Investigating the Success Factors of Expert Users to Inform Device Development

Simon JUDGE[a,b,1] , Zoë CLARKE[a,b] and Mark S HAWLEY [b,a]
[a] *Barnsley Hospital, Assistive Technology Team*
[b] *University of Sheffield, School of Health and Related Research*

Abstract.

Objective Expert user testing is a well recognised tool within user experience and human computer interaction design. Within the domain of assistive technology device design, however, this technique seems to be little used. It is suggested that studying the 'success factors' of expert assistive technology device users may provide a valuable source of data to inform development of assistive technology devices. This paper presents an example of this technique, within the context of a number of studies carried out by the authors, using the example of preliminary data from a study informing the development of an innovative Augmentative and Alternative Communication (AAC) device.

Main Content The paper presents a qualitative study whose objective was to influence the design and further development of an innovative voice-input voice-output communication aid (Vivoca) which has previously reached proof-of-concept stage. The Vivoca device is designed for people with dysarthria and this dictates a number of specific constraints and considerations. In order to understand how Vivoca could be designed to be used successfully by people with dysarthria, this study aimed to identify the factors associated with expert users' successful use of current AAC devices. In order to allow comparison, the study included users with some understandable speech and also those with no understandable speech. The study procedure was designed to provide a profile of participants' communication methods and to identify the factors that participants felt made their communication successful.

Results Preliminary results from the study (currently underway) are presented, including a qualitative analysis of interview data, and data profiling participants' communication methods and context. Initial data has highlighted the very specific requirements for a communication aid design for people with some understandable speech.

Conclusion Study of expert users may provide an effective tool to help inform assistive technology device development.

Keywords. AAC, communication aids, device design, expert users, user involvement, VOCAs

[1] Simon Judge. Simon.judge@nhs.net

Introduction

The development of effective assistive technologies for people with often profound and multiple difficulties is well recognised as a challenging task. The involvement of users within the development process is increasingly accepted as being required [1] although possibly take up of this within industry is still arguably poor [2]. One reason for poor uptake may be because of a lack of specific user-involvement tools for this population, as involvement of users with profound physical, learning and/or communication disabilities may require the use of involvement methods that would not be used for the development of consumer electronics. Within this context a number of mature domains exist with established methods for involvement: the user-experience, usability and interaction design, human computer interaction and user-interface design fields all use well-validated methods for development. Within the assistive technology field, however, these tools seem less well developed and some have inherent challenges. For example involvement of people with communication difficulties around the development of a communication aid is an inherently challenging task as many involvement methods (for example 'speak out loud') involve verbal communication.

Taking the example of voice output communication aids, there is a high level of consideration in the literature around features of design, for example within a recent systematic review of the literature in the last 10 years [3] a thematic analysis of the papers identified 11 themes of which 'ease of use', 'reliability', 'voice/language of the device', 'time generating a message' can be considered predominately design considerations and in addition 'technical support' and 'making decisions' which can be considered ancillary to design. A recent survey of communication aid users [4] identified a framework of considerations around the design of communication aids across three domains of 'device design', 'wider picture' and 'personal context' and found that there was a significant gap between users' expectations around the design of devices and the devices available for them to use. Much other work has also identified features and deficits in device design, for example [5] lists a number of design features for AAC devices appropriate for children.

Studying expert users is a well recognised technique in the field of Human Computer Interaction [6] as a technique that can highlight ways of maximising productivity and demonstrating factors that predispose efficient use of a system. However, little evidence of the use of this technique with AAC or assistive technology can be found in the literature

The authors have been involved with a number of projects developing innovative assistive technologies of different types and have used a range of methods to facilitate inclusion in the development process. These include paper prototyping, 'wizard of oz', iterative development, interviewing and surveying and gathering data from expert users. Each method has been selected according to the needs of the stage of development. For example, the use of expert users has been previously reported by the authors [7] and was found produce a wide range of both positive and negative usability factors. The study presented in this paper also utilises expert user involvement and is presented as an example of the methodology. The study presented aims to solicit information about the communicative tools used by expert users of communication aids as part of a project developing a new voice-input, voice-output communication aid.

A Voice Input Voice Output Communication Aid

Dysarthria, a neuromuscular disorder, is the most common speech disorder affecting 170 per 100,000 population [8]. Although less prevalent, the difficulty in controlling the organs of speech to consistently produce sounds in the required order represents another speech disorder, verbal dyspraxia. Both dysarthric and dyspraxic speech are often unintelligible to unfamiliar communication partners and as a result people with these disorders often use communication aids to express their thoughts. Communication aids are a recognised intervention for people with dysarthria and other conditions resulting in speech that is difficult to understand [9]. However, there are few published studies looking at efficacy of AAC or use of communicative tools for people who have some degree of intelligible speech (to familiar and/or unfamiliar partners). It is assumed that the usage of communication aids will vary according to the level of intelligibility of the speaker. In one of the few studies [10] it was found that the participants, in discussions with familiar partners, used communication aids during conversational breakdown but that the use of AAC was not always effective in full repair of the conversation.

A large cohort of people may exist who have some intelligible speech, have trialled communication aid devices but rejected or abandoned them. This group appears under-researched. The nature of the communication of people with partially intelligible speech is poorly understood and does not necessarily match the nature of communication of people with no speech. There do not appear to be any communication aids currently on the market that are designed specifically for this population or that allow for disordered voice-input as an access method.

The project presented within this paper aimed to develop a communication aid that recognises the speech of partially intelligible speakers (e.g. those with moderate-severe dysarthria) as an input to a communication aid. This is a voice-input, voice-output communication aid (Vivoca) [11], [12]. The design of this device has several very specific constraints and considerations over and above those already existing when designing a communication aid.

1. Study Methodology

The current phase of development of the Vivoca device aims to take it to a prototype pre-production stage. User involvement has been key to the development of this technology and has been planned into all stages of the development. A previous phase of development included a study, using focus group and questionnaire methodologies, of users' and providers' requirements. The study identified some broad user requirements for a device as being one which is faster to use, faster to set up, cost-effective, portable and reliable [13]. This study also identified a number of characteristics that may be indicative of a successful device but was not able to look in depth at the process of interacting with the device. In addition this phase of development included iterative development of a prototype device with four potential users of the device who had severely dysarthric speech. A prototype device, based on a pocket-PC platform was successfully developed and trialled.

The current stage of the development required developing accurate usage scenarios for the device. As noted, the intended population have very specific needs and there has been little work investigating this or designing devices to meet these needs. The

previous work described had already identified the need for a device and some of the broad characteristics that this device should have in order to be successful.

Looking at the remaining development steps to achieve a pre-production prototype system identified some further user requirements that needed to be established. The use of communicative tools to achieve successful communication in the population of current communication aid users needed to be understood in order to successfully design a device to achieve a functional level communicative competence by a user. Further to this, the differing needs of the population of successful communication aid users who also have some intelligible speech also needed to be established.

The study design aimed to draw up a communication profile of participants and then to investigate quantitative and qualitative data about their use of communication aids. The makeup of the study was designed to consist of the following activities, run across two sessions:

1. Use of the Social Networks tool [14] to map a participant's communicative environment and so allow these factors to be considered in relation to their use of communication aids.
2. The "Communication effectiveness survey" (CETI) [15] and the modified CETI [16] to establish the participant's perceptions of their speech and communication effectiveness and look at variances between these in different situations.
3. The "Frenchay Dysarthria Assessment (Intelligibility)" [17] to establish an objective measure of the participant's speech intelligibility.
4. Data logging (where possible) of the participant's communication aid ([18], [19]) to look at actual device usage – recognizing that this is 'one sided' data that does not include the communication partner's perspective.
5. Completion of a communication diary where the participant notes incidences of successful and unsuccessful communication to look at participants' perceptions of factors for success and their perceptions of the role of communication partners.
6. Finally, videoed semi-structured interviews to investigate participants' perceptions of their communication and provide examples of their communication methods.

2. Procedure

The study has been approved by the Leeds West NHS Research Ethics Committee. Recruitment was carried out through NHS professionals within the UK who were asked to identify potential participants who use a voice output communication aid and either: are expert in their use of a communication aid and have either some limited intelligibility or no intelligible speech. Professionals were also asked to identify potential participants who had trialled, but decided not to use, a communication aid and have some speech with limited intelligibility. For this study, the definition of an expert user was given as someone able to use their communication aid functionally in a range of situations (communication environments) and with a high degree of competence.

The initial participants recruited were the existing participants from the previous Vivoca project who are severely dysarthric with speech with limited intelligibility. Half of these participants use a communication aid in limited circumstances and the other two had previously rejected the use of communication aids. In a sense these

participants could be considered expert in their non-use of communication aids. All participants could be understood to some degree by close communication partners, for example family and regular carers. The aims of this phase of the study were to trial the use of the methods in order to assess their appropriateness for describing the communicative environment of the participants and to establish further perceptions of the users around their use of the prototype device. Preliminary analysis of the data was carried out in order to verify the appropriateness of the methods used and ensure that relevant information was emerging.

At the time of writing the additional study participants were in the process of being recruited following delays with the local research governance approval process required before recruitment.

3. Preliminary Results

3.1. Social Networks of participants

The communication circles and communication modes sections of the communication networks tool were used in order to investigate the participants' communicative environment. Different ways of displaying this information in order to aid in its interpretation in both qualitative and quantitative ways have been trialled; an example is shown in Figure 1 .

Figure 1: Communication Network Representation

Initial analysis of the data suggests that this does provide a good method for discussing with the participant their social networks and helping the participant to reflect on the effect of these networks on their communication methods. For example, for one participant, this helped him examine his restricted social participation and the relationship between this and his opportunity and need to use his communication aid.

Other participants reflected on the use of particular communication methods with particular communication groups.

I: Erm, for your family, for your life partners if you like. Which methods do you use? Do you
P: Gob 00:44:58-0
CP: Gob [laughs]
P: Gob [laughter]

[I=Interviewer, P=Participant, CP=Communication Partner, CA=Communication Aid]

Looking across the participants involved so far in the study, commonalities can be seen around their reliance on speech as their predominate communication mode and the weighting of their social networks corresponding to those communication partners who find them easier to understand.

3.2. Communication and Speech effectiveness

The CETI and CETI-M questionnaires were successfully administered during the interviews. They were not administered consecutively, but with another task between the questionnaires to reduce the chance of the participants being influenced by their response to the first questionnaire. The questions on the test were also administered in a different order. The results were collated and plotted to compare the participants' differences in their perception of their speech and communication Figure 2 shows example data for one participant. Looking at the example data, it can be seen that the participant consistently rates his speech as being more effective than his communication when the communication partner is a family member of familiar person. In other situations the participant rated his communication and speech as level except when conversing at distance when the communication rating was higher than speech. Overall, on average and across all situations, participants rated their communication as more effective than their speech.

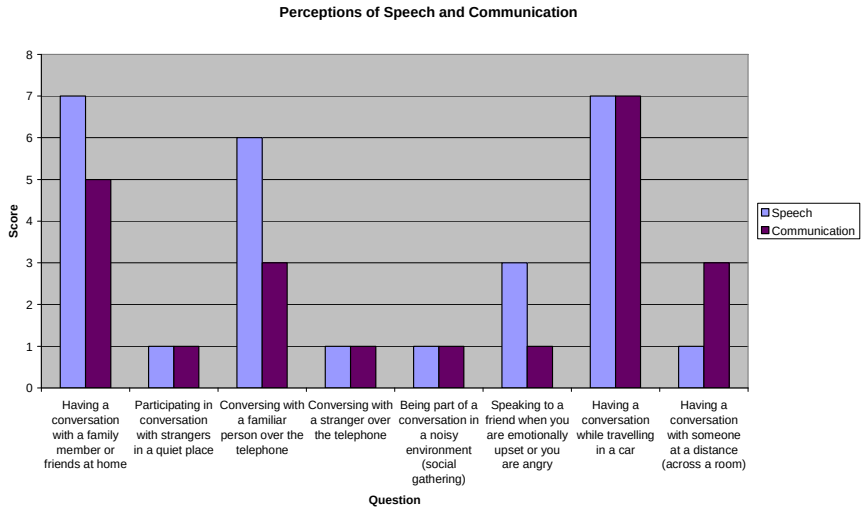

Figure 2: Comparison of a participant's perception of their speech and communication

3.3. Frenchay Dysarthria Test (Intelligibility)

The word and sentence intelligibility tests were successfully administered to all participants. In cases where participants could not read the prompt was read to them. The recordings were scored by a naïve listener (to dysarthric speech) and an experienced listener. No participant scored more than 2 (out of 10) recognised words and 1 (out of 10) recognised sentences with the naïve listener. Only one participant was scored more highly by the experienced listener with 6 words recognised and 3 sentences. Thus the participants can be considered to be severely dysarthric and essentially unintelligible to naïve listeners.

3.4. Data logging and communication diary

It was not possible to set up data logging on the communication aids of the participants who used a communication aid because the devices did not support it. All participants successfully managed to complete the communication diary and it appeared to support the participant in considering their communication transactions.

I: Brilliant. Lots of detail. So out of the diary X what, what do you think were the most successful kind of examples and what do you think made them kind of successful. I know there's one here about kind of catching up on news, that sounds like that was a…

P: (()) Fantastic

I: Fantastic

P: Yeah

I: Was that good cos you you, it just really worked?

P: Yeah. We just talked and just talked.

I: And there was no breakdown of communication?

P: No (())

I: In it you've put that it was communicating for pleasure do you think sometimes because of

P: I do that a lot

I: Yeah

3.5. Qualitative analysis of semi-structured interviews

Transcripts were generated from the interviews with participants and their communication partners and these transcripts were analysed using a focused qualitative thematic analysis based on framework analysis. This analysis was framed around the aims of investigating the participants' perceptions of their communication and in addition specific feedback around their use of the prototype device. The analysis resulted in an initial framework with the following main themes: Perceptions around the use of communication aids and their role (shown in Table 1 with the sub-theme headings as an example); Use of other communication methods; Feedback around use of Vivoca; and Examples of Conversation of participants.

Saturation of the data was not achieved, however it was felt that saturation was emerging and that this initial analysis demonstrated that analysis of the complete data would lead to saturation and an appropriate and relevant framework of themes.

Perceptions around the use of communication aids and their role	Consideration of communication aid use *I: And the [COMMUNICATION AID] is the last resort.* *P: Hmmm* *CP: Always*
	Negative perceptions of use
	Positive perception of use of communication aid
	Potential for use of a communication aid
	Practising use of communication aid
	Rationale around use of communication aids
	Reasons for non-use

Table 1: Example sub-themes and quote from data following qualitative analysis

4. Discussion

This study has demonstrated the potential for working with expert users to illicit data that can contribute usefully to device development. This study utilised a range of methods in order to profile the communication modes and methods of participants. The initial data presented in this paper forms part of an initial validation of the methods and demonstrates that they are capable of highlighting information that is of use to the device development process. For example: initial data from participants with some speech which is understandable to close communication partners implies that communication aids would be used as a minority tool to 'backup' the use of speech. This gives a potentially extremely different perspective on the development of a device for this population.

Initial data from the study suggests that there is a relationship between the social networks of people with limited intelligibility and their participation in society. It is interesting to note that speech is also generally the most frequently used communication method even though these participants are unintelligible to naïve listeners. These data imply that a communication aid designed specifically for this population, taking into account their preference for using their own speech, could contribute to increasing the communicative opportunities and of these individuals.

Comparing participants' perceptions of their speech and communication provides interesting qualitative observations about the participant. Comparing the data obtained in these questionnaires to the qualitative data obtained during the interview corroborates some of the responses on the questionnaire and suggests that the participant was able to use the rating scale reliably to discriminate between speech and communication. Although this data can currently only be treated as part of the qualitative picture of the individual, it will be interesting to compare these data across the different groups to be recruited, to look at difference between the participants with limited and no intelligible speech.

The initial qualitative analysis of the interviews with participants demonstrates that the interviews are able to elicit a wide range of information from the participants around the topic and demonstrates that participants are able to demonstrate significant insight into their communication methods and their effect on lifestyle and participation.

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