Empirical investigations into intuitive interaction: a summary

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Abstract

Intuition is a type of cognitive processing that is often non-conscious and utilises stored experiential knowledge. Intuitive interaction involves the use of knowledge gained from other products and/or experiences. We have developed novel approaches and techniques for studying intuitive use of interfaces, and shown that intuitive interaction is based on past experience with similar things (Blackler, Popovic, and Mahar, 2003a, b, 2004a, b, 2005). Two initial experimental studies revealed that prior exposure to products employing similar features helped participants to complete set tasks more quickly and intuitively, and that familiar features were intuitively used more often than unfamiliar ones. A third experiment revealed that appearance of features seems to be the variable that most affects time spent on a task and intuitive uses. Based on our empirical work, we have developed principles and tools for designers to assist them in making interfaces more intuitive.

1. Introduction

In general parlance, in advertising and in academic papers, the terms “intuitive interaction” or “intuitive use” are commonly used. However, there was previously no agreed definition of intuitive use and no experimental work to establish how it might work. In 2000, we set out to de-mystify “intuitive use” or “intuitive interaction” and establish how it could be applied to new products in order to make them easier to use.

Intuition is a type of cognitive processing that utilises knowledge gained through prior experience (Agor, 1986; Bastick, 2003; Bowers, Regehr, Balthazard, and Parker, 1990; Cappon, 1994; Dreyfus, Dreyfus, and Athanasiou, 1986; Fischbein, 1987; King and Clark, 2002; Klein, 1998; Laughlin, 1997; Noddings and Shore, 1984). It is a process that is often fast (Agor, 1986; Bastick, 1982, 2003; Hammond, 1993; Salk, 1983) and is non-conscious, or at least not recallable or verbalisable (Agor, 1986; Bastick, 1982, 2003; Fischbein, 1987; Hammond, 1993; Noddings and Shore, 1984).

We formulated a definition of intuitive use based on our review of the literature on intuition and limited literature on intuitive interaction and related areas:

> *Intuitive use of products involves utilising knowledge gained through other experience(s). Therefore, products that people use intuitively are those with features they have encountered before. Intuitive interaction is fast and generally non-conscious, so people may be unable to explain how they made decisions during intuitive interaction (Blackler, 2006; Blackler, Popovic, and Mahar, 2002; Blackler et al., 2003a, b, 2004a, b, 2005).*

2. Method

We undertook three experiments with the aim of testing this definition and establishing a thorough understanding of intuitive interaction in order to develop tools that would allow designers to make interfaces more intuitive. These experiments are briefly described and findings and recommendations discussed.

Experiment 1 was undertaken to investigate the hypothesis that intuitive interaction is based on past experience. We investigated; whether past experience of product features increases the speed and/or intuitiveness with which people can use those features and therefore the product (in this case a digital camera); and if interface knowledge is transferred from known products to new ones. Twenty participants were recruited, with a distribution of gender, education and age that reflected to general population.

Experiment 2 was designed to test the findings of Experiment 1 with a slightly larger sample of participants and a different type of product (a universal remote control). Power analysis indicated thirty people would be a minimum number for this experiment. This experiment was a between-groups matched-subjects design, and the thirty participants were in three equal groups (high, medium and low level of technology familiarity). Individual differences were controlled by matching participants for age, level of education and gender in each group.

After Experiment 2 the remote control interface was re-designed according to proposed principles for intuitive interaction design:

- Use familiar symbols and/or words for well-known functions, put them in a familiar or expected position and make the function comparable with similar functions users have seen before.
- Make it obvious what less well-known functions will do by using familiar things to demonstrate their function.

- Increase consistency so that function, location and appearance of features are consistent between different parts of the design, on every page, screen, mode and/or part.

We developed icons from international standards where such standards existed (CEI/IEC, 1998; ISO/IEC, 2003), as we assumed that standardised icons would be frequently applied to similar interfaces and therefore be most familiar to users. Where standards did not exist, we investigated similar products, such as software and other remote controls, to see which icons and/or symbols should be most familiar to users. For features that had no clearly established precedent, we asked the 18 designers involved to investigate users' needs and develop a design which would be familiar to users.

Experiment 3 required four interfaces. The Location-Appearance interface (Figures 1 and 2) used the re-designed location and appearance for the features. The Location interface used only the re-designed locations for the features, while the Appearance interface used only the re-designed appearances. The fourth was the default factory interface also used for Experiment 2 (Figures 3 and 4).

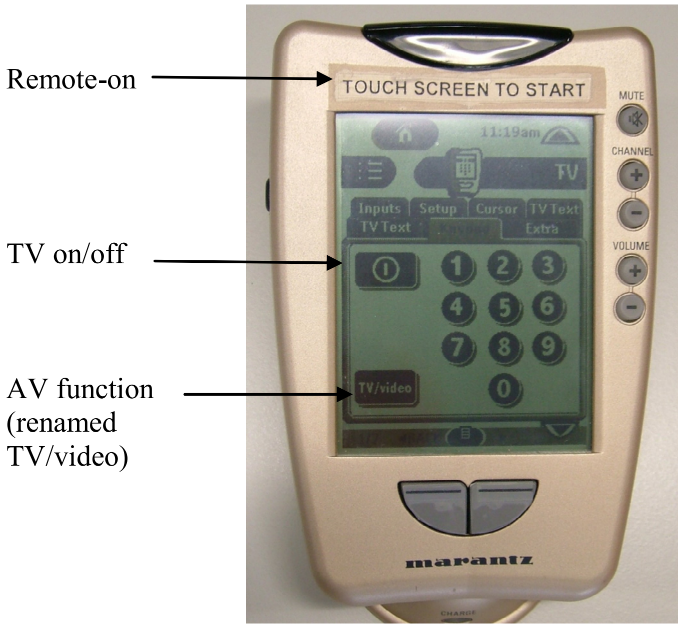

Figure 1: Location-Appearance interface on TV main screen

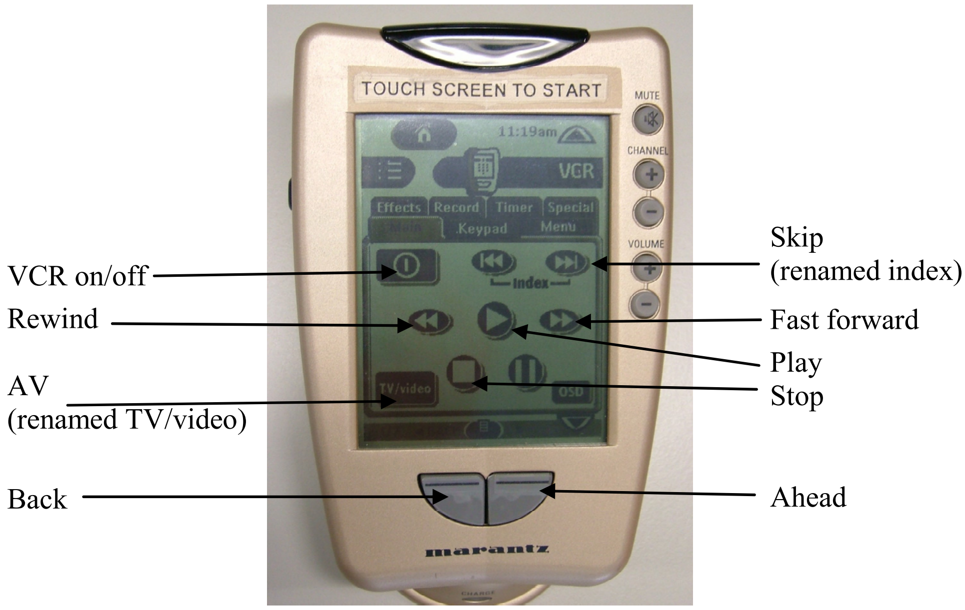

Figure 2: Location-Appearance interface on VCR main screen

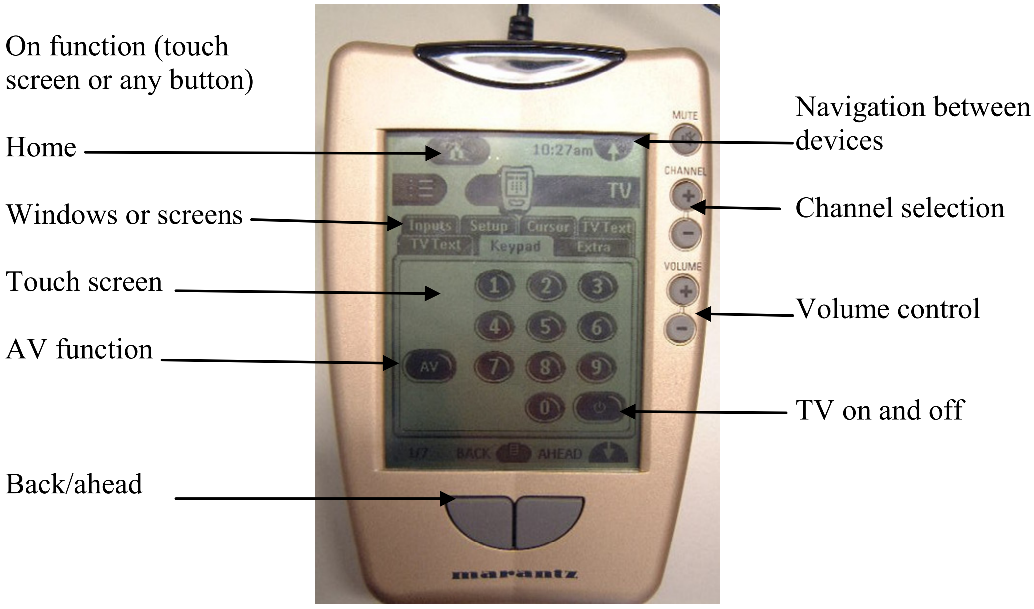

Figure 3: Default interface on TV main screen

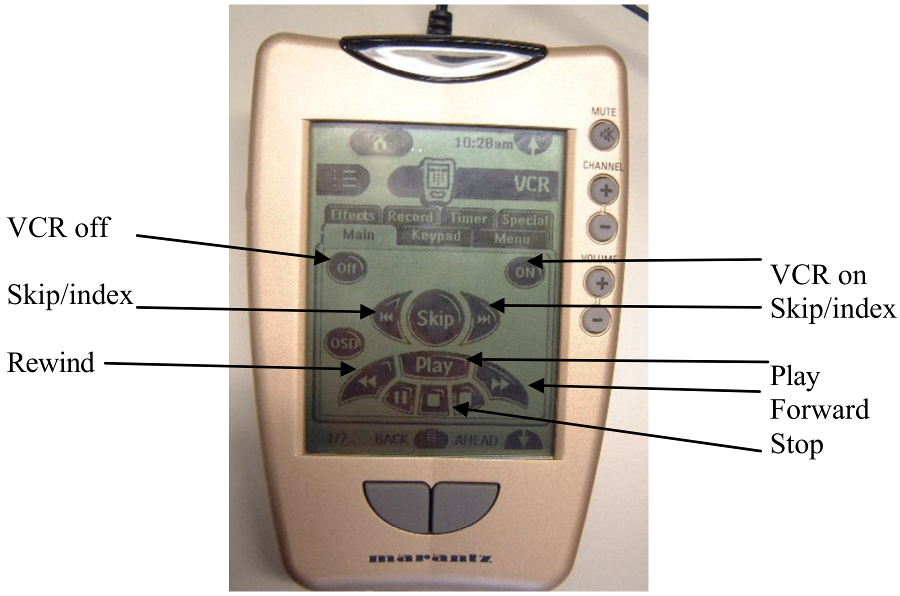

Figure 4: Default interface on VCR main screen

Experiment 3 was planned with the objectives of: testing the three new interface designs against the default design in order to establish if changing the location and/or the appearance of the icons on the remote would make it more intuitive to use than the default design; further investigating the links between age, speed and intuitive uses. Based on power calculations, there were 4 interface groups of 15 people each (Appearance, Default, Location and Location–Appearance) and 3 age groups (18–29, 30–39 and >40). This was a two way matched subjects design and in order to balance the groups to control for individual differences, potential participants were asked to fill in a questionnaire when they volunteered to ascertain technology familiarity, gender and level of education.

The methods for each experiment were very similar. Due to space constraints, the basic method (with variations for each experiment) is described below.

2.1 Apparatus and Measures

All experiments took place in the human centred design research and usability laboratory at Queensland University of Technology. Two digital video cameras were used to record the participants' interaction, one trained on the participants' hands, and the other recording torso and facial expressions (Figure 5). The video camera in view is the one focussed by the experimenter on the participant's hands. The second camera was positioned approximately two metres to the left of the participant's right shoulder. None of the participants had encountered the products used in the tests before the experiments began, and they received no payment in return for their participation. They were recruited from staff (and a few students) of the university and local companies.

The products chosen for the experiments had a mix of features, some unique or unusual and others familiar to some users as they had been employed in various other products. The Fuji 4700 zoom digital camera was used for Experiment 1 and the Marantz RC5000i universal touch screen remote control for Experiments 2 and 3. The remote control was programmed to control a Panasonic NV SD 220 VCR and NEC Chromovision TV.

The technology familiarity questionnaire was designed to reveal information about the participants' experience and behaviour with products related to the mediating product. Rudinger et al.(1994) used a similar questionnaire to measure "general technical experience" of participants. Our questionnaire asked participants about how often they used certain products, and how much of the functionality of those products they used. This questionnaire was used to calculate the technology familiarity (TF) score for each participant. More exposure to, and knowledge of, the products in the questionnaire produced a higher technology familiarity score. How this was achieved is explained in Appendix A. The TF score was used either to group participants (as in Experiment 2) or to balance the groups during subject matching.

Figure 5: Laboratory set-up during experiments

2.2 Procedure

Participants were first welcomed to the laboratory and given an information package and consent form to read and sign. Then all the equipment to be used and the tasks to be performed were explained clearly using a pre-determined script. Intuition has been shown to be vulnerable to anxiety (Bastick, 1982, 2003; Laughlin, 1997). Thus a calm and "permissive" environment should be provided for experiments concerned with intuition (Bastick, 1982, 2003). Participants were encouraged not to worry about the experiment or their performance.

The participants were asked to complete two operations, each of which consisted of a number of tasks. For Experiment 1 these were:

- Use the camera to take a photograph in auto-focus mode using the zoom function
- Find the picture you took. Erase your picture. Search through the other images stored in the camera to find (a specified image). Zoom in on the image so that the details become larger.

For Experiments 2 and 3 they were:

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

The instruction manual was available only on request, and participants were asked to try to work out the operations for themselves, as reference to the manual would mask use of past experience. Immediately after the completion of the operations, a structured interview was conducted. During the interview, participants gave ratings for familiarity of each feature on the mediating product. This could not be done before the experiment as once participants had seen and discussed the features, their interaction with them would be changed.

Participants were thinking aloud (delivering concurrent verbal protocol) while they performed these tasks. Intuitive interaction requires the use of intuition, and intuition, being non-conscious, utilises memories and learning without the conscious mind being aware of it. The non-conscious aspect of intuition has been used in experiments as a criterion for the involvement of intuition or insight (Bastick, 2003). The conscious/non-conscious distinction is generally determined by verbal reportability in experimental situations (Baars, 1988; Schooler, 2002), and the terms *reportable* and *unreportable* are operational definitions of conscious and unconscious, respectively (Bowden, 1997). The use of *reportable* to refer to events which do reach consciousness is non-controversial (Baars, 1988; Baars and Franklin, 2003).

In contrast, the use of *unreportable* to refer to events which do not reach consciousness is more controversial (Bowden, 1997). *Unreportable* may not be equivalent to unconscious because one may be unable (or unwilling) to report certain events which do reach consciousness. However, because there is currently no operational definition of unconscious which is without critics, many researchers, such as Bowden (1997), use the term *unreportable*. The same operationalisation has been used for this research. In a concurrent protocol the intuitive process is conspicuous by the absence of detail and logical thinking steps in the commentary, as the commentary is generated in the conscious mind, which does not have access to the intuitive process.

Schooler, Ohlsson and Brooks (1993) hypothesise that verbalisation disrupts the non-reportable processes associated with "insight" problem solving; possibly the unreportable processes become overshadowed as the focus of concentration/attention is on reportable processes during verbalisation. This was a potential problem for this research. Schooler et al. (1993) recommend that researchers should consider using silent control groups if they are using verbal protocols to assess non-reportable cognitive processes, which would establish if verbalisation is influencing performance. However, this is not possible in this case as we could not assess performance without the protocol.

Therefore, the problem was addressed by not pushing for protocol unless participants were absolutely silent. This lack of requirement to verbalise every single thought meant that the protocol could be used to decide when participants were processing unconsciously, as the unconscious processing was unreportable. When participants did not verbalise in detail because the detail was not consciously available, they were very likely processing unconsciously and so could be using intuition.

2.3 Data Analysis

The performance parameters common to all the experiments were correctness of uses, time on tasks, intuitive uses throughout operations, intuitive first uses of each feature and subjective measures of familiarity of product features. Subjective measures of familiarity were given during the interview, when participants were asked to rate (using rating scales of 1-6) how familiar they felt each feature on the test product was to them. The other variables were coded using Noldus Observer software. We have explained the analysis and coding in depth elsewhere (Blackler, 2006; Blackler et al., 2004b), and we summarise the coding system here.

Correct uses required 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. Correct- but-inappropriate uses were included in the analysis as this research was focussed on correct use of features (which does not always lead to correct completion of tasks).

Time on task is relevant as intuitive processing is faster than more conscious types of processing (Agor, 1986; Bastick, 2003; Salk, 1983), so participants interacting intuitively with the product should complete tasks more quickly. However, we could not assume that completing the task quickly is always the same as completing it intuitively; there could also be other reasons for faster performance, such as faster motor responses. We also needed a measure that showed uses of intuition or intuitive uses. Number or percentage of intuitive uses throughout the operations and intuitive first uses of each feature were problematic variables to measure, but they are the most direct way of quantifying intuitive interactions.

2.3.1 Intuitive Use Heuristics

Our definition of intuitive use is states that intuitive use involves utilising knowledge gained through other experience(s), is fast and generally non-conscious. Intuitive use requires the use of intuition. The main indicators of intuitive uses that were employed to make decisions about types of use during the coding process were:

- Evidence of conscious reasoning: Since intuitive processing does not involve conscious reasoning or analysis (Agor, 1986; Bastick, 1982; Fischbein, 1987; Hammond, 1993; Noddings and Shore, 1984), the less reasoning was evident for each use, the more likely it was that intuitive processing was happening.
- Expectation: Intuition is based on prior experience and is therefore linked to expectations. If a participant clearly had an established expectation that a feature would perform a certain function, he/she 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, 2003; Hammond, 1993). Those uses coded as intuitive were those that participants seemed certain about, not those where they were just trying a feature out. This does not imply they were processing consciously, but that they were confident in what they were doing.
- Latency: If a participant 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 (Agor, 1986; Bastick, 1982, 2003; Hammond, 1993; Salk, 1983), and is associated with subjective certainty. Those uses coded as intuitive involved the participants using the correct feature with no more than five seconds latency, and often much less, commonly one or two seconds.
- Relevant past experience: Participants would sometimes mention that a feature was familiar, showing evidence of their existing knowledge. This did not happen very often; the features people were most familiar with were used non-consciously and not even mentioned in many cases.

"Intuitive use" codes were applied cautiously, only when the use showed two or more of these characteristics. Any uses about which there was doubt were not coded as "intuitive". All recordings were double-checked to make sure codes were correct.

2.4 Results

The main results from all three experiments are summarised below. We have discussed these results in more depth elsewhere (Blackler, 2006; Blackler et al., 2003a, b, 2004a, 2005). Due to space constraints, we have included here only the pertinent results and a couple of graphs for each experiment. For details of full results, means, SDs, power calculations, etc, please see Blackler (2006).

2.4.1 Experiment 1

For Experiment 1, minimum score on TF questionnaire was 0 and maximum was 100. Figure 6 presents the relationship between time to complete the operations and the technology familiarity score, and shows the strong negative correlation between these two variables, r(18) = –0.69, p < .01. This data set was also tested after removal of the outlier evident at 1995 seconds in Figure 7.6 and the result was still a significant negative correlation, *r*(17) = –0.56, *p* < .05

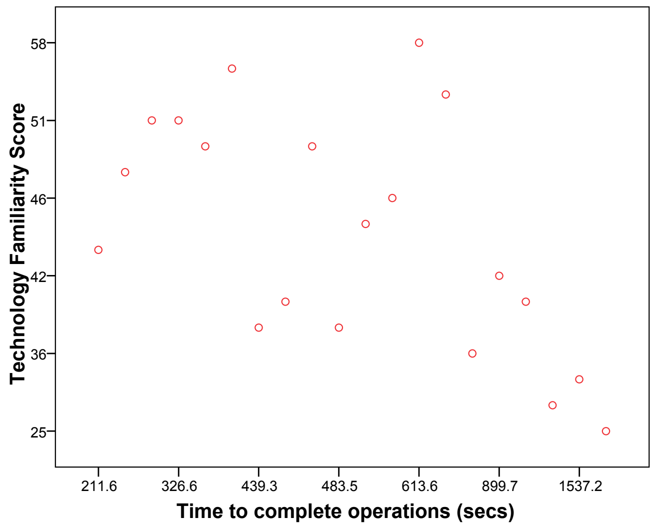

Figure 6: Time to complete operations plotted against technology familiarity score

There was a strong positive correlation between the percentage of intuitive first uses (correct and correct-but-inappropriate) and the technology familiarity score, r(18) = 0.643, p < .01 (Figure 7). Therefore, 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. Mean familiarity of the features also correlated strongly and positively with the mean of the percentage of intuitive uses of the features, *r*(18) = 0.523, *p* < .05.

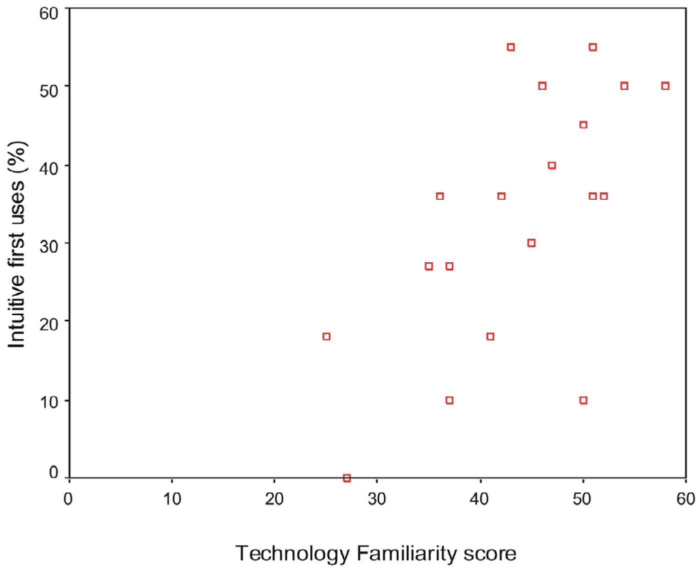

Figure 7: Technology familiarity score plotted against percentage of intuitive first uses (correct and correct-but-inappropriate)

These results suggested that prior exposure to products employing similar features helped participants to complete the operations more quickly and intuitively. The intuitive first uses results are particularly important as, in these cases, the participants had not yet had the opportunity to learn about the feature but used it either correctly or correctly-but-inappropriately the first time they encountered it. These were not physical affordances or in most cases features that could be easily guessed, so participants could base their actions only on past experience of similar features from the same or other domains. Therefore these results offer support for the idea that including familiar features in a product will allow people to use it intuitively first time.

2.4.2 Experiment 2

The technology familiarity (TF) questionnaire used to group the participants had a hypothetical minimum score of zero and a hypothetical maximum score of 110. The high group had scores of more than 75, the medium from 56-75 and the low under 55. Figure 8 presents the relationship between time to complete the operations and the TF group (all error bars are standard error of the mean x1). Levene's test showed that homogeneity was breached, $F(2,27) = 10.22$, $p < .0001$. Therefore, in accordance with Keppel (1991), a strict alpha level of .025 was adopted. A one-way ANOVA showed a significant difference in time to complete tasks, $F(2,27) = 5.77$, $p < .008$. According to the Tukey HSD test, this difference was between the high technology familiarity and low technology familiarity groups ($p = .006$). Participants who had a higher level of technology familiarity were quicker at doing the tasks.

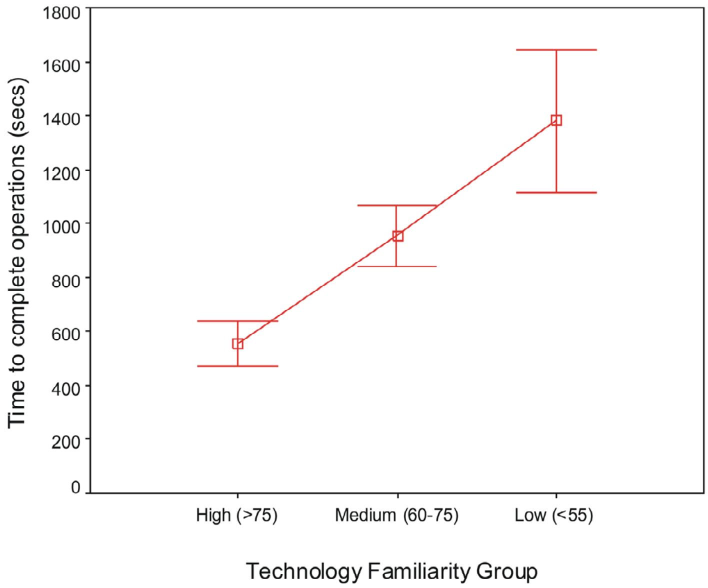

Figure 8: Time to complete operations for each technology familiarity group

A one-way ANOVA revealed that TF group also had a significant effect on the number of intuitive first uses (correct or correct-but-inappropriate), $F(2,27) = 8.58$, $p < .001$ (Figure 9), with a Tukey post hoc test showing that the high TF group had significantly more intuitive first uses than the low TF group ($p = .001$). Participants who had a higher level of technology familiarity were able to use more of the features intuitively the first time they encountered them.

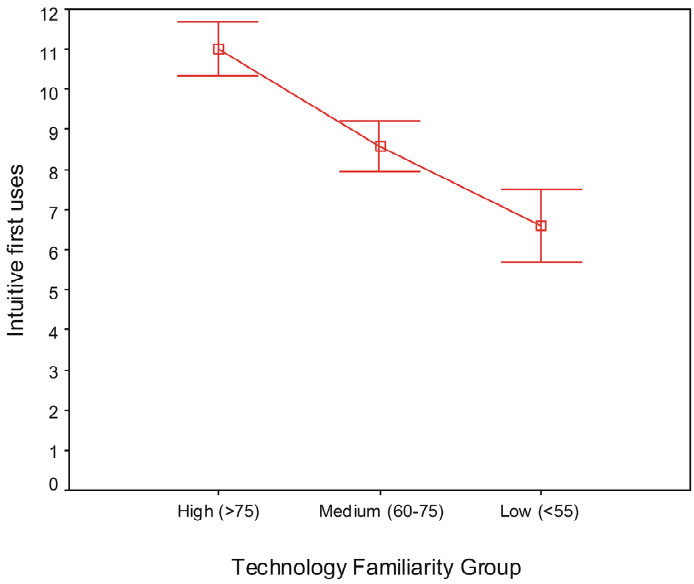

Figure 9: Intuitive first uses (correct and correct-but-inappropriate) by technology familiarity group

Experiment 2 measured number rather than percentage of intuitive uses. A one-way ANOVA showed that age group significantly affected the number of intuitive first uses, $F(3, 26) = 8.62$, $p < .0001$, with the Tukey post hoc test showing the significant difference between the 18–34 groups and both the 45–54 group ($p = .003$) and the >55 group ($p = .002$). The percentage of intuitive first uses of features (correct and correct-but-inappropriate) correlated strongly and positively with familiarity of features, $r(15) = .80$, $p < .0001$, as did the percentage of intuitive first uses of features (correct only), $r(14) = .75$, $p < .001$.

The relationships between time, TF score, familiarity and intuitive uses of the features supported the findings of Experiment 1. People seem to use their previous experience with similar features in order to use new features intuitively. Results relating to age in Experiment 2 are only indicative; age groups were not logically constructed for Experiment 2 as the focus was on TF.

2.4.3 Experiment 3

For Experiment 3 a two way design with three age groups and four interface groups was employed. A two-way ANOVA revealed that interface had a significant main effect on time to complete tasks, $F(3,48) = 3.801$, $p < .016$ (Figure 6). A Tukey HSD post hoc test revealed that participants using the Location-Appearance interface were significantly faster than those using both the Location and Default interfaces. Age group also had a significant main effect on time to complete operations, $F(2,48) = 5.627$, $p < .006$. Both the younger groups completed the operations significantly faster than the oldest one. There was no interaction between age and interface, $F(6, 48) <1$, n.s.

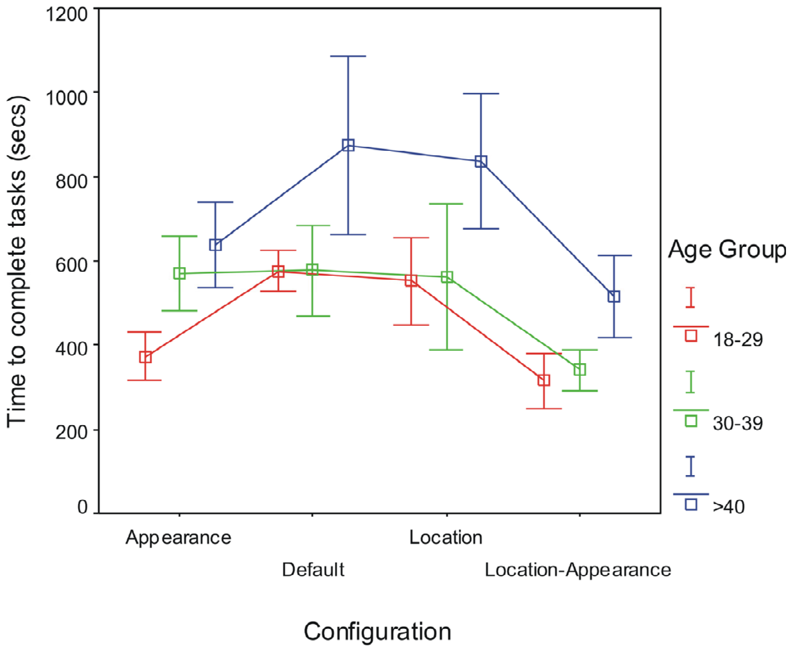

Figure 10: Time to complete operations by interface and age group

A two-way ANOVA revealed that the percentage of intuitive first uses (correct only) showed a significant main effect between the interfaces, $F(3, 48)= 5.584$, $p < .002$. Intuitive first uses (correct only) were significantly higher for the Location–Appearance group than the Location and Default groups. The percentage of intuitive first uses (correct only) did not show any significant variance according to age group, $F(2,48) = 2.403$, $p > .05$ ($E^2 = .09$, power = .46). However, due to the lower power and moderate effect here, it is possible that the low power is masking an effect.

A two-way ANOVA revealed that the effect of interface on the percentage of intuitive uses (correct only) throughout the operations was also significant, $F(3,48) = 4.66$, $p < .01$ (Figure 7), with differences shown by the Tukey HSD post hoc test between the Location–Appearance interface and both Location ($p = .011$) and Default ($p = .012$). There was also a significant main affect between age groups, $F(2,48) = 4.45$, $p < .05$. The significant difference here was between the >40 age group and both the 18–29 ($p = .035$) and the 30–39 groups ($p = .031$) (Figure 7). There was no interaction between age group and configuration, $F(6,48) <1$, n.s.

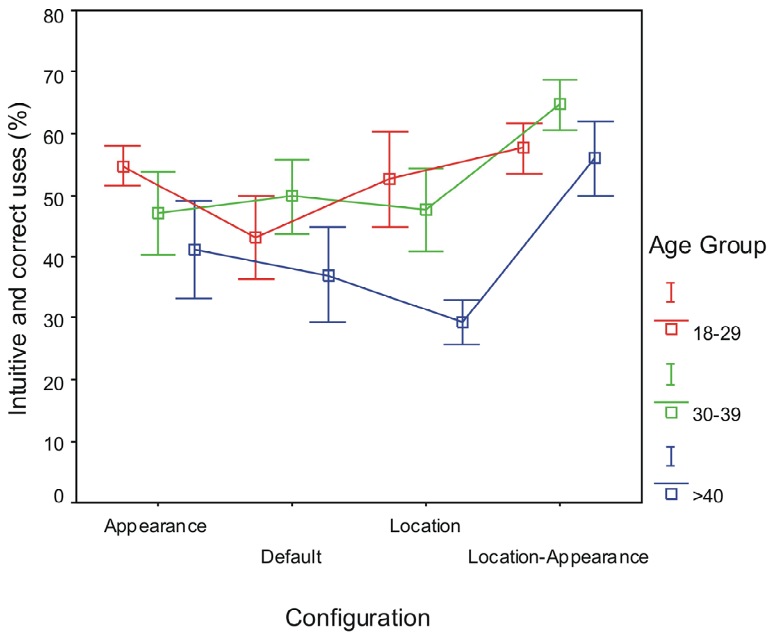

Figure 11: Percentage of intuitive first uses (correct only) by configuration and age group

All the groups using the new interfaces performed better than the default group. The participants in the Location–Appearance group were quickest at doing the tasks and achieved significantly higher levels of intuitive uses than the default group. The participants in the Appearance condition were not significantly different from the Location–Appearance group in terms of time and intuitive uses. Participants in the Location group were the slowest of those using the new designs and had less intuitive uses. These results suggest that the change in appearance of the features had more effect upon these performance measures than the change in location.

Age had a weaker effect than configuration on intuitive uses, but overall the results seem to suggest that there is an effect, with older people completing tasks more slowly and with a lower percentage of intuitive uses. The oldest age group had much more diversity than the younger two, and ages ranged from 40-58 (mainly due to difficulties recruiting older people). Therefore, none of these people are officially in the "old" category (Fisk, Rogers, Charness, Czaja, and Sharit, 2004), and it could be hypothesised that a stronger effect could be found with people over 60 and/or 70. We are currently doing more work in this area.

3. Discussion

The main findings from our empirical research were:

- Familiarity with similar features, as measured by participant ratings during interviews and by TF score, allowed people to use new interfaces more quickly and intuitively than they used those with unfamiliar features.
- The technology familiarity scale was effective in quantifying the level of familiarity with similar features that participants were likely to have.
- Age also had an effect on how quickly and how intuitively participants could complete tasks.
- The appearance of a feature had significantly more effect than its location on how intuitively it was used.

3.1 Properties of Intuitive Interaction

The experiments supported our definition of intuitive interaction. It was found to be facilitated through past experience, and participants who had relevant past experience with particular features used those features intuitively. All the experiments showed that familiarity with a feature allows a person to use it more quickly and intuitively. This is the foundational conclusion to come from this research and informs the principles and tools which we have developed for designing for intuitive interaction (Blackler, Popovic, and Mahar, 2006, Blackler and Hurtienne, 2007). Intuitive use was also found to be fast and often correct, but not infallible. Although latency was one of the criteria for coding intuitive uses, it was one of six overall, and overall time on task was the variable used for time statistics, so this is unlikely to be the effect of circularity. The non-conscious nature of intuition was successfully used, along with other properties such as prior experience, speed, correctness and expectedness, to separate intuitive processing from other types of cognitive processing during the coding process.

3.2 Intuitive Use and Function, Appearance and Location

Experiment 3 demonstrated that intuitive use is enabled more by the appearance of features than by their location. This has implications for the design of interfaces as it seems more important to concentrate on getting the appearance right, rather than the location. Appearance is also more multi-faceted – comprising shape, size, colour and labelling – whereas location comprises only location within local components and (for complex products) global systems. Since appearance is more complex as well as more important for intuitive interaction, it is justified as a priority over location.

However, location should not be neglected altogether as there was some qualitative evidence (through observation) that the correct location could help to decrease search times for individual features. An intuitive appearance helps to prevent confusion and time wasting, but once a person knows what s/he is looking for, putting that feature in a familiar location has been shown to decrease response times (Pearson and van Schaik, 2003; Proctor, Lu, Wang, and Dutta, 1995; Wickens, 1992). More standardisation of location on products (similar to the standardisation of location of various key features of software) may allow location to play a more important role in intuitive interaction.

One of the limitations of this research was that locations on the default interface may have been more familiar than the appearances, so that less differences would be seen between the old and new designs in the case of location. However, based on our expert analysis of the interface, the location and appearance were equally counter-intuitive in the default interface. Another limitation was that it was not possible to test the function of the various features for intuitive interaction because the remote control already had functions assigned to the features. However, without being familiar with the function of a feature, users would not have any idea what to do with it. Therefore, it can be recommended that decisions about the functions required on a product and the way in which those functions work need to be based on familiar processes that users have seen before. The three factors of function, appearance and location have been applied to a set of principles and a conceptual tool which designers can use to make interfaces more intuitive (Blackler et al., 2006, Blackler and Hurtienne, 2007).

3.3 Intuitive Use and Age

Although the older group benefited from the new designs, they still remained slower and had less intuitive uses than younger people. The evidence suggests relationships between age and time and age and intuitive uses. Older people obviously have more overall experience than younger ones, but it is likely that there is some difference in the way that people of different ages can utilise their prior experience to intuitively use a new product. We are continuing work focussed more specifically on intuitive interaction and aging to determine the exact cause of these differences and find solutions that designers can implement.

4. Principles of Intuitive Interaction

These principles are based on our empirical research into intuitive interaction and aimed explicitly at increasing its likelihood. They were extended from those used as part of the re-design process prior to the Experiment 3 (Blackler et al., 2003a), and form the foundation for the methodology we have developed (Blackler et al., 2006, Blackler and Hurtienne, 2007).

4.1 Principle 1: Use familiar features from the same domain

Make function, appearance and location familiar for features that are already known. Use familiar symbols and/or words, put them in a familiar or expected position and make the function comparable with similar functions users have seen before. Principle 1 involves employing existing features, labels or icons that users have seen before in similar products that perform the same function. This is the simplest level of applying intuitive interaction and uses features transferred from similar contexts.

4.2 Principle 2: Transfer familiar things from other domains

Make it obvious how to use less well-known features by using familiar things to demonstrate their function, appearance and location. This principle requires transfer of features from differing domains (either different types of products or technologies or things from the physical world transferred to the virtual world). The desktop metaphor is a good example of this sort of principle successfully applied (Perkins, Keller, and Ludolph, 1997; Smith, Irby, Kimball, and Verplank, 1982).

4.3 Principle 3: Redundancy and internal consistency

Redundancy is a basic and well known principle of interface design, and is essential in ensuring that as many users as possible can use an interface intuitively. If one user is familiar with a word, another may be familiar with the corresponding symbol; or different users may prefer different ways of navigating the same interface. Providing additional options will enable more people to use the interface intuitively.

Increase the consistency within the interface so that function, appearance and location of features are consistent between different parts of the design and on every page, screen, part and/or mode. Keeping internal consistency in this way allows users to apply the same knowledge and metaphors throughout the interface (Kellogg, 1989).

5. Conclusion

We have found support for the idea that intuitive interaction does depend on past experience with similar features, and it is affected by age. Appearance of a feature is more important than location for facilitating intuitive interaction. We have developed principles for designing for intuitive interaction. A conceptual tool to guide designers through the design process for intuitive interaction has also been produced (Blackler et al., 2006; Blackler, Popovic, and Mahar, in press). This tool, and the links between our work and the work of our colleagues in Germany, is discussed by Blackler and Hurtienne (2007).

We are currently conducting further work on refining this tool and also investigating the link between age and intuitive use. There is much potential for other work in this area; however, our research has established a foundation for the study of intuitive interaction, and gives other researchers a solid basis from which to work.

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Appendix A

User Technology Familiarity Questionnaire scoring example sheet

How often do you use the following products? (if you have never used a product of the type, please tick never)

Product	every day	several times a week	once or twice a week	every few weeks	every few months	Only ever used it once or twice	never
Marantz RC5000i universal remote control							✓
Other ***universal*** remote controls **6. Which brands?.….** **…Sony…………………...**			✓				
Standard remote controls for TV		✓					
Standard remote controls for VCR				✓			
Standard remote controls for stereo				✓			
Remote controls for other appliances **Which ones?...………..** **…DVD……………………..**		✓					
Mobile phone	✓						
Stereo, car stereo or personal stereo ***without*** remote		✓					
Personal digital organiser or Palm.					✓		
Web browser (eg Netscape or Internet Explorer)	✓						
Windows or similar	✓						
Other devices with touch-screens **Which ones?........... …**							✓
Score for each entry	6	5	4	3	2	1	0
Total for column	*18*	*15*	*4*	*6*	*2*	*0*	*0*
Total for this question	*45*						

When using versions of these products (below), how many of the features on the product do you use? (if you do not use a product of the type please tick none)

Product	All of the features (you read the manual to check them)	As many features as you can figure out without manual	Just enough features to get by with	Your limited knowledge of the features limits your use of the product	None of the features – you do not use this product
Marantz RC5000i universal remote control					✓
Other ***universal*** remote controls **7. Which brands?……..…..** **…Sony……………………..…**		✓			
Standard remote controls for TV		✓			
Standard remote controls for VCR		✓			
Standard remote controls for stereo			✓		
Remote controls for other appliances **Which ones?…DVD………** **……………………………….**			✓		
Mobile phone		✓			
Stereo, car stereo or personal stereo ***without*** remote		✓			
Personal digital organiser or Palm.				✓	
Web browser (eg Netscape or Internet Explorer)		✓			
Windows or similar		✓			
Other devices with touch-screens **Which ones?…………….** **…………………………….**					✓
Score for each entry	4	3	2	1	0
Total for column	*0*	*21*	*4*	*1*	*0*
Total for this question	*26*				
Grand total (=TF score)	*71*				