Augmenting Icons for Deaf Computer Users

Helen Petrie, Wendy Fisher
Centre for HCI Design
City University

United Kingdom
h.l.petrie|w.fisher@city.ac.uk

Kurt Weimann, Gerhard Weber
Multimedia Campus Kiel
Theodor-Heuss Ring 140
D-24143 Kiel
Germany
k.weimann|g.weber@mmc-kiel.com

ABSTRACT
Tooltips (TTs) can be used to make icons more understandable to users. However, text-based tooltips will not assist users with print disabilities. Four types of TTs to assist deaf and hearing impaired users were implemented: Sign Language, Picture (an enlarged icon and text explanation of the function), Human Mouth and Digital Lips (the last two to assist in lip reading). An evaluation of 16 TTs of each type with 15 deaf users found that the Sign Language and Picture TTs were very positively rated on satisfaction and understanding and would be used again, but that Human Mouth and Digital Lips were of no assistance in their current implementation to deaf users in lip reading the names of icons.

Categories & Subject Descriptors: H.5.4 [**Hypertext/Hypermedia**]: *navigation*, H.5.2 **[User Interfaces]**: *interaction styles*

General Terms: Design, Languages.

Keywords: Tooltips, time design, deafness, adaptation.

INTRODUCTION
Icons are currently ubiquitous in computing systems. These small visual representations improve self-explanation of and control over user interfaces. Being pictorial rather than textual means that ideally users can recognize and understand their meaning more quickly than verbal labels for functions [1], a well-established effect from cognitive psychology [10].

One of the problems we face, both as designers and users, is that so many different icons are needed to represent all the different functions available, even within a particular OS or application, that it is difficult to provide enough different and easily recognizable icons.

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This problem arises partly because of the different possible relationships between the icon (in semiotic terms, the *sign* or *representamen*) and the *object* (or action) that it is attempting to represent [see 4, for an introduction to semiotics, and 3 for discussion of the semiotics of computer icons]. There are three possible relationships between sign and object – iconic, indexical and symbolic. Iconic signs are those where the sign relates to the object by resemblance. If the resemblance is well depicted, this should make the icon extremely easy to recognize and use, the ideal situation. However, many icons in computing systems relate to actions rather than objects, so an indexical sign is often used. An indexical sign relates to the object through some process of causation. For example, the *Print* icon is often a representation of a printer, representing the cause of the required action of printing, rather than the process of printing itself. Thus some understanding of the relationship between the item depicted in the sign and the action required is needed to interpret indexical signs. Finally, symbolic signs relate to their objects by purely arbitrary means, usually because there is no concrete object that relates to the meaning required. Thus the icon used to represent executable files is a symbolic one, as there is no real world object that is directly equivalent to executing a process. For symbolic signs, a learning process of associating the sign with the object or action it is representing is required.

To assist in understanding icons and their different relationships with their associated objects or actions, a number of augmentations have been suggested. Gaver [5] added sounds to icons in the Apple OS to strengthen the relationship between sign and object (although this does not solve the problem of symbolic signs, as the sound is as arbitrary as the visual sign). Baecker and colleagues [2] added animation to icons for a painting application to strengthen the relationship between a series of indexical signs and their associated actions. Both these approaches proved promising, but have not been widely taken up by icon developers. This is in spite of the fact that there is evidence that mixed modality icons were rated by users to be more effective and memorable than uni-modal icons [9]. Ludi [8] also added animation to icons for visually impaired users, although her motivation is not explained (adding

movement without appropriate enlargement may make icons *less* clear for visually impaired users) and no information is provided on evaluation with users.

However, a common occurrence is for text labels to be incorporated into the icon itself to clarify its meaning (e.g. the tool bar in Internet Explorer). A more recent innovation are *tooltips (Tts)*, small text labels that appear if the mouse is hovered over the icon (e.g. the tool bar in Microsoft Word).

The use of TTs means that novice users can access the text label if they wish and explore the relationship between the sign and the object or action represented. This association then needs to be memorized before the icon can be used without the TT. This is a more complex learning process than directly understanding the icon, but one which users usually find easy and useful [6].

However, there are several user groups for whom these text augmentations pose additional problems rather than solving them. These are those user groups for whom textual information is problematic. This includes those whose native language is not the language of the TTs and those with print disabilities. The latter group includes people who are deaf and hard of hearing. It is not widely realized that people who are deaf are either working in a second language (if a Sign Language is their native language) or that their use of written language may be compromised by the fact that they learnt to read and write without full access to the corresponding auditory information [7].

This research aimed to use the concept of TTs to assist deaf and hearing impaired computer users in understanding icons by providing TTs in formats that are more appropriate to their linguistic needs. The most obvious method is to provide TTs in Sign Language, but given that there are many different Sign Languages (even American Sign Language and British Sign Language are very different) and that producing Sign Language TTs will require highly specialized resources (an experienced Signer, video recording facilities), a number of other options were also explored. Some of these options arose from discussions with deaf and hard of hearing computer users as part of the user requirements elicitation process for the MultiReader Project, a project developing a multimedia, multimodal reading system for both mainstream and print disabled readers [12,13,14].

AUGMENTING ICONS FOR DEAF USERS

Our implementation of the augmented TTs is based on a Microsoft Foundation Classes (MFC) ToolBar. The standard TTs provided by MFC consist of a top layer window with text. Figure 1 illustrates the time interval structure of using standard TTs. The interval "point" indicates the time (I_{point}) the user need to reach a icon and hover into it. Interval "wait" is the time (I_{wait}) before the TT pops up. After a duration of I_{show} the TT will disappear. The time the user has to process the information is therefore equal to I_{show}. For this study I_{show} may be adapted to user needs. the case of MFC TTs, I_{show} is a content independent static value of three seconds. In our augmented TTs, I_{show} is content dependent. This results in longer appearance for longer content, since the TT stays visible until the presentation of sign language, human mouth or synthesised lips ends.

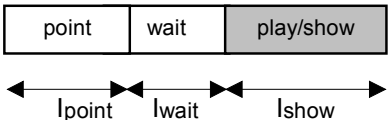

Figure 1. Temporal behavior of tool tips.

Four different types of augmented TTs were implemented (see Figure 2):

Sign Language TTs –a short video of a human signing the function name

Human Mouth TTs –a short video of a human clearly speaking the name of the icon (for lip reading)

Picture TTs –an enlarged picture (64 x 64 pixels) of the icon and a brief text explaining its function (as deaf users may not be familiar with the terms used)

Digital Lips TTs –an animated mouth speaking the name of the icon (for lip reading).

The window size for the videos used in the Sign Language and Human Mouth TTs and for the picture in the Picture TTs was 120 x 180 pixels. The duration of video clips ranged from 1s to 3s. Mouse movement or clicking terminated presentation of TTs.

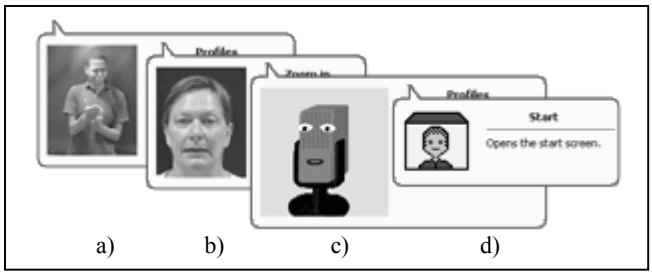

Figure 2. Augmented Tooltips: a) Sign Language, b) Human Mouth , c) Digital Lips and d) Picture tool tips.

The augmented TTs were implemented in the MultiReader reading system for mainstream and print disabled readers. 16 toolbar icons representing the range of functions available in the reading system were provided with all four different types of augmented TT.

EMPIRICAL EVALUATION

Participants

15 deaf people participated in the evaluation, 9 women and 6 men. 10 were pre-lingually deaf and 5 post-lingually deaf.

All were fluent users of British Sign Language (BSL) and all could lip read to assist in understanding spoken language.

Procedure

Participants evaluated the augmented TTs as part of a larger evaluation of the MultiReader reading system. Participants were shown the four different types of the TTs in random order, to avoid practice and fatigue effects. For each type of TT, participants were asked to complete two tasks with a multimedia document in the MultiReader system, a tourist guide to parts of London. Tasks involved searching through a number of pages to find specific pieces of information such as "Where did the fire of London start?" and "Who opened the British Library?". Participants were directed to use particular functions within the system, such as the Table of Contents, to ensure that the full range of TTs was encountered.

After completing the two tasks with the particular type of TT, the participant was asked how satisfying it was to use the tool bar with this type of TT and how understandable the tool bar was with this TT, both on a 5 point Lickert scale (where 1 = very satisfactory or very understandable and 5 = not at all satisfactory or understandable). Then the participant was asked for any qualitative comments on that type of TT Finally, after using all four types of TT, participants were asked to rank the four types in order of preference, to indicate which types they would be interested in using again themselves, and which types they thought should be provided to users in general. The latter two questions were used as in previous research [10] we have found that participants with disabilities can be reluctant to request a special feature for themselves, but recommend it being available for their user group in general.

RESULTS

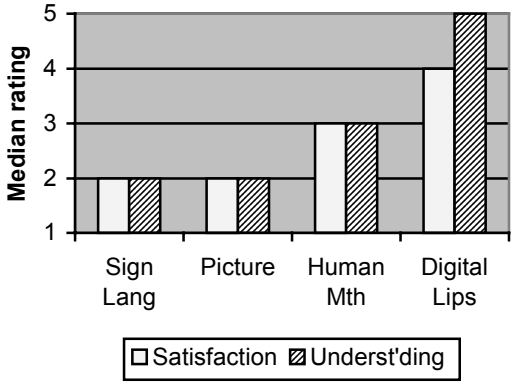

Figure 3: Median ratings of satisfaction and understanding for the four augmented tool tip types.

Median ratings for satisfaction and understanding of the four different types of TTs are shown in Figure 3. The ratings for the two measures were very similar. In each case, a Friedman one-way non-parametric analysis of variance showed that there was a significant difference between the four TTs (for satisfaction: $X^2 = 32.8$, df = 3, $p < 0.0005$; for understanding: $X^2 = 33.6$, df = 3, $p < 0.0005$). Post hoc analyses showed that for both sets of ratings, the Sign Language and Picture TTs were rated significantly more favorably than the Human Mouth TT which was rated significantly more favorably than the Digital Lips TT.

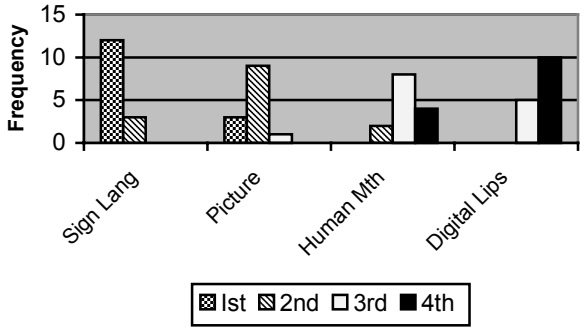

Figure 4: Frequency of rankings for the augmented tool tips.

The responses on the preference rankings for the four TTs are shown in Figure 4. The Sign Language TT was ranked first most frequently (by 12 out of 15 participants), the Picture TT second most frequently, with the Human Mouth and Digital Lips TTs not being ranked first by any participants.

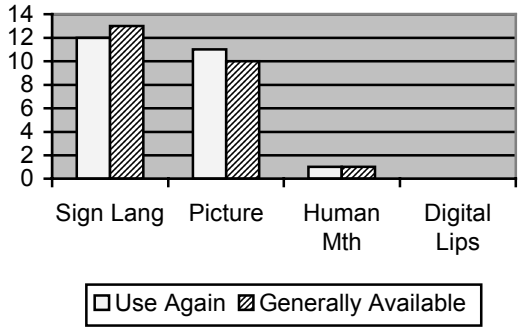

Figure 5: Frequency of interest in using the augmented tool tips again and having them generally available.

The results on the questions of interest in using the TTs again and having them generally available is shown in Figure 5. Results on the two measures on this occasion were very similar, with the Sign Language TT being most likely to be used again (and of most interest to be made generally available), closely followed by the Picture TT. There was little interest in using the Talking Head or Digital Lips TTs again.

Thus, overall, the quantitative results show that the Sign Language TT was most positively received. Some typical

comments from participants were "very clear and accessible", "brilliant". Five of the participants felt that the image needed to be bigger to be able to see the signer clearly. Two participants commented that some of signs might not be familiar to deaf people – as the terms used are quite unusual (e.g. "zoom"), so possibly an explanation of the term needs to be available if this is the case (as with the Picture TT). The Picture TTs also proved popular with participants. Two participants wanted larger text in this TT. Neither the Human Mouth or Digital Lips TTs proved at all popular with participants in their current forms. In the case of the Digital Lips, it was felt that having only the lips animated was insufficient, a whole face was needed and that the animation was too small. In both the Digital Lips and the Human Mouth, it was generally felt that the image was too small for lipreading. There may well also have been a contrast effect with the Sign Language version – once this was experienced, participants felt that the other TTs were far less useful. However, it may be worthwhile to test versions of the other augmentations in which the images provided are larger, lip movements are more clearly articulated, and in the case of the Digital Lips, a whole face is animated.

CONCLUSIONS

The use of TTs in Sign Language was very positively received by deaf participants and received high scores on all objective measures. Additional time for presenting augmentations was thought to be an extremely helpful way to make computer applications much more accessible for this user group. The use of Picture TTs with text explanations of the functions was also very positively received and received high scores. This augmentation would also assist many partially sighted computer users. The use of the Human Mouth and Digital Lips were not positively received in their current forms and need further development and evaluation.

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