Views and Clicks in Digital Libraries

A Comparative Usability Analysis of Eye and Mouse Tracking Data

Eliane Blumer[1], René Schneider[2]

[1] University of Geneva
24 rue du Général-Dufour, 1211 Geneva 4, Switzerland
[2] Haute Ecole de Gestion, Geneva
7, rte de Drize, 1227 Carouge, Switzerland
eliane.blumer@unige.ch, rene.schneider@hesge.ch

Abstract

In this study, eye tracking and mouse tracking data collected from two Swiss digital library web sites are compared, with respect to their specific areas of interest in order to answer two questions: Firstly, to know, how far the perception of the corresponding areas of interests differed from site to site and how far general recommendations can be inferred from this comparison. Secondly, the dispersion on the gaze and the mouse click plots were compared with the results of the two methods with each other to see if one method can be replaced by each other or if both methods should rather be considered as complementary. The results show that especially the choice of color and the use of contrast strongly influence gazes and clicks and that some areas of interest mainly attract views, but not clicks and vice versa, which leads to a complementary distribution pattern, and makes the question of replacing one method by the other obsolete.

Keywords: Usability, Remote analysis, Eye-tracking, Mouse-tracking, Areas of interest

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1 Introduction

Classical usability tests, i.e. tests that are run in a laboratory are often enriched by further data, such as eye tracking to get more findings. In recent years lab-based tests are replaced by online usability methods that integrate complementary data collections, such as mouse tracking. Several studies have been done in the last years (see the literature review following in the next section) to see, how far the methods and results can replace classical approaches or in which way they should be seen as a complement.

In this study, it was tried to combine this research question with a mandate for evaluating the usability of two websites: first, a general web portal for a Swiss digital library (www.e-lib.ch), and second, a subject-specific website for geographical data (www.kartenportal.ch). Both portals were created during a Swiss national initiative, called e-lib.ch, with the major objective to digitize and publish scientific information under a single point-of-access. The overall project e-lib.ch was divided into different subprojects, one of them being "kartenportal.ch", combining a catalogue of ancient and modern maps with a geolocalizing search engine.

In this study, an evaluation of some web pages from both sites was realized, both times in German and French. In every case, online usability and eye tracking tests were done and a mouse tracking software was installed on the servers to track all clicks during two months. None of the tests was overlapping in time with another test. The data collected during this period allowed us further analysis concerning the design of the web sites as well as a methodological study to compare the results of the two different methods.

This paper starts with a further description of the scientific context of this study and the research questions that arose out of this context before citing some prior studies on this matter. It then describes the data collection and analysis before presenting the major results and conclusions. The results of this study should be considered as a preliminary step for further studies, that's why the data has been published under creative commons in an open research data repository (see the end of the paper for further explanations).

2 Context and research questions

The methods used to enrich the mandated online usability tests were eye tracking or gaze control, the latter usually being done in a laboratory environment and remote mouse tracking, which is done online. Mouse tracking is usually done without informing the user that his clicks are tracked, which was also the case in this study. In gaze control, different eye movements are distinguished. The two most important ones are fixations and saccades, whereas the first are the moments, when an eye fixes an object and stands still. As a complement, the latter are the movements between one fixation and another. Today's eye tracking systems permit registering the gaze on a certain object in its whole cycle. By recording the reflection of infra-red lights, which before have been emitted towards the eyes, so called gaze plots or heat-maps can be produced, which can serve as graphically enhanced visualizations of gaze on a certain object and give indications on the numbers or duration of time that users looked at a web page's specific area.

In recent years, the method of tracking mouse clicks gained more and more importance in the area of usability, most probably because of its generally low costs, esp. compared to eye tracking. Furthermore, eye trackers are sensitive gadgets that are often not capable to register properly eye movements from users with different eye handicaps. Not only for this reason, click tracking seems to become the preferred option of choice. As the name already points out, the technology tracks user clicks on a web interface. Recent research concentrated on the use of these two data sources and reasoned about the fact, whether they correlate or not (Cooke 2006), if the mouse or clicks can really be used as substitutes to gaze control (Chen, Anderson & Ho Sohn 2001 and well Johnson et al. 2012) and what patterns follow both of them (Rodden et al. 2010).

In this scientific context, a research project on usability in digital libraries and the usefulness of digital content, the major interest was to know more about the distribution of attention in specific design elements of digital library web sites, i.e. how far different parameters of design could enhance or decrease the perception. Due to the rising interest in online usability methods the researchers also wanted to know more about the replaceability of lab-based and online methods.

3 Literature review

Chen, Anderson and Ho Sohn (2001) as well as Johnson et al. (2012) underline that the mouse can be a substitute for eye tracking and that attention can be measured with mouse movements. Doing the same research in a medical context, Raghunath et al. (2012) underline the same findings and even say that mouse tracking can moderately predict eye movements. Sol, Chen and Marques (2013) even go further and say that the eye is faster than the hand, but admit that these findings are still not precise enough and that further research is necessary in order to be able to make conclusions. For Guo et al. (2010), a correlation between eye and cursor could be found and they tried, in a further step, to predict where the participant would look at. Still, it was not possible to predict in any case where users look at.

Cooke (2006) found out that there are correlations between gaze and cursor position, but didn't mention that one could be replaced by the other. Rodden et al. (2008) analyzed the coordination patterns of eye and mouse movements on search result pages and found three patterns: either, the mouse follows vertically or horizontally with the mouse and use the latter to mark a promising result. Furthermore, they assume that these data can be used to determine relevant parts of websites with varying grades of success. A similar study by Bieg et al. (2010) points out to a correlation between the eye and cursor during search and selection tasks, as well. They discovered two patterns: when the aim object is known, the click is before the gaze. On the other hand, if the object is not known, both patterns, the click and the gaze, are parallel. This means that the correlations are cognitively related, but not perceptively. Similarly, Navalpakkam et al. (2013) found out that both the mouse and the eye are sensitive to two key attributes of page elements – their position on the page and their relevance to the user's task. Furthermore, the page lay-out (one-column page layouts or two column page layouts) doesn't seem to play a role.

Huang, Ryen and Dumais (2011) discovered correlations between cursor and eye movements, especially in search result pages. They assume as well that these two data sources can be used to improve search. They do also assume that the cursor can be useful to determine relevant parts of the web page with varying degrees of success in their design approaches. In line with this, Lagun et al. (2014) recently underlined the fact that cursor data patterns can be used to improve web search.

4 Data collection

4.1 Eye tracking

For the eye tracking test, a state-of-the-art eye tracker (Tobii), installed on screen, was used. In the first setting, twelve screenshots (six of each website by using corresponding content – homepages, news pages etc. – and by alternating between similar pages from e-lib.ch and kartenportal.ch) were presented during 20 seconds to the participants (Hallway Testing at Haute Ecole de Gestion Geneva). After a first pretest, it could be assumed that 20 sec. were too long as participants started looking at the same things after 10 sec. The rather simple page layout underlined the assumption that fewer seconds would be enough in order to bias participants as little as possible. The next pretest was conducted with 10 sec. and results seemed to be more convincing – participants were able to get a comprehensive view of the pages and didn't start looking at the same parts. The final eye tracking test took place on April, 30th 2014 with 14 participants. It is important to mention that there were no problems with any participant in regard of the data collection. In any case, the eye tracker was able to register more than 80% of the eye movements.

4.2 Click data

The clicks were collected as an additional data source with a commercial tool (CrazyEgg) and the integrated click counting module of online usability testing software. Table 1 shows the time span during which the tools were collecting data. As for the tool, the data has been collected on different dates for the different homepage versions, in order to avoid an overlap with the online usability test. The click counts were taken directly by checking the tool's automatically assembled report. On the other hand, the online usability testing tool collected the clicks during the interaction of participants of the online usability test, which means that the clicks are intentional, because users are following a task, which is not necessarily deducible for the clicks collected remote online. Again, these two tests were conducted on different dates. In a final step, the clicks were counted by hand, as they were not too many.

Table 1. Data caption (overview)

	e-lib.ch	kartenportal.ch	Method
Click tracking	16/10–18/12/2013 (German)	15/01–17/03/2014 (German)	Automatically
	16/10–20/12/2013 (French)	21/02–25/04/2014 (French)	
Remote testing tool	09/09–16/09/2013	07/04–25/04/2014	Manual count
	130 participants 67 German 63 French	42 participants 25 German 17 French	

5 Data analysis

Overall, three different types of screenshots were analyzed: those gained by the eye tracker, those extracted by the click analyzer and finally those captured during the online usability test, as illustrated in figure 1. It shows a collated view of all methods used: on the left the cumulated gazes of the eye tracking analysis (in this example: kartenportal.ch); in the middle the click distribution derived for the same page by accumulating all clicks in the test period, and on the right the sparse number of clicks collected during the online usability tests.

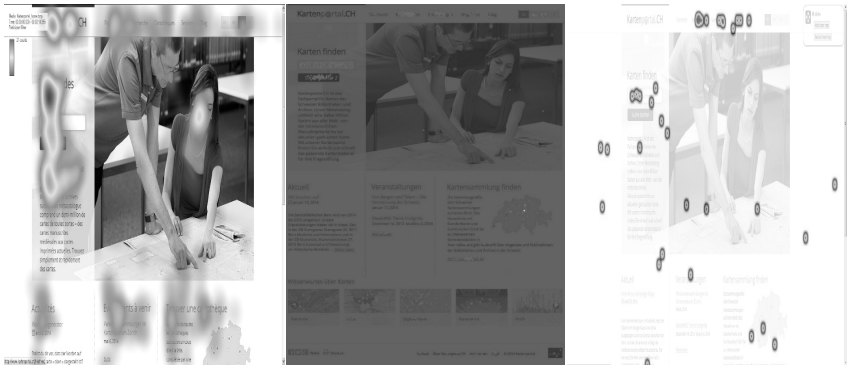

Figure 1: Comparison of eye tracking (right), long time mouse tracking, (middle), and click analysis done during the online usability test (left)

After having collected all different kinds of data, it was possible to compare eye tracking and click-stream data on the one hand as well as the data collected from the two different sites with each other. To compare so, several areas of interest (AOIs) for further analysis (see fig. 2) were selected, using a specific functionality of the eye tracking software. All in all, finally 17 AOIs for the kartenportal.ch and 20 AOIs for the webportal e-lib.ch have been compared. They covered specific areas like “General Navigation”, the search field, the logo etc. (See the data set described at the end of the paper for a full enumeration.)

Figure 2: Areas of interest (kartenportal.ch)

For the sake of illustration, a detailed overview of the data captured for the logo (AOI2) and the search field (AOI3) from both web sites will now be given. Both search fields were subdivided in three further AOIs (AOI 12–14 in the case of the kartenportal.ch and AOI 16–18 in the case of the webportal e-lib.ch).

The following two tables show the compiled number of clicks and fixations for the two selected areas resp. the subareas of interests.

Table 2. Clicks and fixations for kartenportal.ch

Kartenportal.ch	Sum Clicks (Loop11 / CrazyEgg)	Sum Fixations (views)
Logo (AOI2)	5	40
Search for maps (AOI12)	0	45
Search field (AOI13)	130	23
start button (AOI14)	83	14

Table 3. Clicks and fixations for webportal e-lib.ch

e-lib.ch	Sum Clicks (Loop11 / CrazyEgg)	Sum Fixations
Logo (AOI2)	18	43
Search field (AOI6)	430	20
Adv. Search (AOI7)	54	3
Help (AOI8)	13	4

Table 4. Clicks and fixations for webportal e-lib.ch (in seconds)

	Kartenportal		E-lib.ch	
	Total Fixation Duration (Include Zeros) AOI_2	Total Fixation Duration (Include Zeros) AOI_3	Total Fixation Duration (Include Zeros) AOI_2	Total Fixation Duration (Include Zeros) AOI_3
P1	0.37	0.62	1.73	1.1
P2	0.8	1.19	0.47	0.62
P3	0.93	0.6	0.73	0.22
P4	1.26	0.89	0	0.22
P5	0.22	0.71	0.38	0.43
P6	0.56	1.12	1.11	0.62
P7	0.47	1.12	0.54	0.26
P8	1.18	1.43	1.03	0.88
P9	0.08	1.22	0.44	0.49
P10	0.36	1.18	1.65	0.44
P11	0.62	2.37	0.53	0.39
P12	0.73	0.75	0.58	0
P13	1.05	1.98	0.36	0.12
P14	0.45	1.32	0	1.63
P15	0.93	2.17	0.47	0
P16	10.04	18.67	10.03	7.42
Average	**1.25**	**2.33**	**1.25**	**0.93**

Table 4 shows the total duration per test participant on the two major AOIs. As it is clearly visible, total duration depends on the websites. The logo is watched with the same duration in average (1.25 s). But the search part of kartenportal.ch is far more perceived (2.33 s) as the one of e-lib.ch (0.93 s), which may be a consequences of different design approaches.

5.1 Eye-tracking vs. clicks

As shown and mentioned in the tables above, either a region received more views or more clicks, but never both at the same time. This leads to the assumption that the attention, which is correlated with the eye movements, is drawn to information rich areas (such as the red logo in the case of the web-portal e-lib.ch or the red "Start Search" button in the case of the kartenportal.ch) and that the attention that is in relation with a certain functionality is given to other areas. In other words: the most important functionalities did not attract an enhanced visual attention.

This assumption seems to be verified in the click and heat maps of our two case studies, which indeed show very similar distribution patterns: the logo gains a lot of visual attraction and the search field a large number of clicks. Taken the whole design of a homepage into account, it is therefore assumed that either clicks or gazes finally gain attention, either for visual perception or for the use of a functionality. If this complementary distribution is not given, it could be assumed that the website design needs improvement.

5.2 Site to site comparison

Taking a more detailed look at the click stream data, the largest number of clicks was effectuated in the search field AOI. This seems logic, as a search has to be conducted after writing a search term within the field. Comparing the clicks and fixations of the two different start-button approaches, it seems important to mention that nearly no one fixated the button that initiated the search on the e-lib.ch page. Apparently, the design does not attract the eye. Taking a look at the design, the differences are merely between the choices of color. Whereas e-lib.ch has chosen a rather low contrast for the search field, kartenportal.ch uses a highly visible red for the search field. As the search field can be seen as the major feature of a digital library and a high

number of clicks and views are expected, the assumption could be made that the design of kartenportal.ch is slightly more efficient. Nevertheless, this assumption is based on visual analysis of data, and must be confirmed in further tests. Taking a look at the average time of fixation, most participants used the "enter-stroke" on the keyboard to start the search. But still, the start-button of kartenportal.ch was clicked 84 times and only 54 times at e-lib.ch. This difference may be answered by the different design approaches. As it concerns the total fixation duration of the logo, the average of the 14 participants was the same (1.25 s) for both websites. It seems as if the logo has the same importance no matter its design. Interestingly, the second area of interest (i.e. AOI 2, the logo) gained more attention on the kartenportal.ch (2.33 s) than that at e-lib.ch (0.93 s).

6 Conclusion

This paper described the first steps in a data analysis comparing eye-tracking and click-stream data collected from digital library websites. The study was mainly driven by two questions: Firstly, to find out similarities and differences between the data collected from these sites and how far gaze maps and click maps are exchangeable or complementary. The preliminary results show that – concerning counted numbers – they are not disjunctive, but rather complementary. Secondly, it was studied which design factors have an impact on gazes and clicks. Naturally, some areas attract more views, and others more clicks. It seems that mainly the choice of color and the use of contrast have an impact on both gaze and clicks, whereas gaze is stronger related to mere perception and clicks to functions that are related to the task given.

The current analysis is too small to permit statistical correlation and therefore needs further testing; however, it was possible to introduce, similar to Cooke (2006), that eye movements and click counts on digital libraries websites are correlated, in the given case they are complementary or inversely correlated, which means in the case given, that none of these methods could be replaced by another.

It also seems that eye movements do strongly depend on direct perception, where mouse clicks depend on cognition, i.e. the task that the user has

to fulfill (compare Navalpakkam et al. 2013) and it would be interesting to know more about the internal links between perceptive and cognitive acts. Without doubt, in depth research is necessary to further evaluate the current findings in more detail to allow more general conclusions on design issues in digital libraries.

Data

The data is published under creative commons CC-0 and available for verification and further studies at https://zenodo.org/deposit/10895/ under the following doi: http://dx.doi.org/10.5281/zenodo.11481.

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