

*Revisiting Web Design Guidelines by
Exploring Users' Expectations, Preferences
and Visual Search Behaviour*

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The majority of existing Web design guidelines have been derived by expert heuristic evaluations, apparently without involving the users themselves. In this paper we report two studies of an on-going research programme in the area of eye tracking in which we are investigating the relationship between the users' expectations, preferences, and visual search behaviour. The first study captures the position of first fixations while the users look for cues of the brand identity and services of the site. The second study examines how quickly users adapt to an unfamiliar design layout during repeated exposures by measuring the position of first fixation, time to target fixation and sequence of fixations (scan path). In both the studies, the eye tracking data is supported by qualitative data from pre- and post-session questions which elicited the users' expectations and preferences about the target Web-link.

Keywords: Web design guidelines, eye tracking, visual search behaviour, homepages, e-commerce, user-adaptation.

1 Introduction

When considering the design of websites for e-commerce, the HCI literature proposes a variety of design guidelines for websites [Nielsen et al. 2001; van Duyne et al. 2003]. In addition, others have suggested that these guidelines have been derived by personal reviews and anecdotes without reporting the involvement of human participants [Ivory et al. 2001].

The homepage is viewed more than any other page on a website and first impressions are important in attracting new users. Nielsen & Tahir propose that:

The homepage must communicate in a short glance where users are, what your company does and what the users can do at your site. [Nielsen & Tahir 2002]

van Duyne et al. [2003] suggest that the first visit of the homepage is often the site branding which must be initially clear to users. A detailed study has been reported in Nielsen & Tahir [2002] of heuristic evaluations of 50 homepages. Although the guidelines proposed in these studies are straightforward to implement, it has been stated that they could be too general to apply to a particular case, so a wide range of websites are not supported [Beier & Vaughan 2003]. The first study reported in this paper used eye tracking to investigate what users inspect on their first visit to a homepage and how quickly can they establish the brand identity. The study recorded what users looked at first (i.e. position of first fixation) and their initial scanning behaviour. The eye movement data was compared to users' responses to questions about company identity and services during the post-session interviews.

Another set of design guidelines is based on an assumption that visual search behaviour is shaped by expectations, hence they suggest designing user interfaces that conform to conventions. Nielsen et al. underline the importance of maintaining consistency with other websites and webpages:

All webpages are much the same from the user's perspective, they share interaction techniques, they are downloaded (slowly) from the Internet, and they have relatively similar layouts. Those similarities are in fact good because they allow users a measure of transfer of skill from one site to the next. Users complain bitterly when a site doesn't try to use navigation from the majority of other sites. [Nielsen et al. 2001, p.189]

But how do users learn conventions and develop expectations?

Ehret [2002] suggests that when locations of design elements remain constant, performance improves over exposures as users learn the placements of design elements. This implies that consistency of placement of a design element influences visual search. But a recent eye tracking study by McCarthy et al. [2003] investigated the impact of changing the location of design elements and how users performed when viewing the element in unexpected locations. They found that following conventions with other websites did not matter, as users quickly adapted to unexpected design layouts. So, is it important to follow consistency with other websites?, or is it acceptable to place design elements in non-consistent placements on the user interface? The second study reported in this paper investigated how

quickly users adapt to a different location of a design element over repeated exposures. Specifically, it focused on the 'About Us' link on a website.

When users encounter webpages, they are often presented with an overwhelming amount of information, which is a mix of visual and textual design elements clamouring for attention. Thus, understanding the factors that influence the visual search behaviour on the user interface is extremely valuable. Eye tracking has been chosen as the primary evaluation technique for both the studies being reported in this paper. The eye movement data has been supported by outcomes of conventional techniques, such as self-reports of expectations and preferences as elicited from pre- and post-session questions, which enabled a better understanding and interpretation of the outcomes of the two studies.

1.1 Visual Search Behaviour

Theories of visual search, as reported by Horowitz & Wolfe [1998], conclude that visual search relies on accumulating information about the identity of design elements over time. This knowledge enables designers to structure the user interface effectively and influence the user's visual search behaviour. Post-cognitive modelling research, as cited in Horowitz & Wolfe [1998], has demonstrated that people use anticipatory location information to guide visual search, and that visual features sometimes guide the visual search (i.e. expectations and salience) [Hornof & Halverson 2003]. It is primarily through visual search that users locate the content of their Web-based tasks. Despite extensive research into visual search behaviour in disciplines such as psychology, recent research in HCI [Hornof & Halverson 2003] has underlined the importance of developing a unified understanding of users' visual search behaviour. Visual search behaviour on websites is influenced by user's expectations about what is being looked for and where it might be located. Pirolli & Card [1995] talk about the design layout of the display as a bottom-up influence and expectations as a top-down influence. Bottom-up processing refers to the design elements influencing the visual scene itself, such as presentation format, colour, and position, whereas top-down processing refers to the expectations the users develop such as the cognitive processes when viewing a scene. The interactions between top-down and bottom-up influences is identified as Information Scent or Information Foraging [Pirolli & Card 1995]. Unless the design elements such as colour, menu items, graphs (bottom-up) are looked at, there is no 'scent', and therefore, there is no basis for selection.

2 Tracking Eye Movements to Assess Usability

Conventional usability evaluation techniques such as user-observations, think-aloud protocols, questionnaires and interviews focus more on the activities of user performance rather than the understanding of users' cognitive processes [Goldberg et al. 2002]. Therefore, aspects of task performance such as screen navigation, selection of menu items, can be captured but the inferences of cognitive processes are more difficult to explain. Eye tracking studies in cognitive psychology have established that eye movements give an insight into the users' cognitive processes, for example see Just & Carpenter [1976]. Eye movements in reading and information

processing have been studied by Rayner & Pollatsek [1994] and concluded that eye-movement data indicates how easy it is to process a display.

The use of eye tracking in HCI is not a new concept, as Jacob & Karn [2003] have illustrated in their review. Fitts [1954] was the first to conduct a systematic eye-tracking study of pilots using cockpit controls and instruments. In recent years eye tracking devices have become more affordable, and the technology has improved, enabling an increasing number of HCI researchers to engage in eye tracking studies [Dix et al. 2003]. In general, eye-movement data is used to support recommendations for how a user interface should be changed, rather than a broad assessment of the interface's usability [Goldberg & Winchansky 2003].

Previous research [Cowen et al. 2002; Goldberg & Kotval 1999; Renshaw et al. 2003] has established that specific design elements influence eye movements in a predictable way, and they demonstrate that eye tracking metrics are sensitive enough to detect them. Eye tracking has been applied in HCI in two ways: as a real-time input device and its use as a usability evaluation technique [Jacob & Karn 2003]. In the studies reported in this paper, eye tracking has been applied for usability evaluation of websites.

2.1 Eye Tracking Studies of Websites

Granka et al. [2004] report that only a small number of studies have been conducted on eye movement behaviour on webpages. Visual preferences of text and images have been explored by two studies [Ellis et al. 1998; Lewenstein et al. 2002]. Ellis et al. [1998] demonstrated that users completed tasks more quickly and easily on text-based screens, although they preferred image-based screens. The Stanford Poynter Project study Lewenstein et al. [2002] examined how users read on-line and off-line news; they found that text was viewed more than images for readers who read on-line news, whereas the opposite occurred for readers who read off-line news.

Two studies, Josephson & Holmes [2002] and Goldberg et al. [2002], have examined the navigational styles on user interfaces of webpages. Josephson & Holmes [2002] examined users' scan paths on different kind of images widely used on the Internet to test Norton & Stark's scan path theory and identified strong similarities among scan paths, suggesting that different users' eye movements may follow a 'habitually preferred path'. Goldberg et al. [2002] captured navigational styles of users navigating Web portals. They concluded that headers of links are not always viewed before the main body. This research went on to develop specific design recommendations for portals based on the eye-movement data.

The studies discussed above explored navigational styles that the users apply on both off-line and on-line channels but did not investigate the factors that influence the navigation styles. However, recent studies, for example Outing & Ruel [2004] and Pan et al. [2004], aim to understand the factors that influence user's visual-search behaviour.

Pan et al. [2004] investigated some of these factors, such as individual differences, design characteristics of the webpages, the order in which webpages are viewed and different tasks that were given to the users to complete. Gender and viewing order were found to be the key determinants of visual search behaviour.

Men applied different scan paths from women and the order in which the stimuli were presented influenced the scan paths as well.

The Stanford Poynter Project [Outing & Ruel 2004] extended their previous work [Lewenstein et al. 2002] on how users read news websites. They applied a more methodological approach in their latter study. Some of the key points of their latest study [Outing & Ruel 2004] suggest that users navigate more on the upper part of news websites rather than left or right of the page. The size of text was found to be influential in terms of encouraging focused viewing behaviour; smaller text drew more fixations while larger sizes promoted lighter scanning. The users fixated more on headlines with large text rather than headlines with small text.

2.2 Eye Movement-based Metrics and Terminology

In our research programme, Study 1 used the following eye movement-based metrics:

1. Initial gaze: where the participant looked for less than half a second 100 milliseconds (ms) prior to the homepage appearing on the screen.
2. Entry point: the first fixation within 300ms of the display of the homepage. 300ms is the duration of a typical fixation and the typical time in which information extraction occurs [Cowen et al. 2002].

Study 2 used the following eye movement-based metrics:

1. Time to target fixation: the time users need to fixate on the target link gives a basis of performance measurement when a specific search target exists. Since we are interested how quickly or slowly the target link is fixated the time to target fixation is an indication of user performance. The target link in our study is the 'About Us' link.
2. Location of fixation: the location of fixations is used as an indicator of where users look on a webpage to locate the target link.
3. Initial Gaze: initial gaze measures the user's first gaze during 50ms of the webpage appearing on the screen in order to examine where users expect to find the target link.
4. Entry Point: Entry point measures the user's first fixation within 250ms of the webpage appearing on the screen in order to examine which design elements first draw user's visual attention.
5. Scan path: the sequence of fixations indicates the order in which the user looked at areas on the webpage.

The difference in milliseconds (300ms and 250ms) for the capture of initial gaze and entry point between the two studies is due to different sampling rates of the two eye tracking devices used in the two studies. Similar to what has been proposed by Granka et al. [2004], we used a location grid of 6 equal areas (Figure 1) for the analysis of 'initial gazes' and 'entry points' in the two studies.



Figure 1: Sample location grid to analyse eye-movement data with respect to the location of the design elements.

3 Study 1 — Experiment Design

Study 1 collected four types of data:

1. A background questionnaire (eliciting Internet experience and typical Internet usage).
2. Eye tracking data.
3. Responses to questions regarding user's expectations of brand identity and services on e-commerce home pages.
4. Protocols of post-session interviews eliciting users' perceptions of interacting with home pages of e-commerce websites.

The principal focus in the research design was to explore the relationship between user's scanning behaviour and the ability to identify the brand and services on a home page. Our secondary focus was to capture the relationship between user's previous experiences and, therefore, expectations, with their scanning behaviour.

3.1 Participants

Ten volunteers (5 male and 5 female) with age range of 22–51 from the staff and postgraduate student population of the Open University participated in this study. Eight participants were regular (using the Internet 2–3 times per day) Internet users and 2 were frequent (using the Internet throughout the day as a part of their job) Internet users. None of the participants had viewed the homepages used in the study prior to their participation.

3.2 Stimuli and Equipment

Five e-commerce homepages were selected as stimuli for the first study:

- Walt Disney <http://www.disney.com> (family entertainment).
- Pet Smart <http://www.petsmart.com> (retail supplier for pets).
- General Motors <http://www.gm.com> (corporate automaker).
- Federal Highway Administration <http://www.fhwa.dot.gov> (US department of transportation).
- Global Sources <http://www.globalsources.com> (product and trade information for volume buyers).

These 5 sites were chosen from the 50 homepages Nielsen & Tahir [2002] had evaluated as a part of their study. The aim was to compare the design guidelines derived by Nielsen & Tahir [2002] to the outcomes of our eye tracking study. Therefore, the selected homepages were chosen based on the ones that retained the same design layout since Nielsen & Tahir had performed the heuristic evaluations.

Previous research [Loftus 1976] has shown that 15 seconds is sufficient to capture a complete scan path for the first inspection of a display. Therefore, the homepages were presented for 15seconds each. Eye movements were recorded using a SensoriMotoric Instruments (SMI)'s Head-Mounted Eye Tracking Device II (HED-II) at a sample rate of 50Hz [SensoriMotoric Instruments 1999]. An MPEG video file was produced with a moving dot representing the user's eye movements.

3.3 Procedure

After a brief introduction about the study, each participant completed a consent form and a background questionnaire. The eye tracking equipment was then calibrated for the participant. The five selected homepages appeared as a PowerPoint slide show. The order of presentation of the homepages was varied for each participant, in order to reduce possible order effects. The task questions were:

- 'What does this company do?'
- 'What can you do on this site?'

The participant's eye movements were recorded, and the participant's verbal responses and interactions with the webpages were audio- and video-recorded. A post-session, semi-structured interview followed which was also audio-recorded.

3.4 Pre-test Questionnaire

The aim of the pre-test questionnaire was to collect demographic data, and frequency and purpose of Internet usage. In addition, the participants were asked to state three websites they visited often and three websites they were familiar with. The purpose of these questions was to look at those websites and analyse how the users' previous experiences influenced the way they expected to find information related to the task questions in our study. Our analysis showed that in most cases, the websites that the participants had visited regularly or were familiar with had the logo and name of the company either at the top-left corner or in the top-middle of the homepage.

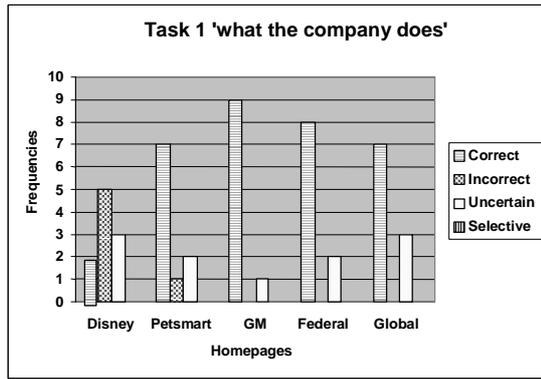


Figure 2: Frequency of responses for Task 1 'What does the company do' across all homepages.

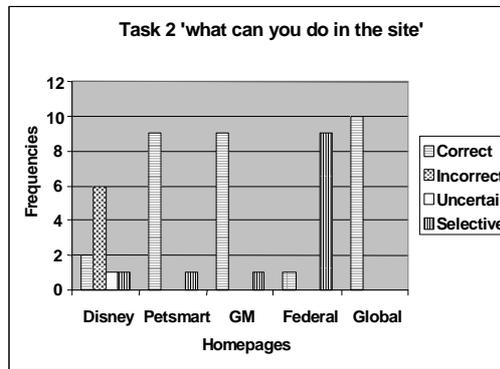


Figure 3: Frequency of responses for Task 2 'What can you do in the site' across all homepages.

3.5 Eye Tracking Session

A common trend was found for the eight users who classified themselves as regular Internet users. Their initial gaze prior to the presentation of the homepage was in the middle of the screen across all homepages whereas the two participants who classified themselves as frequent users looked at the top of the screen. The majority of 'entry points' across homepages were found on the top left and top middle of the page. 60% of 'entry points' fixated on Area A and 40% fixated on Area B of the page (Figure 1 shows Area A and B on a sample webpage).

A coding system was developed to classify the answers given for the task questions. Figure 2 demonstrates the frequency of the type of responses as given for Task 1 across homepages and Figure 3 for Task 2. The GM homepage gathered the highest accurate responses in both task questions indicating that it was easier to

Themes from Post — session Interview	Categories of Responses
Annoying/frustrating design elements.	Too much text; flashy images; images; adverts; introduction page; pop up windows; small fonts.
General preferred design elements.	Simple/clear links; images; sub links to menu items; less text; company's contact details; short description under bold titles; 'About the Company' link; clear structure; easy access to products.
Expectations of homepages.	The name of the company; links to the rest of the site; the company info; large font size of text of company name; title of page; generic information; logo; navigation tool; keywords/phrases.
Perceived position of first look.	Top middle or top left corner of the page; left side of the page.
Perceived first design element to look at.	A peripheral look to confirm it is the site aimed for; the name of the company; links to the rest of the sites.
Perceived factors that influence first fixation.	Information presented on paper documents; natural way of reading; visiting other websites; information presentation of other media (i.e. newspapers).

Table 1: Post-Session responses (users' perceptions) of homepage design.

identify what the company does and what can be done within the site. The Disney homepage gathered the most incorrect answers. The banner of a Visa Disney card on the top of the page caused a great deal of confusion for the users — who confused the site for a place to make an application for a Disney's credit card.

3.6 Post-session Interviews

The post-session interviews consisted of semi-structured questions to allow the participants to elaborate more on their perceptions of homepage-design. We identified themes in this self-report data of the users and developed a catalogue of these themes which detail the characteristics of homepages (Table 1).

It is interesting to see in Table 1 that design elements such as images come under both 'annoying' and preferred' design elements. Users have varying opinions: some prefer to see images of the products they intend to buy and users who dislike images on the homepage as they perceive images as adverts and ignore them.

3.7 Discussion — Study 1

The main aim of Study 1 was to re-examine the existing homepage design guidelines by employing an alternative, user-centred evaluation technique of tracking users' eye movements. This study confirmed the general guideline in Nielsen & Tahir [2002] which is to '*place important information at the top of the page*'. All 'entry point' fixations were at the top left or top middle of the homepage. However, Study 1 data contrasted with guidelines in Nielsen & Tahir [2002] specific to particular homepages, suggesting refinements in the Web design guidelines. These variations are now discussed:

3.7.1 Banner Advertisements

In the homepage study conducted by Nielsen & Tahir [2002] it is suggested that “users tend to ignore anything that looks like a banner ad so it is a poor way of promoting site elements” (p125). Our study suggests that whether or not a banner advert will be ignored depends on its position and presentation format. For example, the banner for credit card on top of Disney page was mistaken for the name of the company, due to its position and size. The ‘entry points’, responses to questions, and self-reports all confirm this confusion.

3.7.2 Product Images

It is suggested in Nielsen & Tahir [2002, p.241] that Petsmart’s (one of the homepages of this study) biggest strength is that it shows examples of the products and content offered on the site. Our study suggests that user’s dislike for images on homepages may conflict with the images’ advantages in ‘drawing the eye’. All participants fixed on product images, even those who disliked and claimed to ignore them. However, those who disliked the use of product-images gave less accurate responses about brand and services. Although this requires further investigation, the use of product images on the homepage could be an obstacle in search efficiency for those users who tend to dislike images.

3.7.3 Design Layout

It is argued in Nielsen & Tahir [2002] that designers should use ‘liquid layout’ that allows users to adjust the homepage size. For example, the Federal homepage, using a ‘liquid layout’ that filled the screen, was described ‘*as well defined and easily recognisable*’ (p161), whereas the GM homepage, which had a fixed size and did not fill the (1280 by 1024 pixels) display, was described ‘*as one that doesn’t make clear whom it is trying to serve or what users can do*’ (p185). However, completeness of inspection and accuracy of brand and service identification in this study ran contrary to the guideline. Users inspected the fixed-size GM homepage fully, whereas their inspection of the full-screen Federal homepage was incomplete, reaching only half way through the homepage. Further, there were more correct task responses for the GM homepage than for the Federal homepage.

4 Study 2 — Experiment Design

The second study reported in this paper examines how quickly users adapt to an unfamiliar design layout and, in particular, how quickly the users adjust their expectations of where to look for a given target link during repeated exposures to a new design layout. A counterbalanced experiment design was applied varying the ten exposures of webpages to eliminate possible order effects. Ten webpages of e-commerce sites were selected and amended so that they would appear in each of the three different exposure styles. So, for example, each webpage was amended in order to have:

1. The ‘About Us’ link at the bottom of the page.
2. The ‘About Us’ link at the top of the page.

Exposures	Description	Purpose
Exposure 1	Did not include the 'About Us' link.	To explore users' expectations of where to find the 'About Us' link before the repeated exposure session.
Exposure 2–7	Six repeated exposures where the 'About Us' link appeared at the bottom of the page.	To examine the effect of consistent design element placement on visual search behaviour.
Exposure 8	The 'About Us' link appeared at the top of the page.	To capture the users' visual reactions when introduced to an alternative design layout after being presented with the repeated exposures in which the 'About Us' link appeared at the bottom of the page.
Exposure 9	The 'About Us' link appeared at the bottom of the page again.	To assess persistence of any affect of repeated exposures on visual search behaviour.
Exposure 10	Did not include the 'About Us' link.	To explore users' expectations where to find the 'About Us' link after the repeated exposure session.

Table 2: Description and purpose of the exposures in the counterbalanced design.

3. No 'About Us' link.

The description of each exposure and purpose is presented in Table 2.

Study 2 tested two sets of hypotheses:

1. The first set addressed the effect of the consistent placement of the target link (About Us link) for Exposures 2 to 7 and predicted that the placement of the target link at the bottom of the page over six repeated exposures would result in the participants' decrease in the time to target fixation and also change in participant's expectations of where to find the target link.
2. The second set examined the effect of the alternative placement of the target link (About Us link) and predicted that the placement of the target link at the top of the page in Exposure 8 would result in quick adaptation to an unexpected design layout.

Specifically, we anticipated that the two sets of hypotheses will be evidenced by shorter times to target fixation, modifications of scan patterns, change of location of first fixations and self-report of preferences and expectations.

4.1 Participants

Ten volunteers (5 male and 5 female) with age range of 22–56 from the staff and postgraduate student population of the Open University participated in this study. 5 participants were regular (using the Internet 2–3 times per day) Internet users and 5 participants were frequent (using the Internet throughout the day as part of their job) Internet users. None of the participants had viewed the homepages used in the study prior to their participation.

4.2 *Stimuli and Equipment*

Prior to the selection of the stimuli, a survey was conducted to identify the position of the 'About Us' link on homepages. 50 European and 50 American e-commerce sites were chosen on the basis of their reported sales. 80% of the homepages placed the 'About Us' link on the top of the page as a global navigation link its position in the navigation bar varied on different websites. On the basis of this survey, we concluded that the convention is to place the 'About Us' link at the top of the page. This led to the assumption that Internet users might be used to finding the 'About Us' link on the top of the page or at least expect to find it in that position due to their previous experiences. Therefore, the position of the target link in the repeated exposures session (Exposures 2–7) was on the bottom of the page.

Ten UK e-commerce homepages from a variety of domains were selected as stimuli for this study:

- Cover4students <http://www.cover4students.com> (campus insurance).
- Hatton Garden Online <http://www.hattongardenonline.com> (jewellery).
- Diamond Daisy <http://www.diamonddaisy.com> (jewellery).
- Travelodge <http://www.travelodge.co.uk> (accommodation).
- Travel Bag <http://www.travelbag.co.uk> (travel).
- Train Line <http://www.thetrainline.com> (travel).
- Saga Holidays <http://www.sagaholidays.com> (holidays).
- Hotel net <http://www.hotelnet.co.uk> (accommodation).
- Past Times <http://www.past-times.co.uk> (gifts).
- To Book <http://www.tobook.com> (accommodation).

The criteria for choosing homepages were that pages should have:

- A design layout that fits within the computer screen (17" flat screen with a resolution of 1024×768 pixels) without requiring scrolling.
- Either a top- or bottom-page navigational bar where the 'About Us' link could appear.

Eye movements were recorded using an ASL (Applied Science Technologies) 504 eye tracking remote pan-tilt camera [ASL 2004] capturing eye movement data at a sample rate of 60Hz. The presentation of the stimuli was controlled by means of the Gaze Tracker? software and presented on the screen and viewed by the participants from a distance of 55cm from the screen.

4.3 Procedure

The duration of a session including the briefing and calibration process was approximately thirty minutes. The session started by giving an introduction of the eye tracking equipment and the study to the participant. The participant completed a consent form and a background questionnaire. The questionnaire captured age, gender, previous Internet experience, and frequency and purpose of Internet use. The participant was asked the following questions regarding the 'About Us' link:

- Where do you look when you want to find information regarding the company?
- Where do you prefer to find it?

These questions were aimed to collect information about the user's expectations and preferences regarding the placement of the 'About Us' link before the eye-tracking session.

The researcher then calibrated the eye tracking camera for the participant. The participant was asked to look at each webpage and find the 'About Us' link. The participant was asked to say aloud where on the interface they found the 'About Us' link in order to indicate that the task had been completed, so that the researcher could press the 'enter' key on the keyboard for the next page to appear. There was no time limit for the task so as to encourage a natural navigation of the webpage. To avoid the researcher's reaction times influencing the data, the eye movement data were used as a measure of the task completion times. After the eye tracking session, the participants were asked:

- Where would you like to find the 'About Us' link?
- What do you think about the webpages you just saw?
- Was it easy to find the 'About Us' link?

These questions aimed to collect information about the user's perceptions and preferences regarding the 'About Us' link after the repeated exposures session.

4.4 Repeated Exposures Effect

The descriptive statistics of the scores to target fixation across repeated exposures are shown in Table 3. There is a difference between the sum of time to target fixation for the first of the repeated exposures (Exposure 2) 179.10 and the last of the repeated exposures (Exposure 7) 38.7.

A non-parametric Trend test [Page 1963] was applied to predict if there was a trend of learning where to look when presented with a sequence of six repeated exposures of homepages where the 'About Us' link appears on the bottom of the page. A Page's L analysis [Page 1963] on the ranked scores of time to target fixation for the repeated exposures revealed a significant trend across exposures: $L_{10,6} = 792$, $p < 0.05$. A trend of time to target fixation decreases as the number of exposures increases was found.

The eye tracking measures were supported by the qualitative data as retrieved from the pre- and post-session questions. When the participants were asked before

Exposures	N	Minimum	Maximum	Sum	Mean	Std. Dev.
Exposure 2	10	3.52	38.86	179.10	17.90	11.41
Exposure 3	10	1.44	44.97	120.16	12.01	13.11
Exposure 4	10	0.72	17.98	64.63	6.46	5.65
Exposure 5	10	1.53	31.64	83.26	8.32	9.99
Exposure 6	10	1.20	41.13	122.62	12.26	14.09
Exposure 7	10	0.91	6.80	38.70	3.86	1.61
Exposure 8	10	2.53	16.16	58.48	5.84	3.99
Exposure 9	10	1.80	22.86	91.00	9.09	6.79

Table 3: Descriptive statistics: Time to target fixation for repeated exposures in milliseconds.

the eye tracking session where they expected to find the ‘About Us’ link they answered ‘*on top of the page*’ or it doesn’t matter as long as they can see it. But, when the participants were asked after the eye tracking session where would they like to find the ‘About Us’ link they answered ‘*on the bottom of the page*’. In addition to the eye tracking data where a trend of adaptation was found as exposures increased, the modification in answers from the pre- and post-session questions suggests an influence of change in location-preferences of the link.

4.5 Alternative Design Layout Effect

A two-tailed paired t-test was used to establish whether there were significant differences between the time to target fixation before the repeated exposures (About Us link at the bottom of the page) and after repeated exposures (About Us link at top of the page) at the 5% alpha level of confidence. There is evidence that the users found the target link quicker when the ‘About Us’ link was placed at the top of the page after having seen it on the bottom of the page in the repeated exposures session as $t_9 = 3.35, p < 0.05$.

After transforming the raw scores using a two-related samples Wilcoxon test, the distributions between the time to target fixation after the repeated exposures (About Us link at top of the page) and after the alternative exposure (About Us link at bottom of the page again) were compared at the 5% alpha level of confidence. Despite the significance difference found when the About Us link is presented on the top of the page, when it is then presented again at the bottom of the page there is a significant difference as $t_9 = 1.98, p < 0.05$.

The results indicate that when placing the target link on the top of the page users find it quicker than when it was placed at the bottom of the page. This might be an effect of their previous experiences which was also indicated in their self-report data. Also, this finding is consistent with the norm captured in our survey regarding the placement of the ‘About Us’ link on leading e-commerce sites. But when presented with the ‘About Us’ link at the bottom of the page again after the repeated exposure a second expectation had developed possibly caused by the consistent placement of the ‘About Us’ link on the bottom of the page over the repeated exposures, indicating that users had adapted to the new design.

4.6 Before and After Repeated Exposures Effect

'Initial gaze' for all participants was always in Areas A or B (i.e. the top left or top middle of the screen — see Figure 1 for the areas) for both Exposures 1 and 10. None of the 'initial gazes' focused on the right side or bottom of the screen (Areas C, D, E and F). This is more of an indication of similar visual search strategies of initial gazes starting from the upper part of the page rather than any indication of user-adaptation across exposures. The very small amount of time (50ms) during which 'initial gazes' were measured might not have allowed the observation of any possible scan path modification. Therefore, the location of the 'entry point' for each participant was measured during the first 250 milliseconds of the homepage appearing on the screen to indicate where the participant first fixated. The 'entry points' were not consistent across participants and varied from homepage to homepage. Nevertheless none of the 'entry points' included the right side of the screen (Areas C and F). This might be influenced by the visual attraction of specific design elements rather than just by the consistent placement of the 'About Us' link.

On comparing the users' scan paths in Exposure 1 and Exposure 10, five users were found to have modified their scan patterns from the first to the last exposure. They started their scan paths in the upper area of the screen (Areas A and B) whereas after the repeated exposures session they started their scan paths in the lower part of the screen (Areas D and E) suggesting an indicator of adaptation after finding the 'About Us' link at the bottom of the page. When looking at the profile of these five users we found that they were frequent Internet users (used it throughout the day) suggesting that they were highly skilled users which might explain their quick adaptation to consistent placement of the 'About Us' link.

4.7 Discussion — Study 2

When placing the target link in a consistent position over a series of exposures the results show that users adapt to consistent placement of the target link which improves their visual-search performance. A trend was found of more exposures leading to decreased time-to-target fixation. Eye movement data was supported by self-reports of change in expectations and preferences of where the target link was expected to be found. The results of Study 2 are in sync with the previous research by Ehret [2002] which suggested that users learn the locations of design elements over series of repeated exposures. On the contrary, McCarthy et al. [2003] found no evidence that performance improves when the target link is placed in expected positions. They found that users adapt quickly to unexpected design layouts. In our study, we found that although users adapt to a design (which is not the norm, e.g. 'About us' link at the bottom of the page) over repeated exposures indicated by decreasing time-to-target fixations (see Table 3), when they are exposed to a design which is as per the norm, their visual-search performance is even better. This shows that in spite of the fact that users 'learn' and adapt to designs different from the norm, they still perform better to designs that follow the norms, indicating that the influence of repeated exposures or adaptation is a secondary effect and it does not overrule the effect of the previous experiences.

5 Conclusions and Future Work

This paper reports two studies of an on-going research programme in applying eye tracking to validate and elaborate Web design guidelines. Our aim has been to capture the user's visual search behaviour and to explore the relationship between user's eye-tracking behaviour, expectations, and preferences based on their previous experiences. Both the reported studies follow a common model of research design employing:

1. Background questionnaire.
2. Eye-movement data.
3. Pre- and post-session interviews.

The results of the two studies corroborated existing design guidelines for webpages, but also identified potential refinements. The first study provided insights of which design elements attract attention and where on the homepage users expect to find specific information about brand identity and website services. The second study found that although more exposures led to decreased time-to-target fixation, indicating that user-adaptation or learning occurred, visual search behaviour is, nevertheless, strongly influenced by previous experiences of visiting other websites.

We have recently conducted three more studies as a part of the next phase in our research programme:

1. The effect of the presence or absence and the size of images on E-travel sites on user's task performance.
2. The presentation format (icon or a textual link) of the key steps in a transaction on an e-commerce site.
3. The optimal combination of text and background colour of e-commerce homepages.

We will be reporting our results from these three studies in the near future.

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