Acceptance of visual search interfaces for the Web - design and empirical evaluation of a book search interface

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ABSTRACT

Today, lists are the prevalent representation format for search results on the Internet (e.g. Amazon or eBay). While lists are well suited for specific queries, they are of little help for nonspecific queries.

Theoretically, visual search interfaces outperform list interfaces for task types such as nonspecific queries, because they make use of additional semantic information (like price, date or review for a book). But what factors determine their acceptance in practice?

We created a graphical interface for searching books and evaluated it in a 51 participant study using the technology acceptance model. The results show that the novel interface is congruent with the model whereas the textual interface differs significantly. Moreover, we found that the variable enjoyment is of higher relevance in visual search interfaces than previously stated.

CR Categories: H.5.2 [User Interfaces]: Evaluation/ methodology—Graphical user interfaces (GUI); H.1.2 [User/Machine Systems]: Human factors—Software psychology

Keywords: information visualization, technology acceptance model, evaluation, eye-tracking, information retrieval

1 INTRODUCTION

None of the major web sites on the Internet applies visualization techniques for the search results presented to the user. This unsatisfactory fact is understandable for those search engines covering the whole world wide web (e.g. Google, Yahoo or MSN) because no presently available visualization technique is able to cover all the different knowledge domains of the web. But why do specialized sites like eBay or Amazon not use them? Search results are presented in static list formats. A user looking for the car that his friend is selling, is happy if he finds the desired result on top of the list. But in case the user is looking for a new car without having specific preferences, he will appreciate an overview of all relevant cars. This is where visualizations are highly beneficial: if more than one result needs to be displayed.

Today, eBay presents all search results as sorted lists, even for unspecific queries. We believe a visualization technique for vague search queries would be helpful to users. It allows for supplemental semantic information such as bidding history or user feedback to be incorporated in the visual interface.

A visualization technique for eBay queries would probably yield the best scientific results due to the complex nature of auctions. Results for that study would have the drawback that they could hardly be generalized to common internet shopping sites due to the very distinct nature of auction websites. Therefore, we decided to work with Amazon's book repository as the data basis for this study. Amazon represents a typical internet shopping site, which allows generalizable conclusions on the acceptance of visual interfaces in online shops. From a technical perspective, the Amazon programming interface permits simple and free access to the data. While various evaluations focused mainly on the objective results of the search process like recall and precision (see [5] for a summary), this study approached search result presentation from the perspective of consumer research. The subjective factors for visual interface acceptance are determined through replication of the technology acceptance model and backed by an eye-tracking study.

For the evaluation of the hypotheses, we designed a novel graphical interface with regards to both technology and complexity. Today's web places some restrictions on the construction possibilities of a visual interface. While interactive technologies such as Java applets were widespread five years ago, they play a minor role today. The competing Flash standard is not yet readily available. Therefore, the interface built for this study is solely comprised of the common technologies HTML and JavaScript. Even though these two programming means could be used to program an equally complex visual interface as using Flash, these would not be comprehensible in a couple of minutes due to its complexity. But as consumers are not willing to spend a lot of time on learning, novel visual interfaces for online information retrieval need to bring simplicity and abstraction together. The interface built for this study incorporates theses aspects and represents a common basis. We expect that more sophisticated interfaces can build upon our findings.

The paper is organized in the following way. The next section presents previous work in the field of acceptance research. The third section introduces the graphical book search interface built for the evaluation study. Section four describes the study in detail. The results of the study are reported in section five and discussed in the subsequent section. The paper concludes with final thoughts in section six.

2 ACCEPTANCE RESEARCH

Numerous applications for information visualization have been developed in the last twenty years. Not all of them have been evaluated through a user study [4, p. 1594]. Chen and Yu state that only a fraction of these evaluations meets standardized criteria like those used in other scientific disciplines (e.g. psychology) [5, p. 864]. Chen and Yu center their work around 27 studies on objective results of visual information retrieval tasks. While work in this area is essential to prove that visual interfaces outperform textual ones, they are only the first step.

Succeeding acceptance studies need to evaluate, how interfaces are perceived. The most sophisticated interfaces yielding much better objective results might never be used in practice due to an awful user interface. Some studies have already been conducted in this area and are presented in the following subsections.

Following a short introduction to the technology acceptance model used frequently, evaluations for information visualization interfaces in general are presented. Studies on internet technology acceptance and other related research are presented in the succeeding subsections.

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2.1 Technology Acceptance Model

The technology acceptance model (TAM) is the predominant model used for the evaluation of the acceptance of novel technologies. It has been developed and initially tested by Fred Davis in 1989 [7]. The model has been extended in numerous evaluation studies over the last 15 years. Venkatesh et al. give a comprehensive summary [26]. The technology acceptance model suggests that the two factors ”perceived ease of use” and ”perceived usefulness” determine the ”intention to use” which in turn influences the actual usage of novel technology. Application fields for the technology acceptance model have been many different types of information technology. Ranging from e-mail usage to internet adoption as a whole ([7, p. 326] and [20]). Most studies on the technology acceptance mode include external factors, which influence the variables ”perceived ease of use” and ”perceived usefulness”.

2.2 Extension of the TAM: Perceived Enjoyment

The technology acceptance model is often extended to incorporate supplemental determinants. ”Perceived enjoyment” is of special importance in consumer research and therefore relevant to this study. Several studies added enjoyment to the standardized technology acceptance model ([8], [19], [21]). ”Perceived enjoyment” measures the user’s intrinsic motivation as compared to ”perceived usefulness” which taps into the user’s extrinsic motivation. Koufaris emphasizes the importance of a joyful shopping experience, which typically leads to consecutive visits to the shop [19, p. 208]. Liaw and Huang explore the role of joy for using a classical web search engine. Their findings support the influential role of ”perceived enjoyment” for the acceptance of a new technology.

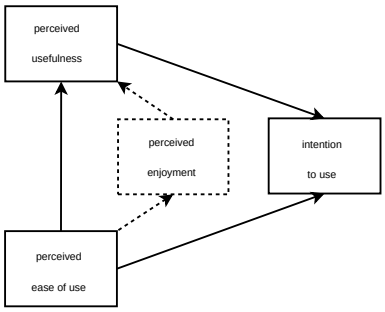

Figure 1: Technology acceptance model + enjoyment

The model in figure 1 summarizes the extended technology acceptance model used in this study. The classical technology acceptance model has been extended by the variable ”enjoyment”. In addition, we expect the determinants (internal factors) cognitive load and experience to reflect the external factors within the model.

2.3 Information Visualization Acceptance

The technology acceptance model serves in most previous studies as a supplemental subjective method that is meant to support the objective measurements of the study. Kobsa, for example, measures the user satisfaction in a study comparing five tree visualization techniques to the built-in Windows Explorer [18]. While Kobsa’s findings indicate that at least one of the visualization techniques is equivalent to the existent interface [18, p. 4], it remains unclear which interface users would choose. In addition to the factor ease of use measured by Kobsa, our study measures both extrinsic and intrinsic motivation.

In a qualitative approach towards evaluating the acceptance of visualization interfaces, Kobsa concludes that the visualization interface applied in the study is beneficial to users but lacks the ability to be easily integrated into the existing workplace applications [13].

2.4 Internet Technology Acceptance

The acceptance of internet technology is a more evaluated research area. Lederer et al. replicated the technology acceptance model in the early stages of the internet [20]. Their results support the hypothesis that technology acceptance can be applied to evaluate internet technology. Furthermore, they found that both ease of use and usefulness are more important factors for the usage of a web site than simple navigation or an appealing design [20, p. 201].

In a recent study, Shih evaluated the acceptance of internet technology for information retrieval tasks [25]. Again, her findings support the technology acceptance model. Shih extended it by adding the external factor ”relevance” and the subjective measure ”perceived performance” to the standard model. Furthermore, she reports that participants rated usefulness significantly higher than enjoyment [25, p. 726].

Whereas the former two experiments tested the general acceptance of web technologies, Money and Turner applied the technology acceptance model to a specific kind of internet technology: knowledge management software [23]. Their results are largely consistent with those of previous research [23, p. 8].

Chen et al. conducted a similar study on the acceptance of virtual stores [6]. They focus on the overall shopping experience and their results are once more in line with the predictions from the technology acceptance model. As in previous studies, they extended the technology acceptance model by adding the factors trust and service quality [6, p. 15].

3 Book Search Interface

The design rationale for the visual interface was to have a simple interface following today’s technological trends. Since none of the existing interface met the requirements, we programmed a new interface that combines features and findings from previous studies. Following some preliminary thoughts in the next subsection, technological restrictions are discussed. Furthermore, the design of the novel interface is presented and its handling explained.

3.1 Search Result Background

In a recent study, Hotchkiss et al. describe the search process as a series of query refinements [11, p. 5]. Consumers tend towards typing only few words without using logical operators (e.g. and/ or). If they cannot find the desired information on the first page, they usually refine their search by entering more specific terms found among the first result set [10, p. 20].

To ease this tedious process, White et al. propose displaying more information about the contents of the result pages [28]. Their findings support the proposition, that users like looking at a whole set of search results (20-30) to evaluate their search instead of seeing only few results as it is typical for today’s search engines [28, p. 227].

Kim backs these findings in her cognitive study on information seeking characteristics on the web [16]. Furthermore, her results suggest that nonlinear navigation between search results is beneficial to the whole search process [16, p. 337]. Present search interfaces inhibit nonlinear navigation through the presentation of search results in a vertical list. Interconnections between search results could facilitate the finding the right result.

3.2 Technological Foundation

Static HTML content was predominant in the first years of the internet. Early applications for visualizing information were mere

prototypes with limited functionality. This may be explained by limited processing power of the client computers as well as the lack of standardized interactive web technologies. The situation changed when JavaScript and Java applets were introduced. Today, applets and most applications based on them have disappeared whereas JavaScript remains in wide use. Applets have been replaced by Flash animations, but they are not as widely available as JavaScript. Therefore simple HTML and JavaScript form the basis of the programmed visual interface. We followed the "Google principle" and built a minimalist user interface offering full basic functionality.

On the server side, scripts have been written to answer client requests. We chose the PHP language to program the application, but in contrast to the client side technology (HTML, JavaScript), the server side technology PHP could easily be replaced by other programming languages like Perl or Java servlets.

As the interface was meant to be realistic, all data used in the experiment was generated in real time from the original Amazon book repository. Especially during the introductory tutorial, participants were able to search for anything they wanted. This enabled them to test the visual search engine for that knowledge domain they knew best. Technically, we sent the query terms to Amazon's E-Commerce Service [1] which delivers a XML document in reply. Style sheet templates were subsequently used to transform the result documents into a PHP data structure which was afterwards used to produce either textual or visual representations of the data.

3.3 The Baseline Interface

Two interfaces have been built for the study. One is the baseline application which emulates the Amazon web page without any distracting side information. It presents search results in the same manner as the original Amazon website. A sample screenshot for the search query "Linux" is depicted in figure 2. It uses Amazon's US book repository, whereas the German one was used for the study.

Figure 2: Screenshot of the textual interface

The interface is structured in the following way. The list that contains the search results is placed in the left half of the screen. In case one of the books is clicked on (either title or image), supplemental information on the book is given in the right half of the screen. The information presented corresponds to the data presented on the original Amazon web page. Besides selecting book information from the first result set, users can click on the appropriate option to view the next or previous 20 results. Furthermore, the user may open the standardized shopping basket. The shopping basket screen and its functionality is similar to that used by the Amazon web site.

3.4 The visual Book Search Interface

The book search visualization is a graph interface built with web technology. It offers minor interaction features for exploring the underlying data. Figure 3 shows a sample screenshot based on the same query as above.

Figure 3: Screenshot of the visual interface

Similar to the textual interface, the right half of the screen shows the selected book. The information included is identical to that of the textual baseline interface. The detailed information is only presented after the user clicks on a graphical book presentation. The left half of the screen shows the visual interface that represent the search result set for the given query. The query term is displayed above the image. Technically, the visualization consists of a JPG-image with an HTML image map to place clickable elements over the image file.

Generally, each book of the result set is represented by a book icon. Each graph is comprised of twenty individual book icons. They are organized in a matrix like format similar to that used for business administration software. In the visualization shown in figure 3 the most recent books are placed on top while the oldest books are arranged towards the bottom of the image. The cheapest books are placed to the left side while the most expensive ones can be found on the right side. Arranging data according to their relation has been widely used in other visual retrieval applications for the web. Kobayashi and Takeda offer a good overview of existing applications [17, p. 158]. The visual book interface represents a compromise between the magnitude of visualization techniques and the level of abstraction for commercial web sites. In order to reach a maximum of potential consumers, the visualization offered by a web site has to be both visually beneficial and easily understandable. Mukherjea emphasizes that abstraction is one of the key factors to be considered for acceptance of novel visual interfaces [24, p. 2].

The axes used in the book visualization are chosen when entering the search query. Possible axes include: price, date of publication, customer review, alphabetical order by author and average price per page. The overall size of each book icon corresponds to its sales rank as transmitted by Amazon. The five most bought books are displayed by an icon bigger than the others. Furthermore, if a book has an average customer review of five stars, a crown is placed on top of the icon.

If the user clicks on a book icon, it is highlighted by a circle and the books related to the current book are highlighted as well. The book relations are visualized by lines connecting the books. Books that are directly related to the current book are the thickest ones and books related to related books (second order or greater) have thinner lines connecting them. Huang gives a thorough explanation of the underlying principles [15].

In addition to these static features, the visualization offers an in-

teractive element to facilitate browsing the search results. If the mouse cursor is placed over a book, detailed information about the book is displayed in a tool tip like manner. Weinreich and Lamersdorf introduced a similar feature to regular web browsing called Hyperscout [27]. Technically, the supplemental information is shown by a JavaScript function. Figure 4 depicts a sample screenshot displaying the interactive feature.

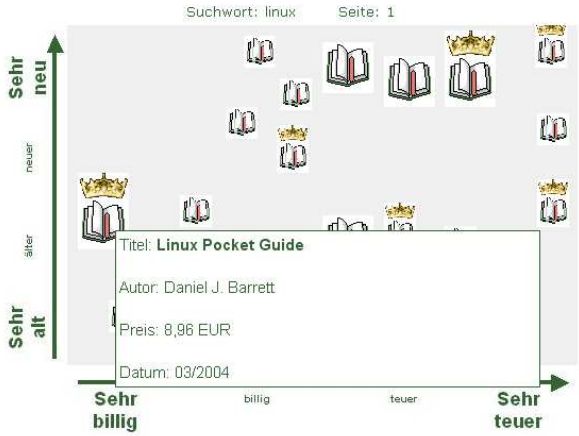

Figure 4: Screenshot of the interactive feature

Usually, each graph contains several groups of related items. In case a user is searching for the term ”java”, he might be interested in receiving information about the island but not about the computer programming language. The visual interface can show related groups of books by highlighting the books with the color corresponding to the group. This technique leans on the work of Donath [9]. Donath’s Loom project colors expressions from participants of a conversation. Pretests showed that the group coloring option was too complex for a short tutorial and thus all features but the group coloring one were evaluated in the study.

4 Experimental Evaluation

The visual book interface was evaluated in an experimental evaluation. The technology acceptance model was used as a subjective measure. These subjective results were backed by an eye-tracking usability study.

4.1 Hypotheses

Following our line of thought presented in the preceding sections, we formulated three hypotheses:

- **H1** The technology acceptance model can be applied to the novel visual book search interface.
- **H2** The new variable ”perceived enjoyment” functions as a mediator between ”perceived ease of use” and ”perceived usefulness”.
- **H3** The determinants ”cognitive load” and ”experience” have an influence on the ”perceived ease of use”.

The hypotheses were derived from the research presented in section two. Naturally, the technology acceptance model should prove as practical for visual information retrieval as it did for textual applications. Backed by other studies on intrinsic motivation, we believe that the influence of enjoyment is currently underrated. Especially for applications built for the consumer market.

Finally, cognitive psychology names the determinants cognitive load and experience as important influencing factors because they are commonly associated with consumer behavior for online shopping applications. A sophisticated interface that is hard to learn and demands a lot of thinking discourages customers from returning to the store.

4.2 Sample

The experiment comprised 51 participants in an eye-tracking laboratory. Due to the effort for analyzing the eye-tracking data, only 19 participants were randomly selected to be monitored this way. The sample consisted mainly of students (90.2%). The majority of participants had a business administration background (59.6%). The average participant was 25.4 years old (sd = 2.58). 31 female and 20 male test persons took part in the evaluation. 91% of the participants stated that their internet usage was high or very high. Furthermore, 86% of them declared to query search engines frequently or very frequently. In contrast, only 46% bought products on the web regularly or more frequently. Finally, a substantial number (18%) of participants had already used some sort of visual search interface.

4.3 Measures

A questionnaire was used as the subjective measure for the study. It comprised items concerning perceived ease of use, perceived usefulness, enjoyment of use, intention to use, cognitive load and experience. The items were derived from the acceptance studies presented in section two. Most items had already been translated into German and were evaluated in other studies.

The eye-tracking backup study was conducted using a head mounted device. Prior to the experiment, the screen was split into areas of interest which represent identical semantic sectors (e.g. a book icon or a button). For evaluation, a special multimedia software was used to attach a time line to each area of interest. This allows for measuring how long each area was looked at by the participants. Granka et al. as well as Goldberg et al. used eye-tracking in a similar context for evaluating user behavior for web search tasks ([14] and [12]). When using eye-tracking for scientific evaluation it should be mentioned, that some authors have already pointed out weak points or problems of eye-tracking analyses ([22] and [2]). Especially the calibration of the head mounted device tends to shift for some participants and needs to be recalibrated.

4.4 Procedure

The design of the experiment includes two independent variables: interface and experience. This yielded four design categories: either the textual or the graphical interface including or excluding preliminary training. The participants were randomly distributed into one of the four categories.

First, the participants were briefly introduced to the experiment. The 19 participants who took part in the backup eye-tracking study received short training on the operation of the helmet camera with subsequent calibration of the device.

After these preparations, participants started the actual experiment. Each test person was asked to solve two scenarios. The first scenario asked for searching a book for one’s aunt who adores orchids. The money limit was twenty Euros. The second scenario consisted of searching a book for the aunt’s husband who is very interested in Linux. Again, the budget was set to twenty Euros.

Depending on the design group, participants were shown a three minute introductory video with accompanying live demonstration. The video was meant to emulate experience with the search engine through presentation of standardized search queries. In either case, test persons were able to explore the respective interface alone for five minutes. Afterwards, the search task was explained to the test

persons who then started working on the task. Thoughts on setting a time limit for task completion were discarded because a fixed maximum would further increase the participant's cognitive load. A typical experimental session lasted 50 minutes.

To eliminate interaction effects, half of the participants used the visual interface at first and afterwards the textual one. The other half used the textual interface prior to the visual one.

Technically, in order to have comparable data repositories, all tasks were conducted using the same underlying data. While participants accessed live data repository during their trial time, they received prefetched data for the common task queries. This precaution prevented unwanted changes in the search result sets for the same query by different test persons.

Finally, participants were presented one questionnaire after each task and were asked to answer it. After completion of the two tasks, test persons were encouraged to ask questions about the study.

5 RESULTS

The presentation of the results is divided into the results from the subjective questionnaires evaluating the technology acceptance model and the results from the backup eye-tracking study. The section starts with a brief overview of the applied methodology.

5.1 Methodology

The first two hypotheses are tested for mediating effects using the analysis proposed by Baron and Kenny [3]. In short, Baron and Kenny state that an influence of the independent variable A on the dependent variable C can be explained through a mediating variable B if: A influences B, B relates to C and the relationship between A and C is weakened by a proven bi-directional prediction of C through B and A. The first two constraints are evaluated through a bivariate correlation analysis. Afterwards, a regression analysis shows whether the mediator can explain a significant effect.

The third hypothesis is evaluated through Pearson correlations and T-tests. The results of the eye-tracking analysis are briefly examined using descriptive statistics.

5.2 Hypothesis H1

The first hypothesis states that the technology acceptance is applicable to the novel visual interface. The analysis follows the scheme formulated by Baron and Kenny. The bivariate correlations for hypothesis one and two are conjunctly depicted in figure 5.

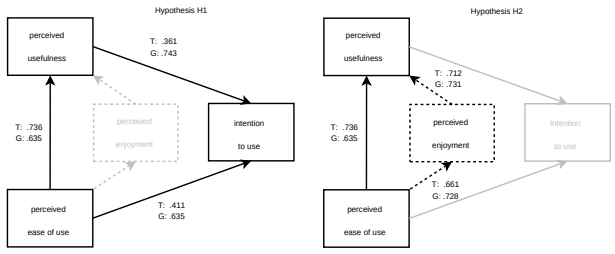

Figure 5: Bivariate correlations for hypotheses H1 and H2

The figure shows the three variables in question and tests were conducted to find out whether ease of use or usefulness are mere mediators. They could also explain some or none of the influence on the intention to use the application. The results show that all correlations are highly significant ($p < .001$). In figure 5, the labels next to the values represent the interface type (G=graphical, T=textual).

Table 1: Regression analyses for hypothesis H1 and H2

	Hypothesis H1			Hypothesis H2		
		intention to use			perceived usefulness	
		B	β		B	β
VIS	ease	0.300	0.274^{*}	joy	0.495	0.572^{***}
	usef.	0.656	0.569^{***}	ease	0.208	0.219^{ns}
	R^2	0.579^{***}		R^2	0.538^{***}	
TXT	ease	0.100	0.095^{ns}	joy	0.371	0.401^{***}
	usef.	0.419	0.430^{*}	ease	0.507	0.472^{***}
	R^2	0.223^{***}		R^2	0.617^{***}	

Concerning the graphical interface, all correlations are quite high. It can be stated that there exists a strong influence of both ease and usefulness on the intention to use. The succeeding regression analysis for the first two hypotheses are shown in table 1.

The influential effect of the variable ease on the intention decreases. It is therefore reasonable to say that ease has an influence on both usefulness and intention to use. And usefulness is the key determinant of the intention to use. Hence, hypothesis H1 can be confirmed.

While the hypothesis holds true for the graphical interface, results for the textual interface are different. The correlations shown in figure 5 indicate a much smaller influence on the intention to use. The succeeding regression analysis depicted in table 1 yields no significant influence of the ease of use on the usefulness. It is plausible to state that the technology acceptance model does not explain the well-known textual interface.

5.3 Hypothesis H2

The second hypothesis claims that the variable perceived enjoyment serves as a mediator between the variables ease and usefulness. The results for the bivariate correlation displayed in figure 5 are similar to those for hypothesis H1.

Results for the graphical interface indicate once more high effect values and they are highly significant ($p < .001$). The results for the regression analysis are displayed in table 1. It can be stated that joy serves as a mediator between ease of use and usefulness. Hypothesis H2 can be accepted for the graphical interface. Matching the preceding results for the textual interface, enjoyment does not serve as a mediator for the familiar textual interface. Both joy and ease of use have a strong influence on the usefulness of an application.

5.4 Hypothesis H3

The third hypothesis considers the influence of the factors cognitive load and experience on the ease of use. The correlation analysis yields high correlations for the visual and the textual interface between the cognitive load and ease of use (graphical 0.72, textual .69, $p < .001$ for both). There exist no significant interrelations for the cognitive load between the visual and textual interface (effect=.13, p=.37).

We tested whether experience (through short tutorial) has an influence on the cognitive load and the ease of use. Results of the t-tests show that the cognitive load is significantly reduced for the visual interface but not for the textual one (visual: $T_{(49)} = 2.108; p < .05$). The experience does not significantly influence the ease of use.

Table 2: Overall regression analysis

	Hypothesis H3		
		intention to use	
		B	β
VIS	ease of use	0.264	0.239^{ns}
	usefulness	0.625	0.545^{***}
	joy of use	0.116	0.116^{ns}
	cognitive load	0.061	0.073^{ns}
	R^2	0.568^{***}	
TXT	ease of use	-0.229	-0.218^{ns}
	usefulness	0.036	0.037^{ns}
	joy of use	0.639	0.708^{***}
	cognitive load	-0.137	-0.203^{ns}
	R^2	0.431^{***}	

5.5 Summary

Finally, a regression analysis containing all major factors yielded overall results. They are depicted in table 2.

To sum up, usefulness is the key determinant for the intention to use with respect to the graphical interface. In contrast, enjoyment has the strongest influence on usage of the textual interface.

The most relevant results of this study, the differences of influence in both interfaces are depicted in figure 6.

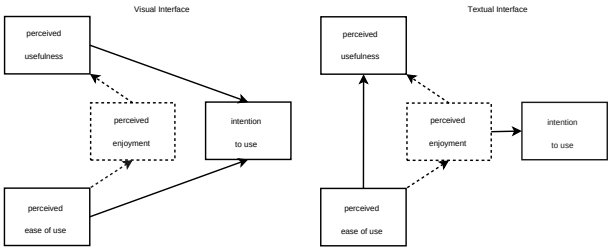

Figure 6: Overall influence for both interfaces

5.6 Eye-Tracking Backup Study

The eye-tracking study mainly served usability purposes. The recorded sessions are analyzed to enhance the usability for future versions of the book search interface. Descriptive statistics most relevant to this study are those involving fixation. The areas of interest are measured by the overall time and number of fixations. The mean values of the overall number of all fixations are 210 for the visual interface and 258 for the textual interface, the standard deviations being 108 and 136 respectively ($p < .1$). Participants had to look at roughly 50 areas less to solve the task visually. Exemplary, navigational elements were looked at 8 times and 4.3 seconds using the visual interface and 9.3 times and 6.6 seconds using the textual interface. Less navigational elements need to be checked to complete the given task.

Finally, the overall completion time was significantly smaller when the visual interface was used. The mean values are 3.21 minutes for the visual interface and 3.99 minutes for the textual interface (graphical sd 1.94, textual one 2.41). Both results are significant ($p < .05$). Using the visual interface, participants solved a task almost 50 seconds faster.

6 Discussion

This study has shown that the technology acceptance model can be applied to the novel user interface presented in this study. Since our findings are in line with numerous other studies that confirm the technology acceptance model, we argue that it would work for other visual information retrieval interfaces as well. In addition, we have shown that enjoyment is significant / a very important factor for the acceptance of the visual interface.

The fact that the model cannot explain the textual interface is also congruent with the theory as it is meant to explain new technologies instead of existing ones. Interestingly, enjoyment is the sole variable that determines the intention to use existing textual interfaces. This might explain the popularity of Google because the search engine may look and feel more fun than others. Furthermore, participants believe that the functionality of most existing book search engines is equally good. This is supported by the fact that usefulness has had no direct effect on the intention to use.

The evaluation of determinants yielded the predicted results only in part. The cognitive load should be taken into account for the design of a new visual user interface. The results have shown that experience can only reduce the cognitive load for the novel visual interface, but has no direct effect on the ease of use. Thus, the cognitive load can be reduced through proper training. Our results show that a three minute video can already reduce the cognitive load significantly.

It should also be mentioned that the sample consisted of 90% university students. It remains unclear whether a less educated sample would have produced similar results. In contrast, the typical internet user has an above-average education.

The role of the variable enjoyment as a mediator in the visual interface could be due to the absence of book cover thumbnails. We opted against including them, because the visual interface was designed to show an abstract graphical representation of the underlying data. A future version of the interface could include thumbnails as this missing feature was mentioned by the majority of participants. This is an interesting fact because in our own experience, quality of the cover and the content of a book do not necessarily correlate.

The overall completion time is another debated subject in consumer research. It is generally believed that the longer a customer visits a shop, the more products he usually buys. As the shopping time would be reduced through the new interface, less products would be bought on average. On the other hand, shopping at the store using the visual interface might be more convenient for users and therefore they may return more frequently. We would also argue that the customer sees an equal or higher number of books throughout the search process due to the visual interface which displays twenty books at a time.

Moreover, less query refinements are necessary because of the visual data representation. Customers are directly able to see related products instantly by following the lines drawn to similar books. This may be another reason for the shortened overall completion time.

The main focus of this study lay on the evaluation of acceptance of novel visual interfaces. Nevertheless, we collected subjective data on how users rated the two interfaces as well. Similar to the results of the eye-tracking study, an extensive reporting of the results would not fit into the contents and length of this paper. In short, participants thought that the textual interface is easier to use and in their perception leads to results in less time (objective results above show the opposite). The visual interface, on the other hand, is more enjoyable, more exciting and participants felt to be more in control. Eventually, participants liked the visual interface better than the textual one when asked for an overall assessment.

7 Conclusion

This study showed once more that insight from other fields of research serves as valuable input for information visualization studies. This study showed that the technology acceptance can be used to answer the question of how new visualization techniques are perceived by users.

In addition, we argue that it is important to measure the acceptance of a novel visualization technique together with the objective data usually collected. A novel visualization technique might have many objective advantages, but it will definitely fail if it is unusable.

Instead of providing a video, both
interfaces can be accessed online at:
http://www.olafthiele.de/aws

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