

Eye Tracking and Usability Testing in Form Layout Evaluation

Agnieszka (Aga) Bojko and Robert M. Schumacher
User Centric, Inc.

Introduction

Form design guidelines are numerous and easily accessible. However, very little published research exists to support these guidelines. Instead, they are based on the opinions of usability experts, their knowledge of human perception, and anecdotal evidence from internal testing with forms. This paper presents our efforts to empirically evaluate form design and better understand the underlying cognitive processes associated with layout.

We begin this paper with a brief overview of two form evaluation techniques, eye tracking and usability testing. We then describe the benefits of using them in conjunction. After an overview of previous form research, we present our systematic evaluation of five form layouts that differed in label and field positioning. The combination of usability and eye tracking measures used in the study (i.e., user behavior, eye movements, and self-report) allowed us to understand how each layout variation impacts form usability. We conclude the paper by discussing the limitations of our study and opportunities for further research.

What is Eye Tracking?

Eye tracking is a technique that captures eye behavior in response to a visual stimulus (e.g., computer interface, photograph, page in a newspaper, TV commercial). When using eye tracking, we tend to assume that where people look is where they focus their attention. This is not always true, as everyone can recall looking at something but not really “seeing it” or noticing something without having to look at it directly. These are some of the caveats that we need to be aware of when studying eye movements. However, in most cases, the “eye-mind” hypothesis holds (with visual attention being slightly ahead of the eye) and, by examining people’s eye movements, we can gain insight into their cognitive processes and learn more about what they find important, interesting, complex, or confusing.

Saccadic eye movements, which consist of saccades and fixations, are the most common eye movements we make. Information processing occurs during fixations, where the eyes are relatively stationary and focused on a particular location of the stimulus. Saccades are rapid

eye jumps from one place of the stimulus to another, during which the eyes are



Figure 1. Gaze plot representing a series of fixations (shown as dots) and saccades (shown as lines) of a person viewing the BFMA International homepage. The size of the dot is proportional to the fixation duration, while the number in the center of the dot indicates fixation order.

practically blind. However, because saccades are so short (less than one tenth of a second), the fact that we cannot see usually goes unnoticed.

The device used to capture eye movements is called an eye tracker. The eye tracker determines the position of one or both eyes multiple times per second. It then superimposes those positions over a recording of the stimulus to determine where the person was looking at any given time. Figure 1 shows an example of a sequence of saccades and fixations (i.e., "scanpath") made by a person scanning the BFMA International homepage.

Commonly used eye trackers differ in physical form, setup procedures, and tracking methodology. Some are most appropriate for studies involving stimuli presented on the computer screen, such as Web sites, software applications, or graphic images. Some are better suited for studies that require interaction with physical objects, such as computer peripherals, handheld devices, or packaging. Others still are best for tracking how people view their surroundings when moving around freely, for example, while playing sports or navigating.

What is Usability Testing?

Usability testing is a research technique that evaluates the ease of use (usability) of a product. Usable products help users achieve their goals quickly, successfully, and with satisfaction. In usability testing, a representative sample of actual or potential end users is asked to attempt real tasks using the product. The researchers observe and record what participants say and do. Data collected can include quantitative and qualitative performance and preference measures. Based on the data, usability problems are diagnosed. The researchers then make recommendations for improving the design of the product to avoid the issues encountered.

Different types of usability tests are administered for each phase of the product development life cycle. *Exploratory tests* are conducted early to examine preliminary design concepts in the form of prototypes or models. *Assessment tests* are conducted midway into the development cycle to evaluate how the design concept was implemented. Finally, *validation tests* are conducted late in the cycle to verify how the actual product compares to a standard, benchmark, or other products. The later the test is administered, the more quantitative and less qualitative it tends to be.

Combining Eye Tracking with Usability Testing

The use of eye tracking in usability testing has recently become more common as the eye tracking systems have become less costly and easier to use. Now, more and more usability groups add them to their labs, supplementing the conventional usability testing techniques with eye movement analyses.

Typically in usability testing, we collect behavioral measures (e.g., click locations, information entered, time on task) and self-report measures using verbal ("think aloud") protocols and post-task / post-test questions. Eye tracking used in combination with usability testing can benefit the research in two ways. First, the eye movement data can *support* findings that are based on behavioral measures and user self report. More importantly, however, these objective data can also *augment* the usability findings by filling in the gaps between observable events and participant comments, thus providing a more complete picture of the interaction. Eye movement analysis can help us assess users' decision-making processes, explain inefficient or ineffective performance, identify search patterns and strategies, and determine what users find important or interesting.

However, eye tracking has a limited applicability in user experience research when used in isolation. A fixation on a face in a picture may indicate recognition, liking, dislike, or confusion. An increased number of fixations on a display can be a sign of interest or inefficient search, depending on what the user is

trying to do. By defining tasks, uncovering user intentions and opinions, and capturing user actions, usability testing methods provide the necessary context without which it would be difficult, if not impossible, to interpret eye movements.

Using Eye Tracking and Usability Testing to Evaluate Forms

In terms of user experience, a good form is one that users can fill out in an efficient manner, without making errors, and without getting frustrated. Therefore, any methods that are used to evaluate forms should target efficiency, accuracy, and user satisfaction, as well as their contributing factors.

Usability testing provides us with opportunities to measure all three of these aspects. The accuracy-related measures consist of form completion rates (percentage of participants who completed the form correctly), types of errors (e.g., missed required field, incorrect entry type, incorrect entry formatting), number of errors (all and those that were left uncorrected), and types of observed difficulties that the participants encountered even though these issues did not result in errors. The main measure of efficiency is how long it took participants to correctly complete a form. Finally, satisfaction can be measured in a qualitative way by asking participants for their opinions or, in a more quantitative way, by asking participants to rate their experience with the form on a numerical scale.

Collecting eye movement measures in addition to some of the measures mentioned above can help understand the processes that contribute to users' efficiency, accuracy, and satisfaction. When users interact with forms, those visual processes help them locate and read the labels, match the labels with the corresponding fields, and confirm that they are entering the right information.

There is a wide variety of eye movement measures, but the most practical ones that apply to forms include scanpath length, the number of fixations on the form, and amount of backtracking (regressive saccades). Long scanpaths with frequent backtracking and a large number of fixations indicate inefficient scanning usually caused by sub-optimal layout and poor information organization. Another useful measure in form evaluation is the average fixation duration. Longer fixations are a sign of increased difficulty in extracting and processing information due to higher information density, ambiguity, or complexity. In addition, pupil diameter can be used as a measure of mental workload with larger pupils indicating more cognitive effort.

Unfortunately, very little empirical research on the usability of forms has been published. In 2006, Penzo conducted two form studies that were described online in UX Matters. In his first study, Penzo tested search forms on the homepages of a few fairly well-known websites. He found that novice Internet users made more fixations on the field label, input field, and the submit button than experts, as if they were trying to confirm their actions. Additionally, participants made more fixations on the submit button when the search box was unlabeled (e.g., on useit.com), likely to verify the functionality of the input field. Participants also directed a significant amount of their attention to the category dropdown located next to some search boxes (e.g., on Amazon). Finally, horizontally compact search forms with the label above the field (e.g., on Flickr) had the shortest completion times as they required minimal scanning.

Based on the findings of this study, Penzo identified a few design guidelines for basic search forms: (1) input fields should be labeled to meet the expectations of the users, (2) drop-downs should be used only if necessary because they are distracting, and (3) forms should be compact to minimize the area that needs to be scanned to use them.

In Penzo's second study, he investigated three different label placements: left-aligned labels to the left of the fields, right-aligned labels to the left of the fields, and left-aligned labels above the fields. This research suggested that right-aligned labels reduced the number of fixations on the form and the time to complete the form as compared to the left-aligned labels. However, labels above the fields reduced the number of fixations even further by allowing the users to process the label and field with a single fixation.

Bolding the labels above the fields seemed to increase time to form completion. This study also confirmed that drop-downs attract more attention than any other form components.

The results informed Penzo's second set of recommendations: (1) labels should be placed above fields, (2) if label placement to the left of the fields is required, they should be right aligned, (3) labels should not be bolded, and (4) drop-downs should be used for important information or placed below more important fields.

Penzo's research generated a lot of online discussion as there seems to be a great demand for empirical research on forms. However, the main drawback of his studies is their very exploratory and qualitative nature as well as a small sample size (four participants per user group). No statistical (or even numerical) analysis was provided to support the conclusions of the study. In addition, the forms were not equivalent across conditions in terms of label complexity, and it is unclear whether or not counterbalancing of the form presentation order was performed.

Our Study

BACKGROUND

We decided to fill in some of the gaps in Penzo's second study by designing and conducting research with a higher sample size, more systematic manipulation of variables, and more quantitative data that enabled statistical analyses. We created longer forms, consisting of 15 fields as opposed to only four, to increase the probability of detecting any existing differences in the impact of the layouts. We also added two other form layouts (#4 and 5) to the three that Penzo investigated (#1, 2, and 3):

1. Left-aligned labels to the left of left-aligned input fields ("*left alignment*")
2. Right-aligned labels to the left of left-aligned input fields ("*right alignment*")
3. Left-aligned labels above left-aligned input fields ("*top alignment*")
4. Left-aligned labels inside of left-aligned input fields ("*in-field alignment*")
5. Left-aligned labels to the left of input fields aligned to the labels ("*flow alignment*")

There is a certain amount of common knowledge about each of these layouts, some of which would greatly benefit from an empirical validation:

1. *Left alignment*
(left-aligned labels to the left of left-aligned fields)
 - a. Examples:
 - Barnes and Noble checkout form
 - U.S. Citizenship and Immigration Services registration form (shown in Figure 2)
 - Garrett Popcorn customer registration form
 - b. Advantages:
 - For cultures that read from left to right, the users' eyes will be naturally drawn to the hard edges on the left. After the user enters information in a field, it is easy to find the beginning of the next label.
 - Users can easily scan all labels to understand the purpose of a set of fields and preview the requested information. This is especially important for unfamiliar forms that are used infrequently. Users first tend to check if they found the correct form and if they have access to the required information. High

The image shows a screenshot of the USCIS 'Create Account' registration form. The form is titled 'U.S. Citizenship and Immigration Services' and 'Create Account'. It contains various input fields for personal information, including First Name, Last Name, Organization Name, User ID, Password, Re-enter Password, Password Hint Question, Enter Response, Re-enter Response, E-mail Address, Street Number and Name, Apt./Suite #, City/Town, State/Province, Country, Zip/Postal Code, Phone #, and Date of Birth. The labels for these fields are left-aligned to the left of the input fields, and the input fields themselves are also left-aligned. The form includes a 'Back' button and a 'Submit' button at the bottom.

Figure 2. USCIS registration form with left-aligned labels and left-aligned input fields.

scannability is also useful in forms with many optional input fields. Left-aligned labels with asterisks to the left of the required fields enable users to quickly find the fields they need to complete.

- This form layout does not require as much vertical space as the top-aligned form (#3) and more information can be displayed above the fold.

c. Disadvantages:

- Depending on the length of the labels, there could be a large amount of white space between where the label ends and the input field begins. This can make the label-field association more difficult.
- This form layout cannot easily accommodate labels of very different lengths because that will increase the amount of white space between the shorter labels and the associated fields.

2. *Right alignment*

(right-aligned labels to the left of left-aligned fields)

a. Examples:

- Netflix registration and account forms (shown in Figure 3)
- Amazon.com checkout form
- Sheraton reservation form
- BFMA new member online application

b. Advantages:

- There is no white space between where the label ends and the input field begins, which makes association between labels and fields easier and faster.
- This form layout does not require as much vertical space as the top-aligned form (#3) and more information can be displayed above the fold.

c. Disadvantages:

- Ragged left edges are unnatural for the eyes of the readers accustomed to reading from left to right. This may make a quick scan of a set of labels slower than in the left-aligned form layout (#1). It may also be more difficult for the eye to find the beginning of the next label in the form. These difficulties apply more to longer forms than short ones.

3. *Top alignment*

(left-aligned labels above left-aligned fields)

a. Examples:

- Mapquest maps and directions forms (shown in Figure 4)
- Ebay registration form
- StarbucksStore.com checkout form

b. Advantages:

- Top-aligned labels tend to reduce form completion time because a single eye fixation is sufficient to process both the label and input field. This is especially true for short and familiar labels such as "Name" or "City".

Figure 3. Netflix registration form with right-aligned labels and left-aligned input fields.

Figure 4. Mapquest directions form with labels above input fields.

- This form layout easily accommodates long labels and fields and provides more flexibility for localization (e.g., if the form has to be translated into Chinese and German, very different label and field lengths will be required).
 - c. Disadvantages:
 - Page length increases and often requires scrolling. The submit button may fall below the fold.
 - If proper spacing between fields and labels is not used or a more salient label treatment, this layout may decrease the efficiency of visual scanning.
4. *In-field alignment*
(left-aligned labels inside of left-aligned fields)
- a. Examples:
 - Comcast.com search and login forms (shown in Figure 5)
 - Yahoo! Mail search form
 - Weather.com location form
 - b. Advantages:
 - This form layout does not require as much vertical space as the top-aligned form (#3) and more information can be displayed above the fold. It also requires less horizontal space than forms #1, 2, and 5. The compactness makes this layout a good candidate for short forms in popup windows. This layout is also used for login and search forms on homepages to save space and not interfere with the visual design of the page.
 - Users can scan multiple labels at once given their compactness and alignment.
 - c. Disadvantages:
 - The label usually disappears when the cursor is placed in the field. Users who tend to move from field to field by tabbing can make the label disappear before they get a chance to read it. Sometimes clicking away from the empty field makes the label reappear but this is not intuitive to many users.
 - If the labels do not disappear on focus, the user can read them but then has to make the effort to delete them before he/she can start typing. This is an inefficient solution and can frustrate the users, especially when the form is long.
 - Fields must be at least as long as their corresponding labels, which can lead to unnecessarily long fields. For example, the “Number of Pets in the Household” label will make the input field very long, where a two-character field would suffice.
 - Sometimes, depending on the visual treatment of the form, it is not obvious that you can click in the field and type in it.
5. *Flow alignment*
(left-aligned labels to the left of fields aligned to the labels)
- a. Example:
 - Miles by Discover Card application form (shown in Figure 6)
 - b. Advantages:
 - The flow layout combines the advantages of the left and right alignment layouts by making the labels easier to scan and reducing the white space between the labels and their corresponding fields.

Figure 5. Labels inside of the fields on the Comcast.com homepage.

- It does not require as much vertical space as the top-aligned form (#3) and more information can be displayed above the fold.

d. Disadvantages:

- The form can appear cluttered and unprofessional.
- A quick scan of the user inputs is difficult due to the lack of left alignment of the fields.

Figure 6. Miles by Discover Card application forms with left-aligned labels followed by the fields.

STIMULI

For the purpose of our study, we created five forms (shown in Figure 7), one for each layout. Each form had an identical set of labels and input fields, presented in the same order. The forms only differed in the way the labels and fields were positioned relative to each other. No form elements other than labels, input fields and the Submit button were included in the forms.

We decided to ask participants for familiar information that they would normally remember without having to refer to materials such as their driver's license or passport etc.

Figure 7. Form layouts used in the study.

SETUP

The study setup is shown in Figure 8. The forms were displayed on a 17" monitor with screen resolution set to 1024 x 768 pixels. Participants used a keyboard and a mouse to interact with the forms. Eye movements were recorded with a Tobii 1750 binocular remote eye tracker with sampling rate of 50Hz and 0.5° spatial resolution. One of the main advantages of this eye tracking system is the fact that it is fully integrated into the monitor and almost invisible to the users. Therefore, it does not interfere with data collection.

PARTICIPANTS AND PROCEDURE

33 adults (16 males and 17 females) between the ages of 22 and 61 ($M = 29$) participated in the study. Each participant filled out all five forms, pretending he/she was registering for a service or purchasing a product. We used a within-subjects experimental design as there can be large differences in eye movements between people performing the same task using the same interface.

However, to reduce order effects, we presented the five layouts in a counterbalanced order. Participants were instructed to work in the manner in which they would normally do at home and complete all of the fields unless they absolutely did not apply to them.

Following the completion of all the forms, participants viewed the five layouts printed on one sheet of paper, and asked to rate each based on two criteria: (1) ease of filling out and (2) visual appeal. The ratings scale ranged from 1 to 10 where 1 was “very difficult” or “very unappealing” and 10 was “very easy” or “very appealing”. Each individual session lasted approximately 10 minutes. At the conclusion of their sessions, participants received compensation for their time.

RESULTS AND DISCUSSION

Form completion time

Time to form completion was measured from the moment the form appeared on the screen to when the participant submitted the form either by clicking on the Submit button or by pressing the Enter key. Figure 9 shows the time data for each of the forms. On average, participants spent less than a minute (56.4 seconds) per form. There were no significant differences between the forms in terms of time to completion, $F(4,30) = 2.1$, $p > .05$.

Errors

Table 1 shows the types and number of errors made by participants during the study. First, we divided errors into two groups based on their status – errors that participants left uncorrected and errors that they corrected prior to form submission. Each of these error groups was further divided based on the specific error type.

Among the errors that participants left uncorrected, the most common type was a wrong format for the Date of Birth (DOB). The field label specified the format – MM/DD/YY – but many participants entered a 4-digit year, 1-digit day or month, or used dashes instead of forward slashes. There were between 8 and 12 DOB formatting errors in each layout condition, and we found no significant differences between the form layouts, $\chi^2(4, N = 33) = 6.27$, $p > .05$. 14 participants out of 33 made this formatting error in at



Figure 8. Our eye tracking lab setup. The participant (to the right) is sitting in front of the Tobii eye tracker, while the session moderator (to the left) is controlling the eye tracking software and administering the tasks. The moderator is also able to see the participant's eye movements in real time (indicated by a blue dot moving across the screen).

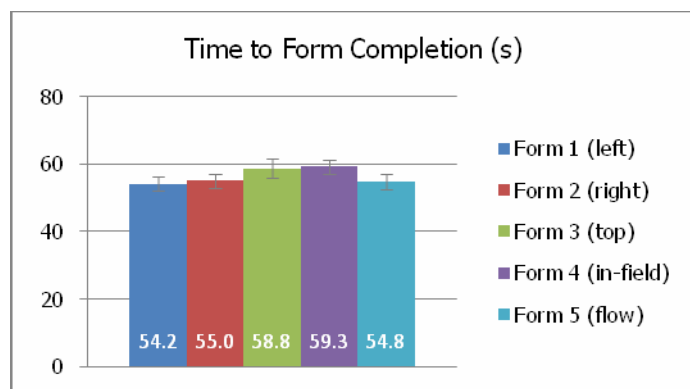


Figure 9. Time it took participants to fill out each form. The bars indicate standard error.

least one form. Most of the 14 (10 participants) formatted their date incorrectly in either four or all of the forms, which suggests that approximately one third of all participants consistently (and independently of the form layout) did not read the label or read it and chose not to follow the required format.

There were also two missing field errors in the submitted forms, one in form 1 and one in form 3. These were fields (Country and Personal Email) that participants left blank even though they completed them in the other forms.

In addition to the errors that were left uncorrected, there were several that participants noticed and corrected in the process of filling out the form (not counting spelling mistakes), usually prior to moving down to the next field:

- 21 instances of participants entering information required for a field directly below (e.g., entering state in the City field, country in the Zip Code field, or mobile phone number in the Home Phone Number field).
- 7 instances of participants entering information that they already entered in the field directly above (e.g., entering home phone number in the Mobile Phone Number field).
- 6 DOB formatting errors
- 1 wrong entry type error for non-adjacent fields (i.e., typing in a phone number in the zip code field).
- 1 instance of a participant combining two fields (i.e., entering both first and last names in the first name field).

There were no significant differences between the forms in any of the above error categories ($p > .05$). However, what caught our attention were the nine errors in one of the “corrected” categories for form 3, where participants entered or started to enter information required for a field located directly below the field in focus. A likely reason for this confusion was the fact that in form 3 the label below the field was almost as close to the field as the label above the field. Thus, the visual relationship between the field and the label below it was almost as strong as the relationship between the field and the label above it.

Error Status	Error Type	Form 1	Form 2	Form 3	Form 4	Form 5	Total
LEFT UNCORRECTED	DOB formatting errors	10	10	8	12	10	50
	Missing fields	1	-	1	-	-	2
CORRECTED PRI OR TO SUBMI SSI ON	Entering information required for a field directly below	6	3	9	2	1	21
	Entering information already entered in the field directly above	2	4	1	-	-	7
	DOB formatting errors	3	1	1	1	-	6
	Wrong entry type error for non-adjacent fields	-	1	-	-	-	1
	Combining two fields	-	-	-	1	-	1

Table 1. Cumulative number of errors made by participants during the study.

Number and distribution of fixations

The first eye movement measure we analyzed was the number of fixations on the form as an indicator of scanning efficiency. After excluding the outliers (± 2.5 SD), we included data from 29 – 31 participants in the analysis. Fixations were determined using the dispersion-threshold method where the dispersion threshold radius was 0.4° and duration threshold was 40 ms.

On average, participants made 89 fixations per form. However, there were significant differences between the forms in terms of the number of fixations, $F(4,30) = 4.25$, $p < .005$. Form 3 received significantly fewer fixations than forms 2 and 5 ($p < .05$), and post-hoc comparisons between form 3 and forms 1 and 4 were approaching significance ($p < .08$). These findings indicate that form 3 had the least number of fixations of all five forms. The number of fixations did not differ between the other four forms. The results from this analysis are shown in the far left of Figure 10.

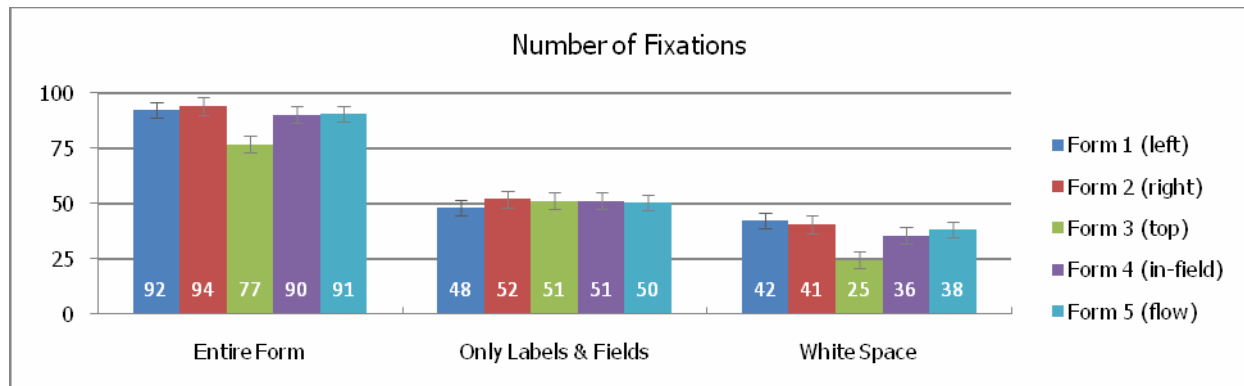


Figure 10. Average number of fixations on each form, only labels and fields of the form, and white space. The bars indicate standard error.

To understand why form 3 had fewer fixations than the other forms, we decided to focus our analysis on fields and labels as opposed to all fixations on the larger rectangular area of the form. When we compared participants' fixations on the fields and labels, we found that each form received a comparable number of fixations, $F(4,30) = .35$, $p > .05$. However, as the middle chart of Figure 10 reveals, only a little more than half of all fixations on the form were on labels and fields. So, where did the remaining fixations go?

If users were not looking at the fields and labels, they must have been looking at the area around them, which consisted of white space and the Submit button. On average, participants made two fixations to the Submit button, and this number did not significantly differ between the forms, $F(4,28) = 2.14$, $p > .05$. But when we compared white space fixations, we found a significant difference between the layouts, $F(4,28) = 15.23$, $p < .0001$. Form 3 had fewer fixations on the white space (32% of all fixations on the form) than the other four forms (~43% of all fixations) ($p < .005$), which is illustrated in the far right chart of Figure 10.

Therefore, the reason why form 3 had the fewest fixations was because participants did not look at the white space as much as they did on the other forms. This finding would make sense if form 3 had the least amount of white space but that is not the case. So, why would participants "waste their looks" on areas that provided no information and were not pertinent to the completion of the form? A viable explanation is that their fixations on white space were not purposeful. The extra fixations on white space were likely a byproduct of participants trying to find their way around the form. For example, in form 1, the extra fixations were spent trying to match the labels to their corresponding fields due to the separation between them. In form 4, fixations on white space occurred when participants forgot the label after it disappeared and had to click away from the field for the label to reappear.

As shown in Figure 11, form 3 had a focused top-down scan pattern. Because most labels were relatively short and familiar, participants were able to process them and locate the corresponding field with a single fixation and benefit from the layout by moving down rather than both laterally and down. Even if processing of the labels with one fixation was possible in forms 1,2, and 5, participants still had to move their eyes to the right to reach the field, so they could not fully benefit from the high label familiarity. Thus, form 3 was more efficient.

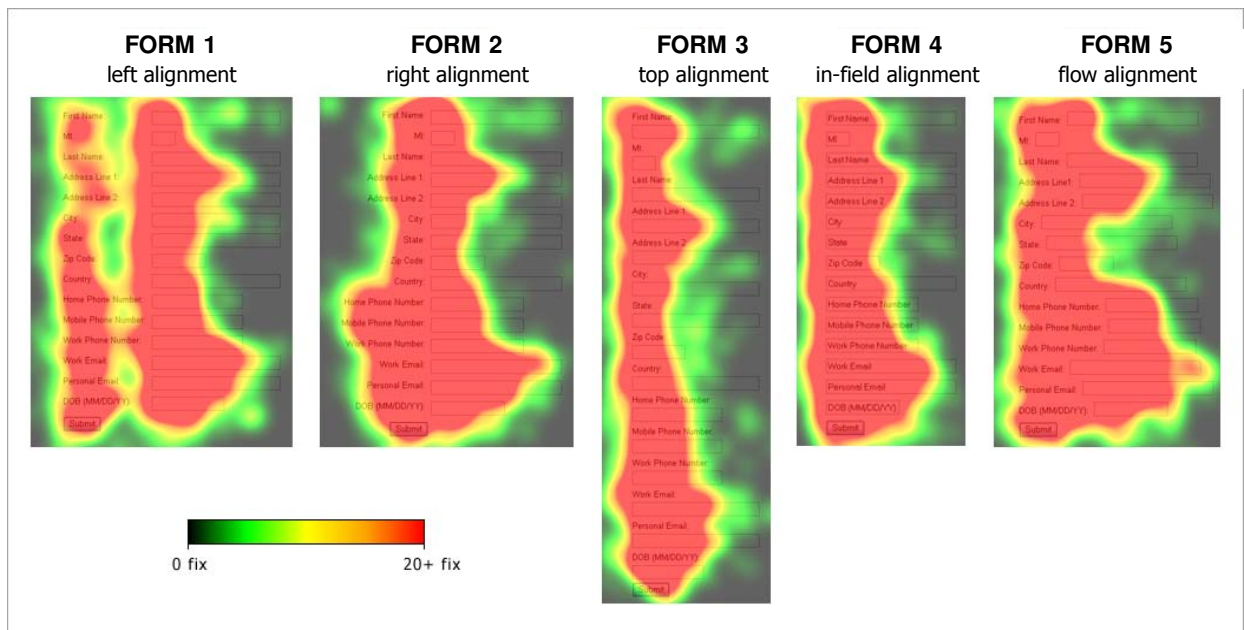


Figure 11. Heatmaps showing the combined gaze activity of all participants. Warmer colors indicate more fixations, while cooler colors represent fewer fixations.

Average fixation duration

The number of fixations is just one of many measures. While fewer fixations indicate increased scanning efficiency, if these fixations are also very long, that may be a sign of more involved cognitive processing due to high information complexity, density, or ambiguity. Figure 12 shows fixation durations for each of the five forms. The average length of a fixation in our study was approximately 271 ms. Our analysis revealed significant differences between the forms, $F(4,28) = 11.79$, $p < .0001$, with forms 1, 2, and 5 having shorter fixations than forms 3 and 4 ($p < .05$).

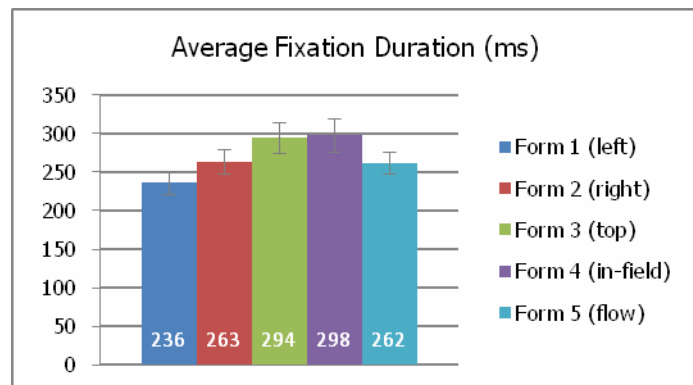


Figure 12. Average fixation duration for each form. The bars indicate standard error.

The fact that forms 3 and 4 had the longest fixations was not surprising. Both seem to require more processing per fixation due to the fact that their layouts allow for reading the label and locating the field on a single fixation. So, while form 3 had the least fixations, it also had the longest fixations.

User ratings

At the end of the each session, we asked the participants to rate the five forms they interacted with using a scale from 1 (very difficult or very unappealing) to 10 (very easy or very appealing). The average user ratings for each form are presented in Figure 13.

The analysis of the ease of filling out ratings revealed significant differences between the forms, $F(4,32) = 28.53$, $p < .0001$. Participants rated forms 1 and 2 as the easiest to fill out, forms 3 and 5 as second easiest, and form 4 as the most difficult ($p < .05$). The visual appeal analysis indicated that there were differences between the forms on this dimension as well, $F(4,32) = 38.57$, $p < .0001$. Participants rated

forms 1 and 2 as the most visually appealing, forms 3 and 4 as less appealing than 1 and 2, and form 5 as the least appealing of them all.

The order of user preference was very similar for both scales. The only difference was for forms 4 and 5. Form 4 received the lowest ratings for ease of use (likely due to the impermanence of labels) but form 5 was considered the least appealing (likely due to the lack of field alignment).

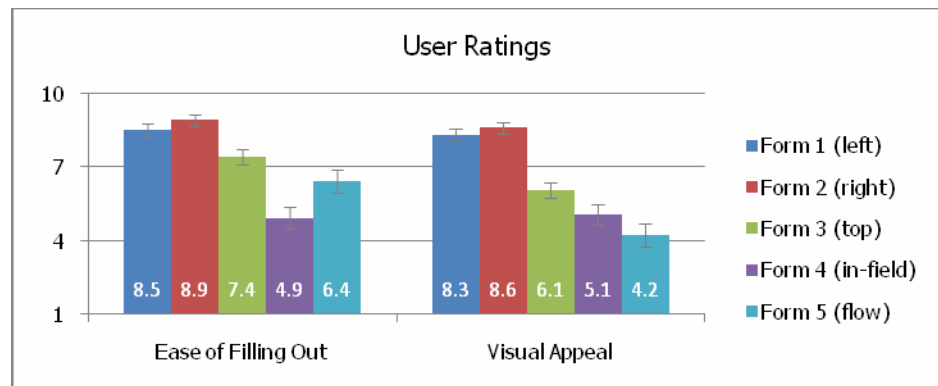


Figure 13. Ease of Filling Out and Visual Appeal user ratings for each form. The bars indicate standard error.

Summary of findings

In terms of user performance, all forms were completed in the same amount of time (less than a minute) and with a comparable number of errors. The most common type of error that was corrected prior to form submission was entering information that was required for a field directly below the field in focus (21 total errors in all forms). The most common error that was left uncorrected was a failure to match the DOB format to that requested by the label (50 total errors).

While time and error provided no differentiation between the forms, the eye movement analysis revealed interesting differences, both in the number of fixations and the average fixation duration. Form 3 had fewer fixations (77) than the other four forms (~92) and thus could be considered the most efficient to scan. The fields and labels received a similar number of fixations on all forms, but the white space in form 3 had the fewest number of fixations of all forms (32% of all fixations as opposed to 43%), which contributed to the observed efficiency. Forms 3 and 4 were found to have longer fixations (~296 ms) than forms 1, 2, and 5 (~253 ms) due to the higher information density per fixated area that consisted of both the label and the field.

Finally, in terms of user satisfaction, forms 1 and 2 were rated as the easiest to fill out and the most visually pleasing (ratings above 8). Form 4 was rated as the most difficult, while form 5 as the least visually pleasing (ratings below 5).

Conclusion

So, what have we learned from this study? Was one layout better than the others?

Observable performance in the form of completion time and accuracy was not affected by the form layout. However, eye movement and user satisfaction measures pointed to forms 1 and 2 as the most satisfying to the users and least demanding in terms of cognitive processing, and to form 3 as the most efficient in terms of visual scanning. On the other hand, the study confirmed known concerns about forms 4 and 5, which demonstrated low user satisfaction, low scanning efficiency, and, additionally for form 4, high processing demands.

The forms we tested were simple and required familiar information typically requested by forms. For more complex forms, inefficient scan patterns and high processing demands could visibly impact performance, thereby making layouts 4 and 5 much slower to complete and more likely to introduce errors. Eye tracking, therefore, revealed issues that would otherwise be difficult to discover.

Further research should investigate the potential interaction between label and field placement and factors such as form familiarity and complexity, label length, and form length. While our study focused on form layout, there are a lot of other factors that can affect the usability of forms, including instructions, content grouping, required field indicators, field lengths, or feedback. Because of the scarcity of research in this area, they all present opportunities for additional studies.

References

- Bojko, A. (2005). Eye Tracking in User Experience Testing: How to Make the Most of It. *Proceedings of the 14th Annual Conference of the Usability Professionals Association (UPA)*. Montréal, Canada.
- Dumas, J. S. and Redish, J. C. (1999). *A Practical Guide to Usability Testing*. Portland, OR: Intellect Ltd.
- Hoffman, J. E. (1998). Visual Attention and Eye Movements. In H. Pashler (Ed.), *Attention*. Hove, UK: Psychology Press.
- Jacob, J. J. K., & Karn, K. S. (2003). Eye Tracking in Human-Computer Interaction and Usability Research: Ready to Deliver the Promises. In J. Hyona, R. Radach, & H. Deubel (Eds.), *The Mind's Eyes: Cognitive and Applied Aspects of Eye Movements* (pp. 573-605). Oxford, UK: Elsevier Science.
- Penzo, M. (2006). Evaluating the Usability of Search Forms Using Eye Tracking: A Practical Approach. *UXmatters*, January 2006 issue. Retrieved March 1, 2008, from <http://www.uxmatters.com/MT/archives/000068.php>.
- Penzo, M. (2006). Label Placement in Forms. *UXmatters*, July 2006 issue. Retrieved March 1, 2008, from <http://www.uxmatters.com/MT/archives/000107.php>.
- Poole, A., and Ball, L. J. (2005). Eye Tracking in Human-Computer Interaction and Usability Research: Current Status and Future Prospects. In C. Ghaoui (Ed.), *Encyclopedia of Human-Computer Interaction*. Hershey, PA: Idea Group Inc.
- Rubin, J. (1994). *Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests*. John New York, NY: Wiley & Sons, Inc.
- Salvucci, D. D. & Goldberg, J. H. (2000). Identifying fixations and saccades in eye-tracking protocol. *Proceedings of the Eye Tracking Research and Applications Symposium*. Palm Beach Gardens, FL.
- Tullis, T. & Albert, W. (2008). Behavioral and Physiological Metrics. In *Measuring the User Experience: Collecting, Analyzing, and Presenting Usability Metrics*. San Mateo, CA: Morgan Kaufman.
- Wroblewski, L. (2007). Top, Right or Left Aligned Form Labels. Retrieved March 1, 2008, from <http://www.lukew.com/ff/entry.asp?504>.
- Wroblewski, L. (2005). Web Application Form Design. Retrieved March 1, 2008, from http://www.lukew.com/resources/articles/web_forms.html.