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By
Hans van der Heijden &
Lotte Sangsted Sørensen

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Hans van der Heijden and Lotte Sangstad Sørensen
Copenhagen Business School

Abstract

To study some aspects of user behaviour in a mobile shopping scenario, the authors of this paper conducted a laboratory experiment in the fall of 2002. In this experiment, we created an artificial camera store and developed a mobile information service for use by the participants. This paper summarises our qualitative observations of the experiences of the participants. We present an analysis of the comments made by the participants on the use of the mobile decision aid, and we discuss these comments based on our own judgement. The paper ends with recommendations for designers of mobile decision aids and with opportunities for further research.

Advancements in information technology continue to influence the ways that people can benefit from the use of information systems. One commercial setting where these benefits are rapidly becoming manifest is the traditional high street retail store. Technically, it is already possible for store products to radiate their product descriptions in a wireless network, and it is possible for personal mobile devices to pick up these product descriptions and display them to the owner of the device. If consumers enter their product preferences into the device, then a decision support system on the device could evaluate the product descriptions and assist the consumer in selecting the best product for purchase. This hybrid form of technology-aided shopping combines advantages from online shopping, such as the option of decision support to aid the evaluation process, with advantages from conventional shopping, such as being in physical reach of the product.

To study some aspects of consumer behaviour in this technology-augmented shopping scenario, the authors of this paper conducted a laboratory experiment in the fall of 2002. In this experiment, we created an artificial camera store and developed a mobile information service for use by the participants. The results of this experiment are documented elsewhere (Heijden & Sørensen, 2002a, 2002b). In this paper, we aim to summarise our qualitative observations based on the experiences of the participants. We present an analysis of the comments made by the participants on the use of the mobile decision aid, we discuss these comments based on our own judgement, and we offer an outlook for further research.

The theoretical background of the experiment was grounded in the decision making theory put forward by Payne and colleagues (Payne, Bettman, & Johnson, 1993). This theory states that decision makers balance the accuracy of the decision and their cognitive effort to arrive at a decision. Often, these dimensions conflict, in the sense that more effort is needed to achieve greater accuracy. Decision support systems can influence this balance by decreasing cognitive effort without compromising on accuracy. Therefore, all else being equal, the use of decision support systems leads either to increased accuracy, or less cognitive effort (Todd & Benbasat, 1992).

Different decision strategies exist to balance effort and accuracy. The most common are *additive strategies* and *elimination strategies*. The first evaluates the alternative as a whole according to certain weighted preferences before continuing to

the next alternative, which is then also evaluated by its own, or compared to the latter alternative. In the second type, the elimination strategies, the decision maker either evaluates all alternatives on a single attribute at the time, eliminating the alternatives that violate a certain threshold, or each alternative is evaluated independently but eliminated as soon as one of the attributes violates the set threshold. Because of the heuristic nature of elimination strategies they are usually quicker and more efficient than the normative additive strategies, though these are apt to give a qualitatively better result.

In the experiment we provided decision support for the additive strategy. Participants could shop with the mobile device by scanning a barcode that was located next to a visual representation of the product. The device would then display information about the scanned product, and provide an assessment of the attractiveness of the product based on the consumer's preferences.

Consumer researchers have found considerable evidence for the notion that consumers follow a two-step process to select a product from a retail store (Engel, Blackwell, & Miniard, 1995; Hauser & Wernerfelt, 1990). In the first phase, consumers select a limited number of products they are willing to consider (the *consideration set*), and in the second phase, they select the best product from this set by comparing the features. Researchers have demonstrated that consumer decisions can be succesfully supported in both phases (Haubl & Trifts, 2000). In the experiment, we only provided support for the generation of the consideration set.

Method

Task and experimental environment

The experimental task in the mobile commerce experiment was to select a digital camera on the basis of personal preferences in a simplified replica of a camera store. Pictures accompanied with barcodes represented the cameras and were set up side by side on a large table. A personal digitial assistant (PDA) was used to scan the barcodes and to retrieve information about the cameras. The information given consisted of values on five different attributes: resolution, photo capacity, digital zoom, weight and price. We defined the specific values and value ranges so as to enable subsequent measurement and analysis of the quality of the consideration set. Further details are documented elsewhere (Heijden & Sørensen, 2002b).

Participants

The subjects of the study were 86 undergraduate students from a Danish business school (48 male, 38 female, mean age = 22.1 years, *SD* = 2.95). Participating in the experiment was a course requirement. Students were briefed and debriefed collectively in class.

Using a 2x2 factorial design we worked with two manipulative factors: 1) task complexity, implying that the problem size could be either 10 or 20 cameras to choose from, and 2) availability of decision support, where participants were either supported by a decision aid (Advanced) or not (Basic). The 86 students were randomly assigned to the four cells.

Table 1 Cells of Manipulative Factors

	Basic	**Advanced**
10	22	21
20	22	21

The decision aid was an application on the PDA that translated the fit of the camera attributes and the subjective preferences of the participant into a color code of 7 shades of blue. The darker the colour blue, the better the fit. There was neither a comparison function, nor an archive function. The device could display only one camera at any time.

The PDA was an iPaq H3850 (Hewlett Packard) with an SPS 3000 barcode jacket (Symbol). Together, the device weighed 262g. We built the software using Microsoft Windows Platform SDK for PocketPC 2002, Symbol Windows CE SDK, and Embedded Visual Basic 3.0 (Microsoft). Figure 2 displays screenshots of the two versions of the mobile information service, the first version without the decision aid, and second version with the decision aid.

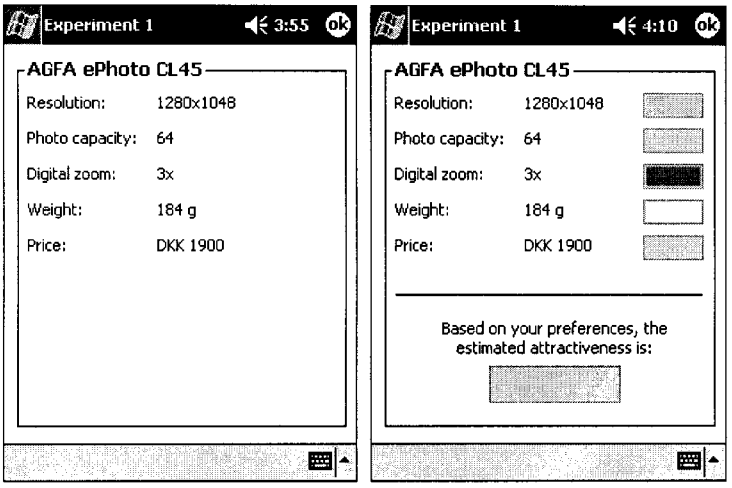

Figure 2 Screenshots of the mobile information service. The first is without decision aid, the second with decision aid. The darker the colour blue, the better the fit with the user's revealed preferences

Procedure

After entering the room the participant was given some basic instructions about the experiment. In order to ensure consistency, instructions were given in writing. Participants then filled out a questionnaire including demographic questions, control questions about the participants' knowledge of digital cameras and a scheme for filling in personal preferences on the five camera attributes that were included in the experiment.

Before beginning the actual task of selecting a camera the participant was shown how to work the PDA. The actual procedure of selecting involved steps parallel to the traditional steps in a decision process mentioned above: a) first scanning the cameras on the larger table, b) then moving the best cameras onto a smaller table and thereby creating a consideration set, c) and finally choosing the one best camera from the consideration set. Participants were told that there were no constraints to how much time they could spend on the task or to how many times they could scan each camera.

When having completed the task, the participant was given a post-survey questionnaire dealing with the experience of selecting by using the PDA. The whole procedure including filling out questionnaires took approximately between 20 and 40 minutes, a few took less and a few took longer.

During the experiment we recorded time, number of scans and cameras in the consideration set. We also took notes on participants' comments and on observations during the decision procedure.

At the end of each of the pre- and postquestionnaires, participants had the opportunity to write whatever remarks they had on filling out the questionnaire, completing the task and so on. Forty-eight students out of the 86 noted such additional comments on either of the two questionnaires. Using our own judgement, these comments were then clustered into four broad themes.

Results and discussion

Some participants commented on various subjects, some just on a single subject. Table 2 summarizes the themes for the participants' comments, and shows the total of comments in each subject category.

Table 2: Participants' comments categorized into subjects

Comments	Number	Total number	Theme
Comparison facility missing	21	36	System functionality
Blue colour	2		
Not useful /no incentive to use device	8		
Useful or easy	5		
Additional information wanted	8	29	Information gathering
Personal assistance	5		
Other attributes are important in experiment	4		
Other attributes are important in general	12		
General comments on their preferences	6	15	Preferences on camera attributes
Preferences conditioned by experiment	9		
Physical contact with product	7	11	Laboratory task vs. real-life shopping

Answers are relative to the novelty of the experience	2	
Usefulness relative to experiment set-up	2	
Various comments	8	8

We will discuss each theme in turn.

Functionality of the decision support system

The one subject that was most commented on, was the lack of an option of comparing the camera attributes without having to scan each camera several times. Some asked for a possibility of storing information in order to review retrieved information, some suggested having a split screen to be able to list cameras next to each other. The lack of such an application arose comments like: "it was hard to choose a digital camera using the mobile device because I could not compare attributes of two or more cameras side by side", and: "My only source of irritation was that I could not hold two cameras up against each other, but had to scan one, then the other, then the first, then the other, to compare all attributes. But the overall attractiveness "helped sort out the interesting cameras." Other remarks indicated that without such an application the decision aid was regarded useless: "a pen and paper could replace the mobile device to weigh ones preferences against each other".

Comments like that show how the experiment, by design promoted a specific and predefined two-step decision process, but the DSS supported only the initial part of the decision process, the overall scanning, and not the more detailed comparison. It supported the task of processing information in order to evaluate an alternative on it's own, weighted by personal preferences, but it didn't support the task of comparing nor did it aid the memory load.

These comments suggest that the idea of differentiating between different *sub-strategies* and not just between overall decision strategies is important. Theoretically the colour code in the experiment would support the additive strategy with its focus on the weights and the alternative as a whole. But because of lack of memory and comparison support, the decision maker could just as well switch to an elimination strategy.

It is therefore important to analyse in more detail the substrategies that consumers use in their decision making. Is it that they have trouble evaluating an alternative as a whole? Is it that they have trouble remembering their previous evaluations? Or is that they have trouble comparing one alternative to another? Each of the three problems can arise in additive strategies. More complex decision aids need to be able to cater for all three of them.

Information gathering

Many participants desired more information than the mobile information service was able to deliver. Some asked for more detailed information on practical matters and on other features such as battery endurance, durability, warranty and design: " I would be more concerned about battery life and optical zoom as well as how many mega pixel. Not necessarily just resolution" and: "Info about emailing pictures or other functional issues would also have affected my choice". Some mentioned that being able to see samples of photos taken with the digital cameras would have been helpful. A couple of participants suggested in a more general sense that the information supply was too limited: "Attached to each barcode should be a ranking list from external analysis of additional information about the product."

Under the heading of information we can also include comments on lack of personal assistance and lack of physical contact with the product. Twelve participants stated such remarks. Statements like: "When I shop I like being able to actually "feel" the merchandise I'm looking for" and "I still prefer shopping with professional assistance" indicate that what can be considered relevant information is much more than just visually presented descriptive data.

Significant information is mediated through physical contact by holding the product and trying it out: "One thing is to view the specifications of a product by flipping through a catalogue, another is to hold the product and put it through tests.", "Shopping based on only logic; I would like to physically feel the object."

Pooling information is a subjective and interactive process over time. It takes time to consider new information and to compare it against earlier information: "When I buy a product of such a category (luxury), I would rather gather more info and spend days considering, before buying it.". "I think that a kind of storage (memory) would have been good – to store camera data – so that you could gather the information at the store and then take it home to review. This, in my opinion, would

make the mobile shopping more functional – it would be more of an 'information gathering' tool."

Getting personal experience from friends or professionals means a great deal: "a salespersons (human factor) opinion was missing", "I would never make my purchase without first consulting a friend or someone I trusted could give me educated and unbiased advice."

Consumers retrieve information about products through other senses like touch, smell and hearing. Through these senses they gather experience on usability and durability. Furthermore it is context bound information for example in comparison to other available products, or to the expected innovation in the product category. The information available will always be limited to a lesser or greater extent, and these constraints are shaped by the environment. In order for mobile commerce technologies to be a contribution to existing shopping environments the facilities should serve a variety of types of information and facilitate an interactive information gathering in a versatile shopping environmet. More complex decision aids should be offering online connection, adding the experience from the physical evaluation to the comparison matrix, and communicating with shop assistant and likewise including this information in the DSS.

Preferences on camera attributes

The decision aid matched personal preferences with camera attributes. Because the information service provided data about five attributes, participants could enter preferences on these attributes only.

There was some confusion about whether the preferences should be related to the specific features and values in the experiment, or whether they should be related to the participants' preferences on digital cameras in general. The fact that participants were asked to structure their preferences within the relatively limited framework evoked many comments, both verbal and written. In order for the experiment to work, participants' preferences had to fit in with the experiment set-up. We had tried to secure this by including the following in the instructions: "We understand that normally when you shop you might find features such as brand name and appearance important. Despite this we ask you to primarily consider the five attributes listed in this experiment." In the following example the participant was putting an effort into following the instructions: "Well, naturally there are some other

factors to consider when purchasing a digital camera... i.e. optical zoom, etc.... But this doesn't apply in the current experiment I suppose. Given that the 5 chosen factors are the only crucial ones - I think my weights accurately reflect my preferences."

There was not only a limit to the number of attributes but also a limit to the number of attribute values. This appeared to have a considerable impact on their preferences and final choices. One example is the price range, which was fairly small and the prices that were fairly low compared to reality. This meant that some didn't give this factor as much weight as they would have in a real life situation: "The price range and weight range in this experiment makes these factors less important than if I was choosing among "all" products on the market.". Another example is the photo capacity: "Usually photo capacity is not something I care about due to the possibility of buying larger memory cards and having a portable computer to download the photos from."

Contrary, the two examples below show how other participants had obviously made their choices on the basis of preferences not covered by the decision aid: "The size of the camera appears to have been very important in my consideration and I don't consider much that I can be completely wrong in trying to decide size from the picture.". And: "I think appearance of the camera had a large influence on my decision."

It is not possible to identify those who stuck to the preferences framed by the experiment, and those who let themselves be guided by other preferences. Actual preferences, which influenced the final choice, could have differed from the preferences stated in the beginning. Some commented afterwards that it was too difficult to ignore certain features: "The way the camera looks is important and it is hard to just brush ones preferences aside."

Also, through observations and verbal comments it became apparent that during the course of the experiment, participants got more and more accustomed to the specific value ranges, which meant that they relaxed on the weights they had given in the first place.

Personal preferences are the very basis for talking about decision quality or accuracy. From the DSS designer and researcher's point of view, it is therefore important to deal with articulating preferences in a controlled and well-defined way. More complex decision aids need to be more specific about consumer preferences and provide a number of ways to enter and adapt them as consumers see fit.

Laboratory task vs. real-life shopping

Many participants felt that the experiment set-up influenced their actions, their preferences and their choices. They were unsure about whether to relate to the task as if it was real life or to understand it in the actual context of the experiment. They felt that the experiment put restrains on their usual tools for decision-making, on the option of physical contact with the product, the option of getting personal assistance and on their ability to know and express their preferences. These types of uncertainties made the experiment seem fictious or awkward to some. One methodological consequence from this is that the motives for their decisions have become arbitrary and unclear.

Some express it directly: "Difficult not to be affected by the research setting (i.e. shopping alone, can't pick up the camera. Etc.)", and: "The usefulness of the device is especially linked to the fact that there were no other methods available. Would have preferred a spreadsheet with all info.". Some did not see the point in using the decision aid when comparing it to conventional shopping: "Maybe it is possible to have a sort of window on the device from which one can call out the selected cameras, that would also make it more practical than in an actual shop, which this experiment reminded too much about." and: "There might just as well had been a sign on the camera, describing the features."

Just like the decision aids support certain strategies in favour of others, the decision environment influences behaviour as well. The decision environment frames and limits the decision process, whether it is a controlled experiment or a realistic shopping environment. More complex decision aids should be aware of these contexts and perhaps acknowledge in some way the limitations of their capabilities.

Conclusion

In this paper we have discussed four issues related to mobile decision aids for consumer decision making. These issues arose out of our observations of participants using a mobile decision aid in a controlled experiment. Because our experiment was designed as a quantitative study, these issues must be regarded only as tentative results pointing towards relevant issues. We encourage further qualitative research on these issues to gain more insight in them.

The prospect of mobile information systems being an integrated part of our daily doings leads to numerous issues for further investigation. We have summarised some of these research questions below:

- When does a consumer chose a specific strategy and on what preconditions?
- What sort of incentives for the decision does the consumer have (e.g. less effort, more accuracy)?
- What sources of information are needed for the consumer decision?
- When, and to what extend, do our preferences on purchase decisions become manifest?
- Are personal preferences concrete and tangible entities?
- How, if at all, can personal preferences be accurately entered into a decision support system?
- What is the relationship between the decision environment (individual, decision tools, product setting) and the decision effectiveness?

To answer questions like the above, it may be necessary to study the subtler and less tangible features of human behaviour. In order to contribute to the existing approach to decision aids in commercial environments, we suggest that researchers should depend on the literature of human computer interaction and more socially oriented action theories (Moran & Dorish, 2001).

We believe that designers of mobile decision aids could benefit from looking towards a new focus by taking advantage of discussions and arguments already developed in other fields. An understanding of the complexity of the field and sensitivity to the context of the purchasing act is necessary, in order to make studies profitable and the design beneficial.

Author note

Hans van der Heijden, Faculty of Economics and Business Administration, Vrije Universiteit Amsterdam, The Netherlands.

Lotte Sangstad Sørensen, Copenhagen, Denmark.

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Correspondence concerning this paper should be addressed to the first author, e-mail: hheijden@feweb.vu.nl.

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