Empirical Study of User Behavior on Home Page Layouts: SAPO Portal Case Study

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Abstract

The use of eye tracking in usability research has increased in the past years. The work presented in this paper reports on an empirical study that took place at the University of Aveiro. 58 participants were asked to read news on the SAPO homepage while their eye movements and mouse interaction were recorded. An analysis of their visual and interactive behavior on the news areas of interest was made as well as other areas of the homepage. Acquired results were considered, and reinforced interaction design criteria used in the reconceptualization of the actual SAPO homepage.

Keywords

Eye tracking, visual behavior, interaction design, usability

1. INTRODUCTION

The use of eye tracking in usability research and analysis is growing. Some of the first signs of eye tracking date back to 1879, when Louis Émile Javal observed a specific pattern in the reading process (Leggett, January19, 2010). Over the following years, eye tracking has been employed in several other areas of research: advertising, video games, design and the web. Many of the R&D projects mentioned in the following sections were feasible because eye tracking technology has become economically accessible and technically evolved into a very accurate and non invasive measuring instrument (Duchowski, 2007; Jacob & Karn, 2003).

The work reported in this paper shows how an empirical study that gathered qualitative information, visual attention data and mouse clicks detected user interaction behavior and confirmed reconceptualization criteria of the Portuguese Telecom SAPO search engine portal.

2. RELATED WORK

(Mosconi, Porta, & Ravarelli, 2008) analyzed on-line newspapers, focusing mainly on their multimedia content. Using eye tracking technology, their study led them to present several suggestions for on-line newspapers, namely for "news formats", "links to multimedia sections", "slideshows", "ad banners" and "videos".

(Holmqvist, Holsanova, Barthelson, & Lundqvist, 2003) discuss the differences between reading traditional newspapers and on-line newspapers (net papers), presenting results that indicate that net paper readers scan more but read less than newspaper readers. (Barthelson, 2002) demonstrated through an eye tracking study that visualizing a webpage follows several criteria, including a page's inherent prioritized layout, that content located in the middle of the page receives more attention and that personal interests and intentions also influence reading choices.

(Hsieh-Yee, 2001) analyzed several studies focused on web search behavior that considered both children and adult participants. Based on research, (Hsieh-Yee, 2001) also indicated, that several factors may influence how users search for information. These factors may be related to a user's background and experience with computers, the web and other information retrieval tools. Additionally, information need, domain knowledge, cognitive abilities, affective states, demographics, and the nature of the information also contribute to the way in which the searcher seeks information (Hsieh-Yee, 2001, p. 169). Finally, the type of search task may also affect information search. People use different search strategies depending if the task is fact-based, open ended or object oriented. (Pan, et al., 2004) indicated that the gender of the subjects, the order in which web pages are visualized

and the interaction between site types influence the behavior or web page viewing. These results confirmed work previously done by (Rayner, Li, Williams, Cave, & Well, 2007) that also demonstrated the effects of individual characteristics and stimuli on eye movement behavior.

Other relevant studies are those elaborated by the Poynter Institute[1], some dating back to the early nineties. The first Poynter study was presented in 1991. Using 90 participants, three newspapers were examined by readers. Results indicated that photos and color are important, and that readers have a common pattern of navigation: readers begin on photos, jump to headlines, cutlines and then text (Garcia, 1991). Another study took place between 1998 and 200 in collaboration with Stanford University (Lewenstein, Edwards, Tatar, & DeVigal, 2000). The study analyzed on-line newspapers and 67 testers were asked to read different newspapers based on preferences and usual habits. Contrary to what was seen in the previous study related to printed news; in on-line newspapers, the main entry point is through text, suggesting that readers prefer pictures to be separated from the news piece. A third study from the Institute titled "Eye Track III" (Outing & Ruel, 2004) took place in 2004 and analyzed once again online readers. The 46 participants that took part in the study were asked to read mock news websites as well as multimedia content while their eye movements were registered. The study resulted in several findings: readers' eyes fix first in the upper left of a page (normally where a logo is placed), then go from left to right; larger headlines (especially located in the left) draw more attention than smaller headlines; text is preferably an entry point into web pages; short paragraphs received twice as much attention as long; ads in the top and left of a page receive the most attention.

(Nielsen & Pernice, 2009) also developed an extensive eye tracking study, having focused on analyzing visualization patterns on websites with a business goal. Over 300 subjects, aged 18 to 64, participated in a study that collected data related to the way people visualize websites, navigation menus, images and advertisements.

3. OBJECTIVES

The main goal of this study was to gather information able of revealing relevant interaction behavior of SAPO users while finding and reading news exclusively on the SAPO homepage. Reconceptualization of SAPO's homepage articulated with this objective and was partially driven as a consequence of the results reported in this paper.

4. METHODS & TECHNIQUES

The present study took place at the University of Aveiro, Portugal and all related data was gathered during one week in March, 2009. The following sections describe details of what can be classified as an empirical study based on eye tracking technology and intrinsic registration of user interaction behavior.

4.1 Sample description

The sample of the study consisted in 58 participants which were selected randomly upon volunteering. Partic-

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[1] Poynter Institute: http://www.poynter.org/

ipants' ages ranged from 18 to 43 and were all members of the University of Aveiro community. 34 participants were male and 24 were female. The average age of the participants was 24.5. For result analysis purposes, the study sample was divided into 4 groups: participants under the age of 20; participants aged 20-29; 30-39 and participants with 40 or more years of age. Table 1 characterizes the number of participants per age group and the respective percentage in terms of the global number. Because most of the participants were students, the 20-29 age group had the greater portion of participants.

	<20	20-29	30-39	40+
No. P.	9	43	4	2
%	15.5%	74,1%	6,9%	3,4%

Table 1: Characterization of participant study sample

4.2 Study method

The present study consisted of two main tasks. First, participants were asked to fill out a small questionnaire which inquired on participants' ages, gender, as well as news reading preferences and behaviors. The second task required participants to visualize, during 10 minutes, news present on the SAPO Portal – Figure 1.
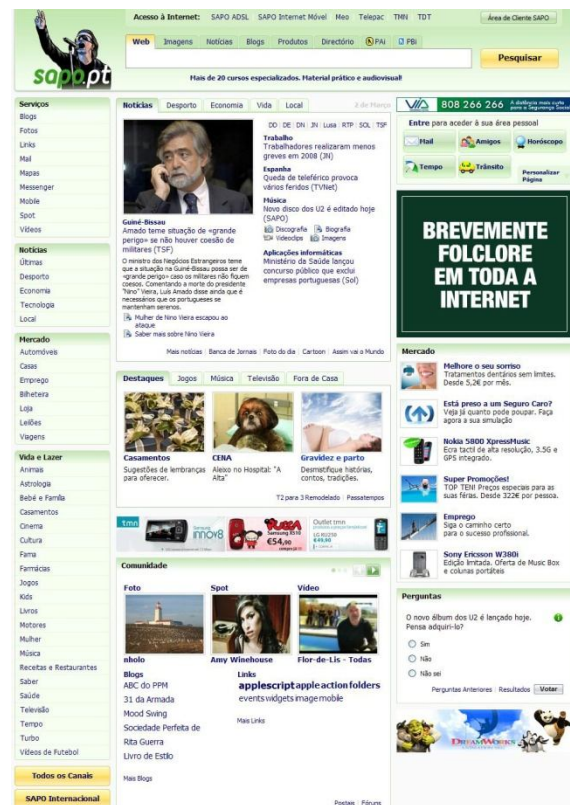

Figure 1: Representation of the SAPO home page

Specifically, participants were asked to randomly visualize any news piece present on the portal and when finished, to return to the home page and continue reading news. The supervising researcher observed each participant's session and, if the participant began reading content that was not news, he/she was asked to return to the home page.

Despite the main objective of understanding participants' visualization behavior regarding news reading, several other areas of interest (AOI) on the SAPO portal were analyzed both in terms of visual behavior but also in terms of mouse interaction.

5. RESULTS & DISCUSSION

Data was acquired via questionnaire as well as with eye tracking software. As referred earlier in section 4.2 – Study Method – the questionnaire inquired on some personal information as well as news reading preferences.

### 5.1 Questionnaire analysis

The data collected through the questionnaires helped answer three main questions: 1 – how frequently participants visualized news on the Internet; 2 – the average time participants spent reading the news on the Internet; 3 – how frequently participants accessed the SAPO portal.

Graph 1 presents the frequency participants spend viewing news on the Internet. 39 participants [p] (67.2%) indicated viewing news on a daily basis, 12 (20.7%) on a weekly basis, 7 (12.1%) indicated rarely viewing news on the internet and 0 participants answered never viewing news.
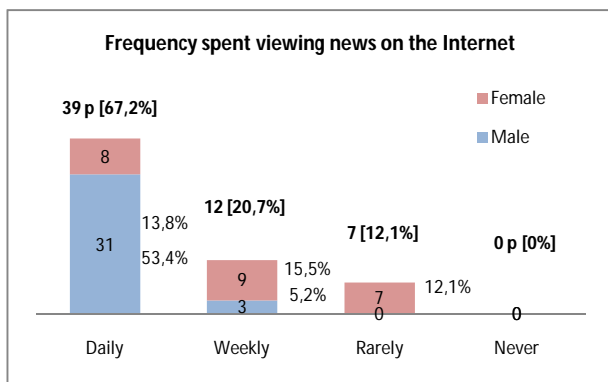
Graph 1: Frequency of viewing news on the internet and distribution according to participant gender

Graph 2 presents the average time, in minutes and per day, spent by the participants visualizing news on the Internet. 8 participants [p] (13.8%) indicated spending less than 5 min/day; 33 participants (56.9%) indicated spending between 5 and 15 min/day while 17 participants (29.3%) answered spending more than 15 min/day visualizing news on the Internet.
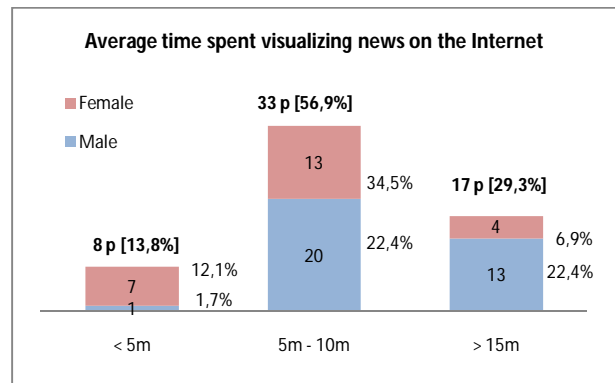
Graph 2: Average time (in minutes) spent visualizing news on the internet and distribution according to participant gender

The final question inquired on participants' accessing frequency of the SAPO portal. The results indicated that 5 participants (8,6%) visit the portal on a daily basis; 9 participants (15.5%) on a weekly basis; 42 participants (72.4%) rarely visit and 2 participants (3.4%) indicated never visiting the portal.

5.2 Visual attention data analysis

As mentioned, the second task of the study required the 58 participants to visualize news on the SAPO portal during 10 minutes. However, for the following analysis, and according to the study goal, only the time spent on the SAPO home page will be considered.

Table 2 summarizes the maximum, minimum and average time spent on the SAPO home page and percentage relative to the average duration of the participants' sessions (9m47.3s).

	Maximum	Minimum	Average
Time	5m56.5s	6sec	1m51.9s
%	57.3%	1.7%	19%

Table 2: Maximum, Minimum and Average Time spent by participants on the SAPO home page and percentage relative to average study duration

The following results and analysis, however, is relative to the average time spent by participants on the home page: 1min51.9sec.

5.2.1 "News Area"

Figure 2 represents the "News Area". The "News Area" is divided into 4 main sections: the "Superior News Tab", "Feature Image", "Feature News piece" and "Other News".

Figure 2: Representation of the "News Area" and the 4 main sections of the area

Table 3 presents the average time participants spent viewing the "News Area"; approximately 1m3s, 56.3% of the average time (1m51.9s) participants spent on the SAPO home page.

	News Area	S. News Tab	Feature Image	Feature News piece	Other News
Time	**1m3s**	**3.5sec**	**7.4sec**	**18.2sec**	**33.3sec**
%	**56.3%**	**3.1%**	**6.6%**	**16.3%**	**29.8%**
Male	57.1%	2.4%	7.9%	18.1%	28.2%
Female	53.6%	3.7%	5.8%	15.5%	28.1%
<20	46.1%	3%	5.3%	17.9%	19.7%
20-29	57.6%	3%	7.3%	17.3%	29.6%
30-39	53.4%	1.6%	6.9%	12.2%	32.2%
40 +	67.6%	3.7%	11.3%	17.7%	33.4%

Table 3: Average time participants spent visualizing the 4 sections of the "News Area" and respective percentage; average percentage spent visualizing "News Area" based on gender and age groups

The results presented in Table 3 indicate that the section "Other News" was the most visualized area (29.8%). This value is distributed among 3-5 small news clippings that are normally present in the section. Therefore, it can be estimated that each one of these small clippings receives on average between 6-10% of visual attention; that is, a smaller value than the combination of "Feature Image" and "Feature News piece" with a total of 22.9% (16.3% + 6.6%) of participants' visual attention on the home page.

5.2.2 "Advertising Areas"
Four areas of advertisement were identified on the SAPO home page. Results indicate that these 4 areas had very reduced visual activity. "Advertising Area (AA) 1", the biggest of the 4 areas, received on average 2.3s of visual attention, 2% of the average time spent by participants on the SAPO home page (1m51.9s). "AA 2" received on average 1.2s (1%) and the remaining 2 areas, "AA 3 & 4" 0.1s (0.1%) of visual activity. Despite these somewhat

insignificant values, other numbers were acquired. "AA 1" was visualized by 49 participants; "AA 2" by 43 and "AA 3 & 4" by 9 and 14 participants. However, if a minimum time of visualization is defined at 1s, 31 participants visualized "AA 1", 24 "AA 2" and 2 and 1 participants "AA 3 and 4". Increasing the time variable to 5 seconds, "AA 1 & 2" was seen by 5 and 4 participants while the remaining two were not seen by any participants. Finally, despite the size and privileged location of area "AA 1" on the homepage, when compared to other areas on the homepage, the quantity of visual attention received is quite insignificant. However, it must be noted that this information should not be final due to the fact that on occasion, perceiving information present in advertisements can be done in very short periods of time. The four "Advertising Areas" found on the SAPO homepage are identified below on Figure 3.
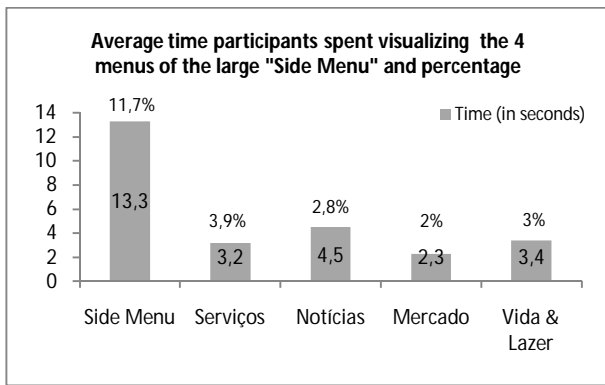
5.2.3 "Side Menu"
Table 4 indicates the average time participants spent visualizing the "Side Menu" and the individual menu sections: "Serviços", "Notícias", "Mercado" and "Vida & Lazer".

	Side Menu	Serviços	Notícias	Mercado	Vida & Lazer
Time	13.3s	3.2s	4.5s	2.3s	3.4s
%	11.7%	2.8%	3.9%	2%	3%

Table 4: Average time participants spent visualizing the 4 menus of the large "Side Menu" and respective percentage

Curiously, despite the "Menu Serviços" having less than half of the number of items present on the "Menu Vida & Lazer", the average time participants spent on either one of these menus was very similar: 3.2s (2.8%) and 3.4s (3%). A possible justification for this occurrence is related to the fact that when visualizing the home page, not all of the home page was visible. The resolution of the screen did not allow for the entire page to be displayed so a participant had to scroll down to see the entire page. Because the limit of visible area is just below the "Advertising Area 2", visible on Figure 3, some of the items on the "Menu Vida & Lazer" are "cropped" which implies that without scroll, both the "Menu Serviços" and "Menu Vida & Lazer" are approximately the same size and therefore, could receive approximately the same duration of attention.

Graph 3 represents the average time spent by participants visualizing the 4 menus – "Serviços", "Notícias", "Mercado" and "Vida e Lazer" – of the large "Side Menu" and respective percentage.

Graph 3: Average time participants spent visualizing the 4 menus of the large "Side Menu" and respective percentage
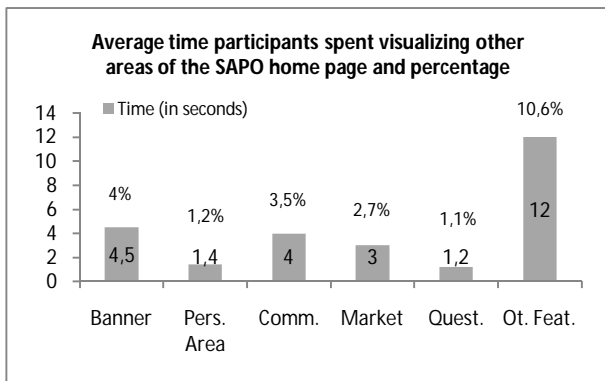
5.2.4 Other areas of the SAPO home page

In addition to the "News Area", "Advertising Areas" and the "Side Menu", other areas of the SAPO home page were also analyzed. Areas such as the "Banner", "Personal Area", "Community", "Market", "Questions" and "Other Features".

	Ban.	Per. Area	Comm.	Market	Quest.	Other Feat.
T	4.5s	1.4s	4s	3s	1.2s	12s
%	4%	1.2%	3.5%	2.7%	1.1%	10.6%

Table 5: Average time participants spent visualizing other areas of the SAPO home page and respective percentage

As Table 5 demonstrates, the "Other Features" area was the most viewed area (10.6%) while the "Banner" – which contains the search area – was the least viewed area with 4% of participants' visual attention.

Graph 4 represents the average time spent by participants visualizing other areas of the SAPO home page: the "Banner", "Personal Area", "Community", "Market", "Questions", "Other Features" and respective percentage.

Graph 4: Average time participants spent visualizing other areas of the SAPO home page and respective percentage

5.3 Mouse interaction data analysis

Although the main purpose of the study was to understand visual behavior, participants' mouse interaction on the areas mentioned in section 5.2 was also analyzed. Considering the 58 participants' that participated in the study, a total number of 714 clicks were registered. The maximum number of clicks made by a participant was 30 whereas the minimum was 1, with an average of 12.3

clicks per participant. Furthermore, on average, 83.3% of the clicks were made inside 3 main areas: the "Side Menu", the "News Area" and a new section, the "Search Area". The remaining clicks were made on some of the areas mentioned in section 5.2.4.
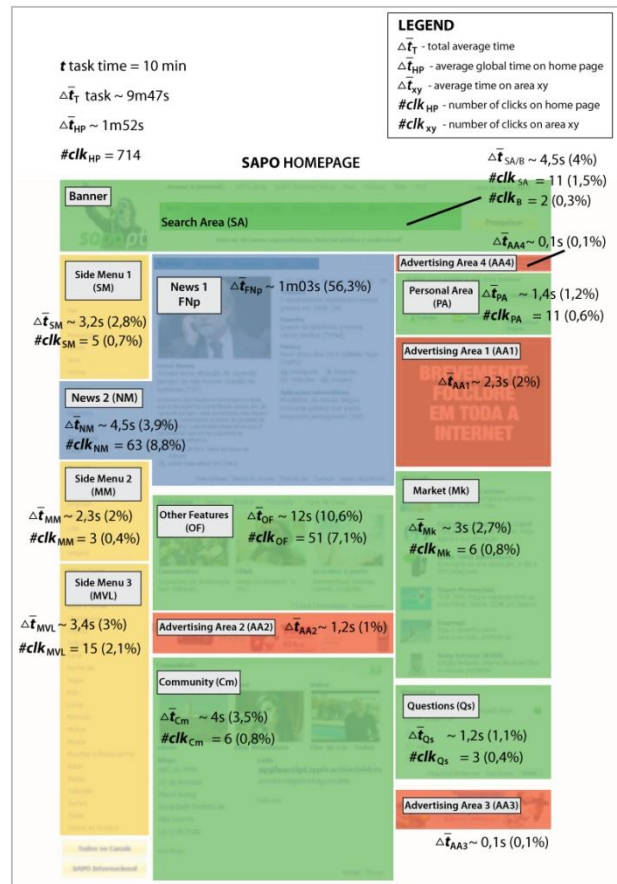

Figure 3: Holistic SAPO home page results representing section contextualization of visual attention and average mouse clicks

Figure 3 represents a holistic home page info-graphic overlay of the average time participants spent visualizing a pre-determined section of the homepage (results mentioned in section 5.2) as well as the number of clicks made upon those sections.

The blue area of interest is relative to the "News Area"; yellow blocks are relative to the "Side Menu"; red blocks are "Advertising Areas" and green areas are other areas of the SAPO home page.

5.3.1 "News Area"

In this section, once again the "News Area" is analyzed. Contrary to what was done for section 5.2.1, two new sections are defined for the "News Area": "Related News" and "Partners". Furthermore, the "News menu" found on the "Side Menu" (section 5.2.3) will also be considered a part of the "News Area" for the interaction analysis. Figure 4 represents the reformulated "News Area" defined for the analysis of participants' mouse interaction and includes: "Superior News Tab", "Partners", "Feature Image", "Feature News Piece", "Related News", "Other News" and "News Menu".
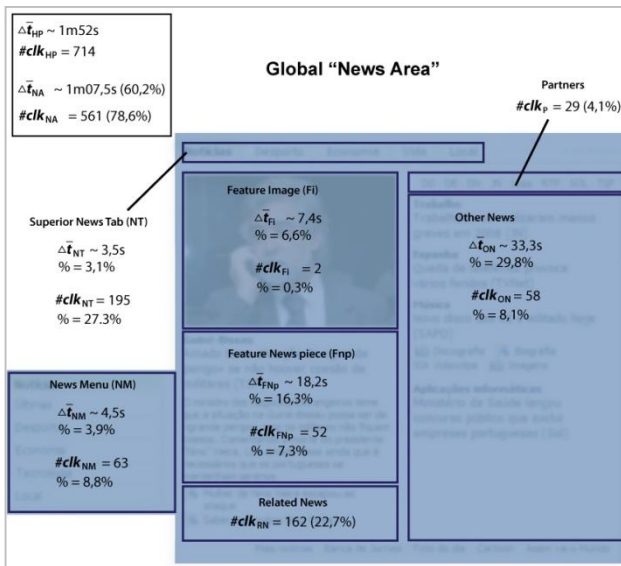
Figure 4: Specific result overlay on SAPO home page News exclusive area, depicting visual attention and average mouse click for each sub-area

Figure 4 also indicates in detail for each of the referred sections the average time participants spent visualizing the content, the relative percentage based on the total average time spent on the home page (1m51.9s), the number of clicks made in the section as well as the relative percentage based on the total number of participant clicks (714).

Table 6 demonstrates the distribution of clicks among the various defined areas in the "News Area". A total of 561 clicks were made in this area (78.6% of the total number of clicks – 714).

	News Area	S. News Tab	Partners	Feature Image
No. Clk	561	195	29	2
%	78.6%	27.3%	4.1%	0.3%
	Ft. News piece	Related News	Other News	News Menu
No. Clk	52	58	162	63
%	7.3%	8.1%	22.7%	8.8%

Table 6: Distribution of number of clicks among the 7 areas of the "News Area" and respective percentage based on total number of clicks on the home page

As the numbers on Table 6 indicate, the "Superior News Tab" received the most number of clicks, with a total of 195 whereas the "Feature Image" received only 2.

Graph 5 represents the distribution of the number of clicks among the 7 areas of the "News Area" – "Superior News Tab", "Partners", "Feature Image", "Feature News Piece", "Related News", "Other News" and "News Menu" – and respective percentage based on total number of clicks on the home page (714).
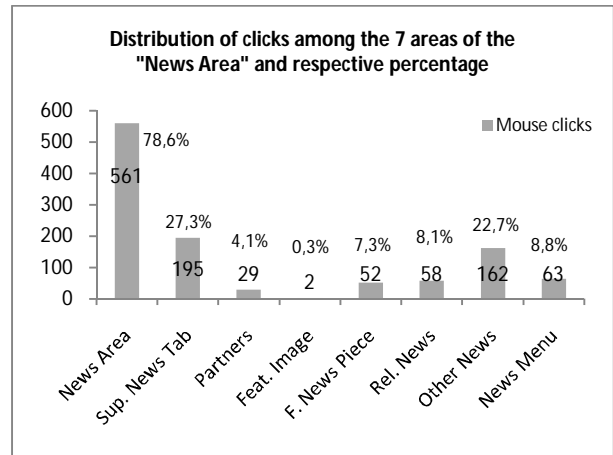
Graph 5: Distribution of number of clicks among the 7 areas of the "News Area" and respective percentage based on total number of clicks on the home page

The "Superior News Tab" is divided into 5 items: "News", "Sports", "Economy", "Life" and "Local". In terms of gender differences in interaction, the most notable difference resided with the "Sports" item where male participants made 35 clicks whereas female participants only made 14.

Grouping together the 4 main sections that are news related – "Feature Image", "Feature News piece", "Related News" and "Other News"; the total number of clicks registered was 274.

The "News Menu" is divided into 5 items: "Latest [news]", "Sports", "Economy", "Technology" and "Local". Of the total number of clicks made in the "News Area", only 63 were made in the "News Menu". Bearing in mind that 3 of the 5 items in this area are similar to those found in the "Superior News Tab" – "Sports", "Economy" and "Local" – and that the "Superior News Menu" received more than 3 times as many clicks (195), one can presume that participants prefer a horizontal menu positioning (and placed at a higher level) than a vertical menu placed on a page's lateral side. Towards this idea contributes the fact that despite the large difference in clicks, both "news menus" had similar average times of visualization: 3.5s (3.1%) for the "Superior Tab Menu" and 4.5s (3.9%) for the "News Menu". Additionally, of the 5 items present on the menu, the "Latest [news]" and "Technology" items were the most interacted upon with 17 and 24 clicks of the 63 total clicks. Furthermore, and although this assumption can't be conclusive, male participants interacted more upon the "Sports" and "Technology" items, a behavior some might consider a "typical" male behavior pattern.

5.3.2 "Side Menu"

Contrary to what was done for section 5.2.3, mouse interaction analysis on the "Side Menu" will not consider interaction made upon the news-specific menu as it was analyzed previously with the "News Area" (section 5.3.1).

Figure 5 demonstrates both the average time participants spent visualizing each of the menus in the "Side Menu" (as well as the relative percentage), as well as the number

of clicks made upon the 3 menus. None of the 3 menus received a great amount of clicks as none were directly related to the objective of reading news. Nevertheless, 15 (2.1%) clicks were registered on the "Vida e Lazer Menu" – the largest of the three – 7 of which on the "Cinema" item. Furthermore, of these 7 clicks, 6 were done by participants grouped in the 20-29 age category, suggesting a greater interest in cinema from the "younger" population.

The acquired results present on Figure 6 do not indicate any significantly relevant difference between average time of participant visualization when compared to the number of clicks made on any of the menus.
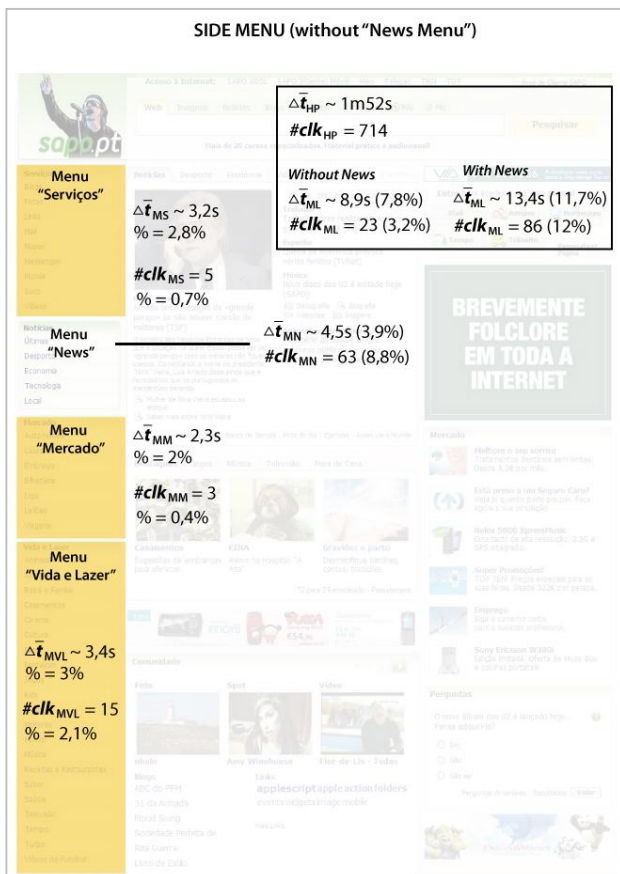

Figure 5: Specific result overlay on SAPO home page Side Menu, depicting visual attention and average mouse click for each sub-area

5.3.3 Advertising and other areas of the homepage

The last of the areas that received some interaction include the "Advertising Areas" as well as other areas mentioned previously in section 5.2.4.

The total number of clicks in these areas was 119 (16.7%). 51 (7.1%) of these clicks were made on the "Other Features" section, found just below the "News Area" (in blue) in Figure 3. Other areas or items that received some relevant interaction were the "Photo of the Day" (Foto do Dia) and the "News Stand" (Banca de Jornais) items with 16 (2.2%) and 13 (1.8%) clicks, respectively. Once again, as the main objective of the study was related to news search, the lack of interaction on these areas is understandable. In terms of the "Adver-

tisement Areas", only 3 clicks were made on any of the 4 advertising spots.

6. CONCLUSIONS

The present study analyzed 58 participants' visual and interaction behavior on SAPO's homepage. Bearing in mind the acquired results, several conclusions can be drawn regarding visual and interaction behavior.

Considering the number of clicks participants made on the horizontal tab in the "News Area", it seems reasonable to conclude that tabs are a more efficient solution for interaction than vertical menus. Despite the average visualization time being similar, the number of clicks made on the "Superior News Tab" was more than 3 times that verified on the "News Menu".

Additionally, tabs in general appear to be the most efficient of the interaction areas, as participants seem to have no difficulties in interacting with the tab paradigm. Furthermore, the ratio clicks/visual attention on tabs is, as the results demonstrate, superior than on any other interaction area of the SAPO homepage.

Another valuable conclusion is that in the global "News Area", the group "Feature Image" + "Feature News piece" is more efficient than the "Other News" area where several small news pieces can be found. In fact, the results indicate that the "Feature Image" + "Feature News piece" received 4 times more visual attention than the "Other News" area.

Other acquired results reveal some interesting information regarding advertisement. The advertising areas that received the most visualizations were those placed in a favorable location. "Advertising Area 1" is favorably located next to the global "News Area", centered on the SAPO homepage. "Advertising Area 2" is also favorably located, vertically centered on the homepage. These results verify what (Barthelson, 2002) stated regarding the importance of a prioritized layout, where content that is centered receives more attention.

While ¾ of the participants indicated that they did not, or rarely visited, the SAPO homepage, their web use literacy is rather high for Portuguese standards. The efficiency of tab use reveals that the participants have a common use of this metaphor and have adopted it comfortably. Tabs in fact provide an efficient way of organizing different contexts of information adjacently maintaining an optimization of the visual field occupation. Tab interface metaphor can also be applied with some degree of scalability and still maintain interaction design coherence.

The results acquired through the empirical study with 58 participants at the University of Aveiro complemented results acquired internally at SAPO's usability laboratory, and had a direct consequence on the reconception and redesign of the SAPO homepage. SAPO's current homepage uses tabs as a dominant scheme of organization and interaction. Additionally, the side menu was removed, freeing up vertical space used for information display. The areas previously indexed in the side menu are now presented as boxes embedded in the page. Finally, areas

exclusive to advertising were not changed and remain in the same place.

Figure 6 represents SAPO's current homepage. At the top of the homepage it is clear that a horizontal navigation paradigm is dominant, as the 4 red outlined boxes indicate. The two highlighted blue boxes at the bottom represent the reorganization of the side menus into "boxes" with items presented vertically. Furthermore, as mentioned, there are no traces of the previous side menu.

Figure 6: Current SAPO homepage layout

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