ICONS AS HELPERS IN THE INTERACTION OF ILLITERATE USERS WITH COMPUTERS

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ABSTRACT

The literacy level of a significant part of the Brazilian population is insufficient for a proficient use of computers and for an autonomous access to digital contents as those currently available on the Internet. Although this problem also exists in other developing countries, its features depend on many sociocultural and educational factors that distinguish each country. Thus, most of the studies on digital inclusion of illiterate users undertaken abroad, as is often the case in studies for countries in Asia and Africa, are not totally suited to Brazil's context, which is mainly characterized by a higher prevalence of functional illiteracy rather than by full illiteracy, and in which multiligualism is marginal. Hence, besides the use of icons as supporters in understanding digital contents, as often proposed for those other countries, we particularize the problem to Brazil by investigating how icons reinforce the reading skills of semi-literate users, a key issue given the literacy level of many Brazilian citizens. Thus, this paper addresses both the use of icons in supporting digital content navigation and their role in scaffolding limited reading skills when accessing digital contents.

1. INTRODUCTION

This study was conducted as part of a larger project aimed at identifying, proposing, integrating and adapting novel solutions of human-computer interaction in order to facilitate the use of computers by illiterate or sensorially-disabled persons (Ávila et al., 2007; Holanda and Dall'Antonia, 2006). Within this broader goal, we focused on the use of icons as helpers in the interactions of low-literacy users have with computational interfaces and with citizen services through the Internet. In face of the scarcity of similar studies for the Brazilian scenario, our study converged results from the international literature on digital inclusion of illiterate users with data gathered from test subjects representative of our target-users in Brazil, seeking to conceive and implement solutions that are suited to the Brazilian context. Icons were evaluated not only as a means to convey ideas and information, but also in situations in which they interwork with symbols (words), whenever pictures and texts are displayed toghether. The study was undertaken in two subsequent phases, each one addressing a specific dimension of iconicity. The results showed some interesting effects in the interworking of icons and texts, which corroborated the strategy of designing interfaces where redundancy and diversity of audiovisual and textual elements improve the intelligibility of the overall content.

Definition of the problem and some solutions

The target-users of our study, individuals with low literacy levels, represent about one third of the overall Brazilian population, and make up an even larger proportion if we focus the elderly and the inhabitants of rural areas. This is a population that faces enormous barriers when attempting to exert its rights or to access opportunities created by the informational society. However numerous they may be, these citizens seem to be neglected or have their specific needs underestimated by many of the existing digital inclusion initiatives.

Furthermore, the focus on the illiteracy issue as a factor of the digital divide is justifiable given the eminently textual nature of most of the contents and services available on the Web. Thus, in a study comparing many countries, Chinn and Fairlie (2006) concluded that the low-literacy is, together with some other factors, directly correlated with a lower penetration of computers and of the Internet. As discussed in (Ávila and Holanda, 2006), the illiteracy creates a vicious circle in which the lack of access to the informational society, which in a large extent results from such low literacy, worsens the inequities that this population has to face in the daily life. In face of that, our project tried, since its begining, to understand these users' needs and the barriers they face when it comes to using computers or going to telecenters. Our aim was to counterbalance such barriers by means of solutions and tools that facilitate their access to the informational society. One of the areas we investigated was then the use of icons as facilitators in the access to digital contents.

Literature review

In the literature review we have found many studies addressing both visual (Brewster, 1998; Takagi et al. 2004; Schnelle and Lyardet, 2006) and auditive (Zajicek and Hall, 2000; Ahmed and Seong, 2006; Cavender et al. 2006; Petrie et al., 2004; Fajardo et al., 2003; Kennaway et al., 2007) disabilities, but we found less studies on the problem of digital inclusion of low-literacy persons (see, for instance, Goetze and Strothotte, 2001). Furthermore, some of those were devoted to the user interaction with other ICTs, such as cell phones (Eiriksdottir et al., 2006; Ahmed and Seong, 2006) or simputers.

And although some research about the access of illiterate citizens to e-gov services and sites has been carried out in developed countries such as Italy (Biasiotti and Nannucci, 2005) and the USA (Akan et al., 2006; Pilling and Boeltzig, 2007), more recurrent in the literature are those studies focusing India, with implementations or propositions generally aimed at the access to job opportunities (Medhi et al., 2005), to health (Huenerfauth, 2002) or agriculture (Plauché e Prabaker, 2006) information or even to digital literacy (Chand and Dey, 2006). Such approaches to the problem emphazise the use of text-free icon-based interfaces. This may be justifiable given the sociocultural reality in rural India, marked by a particular combination of full illiteracy and extreme multilingualism. This complexifies a lot the task of deploying nation-wide e-services with text-based interfaces. This also explains why many of the mentioned studies tried to create icons capable of not only facilitating the interaction, but of completly replacing the use of written language. Even though Brazil and India share some characteristics, such as extensive territories, emerging economies and low average educational level, simply adopting to Brazil solutions specifically developed for India would be a questionable strategy, mainly because of the differences between both contexts. The low literacy in Brazil most often means functional illiteracy, whereas in India it means full illiteracy. India's multilingualism means dozens of official languages and hundreds of local dialects, while Brazil's context is marked by a official monolingualism (the Portuguese language is widespread through the country) but with a population showing varying levels of proficience regarding the standard of the official language – that one used by the State to address its citizens (see, for instance, Martins and Filgueiras, 2007). Thus, our study explored not only aspects of iconicity itself, but also situations where icons interact with symbols, i.e., contexts of concomitant use of texts and images.

2. ICONS AS PROMOTERS OF INTELLIGIBILITY

Even though, as pointed out above, the research results from other countries should not be directly applied to Brazil, they gave us an initial idea of the role icons can play in interfaces for illiterate users. One of them, as described in (Medhi et al., 2005), is that an iconic support plays a key role in an interface for low-literacy users, such as those in rural India. In (Medhi et al., 2007), the same authors studied how to improve the iconic representation of different concepts through the use of audiovisual elements and compared the intelligibility of ten types of representations – text, static drawings, photos, handmade cartoons and video, each one of them alternatively with voice description. The conclusions showed that in general voice descriptions help in the understanding and that although the representations with audio were more intelligible than those without audio, bimodal (audiovisual) information can also be confusing to such an illiterate audience. On the other hand, visually richer information does not forcefully mean better intelligibility, and cartoons can prove to be more effective than photo-realistic representations. Finally, the results were

inconclusive in what regards advantages or disadvantages of dynamic images when compared to static ones, i.e., movement does not imply more intelligibility, and many other factors should be considered.

Theoretcally icons could be an effective support in reducing the symbolic load imposed on the users, since the iconic interpretation does not suppose schooling or proficiency in a given language (arbitrary code), but rather some experience with the real world, something that in some extent does not depend on the education level. However, sometimes real world experiences do not suffice for the acquisition of more abstract concepts, which are very common in e-gov services such as those studied in our project.

Furthermore, nothing garantees that every user will share the same real world experiences as required for the iconic interpretation. Thus, it is worth mentioning, as discussed by (Perry and Macken, 1996), that the Peircean concept of iconicity can be understood as "richly grounded meanings", in which the sign and the represented object are connected in a more natural, rather than arbitrary, way. However, those authors comment that this naturalness is not only a matter of resemblance, but relies on other logic properties and those aspects that work for one individual may not work for others, due to different experiences, cultures, etc.

In other words, using pictures can improve the intelligibility of the presented concepts and facilitate the inferences that illiterate users make, but the quest for perfect icons is meaningless, since the iconicity depends on the previous experiences of every individual, and what is "perfect" for someone may be inadequate or insufficient for others.

In spite of the strictly individual nature of iconic interpretation, it seemed worth looking for icons whose interpretation could depend on experiences that were more ordinary among the target-users. To reach that goal we decided to base our research in field tests and ethnographic studies, similar to those reported in (Medhi et al., 2005 and 2007). Finally, given the particularities of the illiteracy problem in Brazil, we investigated also how the iconic interpretation could interact with the latent reading skills of most users and reinforce each other in a computer interface.

Description of the field activities

To understand the processes involved in the iconic interpretation, especially among individuals that are representative of our target-users, we conducted two tests with the following goals:
- To compare the intelligibility and the credibility of drawings and photos and try to correlate these aspects with sociodemographic factors of the target users;
- To evaluate the interaction between icons and texts, seeking to find the combinations that better suit the literacy level of our target-users.

In order to reduce any regional bias in the results, the tests were conducted in three different Brazilian localities, from distant regions and contexts: Joao Alfredo (7°51'29"S 35º35'25"W), a rural community in the semiarid interior of the State of Pernambuco, Bastos (21°55'17"S 50°43'56"W), a rural community in the prosperous countryside of the State of Sao Paulo, and Francisco Morato (23º16'51"S 46º44'40"W), a poor neighborhood, with a population formed by migrants from other Brazilian provinces, located in the suburb of Sao Paulo, Brazil's largest city. In all three localities the levels of illiteracy are considerably higher than that found in urban areas. The participants were middle-aged and aged men and women, with low or no schooling level and low literacy skills, as indicated by an evaluation we conducted prior to the iconicity test. In Bastos 12 individuals, with average age of 65 years, participated in the test. Four of them were totally illiterate and seven were semiliterate. In Joao Alfredo 8 individuals, with average age of 57 years, participated in the test. Three of them were totally illiterate and five were semiliterate.

First test: intelligibility and credibility factors

The first test evaluated two types of image (photos and drawings) in terms of their intelligibility and the credibility they create among the viewers, as well as some aspects related to their interaction with texts, trying to correlate such factors with sociodemographic variables.

In the test we used images of daily objects and themes. Given that the first e-gov services developed in our project will cover the areas of health care and social security, we selected images related to such areas, such as medical specialties (obstetrician, pediatrician, dentist, oculist and generalist doctor), documents (Id. Card, Social Security card and birth register) and common objects or themes ("dog", "TV set" and "couple").

The credibility factor refers to the confidence each type of image creates in the viewers, or the explicit preference the viewers show for one of the two image types.

The intelligibility factor refers to the capacity a given image has to evoke in the viewers' mind the exact concept we intended to transmit.

In order to create more proximity with the ordinary experiences of the participants, the test conductors described a scenario in which a person called Maria needed to schedule a visit to a given medical specialty in a public health care center. Then the participants were presented to a chart with images (drawings and photos) of the five medical specialties listed above. An extra specialty (nurse), pertinent to the context but not object of the intelligibility and credibility scenarios was added to the charts. The images were arranged in two separate charts, one with the six photos, and another with the six drawings and had similar dimensions and features, as shown in Figures 1 and 2 (the test used colored images). The order of the presentation of the charts was alternated with every subsequent participant to minimize any bias due to the presentation order. The nurse image was used to avoid that the last answer about meaning could be given by exclusion of the previous specialties. The participants were then asked to point the image corresponding to the specialty mentioned by the conductor. The conductor repeated the process until all the five specialties had been mentioned. After finishing this first round, the participants were asked to choose the preferred type of image (photo or drawing), justifying their choices.

Figure 1: Chart with photos of medical specialties

Figure 2: Chart with drawings of medical specialties

Results of the first test

The results of the first test phase are shown in Tables 1, 2, 3 and 4. They indicate a clear preference of the users towards photos, but this preference does not mean, in the same extent, higher intelligibility. The higher credibility of photographic images could result from the fact that photos retain a physical link with the real world, in the sense that they show real doctors, real documents and so on, then giving more credibility to the representation. But intelligibility appears to be much more related to presence of the necessary elements in the image to allow the recognition of the mediated concept, something that also relates to the viewer's past experiences. In what refers to the comparison of the results in both localities, the same pattern was found in Bastos and in Joao Alfredo, and the differences in the percentages shown in Table 3 could be credited to statistical variation given the limited number of participants in the test.

Table 1. Percentages of preference by type of image and locality

Theme	Bastos		Joao Alfredo	
	Photo	Drawing	Photo	Drawing
Dogs	58%	42%	75%	25%
TV sets	58%	42%	75%	25%
Couples	67%	33%	75%	25%

Table 2. Percentages of correct recognition by type of image and locality

Theme	Bastos		Joao Alfredo	
	Photo	Drawing	Photo	Drawing
Dentist	50%	75%	25%	75%
Obstetrician	67%	58%	25%	62%
Pediatrician	64%	42%	38%	25%
Oculist	82%	42%	62%	50%
Generalist	55%	42%	25%	25%

Table 3. Percentages of preference and correct recognition by type of image and locality

	Bastos		Joao Alfredo	
	Photo	Drawing	Photo	Drawing
Preference	92%	8%	87%	13%
Correct recognition	63%	52%	35%	48%

Table 4. Intelligibility of documents by type of image and locality

Theme	Bastos		Joao Alfredo	
	Photo	Drawing	Photo	Drawing
Social security card	92%	92%	87%	87%
Identity card	92%	92%	75%	100%
Birth register	83%	83%	100%	87%

Second test: interaction of icons with texts

The interaction between images and texts occurs frequently in computer interfaces and, depending on the context, it can create situations of anchorage, relay or tagging. According to (Santaella and Nöth, 2005: 55), when displayed side by side, a text and an image allow the holistic interpretation of the message, not a mere addition of two distinct informative messages. Those author point out that Barthes (1964: 40-51) proposed two possible modes of interrelation of text and image: anchorage and relay. In the former, the text guides the interpretation of the image, emphasizing some aspects and neglecting some others. In the relay, text and image are in a relation of complementarity in which "the unity of the message occurs in a more advanced level". Those authors remark that, although in both cases we have indexical references between word and picture, in the anchorage the reference goes from the text to the image, whereas in the relay the viewer's attention is directed from the text to the image and vice-versa.

A third type of interaction between text and image is called "tagging" or "labeling", and corresponds to arrangements where the text names the object or individual shown in the image (Santaella and Nöth, 2005).

In the field of interest of our research were those situations in which juxtaposed icon and text refer to the same concept or theme, creating, by relay, a redundancy aimed at facilitating the interpretation of the concept by low-literacy users. In e-gov services, the situations of "tagging" or "labeling" are also relevant, as, for instance, when the name of a health care center is displayed together with the photograph of its premises, in order to facilitate the identification by the e-gov service users, and also to lend more credibility to the service as a whole through the creation of a direct association to that particular entity in the real world (indexicality).

In face of all these aspects, in the second we aimed to investigate how icons interact with latent reading skills when semiliterate users access multimedia contents in computers. The test also attempted to evaluate the intelligibility of a vocabulary mixing words and expressions from different standards of the language (more familiar versus more formal words). In short, the second test tried to address the following questions:

a) Interpretation of icons;

b) Interpretation of formal words in isolation (only for semiliterate users);

c) Symbiotic relation between icons and less-known symbols, i.e., how icons can help in the interpretation of unknown words;

d) Symbiotic relation between icons and well-known symbols, i.e., how the association of icons with daily life words helps in the reading and interpretation of those words; if and in which extent this combination produces better results when compared to the previous cases (only for semiliterate users).

We conducted a second test phase in a city named Francisco Morato, a poor suburb of Sao Paulo. Five low-literacy subjects participated in the test. Prior to the test we conducted an evaluation of the literacy level of the participants and found that three of them were totally illiterate, and two had low literacy skills.

The test used the software Power Point to arrange a sequence of images and words. The participants were asked to look at the elements in the computer screen and verbalize their interpretation. The conductors took notes of every pertinent aspect observed during the tests.

In the first part of the test six icons were sequentially presented to every participant. The conductors asked the meaning of every icon and classified the answers into three levels: correct, close or incorrect). In the second part six formal words related to the already presented icons were presented sequentially and the participants were asked to read/interpret them. The conductors read aloud every word so that those totally illiterate individuals could also try to guess their meanings. The conductors then took note of the answers as correct, close or incorrect. In the third part, every icon was once again presented in the computer screen, but this time side by side with the corresponding words, so that we could verify if they helped the interpretation of one another. Finally, in the fourth part the icons were presented once more, but now side by side with the corresponding textual description based on words from a more familiar language standard. The selected words refer to concepts that are very frequent in the health care area, including in the current e-gov sites, even though some of them do not belong to the everyday language of most of the low-literacy individuals.

Table 5: List of words and expressions used in the test

Formal words	Informal expressions
cardiologista (cardiologist)	*médico de coração* (heart doctor)
pré-natal (pregnancy care)	*exame de grávida* (pregnancy examination)
hipertensão (hypertension)	*pressão-alta* (high pressure)
tabagismo (tobacco addiction)	*vício de fumar* (smoke addiction)
aleitamento (nursing)	*amamentação* (breast feeding)
diabetes (diabetes)	*açúcar no sangue* (sugar in the blood)

Table 6: Icons displayed without text support

Theme	Semiliterate individuals			Illiterate individuals		
	Correct	Close	Incorrect	Correct	Close	Incorrect
1st icon		1	1		1	2
2nd icon	1	1		1	2	
3rd icon	2			2		1
4th icon		1	1		1	2
5th icon	2			1	2	
6th icon			2	1		2
	Average individual score: 6,5			Average individual score: 5,3		

Table 7: Formal words displayed and uttered without iconic support

Theme	Semiliterate individuals			Illiterate individuals		
	Correct	Close	Incorrect	Correct	Close	Incorrect
1st word			2			3
2nd word			2		1	2
3rd word		1	1		2	1
4th word	1		1	1		2
5th word	1	1		3		
6th word	2					3
	Average individual score: 5			Average individual score: 5		

Table 8: Icons displayed with support of displayed and uttered formal words

Theme	Semiliterate individuals			Illiterate individuals		
	Correct	Close	Incorrect	Correct	Close	Incorrect
1st icon + 1st word	2			3		
2nd icon + 2nd word	2			3		
3rd icon + 3rd word	2			3		
4th icon + 4th word	2	1		2		1
5th icon + 5th word	1				2	1
6th icon + 6th word	2			3		
	Average individual score: 11,5			Average individual score: 10		

Table 9: Icons displayed with support of displayed and uttered informal words

Theme	Semiliterate individuals			Illiterate individuals		
	Correct	Close	Incorrect	Correct	Close	Incorrect
1st icon + 1st word	1	1		2		1
2nd icon + 2nd word	2			3		
3rd icon + 3rd word	2			2		1
4th icon + 4th word	2			1		2
5th icon + 5th word	2			2		1
6th icon + 6th word	1		1	2		1
	Average individual score: 10,5			Average individual score: 8		

The results presented in Table 6 show that three of the six icons (1st, 4th and 6th) were not effective (the conductors observed that they caused hesitation and doubt in the participants of both groups). The reasons for that vary from icon to icon: in the 1st icon, the cardiologist was not recognized because, according to the participants, he didn't look like a real world cardiologist, based on their experiences; in the 4th icon, the image was taken for a "don't smoke warning", whereas some participants didn't recognize the prohibition sign at all, and an elderly participant didn't recognize the cigarette packet used in the icon; finally, the 6th icon proved to be very complex, due to the theme.

It is worth noticing, however, that the inefficacy of some icons was a necessary condition for the test, since one of the purposes was to evaluate how support texts could help the interpretation of unclear images.

The results presented in the Table 7 shows, on the other hand, that three (1st, 2nd and 3rd) out of the six proposed words were not very intelligible to the participants, and only two (5th and 6th) were totally or partially understood. This was also an expected result, since we attempted to select words that arguably did not belong to the vocabulary of the participants. And as discussed for the icons, our goal was to evaluate how the iconic support could help the interpretation of these unknown words.

Although the number of participants in the test (five persons) does not allow for definitive conclusions, the results corroborated the initial hypothesis that the joint interpretation of different sings (icons and words) present in the interface improves the overall intelligibility. This is observed, for instance, when we compare the average scores of those tables referring to the combined use, that were about twice as high as those of the other tables. But the more interesting aspect appears when we compare the first row of Tables 6, 7 and 8: we can see that, while neither the icon (Table 6), nor the corresponding word (Table 7) were understood by the participants, the combination of both signs was recognized successfully by all of them (Table 8), what shows the effect of mutual support. These results seem to confirm the hypothesis that the combined effect of icons and words can be more effective than the sum of their isolated effects.

3. CONCLUSION

The iconicity research described here was intended to shed some light on how icons can facilitate or make possible the access of low-literacy individuals to e-gov services. The first test showed that, even though the use of photographs lends more credibility to the iconic representations, the intelligibility of drawings is not significantly lower than that of photos. In face of these results, one could recommend the use of either type of image, with a preference for photos whenever the emphasis is put on the credibility or in creating a direct connection with a particular entity, and a preference for drawings whenever we represent a general concept or need to take advantage of the flexibility to draw concepts for whom no photographic register is available.

The second test showed that the use of icons could reinforce and scaffold the reading skills of semiliterate users. We saw that the combined effect of icons and texts was, in some cases, greater than the sum of the isolated effects of each type of sign. In such cases we witnessed the importance of the redundancies, which, for these users, provided the extra information elements necessary for creating correct hypothesis and for validating the inferences they make on the basis of their reading skills. The weaker performance with the respective signs in isolation shows that in the absence of this mutual reinforcement between signs the users do not feel confident to guess (hypothesize) the meaning of an element presented to them. In a context of interaction with a computer interface this could mean that the users will find themselves blocked during the navigation, unconfident to select the next menu option, for example. And it was precisely to avoid such problems that we investigated here how to maximize the intelligibility and the credibility of the computer interface and of its underlying interaction model. In terms of recommendations for interface design we could point out that the mutual reinforcement of images and texts has proved to be beneficial for semiliterate users.

In what refers to the use of less formal vocabulary we found out that the intelligibility essentially depends on the familiarity the users have with each word, regardless of the fact that this word is formal/technical or more popular. Thus, even though some expressions formed with everyday words (such as "heart doctor") were understood by the participants, these expressions caused some strangeness, whereas the equivalent formal term (in this example "cardiologist") created no problem at all. But this was not the case for each and every formal/technical word: some of them proved to be totally incomprehensible to most participants.

The final conclusion is that, in contexts similar to Brazil's social and educational reality, the development of computer interfaces and interaction models for low-literacy users needs to address the iconicity issues, such as those discussed above, as well as aspects related to the written language, including the appropriate use of words and expressions to represent the ideas the users need to understand to accomplish the functionalities offered by the provided services or contents.

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