Shifting the Focus: An Objective Look at Design Fixation

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Abstract. Design fixation is a robust phenomenon that has been shown to affect amateurs, experts, and groups of designers across a variety of design domains. An area of confusion concerning the concept of design fixation is whether it is a conscious decision made by a designer or an unconscious action that occurs without awareness. The current research addresses this issue by utilizing eye tracking as an objective measure, in conjunction with subjective feedback, and design performance data to gain insight into the underlying processes of design fixation. It was found that there are major discrepancies in what people remember looking at, what people actually looked at, and what features designers fixated on. These findings inspire a fount of new research questions, as well as a possible rethinking of current design processes.

Keywords: Design fixation, eye tracking, creativity, design.

1 Introduction

A growing body of empirical research has shown that developing ideas that are different from past examples is sometimes more difficult than people assume, even when past designs are suboptimal. Strangely, research has demonstrated that designers often suffer from design fixation, a limitation in a designer's creative output due to an overreliance on features of preexisting designs, or a specific body of knowledge directly associated with a problem [1].

The first studies to examine fixation effects in designers were conducted by Jansson & Smith [1]. In these studies, designers were shown an example of a failed product or system (e.g., a spill-proof coffee cup that would still spill coffee), and then they were given some time in which to come up with an improved product. Some designers were able to think of new ideas, but many designers seemed somehow anchored to the examples that had been shown to them (even though they were explicitly told to create original designs). The research was a compelling example of how design fixation could limit a designer's creative thinking at the very beginning of new product's development.

Recent work on design fixation has tended to focus on what can be done to prevent it. For example, Youmans [2] manipulated whether or not engineers interacted with physical prototyping materials during the design process, and found that engineers

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who did not use physical prototypes were more likely to fixate on the previous design. The conclusion of this experiment was that, somehow, the physical prototypes alleviated the fixation effects.

Other research in this same domain has shown that taking breaks [3], incorporating recognized good design heuristics [4], and utilizing various computer applications [5] all reduce fixation, but they have done little to explain what mental mechanisms are responsible for fixation effects. Most researchers agree that design fixation likely occurs during the very early conceptual design process, and some have argued that working memory capacity (WMC) could have an effect on design fixation (e.g., [6],[7]), but, plainly stated, one of the main problems in preventing the reduction of design fixation is that nobody is really sure exactly why design fixation occurs, or to whom it is more or less likely to affect [8].

The current study was designed to investigate design fixation using techniques Human Factors Engineers call *task analyses*. Task analyses are a collection of methods that systematically measuring how humans perform a task in order to better understand why it is difficult, and optimize it with respect to human capabilities [9], [10]. In this case, the task analysis techniques were used to measure participants' eye movements during a design task. Past research has demonstrated that eye movements are a real-time link to the cognitive processes of a person because people rarely look at what they perceive to be task-irrelevant information [11]. Further, the locus of attention during scene viewing is a strong predictor of which objects in a scene are being encoded in memory [12]. Because eye gaze predicts both active processing of information and memory formation, in our study we hypothesized that the elements of a design that participants look at first or most frequently might be an indication of which design elements they would be most likely to be fixate on in future designs.

The objective of the present research was to investigate why design fixation occurs. Eye movements were hypothesized to be especially important in understanding designer behavior, because they have long been linked to cognitive processes, and because prior research suggests that locus of attention during scene viewing is a strong predictor of which objects in a scene are encoded in memory [12].

1.1 Goals of the Research

The first goal of our research was to test whether participants can accurately recall how they spend time critiquing a previous design. The second and third goals were to confirm whether or not participants' memories or participants' eye movements predicted subsequent design fixations. One of the ongoing questions in regard to design fixation is whether it occurs consciously, with the designer actively deciding to include a previous design element, or subconsciously, with the design element being included without the designer being aware of what they are doing [8]. Thus, the method of combining subjective report and eye tracking data provides a technique of testing whether participants were intentionally fixating to features of a prior design, unconsciously fixating, or both.

2 Method

2.1 Participants

Twenty-one (21) students (mean age = 21.72 years, 4 males) from George Mason University were included in this study. Participants were undergraduate students who received partial course credit for their participation.

2.2 Materials

An SR Research Eye Link II head-mounted eye tracker was used in conjunction with a program created in Experiment Builder. Eye movement data was analyzed in SR Research Data Viewer. The program was run on a Macintosh desktop computer, and participants used a chinrest while viewing the poster to maintain a consistent head position for the eye tracking.

2.3 Procedure

Upon entering the laboratory, participants were fitted with the SR Research Eye Link II head-mounted eye tracker that recorded their eye movements. Once the eye tracker had been calibrated, participants were instructed to view a poster that was displayed on a computer screen in front of them (see Figure 1). They were told that the poster had been used to advertise a student organization last year, but had been ineffective in helping to gain new members.

Fig. 1. The fixation poster that participants saw prior to their own design efforts

Participants were then told that we wanted them to spend time critiquing the old poster for two minutes so that they could attempt to design an original, more effective new poster afterward. After viewing the fixation poster for two minutes, both the fixation poster and the eye-tracking equipment were removed. Participants were then given ten minutes to mentally prepare their own design, a feature of the experiment designed to mimic the conceptual design phase that is often identified in studio design work. Following this ten-minute period, the participants were given blank sheets of paper, a ruler, and a set of 16 colored pencils, and they were asked to spend another ten minutes developing a rough sketch of their poster design.

The Fixation Poster. The example poster used in this study to create design fixation effects (Figure 2) was one that had been demonstrated to create strong fixation effects in a similar population of undergraduate students (see [7]). The poster has been carefully designed by the experimenters to contain a total of 25 'fixation' features, specific design elements of the poster that had been identified in advance as those that might be potentially copied by participants. By identifying these features in advance, we could then quantify the level of design fixation that was appearing in new posters that our participants designed by counting the number of fixation features they contained.

Survey. A survey was given at the end of the experiment to gather basic demographic information, in addition to qualitative data about the strategies that were adopted by the participants during the design task. Questions asked other than the written text, what was the first visual element you looked at, what single visual element of the poster did you find yourself looking at most frequently, and what single visual element did you find yourself looking at for the longest length of time?

3 Results

Posters created by the participants were graded for fixations based on the 25 established 'fixation' features from the original example poster. In the subsequent results, a fixation is an element from the fixation poster that was included in a designed poster. There was an average of 2.84 fixations in each created poster; two of these posters are shown in Figure 2. Two study-blind judges graded the posters and had an inter-rater reliability of $r = .96$. We analyzed our data in order to address the main goals of the project. First, we compared whether participants' memories of how they spent their own time critiquing a previous design was consistent with the data we had gathered about their eye movements. Next, we analyzed whether participants' memories about their design critiques, or their eye movement data, predicted subsequent design fixations. Finally, we looked at the survey data that we had collected for any additional insights about what might be predisposing participants to fixation effects.

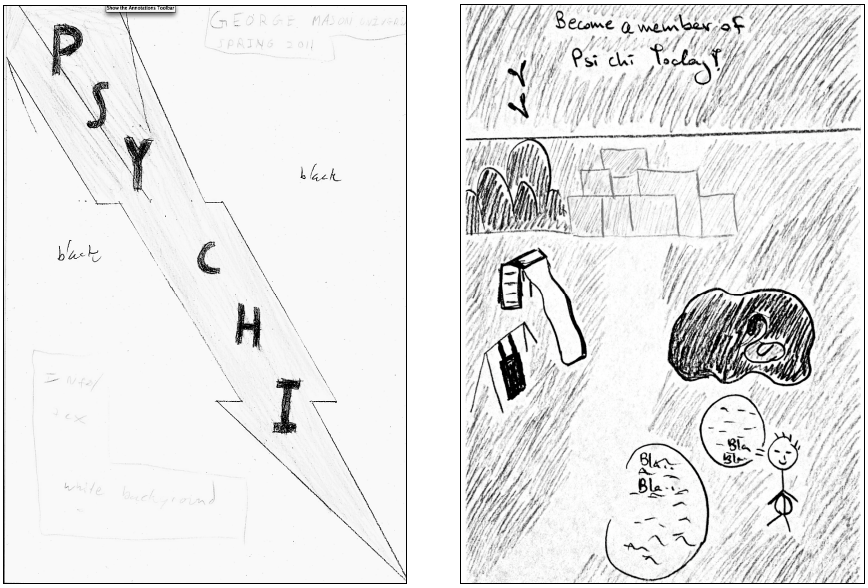

Fig. 2. Examples of less fixated (left) and more fixated (right) poster designs

3.1 Subjective Recall of Eye Movements

One of the research goals was to find out if participants were able to subjectively remember what they actually looked at on the fixation poster first, most frequently, and longest, based on their recorded eye movements. Zero percent (0%) of participants had a match between their subjective recall and objective eye movements of where they looked first; 10% of participants had a match for where they looked most frequently; 5% had a match on where they looked longest.

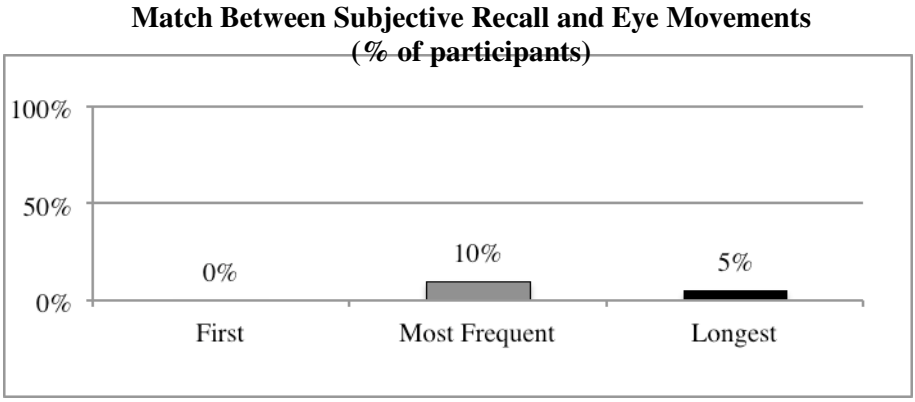

Fig. 3. The percentage of participants where a match was found between a participant's subjective recall and their objective eye movements of where they fixated first, most frequently, and longest

3.2 Subjective Recall and Fixation Effects

In Section 3.1, it was noted that participants were not often successful in matching their subjective recall of what they looked at first, most frequently, and longest. What a participant subjectively remembered looking at first, most frequently, and longest could theoretically lend insight into which elements they may have likely consciously fixated upon when designing their own posters. Participants were most likely to have fixated on what they remembered looking at first – but, even then, only 29% of participants fixated upon what they subjectively stated looking at first. Nineteen percent (19%) of participants fixated on what they subjectively looked at most frequently and 14% of participants fixated on what they subjectively looked at the longest; see Figure 4.

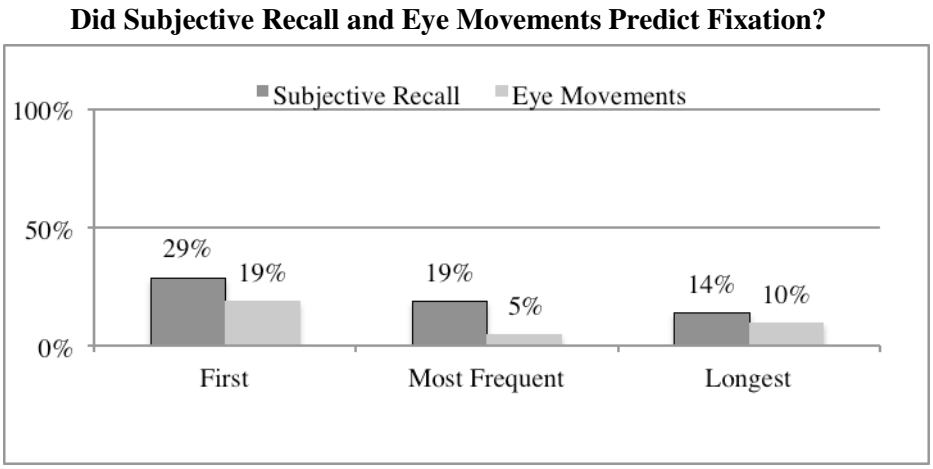

Fig. 4. The percentage of participants that fixated on a feature that was subjectively recalled as looked at first, most frequently, or for the longest duration, and the objective eye movements of each

3.3 Eye Movements and Fixation Effects

High percentages of matches between fixations and first, most frequent, or long lasting eye movements might be taken as evidence that how people spend time looking at an example design could indicate where fixation is likely to subsequently occur. To test whether participants eye movements predicted subsequent design fixation effects, we analyzed which features of the design participants looked at first, most frequently, and for the longest duration, then confirmed whether or not each of these matched with *any* fixation feature in that participant's final poster design. As shown in Figure 4, neither what participants looked at first, most frequently, or for the longest duration was a very good predictor of what they would fixate on.

4 Discussion

We analyzed our data in order to address how accurate people were with remembering where they looked on a poster, if where they looked would be an indicator for fixation, and if what they remembered looking at would be an indicator for fixation. We chose not focus on the effectiveness of their designed posters, but instead on which elements from the original poster they had included, which we termed 'fixations.

There appears to be distinct mismatches between what people remembered looking at on a poster and what they were actually looking at based on their eye movements, correctly matching an average of only 5% of the time across the three questions (see Figure 3). There is also a disconnect between both the subjective recall and objective eye movements and what participants fixated on. Subjective recall was, overall, fairly inaccurate when matched with the objective eye movements, but we wanted to see if the subjective recall would predict fixations included on the designed poster. However, subjective recall predicted an average of only 20.7% across the three trials. We then tried to see if eye movements, an objective measure, would predict fixations included in the designed posters, but that only predicted a fixation on average 11.3% of the time across the three questions.

Our research suggests that designers have poor recall of what they look at, and that neither subjective nor objective data about what designers look at correctly predicts fixation effects very accurately. Given that past research has demonstrated that eye movements are a real-time link to the cognitive processes of a person [11], and that the locus of attention during scene viewing is a strong predictor of which objects in a scene are being encoded in memory [12], it is puzzling that neither measure here was more predictive of fixation behavior.

Further research is clearly needed to determine what is causing design fixation, but one interesting theory of what is happening could be that, because participants were told this was a bad example of a poster, participants spent much of their time thinking and looking at elements of the example poster that they did not like. Later, when they were asked to design their own poster, they did not include those things they had disliked in their designed posters, but they may have been unconsciously primed to think about some of the elements that had not drawn their attention [8]. To use a coffee filter as a metaphor, the elements a participant considered "bad" in the previous design were eliminated, but the rest of the features that had not received attention then made an appearance in the final product. Continuing research will hopefully provide more insight into the underlying processes of design fixation.

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