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The influence of hedonic quality on the attractiveness of user interfaces of business management software

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Abstract

Recent work concerning user satisfaction shows that hedonic aspects of a user interface influence the perceived usability and attractiveness of the product. We investigate if these results can also be applied to business management software. In addition, we try to clarify the impact of hedonic aspects on user preference for different user interfaces.

In an empirical study subjects judged three different user interfaces for the same business task with respect to their attractiveness by filling out the AttrakDiff2 questionnaire (Hassenzahl, M., Burmester, M., Koller, F., 2003. AttrakDiff: Ein Fragebogen zur Messung wahrgenommener hedonischer und pragmatischer Qualität. [AttrakDiff: A questionnaire for the measurement of perceived hedonic and pragmatic quality]. In: J. Ziegler and G. Szwillus (Eds.), Mensch and Computer 2003: Interaktion in Bewegung, 187-196. Stuttgart, Leipzig: B.G. Teubner). The subjects ranked the interfaces also by personal preference. The results show that pragmatic and hedonic qualities have an impact on attractiveness. In addition, the more attractive an interface is the higher is the preference of subjects for this interface.

Keywords: Usability; Aesthetics; Hedonic quality; Business management software

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1. Introduction

Usability evaluations investigate traditionally if the user interface is well adapted to the work context of the user, easy to learn and efficient to handle. A well known example for this focus on effectiveness, efficiency, and learnability are the 10 criteria for a heuristic evaluation formulated by Molich and Nielsen (1990) or Nielsen (1994). Only one of these 10 criteria (called *Aesthetic and minimalist Design*) considers the aspect of a pleasant visual design. But even here the main motivation is to reduce unnecessary stimuli on the screen in order to give the important information the maximal visual weight.

In the last few years researchers in the field of human–computer interaction have increasingly discussed aspects like joy of use (Hatscher, 2001), aesthetics (Laugwitz, 2001), or emotions (Norman, 2003). Preece et al. (2002) summarize these and other related design aspects under the term *user experience goals*. They separate these user experience goals clearly from the *usability goals* like efficiency, effectiveness and learnability. The extent to which an interactive product is enjoyable or pleasant to use is often referred to as the *hedonic quality* of the product (Hassenzahl et al., 2000; Hassenzahl, 2002).

Typical research questions concerning user experience goals or hedonic quality are, for example, the dependency between aesthetic impression and apparent usability of a user interface (Kurosu and Kashimura, 1995; Tractinsky, 1997; Tractinsky et al., 2000), the influence of the colours in a graphical user interface on the mood and performance of users (Laugwitz, 2001), or the relation between hedonic quality and attractiveness (Hassenzahl et al., 2000; Hassenzahl, 2002; Helander and Po, 2003).

Recently, questionnaires for the measurement of the hedonic quality of a user interface have been developed (Hassenzahl et al., 2003; Lavie and Tractinsky, 2004). In this article, we will use the *AttrakDiff2* questionnaire (Hassenzahl et al., 2003). This questionnaire is embedded in a theoretical model which will be described in detail in Section 2.

Empirical research concerning hedonic aspects of user interfaces concentrates mainly on web pages and games. In our opinion it is also important to investigate the impact of such aspects on business users who frequently interact with a software application several hours a day (Schrepp et al., 2004). In addition, empirical results (Igbaria et al., 1994) show that user acceptance of a new technology is affected both by perceived usefulness and perceived fun. User acceptance plays an important role for the success or failure of many software projects. Thus, a deeper understanding of the user experience of business management software has potentially also a high economic impact.

In this study, we investigate whether existing results related to hedonic aspects of a user interface apply also to business management software. Users perceive business management software mainly as a tool which helps them to manage their daily work. Thus, hedonic aspects do not necessarily influence attractiveness to the same degree as on web pages or games.

2. A model for the attractiveness of user interfaces

The hedonic quality of an interactive product, for example a software product, can be measured with the AttrakDiff2[1] questionnaire (Hassenzahl et al., 2003). The questionnaire is embedded in a theoretical model which differentiates between the *pragmatic quality* and the *hedonic quality* of a user interface (Hassenzahl et al., 2000).

Pragmatic quality describes traditional usability aspects, i.e. efficiency, effectiveness and learnability. It focuses on task related design aspects. Hedonic quality describes quality aspects, which are not directly related to the tasks the user wants to accomplish with the software, for example originality and beauty.

Both qualities are subjective aspects of a user interface. Thus, users may differ in their evaluation of these aspects. The model assumes that pragmatic and hedonic quality are two independent quality factors of an interactive product.

The model separates the pragmatic and the hedonic qualities from user interface attractiveness. It is assumed that the perceived attractiveness results from an averaging process of the perceived pragmatic and hedonic quality. Attractiveness can change if the subjective importance of these two quality factors changes. In addition, it is assumed that the perception of a user interface as pragmatic or hedonic is stable over time.

Hassenzahl et al. (2003) further improved the model by splitting the hedonic quality into the two aspects *stimulation* and *identity*. Stimulation focuses on the human need for personal development, i.e. the need to improve personal skills and knowledge. A product can support this human need, for example, by providing new and stimulating functionalities or creative interaction or presentation methods. Identity focuses on the human need to be perceived by others in a particular way: 'humans communicate their personality over products. [...] A product can support this by communicating a desired identity' (Hassenzahl et al., 2003, p. 188). Fig. 1 shows the main concepts of the model and their interaction.

The model was investigated in several studies (Hassenzahl et al., 2000; Hassenzahl, 2002). The results of these studies show that pragmatic and hedonic qualities of a user interface do describe two distinct quality aspects. In addition, and confirming the authors' assumptions, these studies showed that perceived attractiveness of a user interface results from a combination of perceived pragmatic and hedonic quality. Both qualities had nearly the same influence on attractiveness. Another important result is that pragmatic quality showed a significant correlation with a measure of effort. The higher the perceived effort to complete a task was, the lower was the perceived pragmatic quality. Hedonic quality showed no correlation with the perceived effort to complete a task. Thus, hedonic quality is a non-task related quality which is not related to perceived effort.

3. Research questions

We investigate the impact of pragmatic and hedonic quality on the attractiveness of business management software. Users perceive this type of software mainly as a

[1] The items of the AttrakDiff2 questionnaire and their English translation can be found in Appendix A1.

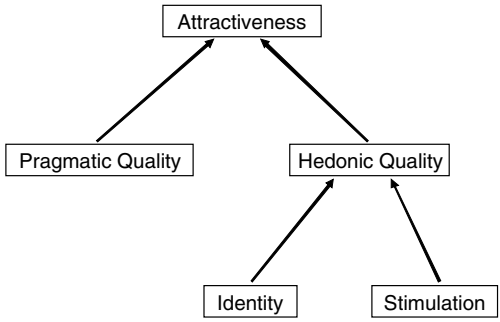

Fig. 1. Main concepts in the model of Hassenzahl et al. (2003).

tool, which supports them in organizing their daily work. Thus, it seems plausible that pragmatic quality is perceived here to be more important than hedonic quality.

Thus, our first research hypothesis is that pragmatic quality influences attractiveness more than hedonic qualities in business management software.

Since we deal with interfaces which are used as tools it is necessary to clarify the role and importance of the concept of attractiveness. It is, for example, possible that a user finds a business management software application quite attractive, but prefers to do his or her job with a less attractive alternative. This situation can occur, for example, if the user bases his or her attractiveness judgments on hedonic and pragmatic quality but selects the interface he or she wants to work with only based on usability considerations, i.e. pragmatic quality.

So we have to answer the question if more attractive interfaces for business management software are preferred compared to less attractive interfaces? Some existing research results can help to understand this connection between attractiveness and preference. Tractinsky et al. (2000) found that beauty or appeal of an interface is linked to the perceived usability of that interface. They summarized their results in the statement *What is beautiful is usable*. In a recent study, Lindgaard and Dudek (2003) showed that this relation between appeal and perceived usability does not exist for all types of interfaces. They investigated several web sites concerning appeal and perceived usability. One of the investigated web sites showed high appeal and user satisfaction ratings but low ratings in perceived usability. But according to the description in Lindgaard and Dudek (2003) this web site was of a very special type. It had more the character of a TV commercial designed to market products.

Typical user interfaces of business management software consist of electronic forms in which the user can enter the relevant data. In addition, the user can search for information and perform actions with the business objects modeled in the software. They are highly interactive and in general optimized for effective data entry. In our opinion, the proposed connection between appeal and perceived usability exists in general for interfaces of this type. We expect to find a dependency between perceived hedonic and pragmatic qualities in such interfaces. Thus, an appealing interface should also be perceived as usable, i.e. high hedonic quality should influence the perceived pragmatic quality in a positive way.

In the model of Hassenzahl et al. (2003) the attractiveness of an interface results from an evaluation based on the perceived pragmatic and hedonic quality. Thus, the concept of attractiveness as contained in the AttrakDiff2 includes a component for pragmatic quality or perceived usability of an interface.

Therefore, our second research hypothesis is that an appealing interface for business management software should also be perceived as usable. As a consequence high attractiveness should cause high user preferences for a user interface.

4. The study

Three variants of a user interface (hereafter referred to as interfaces A, B, and C) were compared with respect to attractiveness and user preferences. Examples of differences between the variants are the general layout of the screen, navigation mechanisms, placement of screen elements (like buttons or navigational links), colouring, etc. All variants provide the same functionality. Therefore, differences concerning attractiveness should exclusively be caused by different interface designs.

4.1. Participants

Two hundred and seventy-two persons were contacted by Email. All persons were students of the *Berufsakademie Mannheim*. Ninety-three of the potential participants started the investigation (response rate 34%). The data of eight participants were incomplete. The data for the remaining 85 participants were included in the analysis. The participants were not given course credits or payment for taking part in the investigation.

4.2. Presentation of the alternatives

Each of the three user interfaces was presented in a sequence of 11 screen shots. Each screen shot showed a step in a business scenario. A short explanatory text preceded each screen shot. After participants had read the text, they could start the presentation of the corresponding screen shot via a push button. The screen shot was then presented for 7 s. Then the next explanatory text for the following step in the scenario was shown automatically.

4.3. The questionnaire

The AttrakDiff2 questionnaire was used to measure attractiveness, pragmatic and hedonic quality of the various user interfaces. This questionnaire is structured as a list of 28 semantic differentials arranged in 7-point scales. The complete list of all AttrakDiff2 items can be found in Appendix A1. Each item consists of a pair of opposed adjectives. Each of the aspects *attractiveness*, *pragmatic quality*, *hedonic quality-stimulation*, and *hedonic quality-identity* is represented by seven items. Typical examples of the items are:

- *unpleasant–pleasant* or *ugly–pretty* (attractiveness),
- *complicated–simple* or *confusing–clear* (pragmatic quality),
- *conventional–original* or *conservative–innovative* (hedonic quality-stimulation),
- *lacking style–stylish* or *poor quality–high quality* (hedonic quality-identity).

The participants entered their ratings into an online form.[2]

The general preferences for the alternatives were collected with a final response sheet, which was also available as an online form. The participants had to state which alternative they liked or disliked most. They were also asked to enter the reason for their decision into a text input field. The analysis showed that only a minority of the participants filled this text input field with adequate comments. Therefore, a further analysis of these qualitative data is omitted here.

4.4. Procedure

The participants were contacted via e-mail. This mail contained a hyperlink by which the procedure could be started. The whole procedure consisted of three blocks:

4.4.1. Instruction

On the first screen displayed after starting the procedure, the participants were asked to read an overview of the study. They were told that a user's typical work sequence (the creation of a so-called *business opportunity*) would be shown in three variants with different user interfaces. The participants were also informed that they would have to assess the attractiveness of the different interfaces.

4.4.2. Presentation of the work sequence

After the presentation of all screens for one interface variant, the AttrakDiff2 questionnaire was displayed. The participants provided their ratings, clicked on a push button and then the screens for the next alternative appeared. In order to avoid sequence effects, all of the six possible sequences to present the three alternatives were employed and randomly assigned to the participants.

4.4.3. The final response sheet

After completing the AttrakDiff2 questionnaire for the last interface variant, a screen was displayed on which the participants express their preferences for the three alternatives. On this screen the participants were asked to state the alternative which they liked the most and the alternative which they disliked the most. In addition, a free text area was available in which the participants could express reasons for their preferences and comments concerning the experiment. After a participant filled out this screen a final screen with thanks to the participant and the information that the investigation is finished was displayed.

[2] Because of a technical problem, one of the items measuring hedonic quality-identity (HQI 6) was not recorded. Therefore, our data-set only contains ratings for 27 out of 28 AttrakDiff2 items.

5. Results

Fig. 2 shows—for each of the three alternatives—the mean scores[3] for the four subscales attractiveness (ATT), pragmatic quality (PQ), hedonic quality-stimulation (HQS), and hedonic quality identity (HQI).

We see that interface *B* scores highest on all subscales. With the exception of alternative *C* on subscale HQS, all scores of *B* are significantly higher than the corresponding scores of the other alternatives ($p < 0.05$, *t*-test two-tailed).[4] Further, alternatives *A* and *C* have similar overall scores, but seem to have different scoring profiles. Alternative *C* scores higher on HQS, but is assessed worse concerning PQ ($p < 0.05$). Table 1 shows the correlations between all items of the AttrakDiff2 questionnaire.

To check the reliability of the AttrakDiff2 subscales for our data we calculated Cronbach's Alpha for the four subscales. The resulting values are: 0.931 for ATT, 0.846 for PQ, 0.762 for HQI, and 0.872 for HQS. Usually, values of the Alpha-Coefficient > 0.7 are considered indicators for good reliability of a scale. The observed values are all above this threshold, so we can conclude that the subscales of the AttrakDiff2 questionnaire show a high reliability for our data.

5.1. Influence of pragmatic quality on attractiveness

Our first research hypothesis is that pragmatic quality influences attractiveness more than hedonic qualities in business management software. To check this hypothesis we investigate the dependencies between the subscales ATT, PQ, HQS, and HQI. Table 2 shows the correlations between these subscales.

As expected there is a high correlation between the hedonic qualities HQS, respectively, HQI and the pragmatic quality PQ. Thus, a positive assessment of the hedonic quality of an interface is connected with a perception of a good usability of that interface.

According to the model described in Section 2 the attractiveness assessment (represented by the subscale ATT) comprises the subjectively weighted perceived pragmatic and hedonic qualities (represented by the subscales PQ, HQI, and HQS). We calculated the corresponding partial correlations to get an idea about the contribution of PQ, HQI and HQS to ATT. The partial correlations of the single subscales with ATT are as follows: 0.574 for PQ, 0.505 for HQI, and 0.392 for HQS. All those correlations differ significantly from zero ($p < 0.01$). These substantial partial correlations show that all aspects contribute to the attractiveness of the alternative user interfaces.

To test our first research hypothesis we conducted a regression analysis. For this analysis we used the ENTER method for variable selection in which all variables are entered in a single step to the regression procedure. As shown in Table 3 below, these results yielded a measure of the contribution of each of the three subscales (PQ, HQI, and HQS) on ATT overall, as well as a measure of these relationships for each user interface (A, B, and C).

[3] The range of scores was 1 (negative) to 7 (positive).

[4] All *p*-values reported in the following always refer to two-tailed *t*-tests.

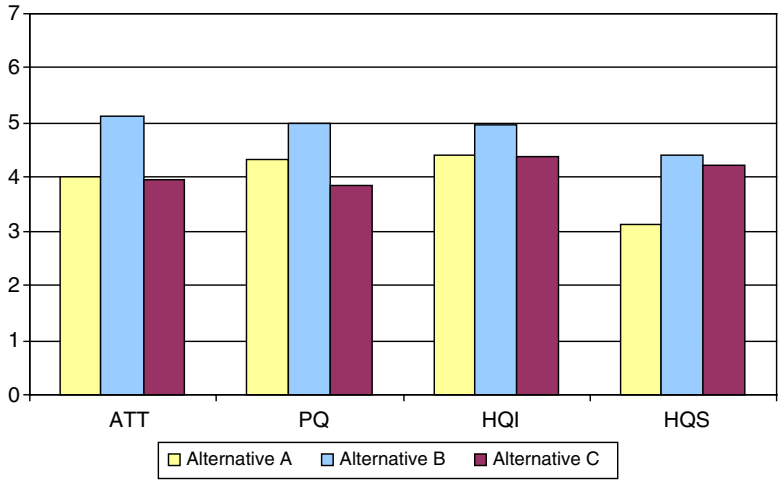

Fig. 2. Mean values for the AttractDiff2 scales *Attractiveness* (ATT), *Pragmatic Quality* (PQ), *Hedonic Quality-Stimulation* (HQS) and *Hedonic Quality-Identity* (HQI).

Over all alternatives PQ, HQI and HQS effectively predicted ATT. We can see in addition that in this condition PQ and HQI contributed almost equally to ATT while the influence of HQS on ATT is lower (see the 95% confidence intervals for b in Table 3). But in fact all three factors contributed to ATT.

For the single alternatives, PQ, HQI and HQS effectively predicted ATT in each case. But the influence of the factors PQ, HQI, and HQS on ATT differs between alternatives *A*, *B*, and *C*, respectively.

For alternatives *A* and *B* the highest β value is found for HQI. The β values do not differ significantly (see the 95% confidence intervals for the regression coefficient). Thus, the data do not allow a definite answer to the question of which variable shows the highest influence on ATT.

For alternative *C* the picture is quite different. Here, PQ and HQI contributed almost equally to ATT while HQS has no significant influence on ATT. This is also confirmed by the 95% confidence intervals for the regression coefficient. These data show that the influence of HQS on ATT is lower than the influence of PQ or HQI on ATT. Thus, HQS plays almost no role in attractiveness evaluation on interface C.

It is difficult to explain this different impact of the three factors PQ, HQI, and HQS on ATT within the model of Hassenzahl et al. (2003). We describe a possible explanation in Section 6.

The subscales ATT, PQ, HQI, and HQS show high correlations. To check if there is a problem with multicolinearity in our data we calculated for each variable the variance inflation factor (VIF). A commonly used cut off criterion is that a VIF value > 4.0 suggests a multicolinearity problem. The observed VIF values in our data (see Table 3) are all below that threshold, so multicolinearity does not seem to be a serious problem in our data set.

To sum up, the three subscales PQ, HQI, and HQS show significant correlations with ATT. In addition, the partial correlations and also the regression analysis showed

Table 1
Correlations between all items in the AttrakDiff2 questionnaire

	PQ1	PQ2	PQ3	PQ4	PQ5	PQ6	PQ7	HQI1	HQI2	HQI3	HQI4	HQI5	HQI7	HQS1	HQS2	HQS3	HQS4	HQS5	HQS6	HQS7	ATT1	ATT2	ATT3	ATT4	ATT5	ATT6	ATT7
PQ1	1	0.57	0.32	0.38	0.24	0.26	0.36	0.53	−0.18	0.42	0.15	0.4	0.43	0.47	0.45	0.2	0.43	0.44	−0.1	0.3	0.57	0.54	0.57	0.58	0.48	0.51	0.51
PQ2	0.57	1	0.65	0.52	0.5	0.41	0.64	0.51	0.08	0.38	0.37	0.57	0.55	0.3	0.39	0.01	0.25	0.43	−0.2	0.11	0.7	0.43	0.62	0.62	0.69	0.58	0.57
PQ3	0.32	0.65	1	0.61	0.56	0.35	0.66	0.47	0.23	0.29	0.49	0.58	0.58	0.19	0.28	−0.05	0.16	0.38	−0.07	0.1	0.59	0.37	0.6	0.51	0.66	0.5	0.59
PQ4	0.38	0.52	0.61	1	0.51	0.19	0.53	0.36	0.06	0.29	0.43	0.47	0.45	0.26	0.32	0.06	0.25	0.44	−0.05	0.14	0.53	0.31	0.45	0.49	0.55	0.46	0.53
PQ5	0.24	0.5	0.56	0.51	1	0.24	0.6	0.39	0.14	0.15	0.4	0.55	0.42	−0.02	0.07	−0.18	0.03	0.2	−0.2	−0.07	0.45	0.24	0.41	0.4	0.53	0.41	0.44
PQ6	0.26	0.41	0.35	0.19	0.24	1	0.31	0.19	0.04	0.27	0.14	0.25	0.27	0.06	0.07	−0.07	0.06	0.2	−0.17	−0.01	0.31	0.24	0.33	0.27	0.31	0.2	0.34
PQ7	0.36	0.64	0.66	0.53	0.6	0.31	1	0.5	0.17	0.31	0.49	0.61	0.62	0.08	0.29	−0.12	0.09	0.45	−0.09	0.01	0.58	0.39	0.57	0.58	0.71	0.61	0.53
HQI1	0.53	0.51	0.47	0.36	0.39	0.19	0.5	1	0.04	0.3	0.38	0.6	0.5	0.28	0.41	0.11	0.28	0.45	−0.09	0.18	0.53	0.43	0.54	0.58	0.56	0.53	0.45
HQI2	−0.18	0.08	0.23	0.06	0.14	0.04	0.17	0.04	1	0.07	0.28	0.1	0.14	−0.01	0.11	−0.08	−0.07	0.1	−0.03	0.06	0.08	0.04	0.11	0.05	0.18	0.06	0.03
HQI3	0.42	0.38	0.29	0.29	0.15	0.27	0.31	0.3	0.07	1	0.38	0.38	0.44	0.47	0.58	0.28	0.43	0.58	0.1	0.39	0.46	0.6	0.56	0.56	0.49	0.55	0.49
HQI4	0.15	0.37	0.49	0.43	0.4	0.14	0.49	0.38	0.28	0.38	1	0.52	0.57	0.11	0.37	0.03	0.15	0.38	0.07	0.11	0.45	0.38	0.45	0.49	0.57	0.49	0.4
HQI5	0.4	0.57	0.58	0.47	0.55	0.25	0.61	0.6	0.1	0.38	0.52	1	0.58	0.19	0.43	−0.02	0.22	0.45	−0.11	0.14	0.54	0.48	0.58	0.61	0.63	0.64	0.55
HQI7	0.43	0.55	0.58	0.45	0.42	0.27	0.62	0.5	0.14	0.44	0.57	0.58	1	0.25	0.46	0.04	0.26	0.51	−0.02	0.16	0.61	0.55	0.65	0.72	0.63	0.68	0.55
HQS1	0.47	0.3	0.19	0.26	−0.02	0.06	0.08	0.28	−0.01	0.47	0.11	0.19	0.25	1	0.65	0.56	0.74	0.51	0.09	0.73	0.31	0.49	0.46	0.36	0.28	0.35	0.36
HQS2	0.45	0.39	0.28	0.32	0.07	0.07	0.29	0.41	0.11	0.58	0.37	0.43	0.46	0.65	1	0.42	0.65	0.69	0.19	0.61	0.42	0.62	0.58	0.57	0.46	0.57	0.47
HQS3	0.2	0.01	−0.05	0.06	−0.18	−0.07	−0.12	0.11	−0.08	0.28	0.03	−0.02	0.04	0.56	0.42	1	0.63	0.28	0.18	0.56	0.05	0.18	0.16	0.13	0.04	0.1	0.18
HQS4	0.43	0.25	0.16	0.25	0.03	0.06	0.09	0.28	−0.07	0.43	0.15	0.22	0.26	0.74	0.65	0.63	1	0.51	0.13	0.76	0.28	0.5	0.43	0.4	0.28	0.38	0.37
HQS5	0.44	0.43	0.38	0.44	0.2	0.2	0.45	0.45	0.1	0.58	0.38	0.45	0.51	0.51	0.69	0.28	0.51	1	0.2	0.52	0.45	0.59	0.52	0.63	0.54	0.6	0.56
HQS6	−0.1	−0.2	−0.07	−0.05	−0.2	−0.17	−0.09	−0.09	−0.03	0.1	0.07	−0.11	−0.02	0.09	0.19	0.18	0.13	0.2	1	0.23	−0.11	−0.03	−0.06	−0.06	−0.05	−0.01	−0.05
HQS7	0.3	0.11	0.1	0.14	−0.07	−0.01	0.01	0.18	0.06	0.39	0.11	0.14	0.16	0.73	0.61	0.56	0.76	0.52	0.23	1	0.15	0.45	0.31	0.28	0.19	0.23	0.29
ATT1	0.57	0.7	0.59	0.53	0.45	0.31	0.58	0.53	0.08	0.46	0.45	0.54	0.61	0.31	0.42	0.05	0.28	0.45	−0.11	0.15	1	0.54	0.78	0.71	0.71	0.65	0.64
ATT2	0.54	0.43	0.37	0.31	0.24	0.24	0.39	0.43	0.04	0.6	0.38	0.48	0.55	0.49	0.62	0.18	0.5	0.59	−0.03	0.45	0.54	1	0.66	0.66	0.54	0.62	0.57
ATT3	0.57	0.62	0.6	0.45	0.41	0.33	0.57	0.54	0.11	0.56	0.45	0.58	0.65	0.46	0.58	0.16	0.43	0.52	−0.06	0.31	0.78	0.66	1	0.73	0.73	0.72	0.63
ATT4	0.58	0.62	0.51	0.49	0.4	0.27	0.58	0.58	0.05	0.56	0.49	0.61	0.72	0.36	0.57	0.13	0.4	0.63	−0.06	0.28	0.71	0.66	0.73	1	0.7	0.76	0.65
ATT5	0.48	0.69	0.66	0.55	0.53	0.31	0.71	0.56	0.18	0.49	0.57	0.63	0.63	0.28	0.46	0.04	0.28	0.54	−0.05	0.19	0.71	0.54	0.73	0.7	1	0.71	0.62
ATT6	0.51	0.58	0.5	0.46	0.41	0.2	0.61	0.53	0.06	0.55	0.49	0.64	0.68	0.35	0.57	0.1	0.38	0.6	−0.01	0.23	0.65	0.62	0.72	0.76	0.71	1	0.63
ATT7	0.51	0.57	0.59	0.53	0.44	0.34	0.53	0.45	0.03	0.49	0.4	0.55	0.55	0.36	0.47	0.18	0.37	0.56	−0.05	0.29	0.64	0.57	0.63	0.65	0.62	0.63	1

Table 2
Correlations of the subscales ATT, PQ, HQS, and HQI

	ATT	PQ	HQS	HQI
ATT	1	0.708	0.533	0.732
PQ	–	1	0.359	0.640
HQS	–	–	1	0.377
HQI	–	–	–	1

Table 3
Regression analysis of PQ, HQS and HQI on ATT over all alternatives and for each alternative separately

Criterion	Adjusted R^2	Predictors	β	b	Std. Err. *b*	95% CI for *b*	VIF
ATT over all alternatives	0.798^{***}	PQ***	0.454	0.480	0.043	0.395 to 0.565	2.07
		HQI***	0.403	0.578	0.062	0.455 to 0.7	2.35
		HQS***	0.212	0.240	0.036	0.17 to 0.31	1.22
ATT for alternative *A*	0.736^{***}	PQ***	0.350	0.337	0.073	0.192 to 0.483	1.82
		HQI***	0.426	0.525	0.094	0.338 to 0.712	1.85
		HQS***	0.374	0.437	0.067	0.304 to 0.570	1.04
ATT for alternative *B*	0.798^{***}	PQ***	0.369	0.397	0.076	0.245 to 0.548	2.09
		HQI***	0.458	0.615	0.105	0.406 to 0.825	2.55
		HQS**	0.207	0.244	0.070	0.104 to 0.383	1.47
ATT for alternative *C*	0.762^{***}	PQ***	0.483	0.532	0.079	0.376 to 0.688	1.79
		HQI***	0.469	0.686	0.112	0.464 to 0.908	2.06
		HQS	0.027	0.034	0.075	−0.114 to −0.183	1.23

$^{*}p < 0.1$; $^{**}p < 0.01$; $^{***}p < 0.001$.

that all three subscales PQ, HQI and HQS contributed significantly to ATT. Thus, we can conclude that our first research hypothesis is not supported by our data.

5.2. Attractiveness and preference

Our second research hypothesis is that more attractive user interfaces are preferred to less attractive interfaces. To check that hypothesis we investigate the dependency between the preference judgments for the alternatives and the subscales ATT, PQ, HQI, and HQS of the questionnaire.

Table 4 shows how often each of the alternatives was assessed as *best* or *worst*.

We transferred the preference judgments of a person into a preference score. The most preferred interface was given a score of 3, the least preferred interface was given a score of 1, and the remaining interface was given a score of 2. The mean preference score per interface and the corresponding mean value of all items in the ATT subscale are shown in Table 5.

As we can see from the table the rank order of the interfaces concerning their mean preference scores matches to their rank order concerning their mean attractiveness scores. The mean preference score and the mean value of the ATT scale for alternative *B* are significantly ($p < 0.05$) higher than the corresponding values for the alternatives *A* and *C*. The alternatives *A* and *C* do not differ significantly ($p < 0.05$) concerning these values.

Table 4
Preferences of the alternative user interfaces

Alternative	*A*	*B*	*C*
'Which GUI do you like the most?'	14 (16.5%)	57 (67.1%)	14 (16.5%)
'Which GUI do you dislike the most?'	33 (38.8%)	14 (16.5%)	38 (44.7%)

Table 5
Mean preference score and mean value of the attractiveness scale ATT per interface

Alternative	*A*	*B*	*C*
Mean preference score	1.78 (SD = 0.71)	2.52 (SD = 0.77)	1.71 (SD = 0.72)
Mean value for ATT	4.00 (SD = 0.9)	5.10 (SD = 1.13)	3.96 (SD = 0.95)

A Spearman rank correlation was then calculated comparing the subscales ATT, PQ, HQI, and HQS of the AttrakDiff2 questionnaire and the preference ranking of the alternatives. For each of the subscales ATT, PQ, HQI, and HQS and each participant a rank order on the alternatives was derived from the subscale. Therefore, we ordered the three alternatives accordingly to their value on the subscale. Then the rank correlation between this derived rank order and the preference ranking was calculated. The single subscales correlate with the general preference as follows: 0.505 for ATT, 0.636 for PQ, 0.383 for PQS, and 0.474 for HQI. All those correlations differ significantly from 0 ($p < 0.05$). The highest correlation is found for PQ.

We also investigated if the preference of a participant concerning the three alternative user interfaces can be predicted from his or her scores on the subscales of the AttrakDiff2 questionnaire.

Assume that X is one of the subscales ATT, PQ, HQI, or HQS. The subscale X can be used to predict the most preferred alternative if the alternative which shows the highest score on X is the alternative a participant liked the most. Conversely X can be used to predict the least preferred alternative if the alternative with the lowest score on X is the alternative the participant disliked the most.

We counted now for each of the subscales ATT, PQ, HQI, and HQS how often a successful prediction concerning the best, respectively, least preferred alternative could be made. When the AttrakDiff2 scores for two alternatives are identical, we eliminated the corresponding cases. The results of this analysis are shown in Table 6.

The best prediction can be made on basis of PQ. For 80.25% of the subjects the alternative with the highest PQ score was also the preferred interface. Thus, if we predict the interface a participant liked the most on the basis of the PQ score the

Table 6
Percentage of participants for which we can infer from the AttrakDiff2 score which alternative was the most, respectively, least preferred one

	ATT	PQ	HQS	HQI
Highest score and most preferred alternative	66.66% 52 out of 78	80.25% 65 out of 81	56.8% 46 out of 81	45.33% 49 out of 76
Lowest score and least preferred alternative	60.26% 47 out of 78	58.02% 47 out of 81	49.38% 40 out of 81	33% 41 out of 76

prediction is correct in 80.25% of the cases. Thus, in the case of business software as investigated here, pragmatic quality seems to have the strongest influence on subjective preferences for interfaces.

To sum up, the most attractive alternative was also preferred by a majority of subjects. We observed a high (0.505) correlation between attractiveness and preference ratings. Even on the basis of single subjects the attractiveness allows a relatively good prediction concerning the preference judgement of a subject. But here the quality of the prediction is even better for PQ than for ATT (see Table 6).

Thus, our second hypothesis that more attractive interfaces are preferred compared to less attractive interfaces is strongly supported by our data.

6. Discussion

A first result of our study is that the AttrakDiff2 questionnaire discriminates between the three alternative user interface designs used in our study. Thus, it is possible to use this questionnaire and the model behind it to measure differences of attractiveness in the area of business management software.

Our first research hypothesis was that pragmatic quality has a stronger impact on the attractiveness of interfaces for business management software than hedonic quality. This hypothesis was not supported by our data. The subscales PQ, HQI, and HQS of AttrakDiff2 showed significant correlations with the subscale ATT. In addition, the partial correlations and also the regression analysis showed that all three aspects PQ, HQI and HQS contributed significantly to ATT. Thus, we can conclude that both hedonic and pragmatic quality influence the attractiveness of the investigated interfaces. Even if business software is mainly seen as a tool the hedonic quality of this tool seems to be an important factor in the perception of its users.

Another interesting result is that the impact of the three subscales PQ, HQI, or HQS on ATT varies by interface (see the regression analysis in Table 3).

According to Hassenzahl et al. (2003) model the attractiveness of an interface results from a subjective evaluation based on the perceived pragmatic quality, stimulation and identification for that interface. The fact that the impact of PQ, HQI, and HQS on ATT differs between the three alternatives screen designs suggests that the subjective importance of these factors in the evaluation process is related to the particular user interface.

How can we explain such a dependency? One may speculate that the design of an interface evokes a user's expectation. This, in turn, influences the importance the user assigns to the factors PQ, HQI, and HQS.

Assume, for example, that an interface A is highly optimised concerning hedonic quality but shows a bad pragmatic quality. Users who see this interface the first time may thus focus their attention on the appealing elements of the interface and may not take notice of the usability issues. Assume now an interface B which shows good usability features, but lacks hedonic quality. The same users may now focus their attention on the usability features and may not notice the issues related to hedonic quality. Thus, a regression analysis may show that the hedonic quality strongly influences the attractiveness of interface A but not of interface B.

This dependency between the design of an interface and the influence of the three factors PQ, HQS, and HQI on ATT must be checked in subsequent studies. If it can be confirmed we need to develop a more dynamic model for the evaluation process from which the attractiveness judgements result.

The hypothesis that more attractive interfaces are preferred compared to less attractive interfaces is strongly supported by our data. The most attractive alternative was also preferred by a majority of subjects and there was a high (0.505) correlation between attractiveness and preference ratings.

Finally, our results indicate that there is a slight difference between measured attractiveness and user preferences. While pragmatic quality is clearly the best predictor for user preferences both pragmatic quality and hedonic quality seem to have nearly the same impact on attractiveness.

7. Appendix A1

Table A1 shows the items from the AttrakDiff2 questionnaire. Please note that there is currently no English version of AttrakDiff2 available. The translated items

Table A1
Items of the *AttrakDiff2* questionnaire and their English translation

Scale	Item	Original German items		English translation	
Pragmatic quality	PQ1	Menschlich	Technisch	People-centric	Technical
Identity	HQI1	Isolierend	Verbindend	Isolates	Connects
Attractiveness	ATT1	Angenehm	Unangenehm	Pleasant	Unpleasant
Stimulation	HQS1	Originell	Konventionell	Original	Conventional
Pragmatic quality	PQ2	Einfach	Kompliziert	Simple	Complex
Identity	HQI2	Fachmännisch	Laienhaft	Professional	Unprofessional
Attractiveness	ATT2	Häßlich	Schön	Ugly	Pretty
Pragmatic quality	PQ3	Praktisch	Unpraktisch	Practical	Impractical
Attractiveness	ATT3	Sympathisch	Unsympathisch	Appealing	Unappealing
Pragmatic quality	PQ4	Umständlich	Direkt	Cumbersome	Facile
Identity	HQI3	Stilvoll	Stillos	Stylish	Lacking style
Pragmatic quality	PQ5	Voraussagbar	Unberechenbar	Predictable	Unpredictable
Identity	HQI4	Minderwertig	Wertvoll	Poor quality	High quality
Identity	HQI5	Ausgrenzend	Einbeziehend	Excludes	Draws you in
Identity	HQI6	Bringt mich den Leuten näher	Trennt mich von Leuten	Brings me closer to people	Separates me from people
Identity	HQI7	Nicht vorzeigbar	Vorzeigbar	Not presentable	Presentable
Attractiveness	ATT4	Zurückweisend	Einladend	Rejecting	Inviting
Stimulation	HQS2	Phantasielos	Kreativ	Unimaginative	Creative
Attractiveness	ATT5	Gut	Schlecht	Good	Bad
Pragmatic quality	PQ6	Verwirrend	Übersichtlich	Confusing	Clear
Attractiveness	ATT6	Abstoßend	Anziehend	Repulsive	Pleasing
Stimulation	HQS3	Mutig	Vorsichtig	Bold	Cautious
Stimulation	HQS4	Innovativ	Konservativ	Innovative	Conservative
Stimulation	HQS5	Lahm	Fesselnd	Dull	Absorbing
Stimulation	HQS6	Harmlos	Herausfordernd	Harmless	Challenging
Attractiveness	ATT7	Motivierend	Entmutigend	Motivating	Discouraging
Stimulation	HQS7	Neuartig	Herkömmlich	Novel	Conventional
Pragmatic quality	PQ7	Widerspenstig	Handhabbar	Unmanageable	Manageable

can thus not be seen as a validated questionnaire. The items are listed in the order and polarity as they appear in the questionnaire.

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