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ABSTRACT

An experimental investigation into the role of interaction in user experience (UX) with a controlled manipulation of interactivity features (e.g. avatars, interactive video) in a university information website is reported. The more interactive version had better affect and hedonic ratings, even though its perceived usability was worse. Analysis of qualitative data showed users were attracted to the interactive features, although they complained about poor usability. The results of the experiments are discussed to consider the role of interactivity in user experience and the differences between users' quantitative judgements of UX and their comments on interactive features which reveal different perspectives.

Key Words: Aesthetics, Usability, Interactivity

Author Biographies

Professor Alistair Sutcliffe retired from the University of Manchester in October 2011; however, he continues his research as a visiting professor in University College London and the University of Lancaster. He has over 250 publications including five books and several edited volumes of papers.

Dr Jennefer Hart is a research fellow at the Open University with research interests in Human Computer Interaction and user experience.

1. INTRODUCTION

After many years of user experience (UX) research since the keystone paper on the "what is beautiful is usable" claim (Tractinsky, Katz & Ikar 2000), little consensus has emerged about how to measure or interpret the construct of user experience (Hassenzahl & Tractinsky 2006; Law, Roto et al. 2009). Considerable UX research has focused on summative evaluation (Hassenzahl 2004; Lavie & Tractinsky 2004); however, designers need to know how user interface features might influence user experience. Experimental manipulations of UX have tended to concentrate on usability or aesthetics by changing colour, typography and layout (Hassenzahl & Monk 2010; Lee & Koubek 2010; Tuch, Roth et al. 2012). Thus, only a small part of the design space described in

existing principles of good design (Kristof & Satran 2002; Lidwell, Holden & Butler 2003) has been explored. The impact of interactive design features, in particular, is poorly understood.

In games and entertainment, the influence of interaction on user experience is obvious (Egglestone, Whitbrook et al. 2010; Jennett, Cox et al. 2008; Bernhaupt 2010), but in other products the connection is not so clear. With the increasing interest in serious games and gamification of many applications (Clark 2009), understanding how interaction design promotes positive UX is an important concern. The few experimental studies of interactivity have shown that it does have a significant influence (Cyr, Head & Ivanov 2009; Teo et al. 2003), but these studies manipulated feedback and computer-mediated communication rather than features such as avatars or interaction in 3D virtual worlds. Our investigation of interactivity is motivated by design features which may enhance presence, immersion and flow in user experience, such as 3D interactive worlds and avatars; this is in contrast to previous frameworks of interactivity (Kristof & Satran 2002; Hoffman & Novak 1996) which have described gradations of user control.

In a review of UX experiments and empirical studies, Tuch et al. (2012) note that in pre-interaction evaluations aesthetics tends to be the dominant factor, but in post-interaction assessment usability is more important, although aesthetics still plays a role. Furthermore, several studies have indicated that user perceptions of aesthetics and usability are susceptible to task-context framing effects (Hartmann, Sutcliffe & De Angeli 2007; Porat & Tractinsky 2012; Sutcliffe & De Angeli 2005), and similar influences have been found for the related constructs of pragmatics and hedonics (Diefenbach & Hassenzahl 2011; Van Schaik, Hassenzahl & Ling 2012).

In previous work (Hart & Sutcliffe 2013). we used a mixed methods approach to compare three websites in the same museum and art gallery domain: two with engaging interactive features (avatars, active graphical worlds) and one standard design. The more interactive sites evoked more user affect, better hedonic ratings but worse usability, and were preferred overall. Analysis of qualitative data investigated associations between users' reference to design features and their judgement of each website. However, the previous study used live web sites with uncontrolled differences in content and many different interactive features, hence we needed to confirm our findings that interactivity plays an important role in web site preference and overall user experience. In this paper we investigate two research questions in a controlled experiment:

- Do specific interactive features (avatars, video) enhance UX measures (HQ,PQ) and affect more than standard (menu-link, still image) interaction?
- How do user perceptions of interactivity relate to specific design features?

The starting point for our investigations is a multi-attribute model of UX in which we have demonstrated that aesthetics, content/functionality, usability, brand and customisation all contribute to overall user preference, although judgement depends on the users' background and task (Hartmann, Sutcliffe & De Angeli 2008). In the previous studies we have shown that content and usability tend to be closely associated with overall preference, although users' judgement of aesthetics and usability is dependent on task framing and user characteristics (Hartmann, Sutcliffe & De Angeli 2007; Sutcliffe & De Angeli 2005; De Angeli, Sutcliffe & Hartmann 2006).

In the following sections of this paper, first we review related work; then we describe an experiment which assesses UX in an experimental manipulation of agent-based interaction in a website. This is followed by a summary of the experiments. The discussion reflects on the importance of interactivity in user experience, and future prospects for connecting summative evaluation of user experience to more formative design.

2. RELATED WORK

User experience is a concept which is frequently discussed but difficult to define. Indeed, UX has been associated with a wide variety of meanings ranging from traditional usability to beauty, hedonic, affective and experiential aspects of technology use (Hassenzahl & Tractinsky 2006; Law & Van Schaik 2010; Forlizzi & Batterbee 2004), including aesthetics, immersion, and presence (Kumar & Garg 2010). O'Brien & Toms (2008) distinguish user experience as a longer-term view from user engagement which reflects a more short-term, affect related experience of use which is pertinent to this study. In their review, Bargas-Avila and Hornbæk (2011) distinguish between 'generic UX' qualitative studies which take a contextual approach to interpreting experience; and dimensional, quantitative studies that aim to understand how the phenomenon of UX might be measured and composed. They note that affect/emotion, aesthetics, and enjoyment are the most commonly analysed dimensions, although inter-study comparison is difficult because of the variety of questionnaires employed. Furthermore, they observe that there has been considerable focus on assessing and interpreting users' experience rather than trying to theorise how UX might relate to user cognition and, more importantly, to user actions and product adoption.

The effect of interactive design features (i.e. 3D graphical worlds and character-based interfaces) in games on affect-based UX has been reported in several studies (Jennett, Cox et al. 2008; Schild, LaViola & Masuch 2012); however, interactivity in other application domains has received less attention. While interaction has been investigated indirectly in websites by pre/post-use assessments of UX via measures such as aesthetics and usability (Lee & Koubek 2010; Porat & Tractinsky 2012), the influence of interactive design features per se on UX has received little attention apart from Sundar et al.'s (2014) study showing that low-level features such as sliders and zoom control, mouse-over effects, and pop-up features improve users' UX attitude ratings. Many definitions of interactivity have been produced, varying from Hoffman and Novak's (1996) categories of machine (UI controls) and person interaction (i.e. Computer Mediated Communication, or CMC), to Kristof and Satran's (2002) seven-level 'control over' grading of features used by Teo et al. (2003); and Lee's (2005) framework of control, connectedness, and responsiveness, used in Cyr et al.'s studies (Cyr, Head & Ivanov 2009; Cyr, Head, Larios & Pan, 2009). Researchers in multi-media learning have proposed multi-faceted models of interactivity (Domagk, Schwartz & Plass 2010; Moreno & Mayer (1999) involving features for personalisation and user adaptation, interactive simulations or microworlds, as well as CMC between learners and tutors. Although several frameworks for interactivity have been proposed (Kristof & Satran 2002; Hoffman & Novak 1996; Lee 2005), the construct of interactivity still escapes a clear definition (Johnson, Bruner & Kumar 2006).

Interactivity may have a positive effect on user satisfaction, effectiveness, efficiency and overall attitude towards websites (Venkatesh, Morris et al. 2003). Teo et al. (2003) manipulated interactivity in terms of communication

facilities such as feedback forms, chat and online forums, to find that more social feedback improved satisfaction and effectiveness of websites. However, neither of these studies recorded users' perceptions of aesthetics, usability or interactivity itself (e.g. engagement). Cyr, Head and Ivanov (2009) investigated interactivity by varying the degree of control and responsiveness and dynamic visualisation, showing that enhancing interactivity in information visualisation positively influenced user perception of efficiency, effectiveness, enjoyment and trust, leading to greater loyalty to e-commerce sites. Interactivity was assessed indirectly in O'Brien's (2010) survey of e-commerce user experience via constructs such as focused attention and user engagement. These were positively influenced by social interaction facilities, while user attitudes to the online shopping experience, such as 'idea and adventure', may have been enhanced by interactive features for product presentation and exploration. In contrast, Yi, Jiang and Benbasat (2011) found that limiting the opportunity to interact with products was more effective than video presentation or unconstrained interaction, concluding that limiting interaction may evoke curiosity and hence may be more persuasive in marketing.

Qui and Benbasat (2005) compared user experience of flow and presence in e-commerce sites with and without avatars, but reported no differences between the designs; however, when Jiang & Benbasat (2007) compared static presentation of products with video and interactive demonstrations, they found that interactivity enhanced users' intention to purchase, and positive attitude towards the e-commerce website. Lee (2005) also reported that more interactive product demonstrations and user response facilities in websites created better trust. In a comparison of websites with the same content but different degrees of interactivity (menu vs. interactive microworlds), De Angeli et al. (2006) found that users' experience (expressive aesthetics, pleasure) and overall preference was positively influenced by the more interactive design. Johnson et al. (2006) argued that interactivity influences user preference because it involves a reciprocal communication process and depends on the level of responsiveness to the user.

To summarise, interactivity has been investigated in several studies (Cyr, Head & Ivanov 2009; Cyr, Head, Larios & Pan, 2009; O'Brien 2010; O'Brien & Toms 2010; Teo et al. 2003) which extended TAM measures (Venkatesh et al. 2003), so whereas the positive influence of interactive features on efficiency, effectiveness and satisfaction has been demonstrated, the connection between interactivity and affect and the non-instrumental aspects of UX (e.g. aesthetics) has received less attention. Furthermore, many manipulations of interactivity (e.g. Teo et al. 2003; Lee 2005) concentrated on support for social connection, feedback and interactive controls, rather than on design features such as avatars and interactive worlds, which might influence UX via flow and presence.

3. INVESTIGATING INTERACTIVITY IN UX

In this paper we define 'enhanced' interactivity as *user interfaces which afford interaction in a graphical world with active media and mediated by a user presence*. We differentiate enhanced interactivity from the standard interactivity present in most graphical user interfaces, i.e. menus, links, sliders, icon manipulations; and interactivity to mediate communication between people, such as chat rooms, wikis, and feedback forums (Hoffman & Novak 1996). Enhanced interactivity encompasses most virtual reality and games UIs, and the upper

two layers of Kristof & Satran's (2002) controls over objects and simulation. The three components of enhancement may vary in sophistication: user presence may include avatar representations and egocentric design view movement controls; 2D graphical worlds to 3D virtual reality; and active media ranging from responsive objects, pop-up features to embodied conversational agents.

3.1 Experimental Design

Two main interactive features were manipulated, avatar and video media, to test the hypothesis that enhanced interactivity websites will be preferred and have more positive UX ratings. Interactivity was evaluated before (initial exposure to home page) and after (interactive task), while enhanced interactivity (active media component) was manipulated by 'with or without avatar and video' designs.

Two bespoke websites were developed based on a University of Manchester website guide for new students. Both sites were aesthetically identical (same design, layout, colour, etc.) and used the same content, but one contained an avatar guide, interactive links and embedded videos, while the other standard design did not have these features (see Figure 1). Content was controlled as far as possible, i.e. the avatar only spoke text that was available on the standard design, while the video only extended the view of static images present in the standard design.

The avatar is a photo-realistic assistant guide developed using Guile 3D studio[1]. The animated computer character delivered a spoken welcome commentary on the home page and acted as a guide to the site but did not have an interactive (question-answer) dialogue. The videos gave a fly-through guide to some key aspects of Manchester Business School, with interactive links.

To investigate users' motivations, attitudes and judgements, a mixed methods approach (Cresswell 2013) was adopted using triangulation of data between questionnaires, interviews and observation. Participants' experience with the two websites was evaluated by a within-subjects, counterbalanced, two-way repeated measures design (*Task* (initial exposure/interactive tasks) x2, *Website* (standard/enhanced interactivity) x2). Users' predisposition towards IT products was also investigated as a between-subject factor. The experimental procedure is shown in Figure 2.

Participants completed the questionnaires after performing the tasks with each web site, which were presented in a counter balanced order. The participants were asked for the overall preferences at the end of the experiment. The experimental procedure was conducted as follows:

- *Briefing and familarisation:* after completing the consent form and demographic questionnaire, participants were given a short training session in which they were shown a similar university home page and asked to complete the first two questionnaires (*Affect* and *Website Quality-HQ/PQ*) to familiarise them with the initial-exposure test.

[1] https://guile3d.com/en/

- *Initial Exposure:* screen shots of the two websites' home pages (see Figure 1) were shown for 0.5 seconds (Lindgaard et al. 2006) using PowerPoint, to control the exposure time by replacing the image with a mask (grey screen). The short exposure time enables a rapid impression of the web page to be made for pragmatic/hedonic quality judgement, while precluding search for content. After completion of each website test, participants completed the two short questionnaires (*Affect* and *Website Quality-HQ/PQ*).
- *Interactive Task*: a navigation task provided a common baseline starting point for all participants. This involved selecting and exploring the campus map and gallery which exposed participants to the avatar and videos in the enhanced interactivity site, or text and static images in the control design. After the tasks, participants were given up to three minutes to explore the site freely without instruction. After the task and exploration period, they completed a number of short questionnaires (see below).
- *Interview*: a semi-structured interview was conducted to elicit participants' preferences and experiences while interacting with the website. At the end of the interview they were asked to rank which website they preferred.

40 subjects (23 female) participated in the study, with ages ranging from 18-25 (38%), 26-35 (50%), 36-45 (10%) to 46-55 (2%). The majority of participants were students (78%), while the remainder were university staff. All participants were being (or had been) educated to degree level and came from a variety of subject areas: business (80%), humanities (8%), business computing (5%), arts (5%) and computing (2%).

Questionnaires

Nine questionnaire scales were used, as follows:

- *Demographics*: general participant information, e.g. age, gender, education, etc.,
- *Affect*: a 9-item bipolar scale captured value-charged affect immediately after each task (overall mood, fun, attractive, curious, interesting, pleasurable, absorbing, exciting, engaging). These items were drawn from several sources on arousal, hedonics and emotion (Berlyne 1960; Lavie & Tractinsky 2004; Lindgaard, Dudek et al. 2011; O'Brien 2010).
- *Hedonic/Pragmatic Quality:* three sub-scales, taken from a reduced version of the AttrakDiff2 scale (Hassenzahl 2004), for perceived hedonic quality-stimulation (HQS), hedonic quality-identification (HQI), and pragmatic qualities (PQ), plus one separate item to measure participants' level of attention (Lindgaard et al. 2006), (13 items).
- *PANAS:* a 14-item bipolar scale consisting of a reduced version of the *PANAS* scale *(Positive and Negative Affect Schedule,* derived from Watson et al. (1988), split between six items measuring positive affect (PA) and six items measuring negative affect (NA). The scale was reduced to remove questions which were not applicable to website (product) quality judgement, i.e. social affect (proud, ashamed, strong); as well as avoiding the same questions in the affect scale.
- *Usability:* a 4-item scale captured users' perceptions of the functionality, navigation and utility of the website after interaction (from (Lavie & Tractinsky 2004; Tractinsky & Zmiri 2005)).
- *Content:* a 3-item scale that captured participants' ratings on the quality, relevance and quantity of content, a reduced version of the Bernier Instructional Design Scale (Bernier 1996) (taken from De Angeli et al. 2006).

- *Service Quality:* a 3-item scale from (Lavie & Tractinsky, 2004) to measure the reliability, trustworthiness and quality of the websites.
- *Overall Experience*: a 3-item scale: visit again, recommend the site and rating the overall experience, from (O'Brien 2010) and two global evaluation constructs, Goodness and Beauty (from Hassenzahl 2004).

Quantitative data was analysed on aggregate average scales. Qualitative data from the interview transcripts was marked up and coded following grounded theory practice (Glaser & Strauss 1967; Cresswell 2013) to produce themed categories from initial open coding mark up of utterances, with frequencies of utterances as well as illustrative excerpts being reported following the mixed method approach.

3.2 Quantitative Data Results

3.2.1 Questionnaire reliability

Questionnaire items on all scales (*Affect, HQ/PQ, Content, Quality, Usability, PANAS* and *Overall Experience*) were aggregated to produce scale averages, since all scales produced high levels of internal reliability with Cronbach alphas ranging from α=0.75 to 0.96. Service Quality and Content scales showed worse reliability individually, and so they were merged (Service Quality & Content) to produce an acceptable α=0.75.

3.2.2 Website design and task differences

A two-way ANOVA was conducted on the Affect and Website Quality scales, using website (2) and task (2) as within-subject factors. No significant effect of *Gender* or *Age* +/- 25 was found when these were added as between-subject factors and this was consistent for all the variables tested (Affect, HQ, PQ, PANAS, Content-Quality, Usability and Overall Experience).

There was a significant main effect of website, $F(1, 39) = 20.54$, $p < 0.001$, $\eta^2 = .35$, and task $F(1, 39) = 16.11$, $p < 0.001$, $\eta^2 = .29$, but no interaction for affect. Participants' affective responses were significantly higher for the enhanced interactivity design (M=4.4) than for the standard design (M=3.7); see Figure 3. Also, participants' affect ratings significantly increased from initial exposure (M=3.6) to post-interaction (M=4.4) for both sites, indicating that affect increases as a result of interaction.

A two-way ANOVA was carried out on the *Hedonics (HQI and HQS)* and *Pragmatic (PQ)* scale using website (2) and task (2) as within-subject factors. The results for Hedonics revealed a significant main effect of website; $F(1, 39) = 17$, $p < 0.001$, $\eta^2 = 0.3$, task $F(1, 39) = 4.36$, $p < 0.05$, $\eta^2 = 0.1$, and interaction (website x task) $F(1, 39) = 8.31$, $p < 0.01$, $\eta^2 = 0.006$. Results for Pragmatics showed a significant main effect of website: $F(1, 39) = 16.5$, $p < 0.001$, $\eta^2 = 0.3$, task $F(1, 39) = 25.3$, $p < 0.001$, $\eta^2 = 0.4$, and interaction (website x task) $F(1, 39) = 9.43$, $p < 0.01$, $\eta^2 = 0.2$. Participants gave the same HQ ratings (M=3.4) for both sites on initial exposure, but after interaction, ratings increased more for the enhanced interactivity site (M=4.4) than for the standard site (M=3.4); see Figure 4. PQ ratings for both sites (M=4.6, 4.7) were similar on initial exposure, but after interaction the standard site (M=5.8) increased more than for the enhanced interactive site (M=4.9); see Figure 5. The enhanced interactivity

site was more aesthetically (HQ) attractive, but fared worse for usability (PQ) after interaction, although perception of usability improved for both designs after interaction.

Two-way ANOVA on *Beauty* and *Goodness*, revealed a significant main effect for task on Beauty F (1, 39) =4.14, p<0.05, η^2 = 0.1, but not for website and no interaction. Participants rated both sites more beautiful after interaction (M=3.8 to M=4.2). No significant effects were found for Goodness.

3.2.3 Analysis of between-site differences

For measures which were only taken after the interactive task, a one-way repeated-measures ANOVA was conducted on the aggregated scales *PANAS, Usability, Service Quality, Content* and *Overall Experience*, to identify any differences between the two websites (enhanced interactivity and standard).

Significant difference was found on the *PANAS + PA* scale between websites: F (1, 39) = 15.31, p <0.001, η^2 = 0.28, with the enhanced interactivity site giving higher positive ratings (M=2.9) than the standard design (M=2.3), but no significant difference was found for the *-NA* scale. No significant difference was found between websites for Usability, Service Quality-Content or Overall Experience. This suggests both sites were equally usable, and were rated similarly for their content and quality. At the end of the interview, participants were asked to rank their favourite websites in order. Twenty five participants (62.5%) chose the enhanced interactivity website while 15 (37.5%) chose the standard design. However this difference was not statistically significant (p>.10, Binomial test) so no conclusions can be drawn about user preference.

3.2.4 Inter-variable relationships

Five variables showed inter-site and inter-task differences; affect and HQ/PQ quality ratings, Beauty and *Positive PANAS*, hence the influence of participants' affective responses and quality ratings on their overall experience was investigated with a multiple regression analysis to test the hypothesis: *Website quality (HQ,PQ), Affect and Positive Emotion (PANAS) influence Overall Experience (Goodness and Beauty).*

All variables were significantly correlated for both sites within pre- and post-interaction datasets; but no significant correlations were found between pre- and post-interaction measures for either site apart from pre/post-PQ for the avatar site (p<0.05); hence ratings changed after interaction for both sites reflecting the inter-task differences found in the ANOVA. Preliminary analysis was conducted to ensure there were no violations of the assumptions of normality, linearity and multicollinearity, and all values were within recommended tolerance (> 10: 0.307 to 0.922), and VIF (< 10: 1.09 to 4.67), (Tabachnik & Fidell 2007).

Two sets of *Multiple Regression* tests were used to assess the influence of four independent (predictor) variables on two dependent variables for both sites (interactive and standard): Predictors: Hedonics (HQ), Pragmatics (PQ), Affect and + PANAS; on (1) Beauty, and (2) Goodness. For completeness further regressions were carried out using Affect, HQ, PQ, and PANAS with Overall experience as a dependent variable; and Content/Service Quality and Usability as predictors for Beauty, Goodness and Overall experience.

For both sites, pre- and post-interaction HQ predicted both Beauty and Goodness apart from post-interaction for the avatar site. PQ predicted Goodness in both sites pre-interaction; however, post-interaction there was only a weak effect for the standard site. Affect and PANAS showed no influence; see Table 1.

Overall experience was predicted by Affect and HQ for the enhanced interactivity site (R^2=0.765, β= .48, p<.01, β= .46, p<.05); and by Affect, HQ and PANAS for the standard site (R^2=0.732, β .26, p<.01, β= .43, p<.001, β= .32, p<.01). Usability was a weak influence on Overall experience for the enhanced (R^2=0.326, β= .26, p<.05) but no significant results were apparent for content/service quality. HQ predicted Beauty in both sites pre-interaction, but only for the enhanced site post-interaction. PQ had no influence on Beauty, but it did predict Goodness in both sites pre-interaction and for the standard site post-interaction.

3.2.5 Summary of quantitative results

Significant main effects supported both hypotheses: interaction enhances UX, and enhanced interactivity improves UX compared to a standard (menu-link navigation) design. This was reflected in differences between the sites and before/after interaction for Affect, HQ, and PQ. The overall difference in the effect sizes is illustrated in Table 2.

The enhanced interactive design produced more positive affect, emotion and higher ratings for HQ as demonstrated by the significance levels, and in medium-level effect sizes for Affect and HQ with emotion being close at 0.28. The task difference was less marked for HQ, which had small-effect sizes, although the differences for PQ, where the standard site was favoured, had a medium-effect size. In the site manipulation, enhanced interactivity produced a powerful effect on UX as measured by HQ and Affect but worse usability. In contrast, the task effect was considerable for Affect and PQ both with medium-effect sizes while smaller effects were seen for HQ.

A model summarising the regression analysis is illustrated in Figure 6. HQ has more consistent relationships with Beauty and Goodness in both the specific-to-general and the general-to-specific (inference model). Goodness is only associated with PQ pre-interaction in both models. Overall experience is predicted by HQ, Affect, and Usability and there no inter site differences apart from Usability predicting Goodness after interaction for the enhanced interactivity site, an observation consistent with the ANOVA PQ difference.

3.3 Qualitative evaluation of the interview data

A total of 447 comments were coded initially by open coding on any references to design and user feelings, and then aggregated to create seven category themes: Content, Usefulness, Usability, Aesthetics, Engaging, Interactive Features and Attractive. Category themes emerged from a combination of top down investigation directed by the quantitative analysis (HQ: Aesthetics-Hedonics, and PQ: usability/usefulness) and bottom up aggregation of lower level codes. Initial open coding in a sample of the transcripts (10 individuals) was checked for inter rater reliability. Initial agreement was 74% of coded utterances. Differences were discussed and reconciled leading to improved inter rater agreement of 95% in a second independent sample. Content is self

explanatory; Usefulness comments related to the utility, or usefulness of the whole design; while Aesthetics comments focused on perceived interface design qualities such as style, layout, colour, graphics, text fonts, etc. Usability comprised either positive or negative descriptions of problems, or good design features for navigation and interface operation. Interactive feature comments were non-usability-related opinions about the avatar, interactive media and other interactive controls. Engaging included general impressions about interactive experience related to flow, presence, exciting interaction or boredom. Attractive covered general positive or negative comments describing reaction to the design, e.g. “It’s pleasing”, “I found it annoying”, “Not much use”. Specific design feature references were coded within all themes apart from content (reference implicit) and usefulness where no features could be identified.

The enhanced interactivity design received a higher frequency of comments (56%) than the standard design (18%), although 26% of the total comments were general without any site-specific reference. Most of the comments on the enhanced interactivity site (see Table 3) referred to interactive features (22% of all comments), followed by usability and engaging (both 8%) and then attractiveness (7%). Although the interactive features, engaging and attractive comments were all very positive, usability in particular and aesthetics were adverse. The frequency distribution of comments for the standard design was similar for all themes; however, its interactive features received many adverse comments (NV -21), even though few actual usability problems were observed.

Although the content of the two sites was exactly the same, the enhanced interactivity version was perceived to have more content, possibly due to the inclusion of videos: “The one [site] with the videos obviously gives more information” [P28]; and the avatar, “The lady was showing us where we can find some relevant information” [P13]; whereas the standard design was considered to have too much content, “There was too much information” [P29], which was “boring to the user to look at” [P7].

Many of the negative comments on the standard design related to its lack of interactivity: “Everything was too static … I found it boring basically” [P30]. The lack of interactive features most commented upon were the absence of interactive links: “There’s hardly anything to click on” [P4]; no hyperlinks on images: “When I clicked on pictures, I tried to show them full size, but I couldn’t” [P37]; along with the absence of videos: “There were just pictures … no videos” [P2]. Overall the participants’ comments indicated that they favoured the more interactive site, despite the various usability problems reported; see Table 4.

In the enhanced interactivity design, the avatar attracted most of the comments made about interactive features (26.9%), although overall these were slightly negative (-5), reflecting a polarised opinion with some participants finding the avatar “intriguing” [P10], and “innovative, as it adds something new and fresh” [P17], which “adds to the experience” making participants feel more “involved” [P30]; while others found the avatar “quite distracting” [P2], “very annoying” [P35], and “very irritating while you are tying to read the website” [P4], because it “made my attention divert from the actual content” [P15], causing participants to feel they were “getting lost” and “confused” [P7]. Although the videos received fewer comments (10%), these were all positive (+22); similarly the interactive links and the map received fewer comments but on balance these were positive (see Table 4). For example, participants found the inclusion of videos “absorbing” [P30] as they “bring you closer to the event” [P38] and “kept

my interest longer than just reading content" [P34]; and the map was considered a "good idea" [P27], which was "very useful" [P13] and "worked very well" [P29], although it did receive a few poor usability comments relating to its not being fully interactive: "I tried to click, but it did not really work … sometimes you have to click twice to make it [photo) appear" [P6].

Attractiveness comments which referenced the avatar (6.8%) were nearly all positive (+15), as were engaging comments (+14); for instance, the avatar "added another dimension" [P3]; she "jumps right out at you" [P3], which "stimulates your aural senses" [P27], because "she talks, so then it's more engaging because she's telling you about it … so it feels nice" [P16]. In contrast, aesthetics (4%) and usability (16.8%) were negative (-9, -32). Negative aesthetics comments were associated with the size and realism, such as, "she's too big compared to the size of the page … she's taking up too much space" [P6), and her appearance, "I found it a bit tacky … somehow it didn't fit with the website" [P23]. Quite a few participants found her "kind of scary" [P1] and "quite frightening" [P6], as "it felt very artificial" [P21] and "really computerised", with a few participants preferring "a cartoon or maybe something a little more real" [P27].

The video feature was rated more favourably for attractiveness (+6) and engagement (+5), with no adverse usability comments, and the same pattern was apparent for the other interactive features which have been grouped under 'general' in Table 4. Nearly all the usability problems pertained to the avatar, with the lack of a mute control being most frequent. The following excerpts illustrate the problems, many of which could be attributed to poor usability design: "When I clicked on a new page she popped up again, which was annoying" [P9], as "she's speaking a lot of the time, even though I put her on mute" [P38]; not being able to control her talking: "she begins to talk automatically even though I didn't click anything" [P20]; confusion about the pop-up photos that the avatar was referring to when she spoke: "these photos would just start coming out and you couldn't figure out the logic of what made them come out … it was kind of irritating" [P1]. Generally, participants felt they did not have enough control over the avatar: "When you turn off the assistant there's no way of getting her back" [P11]; and there was no way to "adjust the volume" [P14], or alter the speed at which she was speaking: "The pace at which she was speaking was very slow" [P21]. The interactive map sustained a few adverse comments, but these were minor in comparison to the avatar.

In conclusion, the qualitative results confirm the quantitative analysis that the enhanced interactivity design produced a more favourable user experience. The interactive features were generally well received, while the standard design was considered boring and was rated less favourably because of its absence of interactive features. Interestingly, this negative view also influenced perception of content even though this was identical for both designs, so the lack of engaging interactive features appears to have created a 'negative halo' effect on content. This was confirmed when content comments were examined by the presentation order: more negative comments were given when participants had seen the interactive design first, than vice versa.

Although the avatar had a positive effect, it also received many negative usability and aesthetic comments, emphasising that interactive features have to be well designed. Other interactive features – the video and map – were well received.

4. DISCUSSION

The results demonstrate a clear advantage for the enhanced interactivity (avatar) site over the control for Affect and HQ, although the standard site scored better on PQ. This confirms hypothesis in research question 1 that interactivity enhances user experience. However, there was no statistically significant difference in overall experience between the sites. A tentative interpretation is that interactivity may making a difference and that is reflected in HQ and Affect and possibly in user preference, but when users make an overall judgement (including Goodness and Beauty) they do not distinguish between the sites; probably because other factors such as content are also taken into account. The absence of any differences in Content-Service Quality confirms that content was perceived similarly in both versions. Quantitative results in the experiment were consistent with our previous study (Hart and Sutcliffe 2013) showing a clear task effect that interactivity enhances user perception on all measures, and a site effect with the enhanced interactivity sites being rated better than the standard design on HQ, the converse for PQ, with no difference in overall measures. These qualitative measures provide insight into which interactive features influence user perceptions of favourable experience (research question 2), demonstrating that the manipulated design features i.e. avatar, interactive video and map were all perceived favourably, even though the avatar, in particular, received many poor usability comments.

Our findings demonstrate that interactivity matters in two ways: first, the general experience of interaction was reflected in increased affect from pre- to post-task measures; and secondly, the inter-site differences present in both experiments indicate that interactivity has an important influence on user affect and hedonic experience. The general effect of interaction has been well established by many pre-post studies that demonstrate that aesthetics may dominate pre-interaction experience; however, usability and utility are more important after experience (Hassenzahl 2004; Lee & Koubek 2010; Kristoff & Satran 2002). The strong task (before/after use) effect in both experiments was also present in Teo et al.'s (2003) findings. Before and after interaction differences in aesthetics and usability perceptions have been reported by Diefenbach & Hassenzahl (2009), while Lee & Koubek (2010) and Lindgaard et al. (2011) found that aesthetics is less influential after interaction, where usability tends to dominate.

The avatar site has a significantly higher affect rating both before and after interaction. One speculative interpretation for the before difference is that the avatar attracted more attention and affect due to a possible CASA (Computer as Social Actors) influence (Reeves and Nass 1996) in which presence of a human image exerts a positive bias. The pre- post-interaction increase in affect we attribute to interactivity, where the avatar site maintained its significant difference over the standard site. The standard site had better PQ but was not preferred overall which is consistent with Hart and Sutcliffe (2013) where the site which had the best usability, was second choice in overall preference. Affect and HQ measures were considerably higher after interaction, as well as favouring the more interactive design; moreover, the ANOVA interaction indicates that the act of interacting (pre/post) with enhanced interactive features may reinforce positive user experience in terms of Affect/HQ measures. Brief exposure appears to produce only moderate affective response, whereas interaction has a more

marked effect. While the influence on affect could depend on the effect of the task, the inter-site differences in HQ-affect point towards the role of interaction design.

These results agree with previous studies demonstrating the importance of interactivity on UX (Cyr, Head & Ivanov 2009; Cyr, Head, Larios & Pan 2009; O'Brien 2010; Teo et al. 2003); however, these studies manipulated either CMC and interactive feedback in websites (Teo et al. 2003) or interactive information visualisation (Cyr, Head & Ivanov 2009). We have extended the influence of interactivity to avatars, interactive graphical worlds/media and other design features which may promote flow as found in games-related user experience (Jennett, Cox et al. 2008; Bernhaupt 2010). The increase in affect we found in both experiments argues for these features contributing towards excitement and flow in user experience, whereas the results of Teo et al. (2003) and Cyr et al. (Cyr, Head & Ivanov 2009; Cyr, Head, Larios & Pan 2009) point towards design features that may contribute via social presence. Our results are also consistent with Yoon et al. (2008) who found that a 3D website design was superior to a 2D equivalent on measures of perceived usefulness, presence and satisfaction. Although they did not consider interactivity explicitly it may have been implicit in differences between the 3D design with zoom, pan and fly through, in contrast to the 2D which had a simple enlarge-image control. The influence of interactivity on affect we found is consistent with the emotional clusters of 'frustration' – possibly usability induced; and 'competence' – more positive efficacy – reported by Saariluomaand and Jokinen (2014), in a study on physical interaction using joystick and gestures for teleoperation.

Interactivity appears to have positively influenced overall preference in spite of the adverse usability attributed to interaction difficulties such as to poor avatar design. Qui & Benbasat (2005) found that avatars did not improve preference or UX expressed in usability measures in an e-commerce study, although their analysis suggested that poor realism and limited interaction may have contributed to adverse user ratings. However, Van Vugt et al. (2006) did find that avatars improved UX in an experimental study manipulating realism and beauty attributes, where more realistic and beautiful characters produced better UX measures, which agrees with the findings of Khan and Sutcliffe (2014) on realistic appearance and persuasiveness of avatar agents.

Although interactive features may enhance user experience, its influence on overall experience and user preference was not significant. This may be a consequence of poor design resulting in adverse usability influencing user perceptions of the more interactive design. For example, poor controls over virtual characters produced an adverse reaction; however, users appeared to partially condone poor design. Although interactivity produced significant effects on affect and hedonic qualities, there was only a modest overall preference for the interactive designs and no difference in overall judgement measures. This may indicate that while interactivity has a strong in-session effect, users may have been assessing the content/utility of the design when they expressed their overall choice. This contrasts with the findings of Cyr et al. (Cyr, Head & Ivanov 2009) and Teo et al. (2003) where the more interactive designs received more favourable overall evaluations. A possible explanation may lie in differences in the interactive features and tasks. In the more task-oriented, instrumental setting of e-commerce (Cyr, Head & Ivanov 2009; Teo et al. 2003), feedback and social interactivity were more directly goal-related than in our study, possibly reflecting an interactivity-utility association.

The inter-variable relationships results are reasonably consistent with the ANOVAs. On initial exposure, pre interaction, there were no inter site differences, however post interaction, while HQ continued as the main predictor for Beauty both sites, HQ also predicted both Goodness for the enhanced site. PQ also weakly predicted Goodness for the enhanced site. These results fit with the ANOVA differences between the sites. The qualitative data also demonstrates that the enhanced site was more engaging and attractive with many positive comments on its interactive features, although there were adverse usability comments. This helps to explain the HQ/PQ inter site differences. The regression analysis produced consistent relationships between HQ, Beauty and Goodness consistent with the inference model hypothesis (Hassenzahl, 2004; Hassenzahl & Monk 2010); although PQ-Goodness relationships were less consistent, being stronger pre-interaction in both experiments. Van Shaik et al. (2012) found a strong task (pre/post-interaction)-PQ effect in an experimental study of news websites, so the diminished influence of PQ we observed post-interaction may reflect poor usability experience. Affect had little effect on other variables apart from Overall experience, indicating that although interactivity appears to influence affect from the ANOVA results, its effect may be transient with less influence on judgement of general product quality.

While our experiment controlled manipulation of two design features (avatar and media) and held other design variables constant (i.e. aesthetics and content), we can not rule out influences from content delivery effects. The avatar design contained several usability errors which biased judgement against the more interactive version. It is a testament to the power of interactivity that this version was preferred in spite of the usability flaws. In this and previous experiments (Hart & Sutcliffe 2013) we have only tested a limited range of interactive design features, e.g. avatars, multimedia, interactive graphical worlds, fly-through navigation. While these design features do appear to influence users' affect and HQ ratings, there may be task-feature interactions; for instance, the effectiveness of avatars might be geared to explanatory conversations rather simple guided tours. Pre-test preference assessment is another improvement which might have revealed changes before/after interaction. Experiments inevitably suffer from limitations in scope. The search-exploration tasks and designs constrain the generalisation of our findings, although they do fit with a common theme on the importance of interactivity from other studies. We only tested in session experience with two short tasks; longer-term multi-session experience may well be different.

In future work we will investigate user experience in the longer term, in line with recent research road maps for UX (Hassenzahl & Tractinsky 2006; Law et al. 2013). Longer-term studies will present methodological challenges to the balance of quantitative and qualitative methods with sample strategies to gather data on the diverse aspects of UX. A further dilemma for planning future research is the materials perspective (Hassenzahl & Monk 2010). To validate our model we need to run experiments across a wide range of domains to investigate the relationship between products and criteria selection. Unfortunately, resource constraints on longitudinal studies limit sampling to a modest number of participants and products. Accordingly we will follow a dual approach of shorter-term experiments to extend the validity of our criteria judgement models across more domains and products, coupled with longitudinal studies of specific products from initial encounter to prolonged use.

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REFERENCES

Bargas-Avila, J., & Hornbæk, K. (2011). Old wine in new bottles or novel challenges: A critical analysis of empirical studies of user experience. *Proceedings of the CHI 2011 Conference on Human Factors in Computer Systems* (pp. 2689-2698). New York: ACM.

Berlyne, D. E. (1960). *Conflict, arousal, and curiosity*. New York: McGraw-Hill.

Bernhaupt, R. (2010). User experience evaluation in entertainment. In R. Bernhaupt (Ed.), *Evaluating user experience in games: Concepts and methods* (pp. 3-7). London: Springer.

Bernier, M. J. (1996). Establishing the psychometric properties of a scale for evaluating quality in printed educational materials. *Patient Education and Counseling,* 283-299.

Clark, A. (2009). *The complete guide to simulations and serious games*. Pheiffer-Wiley.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage.

Cyr, D., Head, M., & Ivanov, A. (2009). Perceived interactivity leading to e-loyalty: Development of a model for cognitive-affective user responses. *International Journal of Human-Computer Studies, 67*(10), 850-869. doi:10.1016/j.ijhcs.2009.07.004

Cyr, D., Head, M., Larios, H., & Pan, B. (2009). Exploring human images in website design: A multi-method approach. *MIS Quarterly, 33*(3), 539-566.

De Angeli, A., Sutcliffe, A. G., & Hartmann, J. (2006). Interaction, usability and aesthetics: What influences users' preferences? *Proceedings of the DIS 2006 Conference on Design of Interactive Systems* (pp. 271-280). New York: ACM.

Diefenbach, S., & Hassenzahl, M. (2009). The "beauty dilemma": Beauty is valued but discounted in product choice. *Proceedings of the CHI 2009 Conference on Human Factors in Computer Systems* (pp.1419-1426). New York: ACM.

Diefenbach, S. & Hassenzahl, M. (2011). The dilemma of the hedonic: Appreciated, but hard to justify. *Interacting with Computers, 23*(5), 461-472.

Domagk, S., Schwartz, R. N., & Plass, J. L. (2010). Interactivity in multimedia learning: An integrated model. *Computers in Human Behavior*, *26*(5), 1024–1033. doi:10.1016/j.chb.2010.03.003

Egglestone, S. R., Whitbrook, A., et al. (2011). Recommending rides: Psychometric profiling in the theme park. Computers in Entertainment (CIE), 8(3), article 21. doi: 10.1145/1902593.1902600 New York: ACM.

Forlizzi, J., & Battarbee, K. (2004). Understanding experience in interactive systems. *Proceedings of the DIS 2004 Conference on Design of Interactive Systems* (pp. 261-268). New York: ACM.

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Aldine.

Hart, J. & Sutcliffe, A. G. (2013). Love it or hate it: The UX of interactivity and user types. *Proceedings of CHI 2013* (pp. 2059-2068). New York: ACM Press.

Hartmann, J., Sutcliffe, A. G., & De Angeli, A. (2007). Investigating attractiveness in web user interfaces. *Proceedings of the CHI 2007 Conference on Human Factors in Computer Systems* (pp. 855-864.) New York: ACM.

Hartmann, J., Sutcliffe, A. G., & De Angeli, A. (2008). Towards a theory of user judgment of aesthetics and user interface quality. *ACM Transactions on Computer-Human Interaction*, *15*(4),1-30.

Hassenzahl, M. (2004). The interplay of beauty, goodness, and usability in interactive products. *Human-Computer-Interaction, 19*(4), 319-349.

Hassenzahl, M., & Monk, A. (2010). The inference of perceived usability from beauty. *Human-Computer Interaction, 25*(3), 235-260.

Hassenzahl, M., & Tractinsky, N. (2006). User experience: A research agenda. *Behaviour and Information Technology*, *25*, 91-97.

Hoffman, D. L. & Novak, T. P. (1996). Marketing in hypermedia computer mediated environments: Conceptual foundations. *Journal of Marketing, 60*, 50-68.

Jennett, C., Cox, A. L., et al. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies*, *66*(9), 641-661. doi:10.1016/j.ijhcs.2008.04.004

Jiang, Z. H. & Benbasat, I. (2007). Investigating the influence of the functional mechanisms of online product presentations. *Information Systems Research, 18*(4), 454-470.

Johnson, G., Bruner, G., & Kumar, A. (2006). Interactivity and its facets revisited: Theory and empirical test. *Journal of Advertising*, *35*(4), 35-52.

Khan, R. F. & Sutcliffe, A. G. (2014). Attractive agents are more persuasive. *International Journal of Human Computer Interaction, 30*(2), 142-150.

Kristof, R. & Satran, A. (2002). *Interactivity by design*. San Francisco: Adobe Press.

Kumar, M. & Garg, N. (2010). Aesthetic principles and cognitive emotion appraisals: How much of the beauty lies in the eye of the beholder? *Journal of Consumer Psychology*, *20*(4), 485-494. doi:10.1016/j.jcps.2010.06.015

Lavie, T. & Tractinsky, N. (2004). Assessing dimensions of perceived visual aesthetics of websites. *International Journal of Human-Computer Studies*, *60*, 269-298.

Law, E. L. & Van Schaik, P. (2010). Modelling user experience: An agenda for research and practice. *Interacting with Computers 22*(5), 313-322.

Law, E. L., Roto, V., et al. (2009). Understanding, scoping and defining user experience: A survey approach. *Proceedings of the CHI 2009 Conference on Human Factors in Computer Systems* (pp. 719-728). New York: ACM.

Law, E. L., Van Schaik, P., & Roto, V. (2013). Attitudes towards user experience measurement. *International Journal of Human-Computer Studies, 4*. doi:10.1016/j.ijhcs.2013.09.006

Lee, S. & Koubek, R. (2010). Understanding user preference based on usability and aesthetics before and after actual use. *Interacting with Computers, 22*(6), 530-543.

Lee, T. (2005). The impact of perceptions of interactivity on customer trust and transaction intentions in mobile commerce. *Journal of Electronic Commerce Research, 6*(3), 165-180.

Lidwell, W., Holden K., & Butler, J. 2003. *Universal principles of design*. Gloucester MA: Rockport.

Lindgaard, G., Dudek, C., et al. (2011). An exploration of relations between visual appeal, trustworthiness and perceived usability of homepages. *ACM Transactions on Computer-Human Interaction,18* (1), 1-30.

Lindgaard, G., Fernandes, G., Dudek, C., & Brown, J. (2006). Attention web designers: You have 50 milliseconds to make a good first impression. *Behaviour and Information Technology*, 25(2), 115-126.

Moreno, R. & Mayer, R. (1999). Cognitive principles of multimedia learning: The role of modality and contiguity. *Journal of Educational Psychology*, *91*, 358-368.

O'Brien, H. (2010). The influence of hedonic and utilitarian motivations on user engagement: The case of online shopping experiences. *Interacting with Computers*, *22*(5), 344-352. doi:10.1016/j.intcom.2010.04.001

O'Brien, H. & Toms, E. (2008). What is User Engagement ? A conceptual framework for defining user engagement with technology. *Journal of the American Society for Information Science and Technology, 59*(6), 938-955.

O'Brien, H. & Toms, E. (2010). The development and evaluation of a survey to measure user engagement. *Journal of the American Society for Information Science and Technology, 61*(1), 50-69.

Porat, T. & Tractinsky, N. (2012). It's a pleasure buying here: The effects of web-store design on consumers' emotions and attitudes. *Human-Computer Interaction, 27*(3), 235-276.

Qiu, L. & Benbasat, I. (2005). An investigation into the effects of text-to-speech voice and 3D avatars on the perception of presence and flow of live help in electronic commerce. *ACM Transactions on Computer-Human Interaction, 12*(4), 329-355.

Reeves, B., & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. Cambridge, UK: Cambridge University Press.

Saariluomaand, P., & Jokinen, J. P. (2014). Emotional dimensions of user experience: A user psychological analysis. *International Journal of Human-Computer Interaction*, *30*(4), 303-320.

Schild, J., LaViola, J. J., & Masuch, M. (2012). Understanding user experience in stereoscopic 3D games. *Proceedings of the CHI 2012 Conference on Human Factors in Computer Systems*. New York: ACM.

Sundar, S. S., Bellur, S., Oh, J., Xu, Q. & Jia, H. (2014). User experience of on-screen interaction techniques: An experimental investigation of clicking, sliding, zooming, hovering, dragging and flipping. *Human Computer Interaction*, 29, 109-152.

Sutcliffe, A.G. & De Angeli, A. (2005). Assessing interaction styles in web user interfaces. *Proceedings of Interact 2005* (pp. 405-417). Berlin: Springer.

Tabachnick, B. G. & Fidell, L. S. (2007). *Using multivariate statistics*. (6th ed.) Boston: Pearson/Allyn and Bacon.

Teo, H.-H., Oh, L.-B., Liu, C., & Wei, K.-K. (2003). An empirical study of the effects of interactivity on web user attitude. *International Journal of Human-Computer Studies*, *58*(3), 281-305. doi:10.1016/S1071-5819(03)00008-9

Tractinsky, N. & Zmiri, D. (2005). Exploring attributes of skins as potential antecedents of emotion in HCI. *Proceedings of the DIS 2005 Conference on Design of Interactive Systems*. New York: ACM.

Tractinsky, N., Katz, A.S., & Ikar, D. (2000). What is beautiful is usable. *Interacting with Computers, 13*(2), 127-145.

Tuch, A. N., Roth, S. P., et al. (2012). Is beautiful really usable? Towards understanding the relation between usability, aesthetics and affect in HCI. *Computers in Human Behaviour*, *28*, 1596-1607.

Van Schaik, P., Hassenzahl, M., & Ling, J. (2012). User experience from an inference perspective. *ACM Transactions on Computer-Human Interaction, 19*(2). 10.1145/2240156.2240159.

Van Vugt, H. C., Hoornb, J. F., Konijna, E. A., & Dimitriadoub, A. (2006). Affective affordances: Improving interface character engagement through interaction. *International Journal of Human-Computer Studies, 64*, 874-888.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *Management Information Systems Quarterly, 27*(3), 425-478.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of Positive and Negative Affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.

Yi, C., Jiang, Z., & Benbasat, I. (2011). Enticing consumers via incomplete product experience: An investigation of online product interactivity designs. *Proceedings of the CHI 2011 Conference on Human Factors in Computer Systems* (pp. 2679-2688). New York: ACM.

Yoon, S.-Y., Laffey, J., & Hyunjoo, O. (2008). Understanding usability and user experience of web-based 3D graphics technology. *International Journal of Human-Computer Interaction, 24*(3), 288-306.

Figures

Fig. 1. The two website home pages: enhanced interactivity with avatar guide and videos (left) and the still image/text standard design (right)

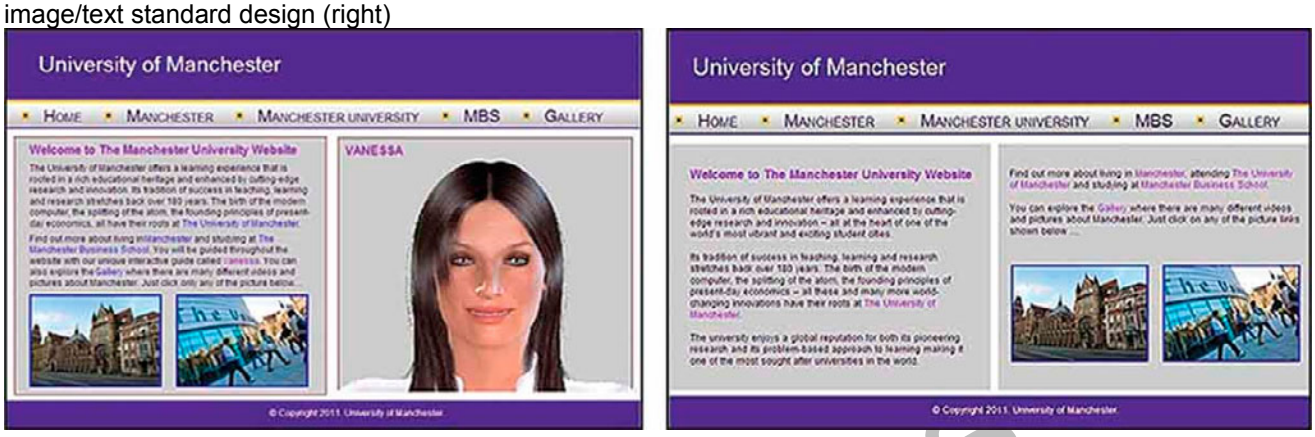

Fig. 2. Experimental method and measurement scales

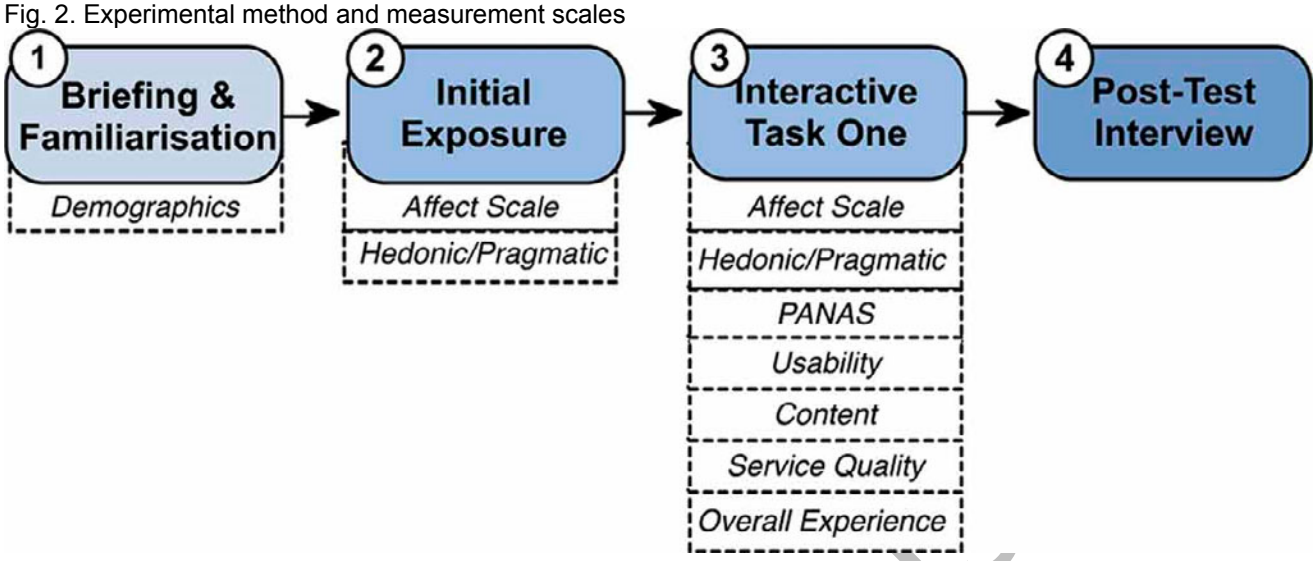

Fig. 3. Affect means for website (x2) and task (x2)

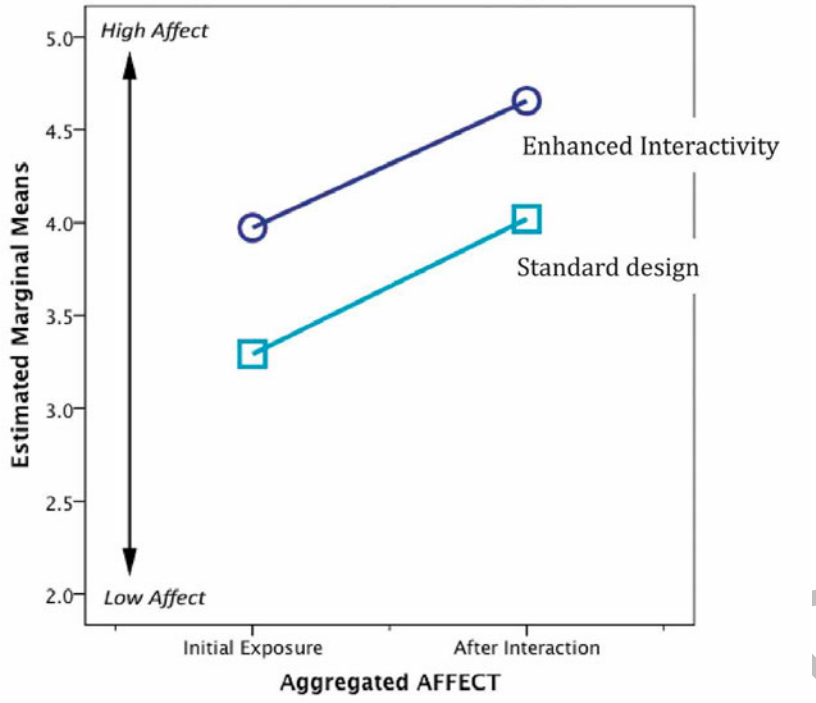

Fig. 4. Aggregated hedonics scale (HQI & HQS) for website (x2) and task (x2)

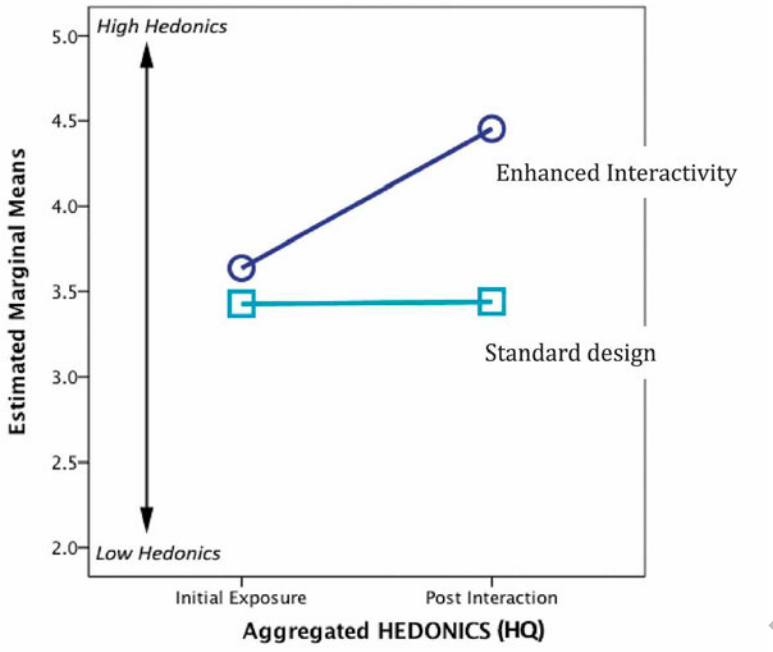

Fig. 5. Aggregated Pragmatic Quality (PQ) for website (x2) and task (x2)

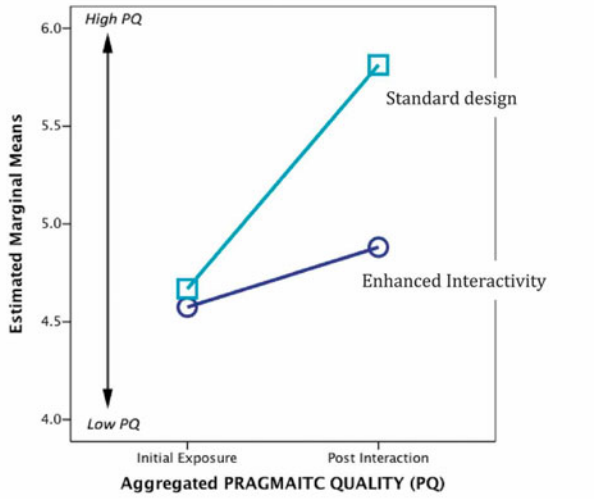

Fig. 6. Summary of the inter variable relationships from regression analysis . Annotations: enh = enhanced interactivity site only, std = standard site only, pre = pre-interaction only relationship. Dashed line denotes a weak relationships p<0.05; other relationships were p < 0.01

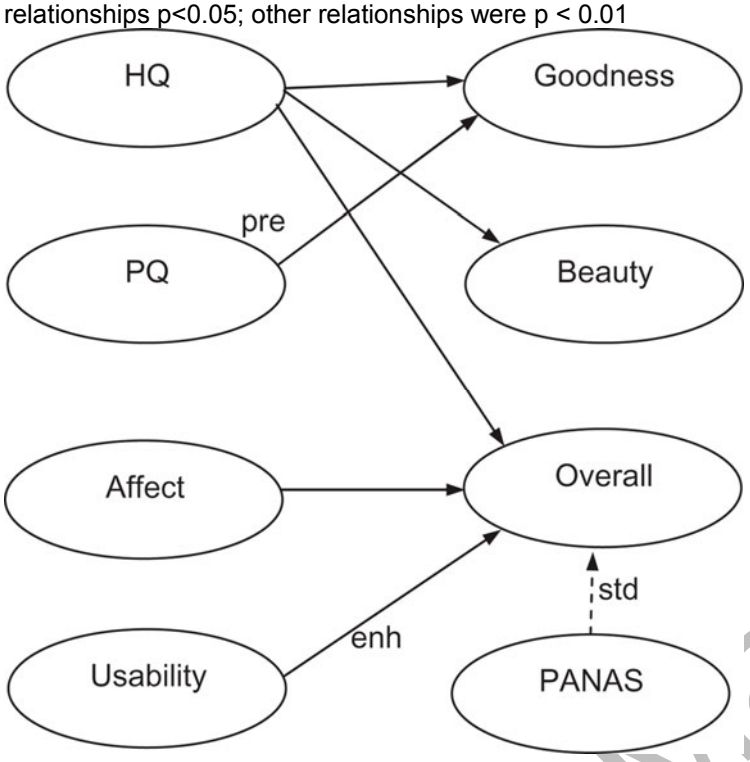

Fig. 7. Model of users' decision-making process during UX. Rectangles on the top line represent processes, rounded rectangles are input knowledge sources.

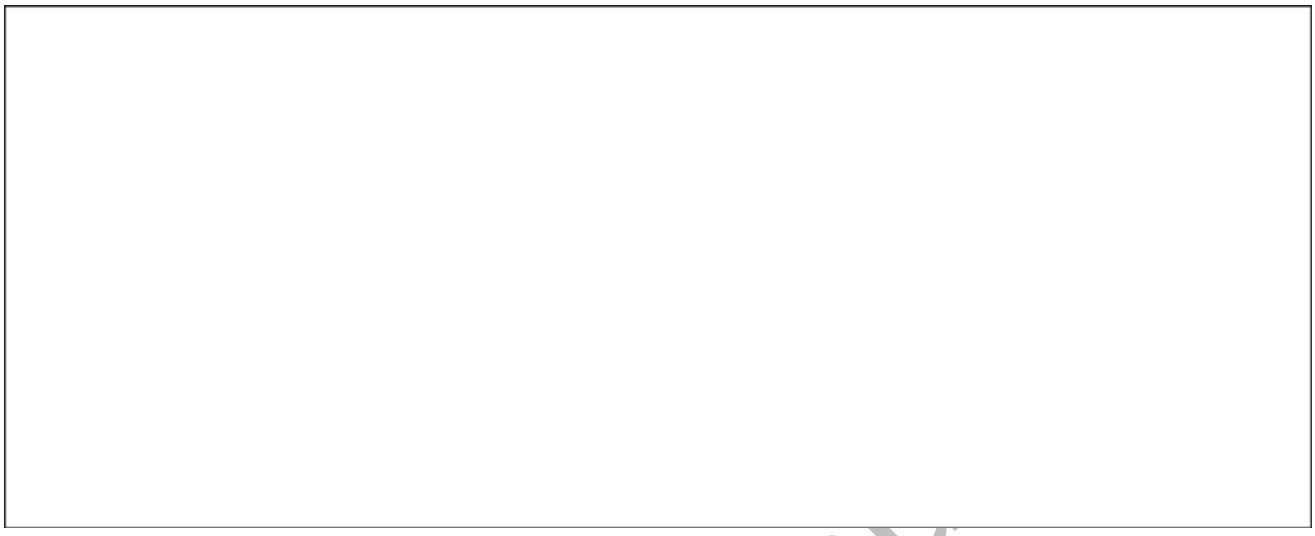

Table 1

Regression results pre and post interaction for both sites, significance * <.05, **, <.01, *** <.001

Enhanced interactivity (Avatar) site

Dep Var R^2 pre/post	Predictor	Pre Interaction		Post Interaction	
		β	Sig	β	Sig
Beauty R^2=0.615 R^2=0.697	Affect	-.01	Ns	.17	Ns
	HQ	.72	***	.68	**
	PQ	.18	Ns	-.01	Ns
	PANAS			-.01	Ns
Goodness R^2=0.71 R^2=0.747	Affect	-01	Ns	.39	Ns
	HQ	.67	***	.39	Ns
	PQ	.36	***	.17	Ns
	PANAS			.06	Ns

Standard site

Dep Var R^2 pre/post	Predictor	Pre Interaction		Post Interaction	
		β	Sig	β	Sig
Beauty R^2=0.686 R^2=0.737	Affect	.21	Ns	.02	Ns
	HQ	.64	***	.76	***
	PQ	.07	Ns	-.01	Ns
	PANAS			.11	Ns
Goodness R^2=0.695 R^2=0.736	Affect	.09	Ns	.22	Ns
	HQ	.57	***	.64	***
	PQ	.36	***	.22	*
	PANAS			.02	Ns

Table 2

Summary of the significance and effect magnitudes in the ANOVAs. <.05, ** <.01, *** <.001

Measure (dep. variable)	p Site effect	Effect size	p Task effect	η^2
Affect	**	0.35	***	0.29
Hedonic Quality	***	0.30	*	0.10
Pragmatic Quality	***	0.30	***	0.40
+ve Emotion	**	0.28	NA	NA

Table 3

Frequency and net valency of comments (+ve minus –ve comments) for the two versions of the website. Frequencies are sub category % of the total comments on both sites (56%, 18%, plus non site attributed 26%= 100)

Comment themes	Enhanced interactivity		Standard design	
	Freq	NV	*Freq*	NV
Attractive	7%	28+	2%	11+
Content	5%	17+	3%	1-
Usefullness	2%	9+	2%	7+
Usability	8%	37-	2%	7-
Aesthetics	4%	4-	2%	2-
Engaging	8%	34+	3%	6+
Interactive features	22%	32+	5%	-21
TOTAL	56%	79+	18%	6+

Table 4 Frequency and net valency of comment sub-categories for enhanced interactivity site

	Comment category	Frequency total	Frequency %	NV
Interactive features 98 NV +32	Video	22	10	+22
	Interactive links	9	4	+9
	Map	8	3.6	+6
	Avatar	59	26.9	-5
Attractive 30 NV +28	Video	4	1.8	+6
	General	9	4	+7
	Avatar	15	6.8	+15
Aesthetics 18 NV -4	Structure	4	1.8	+ 2
	General	5	2.2	+3
	Avatar	9	4	- 9
Engaging 36 NV +34	Video	5	2.2	+ 5
	General	15	6.8	+15
	Avatar	16	7.3	+14
Usability 37 NV -37	Avatar: mute control	20	9.1	-20
	Avatar: pop-up	6	2.7	- 6
	Avatar: pace	6	2.7	- 6
	Interactive map	5	2.2	- 5