Comparing User Satisfaction and Customisation for Variable Size Personalised Menus

Khalid Al-Omar and Dimitrios Rigas

Abstract— This paper reports a comparative empirical investigation of the effects of content size on user satisfaction and customisation of five different personalised menu types: adaptable, adaptive split, adaptive/adaptable highlighted, adaptive/adaptable minimised and mixed-initiative menus. Two independent experiments were conducted, on small menus (17 items) and large menus (29 items) respectively. The experiment was conducted with 60 subjects (30 subjects each on small and large menus) and was tested empirically by four independent groups (15 subjects each). Results show that in small menus, the minimised condition was preferred overall, followed by the adaptable and highlighted types. By contrast, in large menus, the mixed-initiative condition was the most strongly preferred, followed by the minimised approach.

Keywords—Adaptable, Adaptive, Menus, Mixed-initiative, Personalisation.

I. Introduction

Today, with each new release of software applications there is a plethora of features designed to satisfy every user. As a result, graphical user interfaces have become visually complex and hard to organise. This is accompanied by a decrease in the size of the screens of many handheld devices (e.g. mobile phones, PDAs), which further increases the complexity of the interfaces. This complexity has become recognised as a phenomenon which some researchers call creeping featurism [1] and others bloatware [2, 3]. This phenomenon creates conditions where usability problems can arise [3] and where user performance and satisfaction are affected negatively. In response, researchers have sought methods to organise and control such interfaces. McGrenere has suggested multiple interfaces [4] as a solution to software complexity. Others have suggested the use of multimodal [5, 6] and multimedia [7] metaphors (such as speech [8], earcons [9], and audio [10]). As users often have different needs, abilities and usage. On the other hand many researchers have suggested to personalise the interface [11, 12], and content [13, 14] to each individual user. Others have focused on organising interfaces by using sorting techniques (e.g. alphabetical, numerical, chronological, categorical, or categorical colour-coding) and visualisation techniques (e.g. circular menus [15]) [16]. Both of these approaches are suitable for graphical user interfaces that are easy to organise, while for larger or more complex systems a number of researchers have suggested that it is better to customise the interfaces to the needs of individual users to mitigate their complexity [11], since each user will have different preferences, needs, experience and abilities [16].

Personalisation can be achieved by two contrasting approaches, called adaptable and adaptive, which differ regarding who is responsible for performing the customisation. The adaptive approach dynamically changes the interface layout and content to suit each user's needs, while adaptable interfaces provide customisation techniques which permit users to adjust their layout and content to suit their own needs. Thus, these two approaches differ in their control: adaptive approaches are system controlled, whereas adaptable approaches are user controlled [16].

There has been a debate as to which is the better way to customise interfaces [17], each having its particular advantages and disadvantages, given that by their nature, neither suits the full range of users. For example, adaptable interfaces are user controlled and not all users wish to have full control, for many reasons. Since, they might be busy doing their tasks or simply unable to customise. On the other hand, the main advantage of this approach is that it provides a powerful tool with which users can change and control the system. Conversely, the adaptive approach relies on system control and not all users are willing to relinquish control to the system. The main advantage of this approach is that it does not require much effort from users, while its main disadvantages are lack of control, transparency and predictability. Transparency refers to users being able to understand why changes happen, while predictability means their ability to predict what the system will do. Given these differences, some researchers have suggested a mixed-initiative approach, blending elements of the two approaches to mitigate their disadvantages and increase their advantages [11]. The mixed initiative approach therefore uses both system control and user control at the same time.

II. Previous works

Many researchers have sought to increase user satisfaction and reduce selection time by making recently and frequently selected items easier to choose. For example, in a controlled

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experiment, 26 subjects were asked to search for names in a telephone directory accessible through a hierarchy of menus and this was tested against a static system [18]. Subjects performed faster with the adaptive system, which 69% of them preferred. In addition, results showed that the adaptive system reduced the search paths for repeated names, reduced time per selection by 35% and reduced errors per menu by 40%. Trevellyan and Browne [19] replicated this experiment with a larger number of trials because they believed that subjects would eventually become familiar with the static menu and memorise the required sequence of key-presses. They found that the adaptive system was effective and that after using it for a long period of time users did begin to perform better with the static interface. Another study compared an adaptive menu with a static one. In a controlled experiment, sixty-three subjects were requested randomly to complete 24 tasks using both menus [20]. The results showed that the Eighty-one percent of the subjects preferred the static to the adaptive menu. Another example is a static interface was compared to three adaptive alternatives as follows: (1) split interface, where important functions were copied into an extra toolbar; (2) moving interface, where important functions were moved into a toolbar and (3) visual popout interface, where important functions were moved and made visually prominent [21]. Two experiments were conducted. The first had 26 participants and investigated the impact of the different interfaces under two adaptive algorithms (frequency vs. recency based). The results showed that in terms of satisfaction, perceived benefit and perceived cost, the split and moving adaptive interfaces were found most beneficial and least costly, and they were preferred in the more complex task. The visual popout interfaces were found distracting. In the less complex task, there was less support for the adaptive interfaces. The second experiment was conducted with 8 participants and compared adaptation accuracy (70% vs. 30%). The results showed that user performance worsened as the adaptive algorithm's accuracy decreased. More recently, a study examined a new adaptive technique called ephemeral adaptation. Ephemeral menus present predicted items immediately, while remaining items gradually fade in [22]. These new techniques were examined with static and highlighted adaptive menus. The results showed that ephemeral menus and highlighted adaptive menus were preferred to static menus.

There are several experiments that compared the adaptable and adaptive techniques. Direct comparisons of adaptive and adaptable approaches have also had conflicting results. For example, a six-week field study with 20 participants evaluated two interfaces combined with adaptive menus in the commercial word processor MSWord 2000 [23]. These were a personalised interface containing desired features only and a default interface with all the features. During the first four weeks of the study participants used the adaptable interface, then used the adaptive interface for the remaining time. It was found that 65% of them preferred the adaptable interface, 15% favoured the adaptive interface and the remaining 20% chose the MSWord 2000 interface. However, according to [24], there were two potentially confusing variables. First, MSWord 2000 and the proposed interfaces had very different designs, which may have differed in their usability. Second, all participants completed the adaptive condition after the adaptable condition. In another study, McGrenere et al. [11]carried out a controlled laboratory experiment with 27 participants to compare the efficiency of three of the Sears and Schneiderman [25] split menus. The first of these was a static split menu, the second an adaptable split menu where the top half was adaptable by the user and the third an adaptive split menu, where the system would dynamically assign the top half based on frequency and recency of selection. The experiments found no interactive effect between order and menu. On the other hand, the comparison was complicated, according to [24], because performance depended on menu order and subjects were exposed to the three conditions, although when they were not presented with the adaptable interface they were significantly faster with the adaptive or static ones. The findings were that split static menus were significantly faster than adaptive menus. The adaptable menu was faster than the adaptive menu when participants were guided by example, because they were able to understand the value of customisation. In addition, results showed that in these circumstances there was no significant difference between the adaptable and static menus. Nevertheless, 55% of subjects preferred the adaptable menu, 30% the adaptive and 15% the static.

Most studies in the field of personalisation have been limited to the differences and similarities among the static, adaptive and adaptable approaches. Consequently, there has been a small amount of research into mixed-initiative interfaces. Very few references were found in the literature to direct comparisons of a mixed-initiative system with either an adaptive or an adaptable alternative. One of these rare studies compared a mixed-initiative toolbar with adaptable one. Specifically, it compared an adaptive bar (mixed-initiative system) with the built-in toolbar present in MSWord (adaptable system) [26]. It found that the mixed-initiative system significantly improved performance in one of two experimental tasks. In another study, Burnt et al. [27] designed and implemented the Mixed-Initiative Customisation Assistance (MICA) system, which provided subjects with the ability to customise their interfaces according to their needs, while also providing them with system-controlled adaptive support. They found that users preferred mixed-initiative support and that the MICA system's recommendations improved time on tasks and decreased customisation time.

III. Experiment Platform

A. Evaluation Design

A two-factor mixed design was utilised: menu size (small vs. large) was tested between subjects (that is, each subject participated in one experiment), while menu type (adaptable, split, highlighted, minimised and mixed-initiative) was

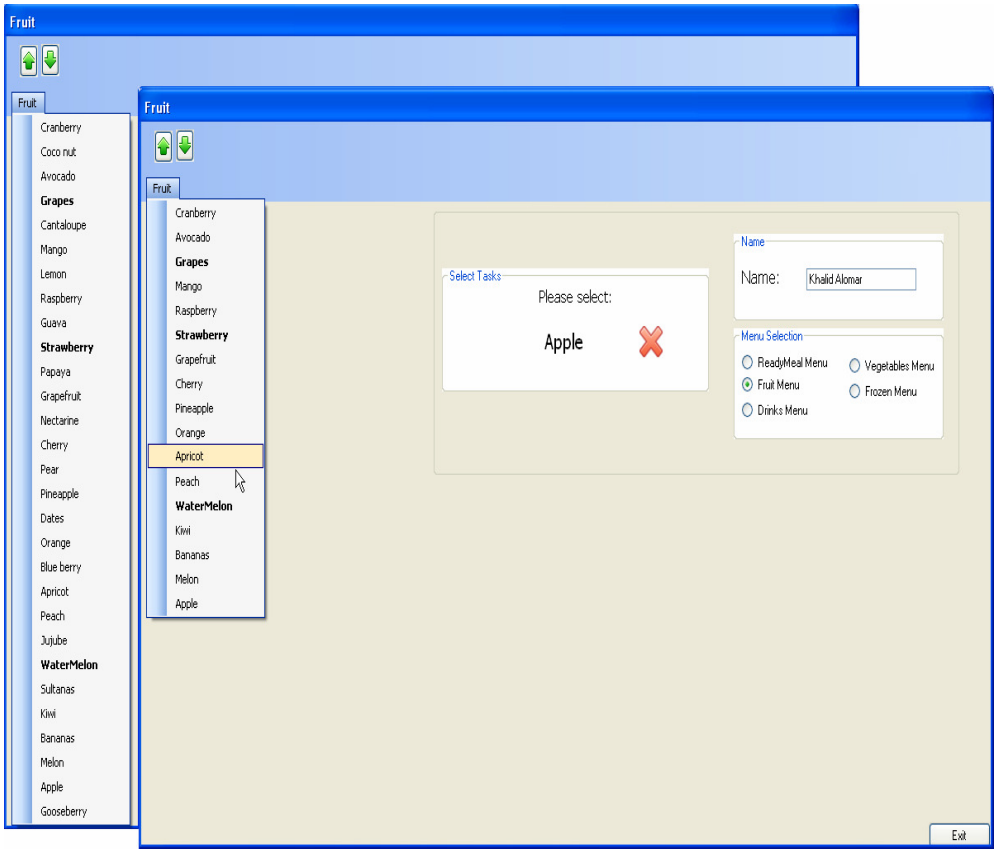

Fig. 1 screens layout in the experiment

compared within subjects (that is, all subjects used all menus). In the first case, we chose a between-subjects design because it was essential to avoid the learning effect of using the same subject twice. In the second, by contrast, a within-subject design was preferred because the perspective of each subject in each condition was needed.

B. Subjects

A total of 60 graduate and undergraduate students voluntarily participated, 30 each on small and large menu designs. These were split 16 / 14 and 19 / 11 respectively between males and females. We decided to have 30 subjects in each experiment because we felt that this number would provide us with sufficient data on the benefits and drawbacks of each approach, while keeping the experiment under control. The ages of subjects in both experiments ranged from 18 to 44, while their average computer usage exceeded 12 hours per week. In both experiments, each subject was randomly assigned to one of five groups of 6 subjects, each of which followed the five experimental menu conditions in a different order. Subjects were given one recorded tutorial according to the experiment they participated in and were then asked to perform the same group of tasks (50 selections for each session in each condition).

C. Menus Design

Five different menu conditions were tested in each of two experiments (on small and large menus): adaptable, split, highlighted, minimised and mixed-initiative menus. Figure 1 and 2 illustrates the five menu types tested in experiments 1 and 2. Our work is different from others because our comparison involved a combination of different approaches. Since the division between personalised approaches is not straightforward, a mixture of these is included in the comparison (Table 1).

Table 1 approaches utilised in each session

Menu	Session 1	Session 2
	Approach used	
Highlighted	Adaptive	Adaptable
Adaptable	Traditional	Adaptable
Minimized	Adaptive	Adaptable
Mixed-initiative	Mixed-initiative	
Split	Adaptive	

The aim is to understand subjects' behaviour under the adaptive, adaptable and mixed-initiative conditions and how it varied with menu size; in other words, to explore the impact of size on these five menu conditions. Within the adaptive approach, the chosen techniques were split, highlighted and

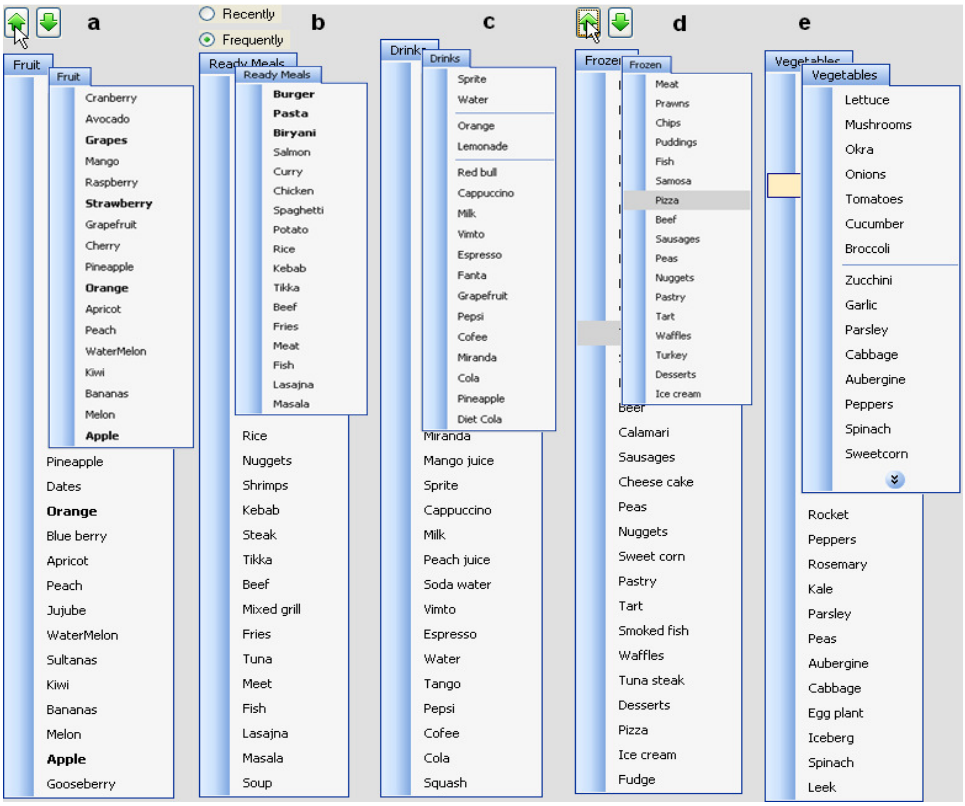

Fig. 2 menus in the experiment

minimised menus, because their use is commonly reported in the literature with successful results and they are commercially utilised. These three techniques provided three levels of adaptation occurring mainly in session 1: (1) changes occurring without moving items (that is, highlighted menu), (2) changes made by moving recently and frequently clicked items to the top of the list and leaving the others unchanged (that is, split menu) and (3) changes made by moving only frequently clicked items to the top of the list and leaving the others unchanged (that is, minimised menu). It was considered essential to investigate which of these techniques was more usable on small and large menus. On the other hand, within the adaptable approach, the chosen techniques were (1) customisation with help not provided (that is, adaptable menu), (2) customisation with assistance provided by highlighting the frequently clicked items (that is, highlighted menu) and (3) recommendation provided by moving frequently clicked items to the top of the list, followed by a horizontal line separating the recently clicked items and hiding the others (that is, minimised menu).

Conversely, within the adaptable approach, the chosen techniques were (1) customisation with help not provided (that is, adaptable menu), (2) customisation with assistance provided by highlighting the frequently clicked items (that is, highlighted menu) and (3) recommendation provided by moving frequently clicked items to the top of the list, followed by a horizontal line separating the recently clicked items and hiding the others (that is, minimised menu).

D. Menus Labels

In the small menu experiment, 85 different nouns from five label categories (17 nouns in each category) were used as labels of the menu items, while for the large menus, there were 145 different nouns from the five label categories (29 in each category). The categories in both cases were vegetables, fruits, drinks, frozen food and ready meals. Nouns shorter than four or longer than eleven characters were excluded, while no more than four nouns in any category had the same initial letter. The category name was shown in the title bar at the top of the menu.

E. Tasks

All subjects were asked to make the same number of selections (50 selections each). Each condition comprised of two task sessions, each of which contained 50 selections. Therefore, each subject performed a total of 500 selections and the thirty subjects made a total of 15000 selections in each experiment.

F. Selection Frequency

Table 2 shows the distribution of the selection frequencies used in the two experiments. The numbers in the first, fourth and seventh columns of the table indicate the vertical position of an item as number of places from the top. The second and fifth columns show how many times an item would occur in 100 selections for the small menu, while the third, sixth and eighth columns show how many times an item would occur in

100 selections for the large menu. A number of different selection frequency distributions are reported in the literature. However, we are interested in the distributions of difficult items where the high-frequency items can be found near the bottom of the list. The distributions for small and large menus were adopted from the literature with some modification [15].

Table 2 selection frequency of small and large menu items and their distribution

Item	Distribution		Item	Distribution		Item	Distrib-ution
	Small	Large		Small	Large		Large
1	0	0	11	2	4	21	2
2	0	0	12	4	6	22	4
3	4	0	13	10	0	23	0
4	8	0	14	12	0	24	8
5	0	6	15	2	0	25	0
6	4	8	16	20	8	26	10
7	0	4	17	8	0	27	12
8	10	6	18	-	4	28	6
9	4	0	19	-	10	29	2
10	12	0	20	-	0	-	-

G. *Experimental Design*

Each of the two experiments followed a within-subjects design and was planned to fit into a one-hour session. Subjects were informed that the menu conditions were divided into two sessions. Session 1 consisted of a 50-item sequence selection and session 2 consisted of the identical 50-item sequence to session 1. Between the two sessions, subjects were given a 2-minute break. For the adaptable condition, subjects were allowed to take extra time during the break to customise their menus if they wished to do so. That was their only opportunity to customise.

H. *Training*

Each subject attended a five-minute recorded training session about their environment before doing the requested tasks. Additional explanation was sometimes provided when needed.

I. *Procedure*

subjects were randomly assigned to different orders of conditions depending on the order of arrival, then a questionnaire was used to obtain information on user demographics, education and computer experience. Before starting each menu condition, subjects were given a recorded tutorial. In the experiment, the subjects performed the five conditions in a predetermined order given by the experimenter. First, they were asked to choose the menu condition according to the order given by the experimenter. The first task session began when the subjects clicked the 'Start' button. Next, a target item was displayed on the screen and subjects were asked to select the same item from the pull-down menu as quickly and accurately as possible. If the wrong item was clicked a cross symbol appeared on the screen. The second target item appeared once the target item had been selected. When a subject selected the correct item, the menu was disabled for 1 second before the next item. Time between the presentation of the target item and the correct selection was recorded, as well as the number of errors (incorrect selections). In the adaptable, highlighted and minimised menus, subjects were told that they could change the positions of the items if they wanted to do so after the first session. In addition, the time required by each subject to customise these menus was recorded. In session 2, item positions remained as they were at the end of session 1, unless subjects customised the positions of menu items. The primary reason for this was to measure the effects of the changes made in session 1, since subjects performed differently. In other words, if subjects had begun session 2 from the same point that they had begun session 1, the result would not have been expected to change. On the other hand, menu design remained as it was, to unify menu conditions across all sessions. For example, in highlighted and mixed-initiative menus the highlighted items would fade away. Finally, a feedback questionnaire was used to rank the menu conditions, to assess subjects' satisfaction and to record any additional comments.

J. *Data Collection*

Quantitative and qualitative data were collected by recording experiments, questionnaires, interviews and observation. Experiments were not recorded, since the time taken to perform the tasks and the number of errors were automatically calculated by the application. In addition, it calculated precisely the time take to customise the menus and the frequency of clicks on the 'recently' and 'frequently' options in the mixed-initiative menu. Questionnaires and interviews also provided data on subjects' opinions and levels of satisfaction, while observation and notes taken during the experiments helped to improve understanding of each condition and to collect the required data.

IV. RESULTS

A. *User satisfaction*

At the end of the experiment subjects were asked to give ratings on a 1 to 5 scale of user preferences. As Figure 3 shows, for small menus exactly one-third of subjects selected the highlighted menu as the preferred type, followed by the adaptable with 8 subjects, while exactly the same number of subjects (5) chose both the minimised and mixed-initiative menus as the best menu. By contrast, only two subjects selected the adaptable menu as the best. On the other hand, the split menu was ranked last by the greatest number of subjects (just over one-third), followed by the mixed-initiative, highlighted and adaptable menus with 8, 5, and 4 subjects respectively. Only two subjects rated the minimised menu lowest. For large menus, Figure 4 shows that just under the half of subjects preferred the mixed-initiative menu, followed by the minimised, highlighted and split menus with 7, 5 and 4 subjects respectively, while no subject selected the adaptable

menu as the best. Indeed, this menu was categorised by 16 subjects as the most undesirable, followed by the split with 11 subjects.

Overall, for small menus, the minimised type was the most strongly preferred, as more than half of subjects ranked it either first or second. This was followed by the adaptable and highlighted menus with exactly half and more than one-third of subjects ranking them first or second respectively. The least strongly preferred types (by 17 subjects each) were the split and mixed-initiative menus. However, 11 of the 17 subjects ranked the split menu last, while 8 did so for the mixed-initiative type, suggesting that the former was the less preferred of the two. On the other hand, for large menus, the mixed-initiative type was ranked first by thirteen subjects, with more than two-thirds ranking it either first or second, followed by the minimised menu, ranked first or second by more than half of subjects. The least desirable was the adaptable type, followed by the split menu.

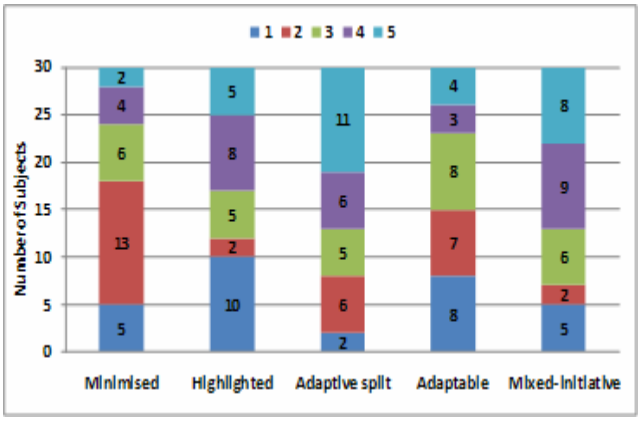

Fig. 3 user satisfaction with usability for small menus

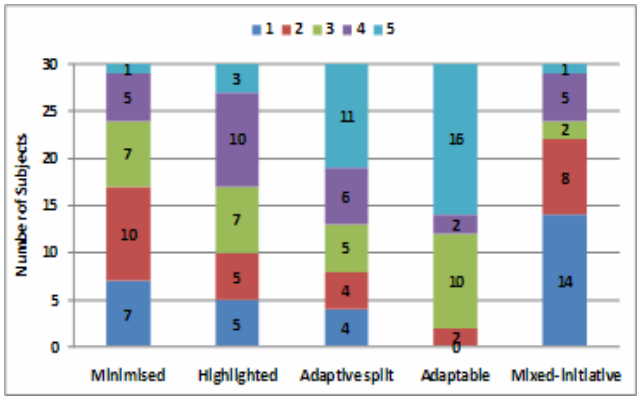

Fig. 4 user satisfaction with usability for large menus

B. *Customisation*

Subjects were not allowed to customise during the tasks; they had one opportunity to do so before starting session 2. It was found that they spent significantly less time customising the small menus than the large ones: 1 hour and eighty two minutes and two hours twenty two minutes respectively (see Figure 5). The results show that subjects behaved differently towards highlighted and adaptable menus according to their size; for example, they customised large menus less than small ones. In addition, subjects who customised adaptable menus spent more time on large than small ones, while those who customised highlighted menus spent less time on large than small ones.

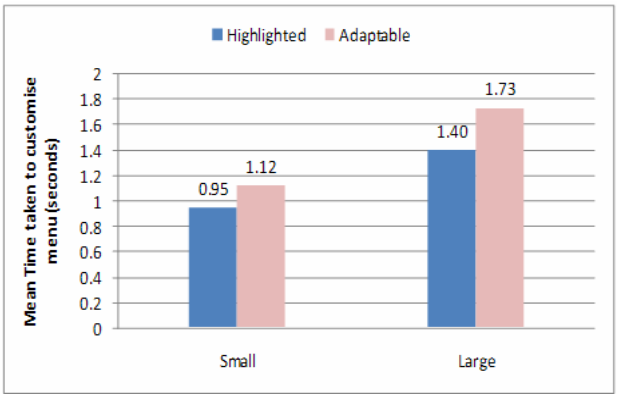

Fig. 5 the time taken by users to customise the small and large menus

C. *Adaptation by Users*

Subjects could easily move items up and down by clicking on the required item and then on an up or down arrow placed above the menu. They were told how to customise and provided with help when needed, since we were interested in the results of customisation, not the way in which it was done. However, it was observed that subjects utilised different criteria for ordering the menu items. The most common approaches were frequency-based and alphabetical ordering. This did not prevent some subjects from using their own criteria. For example, one subject moved the items near the top to the top of the list and items near the bottom to the bottom of the list. In the small menu experiment, the results for the adaptable menu show that it was more efficient than both the highlighted and minimised menus in session 2. In addition, the highlighted and minimised menus were approximately the same in session 2. It is difficult to explain this result, but it may be related to the fact that when asked in the interview, subjects said that they felt in more control when using the adaptable menu than either the highlighted or minimised ones. For large menus, the minimised type was found to be more efficient than both highlighted and adaptable menus.

The results show that subjects behaved differently towards highlighted and adaptable menus according to their size; for example, they customised large menus less than small ones. In addition, subjects who customised adaptable menus spent more time on large than small ones, while those who customised highlighted menus spent less time on large than small ones. These results may be explained by the fact that highlighting some of the items in a small menu makes it appear visually more complex than highlighting the same number in a larger one. It was also found that under the mixed-initiative condition, subjects utilised the frequency and recency techniques more in large than small menus, with respective totals of 120 and 94 selections made by subjects.

D. Adaptation by the System

A second objective was to investigate the effect of different levels of adaptation. Therefore, we conducted a comparison of three adaptive menus in session 1 presented with different types of adaptation: (1) changes occurring without moving items (that is, highlighted menu), (2) changes made by moving recently and frequently clicked items to the top of the list and leaving the others unchanged (that is, split menu) and (3) changes made by moving only frequently clicked items to the top of the list and leaving the others unchanged (that is, minimised menu).

V. Discussion

One of the main usability parameters is user satisfaction. This study attempted to assess which personalisation approach was preferred by users. In addition, this study examined users' views of the amount of personalisation (adaptive and adaptability levels). More specifically, it examined whether the size of personalised menus affected user satisfaction, as it does with other usability parameters (such as effectiveness and efficiency [4], and as it does on small menus [28] and large menus [29]). The results indicate that user satisfaction is affected by the size of personalised content, since satisfaction varied according to size of content. For example, in large menus, the mixed-initiative menu was the most strongly preferred, while in small menus it was the least strongly preferred. In addition, the adaptable menu was the second most strongly preferred menu, while in small format it was the most strongly rejected menu. These results may be explained by the fact that in large menus users prefer to have less control and to have more help from the system, since large content requires more effort and user attention, whereas in small menus, they prefer to have full control because this control will not require much effort. This indicates that users prefer to have control as long as it does not require too much attention and effort.

There was a variety of response towards the design of each approach. First, in terms of design of the menu, subject generally liked the way that the system assisted them by moving items to the top and hiding unwanted ones. However, there were comments suggesting that the possibility of undoing the adaptation action is essential. In other words, there was a need to employ adaptation but with less movement. On the other hand, in terms of design of the adaptable menu, subjects generally liked the method of moving menu items up and down. However, in terms of design of the mixed-initiative menu, subject generally liked the chosen techniques and the recommendations provided by the system. This confirmed that the mixed-initiative approach was generally acceptable. Ultimately, during the experiment it was noticeable that subjects were willing to accept suggestions from the system while performing their tasks. In terms of design of the split menu, subjects generally showed that they did not understand the method of moving menu items up and down. In addition, there were comments suggesting that moving items continually was confusing. In terms of design of the highlighted menu, subjects generally liked the technique of boldfacing the most frequently selected items, rather than moving items.

A. Adaptable Menus

The traditional approach in session 1 was based on users memorising item positions; as pointed out by [1], it takes time to memorise the position of all the items and even when the position of frequently used items is known, the menu does not provide any support. The results for this approach varied according to menu size: it was the fastest condition for small menus but the slowest for large ones. This confirms that the traditional approach is efficient for small menus but less so as content increases. In session 2, subjects were able to customise the menu by reordering the items or putting frequently used ones at the top of the list. However, they still had to memorise the positions of items in order to customise the menu. Again, this approach was the fastest for small menus, while for large ones it was found to be the second slowest.

B. Highlighted Menus

The highlighted approach required less memorising of item positions, since the menus provided support by highlighting the position of frequently used items. The results show that because the frequently used items were already known in small highlighted menus, subjects took slightly less time to customise the menu: an average of 8.59 minutes, compared to 8.89 minutes for adaptable menus. The difference was much greater with large menus: an average of 5.52 minutes compared to 11.67 minutes for the adaptable condition. However, in small menus, the highlighted type had no significant advantage over the adaptable one in either session in terms of selection time, whereas in large menus this condition had an advantage over adaptable menus in both sessions. This confirms that the highlighting technique becomes more efficient as content increases.

C. Adaptive Split Menus

In large menus, the split technique was faster than other conditions in session 1, but was surprisingly the slowest in session 2. A possible explanation for this is that the size of the searching area affected subjects' behaviour, since in session 1 they had to consider the whole menu, whereas in session 2 the frequently clicked items moved to the top of the list and subjects neglected the bottom of the menu, which narrowed the search area. This can be confirmed by observation and interviewing subjects after the experiment. In addition, the results for small menus in session 1 show that the split type was very slow. This result is consistent with those of Findlater and McGrenere [15], who report that accessing menu items on a small screen was slower than on a large one. This may also be the case for searching for items among small content compared to a large one.

D. Adaptive Minimised Menus

In the minimised menu the recency technique was neglected and only the frequency was taken into account. This design

caused subjects to obtain the benefit of the frequently used items only, which seems to have limited the effectiveness of this menu. Therefore, further work needs to be done to establish whether utilising both recency and frequency techniques would be more beneficial.

E. Mixed-initiative Menus

In mixed-initiative menus there were two reasons for uncertainty among subjects: first, this type of menu repeatedly updates the items in the recently-used list; secondly, subjects must choose to display either recently or frequently-used items. These drawbacks seem to limit the effectiveness of this menu type. There is therefore a definite need to show both recently and frequently used items, while avoiding repeated updates of the items.

VI. CONCLUSION

The empirical work reported in this paper has demonstrated that user satisfaction with personalisation approaches is affected by the size of content: as this increases, the usability of the adaptive and mixed-initiative approaches increases and that of the adaptable approach decreases. In addition, it shows that subjects were more likely to customise small menus than large ones. In conclusion, this topic is in need of further investigation; for example, there would be value in exploring other types of menu such as Microsoft personalised menus, which display a short set of items while others are hidden. Another line of enquiry would be to examine these approaches by combining different media such as text and graphics, text, graphics and speech, earcons and auditory icons. Such multimedia combinations might facilitate tasks or introduce new difficulties. Therefore, more research needs to be undertaken on this topic to understand these approaches from different perspectives.

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