05$).

Device Design:

Ease of use was broken down into four features on the questionnaires (‘*efficiency’, ‘reliability’, ‘suitability’* and ‘*adjustability’*), all of which were reported to be important by the majority of users (88%) and professionals (94%, $x^2=13.7$, df=3, $p =0.003$) although ‘*efficiency’* and ‘*reliability’* emerged as the two features of greatest importance. In contrast, as shown in Figure 6, both groups were more likely to feel that current devices were not *‘reliable’* (users 61% ; professionals 62%, $x^2 =26.7$, df=3, $p<0.001$).

<< INSERT FIGURE 6 HERE >>

Effects of good and bad design were clearly expressed in the interviews through the participants' association between a device being easy to use, being well designed, and being simple. Conversely, there was also a clear association between interview participants' perceptions of poor design and the cognitive load they felt the device placed upon them, both in operation and configuration/setup.

How a device is made was explored through the questionnaires in terms of *'comfort', 'size', 'portability'* and *'durability'*. All were considered important to the majority of users (90%) and professionals (84%) but the most important feature rated by both groups was having a device that was '*portable'* (mean ranking of 1.9 by users and 1.7 by professionals). A significant majority of both users (90%, x^2=15.39, df=3, p=0.002) and professionals (81%, x^2=50.46, df=3, p<0.001) reported that there were no *'durable'* devices currently on the market.

Device reliability emerged as a separate sub-theme on final analysis of the interview data. A number of issues relating to reliability were raised by interview participants affecting their 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.

6 *CP Actually you've just been without your communication aid haven't you for four or five weeks. You might want to tell (Interviewer) what you thought or how you felt when you didn't have it. How did you feel every day coming*

into college without your communication aid? So remember, we were asking you how you felt so you need to say 'I..' That's 'like', is that what you're after or are you looking for 'feel'? It's under your verbs I think. Feel's over there.

CA Feel.

CP If it's in the past you might want to say 'I felt' so you'll need to – yeah.

CA Felt.

CP You just say how you felt with no communication aid. There's no right or wrong answer, it's just what you feel.

CA Angry.

Quote 1: Sample extract from 'reliability' sub-theme.

Within the questionnaire, ***Device performance*** was divided into questions relating to whether the device is '*ready to use quickly', has 'a battery that lasts a long time', is 'rechargeable whilst using it' and is 'easy to look after'*. All of these features were rated as 'very important' by the majority of user (88%, x^2=10.2, df=3, p=0.017) and professional (90%, x^2=40.4, df=3, p<0.001) respondents to the questionnaires; both groups ranked the features in the same order of importance, with *'ready to use quickly'* and *'a battery that lasts a long time'* ranked most highly. Users rated all features as not currently available, with having *'a battery that lasts a long time'* least likely to be considered available (73%, x^2=9.1, df=3, p=0.028). Professionals gave more mixed responses (x^2=43.9, df=3, p<0.001): *'ready to use quickly'* and '*rechargeable whilst using it'* were rated as currently available by a marginal majority of professional respondents (57% each) whereas '*easy to look after'* (72%) and *'a battery that lasts a long time'* (66%) were rated as not currently available.

Physical characteristics, and the many aspects thereof, were reported during the interviews. Upon analysis, this sub-theme was found to contain nine distinct areas of concern to interviewees: *batteries; design and aesthetics; display; mounting; ruggedness; size; weight;*

transporting; use outdoors. In each of these areas interview participants highlighted examples where these characteristics exert a recognisable, and generally negative, impact on their use of a device.

The questionnaire also provided data on the ***Physical environment and transport***. An average of 63% of users and 52% of professionals rated most features connected with this sub-theme as not currently available (professional x^2=16.2, df=3, p=0.001).

Design and layout of devices was also investigated through the questionnaires. The majority of user (85%, x^2=15.1, df=3, p=0.002) and professional (78%) respondents considered all features of ***design and layout*** to be important except *'integrating additional features in one device',* where the majority of professional respondents rated this as not important (68%, x^2=112.2, df=3, p=0.000). Both groups gave *'integrate additional features in one device'* a low ranking (mean rankings of 2.89 by user and 3.84 by professional respondents). Conversely, *'being able to find words and messages easily'* was ranked as the most important feature by both groups (mean rankings of 1.1 by user and 1.5 by professional questionnaire respondents). The majority of users reported that their current devices did not include any of the features of design and layout listed in the questionnaire, except for '*producing spontaneous messages'* where a marginal majority felt that this was available (56%, x^2=7.98, df=3, p=0.046).

Device configuration was considered during the interviews. There was reported variation between interview participants 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.

Voice output was discussed in terms of three main aspects during the interviews, according to interviewees' perceptions of their devices: *'personalisation', 'quality'* and *'volume'*.

10 *CP Would you change the accent?*

I You would.

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.

In response to the questionnaires, 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). Conversely, having '*an alternative way of sharing a message'* was given a low ranking by both users (mean ranking 2.8) and professionals (mean ranking 3.3). Professionals 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 they did not currently have a choice of voices.

Wider Picture

The effect of slowed speed of communication was perceived as a great source of frustration by interview participants, who reported that using a communication aid was a slower means

of communicating than would be experienced in naturalistic spoken conversation. This was particularly frustrating where they had previous experience of communicating verbally.

The impact of training and learning was discussed in varying ways by interview participants. Interviewees reported differing 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 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. Specific factors were reported to influence the process of learning how to use a device successfully. These included the complexity of the device and the cognitive load imposed upon the user.

In response to the questionnaires, the majority of users (80%) and professionals (87%, x^2=15.2, df=3, p=0.002) rated training in general as important. 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*'. 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 users and 60% of professionals) that this did not currently take place (professionals x^2=24.9, df=3, p<0.001).

Help and support in general was rated as important by an average of 82% of user and 88% of professional respondents to the questionnaires. Both groups ranked *'ongoing help and support from professionals'* most highly (mean ranking of 2.0 by both users and professionals) although 61% of users (x^2=10.6, df=4, p=0.032) felt this was not currently

offered, in contrast to only 37% of 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 users and 68% of professionals felt that these were not currently carried out. 67% (x^2=15.1, df=4, p=0.005) of user respondents felt that they did not currently receive *'help and support from carers',* compared with 50% of professionals (x^2=15.67, df=4, p=0.004).

Service delivery emerged as a strong theme in the interview data. Some interview participants 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 as and when needed, others expressed frustration that they did not receive more regular support.

The ***Restricted use of communication aids*** became evident during the interviews when some interviewees did not use their device but preferred to communicate verbally, even though 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). Interview participants 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 *I* *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?*

(beeps from VOCA as (X) selects message)

F *no*

6 *I* *But you don't use it when you go out and about?*

CP *Maybe not, no.*

Quote 3: Sample extracts from the 'restricted use of communication aid' theme.

Support of aided communication within immediate environments, and knowing that there were people who could offer support, was reported by the interview participants as relating closely to how confident they were in using their communication aids. However, the range of people who were able to fulfil this role varied greatly between individuals. Some interview participants 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

Motivation and reasoning around the use of aided communication varied greatly between interviewees, who gave reasons that ranged from simple statements of fact, such as *'to talk'* or to *'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'*.

Addressing communication breakdown through communication aid use was clearly demonstrated on a number of occasions during the interviews. Sometimes interview

participants 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 used their device in such situations.

2	*I*	*Do you ever get it out and use it at home for talking?*
	M	*sometime*
	I	*and again can you think what would make you decide to do that?*
	CA	*when .. my.. mum .. and dad .. I don't know*
	M	*(asks CP for help) don't?*
	CP	*opposite of do*
	CA	*don't .. know .. what .. I am .. saying*

Quote 4: Sample extract from the 'addressing communication breakdown through communication aid use' theme.

Context of current use of aided communication was explored by asking interviewees to describe their current means of communication. Interview participants 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 the use of a VOCA was as a minority communication tool within this spectrum of methods.

Experience of other forms of technology, including other communication technologies, prior to their current device, was found during the interviews to be influenced by factors such as the participant's 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 interview participants 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 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.

Control, or the way in which they were able to physically access a device, was one of the elements interviewees reported as influencing the type of device they used. For some interviewees their physical skills were changing (in some cases this meant aiming for an increase in physical ability whilst in others it meant preparing for 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 set up for them 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 using technology alone.

Both having the ability to *'turn a device on and off independently'* and having the *'right access method*' were assigned a high rating by users (mean ranking 2.08 for both) and professionals (mean ranking 2.48 and 1.33 respectively) replying to the questionnaire (see Figure 7). Conversely, having a device that was '*easy to charge up*' was given a low priority by users (mean ranking 2.8) and professionals (mean ranking 3.6), and 73% of users (x^2=9.09, df=3, p=0.028) and 79% of professionals (x^2=43.89, df=3, p<0.001) described this feature as currently non-existent.

96% of users and 60% of professionals reported that no devices currently existed that were *'easy to move between a range of places'* although this feature was most often rated 'very important' by users (88%, x^2=10.20, df=3, p=0.017) and professionals (75%, x^2=40.41, df=3, p<0.001).

<< INSERT FIGURE 7 HERE >>

Availability and ranking correlations

There was a moderate correlation between the ranking and availability measures of the questionnaire data – i.e. the more highly a feature was ranked the more highly it was rated as 'currently available'. This correlation was weaker for users (r= 0.02) than for professionals (r= 0.44).

Discussion

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. Interview participants 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 as a strong 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 may also suggest that users have not been sufficiently included in the design process to date.

Following evaluation of these data, the authors suggest that the framework which was developed during the analysis fills a gap in the characterisation of VOCA use and design. The framework proposed (Figure 5) by this research is constructed around three '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 greater 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.

<<< INSERT FIGURE 8 HERE >>

Limitations

The sampling of interview participants was not designed to balance across device, diagnostic, demographic or other characteristics; sampling also took place in a limited geographical region of the UK. Nevertheless, the diagnostic and demographic balance of the interview participants did reflect the balance of the user respondents to the UK-wide questionnaire, the interview participants did use a range of devices, and saturation of the interview data did seem to occur. Furthermore, the demographics of the users who responded to the questionnaire closely reflected the caseloads of the AAC professionals who responded to the questionnaire.

Conversely, however, the fact that the sample of questionnaire respondents was self-selecting and that the sample size was relatively small suggests that the responses could be biased. Although the sample was sufficient to provide statistical significance for some trends within themes (particularly amongst 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.

Due to time constraints, the questionnaire was designed concurrently with the interviews, with some adjustments made following a preliminary analysis of the interview data, rather than being designed after full analysis of the interview data was completed. Therefore, the design may not have taken into account all of the features that emerged throughout the interviews. The design of the questionnaire may also 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'. There is potential for re-designing the questionnaire based on these results and employing a longer process of iterative testing.

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

A number of the features identified in the study could be considered to be contradictory and, therefore, may be regarded as further limitations. For example, questionnaire respondents reported that current devices are 'useable for spontaneous messages', yet at other points in the survey they highlighted this as a challenge. The authors suggest, however, that these points of conflict can 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 'domains': device design, the wider picture, and the personal context. It is suggested by the authors that the proposed framework compliments existing assistive technology frameworks as it focuses specifically on detailed aspects of communication aid design rather than relating to assistive devices in general. The framework also compliments other frameworks which explore aspects of the service delivery and support of AAC systems to individuals. Furthermore, it is interesting to note that although the study was focused on device design the additional aspects of 'wider picture' and 'personal context' emerged as equally important to users' device usage.

All three domains of the proposed framework present challenges for device design. The data highlight the complexity of the user requirements of VOCAs 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 VOCAs 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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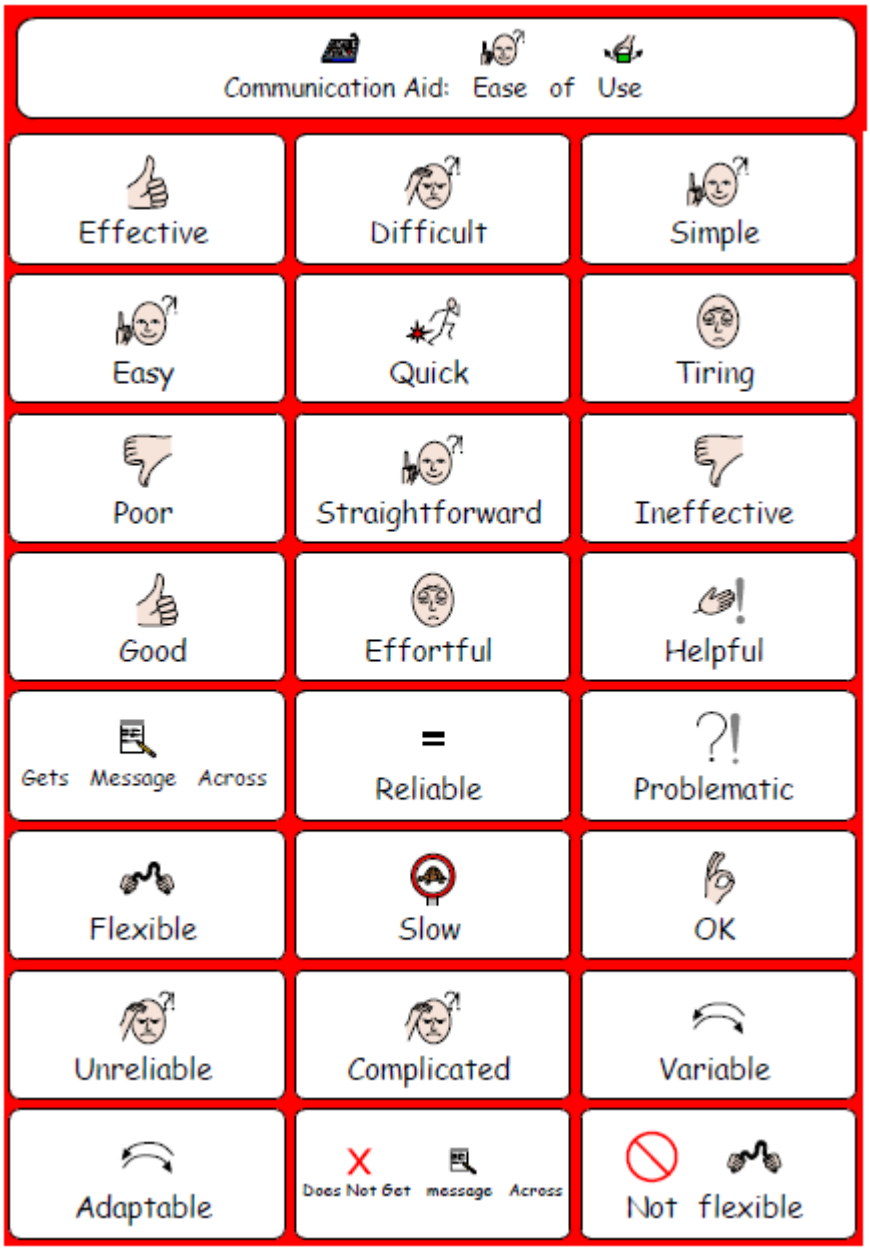


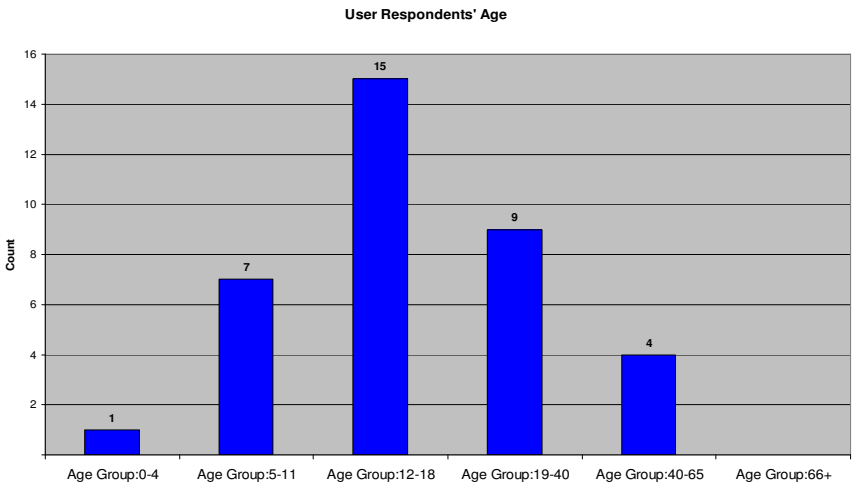
Figure 1: Example Prompt Sheet

Section One: About Your Ideal Communication Aid

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

It would ...	Definitely	Maybe	Not at all	Order of priority for me (1=highest)	My device does this at the moment (✓=yes)
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**)	☐	☐	☐		☐
Is **anything else** important to do with how easy a device is to use? Please write it here:					

Figure 2: Example Questionnaire Page



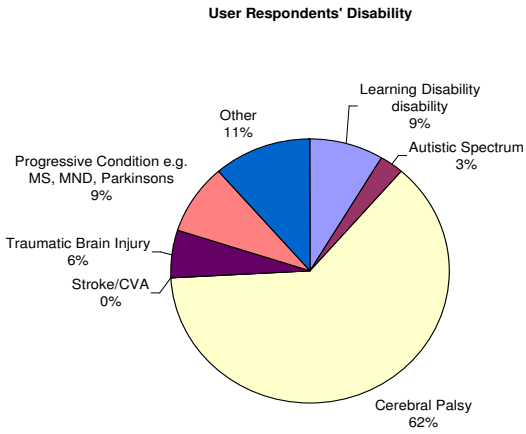


Figure 3: Questionnaire Respondents who use AAC

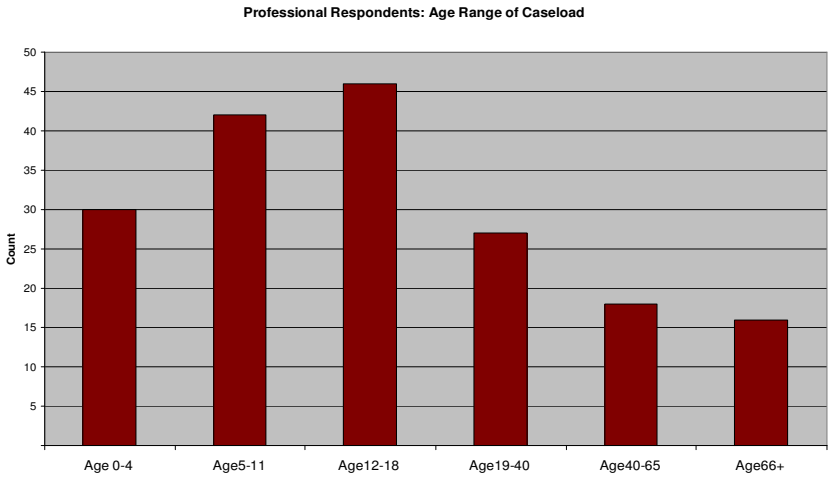


Figure 4: Caseload of Professional Respondents

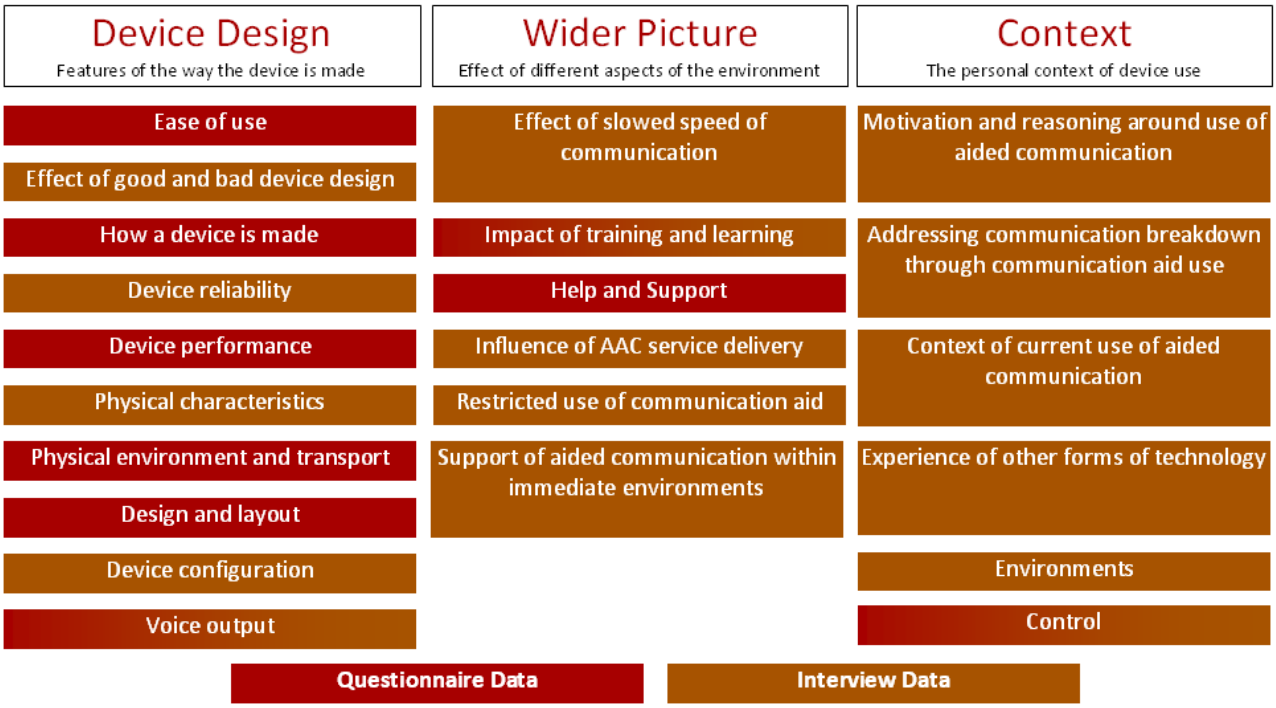


Figure 5: The Three Domains of Communication Aid Use

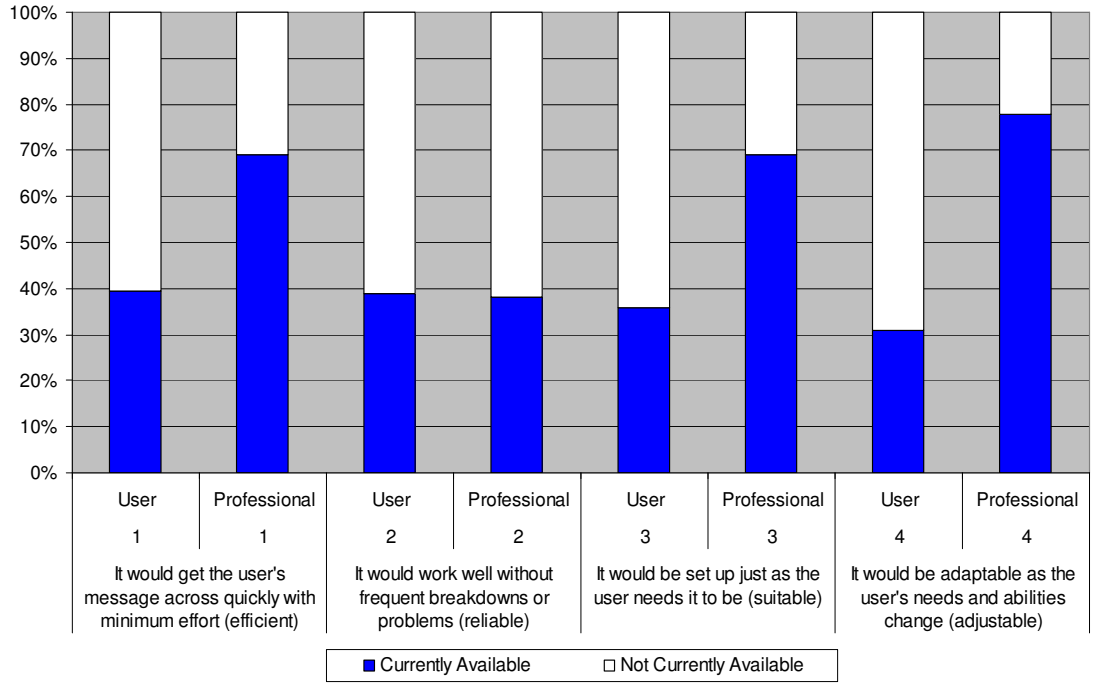


Figure 6: Ease of Use Questionnaire Theme

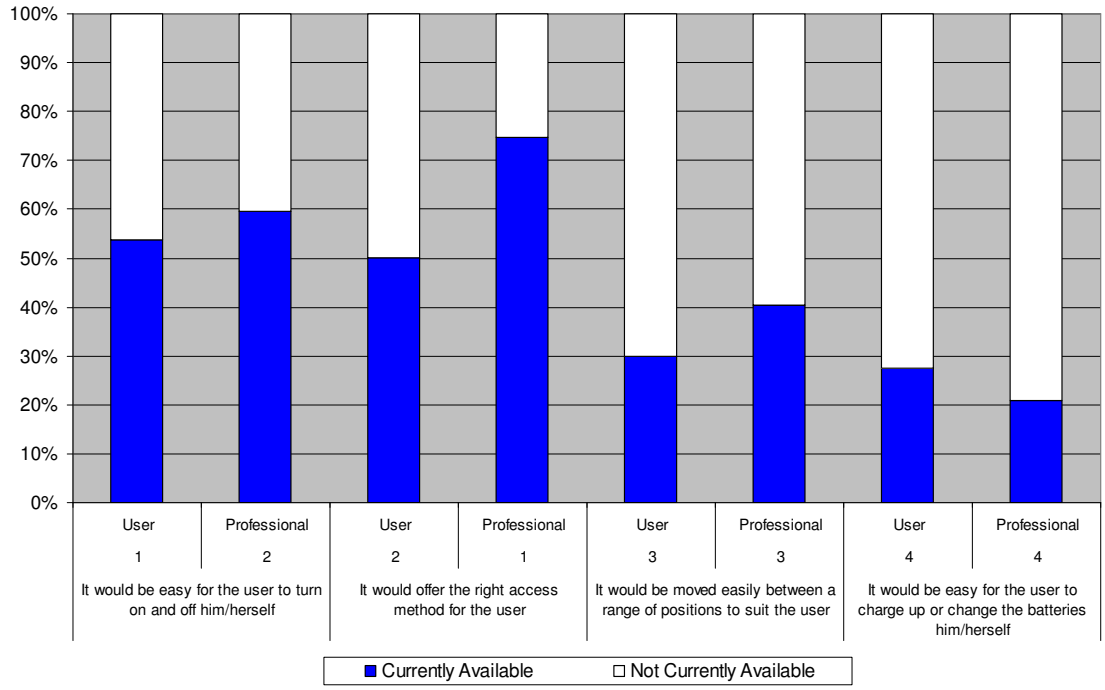


Figure 7: Device Control Questionnaire Theme

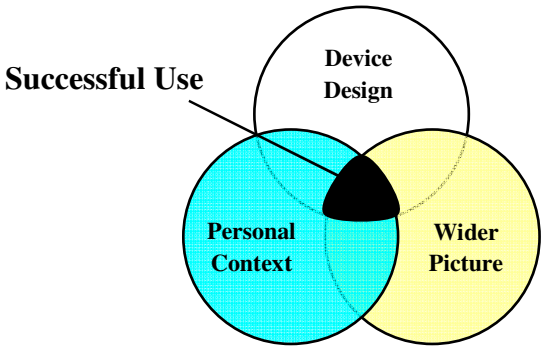


Figure 8: The Three Domains of Successful Device Usage

ID	Current VOCA	Age	Acquired/ Congenital Condition
1	Liberator 14	12-18	Congenital
2	Pathfinder	12-18	Congenital
3	Communication Board. & Tablet PC	19-40	Congenital
4	Liberator 14	12-18	Congenital
5	Lightwriter	66+	Acquired
6	DV4	19-40	Congenital
7	Lightwriter	40-65	Acquired
8	Pathfinder	12-18	Congenital
9	Lightwriter	40-65	Acquired
10	Powerbox 3	19-40	Congenital
11	Vantage	12-18	Congenital
12	Say-It-Sam	12-18	Congenital
13	Lightwriter	40-65	Acquired
14	Vantage	40-65	Congenital
15	Pathfinder	19-40	Congenital

16	Pathfinder	12-18	Congenital
17	Lightwriter	40-65	Congenital
18	Lightwriter	40-65	Acquired

Table 1: Interview Participants

		Count	Column N %
What is your job title?	Speech and Language Therapist	26	45.6%
	Speech and Language Therapist (Specialist)	13	22.8%
	Speech and Language Therapy Assistant	2	3.5%
	Teacher (Specialist)	2	3.5%
	Technician	2	3.5%
	Allied Health Professional	1	1.8%
	Assistant Manager	1	1.8%
	Assistive Technology Specialist	1	1.8%
	Instructor	1	1.8%
	Housewife	1	1.8%
	Occupational Therapist	1	1.8%
	Project Co-ordinator	1	1.8%
	Senior Research Fellow	1	1.8%
	SLT Co-ordinator	1	1.8%
	Team Leader	1	1.8%
	Technical Advisor	1	1.8%
	Technologist	1	1.8%

Table 2: Professional Questionnaire Respondents