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Pacific Asia Conference on Information Systems (PACIS)

6-18-2013

Does Age Matter in Mobile User Experience? Impact of Age on Relative Importance of Antecedents of Mobile User Experience

Jihyun Kim
Yonsei University, catte25@naver.com

Jinwoo Kim
Yonsei University, jinwoo@yonsei.ac.kr

Jae Yun Moon
Korea University, jymoon@korea.ac.kr

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Jihyun Kim, School of Business, Yonsei University, Seoul, Korea, catte25@naver.com

Jinwoo Kim, School of Business, Yonsei University, Seoul, Korea, jinwoo@yonsei.ac.kr

Jae Yun Moon*, Business School, Korea University, Seoul, Korea, jymoon@korea.ac.kr

Abstract

Interest in user experience (UX) has grown as both academics and practitioners perceive that focusing on functional usability provides only a limited understanding of human computer interaction. UX is a comprehensive concept that goes beyond usability and utilitarian aspects of technology use, to include the non-utilitarian, aesthetic, emotional and experiential aspects. A growing body of research based on Hassenzahl's basic UX model has examined the impact of hedonic and pragmatic product attributes on user perceptions of beauty and goodness of the technology, and their subsequent impact on satisfaction. However, the influence of age on these relationships has largely been ignored. We conducted a survey of children, young adults and the elderly's mobile phone UX, and conducted a multi-group analysis of the UX model. We found that age really matters in mobile phone user experience. While prior research has focused on young adults, the important determinants of UX for children and the elderly differed significantly. In accordance with the UX model, young adults' UX evaluation was influenced by both pragmatic and hedonic qualities. Children and the elderly on the other hand focused on hedonic qualities. Our study has implications for the study and practice of UX design.

Keywords: mobile user experience, age, hedonic quality, pragmatic quality.

* Corresponding author

1 INTRODUCTION

With rapid advances in technology and proliferation of easy to use products, users increasingly evaluate technical products based not only on their functional features, but also on factors such as beauty, fun and emotions (Hassenzahl & Tractinsky 2006). Interest in user experience (UX) has thus grown as both academics and practitioners perceive that focusing on functional usability provides only a limited understanding of human computer interaction (Hassenzahl & Tractinsky 2006). UX goes beyond the utilitarian aspects of technology use to an understanding of the dynamic, subjective and context-dependent user emotions that result from technology interactions (Law et al. 2009). In short, UX is a comprehensive concept that stresses not just usability, but the non-utilitarian, aesthetic, emotional and experiential aspects of interactive system use (Forlizzi & Battarbee 2004; Hassenzahl 2013).

Early studies established the importance of the various factors such as fun, enjoyment, beauty and experiential attributes in determining user satisfaction and perception of interactive systems. However, the lack of a conceptual model made it difficult to draw reliable conclusions and practical guidelines regarding the design of interactive systems that would have a positive impact on UX (Hassenzahl 2004). A conceptual model of UX enables researchers and practitioners to empirically examine the causal structure and relationships among the varied hedonic and utilitarian factors and their impact on users' perceived UX quality. It also forms a basis for generating cumulative knowledge regarding important determinants of subjective perceptions of UX (van Schaik & Ling 2008). Since Hassenzahl (2003, 2004) first introduced a model of user experience, there have been a large number of studies that have built upon this model to examine the important factors affecting perceived quality of interactive systems in a wide range of contexts (e.g., van Schaik & Ling 2008).

However, early research implicitly assumes that determinants of UX quality are invariant across different age groups. We argue that this assumption warrants empirical examination. In short, age may be an important factor affecting the relative importance of the antecedents of perceived UX quality. Indeed, age is an important boundary condition that affects the strength and direction of relationships between constructs in many behavioural studies (e.g., Morris & Venkatesh 2000; Morris et al. 2005). Age in particular affects how people experience technologies, due partly to their having been exposed to different generations of technologies. Prior research has found that both children and the elderly exhibit different patterns of behaviours and attitudes towards interactive systems compared to young adults. However, few empirical studies of UX have explicitly incorporated age as an important variable. Most empirical studies of UX have been conducted of young adults such as college students or HCI professionals. The lack of empirical studies that explicitly model age as an important variable is especially problematic for UX research. This is because what constitutes an optimal UX may vary across different generations. Thus, applying an undifferentiated UX model to derive practical guidelines for the design of interactive systems for all age groups may result in sub-optimal UX for the target user population.

The goal of this research is to examine how age affects the relative importance of the determinants of UX, and thus formulate optimal conceptual models of UX by age group. We adopt the most widely-adopted UX model in prior research for its simplicity and extensibility (Hassenzahl 2003, 2004). We examine in particular determinants of mobile phone UX for subjects of varying ages. For the purpose of this research, we focus on 3 specific age groups – children (between ages 8-12), young adults (between ages 18-25), and elderly (over 65).

We focus on mobile phone UX in this study for several reasons. First, it is the most commonly used device across all age groups. While there are many elderly people who have not adopted personal computers, there are few that do not use mobile phones. The quality of the UX with mobile phones may vary depending on users' ages, as aging affects people's cognitive skills. People of different generations have been exposed to different experiences and differ with respect to their prior technical

knowledge, which may in turn shape their reactions and subjective perception of their mobile technology experiences. The different generations vary in their preferences for mobile technologies and the types of features they regularly use. Despite such differences, there is little research that empirically examines the differences in determinants of UX quality across different age groups.

Second, mobile phone use is also an ideal context of study because of the dual nature of these technologies. They at times are instruments to meet utilitarian goals (Helfenstein 2012); at times they are viewed as means of identity expression by users (Katz & Aakhus 2002). Moreover, mobile and smartphones are used in diverse contexts and fill a broad range of user needs. This very diversity renders it difficult to predict the quality of the UX that will be afforded by the same device. Users may enjoy a positive experience while using the smartphone as a communication device, but a negative experience when attempting to use the same device for the purpose of scheduling, gaming or searching for local information. Because of the potential variation in utilitarian and non-utilitarian needs that may be met by mobile phones, they present an ideal context within which to examine determinants of UX quality across different age groups.

In summary, we address the following research question: *Do determinants of mobile phone UX quality differ by age group (children, young adults, and elderly)?* In order to address this question, we administered the basic UX model survey to participants in the three different age groups. Our results indicate that the basic UX model held for the young adult age group. However, the main determinants of UX quality were different for children and the elderly. In the next section we review Hassenzahl's UX model and present our research model. We also present the need to consider age in these models. We then describe our research method and results. We conclude with theoretical as well as practical implications of the study results.

2 RESEARCH BACKGROUND

2.1 Basic Conceptual Model of User Experience (UX)

Hassenzahl (Hassenzahl 2001, 2004) presented a process model of the impact of product design attributes on user experience. According to the model, a product's objective attributes and features affect user experiences with the products and shape their perception of their subjective hedonic and pragmatic qualities. Perceived qualities affect user evaluation of the product's beauty and goodness, which in turn influence the users' emotions (e.g., pleasure, satisfaction) and behavioural tendencies for increased use of the product (Hassenzahl 2003). In short, users are assumed to construct perceived *product attributes* through a combination of the product's designed objective features (e.g., content, functionality) and the users' knowledge and expectations. Hassenzahl's UX model (Hassenzahl 2001, 2003, 2004) also classifies the attributes that define the product character as either hedonic or pragmatic. Hedonic attributes relate to users' identity and expressive needs. Pragmatic attributes relate to features that enable users to effectively and efficiently fulfil their utilitarian goals. Thus, the UX model establishes the need to design products to produce experiences that are enjoyable as well as useful. The pragmatic and hedonic qualities of products are *subjective* user perceptions, and lead to overall evaluations of a product's goodness of beauty. Hassenzahl (2004) found that hedonic qualities impact beauty, whereas product goodness is determined by both hedonic and pragmatic product qualities. Furthermore, user experience with the product affected their subsequent evaluation of pragmatic attributes and product goodness, whereas hedonic attributes and beauty perceptions tended to remain stable in the face of product experience (Hassenzahl 2004).

The basic model discussed above has formed the basis of much empirical studies of UX of interactive systems. van Schaik and Ling (2008) for example examined the impact of web design such as screen design and information organization on user experience with the web sites. Similar to previous studies, they found that product beauty was primarily determined by product hedonic quality, even for interactive systems that did not easily allow for identity expression, i.e., for web sites that were not

personal possessions. In the study, product goodness was affected by both hedonic and pragmatic quality. Moreover, the relationship between pragmatic quality and goodness changed over time with increased user experience with the web sites.

2.2 Age in Studies of User Experience (UX): An assessment of the literature

In order to investigate the age distribution of participants in prior UX studies, a literature survey was conducted. A keyword search was conducted using "UX" or "user experience" in the leading HCI journals (e.g., *Behaviour & Information Technology, Computers in Human Behavior, Interacting with Computers*) and conference proceedings. Of the papers returned from these searches, only empirical studies were retained and those of purely conceptual manuscripts and review papers were dropped from further assessment.[1] In total, fifty nine papers were examined for subjects' age composition.

Among the fifty nine papers, five did not present any demographic information of their study participants. Among those providing demographic information (54 papers), the vast majority (42 papers) deals with either young adults (e.g., Karapanos et al. 2010) or HCI professionals (e.g., Finstad 2010). Seven studies include participants with a wide range of age (e.g., O'Brien 2010), but none has specifically examined the impact of age difference in their analysis. Two studies focused on UX issues with children as subjects (e.g., Joiner et al. 2006), but they did not compare between children and any other age groups. Finally, three papers explicitly compared different age groups but they were all focused on the difference of usability between young adults and the elderly (e.g., Kang & Yoon 2008). In short, few studies have explicitly compared UX issues among different age groups.

2.3 Need for Focus on Age Differences in UX Research

There are several reasons why generational differences are important in research on UX. First, different generations have experienced different life events that have shaped their general attitudes and perceptions, resulting in observed differences in specific attitudes and behavioural tendencies (Williams & Page 2011). In short, experimental differences between groups of subjects of different ages can be attributed to differences in their lifetime experiences (Alatas et al. 2009). Moreover, as different generations have been exposed to different generations of technology there will be important consequences and differences in UX outcomes depending on age (Salkowitz 2008). Hence, in order to capture the temporal and contextual influences on personal UX (McCarthy & Wright 2004), it is imperative that user differences be taken into account. This is because the same technology may be experienced differently by people depending on their situational and individual attributes. We thus argue that there is an urgent need for research that examines UX for not just young adults, but that compares UX across different age groups.

Second, the elderly may exhibit differences in important attributes for high quality UX. A recent interdisciplinary meta-analysis of research older adults' use of computers found that the elderly differ in many respects from young adults (Wagner et al. 2010). Morris and Venkatesh (2000) for example found that subjective norm and perceived behavioural control were more important predictors of behavioural intentions to use technologies for older employees. Moreover, prior research has also found that older people experience more difficulties in learning information search skills and higher levels of computer anxiety (Chua et al. 1999; Czaja & Sharit 1993; Czaja & Sharit 1998). In prior research, there has been a call for more research that explicitly models the impact of age on technology related decisions in a wide range of contexts (e.g., Morris & Venkatesh 2000). A number of recent studies have emerged to compare younger adults' and the elderly's use of technologies. In

[1] Research on user experience is growing rapidly and the search results cannot cover the entire selection of UX related research. We summarize here the general pattern of age concentration in the empirical research. Due to space limitations we do not present the full results of subject age composition in the published studies. These results are available upon request.

particular, with advances in mobile technologies, there has been a surge of research that specifically focused on usability of mobile devices for the elderly population (Arning & Ziefle 2009; Kang & Yoon 2008; Zhou et al. 2012). Kurniawan (2008) found that many older adults experienced difficulties in the use of mobile phones. Most studies comparing younger and older adults' use of mobile technologies have focused on usability issues. As discussed earlier however, UX is determined not only by pragmatic qualities of the product such as usability, but also hedonic qualities such as emotions and enjoyment (Hassenzahl 2004; Tractinsky et al. 2000; van Schaik & Ling 2008). However, there has been little research that has explicitly examined the difference in UX across young and older adults.

Third, children represent a unique audience for innovative technologies such as digital libraries and digital storytelling systems and exhibit different styles of interaction and use with technologies (Druin 2002, 2005; Guha et al. 2005). Early human computer interaction methods and usability testing has focused on adults, with little validation of their applicability when the users are children (Markopoulos & Bekker 2003). Peer tutoring has been suggested as one alternative approach for usability testing when subjects are children (Höysniemi et al. 2003). Much prior research on children as users as focused on usability tests of innovative systems and the impact of digital technology for educational use on learning performance (Bernard et al. 2002; Roschelle et al. 2000). Finally, there has been work that examines usability issues for children of various technologies such as the QWERTY keyboard (Read 2007), mouse (Donker & Reitsma 2007a; Donker & Reitsma 2007b), and mobile phone menus (Ziefle et al. 2006). Collective findings from these studies suggest that children exhibit high levels of curiosity and playfulness in interacting with new technologies and thus are difficult to study based on research frameworks that are informed mainly by an adult perspective. These results suggest that children will exhibit differences in the important attributes and factors that drive their perceived UX quality and satisfaction. However, there is little research to date that directly compares the UX quality of children and adults within the same technological context. In the following section, we present our research model and hypotheses regarding the impact of age on differences in theoretical relationships among constructs in the basic UX model.

3 RESEARCH MODEL AND HYPOTHESES

There is a growing body of research on the determinants of user experience, with many researchers calling for the need for a comprehensive research model to integrate these research findings to build cumulative knowledge (Law & van Schaik 2010; van Schaik & Ling 2008). Similarly, a comparison of the important determinants of UX with interactive systems across users in different age groups is meaningful only when based on a common conceptual model of UX determinants. Piecemeal comparisons of different attributes of the UX by age yield only haphazard conclusions. A model-based comparison of UX by age will reveal important differences in the most important determinants of UX across the different age groups, and how this affects final experiential outcomse of interactive system use. In short, a UX model-based comparison of users of different ages will help uncover the causes of differences in perceived satisfaction of specific technologies for people of different ages.

Much UX research has built upon and extended Hassenzah's (2001, 2003, 2004) UX model. This thus forms the basis for our conceptual model shown in Figure 1. The parsimonious nature of the model (Law & van Schaik 2010) makes it the ideal model within which to examine the impact of age differences. According to this model, hedonic quality affects product beauty and goodness, whereas pragmatic quality affects product goodness alone. Prior research has also found a relationship between beauty and goodness (Tractinsky et al. 2000). The cognitive evaluations of beauty and goodness will in turn affect users' emotions and behaviours. The final outcome of interest for many studies is user satisfaction. While Hassenzahl (2003, 2004) defined satisfaction to be a simple emotional consequence of evaluations of goodness and beauty, research in human computer interaction and information systems has taken a broader perspective regarding user satisfaction. Satisfaction has thus been examined as the final outcome of interest in determining information systems success in a large body

of work on technology acceptance and continued use (e.g., Bhattacherjee 2001; Hong et al. 2006; Wixom & Todd 2005). We therefore examine the impact of product appraisal of beauty and goodness on user satisfaction in our basic UX model. These relationships are depicted in our basic UX model as shown in Figure 1.

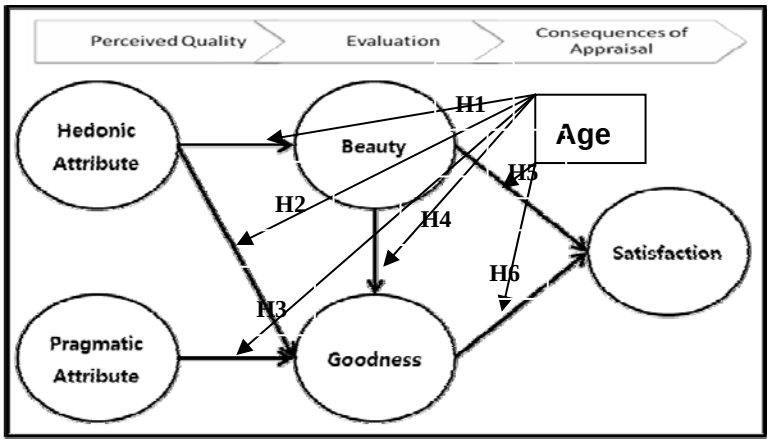

Figure 1. UX Model (Adapted from Hassenzahl 2003)

The focus of our research is whether age affects the overall relationships among the major constructs in the basic UX model in Figure 1. In short, our goal is to examine whether there is heterogeneity in the strength of the predictive relationships in determining overall satisfaction with the mobile UX. Thus, our comparison is between individuals of different age groups – children, young adults and elderly. We thus formlate our hypotheses as null hypotheses for each of the theoretical relationships in our model, based on our earlier discussion of the important role that age plays in user experience.

$H1_0$: The influence of hedonic quality on beauty is the same across children, young adults and the elderly.

$H2_0$: The influence of hedonic quality on goodness is the same for children, young adults and the elderly.

$H3_0$: The influence of pragmatic quality on goodness is the same for children, young adults and the elderly.

$H4_0$: The influence of beauty on goodness is the same for children, young adults and the elderly.

$H5_0$: The influence of beauty on satisfaction is the same for children, young adults and the elderly.

$H6_0$: The influence of goodness on satisfaction is the same for children, young adults and the elderly.

4 RESEARCH METHODS

4.1 Pre-Test of Survey Items

In order to derive a set of measures of UX elements and outcome measures of mobile phone use that could be administered in common across different age groups, we adapted measures from prior UX research (e.g., Hassenzahl 2004; van Schaik & Ling 2008). We conducted a pretest of the measures on a group of elementary students, a group of university students and students from a school of continuing education for older adults.[2] Based on factor analysis results we derived a set of 3 items for

[2] A detailed description and results are available upon request.

hedonic quality, 3 items for pragmatic quality, 3 items to measure user satisfaction, 1 item for beauty and 1 item to measure goodness. These items met reliabiliy and validity criteria for all 3 age groups. The final survey administered to subjects is presented in the Appendix.

4.2 Main Survey Study

4.2.1 Participants

We sampled participants from three different age groups of mobile phone users – 221 children (ages 8-12), 220 young adults (ages 18-25), and 201 older adults (over 65). This age grouping mirrors generational studies that distinguish between baby boomers and millennials and generation Z (Salkowitz 2008). The demographics of survey participants are shown in Table 1. Our total sample is gender-balanced across the three age groups (38%, 32% and 43% of respondents are female in the three groups of children, young and older adults respectively). Although we found no difference across gender, we attempted to minimize any confounding effect of gender by keeping a balanced sample.

Age Group	Gender	N	Average Age (SD)
Children	Male	86	11.03 (0.79)
	Female	135	11.00 (0.81)
	TOTAL	**221**	**11.01 (0.80)**
Young Adults	Male	94	22.70 (1.68)
	Female	126	21.23 (1.77)
	TOTAL	**220**	**22.15 (1.76)**
Older Adults	Male	88	71.50 (6.81)
	Female	113	70.97 (6.10)
	TOTAL	**201**	**71.20 (6.41)**

Table 1. Demographic Profile of Survey Participants

4.2.2 Procedures

In order to maintain consistency of survey procedures across the three different age groups, we conduted the survey offline for all three groups because of difficulties in online survey administration for children and the elderly. This is because online and offline survey results may differ (Faas & Schoen 2006). Also, to maintain a comfortable environment for survey administration we administered the surveys in the classrooms of elementary school, undergraduate college, and lifelong continuing education for children, young adults and the elderly respectively. We constructed a survey adminstration script which was followed at each site in order to maintain consistent instructions and to minimize potential confounding effects from differences in survey administration procedures. We first explained the purpose of the study, and requested that they respond to the short survey on their mobile phone usage experiences. The entire procedure lasted less than 15 minutes, and all subjects were compensated with the equivalent of 5 US dollars.

5 RESULTS

5.1 Measurement Validity and Reliability

To assess measurement scale validity, confirmatory factor analysis (CFA) was conducted on the measurement model using LISREL 8.80. In this study, the fit of the measurement model was assessed in terms of three indices: CFI (> 0.90), NNFI (> 0.90), and RMSEA (< 0.80), which are known to be

less sensitive to sample size, but faithfully reflect the parsimoniousness of the model (Hair Jr. et al. 1998). As seen in Table 2, the fit indices were well above the acceptable thresholds for all three groups.

Age Group	N	CFI	NNFI	RMSEA
Children	221	0.995	0.992	0.041
Young Adults	220	0.989	0.983	0.051
Elderly	201	0.991	0.986	0.041

Table 2. Measurement Model: Goodness-of-Fit

In addition to the model fit, we checked the convergent validity, reliability, and discriminant validity of the item scales. First, to check for convergent validity we examined whether item factor loadings were significant and exceeded 0.70 (Bagozzi & Yi 1988). As illustrated in Table 3, standardized factor loadings for all scale items in the measurement model were significant ($p < .001$) and exceeded the minimum loading criterion of 0.70, except one item of Pragmatic Quality (PRA1 = 0.611). However, since it was close to 0.70 and was marginally significant, we retained the item. Second, we assessed item composite reliability (> 0.70) and AVE (Average Variance Extracted > 0.50). As seen in Table 3, composite reliabilities and AVEs for all constructs exceeded the recommended thresholds (Hair Jr. et al. 1998).

Construct	**Item**	**Children (N = 221)**			**Young Adults (N = 220)**			**Elderly (N = 201)**		
		FL	**CR**	**AVE**	**FL**	**CR**	**AVE**	**FL**	**CR**	**AVE**
Pragmatic	PRA1	0.611	0.766	0.526	0.863	0.870	0.619	0.783	0.870	0.692
Quality	PRA2	0.846			0.831			0.896		
	PRA3	0.700			0.798			0.809		
Hedonic	HED1	0.877	0.883	0.717	0.879	0.907	0.764	0.784	0.836	0.630
Quality	HED2	0.882			0.858			0.811		
	HED3	0.777			0.885			0.788		
Beauty	BEAU1	0.990	0.980	0.980	0.985	0.970	0.970	0.984	0.960	0.960
Goodness	GOOD1	0.988	0.976	0.976	0.979	0.958	0.958	0.982	0.960	0.960
Satisfaction	SAT1	0.885	0.869	0.692	0.930	0.882	0.716	0.870	0.856	0.667
	SAT2	0.919			0.872			0.859		
	SAT3	0.670			0.723			0.710		

Table 3. Convergent Validity and Reliability

Third, Fornell and Larcker's (1981) test was conducted to assess the discriminant validity of constructs. This test requires that the AVE for each construct be greater than the squared correlation between the construct and other constructs in the model (Gefen 2003). Table 4 shows the correlation matrix, with the correlations among the constructs and the square root of AVE on the diagonal. The five diagonal elements are all larger than their corresponding correlation coefficients, which indicate that the metrics have reasonable discriminant validity.

The extent of common method bias was assessed as follows. First, Harman's single-factor test was conducted, including all items in a principal components factor analysis (Podsakoff et al. 2003). When one general factor dominates the covariance among measures, it is said that there is common method bias. There was more than one factor with eigenvalues over one, and no single factor explained all the variance in any of the groups: the factor with the greatest eigenvalue accounted for 46.17% of the variance of children data, 36.14% of young adult data, and 39.61% of older adult group data). Our data

thus do not suffer from serious common method bias. Second, we created a common method factor and added it to the measurement model to assess the effects of an unmeasured latent method factor (Podsakoff et al. 2003). In our analysis, the factor loadings of each theoretical construct remained significant despite the inclusion of a common method factor, which further indicates the low chance of common method bias. Thus, we find that common method bias do not pose a significant problem for this study.

	PRA	HED	BEAU	GOOD	SAT
PRA	**Children: 0.725** **Young: 0.831** **Elderly: 0.832**				
HED	0.394	**0.847**			
	-0.309	**0.874**			
	0.357	**0.793**			
BEAU	0.237	0.784	**0.990**		
	-0.033	0.534	**0.985**		
	0.283	0.711	**0.980**		
GOOD	0.335	0.703	0.726	**0.988**	
	0.126	0.517	0.492	**0.979**	
	0.273	0.696	0.634	**0.980**	
SAT	0.407	0.747	0.641	0.618	**0.832**
	0.244	0.488	0.468	0.639	**0.846**
	0.329	0.513	0.435	0.485	**0.817**

Table 4. Discriminant Validity

5.2 Structural Model Results

We tested our research model separately or each age group (children, young adults, and elderly), using structural equation modelling (SEM) techniques with LISREL 8.80. The results shown in Table 5 indicated that the indices of the structural model fit for our model were well above acceptable thresholds (CFI > 0.90, NNFI > 0.90, RMSEA < 0.80) for all three groups. We present a more detailed discussion of model test results in the subsequent sections.

Age Group	N	CFI	NNFI	RMSEA
Children	221	0.981	0.973	0.075
Young Adults	220	0.976	0.966	0.073
Elderly	201	0.989	0.985	0.049

Table 5. Structural Model: Goodness-of-Fit

5.2.1 Structural Model Test: Young Adults

Results on structural model testing for the Young Adults group are shown in Figure 2 below. All path coefficients of the causal links were significant, most of them at $p<0.001$, with only one path at $p<0.01$ (the path from beauty to satisfaction), which implies that the basic UX model faithfully explain the causal relationships among the five UX variables for young adults.

5.2.2 Structural Model Test: Children

Results on structural model testing for the children group are shown in Figure 3 below. The path from pragmatic attribute to goodness was insignificant contrary to what was expected. This implies that

usability does not matter much for children when they evaluate the goodness of their mobile phone. All other path coefficients were significant.

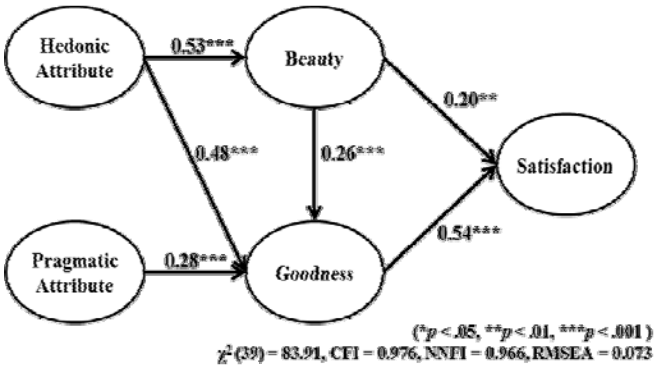

Figure 2. UX Model Results: Young Adults

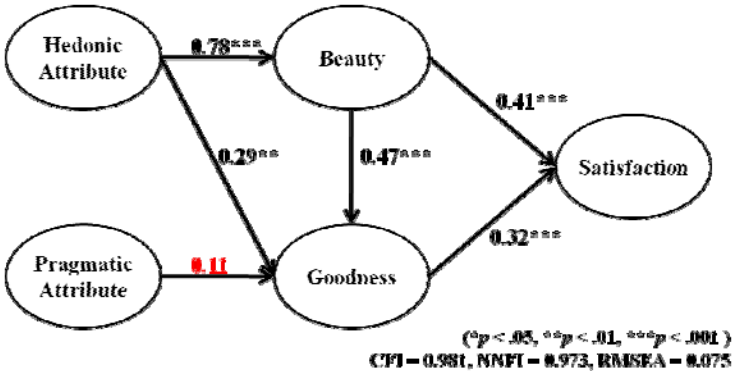

Figure 3. UX Model Results: Children

5.2.3 Structural Model Test: Older Adults

Results of testing the structural UX model for the elderly group are shown in Figure 4 below. Similar to the children group, the path from pragmatic attribute to goodness was insignificant. This implies that usability did not play a substantial role for older adults' evaluations of their mobile phones' goodness, which is quite contrary to common belief that elderly people are the most sensitive to usability.

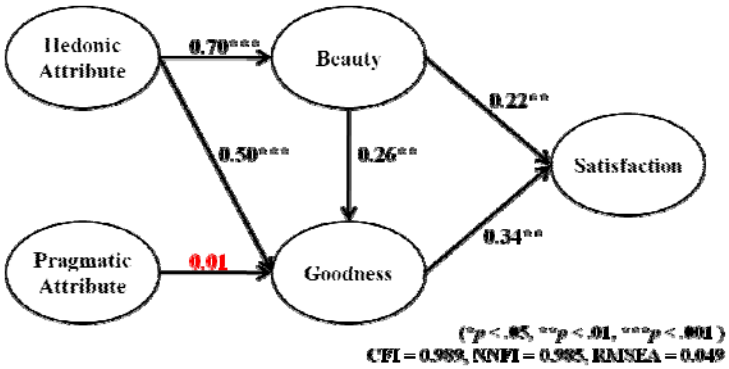

Figure 4. UX Model Results: Older Adults

In summary, children, young adults and the elderly exhibit differences in the important antecedents of UX quality and satisfaction. The results of the separate sample analysis for the respective age groups demonstrate that the model is valid for young adults. However, for children and the elderly the path from pragmatic quality to goodness was insignificant in the basic UX model. We next conducted a multi-group analysis to assess whether the differences in the relationships for the different age groups were significant.

5.3 Multi-Group Comparison of the UX Model (Test of Null Hypotheses of No Difference)

We conducted a multi-group analysis to examine whether there are statistically significant differences in the strength of the relationships between the UX model constructs for the various groups. We thus were able to conduct a pairwise comparison (children vs. young adults, young adults vs. elderly, and children vs. elderly) of the unstandardized path coefficients of the structural UX model for each age group.

The results indicate that there is no significant difference in the relationship between goodness and satisfaction across age. As shown in Table 6 however, there are significant differences in the strength of the relationship between other constructs. Hedonic quality had a statistically significant weaker effect on beauty for young adults (0.49***) compared to children (0.89***) and the elderly (0.88***). This implies that young adults are less influenced by hedonic quality than children and the elderly when forming perceptions of beauty. The elderly (0.59***) were also significantly more likely to be influenced by hedonic quality when forming evaluations of the goodness of mobile phones than children (0.30**). Perceived hedonic attributes were thus more important for older adults' evaluations of product goodness. Second, as we saw in our independent sample analyses of the basic UX structural model there were significant differences in the strength of the relationship between pragmatic quality and evaluation of the goodness of mobile phones. In the independent sample analysis there was a significant positive impact of pragmatic quality on goodness for only young adults (0.28***), with the relationship being insignificant for both children and the elderly. Multi-group analysis for pairwise group comparisons revealed that there was this difference was significant only between young adults and the elderly. In short, the elderly are more sensitive to and place more importance on pragmatic quality in evaluating mobile phone goodness compared to young adults.

Path	Significant difference (unstandardized path coefficient)	No Difference
HED → BEAU	**Young adults (0.53***) < Elderly (0.88***) Children (0.89***)**	
HED → GOOD	**Children (0.30**) < Elderly (0.59**)**	Young adults (0.48***)
PRA → GOOD	**Elderly people (0.02) < Young adults (0.28***)**	Children (0.20)
BEAU → GOOD	**Young adults (0.26***) < Children (0.43***)**	Elderly people (0.27**)
BEAU → SAT	**Young adults (0.20**) < Children (0.42***)**	Elderly people (0.22**)
GOOD → SAT		Children (0.35***); Elderly people (0.37**); Young adults (0.54***)

Table 6. Multi-Group Analysis: Comparison of Path Coefficients (Children, Young adults, Elderly)

Finally, there was a significant difference between children and young adults with respect to the impact of beauty on both goodness (children 0.43*** vs. young adults 0.22***) and satisfaction (children 0.42*** vs. young adults 0.18**). For children, compared to young adults, beauty was a consistently strong and important predictor of evaluations of mobile technology goodness and satisfaction with the technology. In summary, we statistically tested for and found significant

differences in the 5 paths across the different age groups. Overall, the role of hedonic quality on product evaluation was most important for the elderly; young adults were most influenced by pragmatic quality, and children placed the most importance on beauty in evaluating satisfaction. In short, we rejected the null hypotheses of no difference in the path coefficients across the three age groups for hypotheses 1 through 5, but not for hypothesis 6.

6 CONCLUSION AND DISCUSSION

In this study we empirically tested a model of mobile phone user experience for children, young adults and the elderly, in order to examine whether there were significnat differences in the important determinants of UX quality and satisfaction. We found that there were important differences in UX evaluation depending on age. First, for children and the elderly, pragmatic product attributes had no significant impact on product goodness evaluations. On the other hand, hedonic quality was a more important determinant of goodness, with the path being significantly greater than for young adults. This is counter to prior research results that stress that functional usability is especially critical for the design of products for users such as the elderly and children who are less cognitively skilled. This seemingly contradictory finding may be due to the following reasons. First, young adults may be more sensitive to usability and practical functionality of mobile phones. Young adults with more extensive technology experience are better equipped to evaluate functional quality of mobile phones in intricate detail. Children and the elderly on the other hand may have fewer expectations regarding the utilitarian functionality of mobile phones, and hence be more influenced by the aesthetic and fun factors of these technologies. Second, children and the elderly may only make use of simpler functions. For example, for young adults who make active use of the diverse features such as schedulers, memos, traffic information, and information search, usability of the phone to ensure ease of use may be critical. However, for children and the elderly who make use of a limited range of features, such usability issues may not be as important. Finally, because mobile phones are mostly equipped with features that cater to the younger adult group, children and the elderly may be less satisfied from a functional usability perspective.

More specifically, there were important group differences in the impact of hedonic quality, pragmatic quality and beauty on evaluations of product goodness. The effects of hedonic quality, pragmatic quality and beauty on evaluations of goodness was strongest for the elderly (0.59**), young adults (0.28***), and children (0.43***) respectively. It is interesting that there are such differences in the relative importance of factors determining mobile UX quality and hence satisfaction. We discussed the possible reasons for the relative importance of pragmatic quality for younger adults above. One reason hedonic quality is relatively more important for the elderly may be that as people age their motivation and need to preserve a positive self-image may become stronger. Hence, they may prefer mobile phones that satisfy their need to preserve a positive and unique self-identity and enabling them to express themselves, rather than those that provide extra utilitarian functions. In short, the mere possession of the latest generation of mobile phones may result in more positive UX due to the hedonic expressive satisfaction they confer. Children on the other hand placed greater importance on beauty in evaluating their mobile UX and satisfaction. Children typically engaged in various methods of decorating and improving the exterior of their mobile phones through stickers and cases for example. In short, they had a strong need to express their identity through their mobile phones.

Our study has several limitations. First, we did not formulate specific hypotheses regarding the specific differences between the different age groups. This is because there is a lack of prior empirical research and theories that would enable us to make such theory-driven hypotheses. Our paper took a first step in establishing the presence of age differences in UX determinants. Future research should take a step further in formulating specific age-related hypotheses and empirically testing these with different technologies. Second, our research focused on mobile phone UX. While mobile phones are used by people of all ages and gender, they may be particularly liable to age-related differences in the determinants of UX quality. Hence, we cannot reliably conclude that the observed differences in

mobile UX determinants will hold for the UX of other interactive systems. This may be further compounded by the fact that different age groups may use different generations of mobile phone technologies that result in differences in the important factors for user experience. Future research should examine the generational differences of UX determinants for a more diverse range of interactive systems and technologies. Fourth, we sampled our subjects of all 3 age groups from various educational institutions – elementary schools, colleges and continuing education institutes. The nature of this sample may limit the generalizability of our findings. Future research should attempt to extend the research to examine subjects in a wider range of age groups and more diverse occupations. Finally, we did not control for other factors that may potentially result in differences in perceived UX, that may be related to age – such as, physical characteristics and technology experience. Future research may build on prior research (e.g., Arhippainen & Tähti 2003) that control for these factors in addition to age to examine the impact of age on determinants of UX.

In spite of these limitations, our research has important theoretical implications. First, our study is the first to empirically examine the impact of age on important determinants of UX quality. Prior research examined differences between the elderly and young adults in usability issues, but our study represents a more systematic test of the different mechanisms through which users of different ages assess UX quality and satisfaction. Second, post-hoc analyses revealed that the basic UX model that has been the basis of much prior UX research demonstrated a good fit with the empirically-determined best-fitting model for younger adults, but not for children and the elderly.[3] These results indicate that there may be inherent biases towards young adults in the existing UX research.

Practically, our research results indicate that designers of technologies should take note of the age of the target user group deciding the important UX antecedents they will focus on. While young adults of mobile phones place equal importance on both pragmatic and hedonic qualities, children and the elderly focus on hedonic qualities. In conclusion, we found that age really matters in user experience for mobile phones. Elderly and children's user experience is quite different from young adults for whom the vast majority of past research has been conducted. This study indicates that customized UX models that best fit the characteristics of elderly and children are needed to provide better quality experience to the elderly and children, who are becoming more important users of information technology in the future.

Appendix

The survey consisted of 8 pairs of polar adjective items that described users' experiences with their mobile phones, to fill in the statement "My mobile phone is (_____)." Users were asked to indicate on a 7-point semantic differential scale which of the paired adjectives best described their user experience. Item pairs were: 1) complicated – simple; 2) confusing – clear; 3) unruly – manageable; 4) lame – exciting; 5) standard – creative; 6) typical – original; 7) bad – good; 8) ugly – beautiful. The scales were anchored on a 7 point scale as "extremely (1) – neutral (4) – extremely (7)".

Three additional items measured general user satisfaction with their mobile phone on a 7 point Likert scale. The items were as follows: 1) "All things considered, I am satisfied with my current mobile phone", 2) "If I could do it again, I'd buy my current mobile phone", 3) "My choie to purchase my current mobile phone was a wise one."

[3] We were not able to report these post hoc analysis results due to space limitations. These are available upon request.

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