Eye Tracking Insights into Effective Navigation Design

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Abstract. An intuitive and easy to navigate interface is the cornerstone to good user experience (UX). Usability issues often arise from navigation that has been poorly designed, often because of the organization, placement, visual design, or terminology used. Current methods for measuring the effectiveness of navigation are limited to observable behaviors and verbal feedback from participants. Eye tracking is becoming an increasingly common tool in UX testing, in part to discover new ways to optimize navigational elements. This paper addresses how eye tracking can be used to understand the effectiveness of commonly used navigational elements in interface design.

Keywords: Eye tracking, usability, user experience, navigation, menu systems, interface design.

1 Introduction

How many times have you become lost while navigating through an interface? An intuitive and easy to navigate system is the cornerstone to good user experience. Nearly all digital products have some sort of menu system that must be navigated in order to complete a task. Usability issues often arise from navigation that has been poorly designed, usually because of the organization, placement, visual design, or terminology used. According to the International Standards Organization, usability refers to “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." [1] Jeffrey Rubin also includes the following usability objectives [2]:

- Usefulness - product enables user to achieve their goals - the tasks that it was designed to carry out and/or wants needs of user.
- Effectiveness (ease of use) - quantitatively measured by speed of performance or error rate and is tied to a percentage of users.
- Learnability - user's ability to operate the system to some defined level of competence after some predetermined period of training. Also, refers to ability for infrequent users to relearn the system.
- Attitude (likeability) - user's perceptions, feelings and opinions of the product, usually captured through both written and oral communication.

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For the purposes of this paper, navigation design will be primarily discussed on the basis of effectiveness (ease of use), efficiency, and learnability.

The evaluation of usability often takes place in a usability test whereby participants are asked to perform a series of tasks using a system. Usability tests can include a variety of metrics to assess usability [3] including think-aloud protocol, observable behaviors (i.e. mouse movements, clicks, etc.), and self reported measurements such as post experience surveys. Qualitative data from these measurements can result in understanding common behavior patterns, self-reported feelings (i.e. frustration), and relative easy of use. Quantitative data can include time to task completion, number of clicks or key presses, error rate or recovery, etc. These metrics can be very effective in measuring the performance of navigational elements, however they are limited to what a user actually does and what they selectively self report to the study facilitator.

In trying to understand what users decide to pay attention to we can't always rely on the participants to accurately tell us. Participants are terrible at self-reporting where they looked. For the most part, this is due to our eyes often moving involuntarily and the limits of our short-term memory. Guan et al.[4] measured the extent to which participants did not discuss elements that they in fact visually attended to. They labeled these as omissions. Participants had omissions 47% of the time, meaning that almost half of the time they did not mention elements that they looked at. Omissions may have occurred because participants forgot about seeing the elements, or perhaps simply because they just didn't think or care to mention them. It should also go without saying that a researcher can't simply ask a participant if they noticed a certain on-screen element. This action draws the participant's attention directly towards something that they may or may not have originally seen. This inherently and irreversibly biases the participant and no confident answer can be obtained. Eye tracking provides an objective running commentary of where the individual looks without any need for participants to verbalize what they have seen. Eye tracking can be a complementary tool combined with traditional usability testing methods to not only understand what a user is doing, but also where they look while completing tasks[5]. Even the most intuitive navigation structure is useless if users never notice it.

2 Effectiveness (Ease of Use)

Effectiveness is the completeness and accuracy with which users achieve specified goals. It is determined by looking at whether the user's goals were met successfully and whether all work is correct [6]. Effectiveness is the driving force behind successful task completion and helping users to complete their goals. Navigation is often the primary way for users to be able to access information and to get from one function within a system to another. Applications today use a variety of navigational elements to help users accomplish their tasks. Many of these elements build off of more traditional designs such using dropdown menus with increasing complexity. The effectiveness of these menu systems is determined by whether a user can locate and use the navigation option they are seeking and take them to the expected location.

2.1 Dynamic Menu Systems

Dynamic menu systems, such as fly-outs and dropdowns, have become commonly-used navigation paradigms. These menus have the benefit of allowing users quick access to content without the need to fill up the valuable screen real estate with navigational elements. While these may be beneficial, dynamic menu systems also have their share of usability problems.

According to Cooke [7], researchers have found that before people fixate a specific menu item, they first visually "sweep" the menu. Next, users view the first one or two items on the menu. Then users glance at items at the bottom of the menu and finally, at the middle of the menu.

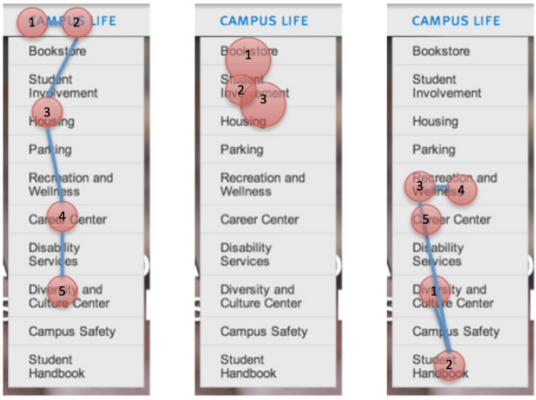

Fig. 1. Before users fixate a specific menu item, they first visually "sweep" the menu. Next, they view the first one or two items on the menu. Then they glance at items at the bottom of the menu and finally, at the middle of the menu.

To improve visual search efficiency, user interface designers can take advantage of this behavior. Important navigation items within the menu should be placed at the very top of the list, and items of least relative importance should be placed towards the middle.

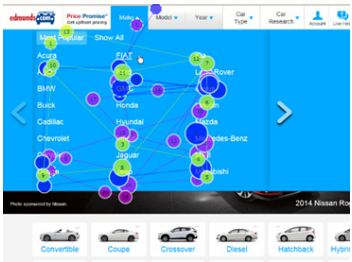

Fig. 2. In a pilot study of Edmunds.com, several participants scanned the columns quickly and had difficulty locating Land Rover, even though columns were structured in alphabetical order

Fig. 3. The sub navigation options are not displayed until the user hovers over the primary navigation

Many news websites require users to hover over each of the primary navigation options to see the sub navigation options. Presenting both the primary and secondary navigation in a horizontal format can negatively impact users' ability to effectively scan the menu options. Users may hover over a category and then only scan the immediate sub navigation below, and they do not start at the very beginning of the sub navigation options. Instead, they quickly move their mouse over additional primary navigation categories while they continue browsing. This causes users to often miss sub categories that might be of interest to them.

3 Efficiency

It is the job of a user experience designer to effortlessly guide a user through an interface to reach their goal. Efficiency can be described as the speed (with accuracy) in which users can complete the tasks for which they use the product [5]. Whitney Quesenbery states that, "Navigation design elements such as keyboard shortcuts, menus, links and other buttons all have an impact on efficiency. When they are well-designed, with clearly expressed actions, less time and effort are needed for the user to make navigation and action choices." A good user experience is when a user does not have to spend a significant amount of time locating, evaluating and using the navigation. Jakob Nielsen puts it this way:

It may seem like people should look at global navigation more than a quarter of the time, but think of it as you would a lifejacket stored under your seat on an airplane. You may confirm its existence during the safety instruction presentation, but you are not going to put it on, inflate it, and wear it just in case you need to evacuate. Nor will you repeatedly look to make sure it's still there during your flight. But you know where it is if you need it. You ignore it when you don't. That's the way it is with Web site menus. [8]

There have been few studies about the optimal viewing position of primary navigation elements, and there does not seem to be a consensus on which format has the best user experience (Kingsburg and Andre, 2004; Kalbach and Bosenick, 2003; DeWitt, 2010). Kingsburg and Andre [9] found that navigation times were slightly faster when the primary menu was located on the left. Kalbach and Bosenick [10] found no evidence that vertical left-located menus were significantly faster and concluded that top-aligned menus performed the best.

DeWitt [11] sought to gain a better understanding of how the placement of primary navigation impacted a user's experience. They studied the eye-tracking behaviors of 147 participants across 15 navigational menus. They found that designing a vertical or horizontal menu does not seem to impact how quickly users can locate the desired

item within the menus, although vertical menus run the risk of requiring page scrolling which slows down navigation.

Users are accustomed to seeing the sub navigation in close proximity to the primary navigation either in a horizontal or vertical format. In the Kingsburg and Andre study, navigation performance was best when the secondary and tertiary menus were placed together. User experience problems arise when users cannot easily identify the sub navigation elements on a web page.

Task performance is a key way to measure the efficiency and effectiveness of a navigation system. Users need to be able to quickly identify navigational elements, understand what they mean, and be able to keep track of where they are. Time to first fixation is a useful way to measure the amount of time it takes before a user notices navigational elements on the page. We can tell exactly how quickly they notice elements and the relationship between when they notice other screen elements.

We can also analyze the specific elements within a given area, such as the number of links within a set of navigation items that the user looks at before deciding which one to click on. We can then measure the time it takes from noticing a navigational element to how long before the element is clicked. Task performance can be significantly slowed if users are forced to read through a long list of links before finding the one they want to click on.

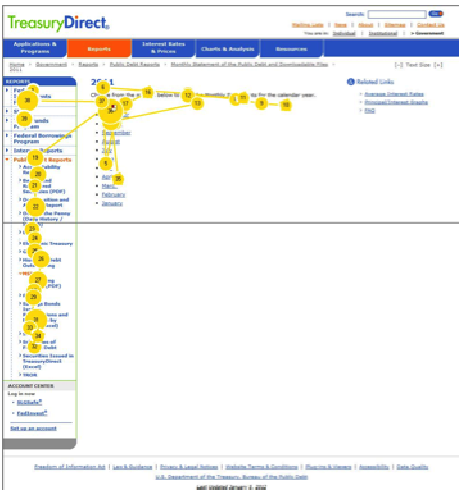

Fig. 4. Participants would scan the long list of links looking for keywords that would help them get to the information they were seeking

The quantitative capabilities provided by eye tracking allow researchers to accurately report on how quickly a participant noticed a navigational element and then how much time elapses before they make a select from the menu. It is also possible to track the number of fixations that occur within a navigational element and also the duration of the fixations prior to an element being clicked.

4 Learnability

Menu systems, no matter how complex, should be designed in a way so as to be intuitive to the user. The labeling and terminology used in a navigational interface can negatively impact ease of learning if it does not match the user's mental model. Eye tracking can often identify issues associated with poor labeling when there are a relatively high number of fixations and high fixation duration of a link label. Regressive saccades are a common fixation movement that can indicate that a user did not see a link that they were expecting to find, or they are evaluating and/or reevaluating the meaning of a given set of links, possibly due to a lack of cues. Goldberg [13] suggests that optimal scanning patterns include long saccades, short scanpaths, and few fixations in a small area of focus.

4.1 Visual Affordance

With any new interface users need to quickly gain an understanding of which elements on the screen can be used to navigate. Users often spend only a few seconds taking in all of the elements of the page. Within these few seconds, they are establishing a mental floor plan of the interface. During this short time, elements that are the most visually prominent will get the most attention and will help shape the user's perception of the interface. Visual affordance provides a cue to the user that a certain element is clickable. Users frequently miss in-line links when there is insufficient visual affordance. This is particularly problematic when links are embedded within paragraphs of text where users typically scan the information very quickly and often skip over large areas.

Interface designers often rely on the Gestalt principles, which are time-tested methods that shape the visual hierarchy that a user will see. For example, the law of similarity reflects the idea that elements will be grouped perceptually if they are similar to each other. Applying Gestalt principles to the design of navigation can help highlight the presence of navigational elements and provide a cue for users to know which elements are related to each other and which are not.

4.2 Visual Hierarchy

Eye tracking excels at helping user experience designers understand how users perceive the visual hierarchy of the elements on a page. The navigational elements of an interface are in direct competition for the user's attention and can often take a backseat to other content. This can often result in users not noticing navigational elements and consequently not understanding how to get to the information they seek. It is critical for navigation to be designed in a way where it is easy to find and is consistent from screen to screen. This consistency will help users to learn to use the interface faster and to make navigational elements predictable, however ultimately less prominent compared with the rest of the content.

The redesign of the San Francisco Police Department's website significantly altered users' eye gaze patterns. Much of the content and layout in the redesign changed, with the exception of the right column navigation.

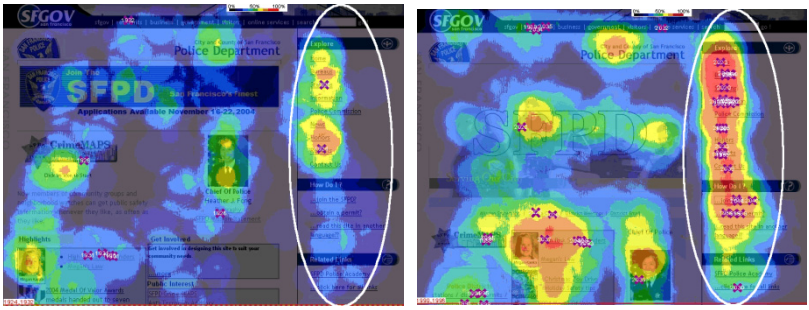

Fig. 5. Original (left) and modified (right) versions of the San Francisco PD website (Courtesy, EyeTools, 2005)

However, the design changes led to large changes in user behavior in the right column, as evidenced by both the eye tracking and click data. 64% of participants clicked on the right navigation on the redesigned page whereas only 14% of participants clicked on the right navigation on the old design. Participants looked at the new right navigation longer and more often, indicating that they read more in that area, despite no change to the design or content of the right navigation. A change on one part of the page can impact other, unrelated elements on the page. The right navigation bar was used completely differently on the new re-designed website because the content to the left of it changed [14].

Interfaces with clear visual affordances for representing navigational elements and a visual hierarchy that highlights navigation where users expect to see it can significantly increase effectiveness, efficiency, and learnability.

5 Conclusion

Creating a usable navigation design is a critical element of a positive user experience. This paper discussed how eye tracking could be a valuable addition to studies that focus on evaluating the usability of navigational elements. Usability attributes specific to navigation were addressed including effectiveness, efficiency, and learnability. Eye tracking can help provide quantitative measurements for each of these attributes and does not rely on the highly subjective nature of either the study participant or facilitator. Eye tracking can provide deeper insights that would not be possible to obtain by think-aloud or self-reporting techniques. As eye tracking becomes a more ubiquitous tool in user research, we can expect more attention to be paid to not only how users interact with an interface, but also how they view it.

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