

Best-Practice - Mobile Testing

Viewing mobile usability studies with the example of an eyetracking study in the retail sector

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Abstract—Today, usability testing in the development of software and systems is essential. A stationary usability lab offers many different possibilities in the evaluation of usability, but it reaches its limits in terms of flexibility and the experimental conditions. Mobile usability studies consider consciously outside influences, and these studies require a specially adapted approach to preparation, implementation and evaluation. Using the example of a mobile eye tracking study the difficulties and the opportunities of mobile testing are considered.

Index Terms—eyetracking, mobile eyetracking, mobile testing, mobile usability, usability, user experience

I. INTRODUCTION

WORLDWIDE we can observe that the field of usability is paid more attention to when developing software and systems. According to DIN EN ISO 9241-11, usability is "the extent in which a product can be used by specific users in a specific context to achieve certain goals effectively, efficiently and satisfactorily."¹ In addition to the target and the relevant context of use the user is clearly put in the centre. The technical options should be geared towards the needs of the user and not vice versa. In the middle of the 1980s this requirement was formulated by Donald Norman and Jakob Nielsen due to massive problems in dealing with technical artefacts. Finally, usability is also an indicator for user acceptance as an effective and easy-to-use product will cause no frustration to the user rather a positive user experience will be created. That's why emotions play an important role. This is known as user experience², an expanded concept of usability, especially when the emotional aspects are considered in the context of use. It can be seen that studies on movements of the user focusing on his behaviour can be conducted in many areas of human life. A laboratory is not always the best place

¹ DIN EN ISO 9241 (1997), S.94. Ergonomische Anforderungen fuer Buerotaetigkeiten mit Bildschirmgeraeten. Berlin: Beuth Verlag

² vgl. Sarodnik, F., Brau, H., Methoden der Usability Evaluation Wissenschaftliche Grundlagen und praktische Anwendung, 2.Auflage, Bern: Verlag Hans Huber, 2011.,S.22

for these observations. Denoting the user for example as customer and the technical artifact is a sales area, then give yourself more important applications for usability studies. your conference editor concerning acceptable word processor formats for your particular conference.

This is where the mobility comes in, as you are faced with the following question before the study: If you build a sales area in a laboratory environment, or do you test directly where a real customer wants to make a real purchase.

Both approaches have their place and should be discussed prior to an investigation. The mobile testing provides compared to the laboratory testing significant added value: the testing under real conditions. Those conditions, however, in terms of data collection can also be viewed as potential sources of error causing for mobile testing a specially customized approach to preparation, implementation and evaluation.

Laboratory tests are problematic for purely logistical reasons³. It is at this point explicitly noted that a laboratory test can complement a mobile test very well. How and in what way this is possible is exemplified here. Usability testing is comprised of various methods for evaluation. The use of a particular method depends heavily on the context. For laboratory tests and for mobile usability studies the eye tracking is an adequate means. Below the example of the mobile eye tracking used for shelf tests in retail is examined. As a measurement tool, the mobile company Tobii eye tracker (Tobii Glasses) is used. The device offers the advantage over similar tools: extreme compactness and lightness. Therefore it is perceived by the subjects to be very handy and not disturbing.

II. PREPARATION OF A MOBILE TEST

A. Necessity

Each evaluation of usability requires a preparation phase. In a mobile test this phase is particularly important. A mobile test usually runs always in a different environment. So local

³ Think, for example, on transportation costs and to the structural conditions of a laboratory environment.

conditions vary from test to test. This is an important point that needs to be thought through in preparation. Furthermore, a content preparation is not only useful, but as with any usability study also imperative. As the preparatory phase can be designed specifically for a mobile test should be explained in the following section.

B. Problem definition

Mobile usability tests as mentioned in the introduction may facilitate specific mistakes in application as well as special approaches. The location in this case is a shop with an extremely broad range of products. There is a wide range of applications for mobile usability tests and, at the same time, a great variety of possible research issues that can be worked on with this type of test. Normally, in a shop, we look at the purchasing behaviour of clients often with the help of shelf tests⁴. The shop management mentioned problems with the organic products range, which generate, despite the general trend, little sales in this shop.

C. Content preparation

In order to carry out a mobile usability study, conceptual considerations are necessary to provide as a result a test scenario with a specific problem. For the development of this test scenario, first the weaknesses in the previous processes are revealed. For a study in the retail sector the customer is to be regarded in their shopping process.

To identify a specific target group and to find within this target group members and typical typical customer, personas⁵ can be created. Prerequisite for the creation of personas are real information as can be obtained through interviews and initial field observations.

The basic structure of a persona can be represented as follows:

- real Name
- realistic photo of the person
- demographic information
- profession
- objectives, expectations, wishes
- preferences, hobbies, dislikes
- quote

If you got some concrete information and found out the typical customer, a review with the client is an important step. The problem notified in II-B - the relatively weak sales of organic products - must be substantiated before a possible investigation. To this end, offers an expanded interview

⁴ more information about shelf tests can be found in the book: Eyetracking im stationären Einzelhandel (2005), Dr. Nadine Berghaus, Koeln: Josef Eul Verlag GmbH

⁵ vgl. Richter, M., Flueckinger, M., Usability Engineering kompakt – Benutzbare Software gezielt entwickeln, 2.Auflage, Heidelberg: Spektrum Akademischer Verlag, 2010., S.28ff

method that looks at the actual purchase process and thereby represents the behavior of the customers in the sales area. This observation and interview method is known as Contextual Inquiry⁶.

The result of the substantive preparation of a mobile usability study is to create a test scenario with concrete tasks. The task is derived directly from the problem. If the problem e.g. The low product sales of a particular product group, then the task is to deal with the Why.

First evidence already produced a survey of 54 customers in the market. The results of two contextual questions illustrate the current situation:⁷

Question 1: Do you have already bought organic products in this store?

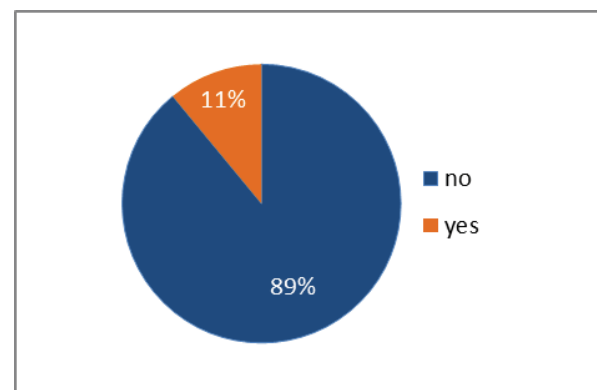


Fig. 1 - Answer to question 1

Question 2: Do you expect the offer of organic products in this store?

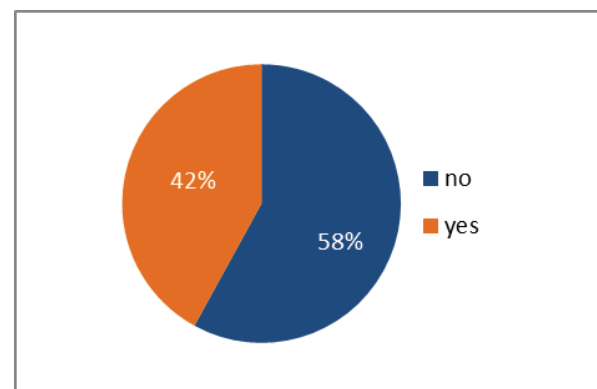


Fig. 2 - Answer to question 2

Nearly 90 percent of respondents in this store never bought organic products (Fig. 1). More than half of respondents do not expect organic products in this retail store (Fig. 2) Even with these two pieces of information it can be illustrate how

⁶ vgl. Richter, M., Flueckinger, M., Usability Engineering kompakt – Benutzbare Software gezielt entwickeln, 2.Auflage, Heidelberg: Spektrum Akademischer Verlag, 2010., S.21ff

⁷ These questions are part of a survey, which was ahead of the investigation directly addressed in the market to customers.

the supply of organic products currently carried out in this market generally. Therefore a method of investigation is to propose, which may appoint the reasons for this condition. A mobile eye tracking study puts the visual aspect of a purchase process in the focus of attention. Maybe a product is too insignificant? A product can't be found? Draws a product the customers attention on itself? These are examples of typical questions that can be examined with an eye-tracking test.

D. Technical preparation

The focus of the technical preparation of a mobile usability study is the first evaluation of the necessary hardware and software. In the case considered here, the suitability of a specific eye tracking system will be established. The following requirements have to be met:

- 1) The eyetracker has to be mobile.
- 2) The eyetracker must be up and running quickly.
- 3) The eyetracker should not disturb the customer during shopping.

A device that meets these requirements is the mobile eye tracker by the company Tobii, entitled: Tobii Glasses. The name already suggests that it is an eye tracker in the form of glasses. The unit is very light and after a short period of familiarization of the subject hardly noticed. After a test the eye tracker Tobii Glasses is ready for use immediately.

Nevertheless, such a device places special requirements to the test staff. To ensure a smooth testing process, an introduction of the research team, which meant the testers, is absolutely necessary. The calibration of the eyetracker, which is essential to any direct test preparation can be described as particularly challenging. A test is designed to produce usable data, if the calibration performed carefully. The testers need to practice this procedure frequently, thereby to get into a routine. During a field test may not happen in this case as a glitch because that would seem unprofessional on the subject, time-wasting and could be the subject may move to cancel the test.

It is also important at this preparatory stage, to plan the overall technical structure and test examples, since the calibration of the glasses is only a technical component during eye-tracking session.

For efficient data analysis, IR marker⁸ are used, during the test a unique ID⁹ sent to the glasses. Characterized additional information can be introduced into the receiving material, whereby a positioning of the test person is possible. How does the use of the IR marker affects an automatic analysis of the data is carried out at a later point. The team must practice not only dealing with the eye-tracking glasses, it also needs to know the opportunities and requirements of the complete

⁸ IR markers (infrared markers) have two modes of operation - when used with a suitable holder the marker is assigned a unique ID, without attachment the marker is used for the calibration of the mobile eye tracker.

⁹ ID (identification number) - are in the basic 30 markers + holder and thus 30 unique IDs. The software Tobii Studio can handle with a larger number of IDs.

equipment.

E. Planning the implementation

The planning effort for a field test is much higher than for a test in the laboratory. Therefore the familiarization with the real test environment should not be made until the day of the test. A sales area shall not claim to be an ideal test environment. In order for a mobile eye-tracking study nevertheless obtain usable data, it must be a logistical planning site.

The scheduling plays a very important role. The optimum time of testing was coordinated with the market management¹⁰.

To be seen as a test team to be, any tester must be clearly identifiable as such¹¹. It is a special role that the testers belongs during the investigation, and this should also be clearly visible to the outside.

The positioning of the equipment is another important planning step. You need an area for the calibration process, you have to test whether the IR markers to attach the shelf, you have to look at the entire case consistent sales area, the influencing of the test persons by the construction technique has to be avoided. It must be collusion with the staff. If employees are not informed, they are unsafe against the subjects. A mobile eye-tracking test is considered a normal purchase history. These include e.g. the possibility of responding to the employee, if a specific product is not found¹².

The distribution of tasks within the test team must be clearly regulated. The following services have to be provided by the test team for the mobile eye tracking study:

- Approaching potential test persons for the purpose of acquiring
- Calibration of the mobile eye tracker
- Test observation
- Adoption and thanks

The methodological approach and the specific test procedures are described in more detail in the following section.

F. Methodical and chronological sequencing of the test

In order to ensure the most comprehensive answer to the question elaborated, a mobile usability study should include not only the test itself. In the previous part different methods are named, some of these may occur in succession, partly in parallel. Therefore we speak of a mixture of methods. In the case under consideration the combination of methods consists

¹⁰ On weekdays, where goods will be given to the shelves, are ranges of products in the aisles. The normal sales situation is altered. Therefore a test on such a day is unfavorable.

¹¹ For this study each tester was equipped with a name tag to make the membership of the research team identified.

¹² The employees were in this case explicitly instructed the subjects to be treated as ordinary customers and provide necessary assistance.

questionnaires, eye tracking, interviews and field observations. The questionnaires are part of the test documents. To claim the participants not longer than necessary, the questions must be formulated clearly and allow a rapid response. Answering the questions will take the form of an interview, so the tester has the possibility to minimize the time spent. For the test, a shopping list was prepared by the test team, which has to be processed by the test person. The 5 items on the shopping list were not selected randomly. First there was a study of the so called Rennerliste, which contains information about the sale of the individual product categories. If data has to be collected by questionnaire before the actual test, so these issues should not affect the test participants. If any information is given to the test person, the test sequence will be changed. Initially used questionnaires may not receive any information about where certain items are located. Under certain circumstances it may be appropriate to share a questionnaire and access some information after the test. This approach should also be used for the investigation of the considered application. The questions before the test used for statistical surveys and the assessment of the purchasing behavior of the test participants. After the test, the participant has to answer short questions to test progress. In the final questions to the test person 5 product photos are shown, which were not on the shopping list. The test team developed for this part of the investigation a memory test, which checks the quality of perception of certain products. To collect these information, the making of special, meaningful product photos is necessary¹³.

In a usability test in general, and in a mobile test in particular, the creation of equal conditions is very important. This is also called a stereotypical test procedure. It has been shown that a checklist for the performance of the test is very advantageous. Thus, not only have the same sequence of the individual test sequences are adhered to, it is also necessary to ensure that all test subjects received the same information before the test. Even the wording of the explanations to the test persons should be the same as with every test.

When considering the time required, the test team agreed that it is necessary to carry out the tests estimate at least one working day. Per subject, the entire test should not take longer than 15 minutes. This is due to the fact that the subjects will not be acquired in advance of the test, as is customary for a test in the laboratory. The potential subjects are real customers who want to carry their shopping in this market. This daily process should be the basis for the proposed eye tracking test. Since it was suspected that many customers can spend time for the test, the expectations regarding the expected number of subjects were very moderate. The target of the test team was to perform at least five usable tests.

Other considerations were concerned with the question of how to complement a mobile eye tracking test methodology. In the planned test in a sales area it comes out mostly about whether certain products with as little problems can be found. A single product here to look so detailed that you can assess

¹³ For this test, the product photos specially tailored to use them in subsequent laboratory tests.

whether the customer focuses more on the product label or on the product image, can afford a mobile eye-tracking test barely. Here, the test team developed as an extended test method a special stationary eye-tracking study that can provide additional information. For this test, the product photos that were used in the memory test are reused. The extended methodology clearly shows that mobile testing can be usefully complemented by stationary tests¹⁴.

III. CARRYING OUT THE TEST

A. Test setup in the market

The test setup in the market must be made prior to the sale operation. For setting up the test area for a mobile task based eyetracking study the following tasks have to be executed:

Install and set up the IR markers: IR markers are optional elements for an eye-tracking test. They allow fast automated analysis of the data with a **GazePlot** or a **Heatmap**. The IR-marker must be placed on the shelf to be considered.

Creation of a calibration area: Before each test, calibration of the Tobii Glasses is necessary. For this purpose, a sufficiently large, monochrome, uniform surface is required, that must be prepared and installed at a suitable location¹⁵. The subject needs to set up the eye-tracking glasses at a distance are of exactly one meter in front of this area. The tester must be equipped with an IR marker constitute a virtual raster, which look at the test person. The actual calibration area could be built in a low-traffic area of the market.

Provide a desktop environment for completing the questionnaire: As the response to the questionnaire will be moderated by a member of the test team, the calibration site used for this task. It is important to ensure that test takers receive no insight into the test data and running tests of other test takers. It must be ensured that a test has been completed, before another new participant enters the test environment.

Thanks to test persons: The active participation in such a study is not self-evident. Customers who agree to participate in the study will receive a small gift for their help¹⁶.

Ensure ready to use test equipment: The entire experimental technique works with batteries. In a field test, sometimes it can be a problem when batteries need recharging. Therefore charging options has to be provided before the test starts. This is particularly important for the IR markers used for calibration and for the recording device. The battery capacity of the recorder should not be completely exhausted, because you cannot judge exactly how many minutes the device must record before the test. Overall, the recording

¹⁴ The valuable information is retained about a mobile application scenario, but they are enriched with additional facts from the laboratory.

¹⁵ The required surface was realized by the research team with the help of two flipcharts.

¹⁶ It is recommended to provide these little gifts visible before the test, to create an additional incentive for participation.

device of the Tobii Glasses can record about 70 minutes continuously with one battery charge. By the required calibration prior to each test, in reality this time is not achieved. The charge of the IR marker on the shelf is not critical. These are usually active only when the subject with eye tracking glasses is nearby.

Preparation of the methodical process: For a rapid test procedure, it is necessary to provide all the test papers before the examination. The workflow for the test has been already discussed here but it needs to be went through step by step in the real environment. A dry run is recommended.

B. Chronological sequence of the test

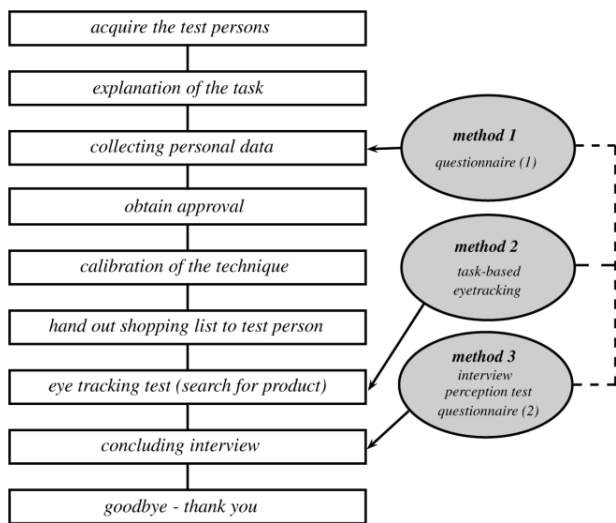


Fig. 3 - Chronological sequence of the test

Considered for the mobile eye-tracking test a chronology was developed, which forms the basis for the collection of comparable data. A deviation from this order may affect the reliability of the data collected and thus corrupt the negative results of the test. Fig. 3 brings the sequence of tests with the use of usability methods in relation.

IV. REMACHINING THE TESTS

A. Archiving and import of the test data

The test data are recorded on SD card¹⁷ during the test. Each recording receives a unique session ID. The SD card must be read and imported into the special software Tobii Studio¹⁸ for the analysis.

B. How to Create a PostScript File

Using the Tobii Studio software, the next step must determine the suitability of the individual recordings. This

¹⁷ SD Card - SD Memory Card (Secure Digital Memory Card) is a digital storage medium. For the recording device of the mobile Eyetrackes Tobii Glasses an SD card with a maximum capacity of 4GB (4 Gigabyte) is used. In order for the recording of about an hour of video, including all metadata.

¹⁸ Tobii Studio version 2.3 (and above) can handle data with the Tobii Glasses.

may rely very important on observations made during the test. Therefore, it is recommended that at least a part of the tester is also involved in the evaluation of the data. The operations at the mobile testing are layered and complex that the individual test persons can be assessed only by knowing the complete test procedure. For a comprehensive documentation that brings a separate evaluation team to the same level of knowledge as the test team, remains no time during the field test experience.

A mobile eye tracking study first requires the conscientious performance of the calibration of the eyetracker. The changing of the position of the eye tracker during the test by the test person, caused erroneous data. These data are not suitable for subsequent analysis¹⁹.

C. Data treatment using parallax correction

Depending on the eye tracker, there are factors that can be corrected automatically. The eye tracker of the company Tobii, which was used for this study, allowed to correct the so-called parallax error using the Tobii Studio software. This occurs due to the fact that the calibration of the eye tracker is a fixed distance of one meter. During the test process, consider the subject specific objects from a distance or in a very short range. So there is a displacement of the actual subject region. According to data analysis, a test person has not seen a particular product, even though the subject has taken this product off the shelf. This shift can be achieved out by using the parallax correction within the software Tobii Studio.

D. Automatically generated evaluations

GazePlot²⁰ and Heatmap²¹ are visualizations that can be created using the Tobii Studio software. There are eye movements (fixations²² and saccades²³) or represented clusters of fixations. At a mobile eye tracking study specific areas are considered of particular interest. For a shelf test, this interesting area can be a full rack or a certain part of a shelf. Since each product follows a specific sequence, which implies by the test person itself, the data, collected for an automated analysis cannot be directly compared. This is an important difference between a mobile and a stationary eyetracking study. For a mobile test, test subjects can approach to be examined the shelf from different directions, or they can look at the shelf from a small or a large distance. To make the collected data more comparable tests, we made a photo prior to the examination (see Fig. 4) from the observed shelf or from a part of the shelf on. For this recording, the IR markers have been placed on the shelf. Since each marker has a unique ID, must be an accurate identification of the marker within the

¹⁹ For more information about error detection and error handling can be found under item IV-F.

²⁰ A GazePlot represents eye movements as a chronological sequence of fixations and saccades

²¹ A Heatmap identifies areas that were considered long or often.

²² A fixation within a view profile is shown as a point range.

²³ Two fixations are connected within a view course by a saccade. This is no information acquisition.

Tobii Studio software. Therefore it is important, the use of the markers to be documented in the device exactly, i.e. to note the ID number of each marker.



Fig. 4 - wide-angle lens recording of the shelf

By using the Tobii Glasses itself for making the photos (see Fig. 5), this marking is done automatically²⁴.



Fig. 5 - Photographic recording of the shelf with Tobii Glasses

Automatically generated evaluations based on static AOI²⁵ are very attractive when fast initial results to be made visible. A critical examination of the data obtained is essential. It has been shown that under certain circumstances there is no detection of the eye movement data. This is e.g. due to the fact that for a precise positioning of the subject must always include at least 4 IR markers in sight. At close range, i.e. if the customer is close approaches to the shelf for taking a product, this may lead to problems.

²⁴ Due to the local conditions in a sales area a photograph with an external camera with wide-angle lens is recommended. When comparing the figures 4 and 5 perspective distortion when shooting with the Tobii Glasses can be seen

²⁵ A AOI (area of interest) is an individually defined area which is regarded as a test of the subject, and for which an eye movement analysis is of great importance. A static AOI is featured on a photo on which the eye movements of all tests can be aggregated.

E. Work with dynamic Areas Of Interest

Besides the use of an static image to bundle the eye movements of all tests, as described in section IV-D, so-called dynamic Areas Of Interest (dynamic AOI²⁶) are used for evaluation. The advantage of this approach is the independence of the IR markers. Data are recorded at close range. The creation of dynamic Areas Of Interest is very complicated, but should be used if the AOI based on static, automatically generated evaluations on the basis of test observations are considered to be faulty.

F. Error estimation

While eye tracking studies in stationary automatic evaluations are based on static AOI, can consider to be quite reliable, the application is considered critical in field trials. Local conditions play a major role, because a store shelf is not designed for the inclusion of IR markers. You have to make compromises which sometimes have incorrect or missing data as a result. Alternatively, the more complicated method of application of dynamic AOI can be used. Both methods were described in the sections IV-D and IV-E.

The data derived from the two methods are very comprehensive and should not be considered complete at this point. For an error estimation example, the value Total Visit Duration²⁷ chosen for two specific products (see Fig. 6). The differences are sometimes considerably and give the reason for the need for the critical analysis of the data determined automatically.

exemplary comparison - Total Visit Duration

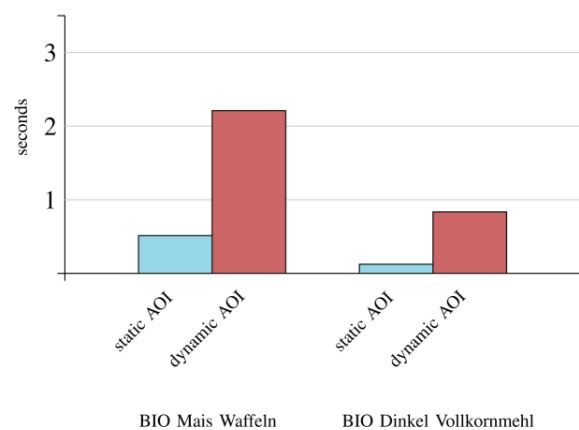


Fig. 6 - error estimation

G. Evaluation of data

As shown in section II-F the use of a mix of methods is an

²⁶ Dynamic AOI and static AOI in terms of the creation. Dynamic AOI on the changing media (videos) are created. creating dynamic AOI is very time consuming because the size and shape of the AOI must constantly change.

²⁷ The average Total Visit Duration is calculated from the duration of individual fixations in a given AOI divided by the number of tests

adequate means in a mobile usability study for a comprehensive analysis of usability problems. For the analysis of the data from this approach consequences resulting directly. A methodological analysis is applicable to a first rough estimate, for a deeper analysis, a method-disciplinary approach can be selected. The team needs to evaluate this specific data and discover relationships. Much is possible, not everything makes sense. An example at this point is to the buying experience, which was determined during the interview before the test, and the time for finding a certain product are brought into relation. The following questions were used to assess the buying experience:

Question 1: How often do you shop in this store?

Question 2: Are you aware of discount offers at this store?

During the eyetracking study of each test subject the times for locating specific products were determined. Bringing these data together with the data on the buying experience, the following picture emerges:

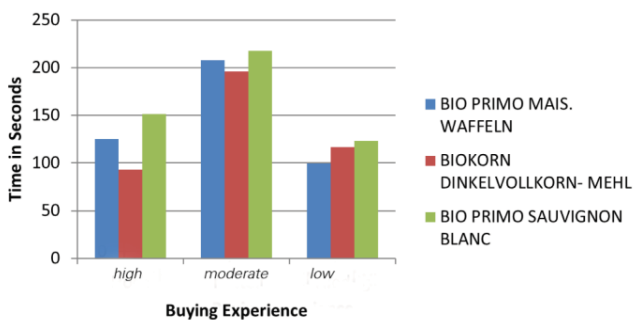


Fig. 7 - buying experience and time to find the products

It can be seen that the buying experience in the search for organic products only plays a minor role. Even experienced buyers (regular customers) have trouble finding the products.

H. Methodological supplement of a mobile eye tracking test

As discussed in Section II-F discussed, certain questions will be answered by additional tests in a usability lab. For these methodological supplement of a mobile eye tracking tests, a steady eye tracker was used. Six test persons were given the task to see product images as a slide show.

What is a customer oriented when viewing a specific product?

In answering that question on any product image, three AOI were created and grouped accordingly:

- AOI Group 1 - product photo
- AOI Group 2 - Bio-Logo

- AOI Group 3 – scripture



Fig. 8 - example - with and without AOI

Looking at the time to first fixation²⁸ it can determine that the Logo acts as an eye catcher. The time to the first fixation in this area is the shortest. The value of total fixation duration (including zeros)²⁹ for the scripture area is the greatest. This allows conclusions to the general reception of information. For a detailed consideration other values are to be determined, but at this point not to be displayed completely. This analysis delivered the result that the section of the scripture is the most relevant area for recognition and remembrance.

V. CONCLUSION

A. Unforeseen and unforeseeable difficulties

When planning a mobile usability study, the test team must discuss any difficulties, which can be divided into two groups:

a) from a technical perspective: The risk of technical problems is given both in the laboratory and in a study in the field. It is critical, however to evaluate the case of mobile usability studies in the field. The test team has to make a sufficient number of storage devices available and provide for the recharge of the battery. Regarding the calibration it has been suggested prior to the examination that the lighting in the market could complicate the calibration procedure. The time required for calibration could increase, the inaccuracy may be higher, which can potentially lead to abortion of the test. In practice, these assumptions are partially confirmed. The lighting conditions were not optimal, nevertheless an abortion of the test was not necessary.

b) regarding the test persons: Before a mobile usability study there is no guarantee that a sufficient number of subjects is available. The subjects to be an investigation in the field is not usually invited. They are accessed spontaneously, and to refuse to participate. Presumptions that too few customers

²⁸ is the time a test person first looked on the AOI

²⁹ calculates the average total fixation duration (including zeros) by the duration of individual fixations in a given AOI group divided by the number of recordings.

could be acquired for a test were not confirmed in practice. The great popularity led however to a technical problem. It had considerably more calibrations are carried out as planned, which claimed the battery of calibration markers than.

The potential problem areas have been identified before the test though, concrete difficulties were not entirely predictable.

B. How to Create a PostScript File

Finally it can be stated that the positive aspects outweigh the considered here mobile usability study. Even some of the expectations were surpassed the test. Particularly positive subjects acquisition is emphasized.

It has also shown that the preparation and evaluation phase are particularly challenging. Each task has to be reconsidered for a test in the field. We know the tools, but they must be put together for each viewing again and again.

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