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Abstract

An experiment, using two versions of a Web site varying in usability, tested three models of user experience: an interaction experience model, a technology acceptance model and an integrated experience-acceptance model. We found that the perceptions of three product attributes (*Pragmatic Quality*, *Hedonic Quality-stimulation* and *Hedonic Quality-identification*) and technology acceptance variables (the beliefs of *Perceived Ease of Use*, *Perceived Enjoyment* and *Perceived Usefulness*, and *Intention to Use*) are separate underlying psychological dimensions. A positive effect of usability on task performance, interaction experience and acceptance was found. In the interaction experience model, the evaluation of *Goodness* (overall interaction quality) was less stable and influenced by both *Pragmatic Quality* and *Hedonic Quality*, but the evaluation of *Beauty* was more stable and only influenced by *Hedonic Quality*. In the technology acceptance model, *Perceived Ease of Use* was a determinant of *Perceived Enjoyment* and *Perceived Usefulness*, and the latter two were independent determinants of *Intention to Use*. In the integrated model, perceptions of product attributes were independent determinants of beliefs, but evaluations were not independent determinants of *Intention to Use*. Future modelling work should address a range of interactive systems, information architecture and individual differences.

Keywords: user experience; modelling; Web site; usability; technology acceptance

1. Introduction

A major area of HCI research focuses on how a positive ‘user experience’ (Hassenzahl & Tractinsky, 2006) of interactive systems can be promoted. Conceptually, the preferred term ‘interaction experience’ (more) accurately describes what is studied: users’ experience does not only include usability, but also other cognitive, socio-cognitive and affective influences on users’ interaction with artefacts, such as aesthetic experience. Research in this area is timely because we have entered the *loyalty decade* as proposed by Nielsen (2008). In the *conversion decade* (2000-2010) the emphasis has been on ensuring that visitors to a Web site become customers, with usability as the main factor in improving the success of Web sites. Nielsen argues that in the *loyalty decade* (2010-2020) the emphasis will be on ensuring that customers return to conduct repeat business, with interaction experience as the main success factor. Therefore, the success of interactive systems will to a large extent be positively influenced by the way in which they promote a high-quality experience for their users, in other words good usability alone will not be sufficient for success. However, good interaction experience may not be sufficient either, given that conducting repeat business on a particular Web site presumes customers’ acceptance of the site. Indeed, research has found that technology acceptance variables (e.g. *Perceived Usefulness*) are antecedents of online loyalty (e.g. Cyr, Head & Ivanov, 2006; Cyr, Hassanein, Head & Ivanov, 2007) and aesthetic design is an antecedent of *Perceived Usefulness* (Schultz, n.d.). These considerations justify the need for an integrated approach to the study of interaction experience and technology acceptance. The current study focuses on modelling as understood in the structural-equation-modelling literature. This involves a measurement model of the constructs that are investigated and a structural model that represents the structural relations between the constructs.

However important a high-quality interaction experience may seem, it is not yet clear to what extent aesthetic experience – as one aspect of interaction experience – will lead to a successful product in the sense that potential users will be willing to employ it. Some work exists that has conceptualised and modelled aesthetics to some degree of sophistication using different frameworks (e.g., Hassenzahl, 2003, 2004; Lavie & Tracktinsky, 2004; Norman, 2004), but this work does not address the acceptance of the artefacts the aesthetics of which are studied. Other work has studied the role of aesthetics in technology acceptance, but there has been a lack of differentiation in the modelling of aesthetics. However, two studies (van der

Heijden, 2003; Cyr et al., 2006) have independently found that perceived aesthetics are antecedents of acceptance constructs (*Perceived Usefulness*, *Perceived Ease of Use* and *Perceived Enjoyment*). Furthermore, there is a lack of research manipulating interface design characteristics and task characteristics, and observing their effects on interaction experience and acceptance, as a basis for demonstrating causal effects. The current study therefore investigates interaction experience in relation to technology acceptance, while manipulating interface design and task. The theoretical significance of this work is that it will contribute towards a better understanding of (a) how interface design characteristics and task characteristics influence users' perceptions of the essence of an artefact in terms of its attributes related to interaction experience and how these perceptions influence users' value judgement of this experience and (b) how – conceptualised with more differentiation – hedonic and aesthetic aspects of interaction experience influence technology acceptance. The practical significance of this work is that it has the potential to contribute to better design guidance for interactive systems such as Web sites. The determinants of interaction experience and technology acceptance or the relationship between them have not been explored to the extent that is proposed here.

2. Background

There are two approaches to the identification of higher-level concepts in web-site design as a basis for enhancing interaction experience (Tractinsky, Cokhavi, Kirschenbaum & Sharfi, 2006). First, in a screen-design-based approach (e.g., Kim, Lee & Choi, 2003; Ngo, 2001; Park, Choi & Kim, 2004), design factors are identified in the objects and in their organization on a web page that influence interaction experience. This approach has led to the design of guidelines for usability (e.g., Galitz, 1997), although doubts have been raised about its usefulness for designing aesthetics (Tractinsky, 2004). The reason is that this design will have to address a very large number of combinations of design options combined with a wide range of individual differences in users' aesthetic preferences. Second, in an information-processing approach, users' processing of the attributes of artefacts (Hassenzahl, 2004), including web pages (e.g., Lavie and Tractinsky, 2004), is studied at different levels of cognition (Norman, 2004). A theoretical model will facilitate the building of a cumulative body of knowledge, when addressing the question of how judgements of the overall quality of an interactive product are formed (Hassenzahl, 2004). At present, in the current early stage of research in this area, Hassenzahl's (2003, 2004) model of interaction experience provides a starting point, using an information-processing approach.

According to Hassenzahl's (2003, 2004) model of interaction experience (see Figure 1 [a]), users construct product attributes by combining a product's features with personal expectations or standards. Product attributes, such as content, presentation, functionality and interaction style, affect users' perceptions of product attributes. There are two main types of product attribute that users perceive: *Pragmatic Quality*[i] (user-perceived usability) and *Hedonic Quality* (pleasure-producing product qualities). Two types of *Hedonic Quality* are *stimulation*[ii] (personal) and *identification* (social). According to Hassenzahl, an artefact can be stimulating by offering novelty and challenge, and can lead to identification by communicating important personal values to relevant others. An artefact's character is "a bundle of attributes …" which "can be understood as a cognitive structure that integrates product attributes and their co-variation" (Hassenzahl, 2004, p. 322). In Hassenzahl's (2004, p. 322) view, "using a product with a particular … character in a particular situation will lead to consequences, such as emotions (e.g., satisfaction, pleasure), explicit evaluations (i.e., judgements of appeal, *Beauty*, *Goodness*), or overt behaviour (i.e., approach, avoidance)". Perceptions have a positive effect on evaluations, in particular judgements of *Beauty* and *Goodness*, which are considered as high-level constructs ('verdictive', in the sense of "expression an authoritative judgement", p. 323) and which are distinct from their low-level determinants (perceptions which are 'substantive', in the sense of "relating to the essence or substance", p. 323). In Hassenzahl's framework, *Goodness* is a user's evaluation of the overall product quality and *Beauty* is a user's evaluation (value judgement) about an (aesthetic) experience or particular element (e.g. a Web page) of that experience. Perceptions are distinct from evaluations because a positive perception of pragmatic or hedonic product attributes can lead to a positive evaluation, though this is not automatic. Whereas *Hedonic Quality* is relatively stable over time, *Pragmatic Quality* is changed through experience of using a system. Therefore, because *Beauty* is only influenced by *Hedonic Quality* it is also relatively stable, but *Goodness* is less stable as it is influenced by both *Pragmatic Quality* and *Hedonic Quality*. A recent empirical study (van Schaik & Ling, 2008) tested and confirmed Hassenzahl's model in the context of the use of Web sites. Based on Hassenzahl's framework the following hypotheses are presented.

__________ Insert Figure 1 about here. __________

Hypothesis 1: the usability of Web site design is a determinant of *Pragmatic Quality*.

Hypothesis 2: *Pragmatic Quality* is a determinant of *Goodness*.

Hypothesis 3: *Pragmatic Quality* is not a determinant of *Beauty*.

Hypothesis 4: *Hedonic Quality* (identification and stimulation) is a determinant of *Goodness*.

Hypothesis 5: *Hedonic Quality* (identification and stimulation) is a determinant of *Beauty*.

Hypothesis 6: *Beauty* before Web site use is a determinant of *Beauty* after use, after controlling for *Hedonic Quality* (identification and stimulation) after use.

Hypothesis 7: *Goodness* before Web site use is not a determinant of *Goodness* after use, after controlling for *Pragmatic Quality* and *Hedonic Quality* (identification and stimulation) after use.

Although Hassenzahl's model provides a sophisticated account of interaction experience it does not address potential users' acceptance of artefacts. One dominant line of research for more than twenty years since Davis's (e.g. Davis, 1989) ground-breaking initial work has produced the Technology Acceptance Model (TAM). This work has challenged and complemented usability research. The reason is that even if a product is highly usable its potential benefits in terms of effective and efficient task performance will not be realised if potential users are not willing to employ it. In models of technology acceptance (see Figure 1 [b]), system (design) characteristics – including the usability of system design – influence *Perceived Ease of Use* (the extent to which using a system will be free of effort). *Perceived Ease of Use* has a positive effect on *Perceived Usefulness* (the extent to which using a system will enhance a user's job performance), as less effort involved in using a system will contribute to enhancing job performance. Because an interactive system that is easier to use also removes barriers and facilitates access to its functionality, usability also has a positive effect on *Perceived Usefulness*. Both *Perceived Ease of Use* and *Perceived Usefulness* have a positive effect on *Intention to Use* a system, but the influence of *Perceived Ease of Use* can be considerably weakened after controlling for *Perceived Usefulness* (Davis, 1993) or hypothesised to be mediated by *Perceived Usefulness* (Cyr et al., 2006, 2007). *Intention to Use*, in turn, has a positive effect on (the rate of) *System use*. Consistent with the origins of TAM in the Theory of Planned Behaviour (Ajzen, 1988), *Attitude towards system use* (the evaluation of the act of using a system as positive or negative) would be modelled as a mediator of the effects of *Perceived Ease of Use* and *Perceived Usefulness* on *Intention to Use*, but –

although *Attitude* is still being used in many research studies – recent research has concluded that this mediator is superfluous and has therefore been removed from the model (Venkatesh, Morris, Davis & Davis, 2003). As the following hypotheses are proposed in TAM (e.g. Davis & Venkatesh, 1996) and have been confirmed repeatedly, there are presented without further discussion.

Hypothesis 8: Usability is a determinant of *Perceived Ease of Use*.

Hypothesis 9: Usability is a determinant of *Perceived Usefulness*.

Hypothesis 10: *Perceived Ease of Use* is a determinant of *Perceived Usefulness*.

Hypothesis 11: *Perceived Ease of Use* is a determinant of *Intention to Use*.

Hypothesis 12: *Perceived Usefulness* is a determinant of *Intention to Use*.

Recently, the role of *Perceived Enjoyment* within models of technology acceptance has been investigated. *Perceived Enjoyment* is conceptualised as the degree to which the use of an interactive system will be enjoyable in its own right, irrespective of any external (performance) rewards (Sun & Zhang, 2006a), and, in this sense, is identical to the concept of intrinsic motivation as used in TAM research (Davis, Bagozzi & Warshaw, 1992). According to van der Heijden (2003, 2004) and Cyr et al. (2006, 2007), just as *Perceived Ease of Use* is an antecedent of *Perceived Usefulness*, *Perceived Ease of Use* is an antecedent of *Perceived Enjoyment*. The reason is that, just as an interactive system that is easier to use removes barriers and facilitates access to its functionality, so an easier-to-use system removes barriers to and facilitates access to its inherent qualities that make it enjoyable. In addition, *Perceived Enjoyment* has been proposed and confirmed to be a determinant of *Intention to Use* (Cyr et al., 2006, 2007) and actual system use (Igbaria, Schiffman & Wieckowski, 1994). This is because when users experience pleasure or enjoyment from using an interactive system they are more likely to form intentions to use than would otherwise be the case (e.g. Davis et al., 1992). Therefore, the following hypotheses are presented, previously confirmed by van der Heijden (2003, 2004) and Cyr et al. (2006, 2007).

Hypothesis 13: *Perceived Ease of Use* is a determinant of *Perceived Enjoyment*.

Hypothesis 14: *Perceived Enjoyment* is a determinant of *Intention to Use*.

The current study integrates Hassenzahl's model of interaction experience into TAM. The motivation for this exploration is (a) to produce a more complete model and (b) to clarify the role of interaction experience in technology acceptance. Because of a difference in the phenomena that they model, the two models address different aspects of human-computer interaction. As originally conceived, TAM – originating from research in management information systems – had a utilitarian focus with the (implicit) aim of enhancing users' productivity, a focus shared with usability research. In contrast, Hassenzahl's model of interaction experience focuses on constructs beyond usefulness and usability, that is, *Hedonic Quality* and aesthetics. Both models have received empirical support in previous research, but the role of interaction experience in technology acceptance has not been investigated theoretically and empirically to the extent proposed here. Our goal is to create an integrated a model that better predicts the endogenous variables than the existing separate models do.

In relation to the perception of aesthetics, Hassenzahl (Hassenzahl, 2003; Hassenzahl & Ullrich, 2007) has introduced the concept of *mode of use* to describe the mental state of a user in relation to a product or system. According to Hassenzahl (2003, p. 39-40),

> Usage always consists of behavioural goals and actions to fulfil these goals. In goal mode goal fulfilment is in the fore. The current goal has a certain importance and determines all actions. The product is therefore just 'a means to an end'. ... In action mode the action is in the fore. The current action determines goals 'on the fly'; the goals are 'volatile'. Using the product can be an 'end in itself'. Effectiveness and efficiency do not play an important role. Individuals describe themselves as 'playful' and 'spontaneous'.

The particular mode of use is triggered by the situation in which the product is used and users' perceptions of the system are expected to depend on the mode in which they approach the system. Perceptions may be influenced by their judgement of the extent to which the system will support their goals or actions and are more consistent when perceptions are formed in a particular mode of use (van Schaik & Ling, 2009). Because in action mode users' interaction is playful and spontaneous, *Perceived Enjoyment* is supported. Therefore, the following hypothesis is presented, previously confirmed by van Schaik (2009).

Hypothesis 15: in action mode, *Perceived Enjoyment* is higher than in goal mode.

Psychological research on positive experience has identified hedonic (pleasure-producing) experience as a determinant of intrinsic motivation (Waterman, Schwartz & Conti, 2008), while in the context of human-computer interaction the latter has been equated to *Perceived Enjoyment* (Davis et al., 1992) and *Perceived Ease of Use* (Davis, Bagozzi & Warshaw, 1989). Furthermore, hedonic experience has been theoretically proposed and empirically verified to be a predictor of *Perceived Enjoyment* and *Perceived Usefulness* (Childers, Carr, Peck & Carson, 2001). In the context of interaction experience, *Hedonic Quality* is a user's perception of the extent to which specific hedonic attributes are true of a particular interactive system without any reference to that user's actual use or possible use, whereas *Perceived Enjoyment*, *Perceived Ease of Use* and *Perceived Usefulness* are a user's beliefs of the extent to which specific consequences (in terms of enjoyment, reducing the effort involved and enhancing task performance, respectively) will follow from the user's use of an interactive system. In addition, it is important to note that, according to models such as TAM (e.g. Davis, 1993), system characteristics (e.g. usability) are determinants of beliefs about the consequences of system use (e.g. Perceived Ease of Use). However, it is people's perceptions of system characteristics that determine outcomes (e.g. beliefs) when these outcomes are subjective (Guo & Poole, 2009). Therefore, it is people's perceptions of *Hedonic Quality* that have a direct effect on the beliefs of *Perceived Enjoyment*, *Perceived Ease of Use* and *Perceived Usefulness*. Thus,

Hypothesis 16: *Hedonic Quality* (identification and stimulation) is a determinant of *Perceived Usefulness*.

Hypothesis 17: *Hedonic Quality* (identification and stimulation) is a determinant of *Perceived Ease of Use*.

Hypothesis 18: *Hedonic Quality* (identification and stimulation) is a determinant of *Perceived Enjoyment*.

One major difference between Hassenzahl's model and TAM is that Hassenzahl studies people's perceptions (*Pragmatic Quality* and *Hedonic Quality*) and evaluations (*Goodness* and *Beauty*) of an interactive system (object), whereas TAM studies people's beliefs (*Perceived Ease of Use*, *Perceived Usefulness* and *Perceived Enjoyment*) and intentions regarding their own behaviour (action) in relation to an interactive system (object). The link between the experience model and TAM can be understood by examining the origin of TAM in psychological models of rational behaviour, in particular the Theory of Planned Behaviour (Ajzen, 1988, 1991) and the Theory of Reasoned Action (Ajzen & Fishbein, 1980). In models of rational behaviour, two types of evaluation are distinguished: evaluations of objects (e.g. an interactive computer system) and evaluations of actions (e.g. using an interactive computer system). According to the *principle of compatibility*, "each attitude or behaviour has the four elements of action, target, context and time, and [...] correspondence between attitudes and behaviour will be greatest when both are measured at the same degree of specificity with respect to each element. Hence, a behaviour consists of (a) an action, (b) performed towards a target or object, (c) in a particular context, (d) at a specified time or occasion" (Conner & Sparks, 2005, p. 170). Evaluations are the antecedents of intentions to act (in the Theory of Planned Behaviour) or of actual behaviour (in the Theory of Reasoned Action). Based on the *principle of compatibility*, evaluations of actions performed on objects are more closely linked to and better predictors of outcomes than evaluations of objects; however, evaluations of objects should not be discarded when studying evaluations of actions and may affect behaviour(al intentions) independently of evaluations of actions (Conner & Sparks, 2005) and may therefore have additional effects on acceptance outcomes. Therefore, in a model of technology acceptance, the evaluation of an object can influence *Intention to Use*, independent of beliefs such as *Perceived Usefulness*. Theoretically, evaluations of objects (*Goodness* and *Beauty*) are therefore antecedents of *Intention to Use*; however, there is a lack of research investigating the role of evaluations of objects in technology acceptance. Therefore and consistent with the theories of rational behaviour,

Hypothesis 19: *Goodness* is a determinant of *Intention to Use*.

Hypothesis 20: *Beauty* is a determinant of *Intention to Use*.

Although *Pragmatic Quality* and *Perceived Ease of Use* both represent subjective usability they are different. *Pragmatic Quality* is a user's perception of the extent to which specific attributes are true of a particular interactive system (object) without any reference to the particular user's actual use or possible use, whereas *Perceived Ease of Use* is a particular user's belief of the extent to which specific consequences will follow from the particular user's use (action) of an interactive system (object). On the one hand, a user's perception of an object (here, *Pragmatic Quality*) is the user's internal representation of the attributes of the object. On the other hand, a user's belief of an action towards an object (here, *Perceived Ease of Use*) is the user's internal representation of the consequences of that user's action of using the object. This difference is also reflected in the items measuring these two different constructs. Therefore, in the light of the *principle of compatibility*, the construct *Pragmatic Quality* is less specific than *Perceived Ease of Use* because it is an internal representation of object attributes and it does not refer to any action of using the object – by the respondent, others or people in general. However, *Perceived Ease of Use* includes both the object that is used and the action of using by the respondent, and is therefore more specific and it is an internal representation of the consequences of object use. Thus,

Hypothesis 21: *Pragmatic Quality* is a determinant of *Perceived Ease of Use*.

Based on our review of influential models of interaction experience and technology acceptance, we conducted an experiment, in which participants used different versions of a Web site (an online encyclopaedia), addressing the following aims: (1) to test the measurement model underlying the study; (2) as a manipulation check, to test the effect of usability on objective and subjective outcome measures; (3) to test the hypotheses related to our Interaction Experience Model, based on Hypotheses 1-7; (4) to test the hypotheses related to a Technology Acceptance Model, based on Hypotheses 8-15; and (5) to test the hypotheses related to our integrated Experience-Acceptance Model, based on Hypotheses 1-21.

3. Method

3.1. Design

The experiment used a 2×2 independent measures experimental design with two factors: the usability of Web site design (more usable or less usable) and mode of use (goal mode or action mode). The first independent variable was included to manipulate the usability of the Web site, and to test its hypothesised effect on *Pragmatic Quality*, *Perceived Ease of Use* and *Perceived Usefulness*. This was achieved by using a more readable sans serif font (see Figure 3a) and standard presentation of the mouse cursor or by using a less readable font (see Figure 3b) and non-standard presentation of the mouse cursor. These manipulations were chosen because they had been successful in previous research (van Schaik & Ling, 2008) in terms of having a statistically significant effect on objectively and subjectively measured usability. The second independent variable was used to test the hypothesized effect of mode of use on *Perceived Enjoyment*. In the experiment, goal mode corresponded with an information retrieval task and action mode with an exploration task (see Section 3.4). Outcome measures included perceptions of attributes and evaluations of web pages, measures of acceptance, and – for the conditions using goal mode – task performance measures (percentage of correct answers and number of tasks completed).

__________ Insert Figure 3 about here. __________

3.2. Participants

There were 128 undergraduate psychology students (100 females and 28 males), with a mean age of 22.79 years (SD = 6.80). They took part as a course requirement. All had used the Web and 50% and had used the Web site *Wikipedia* before taking part in the experiment. Mean years of experience using the Web was 4.72 (SD = 3.69), mean time per week spent using the Web was 21.41 hours (SD = 12.15) and mean frequency per week of using the Web was 10.33 times (SD = 7.06).

3.3. Materials and equipment

The interactive system that was used in the experiment was the online encyclopaedia *Wikipedia* (*http://en.wikipedia.org/*). The same site was presented in two versions: more usable - using Arial as font (Figure 3 [a]) with arrow-shaped cursor - and less usable - using Lucida Calligraphy (Figure 3 [b]) with hand-shaped cursor. The experiment ran on personal computers (Intel Pentium, 2.8 GHz, 512 Mb RAM, Microsoft Windows XP operation system) with 17-inch monitors and a screen resolution of 1024×768 pixels. Contrast and brightness were set to optimal levels.

Participants gave responses to two psychometric instruments: an interaction experience inventory used by Hassenzahl (2004) and a technology acceptance inventory. The interaction experience inventory (a subset of 11 items of Hassenzahl's instrument) used a 7-point semantic-differential response format and the technology acceptance inventory (14 items) used 7-point Likert scales (see Appendix). The interaction experience inventory measured perceptions of three product attributes (*Pragmatic Quality*, *Hedonic Quality-identification* and *Hedonic Quality-stimulation* - three items each; these were the three best items for each of attribute identified by van Schaik & Ling [2008]) and two items to measure product evaluations (*Beauty* and *Goodness* - one item each). The technology-acceptance inventory measured the following acceptance factors for the Web site that participants used: *Perceived Usefulness* (four items), *Perceived Ease of Use* (four items), *Intention to Use* (three items) and *Perceived Enjoyment* (three items). The items originated from Venkatesh *et al*. (2003), except Venkatesh and Speier's (2000) *Perceived-enjoyment* items.

3.4. Procedure

The experiment consisted of four stages: (1) a viewing task (of typical *Wikipedia* pages), followed by (2) the interaction experience inventory, (3) a task using the site (either - in goal mode - finding answers to a series of specific information retrieval questions or - in action mode - exploring the site) and (4) a second longer questionnaire. The experiment was run in a computer lab with groups of 15 to 20 participants who worked independently. The manipulation of usability was introduced in Stage 1 and continued in Stage 3. The manipulation of mode of use was introduced in Stage 3 because this required that participants actually used the Web site and Stage 3 was the only time that required actual use of the site. Therefore, when completing the interaction experience inventory in Stage 2, participants had been exposed to one of the two levels of usability, but when completing the larger questionnaire in Stage 4 they had been exposed to one of two levels of usability and one of two levels of mode of use. In Stage 3, in the information retrieval task (in goal mode), typical tasks were included that users perform with encyclopaedic Web sites. Three practice questions were followed by the main information retrieval task. Examples of questions included 'What is the main component of the gemstone lapis lazuli?' and 'Who was the governor of Sicily at the time of Cicero?'. Participants completed tasks for 20 minutes and there were sufficient tasks to ensure that no participant could finish all questions within this time. Once participants had read the question, they had to click on a button labelled 'Show Web site'. The home page of the Internet site then appeared on the screen and, using the site, they had to find the answer to the question. Participants were told to take the most direct route possible to locate the answer. Having found this, they clicked on a button labelled 'Your answer', which opened a dialog box at the bottom of the screen. Participants typed their answers into the box and then clicked on a button labelled 'OK'. The next question then followed. In the exploration task (in action mode), participants were free to use the Web site to explore their own interests for 20 minutes. In Stage 4, in addition to the interaction experience inventory, the final questionnaire included the acceptance inventory, demographic questions. The experiment took approximately 45 minutes to complete.

3.5 Data analysis

Partial-least-squares path modelling (PLS for short; Esposito Vinzi, Chin, Henseler, & Wang, 2010) was used for data analysis for the following reasons. PLS allows the analysis of both single-stage and multi-stage integrated[iii] models with latent variables, allowing the integrated analysis of a measurement model and a structural model. Each latent variable (usually a psychological construct) is measured using one or more manifest variables (usually psychometric items). In contrast to covariance-based structural equation modelling techniques, PLS explicitly supports both reflective measurement and formative measurement. This feature of PLS makes its use in experimental research that uses psychometric outcome measures (such as the current study) advantageous, as it allows both the appropriate modelling of psychometric measurement (using reflective indicators) and the appropriate modelling of the effect of experimental manipulations (using formative indicators). PLS does not demand some of the strict restrictions imposed by covariance-based structural equation modelling - including those of large sample size, and univariate and multivariate normality. PLS is compatible with multiple regression analysis, analysis of variance and unrelated t tests, the results of which are special cases of those of PLS. For an integrated and consistent approach, all analyses were conducted using PLS with the SmartPLS software (Ringle, Wende & Will, 2005) unless stated otherwise. In PLS analyses, a bootstrapping procedure (N = 5000, as Henseler, Ringle & Sinkovics, 2009, recommend) was used to test the significance of model parameters. The results are based on the data from all participants (N = 128) unless stated otherwise.

4. Results and discussion

4.1. Analysis of measurement model

Aim 1. In exploratory factor analysis (not using PLS), a seven-factor solution was found for post-use scores of interaction experience items and technology-acceptance items (using data from Stage 4), with the following factors: *Perceived Usefulness*, *Hedonic Quality-stimulation*, *Pragmatic Quality*, *Hedonic Quality-identification*, *Perceived Enjoyment*, *Intention to Use* and *Perceived Ease of Use* (see Table 1). The results of subsequently testing the measurement model (using PLS) presented here are those of the most complex combined measurement model and structural model[iv]. This is because this model includes all the psychometrically measured latent variables. Reliability was analysed (see Table 2), and convergent and discriminant validity was assessed (see Table 3). The reliability of each individual reflective item is assessed by its loading on the construct of which it is an indicator, which should be 0.7 or higher (Henseler et al., 2009). All the loadings exceeded this cut-off point. Using a bootstrapping procedure, the loadings of all items were found to be statistically significant ($p < 0.001$). At the construct level, reliability was analysed using the composite reliability co-efficient, which needs to be 0.7 or higher. All the co-efficients exceeded this cut-off point.

__________ Insert Tables 1, 2 and 3 about here. __________

Convergent validity (the extent of consistency among the items measuring a particular construct) was analysed using the average variance extracted (AVE) by a construct from its indicators, which should be 0.7 or higher (Henseler et al., 2009). All values exceeded this cut-off point. Discriminant validity (the extent to which a measure of a particular construct differs from measures of other constructs) was assessed by analysing the square root of the AVE by each construct from its indicators, which – according to the Fornell-Larcker criterion – should be greater than its correlation with the remaining constructs. All values met this condition.

The following task performance measures provided evidence for the criterion-related validity of the scales (their power to predict other outcomes) in terms of task performance. Sizeable correlations ($|r| \geq 0.32$) were found for task completion measured as number of tasks completed (with post-use *Pragmatic Quality* and *Goodness*, *Perceived Enjoyment*, *Perceived Usefulness* and *Perceived Ease of Use*, $0.33 < r < 0.40$), and correctness (with post-use PQ, *Goodness*, *Perceived Usefulness* and *Perceived Ease of Use*, $0.43 < r < 0.57$).

In sum, although the seven psychometric scales used in the experiment had been analysed separately (Venkatesh & Speier, 2000; Venkatesh et al., 2003; Hassenzahl, 2004; van Schaik & Ling, 2008), their psychometric properties had not been analysed together. Our results provide evidence for the reliability, the convergent, discriminant and criterion-related validity (in this section), and sensitivity (in Section 4.2.2) of our set of measures of perceptions and acceptance constructs.

4.2. The effect of usability and mode of use on outcomes

4.2.1. Manipulation check of usability

Aim 2. The effect of usability on task performance measures was tested using PLS path modelling.[v] The effect of usability on correctness (percentage of correctly completed tasks), $t = 3.31$, $p < 0.001$, $d = 0.58$ (mean [*SD*] = 66 [16] for high usability and mean [*SD*] = 55 [21] for low usability), and number of tasks completed, $t = 2.55$, $p < 0.05$, $d = 0.49$ (mean [*SD*] = 7.42 [3.05] for high usability and mean [*SD*] = 5.97 [2.90] for low usability), was significant. In conclusion, the effectiveness of the manipulation of usability of site design was confirmed.

4.2.2. The effects of usability and mode of use on post-use perceptions and evaluations, and acceptance

Aim 3. The effect of usability and mode of use and their interaction on post-use perceptions and evaluations, and acceptance was tested using PLS path modelling.[vi] There was a positive effect of usability, $t = 3.64$, $p < 0.001$, $d = 0.65$, and the effect of mode of use (with higher PQ in the exploration task), $t = 2.21$, $p < 0.05$, $d = 0.41$, on PQ was significant, but the interaction effect was not, $t < 1$ (see also Table 4). The positive effect of usability, $t = 2.51$, $p < 0.05$, $d = 0.48$, on HQI was significant, but the effect of mode of use, $t = 1.46$, $p > 0.05$, and the interaction effect, $t < 1$, were not (see also Table 4). The main effects of mode of use, $t = 1.21$, $p > 0.05$, and usability, and the interaction effect, both $t < 1$, on HQS were not significant (see also Table 4). The positive effect of usability, $t = 2.97$, $p < 0.01$, $d = 0.53$, and the effect of mode of use (with higher *Goodness* in the exploration task), $t = 2.41$, $p < 0.05$, $d = 0.45$, on *Goodness* were significant, but the interaction effect was not, $t = 1.39$, $p > .05$ (see also Table 4). The main effects of usability, $t = 1.86$, $p > 0.05$, and mode of use, $t = 1.56$, $p > 0.05$, and the interaction effect, $t = 1.04$, $p > 0.05$, on *Beauty* were not significant (see also Table 4). In sum, these results show the positive effects of usability on PQ, HQI, and *Goodness*, and of the exploration task on PQ and *Goodness*.

__________ Insert Table 4 about here. __________

Aim 4. The effect of mode of use (with higher *Perceived Ease of Use* in the exploration task), $t = 2.02$, $p < 0.05$, $d = 0.40$, and the positive effect of usability, $t = 3.11$, $p < 0.01$, $d = 0.54$, on *Perceived Ease of Use* were significant, but the interaction effect was not, $t < 1$ (see also Table 5). The same main effects of mode of use, $t = 3.12$, $p < 0.01$, $d = 0.58$, and usability, $t = 2.89$, $p < 0.01$, $d = 0.53$, on *Perceived Enjoyment* were significant, but the interaction effect was not, $t = 1.12$, $p > 0.01$ (see also Table 5). In addition, the same main effects of mode of use, $t = 2.88$, $p < 0.01$, $d = 0.55$, and usability, $t = 2.97$, $p < 0.01$, $d = 0.55$, on *Perceived Usefulness* were significant, but the interaction effect was not, $t < 1$ (see also Table 5). Furthermore, the same main effects of mode of use, $t = 1.99$, $p < 0.05$, $d = 0.38$, and usability, $t = 2.22$, $p < 0.05$, $d = 0.42$, on *Intention to Use* were significant, but the interaction effect was not, $t < 1$ (see also Table 5). In sum, these results demonstrate the positive effects of usability and the exploration task on beliefs and *Intention to Use*.

__________ Insert Table 5 about here. __________

In sum, previous research had investigated the effect of usability (van Schaik & Ling, 2008) and mode of use (Hassenzahl, Kekez & Burmester, 2002; Hassenzahl & Ullrich, 2007) separately, but the effect of usability on task performance and the effects of mode of use and usability together on perceptions of attributes and acceptance had not been studied. The manipulation of the usability of Web site design (with better outcomes when the usability was higher) was successful in its significant effect on correctness and task completion. Further evidence for the effectiveness of the manipulations comes from the test results (presented in Section 4.3) of *Hypotheses* 1, 8, 9 (for usability) and 15 (for mode of use), where more usable design and exploration (action mode) had a positive effect on outcomes.

4.3. Model testing

In relation to *Aims 3, 4 and 5*, three models (see Figure 2) were tested, using PLS path modelling, with test results presented in Figure 2. Assessment of the structural model and the hypotheses involved analysis of the standardised path coefficients and R^2 – variance explained – in each endogenous latent variable[vii].

__________ Insert Figure 2 about here. __________

Interaction Experience Model

Aim 3. The results presented in Figure 2a and further results presented here confirm *Hypotheses 1-7* (*Hypothesis* 4 only for *Hedonic Quality-identification*), thereby providing further evidence for the Interaction Experience Model (see Figure 1 [a]), in addition to previous research findings (Hassenzahl, 2004; van Schaik & Ling, 2008). Together, (a) the results from additional tests and (b) the significant effects found in the previous ANOVA-type analyses demonstrate that the effects of experimental manipulations on *Goodness* were mediated by perceptions, as these effects became non-significant after controlling for perceptions, β = 0.02, $t < 1$, for usability, and $\beta = -0.08$, $t = 1.35$, $p > 0.05$, for mode of use. Using Chin's (1998) conventions for the effect size R^2 for each endogenous variable (where 0.19 is weak, 0.33 is moderate and 0.67 is strong), the statistically significant effect sizes were strong for *Goodness* and *Beauty*, and weak for *Pragmatic Quality*. These results and the results from the ANOVA-type analyses provide further evidence of the view that (1) *Beauty* is more stable than *Goodness* and affected by pre-use *Beauty* after controlling for perceptions – whereas *Goodness* is not affected by pre-use *Goodness*, and (2) *Beauty* is influenced by perceptions of pleasure, but *Goodness* by perceptions of usability and pleasure as well as usability and mode of use.

Given our findings, confirming previous findings of Hassenzahl (2004) and van Schaik and Ling (2008), the conclusion follows that after experience with using a product a first impression in terms of aesthetics is insufficient to drive overall judgements of system quality. Our results – showing the effects of usability and mode of use – as well as those reported by Venkatesh (2000) and van Schaik and Ling (2009) – demonstrating the role of context – provide strong convergent evidence against the notion that the first impression is all-important. These findings challenge previous research (e.g. Lindgaard et al. 2006; Tractinsky et al., 2006) which has, perhaps unwittingly, given credence to this view.

The following findings were not predicted, but can be accounted for as follows. *Pragmatic Quality* is lower in goal mode. This is because barriers to goal attainment are much more salient and severe as long as they block goal attainment. In action mode, goals can per definition be constantly redefined or given up; thus, barriers do not matter as much and never become severe (if so, the user most likely changed to goal mode). Accordingly, *Pragmatic Quality* becomes less important, or harder to prevent, which should result in mild positive ratings. *Hedonic Quality-identification* was higher with a more usable site design. The more usable design – because of its clear font and standard presentation of the mouse cursor – differed from the less usable design in terms of presentation style that users would identify with, therefore making a pleasurable experience of identification more likely. *Goodness* was higher in action mode. *Pragmatic Quality* had an effect on *Goodness* and mode of use had an effect on PQ (higher in action mode); therefore, *Goodness* was higher in action mode.

Technology Acceptance Model

Aim 4. The results presented in Figure 2b and further results presented here confirm *Hypotheses 8-15*. In relation to *Hypotheses* 9 and 11 mediator effects were observed. As shown in Figure 2b, in relation to *Hypothesis* 9, the effects of usability on *Perceived Ease of Use* and of *Perceived Ease of Use* on *Perceived Usefulness* were significant. However, the effect of the predictor usability on *Perceived Usefulness*, which was not significant when *Perceived Ease of Use* was also a predictor, became significant when *Perceived*

Ease of Use was removed as a predictor, $\beta = 0.27$, $d = 0.55$, $t = 2.88$, $p < 0.01$. Therefore, *Perceived Ease of Use* was a mediator of the effect of usability on *Perceived Usefulness*. Furthermore, as shown in Figure 2b, in relation to *Hypothesis* 11, the effects of *Perceived Ease of Use* on *Perceived Usefulness* and of *Perceived Usefulness* on *Intention to Use* were significant. However, the effect of the predictor *Perceived Ease of Use* on *Intention to Use*, which was not significant when *Perceived Usefulness* was also a predictor, became significant, $\beta = 0.40$, $t = 4.55$, $p < 0.001$, when *Perceived Usefulness* was removed as a predictor. Therefore, *Perceived Usefulness* was a mediator of the effect of *Perceived Ease of Use* on *Intention to Use*, confirming the results of previous research (e.g. Davis, 1993). Together, (a) the results from additional testing and (b) the significant effects of experimental manipulations on *Intention to Use* found in the ANOVA-type analyses demonstrate that the effect of mode of use on *Intention to Use* was mediated by beliefs, $\beta = 0.07$, $t = 1.13$, $p > 0.05$.

The significant effect sizes of R^2 were strong for *Perceived Usefulness* and *Intention to Use*, moderate to strong for *Perceived Enjoyment*, and weak for *Perceived Ease of Use*. These results demonstrate the predictive power of 'traditional' TAM variables (e.g. Davis, 1993) and the important role of *Perceived Enjoyment* (van der Heijden, 2003, 2004; Sun & Zhang, 2004, 2006a, 2008; Cyr et al., 2006, 2007). The greater effect size of *Perceived Usefulness* than that of *Perceived Enjoyment* on acceptance outcomes (Igbaria et al., 1994) was also confirmed.

The following findings were not predicted, but can be accounted for as follows. *Perceived Usefulness* and *Perceived Ease of Use* were lower in goal mode. *Perceived Ease of Use* is lower in goal mode. This is because barriers to goal attainment are much more salient as a consequence of users' attempts to achieve a goal and severe as long as they block goal attainment. In action mode, goals can per definition be constantly redefined or given up; thus, barriers do not matter as much and never become severe (if so, the user most likely changed to goal mode). Accordingly, Perceived Ease of Use becomes less important, or harder to prevent, which should result in mild positive ratings. Given that action mode results in higher *Perceived Ease of Use* than goal mode and higher *Perceived Ease of Use* results in higher *Perceived Usefulness*, it follows that action mode results in higher *Perceived Usefulness*. *Perceived Enjoyment* was higher with the more usable site design. Given that a more usable design results in higher *Perceived Ease of Use* and higher *Perceived Ease of Use* results in higher *Perceived Enjoyment*, it follows that a more usable design results in higher *Perceived Enjoyment*.

Integrated Experience-Acceptance Model

Aim 5. The results presented in Figure 2c and further results presented here confirm *Hypotheses* 8-18 and 21 (*Hypotheses 16 and 17* only for *Hedonic Quality-identification*). In relation to *Hypothesis* 8, the effect of the predictor usability on *Perceived Ease of Use*, which was significant in the technology acceptance model, became non-significant in the integrated experience-acceptance model with the introduction of the predictors *Pragmatic Quality*, *Hedonic Quality-identification* and *Hedonic Quality-stimulation*. However, the effect remained significant, $\beta = 0.25$, $d = 0.54$, $t = 3.31$, $p < 0.001$, after the removal of *Pragmatic Quality* and *Hedonic Quality-identification*, indicating that these variables acted as mediators. Consistent with the results of previous research (see Venkatesh et al, 2003), *Hypotheses 19 and 20* were not confirmed: the significant path coefficients from *Beauty*, $\beta = 0.25$, $t = 2.34$, $p < 0.01$, and *Goodness*, $\beta = 0.48$, $t = 4.47$, $p < 0.001$, to *Intention to Use* became non-significant after controlling for the beliefs of *Perceived Ease of Use*, *Perceived Usefulness* and *Perceived Enjoyment*. According to Venkatesh et al., this effect of evaluations – and, given the *principle of compatibility*, even more so the effect of the evaluations of objects – is spurious because of the effect of beliefs on evaluations, when at the same time beliefs have a direct effect on *Intention to Use*.

For the dependent variables with predictors additional to those in the technology acceptance model, the effect sizes of R^2 were strong for *Perceived Usefulness*, *Intention to Use* and *Perceived Enjoyment*, and moderate to strong for *Perceived Ease of Use*. In PLS path modelling, the effect size f^2 expresses the increase in the value of R^2 in relation to the proportion of variance in an endogenous variable that remains unexplained (Henseler et al., 2009). Using Cohen’s (1988) conventions for the effect size f^2 for each endogenous variable (where 0.02 is weak, 0.15 is moderate and 0.35 is strong), the effect sizes f^2 (of change in R^2 from the Technology Acceptance Model to the integrated Experience-Acceptance Model) were very strong for *Perceived Ease of Use*, strong for *Perceived Enjoyment*, moderate to strong for *Perceived Usefulness* and negligible for *Intention to Use*. Thus, the integrated model is more complete than the technology acceptance model because it predicts endogenous technology acceptance variables better than the technology acceptance model does. Moreover, test results of the integrated model clarify the role of interaction experience within technology acceptance by showing that perceptions of product quality (*Pragmatic Quality* and *Hedonic Quality*) predict beliefs (*Perceived Enjoyment*, *Perceived Ease of Use* and

Perceived Usefulness) independently of other variables, but *Goodness* and *Beauty* do not independently predict *Intention to Use*.

When the usability of Web site design is reduced, objectively-measured usability in terms of task performance is reduced as are perceptions and acceptance of the site under consideration. Apart from the effect of the usability of site design on objective usability measures, the effect on acceptance is another important reason for designing usable Web sites. In fact, if a system's usability is further reduced (as a result of a poor [interaction] design or otherwise), *Perceived Ease of Use* will suffer more and eventually *Perceived Usefulness* will be reduced further. Consequently, *Intention to Use* will diminish further and, ultimately, potential users will not use the system. An additional implication of our results is that the negative effect of poorer usability further reduces acceptance in goal mode (below the level of acceptance in action mode), which would result in users rejecting a system more readily.

The effect of *Hedonic Quality* on different types of belief showed a result that may seem surprising at first. The effect of both types of *Hedonic Quality* (identification and stimulation) on *Perceived Enjoyment* was significant. However, only the effect of *Hedonic Quality-identification* on *Perceived Usefulness* and *Perceived Ease of Use* was significant. The reason for the non-significant effect of *Hedonic Quality-stimulation* can be understood from the nature of this perception and two beliefs involved. *Hedonic Quality-stimulation* signifies stimulation and arousal, but these qualities are not consistent with both *Perceived Usefulness* and *Perceived Ease of Use*. Indeed, both focus on achieving task performance, which would be hindered by stimulation and arousal. However, stimulation and arousal are consistent with the nature of *Perceived Enjoyment*. Therefore both types of *Hedonic Quality* were predictors of *Perceived Enjoyment*.

Several researchers have addressed the modelling of interaction experience, in particular the role of aesthetics, in TAM (e.g., Cyr et al., 2006; van der Heijden, 2003, Zhang & Li, 2005), using diverse conceptualisations of aesthetics. They have typically focused on perceptions of aesthetics rather than evaluations, not differentiated between different types of perception and not addressed the relation between perceptions and evaluations. Furthermore, aesthetics and affect are related factors that influence acceptance. These concepts are sometimes confused (see, e.g., the introduction in Zhang & Li, 2005), but Sun and Zhang (2006b) provide a framework for studying the role of the broader concept of affect that includes various types of affective reaction toward using interactive systems. Different studies usually place emphasis either on affect (e.g. Hassenzahl, 2004) or on aesthetics (Hassenzahl & Ullrich, 2007) and do not explicitly address both in relation to acceptance. From our model tests it appears that evaluations (*Goodness*) do not have any additional explanatory power after controlling for beliefs, at least not for information-oriented Web sites that can be used for work or leisure (an online encyclopaedia in this study). This result is consistent with the view taken in later TAM research (e.g. Venkatesh et al., 2003) that evaluations do not contribute to the prediction of *Intention to Use* after controlling for beliefs. However, other possible reasons for the 'negative' result of evaluations in our TAM include the following. Firstly, consistent with the principle of compatibility, evaluations of objects (in this case *Beauty* and *Goodness*) are relatively poor predictors of acceptance outcomes because they do not include a specification of action, context and time. Secondly, there is a difference in the time frame modelled by models of interaction experience and TAM. Models of interaction experience typically focus on the process of interaction within a session. However, models of technology acceptance, similar to their origins in models of rational behaviour, do not attempt to model individuals' actions on specific occasions, but instead focus on 'regularities in behaviour, consistent patterns of action, response tendencies' (Ajzen, 1988, p. 46). Therefore, the immediate experience of human-computer interaction in terms of *Goodness* and *Beauty* may not be predictive of *Intention to Use* (over a longer time span), beyond the effect of beliefs such as *Perceived Usefulness* (see also Kahneman, 2010, for the difference between immediate experience and remembered experience).

5. General discussion

A number of issues arising from the current study are discussed. These are the role of aesthetics in different stages of product use, the role of *Perceived Enjoyment* in technology acceptance, an integrated conceptual framework and the product as a fixed-effect fallacy.

5.1. The role of aesthetics in product use

It appears that the role of aesthetics differs depending on a user's stage of the use of a particular product. The immediate impact (within 500 ms) of the aesthetic (appearance) qualities of a Web site could influence potential users' decision to visit that site (Lindgaard et al., 2006; Tractinsky et al., 2006). Regarding the initial impact of aesthetics (after 500 ms), if a Web site is sufficiently aesthetic (otherwise the site may not be visited in the first place) then in goal mode a system's usability and functionality - both supporting goal achievement - will influence acceptance; in action mode, stimulation - supporting playfulness and spontaneity - will influence *Beauty*. In the long term, in goal mode and with highly skilled task performance *Pragmatic Quality* and *Hedonic Quality* will become irrelevant and functionality will increasingly influence acceptance (Overby & Lee, 2006). In action mode, novelty and challenge may wear off, but identification will influence *Beauty*. These predictions should be tested in future research, in particular because for hedonic systems (designed with an emphasis on pleasure) – as opposed to utilitarian systems (designed with an emphasis on usefulness) – evaluations may affect system acceptance.

The models considered in the current study are inspired by successful theories of rational behaviour (e.g. the Theory of Planned Behaviour), in which the direction of cause-effect relations is fixed. The use of these models would seem particularly appropriate in situations where the relations between constructs are relatively stable. More recently, models using an inference perspective have been applied to the modelling of interaction experience (e.g. Hassenzahl & Monk, in press). These models allow for an account of more flexible processing of product-related information and would seem especially suitable for modelling a process interaction experience in which the direction of relations between constructs can change.

5.2 The role of *Perceived Enjoyment* in technology acceptance

This study has demonstrated that *Perceived Enjoyment* can have a powerful effect on *Intention to Use*. This result is consistent with empirical results reported and the theoretical position taken in earlier work. For example, both Cyr et al. (2006), and Dickinger, Arami and Meyer (2008) found evidence for a direct effect of *Perceived Enjoyment* on *Intention to Use*, with the latter finding that this influence was twice as strong as the influence of usefulness on attitudes towards use. Similarly, Liao, Tsou and Shu (2008) found that enjoyable content and an interactive interface have a greater effect on consumers' attitudes than the simple and accessible functional design of a set-top box to provide multimedia content on demand. Such close links with attitudes towards use indicate that intrinsic concerns, particularly *Perceived Enjoyment*, should be of significant concern to developers of a wide range of technology, especially given that *Perceived Enjoyment* has been found to be related to shoppers' messaging, browsing and purchasing activities (Ramayah, Jantan & Aafaqi, 2003).

The strength of the influence of *Perceived Enjoyment* may depend on the type of interactive system. In particular, the effect may be stronger when hedonic systems are used, for example in the context of leisure, when users are focused on pleasure; however, the effect may be weaker when utilitarian systems are used, for example in the context of work, when users focus on productivity (Sun & Zhang, 2006a). For utilitarian systems, *Perceived Ease of Use* may be a moderator of the effect of *Perceived Enjoyment* on *Intention to Use* (Venkatesh, 2000). Venkatesh argued theoretically and found empirical evidence for the notion that the influence of *Perceived Enjoyment* becomes stronger over time in a process of anchoring and adjustment.

5.3. An integrated conceptual framework for interaction experience and technology acceptance

Based on a conceptual analysis of recent research on interaction experience (e.g., Cyr et al., 2006; Hassenzahl, 2004; Hassenzahl & Ullrich, 2007; van der Heijden, 2003; Lavie & Tractinsky, 2004; van Schaik & Ling, 2008) and the current study, we propose a conceptual framework for research on interaction experience and technology acceptance (see Table 6). Our framework is based on existing models of interaction experience and technology acceptance as well as the results and arguments presented here. Within a session with an interactive product, product characteristics influence users' perceptions of product attributes and beliefs about the consequences of product use and these, in turn, affect evaluations. Our study found evidence for these relations. Over a longer time span, product characteristics consistently influence beliefs. Beliefs are determinants of evaluations. Evaluations of actions (using a product) then have an effect on intentions and these, in turn, influence people's rate of using a product. Evaluations of objects (products) may independently have an effect on intentions. Our study also found evidence for these relations, but evaluations of a product did not contribute to intentions over and above the effect of beliefs on intentions. Still, depending on the combination of ownership, mode of use, context of use, individual-difference variables (such as need for cognition) and product type (hedonic or utilitarian), evaluations may be influential. This speculation should be the subject of future research.

__________ Insert Table 6 about here. __________

Although a full review of the literature is beyond the scope of this publication, we believe that our framework is a useful starting point for further theoretical and empirical research and should be extended by such research, taking into account the following results of a conceptual analysis. Some concepts involved in categorising product attributes and perceptions of these that are used by Hassenzahl and Tractinsky

(Tractinsky & Zmiri, 2006) appear to be very similar (e.g. stimulation and aesthetics; see also Hassenzahl & Monk, in press) or have a part-whole relationship (identification and symbolism). The relations among perceptions of aesthetics from different conceptualisation schemes are not clear-cut. However, an analysis of psychometric items used in research studies shows a similarity between those representing *Hedonic Quality-identification* (Hassenzahl, 2004) and expressive aesthetics (Lavie & Tractinsky, 2004; see also Hassenzahl & Monk, in press). Furthermore, based on van Schaik and Ling's (2009) discussion of the relationship between usability and classical aesthetics, it is likely that *Pragmatic Quality* (Hassenzahl) and classical aesthetics (Lavie & Tractinsky) are correlated. This is because the characteristics of classical aesthetics (order and familiarity) should increase the usability of a system and therefore its *Pragmatic Quality*. However, there are additional aspects of usability that are not addressed by classical aesthetics.

5.4. The product as a fixed-effect fallacy

The issue of the product as a 'fixed-effect fallacy' that Monk (2004) has identified is important to consider. In sum, without sampling products it is not possible to determine whether and to what extent statistical data analysis using the product variable as a fixed effect would produce different results from an analysis using the product variable as a random effect. In relation to the study reported here, our position is that if the aim was to address the issue by sampling products sufficiently for valid statistical analysis of product as a random effect it would be practically prohibitive to conduct the research for at least two reasons. First, as a result of statistical requirements it would involve a sample of at least 25 products, for which all participants would have to follow the experimental procedure for a total of 25×45 minutes = 18 hours and 25 minutes or the sample size (the number of participants) would have to increase by a factor 25. Second, it would involve (re)programming different experimental versions of each of the 25 products and in some cases, depending on how the Web sites are coded, this could involve building entirely new versions of a Web site. Our position is that in such circumstances, the best course of action is to choose a product that can be considered as representative of the type of product about which one wants to draw conclusions and then experimentally manipulate product characteristics in order to observe their effect on task performance and interaction experience. Both types of outcome measure are important, because in many cases the possibility of poor task performance coupled with positive interaction experience are not desirable and, of course, (poor usability leading to) poor task performance can be the cause of poor interaction experience. Without experimental manipulation, conclusions about the effect of actual design characteristics on interaction experience are precluded.

Obviously, sampling products as a random effect is relatively straightforward in non-experimental questionnaire-only studies or non-experimental studies that involve no or little interaction with a product. The problem with such studies is that they cannot analyse actual system use in relation to interaction experience and, most important, they lack experimental control. Therefore, again, any conclusions about the effect of actual design characteristics on interaction experience are precluded. Furthermore, if both subjects and products are used as random effects, the appropriate statistical analysis would be multilevel modelling or hierarchical linear modelling (Luke, 2004) rather than two separate analyses: one with subjects and another with products as a random effect. This is because multilevel analysis can analyse both random effects simultaneously and analyse interaction effects that separate analyses cannot.

6. Conclusion and future work

In conclusion, we found strong evidence for our measurement model of interaction experience and technology acceptance and for our separate models of interaction experience and technology acceptance. Our integrated model of interaction experience and technology acceptance explained substantial additional variance in technology acceptance variables from interaction-experience measures of product perceptions, but not of product evaluations.

In the *loyalty decade*, the success of interactive systems will, to a large extent, be positively influenced by the way in which they promote a high-quality experience in their users. The change in emphasis from usability to interaction experience to achieve success requires a new research effort, as interactive systems based on digital innovations are increasingly being used as a mechanism to enhance human task performance. However, recent work has been critical of Web 2.0 sites in terms of their support for a positive interaction experience (Nielsen, 2007) and has argued that public-sector sites may underperform in terms of their interaction experience, compared to commercial sites (Nielsen, 2005). Therefore, future research should address the modelling of interaction experience in different types of interactive system and take into account the system characteristic that still has the biggest impact on usability: information architecture (Nielsen, 2009). The effect of information architecture on usability has been confirmed by other research (e.g. Resnick

& Sanchez, 2004; van Schaik & Ling, 2008). In order to comprehensively assess and model interaction experience, this research should also study individual-difference variables (Amichai-Hamburger, Kaynar & Fine, 2007; Juvina & van Oostendorp, 2006) in relation to interaction experience. In fact, by addressing individual differences as well as system characteristics, task (e.g. an information-finding task or a more interactive task of editing the content of an online encyclopaedia) and task context (mode of use), researchers will take into account all three elements of Finneran and Zhang's (2003) person-artefact-task model in their pursuit of understanding interaction experience. Furthermore, in order to assess the consequences of interaction experience over a longer time span, we recommend that its modelling takes place within the framework of technology acceptance.

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Appendix - Questionnaire items

	Pragmatic Quality - I judge the web pages to be
PQ1	Complicated - Simple
PQ2	Impractical - Practical
PQ3	Confusing - Clear
	Hedonic Quality-identification - I judge the web pages to be
HQI1	Amateurish - Professional
HQI2	Gaudy - Classy
HQI3	Unpresentable - Presentable
	Hedonic Quality-stimulation - I judge the web pages to be
HQS1	Standard - Creative
HQS2	Conservative - Innovative
HQS3	Commonplace - New
	Beauty - I judge the web pages overall to be
Beauty1	Ugly - Beautiful
	Goodness - I judge the web pages overall to be
Goodness1	Bad - Good
	Perceived Enjoyment
PE1	I find using the Web site to be enjoyable

PE2	The actual process of using the Web site is pleasant
PE3	I have fun using the Web site
	Perceived Ease of Use
PEOU1	My interaction with the Web site is clear and understandable
PEOU2	It is easy for me to become skilful at using the Web site
PEOU3	I find the Web site easy to use
PEOU4	Learning to operate the Web site is easy for me
	Perceived Usefulness
PUSF1	I would find the Web site useful in finding information
PUSF2	Using the Web site would enable me to accomplish tasks more quickly when finding information
PUSF3	Using the Web site would enhance my effectiveness in finding information
PUSF4	Using the Web site would make it easier to find information
	Intention to Use
IU1	I intend to use the Web site in the next month for finding information
IU2	I predict I would use the Web site in the next month for finding information
IU3	I plan to use the Web site in the next month for finding information

Note. The items all used 7-point scales. For *Pragmatic Quality*, *Hedonic Quality-identification*, *Hedonic Quality-stimulation*, *Beauty* and *Goodness* the endpoints are the two adjectives presented. For the other scales the endpoints were Strongly disagree (presented left) and Strongly agree (presented right).

[i] Although *Pragmatic Quality* and *Perceived Ease of Use* (introduced later) both represent subjective usability they are different. *Pragmatic Quality* is a user's perception of the extent to which specific attributes are true of a particular interactive system (object) without any reference to the particular user's actual use or possible use, whereas *Perceived Ease of Use* is a particular user's belief of the extent to which specific consequences will follow from the particular user's use (action) of an interactive system (object).

[ii] This is the dimension of arousal activation in Zhang and Li (2005).

[iii] All the relations between variables are estimated simultaneously. Therefore, whereas multiple regression analysis needs several separate analyses, one for each dependent variable, these can be conducted as a single analysis using PLS.

[iv] This is the last structural model presented in the Results section.

[v] The analysis used data from the participants taking part in the information retrieval task/goal mode, N = 63.

[vi] The analysis is essentially a series analyses of variance (ANOVAs), but accounting for measurement error, which (conventional) ANOVA is not capable of.

[vii] When the additional significant effects found in the previous ANOVA-type analyses were included, the same pattern of results with respect to statistical significance for the hypotheses was found.

Table 1
Exploratory factor analysis of questionnaire items

	Factor						
Item	Perceived Usefulness	Hedonic Quality-stimulation	Pragmatic Quality	Hedonic Quality-identification	Perceived Enjoyment	Intention to Use	Perceived Ease of Use
PUSF3	.53						
PUSF2	.52						
PUSF4	.47						
PUSF1	.34						
HQS2		.86					
HQS3		.66					
HQS1		.61					
PQ3			.78				
PQ1			.69				
PQ2			.66				
HQI3				-.69			
HQI1				-.65			
HQI2				-.65			
PE1					-.82		
PE3					-.73		
PE2					-.69		
IU1						1.00	
IU3						.95	
IU2						.94	
PEOU2							.82
PEOU4							.74
PEOU3							.62
Eigen-value	6.21	5.89	5.81	6.87	8.63	10.36	7.85

Note. Items are of post-use perceptions of product attributes and measures of technology acceptance. Extraction method: principal axis factoring. Direct oblimin rotation was used as the constructs were theoretically not orthogonal. Figures per item are factor loadings from the pattern matrix, with values ≤ 0.30 suppressed.
PQ: Pragmatic Quality. HQI: Hedonic Quality-identification. HQS: Hedonic Quality-stimulation. PE: Perceived Enjoyment. PUSF: Perceived Usefulness. PEOU: Perceived Ease of Use. IU: Intention to Use. Items are numbered per scale; for example, HQS2 represents Hedonic Quality-stimulation, Item 2. PEOU1 was excluded because of multicollinearity.

Table 2
Coefficients of reliability and convergent validity

Construct/indicator	Average variance extracted	Composite reliability	Loading	Standard error	t^a
Pragmatic Quality	0.79	0.92			
- PQ1			0.83	0.06	13.89
- PQ2			0.91	0.02	41.65
- PQ3			0.93	0.02	59.26
Hedonic Quality - identification	0.84	0.94			
- HQI1			0.93	0.02	50.53
- HQI2			0.91	0.02	40.72
- HQI3			0.91	0.03	31.28
Hedonic Quality - stimulation	0.76	0.90			
- HQS1			0.89	0.03	33.93
- HQS2			0.87	0.03	28.01
- HQS3			0.85	0.03	27.39
Beauty					
- Beauty1	1.00		1.00	0.00	
Goodness					
- Goodness1	1.00		1.00	0.00	
Perceived Ease of Use	0.87	0.95			
- PEOU2			0.93	0.02	47.78
- PEOU3			0.93	0.02	39.92
- PEOU4			0.94	0.02	50.46
Perceived Usefulness	0.88	0.97			
- PUSF1			0.91	0.03	34.73
- PUSF2			0.95	0.01	68.72
- PUSF3			0.96	0.01	84.88
- PUSF4			0.95	0.01	67.16
Perceived Enjoyment	0.88	0.95			
- PE1			0.95	0.01	99.77
- PE2			0.91	0.03	26.21
- PE3			0.94	0.01	63.39
Intention to Use	0.97	0.99			
- IU1			0.98	0.01	173.54
- IU2			0.98	0.01	94.62
- IU3			0.98	0.01	130.04

[a]Bootstrap, $N = 5000$

Table 3
Coefficients of discriminant validity

	Beauty	Goodness	Hedonic Quality - identification	Hedonic Quality - stimulation	Intention to Use	Perceived Enjoyment	Perceived Ease of Use	Pragmatic Quality	Perceived Usefulness
Beauty	1.00								
Goodness	0.67	1.00							
Hedonic Quality - identification	0.70	0.80	0.92						
Hedonic Quality - stimulation	0.65	0.54	0.57	0.87					
Intention to Use	0.58	0.65	0.65	0.54	0.98				
Perceived Enjoyment	0.65	0.69	0.67	0.65	0.74	0.94			
Perceived Ease of Use	0.53	0.64	0.63	0.44	0.69	0.65	0.93		
Pragmatic Quality	0.53	0.73	0.64	0.46	0.51	0.56	0.67	0.89	
Perceived Usefulness	0.59	0.75	0.76	0.53	0.83	0.71	0.80	0.63	0.94

Note. Off-diagonal values are correlations. Diagonal values are square root of average extracted variance.

Table 4
Post-use perceptions of product attributes and product evaluations as a function of usability and mode of use

	Pragmatic Quality			Hedonic Quality-identification			Hedonic Quality-stimulation			Goodness			Beauty		
	Mode of use			Mode of use			Mode of use			Mode of use			Mode of use		
Usability	Action mode	Goal mode	Overall	Action mode	Goal mode	Overall	Action mode	Goal mode	Overall	Action mode	Goal mode	Overall	Action mode	Goal mode	Overall
Low															
- Mean	4.37	3.89	4.13	4.70	4.22	4.46	4.31	3.72	4.02	5.03	3.97	4.50	3.78	3.13	3.45
- SD	(1.32)	(1.63)	(1.49)	(1.33)	(1.66)	(1.51)	(1.31)	(1.39)	(1.37)	(1.47)	(1.93)	(1.78)	(1.26)	(1.60)	(1.47)
High															
- Mean	5.33	4.67	5.01	5.21	4.95	5.09	4.11	3.96	4.04	5.42	5.16	5.30	4.00	3.87	3.94
- SD	(1.10)	(1.24)	(1.20)	(1.02)	(1.01)	(1.02)	(1.34)	(1.03)	(1.20)	(1.09)	(1.19)	(1.14)	(1.03)	(1.20)	(1.11)
Overall															
- Mean	4.85	4.28	4.57	4.96	4.58	4.77	4.21	3.84	4.03	5.23	4.56	4.90	3.89	3.49	3.70
- SD	(1.29)	(1.49)	(1.42)	(1.20)	(1.42)	(1.32)	(1.32)	(1.22)	(1.28)	(1.30)	(1.70)	(1.54)	(1.15)	(1.46)	(1.32)

Note. Figures are means, with standard deviations in brackets.

Table 5
Acceptance outcomes as a function of usability and mode of use

	Perceived Enjoyment			Perceived Usefulness			Perceived Ease of Use			Intention to Use		
	Mode of use			Mode of use			Mode of use			Mode of use		
Usability	Action mode	Goal mode	Overall	Action mode	Goal mode	Overall	Action mode	Goal mode	Overall	Action mode	Goal mode	Overall
Low												
- Mean	4.37	3.35	3.86	4.94	4.07	4.51	4.92	4.29	4.61	4.65	3.68	4.16
- SD	(1.45)	(1.37)	(1.49)	(1.30)	(1.60)	(1.51)	(1.35)	(1.62)	(1.51)	(1.74)	(2.00)	(1.92)
High												
- Mean	4.80	4.31	4.56	5.52	4.95	5.24	5.49	5.10	5.30	5.06	4.71	4.89
- SD	(1.26)	(0.97)	(1.14)	(1.10)	(1.12)	(1.13)	(1.01)	(0.95)	(0.99)	(1.63)	(1.42)	(1.53)
Overall												
- Mean	4.59	3.82	4.21	5.23	4.50	4.87	5.21	4.69	4.96	4.86	4.19	4.53
- SD	(1.36)	(1.28)	(1.37)	(1.22)	(1.44)	(1.38)	(1.22)	(1.38)	(1.32)	(1.68)	(1.81)	(1.77)

Note. Figures are means, with standard deviations in brackets.

Table 6
Conceptual framework

Research domain	Product/system attributes and task context	Perceptions of product attributes	Beliefs regarding consequences of product use	Evaluations	Intention
	Van Schaik and Ling (2008); Hassenzahl and Ullrich (2007)	Hassenzahl (2004)	Cyr et al. (2006)	Hassenzahl (2004); Venkatesh et al. (2003)	Davis and Venkatesh (1996)
Aesthetics in interaction experience		Hedonic Quality-stimulation Hedonic Quality-identification Hedonic Quality-evocation		Beauty[a]	
	Usability	Pragmatic Quality			
				Goodness[a]	
Technology acceptance	Mode of use		Perceived Enjoyment Perceived Ease of Use Perceived Usefulness		
				Attitude towards use[b]	Intention to Use

[a]Evaluation of object [b]Evaluation of action

Research highlights

An integrated model of interaction experience clarifies the role of perceptions of product attributes and product evaluations in the acceptance of a product.

In interaction experience, perceptions of product attributes and technology acceptance constructs are separate underlying psychological dimensions.

In interaction experience, the evaluation of overall interaction quality is less stable and influenced by both *Pragmatic Quality* and *Hedonic Quality*, but the evaluation of *Beauty* is more stable and only influenced by *Hedonic Quality*.

Perceptions of product attributes as indicators of interaction experience are independent determinants of *Perceived Enjoyment*, *Perceived Usefulness* and *Perceived Ease of Use*.

Product evaluations as indicators of interaction experience are not independent determinants of *Intention to Use*.

Version 2 (reduced version, second preference)

Interacting with Computers, Volume xx, Issue xx, Pages xxx-xxx (date). Integrated model of interaction experience for information retrieval in a Web-based encyclopaedia. Paul van Schaik and Jonathan Ling.

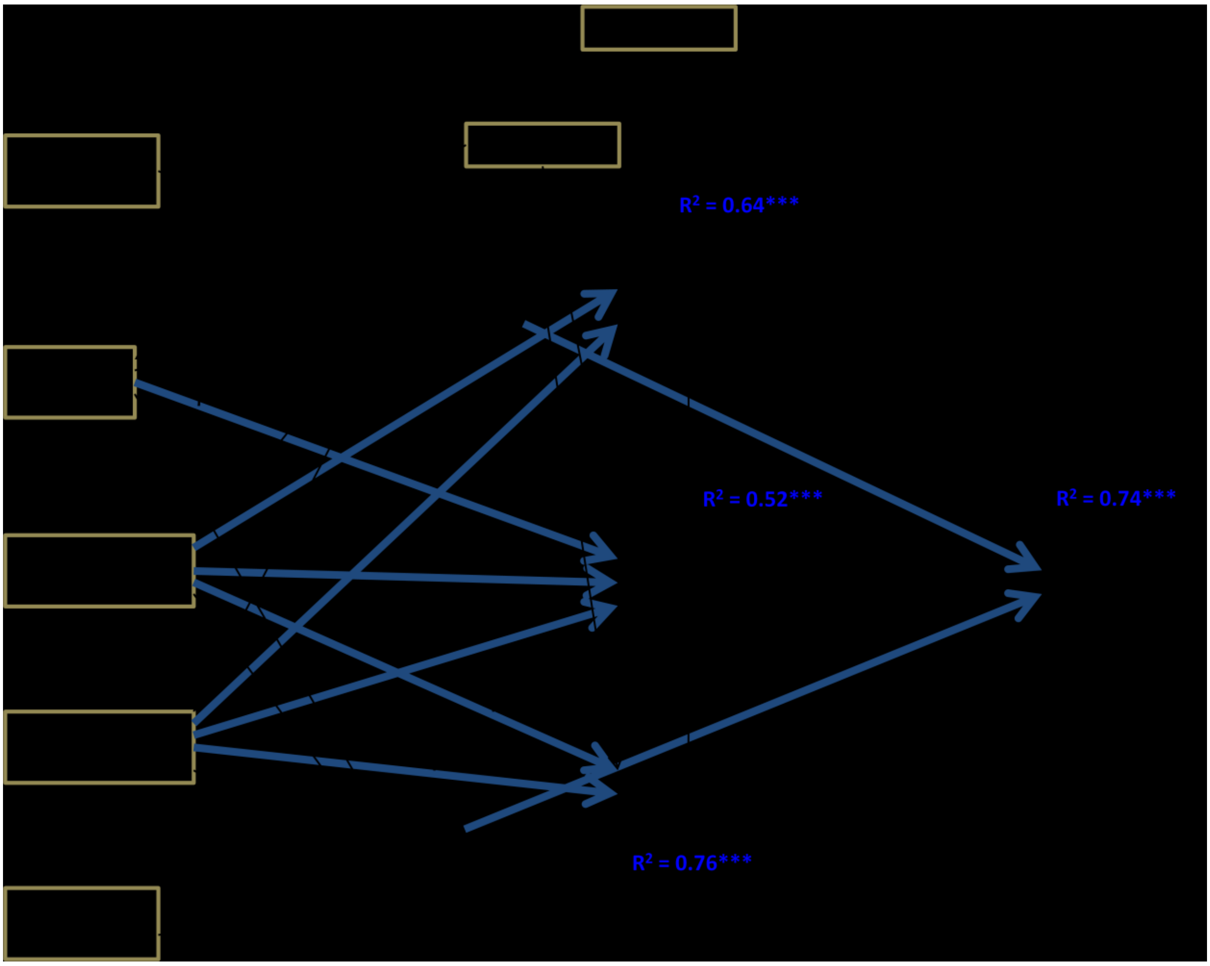


Figure captions

Figure 1. Model of technology acceptance

a. Hassenzahl's model of interaction experience (based on Hassenzahl, 2003, 2004)

b. Technology acceptance model (based on Davis & Venkatesh, 1996)

Figure 2. Research models

a. Interaction Experience Model

b. Technology Acceptance Model

c. Technology Acceptance Model augmented with interaction experience

Note. H: Hypothesis. Hypotheses in bold text were confirmed by test results. Figures with hypotheses are β-values.

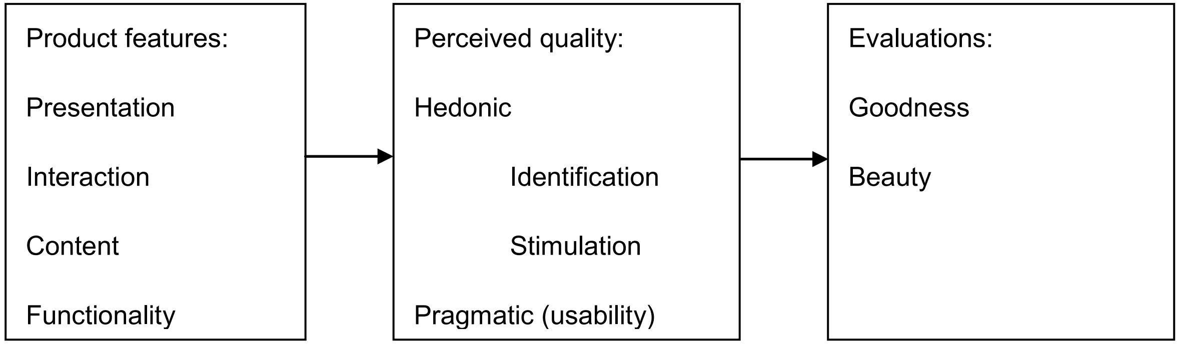
* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Figure 3. Typical web pages used in the experiment

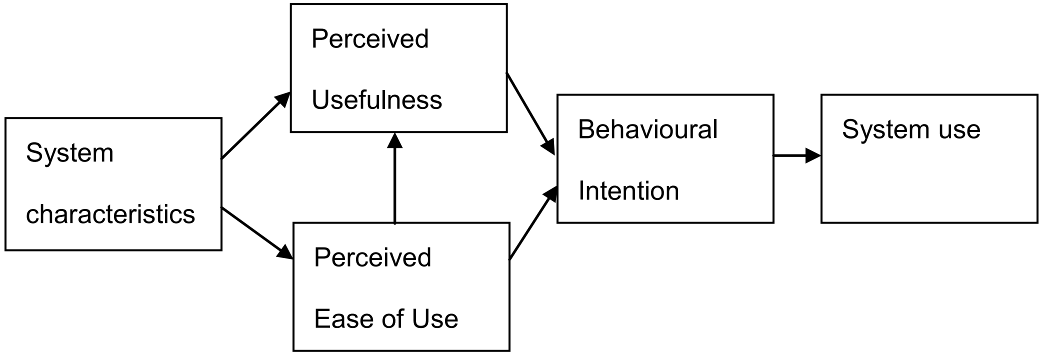
a. High usability

b. Low usability

Interaction experience model of Web-based information retrieval

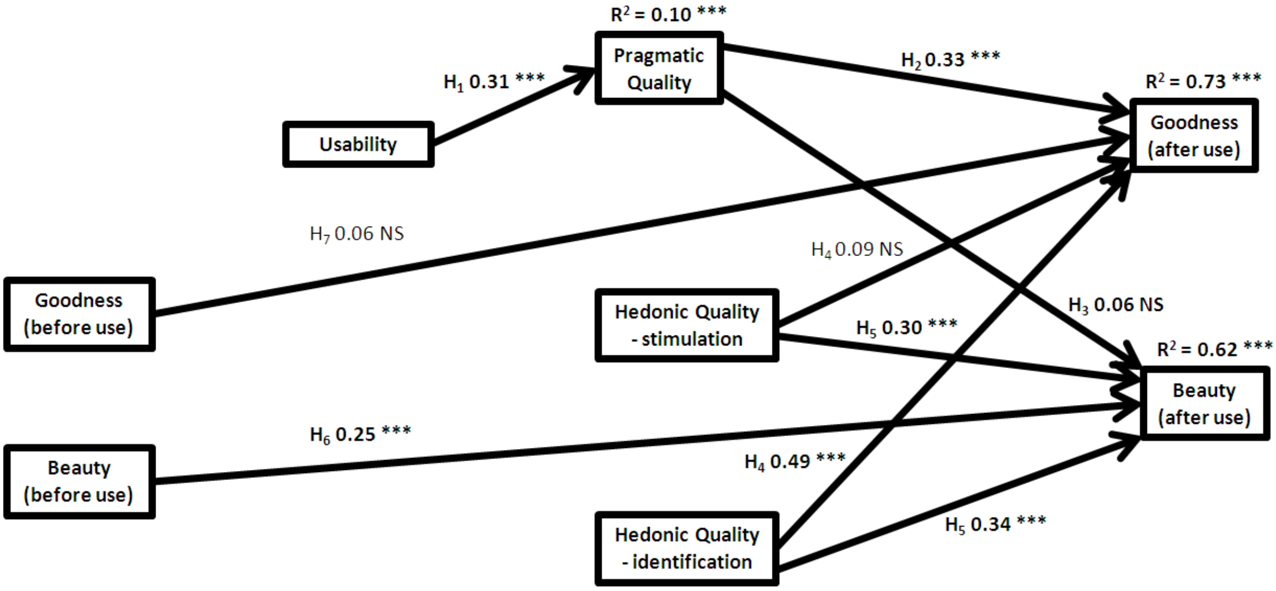


a.

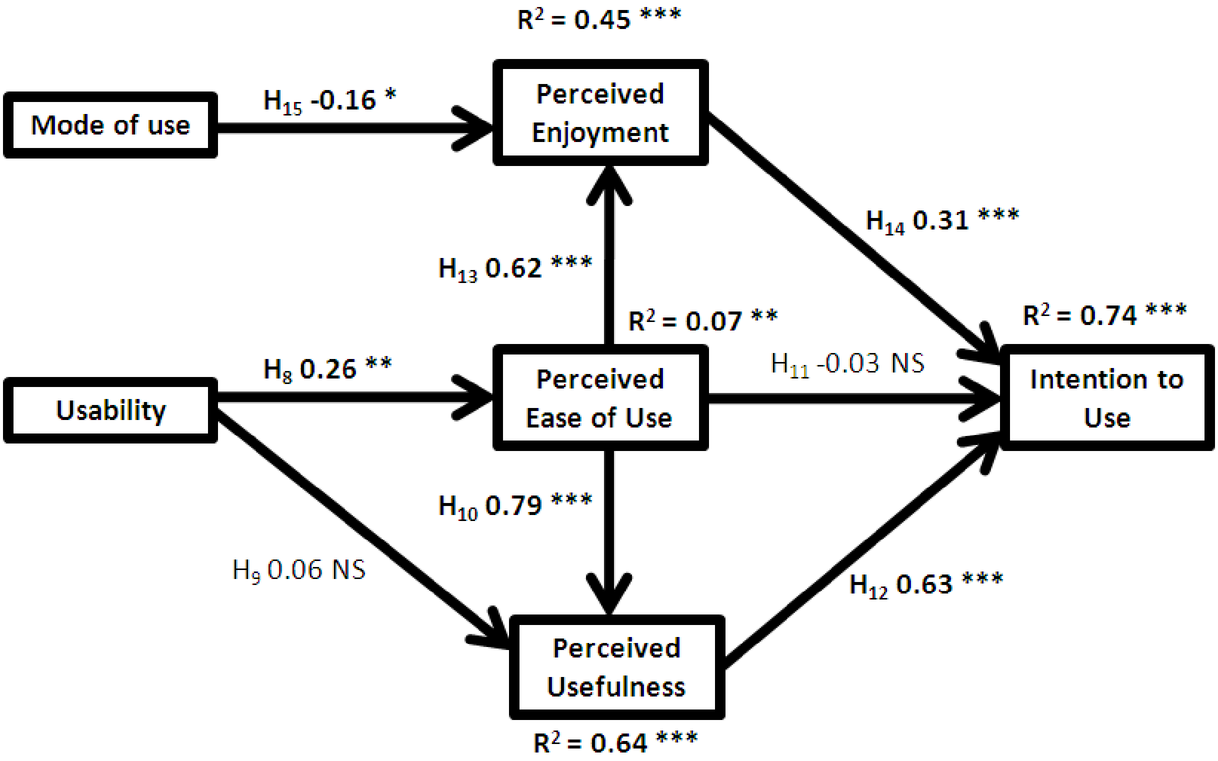


b.

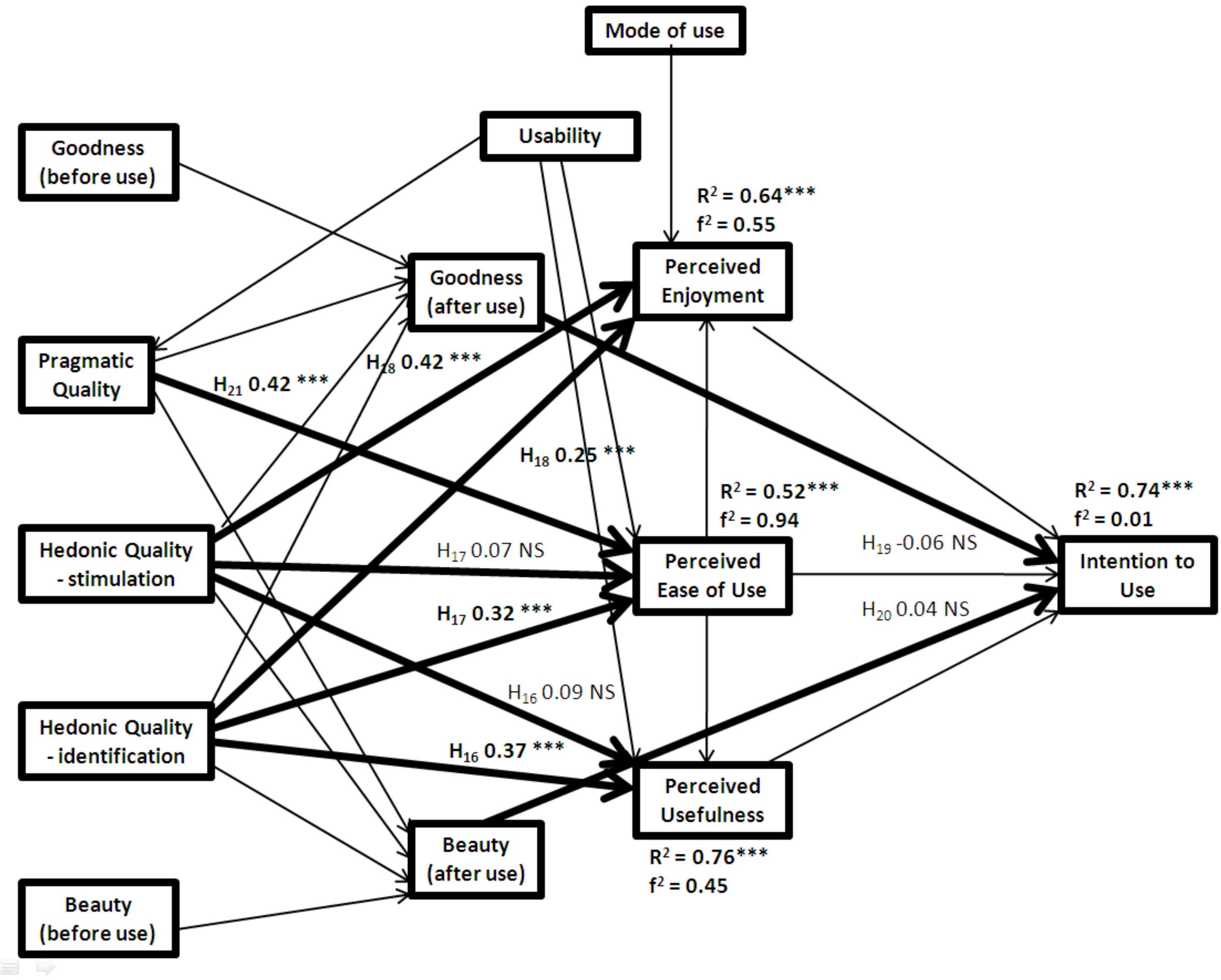
Figure 1


R2 = 0.10 ***
Pragmatic Quality
H1 0.31 ***
Usability
H2 0.33 ***
R2 = 0.73 ***
Goodness (after use)
H7 0.06 NS
Goodness (before use)
H4 0.09 NS
Hedonic Quality - stimulation
H3 0.06 NS
H5 0.30 ***
R2 = 0.62 ***
Beauty (after use)
H6 0.25 ***
Beauty (before use)
H4 0.49 ***
Hedonic Quality - identification
H5 0.34 ***

a.

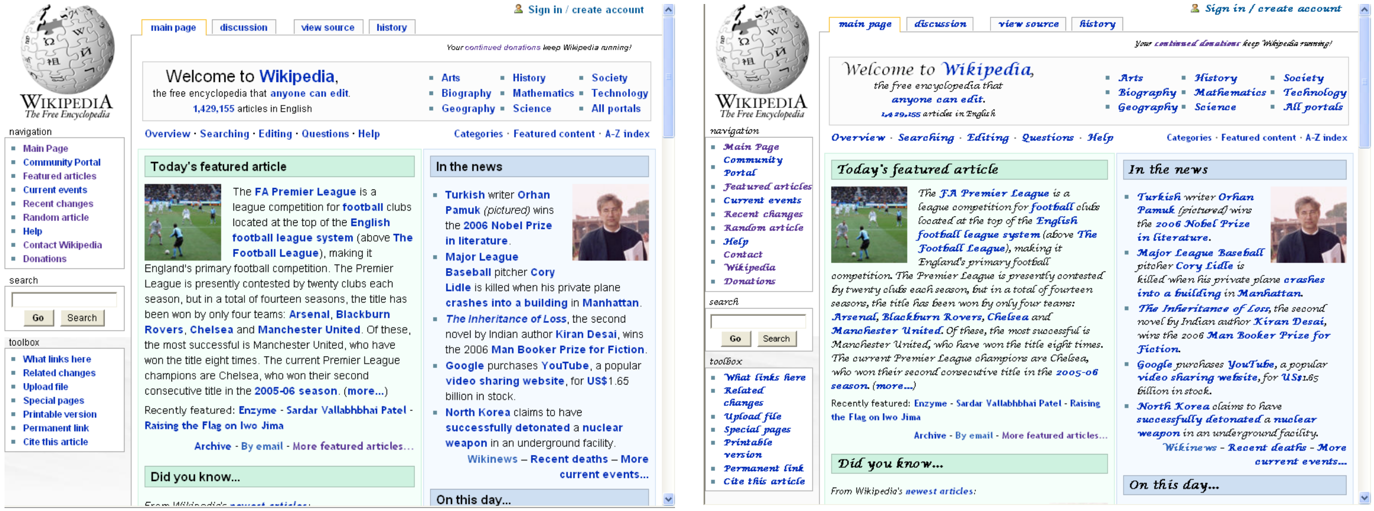

R^2 = 0.45 ***
Mode of use
H$_{15}$ -0.16 *
Perceived Enjoyment
H$_{14}$ 0.31 ***
H$_{13}$ 0.62 ***
R^2 = 0.07 **
R^2 = 0.74 ***
Usability
H$_8$ 0.26 **
Perceived Ease of Use
H$_{11}$ -0.03 NS
Intention to Use
H$_{10}$ 0.79 ***
H$_9$ 0.06 NS
H$_{12}$ 0.63 ***
Perceived Usefulness
R^2 = 0.64 ***

b.


Mode of use
Goodness (before use)
Usability
R² = 0.64***
f² = 0.55
Goodness (after use)
Perceived Enjoyment
Pragmatic Quality
H21 0.42 ***
H18 0.42 ***
H18 0.25 ***
R² = 0.52***
f² = 0.94
R² = 0.74***
f² = 0.01
Hedonic Quality - stimulation
H17 0.07 NS
Perceived Ease of Use
H19 -0.06 NS
Intention to Use
H17 0.32 ***
H20 0.04 NS
H16 0.09 NS
Hedonic Quality - identification
H16 0.37 ***
Perceived Usefulness
Beauty (after use)
R² = 0.76***
f² = 0.45
Beauty (before use)

c.

Figure 2


Sign in / create account
main page
discussion
view source
history
Welcome to Wikipedia,
the free encyclopedia that anyone can edit.
1,429,155 articles in English
Arts History Society
Biography Mathematics Technology
Geography Science All portals
Overview · Searching · Editing · Questions · Help
Categories · Featured content · A-Z index
navigation
Main Page
Community Portal
Featured articles
Current events
Recent changes
Random article
Help
Contact Wikipedia
Donations
search
Go Search
toolbox
What links here
Related changes
Upload file
Special pages
Printable version
Permanent link
Cite this article
Today's featured article
The FA Premier League is a league competition for football clubs located at the top of the English football league system (above The Football League), making it England's primary football competition.
In the news
Did you know...
On this day...

a. b.

Figure 3