

Search and navigation as retrieval strategies in large photo collectionsⁱ

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ABSTRACT

In this exploratory study we investigated the use of search and navigation as strategies for retrieval in large collections of digital photos. The main goal of the research was to test out models and methods that can describe retrieval behaviour and preferences. A focus group interview was conducted and demonstrated the need for taking various types of factors and measurements into account. We examined relationships between independent variables (happiness levels, satisfaction with and confidence in the search results, feeling lost during search,), and perceived satisfaction as dependent variable. The analysis showed statistical significant relationships for some important factors, but also indicated limitations in the applied theoretical framework, in particular related to use of emotions as independent variables. The study also showed that users’ own perception of which retrieval strategy was the fastest differed from the actual time they used on search and navigation tasks. This confirms the need for analytical models that integrates subjective preferences/perceptions and measurement of objective factors.

Categories and Subject Descriptors

H5.2 User Interfaces: Evaluation/methodology; H3.3 Information Search and Retrieval

General Terms

Experimentation, Human Factors, Measurement

1. INTRODUCTION

This paper is a result from work in the Mariage (NCC 2009) research project, which stands for *Making Rich Media Accessible for Generations*. The project aimed at the development of principles, frameworks and demonstrators for life-time personal multi-medial albums. Media types of interest are photographs, videos, music and software-based media such as web pages, flash films/animations, and computer games.

This article addresses the aspect of *understanding strategies for end user retrieval of digital photos in large photo collections*. In the Mariage perspective, the development of sustainable and user

friendly strategies for retrieval in multimedia collections is important.

The research question is to study users’ preferences for two different retrieval strategies, *search* and *navigation*. *Search* means using the text search function, by applying keywords that matches photo metadata, e.g time and place. *Navigation* means to navigate visually through “tree” structures and pictures in photo collections, following implicit structures generated from metadata.

The experimental setting was designed to enable measuring of participants’ subjective feelings before and immediately after search and navigation sessions. Furthermore, the study examines the relationship between the subjective factors and objective behavioural factors, such as time used on different tasks.

In this paper, “subjective factors” refers to the participants’ own reported feelings, perceptions and assessments (Gwizdka 2007) before, during and after the task.

Previous related studies have reported lack of significant relationship between mood prior to the search/navigation, task difficulty level, searcher’s interest in a task and positive and negative affects. This reflects that the relation between search and mood is a complex one from a research perspective, in particular in terms of methodically sound design (Nahl and Bilal 2004). We believe that some of the methodological challenges are partly due to the design and operationalization of the variables involved. One research aim of this explorative study is to provide improvements of how the variables are operationalized and formulated in the questionnaire to be used by the participants.

After a brief review of previous studies, we present our model and approach. This is followed by a description of methods, results from a preparatory focus group, the participants, tasks and procedure. The article then presents and discusses the results.

2. Related research

Our research approach departs from the basic assumption in the literature (Lopotovska 2009, Gwizdka and Spence 2007, Kules and Shneiderman 2008) that search and navigation strategies, and

how users perform in carrying out such tasks, are influenced by subjective factors such as feelings, perceptions and evaluations

The present study extends the line of previous research in three ways:

(1) by focusing specifically on the study of search as well as navigation in digital multi-media material,

(3) focus on improving the operationalization of central variables (in particular the independent variables).

(4) a broader empirical approach, comprising both qualitative and quantitative approaches and methods.

Recent studies of search and navigation in textual material seem to indicate that the most efficient and user friendly approach is to *combine* search and navigation strategies in what is called a *faceted search* approach. (Li and Belkin 2008) However, research is less conclusive concerning which strategy will be preferred by users in retrieving multimodal material, such as photo collections. We believe it may be fruitful to study search and navigation experimentally in a photo collection setting.

The literature provides two ways to describe subjective states. First, ask participants *how they feel*. Second, ask participants *how happy they feel*. Both approaches have its merits and are widely applied in research, the first dominates in information science and market research, the second in measuring well-being in psychology (Kahneman, 2000).

The study draws upon previous studies (see Gwizdka and Spence 2007 for an overview) that have examined the relationships between searchers' subjective states and their behavior. Much of the work has been carried out in information science, but also studies in psychology shed light on several relevant aspects related to particular subjective factors, e.g. the notion of happiness (Kahneman, 2000)

Subjective aspects of information searching include aspects pertaining to the user's perceptions and feelings. The literature in the field includes studies of searchers' satisfaction (Su, 2003), relevance judgments (Saracevic, 2007) and feelings associated with the search stages (Marchionini, 1995; Agosto, 2002).

In previous inquiries in search studies, the approach to describing subject states is to ask participants how they feel. Various types of feelings can affect searcher's performance, but the feelings can also be affected by various other factors, such as user interface and the difficulty of the task.

There are several methodical challenges that must be dealt with in this type of research. Previous related studies (Lopatovska 2009a and b) have reported that due to several reasons there seems to be a lacking statistically significant relationships between mood prior to the search, topic of the search, sequence of task, task difficulty level, searcher's interest in a task and positive and negative affects (Lopatovska 2009). The present study will take into account that measuring mood in an experimental setting is often demanding. Clearly, search is a highly complex task for research (Nahl & Bilal, 2007) and participants' mood in the experimental setting may be affected by a number of factors that are not related to the task. However, lack of significant results may also be related to how the main themes, question and items are operationalized and formulated.

3. RESULTS FROM FOCUS GROUP

A focus group interview (Lindlof and Taylor 2002) was conducted to specify the research questions, increase our understanding of actual patterns of use and to provide input for the design of the planned experiment. It was important to gain insights about user strategies and behaviour from actual users.

The focus group comprised six people, varying in age from 20 to 73. All had experience and interest in photos and photography, but only one could be labelled an expert user. All participants were active photographers, most of them on a daily basis. The researchers had prepared an interview guide and had defined several themes for the group's work: equipment, hardware and software used, organization of collections, tagging/metadata, sharing with others, security, privacy and retrieval practices and experiences. The focus group interview lasted about two hours. The participants argued that navigation provided a feeling of closeness and personal control of the photos that a search alternative would not provide in the same way.

A striking result was that although all participants had large photo collections (only the expert user had systematically tagged his photos), it was not meaningful for them to apply search as the main method for retrieval. Time was the main organising factor, (typically a folder for each month and the subfolders for week and also days, and they typically used the options (year, month, date) offered in Windows Photo Gallery. The participants argued that navigation provided a stronger feeling of meaning, closeness and personal control of the photos than a search alternative would provide.

Another result relevant in the Marriage context, was that the young and the middle aged participants focused on creating *albums*, i.e. carefully selected photos (perhaps 1 to 100) that were gathered not only for personal use, but also to be made available for friends and family. Sharing photos was a central goal. According to the participants' preferences, *social* considerations seem to play a more central role than what was expected by the researchers. For the younger participants, making sense of the photo collection depended heavily on how albums could be seen by others. For these participants, their photo collection was seen as raw material for the construction of physical albums - which can be seen as the ultimate goal or end-product for their photographing endeavours. The participants (in particular the younger ones) clearly favoured to construct and distribute a physical (rather than digital) album. Several of the participants used such albums as Christmas gift to friends and family.

The way the younger participants used Facebook was also interesting. They used Facebook as a social medium just as most others use it. They also presented personal photos like others do. What was unexpected and interesting was that they also used Facebook as one of the main storage medium for their own photo collections.

The focus group participants were all dedicated amateur photographers with large collections of photos that require a systematic approach to management and maintenance tools and practices. It is a paradox that the participants applied storage and search mechanism that were surprisingly simple and non-efficient in terms of time and effort spent. The participants applied an incremental "bottom-up approach" in managing and searching their photo collections. They preferred navigation rather than search even though this was a more time-consuming and less

efficient approach. No metadata except the ones automatically produced by the camera were applied to the material. However, it can be speculated that users would have preferred search if their photos had been supplied with proper metadata at the outset, i.e. in the initial process of designing and constructing the photo collection structure. To apply metadata *after the fact* is more demanding, time consuming and less motivating; there may be thousands of photos that need to be post-processed.

The focus group seemed to indicate that the navigation mode has a strong position due to users' preferences for subjective control and overview in order to be able to select the relevant and meaningful photos. However, their preference for navigation can also be interpreted as a *fait accompli* since most participants have photo collections that are not designed for and equipped with relevant metadata that may make search a viable and realistic option. Search is simply not a relevant alternative. Thus, a preference for navigation can be expected. A fair hypothesis may be that user might prefer search if they know exactly what they are looking for and the photo database has metadata/tags that enable detailed search.

4. METHODS

In the following section the conceptual and methodological basis for the experiment is presented. A brief presentation of concept and how they are operationalized is followed by descriptions of the participants, the image collection and the task design and tasks.

4.1 Measuring feelings, perceptions and moods

4.1.1 Perceptions and feelings

Participants filled out questionnaires after each task. These questionnaires comprised two main sections, one section about perceptions and feelings and another section about mood. The section about perception and feelings such as

- Perceived level of *difficulty*,
- *Feeling* while searching
- *Getting lost*
- *Confidence*.

In order to increase level of reliability, these variables are seen as *constructs* of three defining, similar questions/statements in terms of content, but with changes in language and wording. For example, the questions defining and operationalizing Level of difficulty are:

1. Was it easy or difficult to solve this task
2. It is complicated to carry out the task
- 3 It was difficult to find the pictures that I was asked to find.

The participants shall fill out their response on a scale of 1 to 7

The operationalization of the variable constructs was an important research effort in its own right.

4.1.2 Mood

Participants' mood was measured using Positive Affect (PA) and Negative Affect (NA) Schedule (PANAS). The PANAS comprised of two 10-item scales that measure positive affect

(feeling enthusiastic, alert, active etc.) and negative affect (feeling of anger, afraid, guilt, nervousness, etc.). A typical way of using PANAS is to measure past and present moods (Mackinnon, Jorm, Christensen, Korten, Jacomb, & Rodgers, 1999). In this project the PANAS form was filled out after the completion of each of the six tasks. PA and NA questions presented to participants after search tasks asked for their feelings just after the completion of the tasks.

4.2 Participants

Twenty subjects participated in a study conducted in a controlled experimental setting. Participants were students recruited from University of Oslo and Oslo University College. The inclusion criteria were simply that they spoke and read Norwegian well and were capable ICT users (not experts). They ranged in age from 20 to 25 years, a few older, but all less than 30. Participants were offered a monetary incentive (300 NOK, approximately 35€).

4.3 Photo collection and user interfaces

The photo collection used in our experiments was constructed by compiling a subset of photos from a freely available collection of photos of an existing family that has made several thousands of their own photos public under a Creative Common License¹ through Flickr². The collection used in the test comprised 1000 photos that were selected from the larger collection. Each original photo had been tagged, i.e., described with a few words, by the owner, and this description was attached as metadata to the respective image. The photos were typically described with a name (*who*), a couple of words describing what is going on (*what*), and some information about the occasion (*where and when*).

The photos were made available for the participants through Picasa, an image management tool offered by Google. We chose Picasa 3.0 as it allows to conduct both image navigation and search, it has support for all relevant meta tags, and it has a simple, intuitive and very responsive user interface. Moreover, it is freely available on all major platforms, namely Windows, Mac, and Linux. Other interfaces and tools were considered, e.g. Windows and iPhoto, but Picasa was chosen mainly because it was less intrusive and more transparent and intuitive for users and thus provided an efficient and sustainable tool for studies of search and navigation from the user's perspective. All person names are changed except for the original labeling and other relevant metadata such as time.

The user interfaces for both search and navigation are shown below in Figure 1 and 2 respectively.

¹ <http://creativecommons.org/licenses/by-nc-sa/2.0/deed.en>

² www.flickr.com

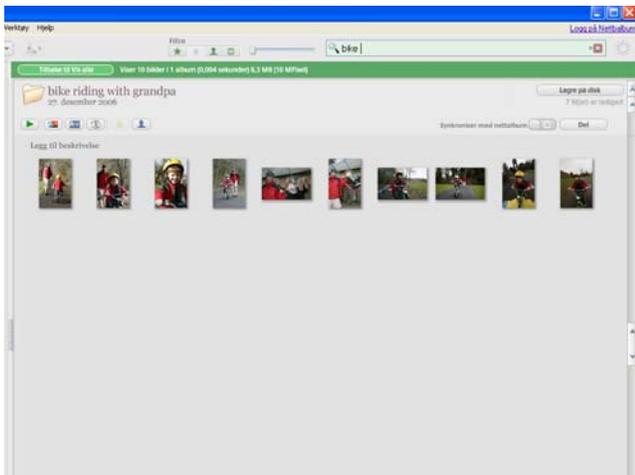


Figure 1 Search mode in Picasa.

The figure above shows the search mode. The participant is supposed to use the search field. Relevant input (e.g “bike”) in this field will immediately (one letter is enough) show relevant photos (involving “bike”). The navigation structure is not visible.

In the figure below the navigation mode is illustrated. The photos are on the right hand side, the navigation structure is on the left hand side.

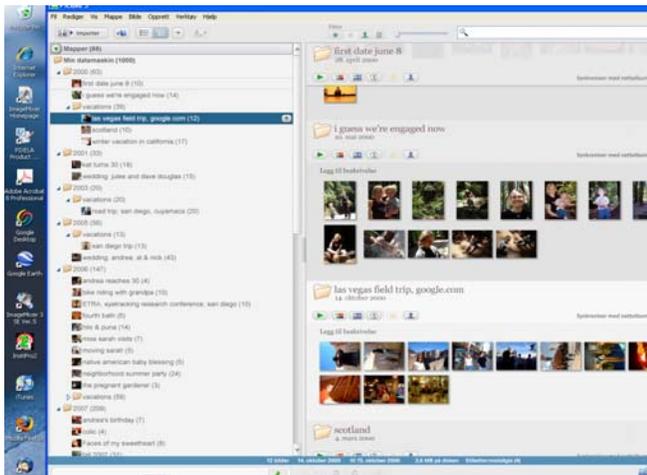


Figure 2 Navigation Mode in Picasa.

4.4 Task design and procedure

The experiment used a 1x2 within-subject (Kules and Capra 2008) design in which all participants used the same interface to complete two types of tasks, *search* type and *navigation* type search, alternating the mode used first. 10 participants started with search tasks, 10 with the navigation tasks

4.4.1 User Scenario and Tasks

The participants were presented with the following scenario.

“You are supposed to assist the Smith family in retrieving pictures that shall be put into two new family albums about the Smiths.

The family intends to give the albums to friends and relatives. The family has specific wishes about what pictures to select, but they need your assistance in retrieving these. You shall carry out six different tasks that will lead you to the preferred pictures.”

Search tasks

- 1a. Search for pictures of Al, Andrea, Nick and Paul from the two recent years (2008 and 2009) and put them in the album. Find two pictures of each person, or alternatively pictures that show several of them together.
- 2a. Search for pictures from all trips to San Diego and find one picture from each trip in which members of the family have participated
- 3a. Search for pictures from the three most recent years that show Nick’s and/or Paul’s sporting activities, soccer and cycling.

Navigation tasks

- 1b. Use navigation to retrieve pictures of Al, Andrea, Nick and Paul from the two recent years 2008 and 2009. Find two pictures of each person, or alternatively pictures that show several of them together.
- 2b. Navigate to find pictures from all trips to San Diego and find one picture from each trip in which members of the family have participated.
- 3b. Navigate to find pictures from the three most recent years that show Nick’s and/or Paul’s sporting activities, soccer and cycling.

4.4.2 Setting and procedure

An experiment took place in a laboratory with a laptop computer , and was filmed with a video camera. The computer recording software Morae³ recorded the session.

Each participant was scheduled for an individual session lasting from 50 to 120 minutes. The procedure and tasks to be carried out by the participants were:

- Upon arrival read and sign the consent form and listen to the explanation of the procedure.
- Fill out a pre-task questionnaire.
- Familiarization with the Picasa software, with an example to demonstrate the interface and the functionality.
- Read the scenario and the tasks
- Conduct search/navigation task (six tasks)
- Fill out questionnaire after each task
- Fill out post-task questionnaire and the open-ended questions about search versus navigation
- Short Interview concerning the answers to the open-ended questions and any other matter
- Receive NOK 300.

³ Morae by TechSmith is a software that records real-world actions, such as user speech and facial expressions, along with detailed application and computer system data to provide a view into the way that web sites and software are seen and experienced.

5. Results from experiment

The findings presented in this section serve two purposes. First, we show some illustrative results based on the collected data. Second, we discuss and show some possibilities as well as limitations of the analytical and theoretical models that are applied.

Partial least square (PLS) is the statistical analysis technique applied to interpret how the factors are associated with each other. PLS^[4] can be used with small sample, but there is a limitation related to the number of factors in the structural model (Chin, 1998). In this study five concepts are used as independent variables. These are level of difficulty, level of confidence, to what extent the user got lost, negative and positive emotions. The sample size indicates that a structural model should contain two of these concepts and one dependent variable. Because of the second purpose, all five concepts are included in the model presented below.

In a structural model, it is possible to analyze to what degree, if any, these concepts are associated with or have an influence on dependent variables such as satisfaction and use of time. Use of time is an efficiency measurement which can be measured by the Morae software that was applied in this study.

The figures 3 and 4 present the comparison of use of time for search vs. navigation. In both groups task 1, 2 and 3 were performed. The only difference is the mode. Figure 1 presents the comparison of search vs. navigation when the participants did the task for the first time. After doing the search, the same person did navigation. Hence, the tasks 1, 2 and 3 were repeated. The comparison of use of time in the repetition is shown in figure 4. The scale is on interval level. 1 means up to 119 seconds, 2 means 120 to 179 seconds, 3 means 180 to 239 seconds etc.

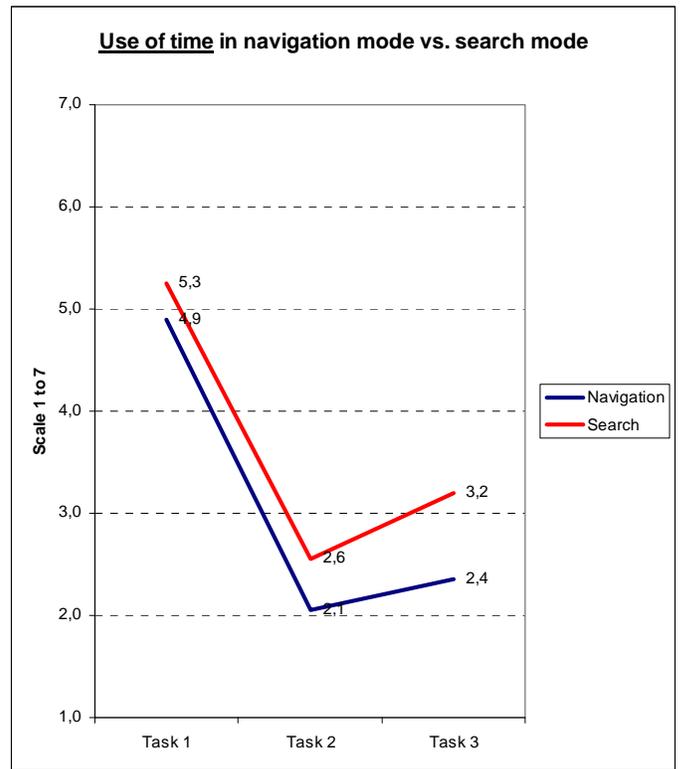


Figure 3 Comparison of use of time between navigation mode and search mode

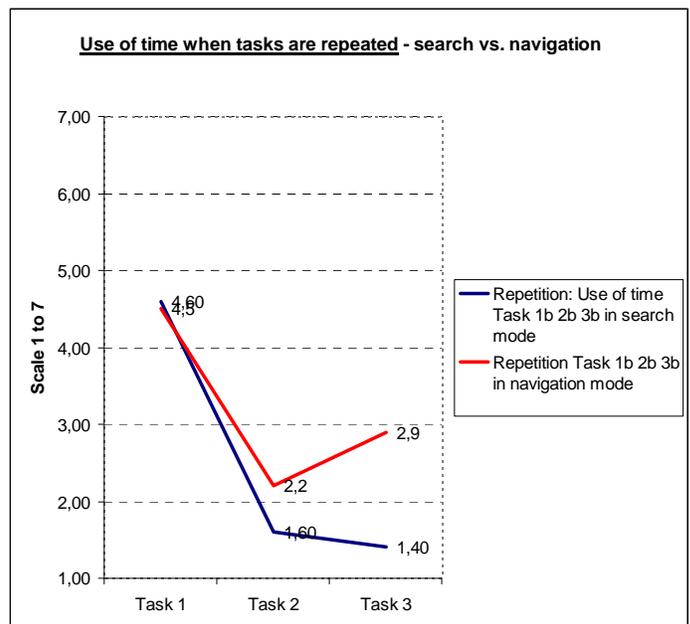


Figure 4 Comparison of use of time between navigation mode and search mode when the tasks are performed a second time.

For both modes (search and navigation) the respondents used less time on the tasks when the tasks were repeated. The findings

indicate that the navigation mode is the faster of the two modes. In their comments 12 of the 20 respondents wrote that search is faster than navigation. Since the tasks are time-stamped, it is possible to judge this subjective assessment of the users. In both groups 6 out of 10 stated that search is faster than navigation. For the group that did navigation first, search was the fastest mode for all of them. However, this is primarily due to the learning effect. In the group that did search first and then navigation, 6 of 10 also stated that search is the fastest mode, but for 5 of the 6 this was not the case. The findings indicate that users are not accurate when estimating how much time they use on a task and which mode that is the faster. The pattern revealed is a reduction in time spent on the tasks when the tasks are repeated. A reasonable explanation for this is the learning effect.

The users were also asked about which mode they preferred. Although a majority (11) stated in their free comments that they believe search was the faster, 9 of 20 informants preferred navigation when asked to choose between modes. The informants seemed to appreciate other virtues than speed. One informant formulated what seemed to be a common view: "It is better to search when you are going to find specific photos. Navigation can be ok if you would like an overview of all the photos you have got".

A model that depicts the relationships between factors and concepts has to be based on former studies in the field. The model (see below, Figure 5) includes factors used by Kules & Capra (2008), Gwizdka & Spence (2006), Lopatovska (2009a and b). Also the PANAS framework is included here.

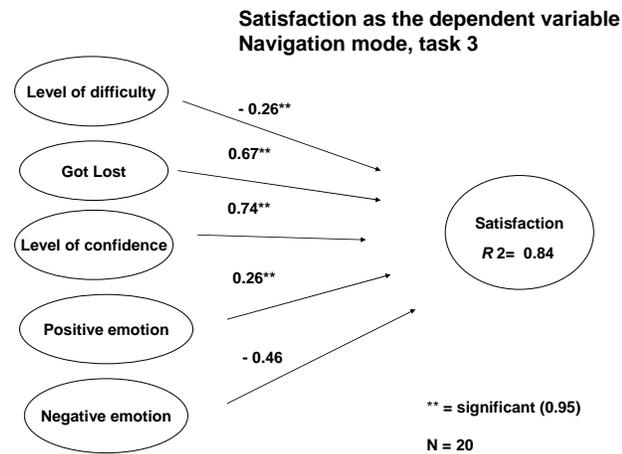


Figure 5; Structural model and results

The results can be interpreted as follows. The R^2 is on a high level. All five factors are significant and contribute in explaining the variance of the dependent variable satisfaction. Hence, the model explains a substantial amount of variation of satisfaction for task 3. For the factor getting lost "disagree" is computed as a low number and "agree" as a high number. Therefore, when the participants reported getting lost while doing the task, this has a negative effect on satisfaction. Positive emotions have a positive effect on satisfaction. This is also the case for level of confidence.

Level of difficulty and negative emotions are also significant and contribute to explaining the amount of variance in the model.

A composite reliability metric for internal consistency assesses construct reliability. Table 1 below shows that all construct reliabilities exceed Nunnally's (1978) suggested 0.7 benchmark. The alphas are all above 0.6 which is regarded as a benchmark for exploratory studies. Convergent validity is examined using the average variance extracted (AVE) and all constructs were above the benchmark of .5 (Fornell and Larcker, 1981)

With two modes and three tasks, it is possible to run this analysis 6 times. Figure 5 shows only one of them. We also ran this analysis with satisfaction as the dependent variable for the three tasks in search mode and the two remaining tasks in navigation mode. The results from this analysis can be summarized as follows. The following factors were significant: "got lost" every time, "level of difficulty" five of six times. "level of confidence" five of six times, negative emotions four of six times and positive emotions two times. Due to small size of the data-set we have to be cautious when interpreting these findings. Although it is positive that some of the factors seem to have a significant contribution each time or 5 of six times, the results must be interpreted as interesting and promising, but preliminary.

	AVE	Composite Reliability	Cronbach Alpha	Communality
Got lost	0.82	0,93	0,91	0.82
Level of confidence	0,84	0,94	0,91	0,84
Level of difficulty	0,72	0,88	0,80	0,72
Negative emotion	0.74	0,92	0,89	0,74
Positive emotion	0,72	0,92	0, 88	0,72

Table 1: Constructs reliability assessment

5. Discussion and conclusion

In this explorative study, we set out to investigate users' preferences for two different retrieval strategies in large photo collections, search and navigation. A focus group was organized to gain insights about users' preferences, and a consecutive experiment with 20 participants was carried out.

The focus group showed that the participants, who were all experienced users and producers of digital photo collections, had clear preferences for navigation as the main retrieval method for their own personal photo collections. This is clearly in line with the recent literature in the field on search and navigation in the field of personal information management (e.g. Bergman et al 2008) where it is shown that users have a strong preference for navigation and with search considered to be "a last resort".

A closer look at the context and in particular the focus group participants' way of organizing their photo albums, reveal that their preference for navigation may be caused at least in part by the fact that their photo collections were not tagged in a way that could make search a realistic option. In other words, the photo albums were in practice not searchable. It seems that their preferences were shaped by this circumstance. However, taking the participants own explanations into account we can see that the contextual factors are only a part of a broader picture. The focus group participants themselves argued that navigation was preferred because this way of retrieving provided feelings of closeness, personal meaning and control that a search alternative would not provide in the same way. This is also in line with findings in the literature, e.g. Shneiderman (1997) who argues that navigation in hierarchies provides high degree of consistency as it confirms user expectations.

The participants in the experiment also appreciated navigation although they also meant search was the faster. The participants appreciated overview and feeling of control. One of the participants stated that: "It was easier to find a specific photo by searching, but I found it easier to get an overview with navigation. This is also what I am most used to in photo albums".

The initial results from the experiment showed that in this field explaining the role of perceptions and preferences is a complex undertaking. The Morae software, used in the experiment, maps the participants' behaviour, e.g time used on each task. We have seen that most of the participants in the experiments stated (when asked after they have completed the experiment) that they believed search was the fastest alternative. However, the measurement of time actually used on different type of tasks showed that navigation was the faster.

The analytical model of the experiment departed from the observation in recent research in the field of search and retrieval that there seems to be a lacking statistically significant relationships between various factors: mood prior to the search, topic of the search, sequence of task, task difficulty level, searcher's interest in a task and positive and negative affects. (Lopatovska 2009a) The present study addresses this challenge by combining two established and validated models, the subjective factor models used by Kules and Shneiderman (2008) and others, and the PANAS model that is applied in a number of recent studies of search (Lopatovska, 2009a and b). Both models are often applied separately, but to our knowledge not in an integrated way in studies of retrieval strategies. The rationale for this is that we believe applying both provide a richer picture of the role of subjective factors.

The results presented are based on a relatively small sample, but the findings indicate that there are significant relationships between the several of factors mentioned above and satisfaction with the task performance for various tasks and across different modes.

The results presented in the previous part showed that effects of emotions (moods) on satisfaction are less clear. Only partly significant relationships were found. Arguably, measuring the impact of emotions in this context may be challenging in several respects. The emotions reported may be shaped by a variety of factors in this experimental setting. Of course, interpreting the results in terms of "personal e-memory and retrieval" can be problematic since the participants don't have a personal stake in

the outcome of the search and navigation tasks, as also observed and discussed by others (Lopotovska 2009a). For student volunteers their main motivation for participating may be the reward, which they will receive anyhow. The participants reported feelings can in principle be attributed to other, undefined factors that are not related to the task. Thus, it is not a surprising result that there was a partly a lack of significant relations when it comes to the study of emotions as provided by the PANAS model. What could be expected, and also was found in the material, was that for example feeling of getting lost was significantly correlated with level of satisfaction. But this is understandable as the independent variable "feeling of getting lost" can much more easily be associated with the actual task performance. This underlines the needs for models that are more sensitive to tasks and contextual factors.

In our future work we plan to further develop revisions of the analytical model and apply it on a larger sample of participants. A larger sample would provide an opportunity for further analysis of the relations between subjective and objective factors. The results indicate that the main initial idea about the need for developing models that combined "subjective" and "objective" variables has been supported. Studies of preferences must be combined with studies of actual behaviour and context in order grasp the complexity of retrieval practices.

A factor that is not studied here, but which in our view can be fruitful and important to integrate in the model, is the strong *social* character of "photo management" and user behaviour. The important role of the social aspects, collaboration and sharing was a major finding in the focus group and appears to shape the way digital photos are managed and retrieved. These are aspects that should be integrated in the research framework.

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