Intuitive Interaction with Complex Artefacts

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Abstract

This paper addresses the application of intuitive interaction to interface design. Intuition is based on experiential knowledge and people can only use intuitive processing if they have previous experience to draw on. Previous research has revealed that prior knowledge of features of a digital camera and a universal remote control allowed participants to use those features intuitively. An experiment was conducted to test various interfaces applied to the universal remote control. The interfaces were designed according to principles developed previously. Users were video recorded doing set tasks with one of the four remote control interfaces. The video data were later analysed using Noldus Observer VideoPro software. All of the new interfaces were found to be quicker and more intuitive to use than the default interface provided by the manufacturers. By applying the principles of intuitive interaction developed previously, it was possible to increase the intuitive usability of the product.

Introduction

Intuition is a type of cognitive processing that is often unconscious and utilises stored experiential knowledge. Intuitive interaction involves utilising knowledge gained through other products or experience(s). Therefore, products that people use intuitively are those with features they have encountered before (Blackler et al., 2003a, 2003b). The three main properties of intuition are that it is based on experiential knowledge (King and Clark, 2002; Noddings and Shore, 1984; Bowers et al., 1990; Dreyfus et al., 1986; Agor, 1986; Bastick, 1982; Fischbein, 1987; Laughlin, 1997; Klein, 1998), is generally non-conscious (Bastick, 1982; Fischbein, 1987; Noddings and Shore, 1984; Agor, 1986; Bastick, 1982), and is often faster than more analytical cognitive processing (Salk, 1983; Bastick, 1982; Agor, 1986).

Blackler et al. (2003b) conducted an experiment to test the thesis that intuitive interaction involves utilising knowledge gained through other products or experience(s). Participants were video-recorded using a digital camera whilst delivering concurrent protocol. Afterwards, participants were asked how familiar each feature was to them and they completed a Technology Familiarity questionnaire. In the questionnaire, participants indicated how often they used common consumer electronics products, and how much of the functionality of those products they used.

Products in this questionnaire employed similar features to the camera used in the study. This questionnaire was used to calculate each participant's Technology Familiarity (TF) score. The results suggested that prior exposure to products employing similar features helped participants to complete the operations more quickly and intuitively, and more familiar features were intuitively used more often. The camera borrowed features from other digital products, so expert users of digital cameras who had low Technology Familiarity completed the tasks more slowly and effortfully than novices with digital cameras who had higher Technology Familiarity.

Blackler et al. (2003a) conducted an experiment using a universal remote control to further test the thesis. The three main remote control screens that were tested can be seen in Figures 1-3. Technology Familiarity score was the Independent Variable. This was determined by the Technology Familiarity questionnaire which was adapted to include products similar to the remote rather than the camera. This study supported the previous findings. Participants who had a higher level of Technology Familiarity were able to use more of the features intuitively first time and were quicker at doing the tasks. Features that were more familiar were intuitively used more often. Those with a lower Technology Familiarity score required more assistance (Blackler et al. 2003a).

The present experiment was designed to test several different interface designs on the remote control. It was predicted that the new designs would be quicker and more intuitive to use than the default interface, and the experiment should determine which design would have the most effect.

Interface Design Process

The four test designs are shown in Table 1.

Table 1. Interface designs

Configuration	Explanation
Default	default design used by Blackler et al. (2003a)
Location	new location for features, default appearance
Appearance	new appearance for features, default location
Location-Appearance	new appearance and location.

Eighteen postgraduate industrial designers were asked to re-design the remote control interface according to the principles developed by Blackler et al. (2003a, 2003b). The researchers developed a brief specifying the icons to be used for particular features. The icons were developed from international standards where existing (CEI/IEC, 1998; ISO/IEC, 2003), as it was assumed that standardised icons would be frequently applied to similar interfaces and therefore be most familiar to users. Where standards did not exist similar products such as software and other remote controls were investigated to see which icons/designs should be most familiar to users. For features which had no clear established precedent the designers were asked to develop a design which would be familiar to users. The features that were re-designed were those that were most frequently used in Blackler et al's (2003a) experiments that were able to be changed. Some of the features of the default design could not be changed. Table 2 details the new feature designs.

AV function (used to select video channel)

TV on and off

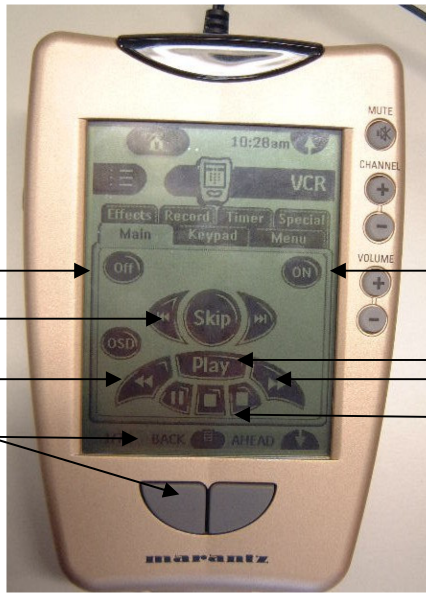
Figure 1. Default design on TV keypad screen

VCR off

Skip

Rewind

Back and ahead



VCR on

Play

Forward

Stop

Figure 2. Default design on VCR main screen

Remote on (touch screen or any button)

Four way navigation keys

Enter

Menu

Figure 3. Default design on VCR menu screen

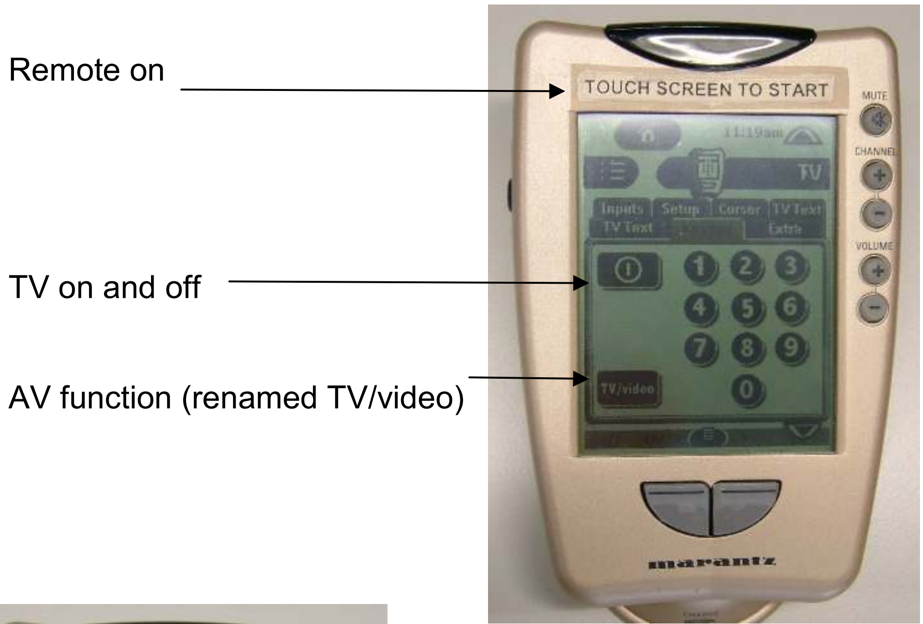


Figure 4. Location-Appearance Design on TV keypad screen

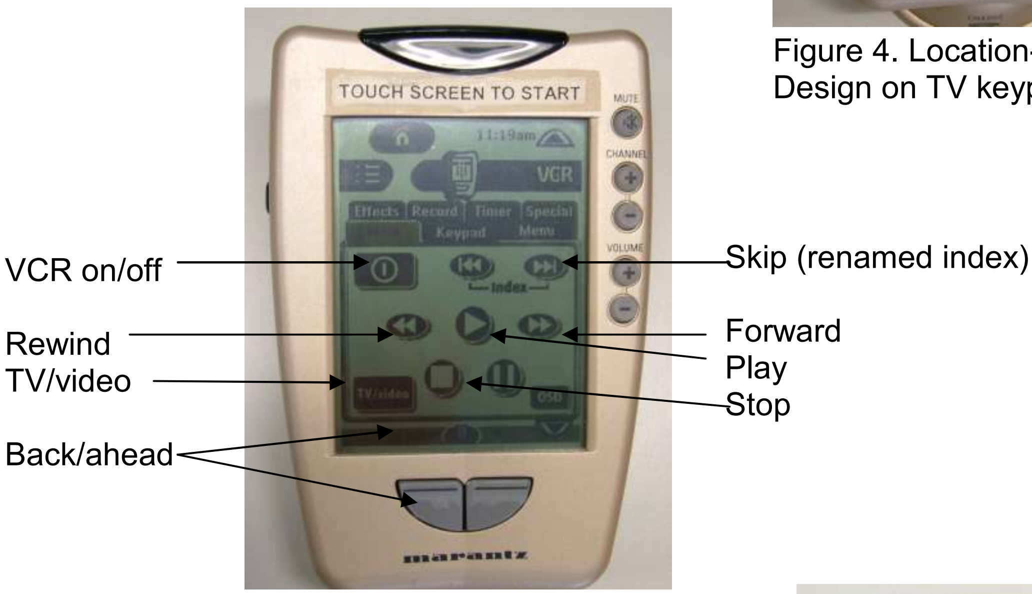


Figure 5. Location-Appearance design on VCR main screen

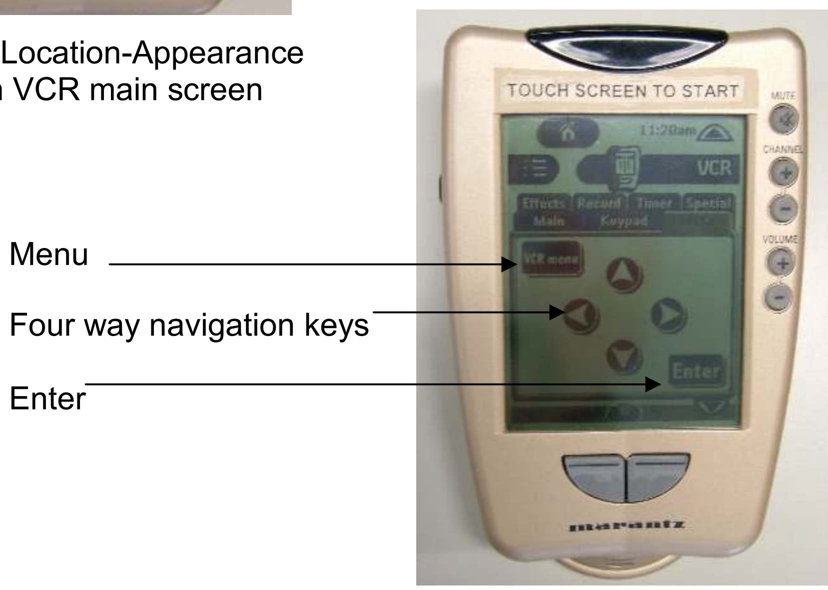
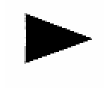
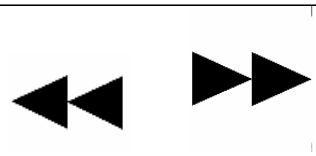
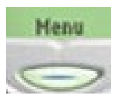
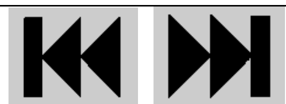


Figure 6. Location-Appearance design on VCR menu screen

Table 2. Re-designed features

Feature	Reference for design	Illustration
Play	CEI/IEC 60417-2 ISO/IEC 18035	
Stop	ISO/IEC 18035	
Forward /Rewind	CEI/IEC 60417-2 ISO/IEC 18035	
Four way	Designers choice	
VCR on/off	CEI/IEC 60417-2	
Enter	Designers choice	
Menu	Designers choice	
TV on/off	CEI/IEC 60417-2	
AV function	Label as TV/Video Exact style designers choice	
Remote on	Label as “Touch screen to start” or similar Exact style designers choice	
Back/ahead	Label Back and → as Internet Browsers Mark on hard keys as mobile phones	
Skip/index	ISO/IEC 18035	

The Location-Appearance design chosen (Figures 4-6) was simple and clear, similar enough to the existing interface so as not to confound the experiment by revealing to participants which screens were changed from the original, and easy to adapt to the Location and Appearance designs (The Location design used only the new locations for the features, while the Appearance design used only the new appearances). Some fine-tuning was done by the principle researcher before the design was ready for testing. Much of this consisted of defining the location of the features by looking at existing audio, TV and VCR remotes and software in order to establish the most common (therefore most familiar) locations for the features.

Participants

University staff were asked to volunteer to take part in the study, and 60 participants were selected from the pool of volunteers. None of the participants had encountered the remote control used in the tests before, and none received payment. Participants were divided into four equal groups according to age groups and experimental condition (Table 3). Individual differences were controlled by selecting a cross section of the community in terms of Technology Familiarity, level of education and gender for each group. The Technology Familiarity questionnaire developed by Blackler et al. (2003a) was used to calculate the Technology Familiarity.

Table 3. Experimental groups

Configuration	Age group	Male	Female	Total
Appearance	18-29	1	4	5
	30-39	2	3	5
	40+	4	1	5
	Total	7	8	15
Default	18-29	2	3	5
	30-39	1	4	5
	40+	4	1	5
	Total	7	8	15
Location	18-29	2	3	5
	30-39	2	3	5
	40+	3	2	5
	Total	7	8	15
Location-Appearance	18-29	1	4	5
	30-39	3	2	5
	40+	3	2	5
	Total	7	8	15
Total		28	32	60

Procedure

Each of the interface configurations was downloaded into the Marantz RC5000i universal touch screen remote control from the Marantz RC5000 setup software. The remote was programmed to control a Panasonic NV SD 220 VCR and NEC Chromovision TV. The remote control, TV and VCR were on the same settings, while the videotape was in the same place in the program for each experiment.

The experiments took place at random times during the day, in the same air-conditioned room with the same level of artificial light. The recording equipment was positioned in the same way for each participant. The experiment and all the equipment used was explained consistently. Intuition has been shown to be vulnerable to anxiety (Laughlin, 1997, Bastick, 1982) so a calm environment was maintained. Participants were later asked if they had been anxious during the experiment, and their answers were compared with the time it took them to do the tasks.

The participants were asked to complete three operations, each of which consisted of a number of tasks (Table 4).

Table 4. Operations

Operation One	Use the remote control to turn on the television and VCR and start playing the tape in the VCR
Operation Two	Go to the start of the current recording (give name of program), play that scene for a few seconds and then stop the tape.
Operation Three	Reset the clock on the VCR to 1724

The manuals were only available on request and participants were asked to try to work the operations out for themselves because using the manual masks the use of experience, on which intuition is based.

Variables, Methods and Measurement Tools

Variables measured through this experiment and the methods and tools used are shown in Table 5.

Table 5. Variables, Methods and Measurement Tools

Dependant Variables	**Methods and Measurement Tools**
Time to complete operations	Observation using Observer Video Pro
Correct, inappropriate, incorrect and attempted uses of remote control features	Observation using Observer Video Pro
Percentage of features used intuitively and correctly first time per participant	Observation using Observer Video Pro Concurrent protocol
Familiarity of each feature	Structured follow up interview
Assistance received	Observation using Observer Video Pro

During the tasks, participants were delivering concurrent protocol (think aloud procedure). This protocol method was chosen because it eliminates the problems involved with people forgetting details when using retrospective protocol.
Two digital video cameras were used to record the activity, as used by Vermeeren (1999) and Blackler et al. (2003a, 2003b). One was focussed close-up on the participants' hands as they operated the remote, and the other recorded the whole scene (Figure 7).

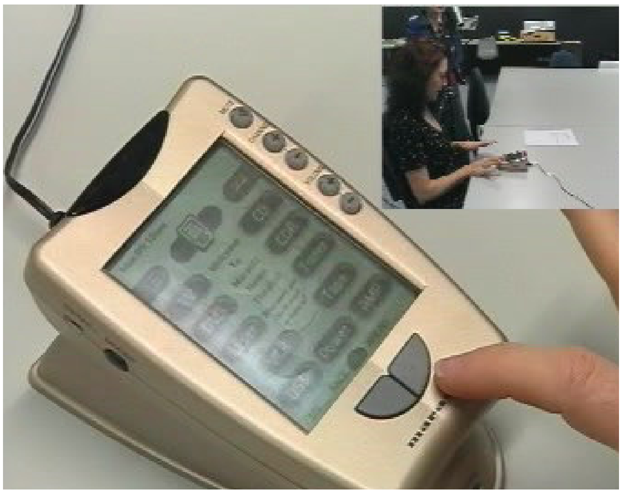


Figure 7. The mixed views from both video cameras

Coding Data

Noldus Observer Video Pro software was used to log participants' time on each operation and to code the video footage and produce quantitative data. The audio-visual data were coded as shown in Table 6.

Table 6. Data coding

Feature used	unique feature code other (for features not commonly used)
Correctness of each use	correct correct for feature but inappropriate for task incorrect attempted
Type of each use	intuitive use quick use use by trial and error logical reasoning use getting help during use mistaken use
Assistance received	from manual from Experimenter

Coding Heuristics

Correct uses were those that entailed the correct action for the feature and for the task or subtask. Correct but inappropriate uses involved a correct use of a feature which was not correct for the task or subtask. Incorrect uses were wrong for both the feature and the task or subtask and attempts were uses that did not register with the product, for example due to failure to activate a button on the touch screen.

The coding heuristics used to determine which uses were intuitive were based on the research and reading conducted into intuition. The main indicators of intuitive uses are explained below:

Evidence of conscious reasoning: Since intuitive processing does not involve conscious reasoning or analysis (Bastick, 1982; Fischbein, 1987; Agor, 1986; Noddings and Shore, 1984), the less reasoning was evident for each use, the more likely it was that intuitive processing was happening. Commonly, participants processing intuitively would not verbalise the details of their reasoning. They may briefly verbalise a whole sub-task rather than all the steps involved although they did perform all the steps. Or they would start to press a button and then stop to explain what they were about to do, or perform the function and then explain it afterwards. Their verbalisation was not in time with their actions if they were processing unconsciously while trying to verbalise consciously.

Expectation: Intuition is based on prior experience and therefore linked to expectations. If a participant clearly had an established expectation of a feature to perform a certain function when they activated it, they could be using intuition.

Subjective certainty of correctness: Researchers have suggested that intuition is accompanied by confidence in a decision or certainty of correctness (Bastick, 1982). Those uses coded as intuitive were those that participants seemed certain about, not those where they were just trying a feature out.

Latency: When users were able to locate and use a feature correctly reasonably quickly it could be coded as intuitive. If they had already spent some time exploring other features before hitting upon the correct one that use was unlikely to be intuitive as intuition is generally fast (Salk, 1983, Bastick, 1982, Agor, 1986), and is associated with subjective certainty (Bastick, 1982).

Relevant past experience: Participants would sometimes mention that a feature was like their remote at home, or that they had seen a feature before, showing evidence of their existing knowledge.

“Intuitive use” codes were applied cautiously, only when the use showed two or more of these characteristics and the researcher was certain about the type of use. All data were double-checked to make sure codes were correct.

Results

The assumptions upon which this work was based were that those with a higher Technology Familiarity (TF) score would perform the tasks more quickly and intuitively than those with lower scores, and that there were no significant differences in performance due to either gender or anxiety level. These assumptions were based on previous work (Blackler et al., 2003a, 2003b).

There was a significant negative correlation between TF score and time to complete operations, $r(58) = -.5753$, $p<0.0001$, and a significant positive correlation between TF score and the percentage of features that were used intuitively and correctly the first time, *r*(58) = .4495, *p*<0.0001. The relationship between time and Technology Familiarity is shown in Figure 8. These results are similar to those achieved during previous work (Blackler et al., 2003a, 2003b). A t-test revealed that gender had no significant effect on time to complete operations, *t*(59)= .717, *p*<4. Time to complete operations was also not significantly different for those who said they were anxious and they who did not, *t*(59) = 1.594, *p*> .05. An ANOVA showed that level of education also had no significant effect on time to complete tasks, *F*(3,48) = 1.034, *p*>.05. Therefore the assumptions are met and the comparisons between the interfaces can be seen as valid.

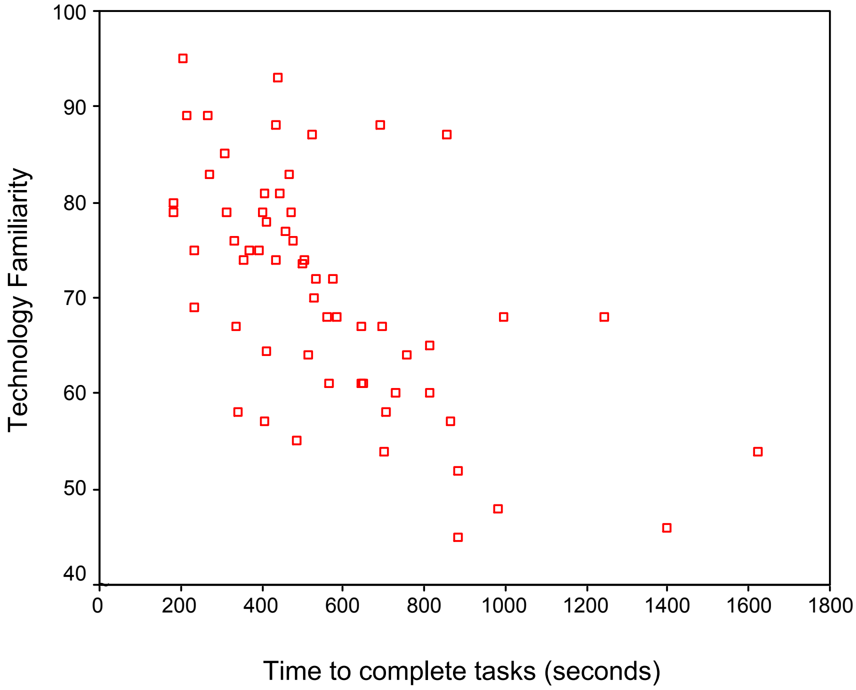


Figure 8. Time to complete tasks by TF score

The performance parameters used to asses the interfaces were time to complete operations and percentage of first uses that were intuitive and correct. Only uses of those features that were changed were counted. The data on intuitive first uses are particularly important as they confirm that people are able to use a feature intuitively the first time they encounter it if it is something they can recognise. Time was used as a performance indicator as it is accepted that intuition is faster than other types of cognitive processing (Salk, 1983, Bastick, 1982, Agor, 1986).

Time to complete operations showed variation between the groups (Figures 9 and 10). The Location-Appearance group was quickest, followed by Appearance, Location and then Default. A two way ANOVA revealed that both configuration, *F*(3,48) = 3.801, *p*<.016 and age groups, *F*(2,48) = 5.627, *p*<.006 had a significant effect on time to complete operations. There was no interaction between these factors (Figure 10). The significant difference between age groups indicates that age is a predictor of the time it will take to do the tasks. This has not affected the comparisons between the configurations, but it is interesting in itself that younger people, in all configurations and at all levels of technology familiarity, are completing the tasks more quickly than older ones.

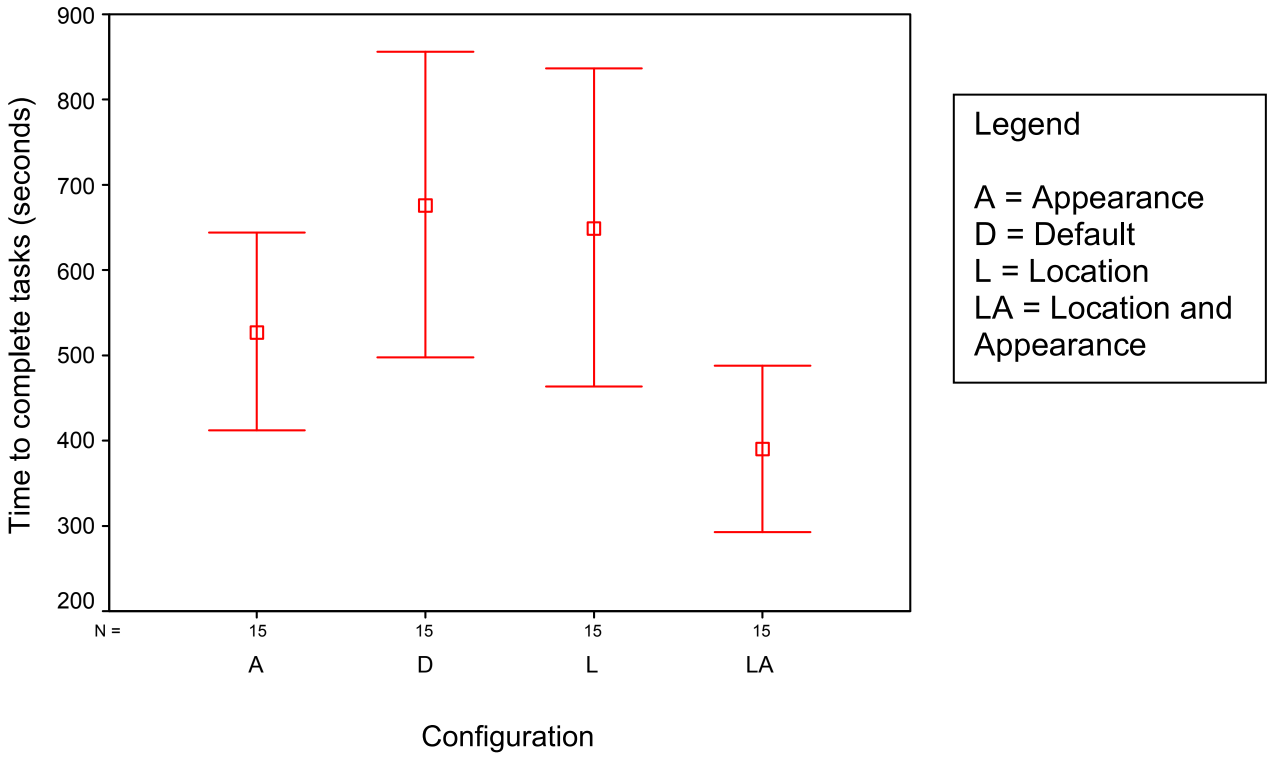


Figure 9. Time to complete tasks by configuration.

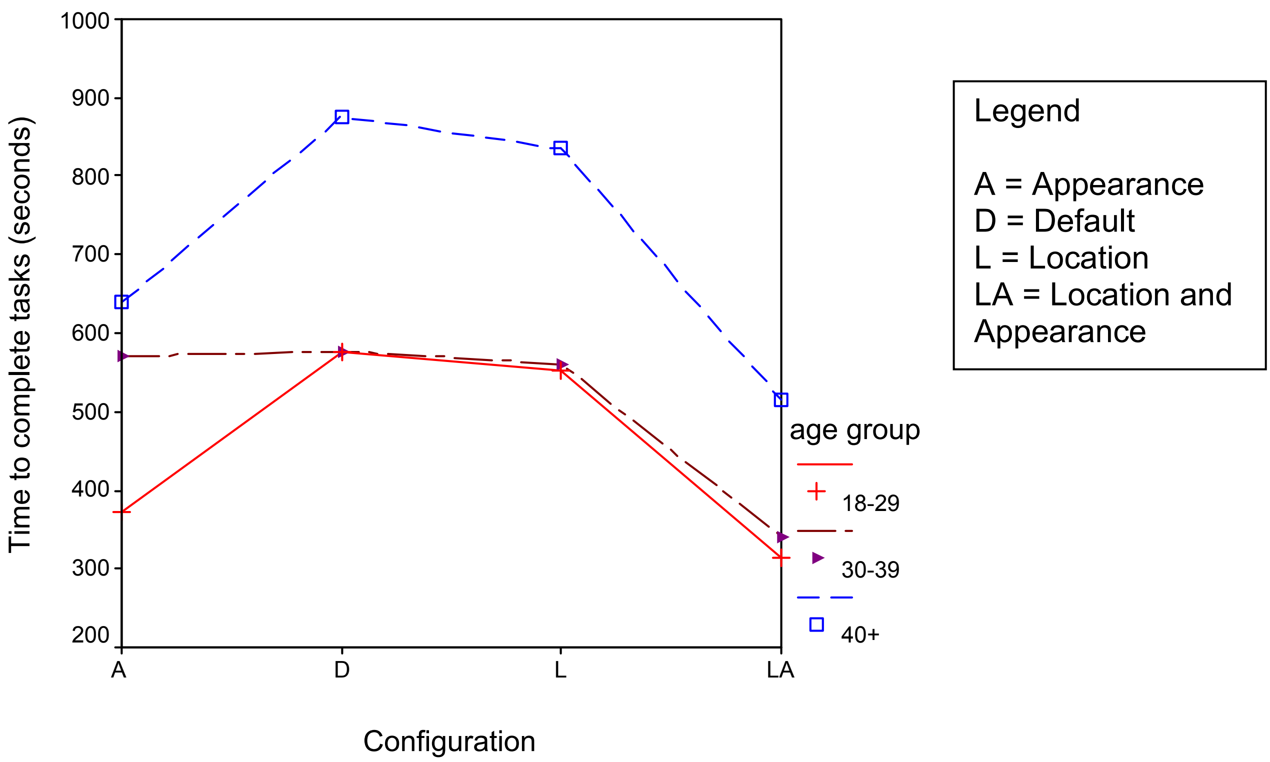
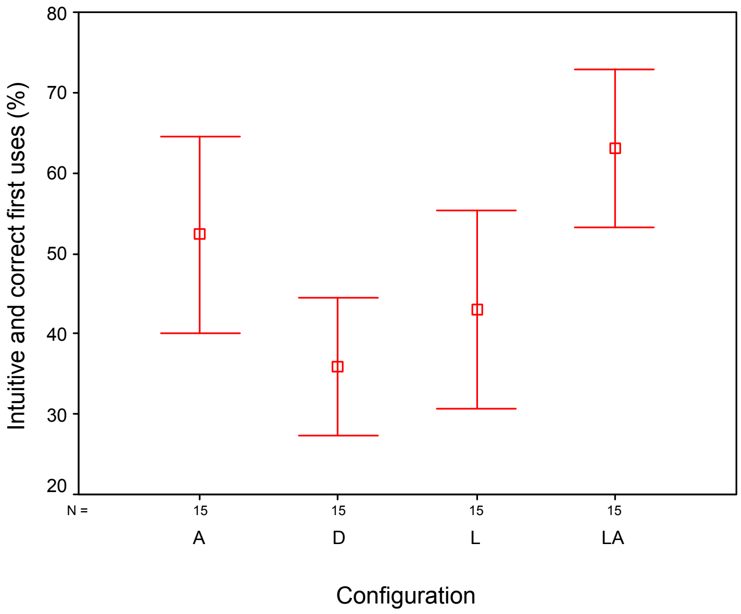


Figure 10. Time to complete tasks by configuration and age group

Table 7 shows the mean first uses that were correct and intuitive for each age group in each configuration. A two-way ANOVA revealed that the percentage of first uses that were correct and intuitive was significantly higher for the Location-Appearance group than the Default and Location groups, $F(3, 48) = 5.584$, $p < .002$. All the new designs had more intuitive first uses than the default, but the location group had a mean closer to the default group (lowest) and the Appearance group nearer to the Location-Appearance group (highest) (Figure 11). The percentage of features used intuitively and correctly first time did not show any significant variance according to age group, $F(2,48) = 2.403$, $p > .05$.

Table 7. Percentage of intuitive and correct first uses

Configuration	Age group	Mean Percentage of correct and intuitive first uses
Appearance	18-29 30-39 40+ Total	59.02 55.40 42.55 52.33
Default	18-29 30-39 40+ Total	38.57 34.79 34.32 35.89
Location	18-29 30-39 40+ Total	48.03 56.11 24.76 42.97
Location-Appearance	18-29 30-39 40+ Total	61.82 65.45 61.81 63.03



Legend

A = Appearance
D = Default
L = Location
LA = Location and Appearance

Figure 11. Percentage of intuitive and correct first uses by configuration

Discussion

The participants in the Location-Appearance group were significantly quicker at doing the tasks than the Default group and achieved significantly higher levels of intuitive first uses than both the Default and Location groups. Participants in the Location group were the slowest of those using the new designs and had less intuitive first uses. These results suggest that the change in appearance of the features had more effect upon these performance measures than the change in location. When observing the participants it was possible to see that when a feature was in the place they expected it to be they found it more quickly, but the speed gain was not enough to make a significant difference to the overall task. Also, another reason for this may be that some of the locations chosen may have been less than ideal. For example, "enter" was re-located to the bottom right of the screen as it is on a keyboard, but many people expected it to be in the centre of the 4 way as it is on some digital cameras and other devices, including the default design. This suggests that people were expecting to see the small device standard and not the computer standard, so transfer between similar products may be easier than transfer between more dissimilar ones.

The fact that older people were slower at completing the tasks but did not show any significant difference in intuitive first uses suggests that well known factors of aging such as speed of reaction times and cognitive processing were responsible for their slower times rather than any difference in their use of intuition and familiarity with the features of the product. Older people are poorer than younger ones at consciously recollecting a "prime" in an experimental situation, but they can use the primes to answer other tasks (Howard & Howard, 1997). So, unconsciously the system is working as well as younger people's but information is not so readily consciously available. Older people maintain previously learned automatic processes, but they do not automatise so easily (although performance still improves with practice). Therefore, they could access the information they had in memory about the features that were familiar just as easily as younger people which is why the intuitive first uses were not affected. However, they would have found it more difficult to learn the system navigation and remember where each feature was located and what the unfamiliar ones did, which may explain the longer time taken.

Conclusion

Concurring with Blackler et al. (2003b, 2003a), these findings suggest that relevant past experience is transferable between products, and probably also between contexts, and performance is affected by a person's level of familiarity with similar technologies. Using familiar labels and icons and possibly positions for buttons helps people to use a product quickly and intuitively the first time they encounter it. Appearance (shape, size and labelling of button) seems to be the variable that most affects time on task and intuitive uses. The fact that the Location group was quicker and had more intuitive first uses than the Default group, and the Location-Appearance group was quicker and had more intuitive first uses than the Appearance group suggests that location of features does have some effect, but appearance of features is far more significant. Future work will include providing recommendations for designers on applying intuitive interaction to products.

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