

Localization beyond National Characteristics: The Impact of Language on Users' Performance with Different Menu Structures

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Abstract. The consideration of cognitive differences between user groups in the field of human-computer interaction is still in its infancy. The present paper presents two explorative studies looking at the impact of the users' native language on their performance with different menu structures for mobile phones. Object- and verb-oriented menus with different levels of hierarchy were tested with users in Mexico and Germany. A follow-up study looked at the performance with verb- and object oriented menus by Arabic native speakers in Egypt. The results suggest that flat hierarchies are to be preferred independent from any cultural impact. While the first study did not yield a significant difference between Spanish and German native speakers using verb- and object-oriented menus, Arabic users performed significantly better with verb-oriented menus.

Keywords: internationalization, localization, cross-cultural usability, information architecture, user-centered design.

1 Introduction

Since the worldwide diffusion of information and communication technology (ICT) is increasing, so is the diversity of users and their characteristics. As a consequence, the efforts to internationalize and localize products and systems made their arrival into the field of human-computer interaction (HCI). While internationalization (i18n) refers to the removal of sensitive elements, localization (l10n) describes the process of adaptation by adding local components that are specific to a certain context of use [1]. These components and elements can be classified into four categories [2]: technology, language, culture and cognition. Technological adaptations refer for instance to different character sets, date and time formats as well as legal frameworks. In a broader sense, the technical aspects include furthermore areas like mobile network standards (GSM, TDMA etc.), electrical conditions, plugs, video standards and technical

infrastructures in general that differ between countries. Language, the second category, describes the translation of text used in manuals and throughout the user interface. More often than not, cultural aspects are often not included. Spanish, for instance, allows through an international, a universal, a mid-Atlantic and a neutral version to translate any text for a worldwide audience without considering local characteristics [3] [1]. The meaning of color, icons, symbols, sounds, functionality and social aspects of technology add up to the cultural category. Central elements of ICT like menu trees, interaction principals or interactive sequences are related to the last category, cognition. Research on cognitive differences between user groups relevant to the HCI community is still in its infancy, while technological, linguistic and cultural factors for i18n and l10n have been investigated intensively during the last decades [4], [5], [6], [7], [8], [9], [10]. Therefore, we address these aspects reporting two exploratory studies that focus on the relationship of menus with the native language spoken by the user.

2 First Study

2.1 Derivation of Hypotheses

From literature review as well as from a preceding field study on the cultural differences of mobile phone usage in Mexico and Germany, two characteristics of menu structures were identified to function as independent variables: verb-object vs. object-verb orientation and the maximum number of hierarchical levels used for the menu.

Verb-Object vs. Object-Verb. Spanish can be considered a verb-first language due to the pre-dominant word order “subject-verb-object” (SVO) [11]. In German, however, SVO exists in the main clause only, while the subordinate clause is predominated by the word order “subject-object-verb”. Koster [12] argues that the underlying structure of both Dutch and German has to be seen as SOV. Furthermore, German can be categorized as a “verb-second language” [13]. This supports its object-oriented character. Hereby, the only possible translation of the German predicate “die Freundin anrufen” (object-verb order, “call the girlfriend”) into Spanish is “llamar a la amiga” (verb-object order). The same observation can be made using compound verbs expressing events of the past in both languages.

Command-line interfaces like MS-DOS or the UNIX shell are verb-oriented [14]. Hereby, the verb is specified first and then the object the action will be applied to. In order to delete a text file named “text.txt” the command “del text.txt” has to be chosen. In contrast, windows-based interfaces like MS Windows follow an object-oriented approach. The objects are chosen first and then the verb (action). In order to delete all files in a folder, the user needs to select all files (objects) first and then to choose the action (delete) [14].

Generally, this leads to the question of whether the dominant grammatical structure of a user’s native language has an impact on the user’s performance with verb- and object-oriented menus respectively.

Maximum Levels of Hierarchy. Chen and Macredie [15] found a correlation between the degree of field-dependency (FD) as a cognitive style and the navigational behavior in information spaces. The concept of FD used here is based on Witkin et al. [16]. People with a high level of FD tend to describe objects through their relationships with other objects in space, whereas people with a low FD-index separate objects from their context while perceiving them. According to Sherry and Macredie, high-FD is followed by a rather linear and serial navigation style. This could be supported by a rather flat hierarchy of a possible menu. In contrast, a low FD-index that results in a more non-linear and non-serial navigational style could be supported in a better way by a stronger hierarchy of a menu with more levels.

Several research projects demonstrated furthermore an impact of cultural differences on the FD-index. According to Holtzmann et al. [17], Mexicans tend towards field-dependency, whereas people in the U.S. show a stronger tendency towards field-independency. Based on the characteristics stated by Nisbett for explaining cultural differences in cognition [18], it is assumed that these results for the U.S. can be transferred to German participants. Holtzmann et al. [17] showed as well that the age of the participants tested influenced the results. The older they were, the more they tended towards field-independency. Halpern [19] states that men tend to be field-independent, while women show a stronger tendency towards field-dependency.

Hypotheses. The above discussion leads to the derivation of the following (partly opposing) hypotheses using both orientation (verb, object) and hierarchy as independent variables:

1. Spanish-speaking participants tend to show a better performance with verb-oriented menus based on the verb-orientation of the Spanish language
2. German-speaking participants tend to show a better performance with object-oriented menus due to the object-orientation of the German language.
3. Based on the expected differences in the FD-index it is predicted that German participants will show a better performance with menus of a stronger hierarchy while Mexican participants will show a better performance with flat hierarchies.
4. Based on the existing recommendations for the maximum level of hierarchies it is predicted that both Mexican and German participants will show a better performance navigating within low hierarchical menus than using menus with a stronger hierarchy.
5. Prior exposure to and experience with object-oriented user interfaces will lead to a better performance with object-oriented menus as well as to a decreasing performance with verb-oriented menus.

2.2 Menus

Two variables with two parameter values each allow the construction of 4 different menu versions: object-oriented with a strong hierarchy (oi), object-oriented with a

low hierarchy (od), verb-oriented with a strong hierarchy (vi), verb-oriented with a low hierarchy (vd).

The different menus have been developed based on the standard original menu of the Siemens S55 mobile phone, which was classified as “object-oriented with strong hierarchy”. The “object-oriented, low hierarchy”-version was developed through a re-ordering of the complete functions in a maximum of 2 instead of 4 menu-levels. The verb-orientation was constructed using the standard original menu in three steps: First, the corresponding verbs were derived from each noun (object). Second, this new list of verbs (actions) was clustered into one shorter list of 11 verbs covering all the functions. Third, this shorter list became the first menu level.

To take the connection to the Internet with the mobile phone as an example, the respective function can be found in the original standard menu by selecting “Surf & Fun” at the first menu level and “Internet” at the second menu level. The verb-oriented menu provides this function by selecting first “connect” at the first and “Internet” at the second level.

2.3 Method

Experimental Design. In order to test the hypotheses mentioned above a mixed across-and-within-subject design was chosen (3 groups of Ss \times 2 hierarchy levels \times 2 verb/object-oriented menus). Each participant was asked to find 4 functions in each of the 4 ($= 2 \times 2$) different menu versions. The experiment was conducted with 3 groups (1 in Germany, 2 with low/high educational background in Mexico). This provided the opportunity to integrate language, computer literacy and formal education as possible factors. Each participant was assigned randomly to one of 24 ($= 4!$) conditions, where each condition represented a different order of the 4 different menu versions. Therefore, each of the 3 groups group consisted of 24 participants.

Test Procedure. Each test run started with an opening semi-structured interview of about 20 minutes to collect demographic data, level of education, attitudes to technology, technical experiences and cultural issues. The second step included a test of the level of FD with the test of Witkin et al. [20]. The third part consisted of the main task, i.e., finding 4 functions in each menu version on the mobile phone: dialed calls, volume of ringtone, alarm clock and SMS inbox followed by a short questionnaire to rate each menu individually. In a closing debriefing interview each participant was asked to provide an overall rating of the menus while mentioning the main positive and negative issues found.

Participants. As mentioned above, the sample consisted of 3 groups. Each group had been balanced concerning career, gender, age and native language (see table 1).

Table 1. Demographics of participants

Demographic	Group 1 (MX 1)	Group 2 (MX 2)	Group 3 (D)
Location	Mexico	Mexico	Germany
Recruiting	Craftspeople, vocational school students	University students	University students
Age	17-25	18-25	18-25
Mobilephone ownership (years)	0.26	0.09	0.30
Computer experience (years)	0.82	6.25	11.25
Formal education (years)	9.25	13.58	15.42

2.4 Results

Data Collection and Conditioning. The following objective measurements were extracted from the log file of the prototype: time in milliseconds for each task and menu version, errors for each task (an error was defined as a selection of a wrong function), number of steps for each tasks, navigation path and selections (not covered in this paper)

The following subjective measurements were collected during the semi-structured interviews that took place between each menu version as well as at the end of the test: rating of preference for each menu (position 1-4), easiness of task completion (scale 1-5), speed of task completion (scale 1-5), clearness of task completion and menu (scale 1-5), level of satisfaction with menus (scale 1-7).

Due to the different positions of the same function in each menu the measured times for the completion of the tasks would not be comparable. This is because a different amount of steps is needed to reach the function in each menu and it would overlay the effects that were planned to be measured (hierarchy and verb-object vs. object-verb orientation). Therefore the times for finding the functionality have been normalized with a GOMS model.

Data Analysis. A first analysis of the data shows an overall significant interaction of group membership with menu versions ($F_g = 29.51$, $p < .01$). Both hierarchy levels and verb/object-orientation presented separately as well a significant interaction with group membership ($F_{ov} = 132.79$, $p < .01$, $F_h = 132.79$, $p < .01$). No significant interaction of group membership with the levels object- and verb-orientation was found, while the levels flat and strong hierarchy showed a significant interaction with group membership.

Hypothesis 1 stated that Spanish-speaking participants tend to show a better performance with verb-oriented menus. This hypothesis has to be rejected as participants of both Spanish-speaking groups needed significantly more time for the task completion using the verb-oriented menus.

Hypothesis 2 argued that German-speaking participants tend to show a better performance with object-oriented menus due to the object-orientation of the German language. It has to be partly accepted. The German participants showed a significant better performance with the object-oriented menu versions. However, the results of the Spanish-speaking groups showing as well a better performance with object-oriented menus does not allow to conclude that the language might have an impact on the preferences for the menu structure.

In hypothesis 3 it was said that German participants will show better performance with menus of a stronger hierarchy while Mexican participants will show a better performance with flat hierarchies. This hypothesis needs to be rejected as all groups showed a significant better performance with flat hierarchies.

Hypothesis 4 claimed that both Mexican and German participants will show better performance navigating within low hierarchical menus than using menus with a stronger hierarchy. This hypothesis is accepted as all groups showed a significant better performance with flat menus.

Hypothesis 5 forecasts that prior exposure to and experience with object-oriented user interfaces will lead to a better performance with object-oriented menus as well as to a decreasing performance with verb-oriented menus. Both menu versions showed a strong and significant correlation with prior computer experience. This result, however, does not allow the conclusion that prior computer experience leads to a better performance with object-oriented menus and a decreasing performance with verb-oriented menus. Therefore, this hypothesis has to be rejected.

2.5 Discussion

The results presented in the previous section seem to provide a clear picture: Generally, flat hierarchies were preferred independently from any cultural factor. Similarly, all participants seem to perform significantly better with object-oriented menus in contrast to verb-oriented menus. A closer look at the quantitative and qualitative data, however, reveals that both Mexican groups showed an increased error rate with each task. In addition, it was observed that the strategy for solving the tasks changed from a structured one to a trial and error approach. Exploring the data further shows a significant interaction between object-oriented and verb-oriented on the one hand and group membership on the other hand ($F=4.97$, $p=.01$). Group MX1 shows a strong tendency towards a better performance with the verb-oriented menus ($F=3.66$, $p=.068$), whereas group D shows a strong tendency to perform better with object-oriented menus ($F=3.44$, $p=.076$).

The better performance with verb-oriented menus of group MX1 while showing a higher error rate compared to object-oriented menus and a lower number of correct first choices leads to the assumption that the time to recover from errors tends to be substantially less compared to object oriented menus. This way, the first hypothesis seems to be confirmed. However, it cannot be claimed that linguistic factors are causing this difference in performance because group MX2 does not show any significant difference. Therefore, it can be assumed that both computer experience and formal schooling might have a considerable greater impact on the performance of the

participants. A stepwise regression of both factors for the verb-oriented menus does not exclude either of them. However, the significant result for the factor computer experience ($T = -2.64$, $p < .05$) compared to the factor formal schooling ($T = -1.63$, $p < .20$) suggests the tendency that computer experience can be used with more confidence as a predictor.

A possible explanation for this result might be that in order to achieve a goal using an object-oriented menu, the user needs to have a greater prior knowledge of the objects that the system offers to complete a task. The user needs to know in advance, which object of the system corresponds and implements the process to reach her goal. Thus, choosing the right object right at the beginning of a task is crucial to be able to complete it. The concept of the implemented objects is an additional aspect that has to be learned. On the other hand, verb-oriented menus seem to offer a smaller step in the beginning of the series of choices that the user has to make for completing a task or to search a function. Prior knowledge is not needed to the same amount, while simplicity is offered right from the beginning. The following example observed a lot at the group MX1 illustrates this possible explanation:

The first problem of the main task was to look up a number the user had already dialed before in the list of the dialed numbers. The object-oriented menu with a strong hierarchy required two steps selecting first the menu item “call records” (Spanish: “Lista de llamadas”) and second the item “dialed numbers” (Spanish: “Números marcados”). The verb-oriented menu with a strong hierarchy required three steps instead: “look up” (Spanish: “consultar”), “call records” (Spanish: “Lista de llamadas”) and “dialed numbers” (Spanish: “Números marcados”). In spite of the fact that the verb-oriented menu required one step more, users found the respective function with an average of 20% faster.

2.6 Conclusion

Within the scope of this study, three different questions have been investigated.

The first question, deals with the impact of the user’s native language on the preferences of menu structures. Both object- and verb-oriented menus as well as Spanish as a verb-oriented language and German as an object-oriented language have been tested. The results suggest that there is no direct influence of the mother tongue on the preferences of menu structures as both hypothesis one and two were rejected.

While answering the second question about the influence of prior computer experience and formal schooling on the preferences of menu structures, it could be shown that concrete prior experiences with object-oriented graphical user interfaces can be taken as a predictor for the performance with verb and object-oriented menus as hypothesis four and five were confirmed. The results suggest that verb-oriented menus lead to a significant increase of a system’s usability, especially as far as novice users are concerned.

The participants showed, independently from any cultural or contextual factor, a significantly better performance with flat hierarchies (2 levels maximum), while menus with a strong hierarchy (4 levels maximum) led to a significant slower interaction.

3 Second Study

The second study follows up on the first hypothesis mentioned above: Speakers of a verb-oriented language would show better performance with verb-oriented menus. The results of the first study suggest that prior experience with information technology seems to be the decisive factor for the performance with menus instead of the word order given by the native language of the test subjects.

In order to verify this result, a similar test has been conducted with a group of Arabic native speakers in Egypt. Both “subject-verb-object” (SVO) and “verb-subject-object” (VSO) are the predominant word orders in the Arabic language according to Dahlgren [21]. Therefore, Arabic can be classified as a verb-oriented language.

Participants. The group’s demographics corresponded to both Mexican groups of the previous study. 24 University students with extensive prior experience using ICT formed the first half of the group. The second half consisted of 24 subjects without any prior experience using ICT.

Procedure. The test subjects have been asked as well to find 4 different functionalities in a mobile phone menu, similar to the first study. This time, the device has been a smart phone while the menus were implemented as HTML pages. Interestingly, it was not possible to find enough Arabic native speakers in Egypt that would use their mobile phones in Arabic instead of English. Therefore, the respective menus presented were English translations of the menus used in the first study. Since English is a verb-first language (SVO) as well, there is no conflict between both languages with respect to effects of word order.

Results. Overall, it took the 48 test subjects significantly longer ($p < .001$) to find the given functionalities in the object oriented menu (8.87s) in comparison to the verb-oriented menu (6.49s). This effect was even more prominent within the subgroup of subjects with extensive prior experience using ICT. They found the functionalities in the object-oriented menu in 12.09s, while it took them 7.41s with the verb-oriented menu ($p < 0.001$). The subgroup with no prior experience using ICT, however, did not show a significant difference ($p > 0.4$) between the object-oriented version (5.69s) and the verb-oriented version (5.59s).

Discussion and Limitations. The results suggest rather clearly that the word order of the language spoken by the participants has an effect on the performance with verb- and object-oriented menu structures. The prior experience with ICT did have an impact resulting in a better performance with verb-oriented menus. Prior experience with existing menu structures could have had as well an impact on the results. In addition, the users were able to see 9 entries of the menu at a time instead of 3 in the first study. This aspect provided the participants with a better overview of the different options available.

4 Conclusion and Future Work

The work presented here covers two important aspects when designing menus for ICT: the levels of hierarchy and the criteria for sorting of functionalities. It has been shown that flat menus with a maximum depth of two levels are to be preferred

independent from any cultural context. In contrast, the impact of the users' native language on the performance with verb- and object oriented menus respectively did not present such a clear picture. The first study focusing on Spanish (verb-oriented) and German (object-oriented) native speakers suggest that the prior experience with ICT can be seen as a determining factor while the language can be excluded. The second study looking at Arabic (verb-oriented) native speakers showed opposite results: the overall results show a significant better performance with verb-oriented menus while this effect is even stronger for the tech-savvy users.

The comparability between both studies is limited due to the methodological differences mentioned before. Therefore, there is no concluding answer to be given regarding the linguistic aspect of menu design. It is recommended to redesign the study while extending it to other languages. German is considered an object-oriented language even though both SVO and SOV word orders are present. There are, however, other more prominent object-oriented languages such as Hindi and Korean that should be included. Both Spanish and Arabic are clearly verb-oriented languages and should be present in follow-up studies as well.

The first study accounted for the factor of prior experience with mobile phones with subjects that did not own a mobile phone before. The second study recruited participants with a uniform level of prior mobile phone usage. In order to account for this factor in a better way it is recommended to design a menu for an application that is not yet known to the participants. This could be a TV program guide on television or an app for a smart phone with a novel service not known to the users.

Finally the menu for the tested application should be translated into the local language completely. The challenge of participants being used to a user interface in English can be solved by adapting the content of the application to local customs. The native language would be more acceptable for instance in applications that deal with locally rooted traditions such as cooking.

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