Overcoming the Language Barrier: The Potential of the Visual Language LoCoS in International Human-Computer Communication

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Abstract. The present paper investigates whether the artificial language LoCoS is suited for application in international Human-Computer Communication, in comparison to natural and extended-natural foreign language. In the present study, LoCoS was examined with regard to criteria of effectiveness, encoding, efficiency, acceptance, learnability and functionality in contrast to English or English in combination with emoticons. The random sample yielded 47 persons from 19 different countries totally. A tentative acceptance of LoCoS as a symbolic language was observed, although the effort required to learn it was rated notably lower than that required to learn a foreign language. Communication occurred more efficiently because fewer LoCoS symbols than words were used. A general trend towards the use of extended natural languages could be detected, indicating that symbols are not exclusively accepted (yet), but are increasingly used in combination with a natural language.

Keywords: International Human-Computer Communication, Visual Communication, Internationalization, Artificial Languages, Visual Languages, Iconic Languages, Semiotics.

1 Introduction

The development of written and spoken language over several thousand years to its present diversity represents one of the most important aspects of human evolution. The creation of a universal writing system, enabling communication regardless of native language and cultural background, would be a major achievement for science and society. In the future, people would not have to study for months to pick up a new language [1]. Multilingual communities are already using machine translation to overcome the language barriers which are arising with growing frequency. However, inevitable semantic translation errors still occur which make precise interpretation difficult [2]. English is often declared language of the World Wide Web [3], but how optimal and effective do we communicate using English [4]? Internationally unambiguous visual languages, such as LoCoS, could help overcome cultural and linguistic barriers [4], and thus facilitate international human-computer communication.

N. Aykin (Ed.): Usability and Internationalization, Part II, HCII 2007, LNCS 4560, pp. 527–536, 2007.

Moreover, recognition of symbols may be more intuitive, as fewer people suffer from dyslexia in cultures with symbolic written language such as that used in China [5]. The increasing use of acronyms and emoticons, which, except for Japanese emojis, generally have conserved meaning world-wide, indicates a trend for internationally universal expression. However, attempts to artificially create and popularise international auxiliary languages in the past, such as *Leibniz' Universal Language, Solresol, Volapük, Lingua Franca, Esperanto* and *Interlingua* have failed largely due to either their initial effort required to learn them [6] or due to their origins in Indo-European languages [7]. Whereas *Blissymbolics* by Charles K. Bliss, based on rather abstract than iconic symbols [8], found its use in special education, Otto Neurath's *Isotype* had a big influence on graphical user interface design. Still, computer-based visual languages intentionally designed for research purposes in the past decade, such as the *Elephant's Memory, VIL, CAILS* and *Musli*, did not experience a break-through in use. This failure may be because contrary to the sophisticated English language no official grammars were published, and except for a basic prototype no cutting-edge GUI-applications were developed and projects were abandoned [9]. The international visual language LoCoS is based on 19 major iconic symbols and can be learned in 1-2 days, which makes it perfectly suitable for use in international Human-Computer Communication or Human-Computer Interaction [10]. The LoCoS-for-Mobile-Devices Prototype by AM+A (Fig.1) provides a method of utilization of LoCoS in mobile devices [8]. The present study links to it in that way, that it aims to examine LoCoS to be used by people of different linguistic and cultural backgrounds in an Human-Computer Communication environment.

Fig. 1. LoCoS-for-Mobile-Devices Prototype [8]

2 LoCoS

2.1 Concept and Development

LoCoS is an artificially created, universal iconic language originally developed by the Japanese Graphic Designer Yukio Ota in 1964. *LoCoS* stands for *Lovers' Communications System* [11, 12]. It aims at facilitating international communication among people regardless of their linguistic and/or cultural background. Among artificially

created languages, in addition to being associated with pictographic symbol languages, it also classified as an international auxiliary language. Since its first publication, over the years the system has been widely expanded, so that today more than 1,000 distinct symbols exist. The majority of literature has been published in Japanese, with hardly any translations into English or other languages. Moreover, LoCoS has its own pronunciation system [10] which will not be included in the current analysis.

2.2 Morphology and Syntax

Single words in LoCoS are represented by pictographs. By combining 19 major symbols (Fig. 2) with each other, new terms can be formed. A circle (*sun* or *day*) with a dot (*point existence*) in the center can stand for *day* or *today*, for example. Past and future tense are expressed by a line (*to do*) proceeded or followed by a dot. *To see* (Fig. 3) results from combination of the symbols for *to do* and *eye* [10].

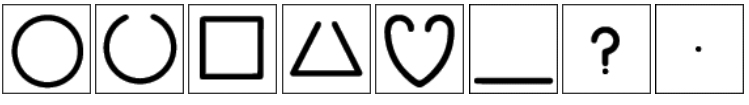

Fig. 2. Selection of some of the 19 major LoCoS symbols (*day, man, thing, thought, feeling, place, question, point existence*) [10]

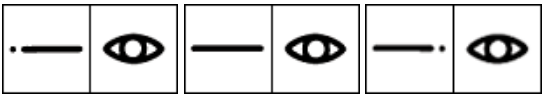

Fig. 3. Past (*saw*), present (*see*) and future tense (*will see*) of the verb *to see* [10]

Complete sentences in LoCoS can be created by arranging symbols in a triple-lined grid. The symbols are read from the left to the right. The main content is placed in the middle row. Adverbs are allocated to the top and adjectives the bottom row [10]. However, due to save space, Marcus [8] confined his LoCoS-for-Mobile-Devices prototype application to single-line writing (Fig. 4). Due to this and technological limitations, in this study, a triple-line grid was not used.

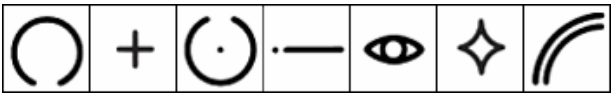

Fig. 4. Example for a complete declarative sentence in LoCoS: *You and I saw a beautiful rainbow* [10]

3 Experiment

To define Human-Computer Communication, i.e. the quality criteria and corresponding measurements (dependent variables), 3 different models were considered. The

first model included the requirements of an artificially created international language as defined by the International Auxiliary Language Association (IALA): *learnability, correlation to native language, functionality, consistency* and *neutrality*.

The second model consisted of the 3 core aspects for usability evaluation as defined by the International Organization for Standardization (ISO) in the ISO guideline 9241-11: *acceptance, effectiveness* and *efficiency*.

The third model employed the quality criteria (primary capability principles) used by Leemans [13] to evaluate the applicability of his created visual language VIL in human-computer communication. To receive specific measurements, he assigned his criteria to Shneiderman's measurable human factors (in brackets) [14]: *learnability* (time to learn, retention over time), *extensibility*, *encoding* (speed of performance, error rate) and *decoding* (speed of performance, error rate).

Emerging from the 3 models mentioned above and taking into consideration practical restrictions on time, technical possibilities and the limitations of a remote test, the present study focused on the 6 quality criteria *acceptance, learnability, functionality, effectiveness, encoding and efficiency*. The corresponding objective and subjective variables of error rate, satisfaction and effort to learn were extended by including more specific items such as number of words or LoCoS symbols, preference and utilization (Table 1).

Table 1. Analyzed criteria with corresponding subjective and objective measurements

Criteria	Subj. Measurement	Obj. Measurement
Acceptance	Preference	
	Satisfaction	
Learnability	Effort to Learn	
Functionality	Utilization	
Effectiveness		Error Rate
Encoding		Error Rate
Efficiency		Number of Words/Symbols

3.1 Hypotheses

The following hypotheses were posited:

H1 (Acceptance). LoCoS facilitates communication among people of different linguistic and cultural backgrounds.

H2 (Learnability). Learning a symbolic language like LoCoS requires less learning effort than learning a natural foreign language, because symbol recognition happens more intuitively.

H3 (Functionality). LoCoS is suitable for modern forms of communication, i.e. chatting and sending short text messages (SMS).

H4 (Effectiveness, Encoding). Fewer errors occur while encoding messages from English into LoCoS compared to encoding messages into a natural or an extended natural foreign language like English.

H5 (Efficiency). Communication using LoCoS is more efficient and requires fewer symbols than words used to express the same thought.

3.2 My LoCoS Community – Test Application

As we wished to gather data from a culturally diverse sample, the study required participants to be recruited from as many countries as possible. The most efficient way to achieve this was to use a remote test conducted online via the world wide web. Therefore, an online forum was set up as the test application. Based on the open source SMF software, *My LoCoS Community* was implemented. It simulated an imaginary application environment for testers, accessible from anywhere in the world with unrestricted internet access. Through integration of a WYSIWYG-editor (Fig. 5) into the software, graphic LoCoS symbols were incorporated into the application, so that the participant could select them via a simple mouse-click from a pop-up-menu. The LoCoS pop-up menu included more than 280 different LoCoS symbols arranged thematically into several categories.

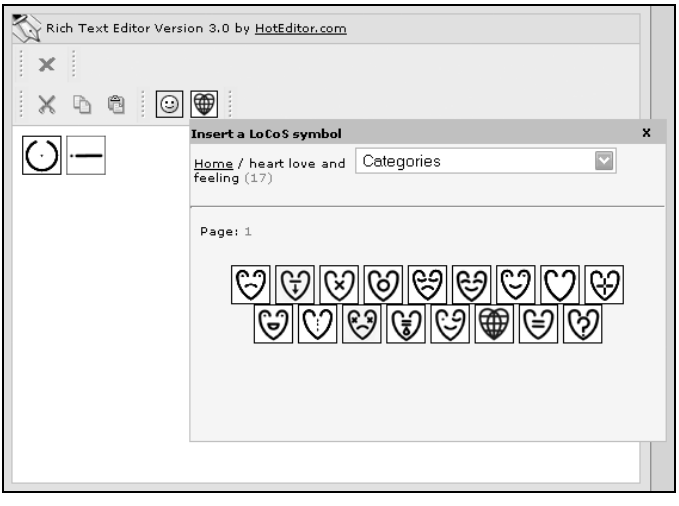

Fig. 5. WYSIWYG-editor with LoCoS pop-up menu

3.3 Method and Material

Communication within the *My LoCoS Community* was divided into 3 conditions: firstly, via a natural language, secondly via an extended natural language and thirdly via an international symbolic language. This resulted in participants being allocated to one of 3 groups: the control group using English (Group C), the first experimental group using English with Emoticons (Group E_1) and the second experimental group LoCoS (Group E_2).

The first part of the test, in which objective variables were measured, consisted of an assignment to verbalize (Group C and E_1) or encode (Group E_2) 10 standard sentences – 6 declarative, 2 interrogative and 2 imperative. The second part of the test was a survey to collect subjective data, such as demographical, behavioral and attitudinal information. The test application, the online-forum *My LoCoS Community*, was activated for a period of 4 weeks between February and March 2006. Test

persons were recruited through an e-mail invitation letter which was posted to several mailing lists and newsgroups shortly before and during the testing period. The average time to participate was estimated at 30-45 minutes. After registering and logging-in, test subjects had access to different pdf files, containing extended test instructions and an introduction to LoCoS (LoCoS Manual), according to the group to which they were assigned. The only prerequisite for participation to be a non-native English-speaker, to equalize linguistic background as far as possible among subjects. An exception existed for Group E_2 (LoCoS), as the tasks were completed using LoCoS and not English. Other differences among participants were controlled by randomly allocating them to either Group C, Group E_1 or Group E_2 [15].

Overall, 47 people (N=47) participated in the study. Of these, 20 participants were in Group C, 18 participants were in Group E_1 and 9 participants were in Group E_2. The apparently uneven allocation of the groups was due to the fact that although 130 people registered to participate, only 15.4% of Group C, 13.8% of Group E_1 and 6.9% of Group E_2 entirely submitted their results. Differences between groups in regard to gender, native language, country of residence, age, English proficiency, online-forum experience and habit of emoticon use were not significant (p>0,05). The random sample yielded participants from 19 different countries including Germany, South Korea, United States, Italy, Pakistan, Slovenia, Bulgaria, China, Finland, Ireland, Israel, Canada, Mexico, Poland, Sweden, Slovakia, Spain, Hungary and United Kingdom. Nearly two-thirds of participants (30) stated either German, French, Russian or Spanish as their (first) native language. The ratio between male and female test-takers was 1.3:1. The average age was between 18 and 35 years.

Table 2. Means and standard deviation of selected variables between groups

Group	English	English w/ Emoticons	LoCoS	Sig.
Gender (Male/Female)	12/8	10/5	3/6	$\chi 2(2)=2.699$, p=0.259
Native Language				$\chi 2(10)=14.411$, p=0.155
Country of Residence				$\chi 2(36)=33.607$, p=0.538
Age (Categories 1-7)	2.60±0.503	2.50±0.522	3.11±1.264	p=0.174
English Proficiency (1-5)	3.50±0.761	3.80±0.414	3.56±0.726	p=0.398
Online-Forum Exp. (1-4)	2.17±1.150	2.38±1.088	2.33±1.118	p=0.853
Emoticon Use (1-4)	2.75±1.020	2.38±0.719	2.44±0.882	P=0.428

4 Results

4.1 Subjective Data

Acceptance (H1). Hypothesis H1 was analyzed by questioning the preferred communication method – if no common language between conversational partners was shared – and also the extent of participant's subjective satisfaction. 3 respondents reported a preference for communicating in English, whereas 5 respondents would

favour using English in combination with emoticons. Only 1 person stated a preference for LoCoS from the 3 tested communication methods. An interesting finding was that 7 out of the 8 people who preferred English with or without emoticons were non-native-English speakers. Subjective satisfaction on a scale between 1 (very easy) and 7 (very hard) was rated on average 3.2 in Group E_2, 1.8 in Group E_1 and 2.5 in Group C. Summarily, a tentative acceptance of LoCoS as a symbolic language was observed, but hypothesis H1 could not be verified in this study.

Learnability (H2). Contrary to H1, a majority 7 out of 9 participants from Group E_2 agreed that learning a visual symbolic language like LoCoS requires less time and effort than learning a natural foreign language. They also shared the opinion that this is because symbol recognition takes place more intuitively, though this could not be objectively verified.

Functionality (H3). The statement that LoCoS is as suitable for use in Human-Computer Communication (SMS, instant messaging) as natural languages since communication of complex information is possible, was both confirmed by 4 participants and disconfirmed by 4, while 1 interviewee neither provided no response. Furthermore, 8 of 9 participants could imagine the use of LoCoS for communication among hearing-impaired people. 7 of 9 interviewees could imagine LoCoS to be useful in scientific or formal communication. 6 respondents shared the opinion that LoCoS is ideal for teenage communication, while another 6 felt it would be useful for any age groups. The fewest number of endorsements were given to the uses of LoCoS as machining operating language (2 votes) and for poetry (1 vote).

4.2 Objective Data

Effectiveness/Encoding (H4). For examination of hypothesis H4, the mean semantic, tense, spelling and word-order errors for all of the 10 sentences were calculated for each group. The system of error measurement derives from natural languages, since to our best knowledge there is no specific metric for visual languages. A One-Way ANOVA showed that there was no significant difference in average error rate between groups (C, E_1 and E_2) ($p=0.779$). A post hoc LSD test also did not reveal any significant differences between individual pairs of groups. Therefore, the hypothesis could not sufficiently be supported with these data.

Efficiency (H5). For evaluation of efficiency and validation of hypothesis H5 the mean numbers of words or LoCoS symbols used for all 10 sentences in each group were calculated. In this study efficiency reflects the effort needed for typing and keying in letters or LoCoS symbols. It does not attempt to serve as a measure of cognitive processing. Assuming the standard length of an English word to be 5 letters, the total numbers of letters for every 10 sentences in Group C and E_1 were divided by 5 to calculate the average number of words to be compared with LoCoS symbols used in Group E_2 (1 LoCoS symbol = 1 word). Each emoticon used in Group E_1 counted as five letters (1 word). A One-Way ANOVA revealed a significant difference between groups ($p=0.022$). A post hoc LSD test showed that this significance was due to a

significant difference between Groups C and E_2 (p=0.008), as well as between Groups E_1 and E_2 (0.017) (Fig. 5). Overall, communication occurred more efficiently because fewer symbols than words were used to express the same thought.

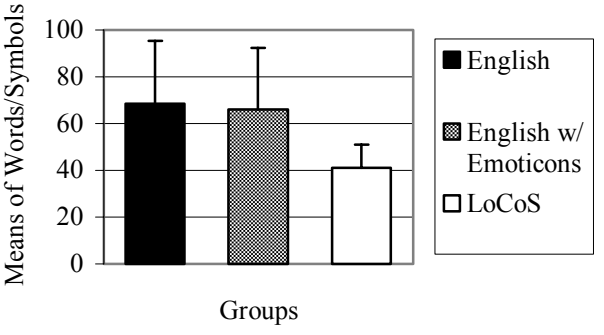

Fig. 6. Means of words/LoCoS symbols used and standard deviation

5 Discussion

A general trend towards the use of extended natural languages could be detected, indicating that while symbols are not exclusively accepted (yet), they are increasingly used in combination with a natural language in Human-Computer Communication. The reason for the tentative acceptance of an artificially created iconic language like LoCoS may be that while learnability is an important theoretical evaluation of a language, it does not predict practical success [16]. Publications in several major spoken languages are essential for an increasing awareness and natural distribution of LoCoS. The creation of symbols representing technical functions could facilitate application of LoCoS in the context of Human-Computer Interaction. However, LoCoS' advantage in comparison to other artificially created visual languages is that it does not claim to be a replacement for natural languages [11].

In previous studies there have been many approaches for creating different visual languages. Future experiments should employ a professionally developed mature iconic language like LoCoS to focus research findings in relation with Human-Computer Communication or Interaction, and ensure results are comparable across studies. In addition, LoCoS itself could be examined for the usefulness of multimedia attributes such as color [8], animation, audio or tool-tip help.

To optimize the assessment procedure, there is a need for a non-ambiguous system of measurement developed specifically for evaluation of visual languages, to compliment the current criteria. It is critical to determine whether the number of words used by subjects indicate the powerfulness of a language or simply the restricted vocabulary of a novice. To include people who may not have access or exposure to computers, a future test could be conducted by collaborating lab sites worldwide. Moreover, offering the test in participants' native languages would provide a better comparison of their task performance. Through an individually

implemented test application and a test design which allows for tracking of cognitive effort and physiological data (eye fixation duration, saccade rate etc.), assessment measurements could be determined objectively. Imaginative, partly incomplete dialogues as part of the test task would provide a more natural communicative situation to subjects, as opposed to the sentences used here. We suggest use of a common communication device prototype as test application as the best possibility.

In addition, we imagine LoCoS could be implemented within educational learning software for speech- or learning-impaired people or children, or integrated in e-mail or instant messaging communication software. In this way, it could aide intuitive language acquisition and promote international communication using state-of-the-art technology. Horn [17] points out that visual languages, and thus LoCoS, could be applied in distance learning or help managing international telephone conferences between multi-ethnic groups. In the end, LoCoS – as any other artificially created language – relies on psychological acceptance which is defined by initially motivating as many people as possible [18], a process which assesses viability rather than theoretical criteria.

Acknowledgements. Deep thanks and appreciation to Aaron Marcus as a source of inspiration and for providing rare, original LoCoS material. Many thanks also to Yukio Ota as inventor and designer of LoCoS.

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