Affordance Theory and Fitts's Law in UI Design for Web-based Survey

Abstract

Web surveys have advantages over their paper counterparts in aspects such as lower marginal costs, flexible data management, reporting systems, and higher incidence rates. These advantages contribute to the growth of web surveys used in business, research, and other areas.[1] However, as web surveys have become increasingly popular, respondents are more likely than ever to experience survey fatigue. When survey fatigue occurs the quality of their answers deteriorate, and consequently the respondents lose patience and become increasingly prone to producing "straight-line" answers that do not reflect their opinions. Survey fatigue can stem from multiple factors such as poorly worded survey questions, a lack of incentives, or from an obtrusive user interface design. Among these factors, obtrusive user interface design is an issue that can be improved by applying good user interface design principles.[2]

This research studies the application of Gibson's affordance theory and Fitts's Law in web interface design, and examines whether they will improve the effectiveness and response quality of web surveys. Controlled experiments are set up to compare the interface alternatives in the following aspects: user response time, response quality, and user preference of either interface. More specifically, the response time is tracked by event-driven AJAX calls that are associated with each investigated element; response quality is measured by analyzing the responses; and the user preference is collected by a set of three opinion questions.

The research results indicate that there is an improvement in response time and response quality when the web survey interface offers users appropriate affordances and adopts the Fitts's Law. In addition, the results also reveal that users are not aware of the benefits of the improved user interface before using it, but most users can recognize the benefits once they start interacting with the interface that provides better affordances.

Introduction

Affordance theory

Affordance theory is a highly influential theory introduced by James J. Gibson. The theory refers to the qualities of an object or environment that communicate opportunities to do certain things.[3] In web user interface design, when users see elements on a web page, they gain perceived affordances of the elements and implications of what the users can do with them.

In the context of web survey design, more specifically, different HTML form elements are intended for different purposes. For example, radio buttons suggest users to make one and only one choice whereas checkboxes suggest the possibility of more than one selection. The affordances of input elements on a web survey form should correspond with their intended functions.[4] When the affordances of web elements are misinterpreted or misused, the elements may conflict functionalities, leading to misinterpretation of the questions' intention and inaccurate results, which in turn reduce the quality and effectiveness of data collected through the web survey. For instance, a single-line textbox is not appropriate when the survey designers need paragraph responses from the users, because the perceived affordance of a single-line textbox is to provide a sentence that may not span multiple lines.

Misrepresented affordance

Affordance aligns with intended purpose

Gibson also argued that there are two different types of perception theories that are inferential theory and direct perception theory. The inferential theory refers to responses to perceptions that are based on experience, whereas the direct perception theory means that the perception acts directly on the perceiver in the environment, and the responses from the perceiver do not depend on meaning-conferring inferences.[5]

In the following example of setting panels from Windows 8 and iOS, the way that users recognize affordances is different. In Windows 8, the "Change PC Settings" field is not highlighted unless the cursor moves to that area. Before users have learned about this feature, they may assume that it is a text label. The affordance of "Change PC Settings" being a clickable item is acquired only after the users see the highlight. In comparison, iOS has elements that convey affordances without the users taking any action. The digital buttons on the configuration page resemble their physical counterparts and the text boxes resemble paper forms that users have had experience filling them out, and the invoked affordances make what users comment as "intuitive".
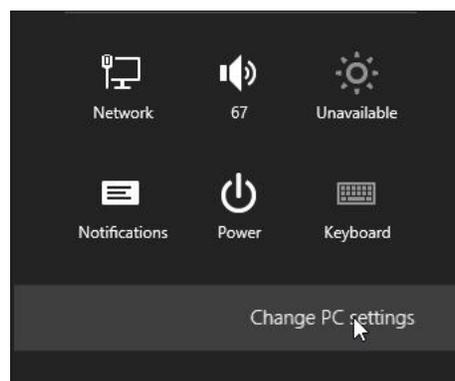
Inferential Perception - Interact with the interface to acquire new affordance

Direct Perception - Clear indication of affordance from buttons and text fields

Fitts's Law

Fitts's Law predicts that the time required to rapidly move to a target area is negatively proportional to the distance to the target and positively proportional to the size of the target. The law is also expressed in the following formula:

$$T = a + b \log_2 \left(1 + \frac{2D}{W} \right)$$

where T is the average time taken to complete a movement when interacting with the user interface, D is the distance from the starting point to the center of the target, and W is the width of the target measured along the axis of motion. a and b are empirical constant values that are specific to the kind of pointing action.[6]

According to Fitts's Law, the size of input elements on a web survey affects the time a participant spends to enter their responses. Most survey systems use default HTML form element (e.g. radio buttons, drop-down menus) style, whose clickable region often has a smaller percentage in terms of size of the entire option. For example, radio buttons and checkboxes have clickable regions that are only limited to the handles of these elements. Nowadays, most web users have screen resolutions greater than 1024 * 768,[7] and with the increasing resolutions, web contents are rendered smaller in terms of physical size on the screen, and it requires more careful maneuvering of the pointing device to reach elements on the webpage. One aspect of my research compares the average time spent on conventional HTML form elements to that of improved usability based on Fitts's Law.

○ Freshman
○ Sophomore
○ Junior
○ Senior
○ Fifth or higher (Graduates)

A set of conventional radio buttons

What year in school are you?

| Freshman | Sophomore | Junior | Senior | Fifth or higher (Graduates) |

A set of radio buttons with improved affordances

Methods

The survey is designed for a university organization to ask for students' opinions about the service and events provided by the organization. The survey is divided into an experimental group and a controlled group, where the experimental group is modified from the controlled group to study the application of the affordance theory and Fitts's Law in web form elements. In the survey, there are 5 radio button questions (excluding Question 1), 3 check box questions, and 4 open-ended questions.

The survey is password-protected so that only the students and faculty of the university are allowed to access and participate. The experimental and controlled version of the survey will be silently alternated by the system. Once the students consent to participate in the research, they are redirected to either version of the survey, and they will not be able to identify the version. Both versions of the survey contain identical information, in terms of questions and the phrasing of instructions. The only difference is the form elements that involve the application of the affordance theory and Fitts's Law. Each participant is restricted to finishing the survey just once because each login ID is allowed only one entry into the database. The participants are given unlimited amount of time to finish the survey. All survey questions are optional and participants can either partially finish a question or omit any question as they wish.

Radio button

In the experimental version, the round radio buttons are modified to become rectangles that enclose the text contents of each option, thus increasing the clickable area by over 100% depending on the length of the text information. Moreover, the modified buttons use borderlines and changes in shadow to imitate the appearance of physical push buttons used in home appliances and electronics, offering users better affordance in terms of the functions. In the controlled version, the radio buttons are set to be the default HTML style, and they follow the convention of vertical arrangement of radio buttons that are used in many traditional web survey forms. Response rate, response time, and user preference are measured in the radio button group.

How many FAC sponsored events have you been to this semester?

| 0 | 1 | 2 | 3 | 4 | 5 or more |

Experimental group - radio buttons

How many FAC sponsored events have you been to this semester?
- ○ 0
- ○ 1
- ◉ 2
- ○ 3
- ○ 4
- ○ 5 or more

Control group - radio buttons

Checkbox

In the experimental version, the checkboxes are styled the same as the radio buttons used in the experimental version except that multiple options can be selected. If the user selects the "Other" option, an input text box will appear underneath, allowing the users to enter their answers. In the controlled version, the check boxes again follow the conventions of how the checkbox is used in traditional web forms. Response rate, response time, and user preference are measured in the same way as that of the radio buttons. However, in addition to the radio button group, the time lapse from one selection to another (if a user selects multiple options) is also recorded.

How do you find out about FAC funding applications? (Check all that apply.)

| Posters | FAC Facebook | FAC Website | TruView | Word-of-Mouth | Other |

Please specify:

Experimental group – checkboxes

How do you find out about FAC funding applications? (Check all that apply.)

- ☑ Posters
- ☑ FAC Facebook
- ☑ FAC Website
- ☐ TruView
- ☐ Word-of-Mouth
- ☑ Other

Please specify:

Control group - checkboxes

Text area and text input

Text areas and text input elements are both used to collect text information from the users. The primarily difference between them is that text areas can span multiple lines while text input element cannot. This research studies the difference that these two input elements make in an open-ended question that prompts the users for feedback, comments, and suggestions for the organization. No information in the question reveals how long or what style the response should be. The results, however, will suggest if there is a correlation between the collected results and the affordance of these two input elements.

In the experimental version, a text input is used that can only hold one line of text regardless of its length. Hitting the Enter key will bring up a prompt that confirms with the user whether he

or she is finished with the survey and wishes to submit. The user can return to the survey if "Cancel" is selected. In the controlled version, a text area is used in comparison to the text input element. Responses and the length of the responses are measured.

Control group - text input

Experimental group - text area

Time tracking

Once a participant starts the survey, the survey system tracks the time that the participant spends on each question. A timestamp is created and saved in the database whenever the participant interacts with an input element on the page. For instance, a participant may answer a question with radio buttons by clicking an option. And by clicking on the radio button, the system timestamp is saved on the database in association with the question and the participant ID. A set of user interaction data is therefore collected for quantitative analysis.

The lapse of time between two questions is tracked in the following way: Each input element on the survey form is associated with a corresponding AJAX call that sends the current system time to the database. The time interval between two questions is measured by calculating the difference of system times for these two questions. For example, the response time for Question 2 is the difference between finishing Question 1 and starting to finish Question 2. As for radio buttons and check boxes, the AJAX calls are associated with button selections, whereas for text inputs and text areas, the AJAX calls are associated with `onfocus` and `onblur` events.

The response time for Question 1 is not measured because there is not an appropriate way to measure the time spent only on Question 1, especially when brief instructions are located immediately before Question 1.

If survey participants change their answers, the time interval between questions is calculated only by the first activation of timing events. In other words, the additional time for switching answers is not considered as in the time interval because it is very likely that participant changes his or her mind after a second thought, which is not closely related to the affordance of HTML form elements.
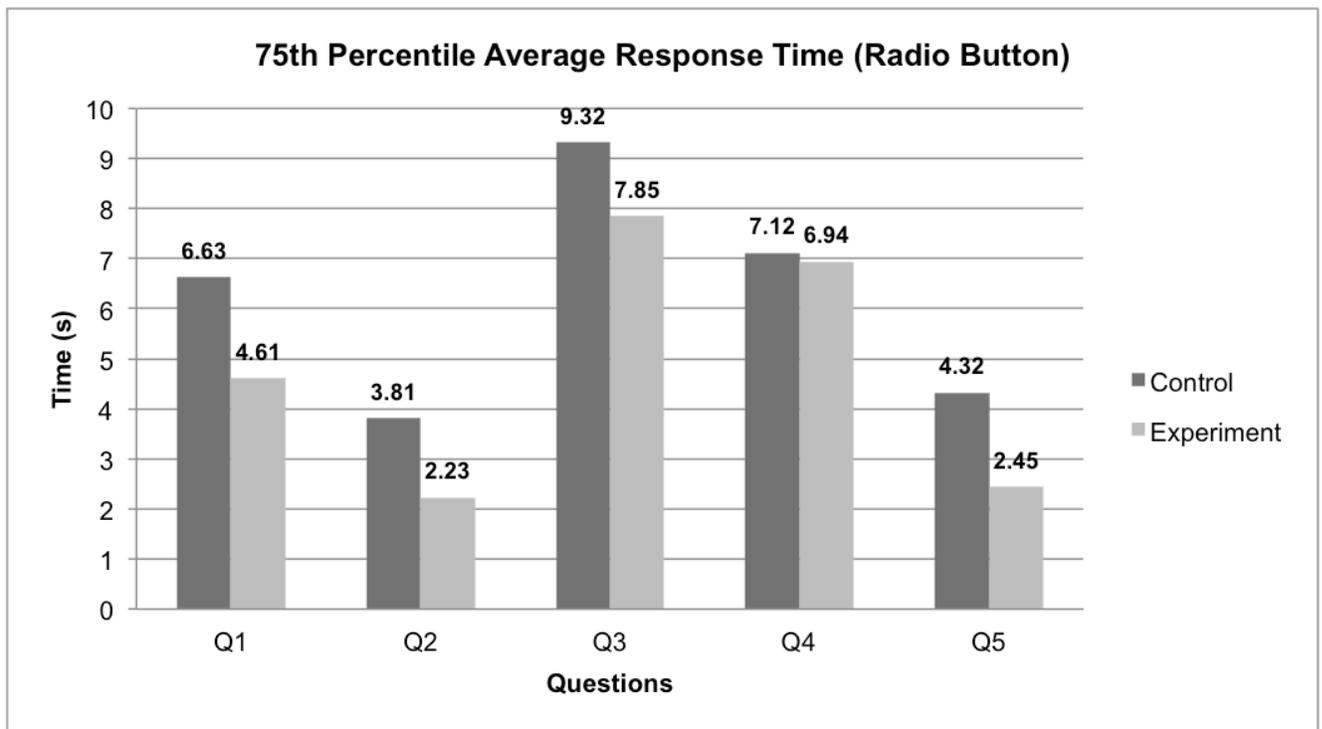
Opinion questions

The opinion questions include 3 multiple-choice questions that ask participants for their preferences for each of the experimental input elements. Both the control and experimental versions use the same opinion questions. For each of these questions, two screenshots are placed next to each other, showing two input controls from each version. Participants are supposed to choose only one style that they find favorable. The question is phrased up as, "Which one of the
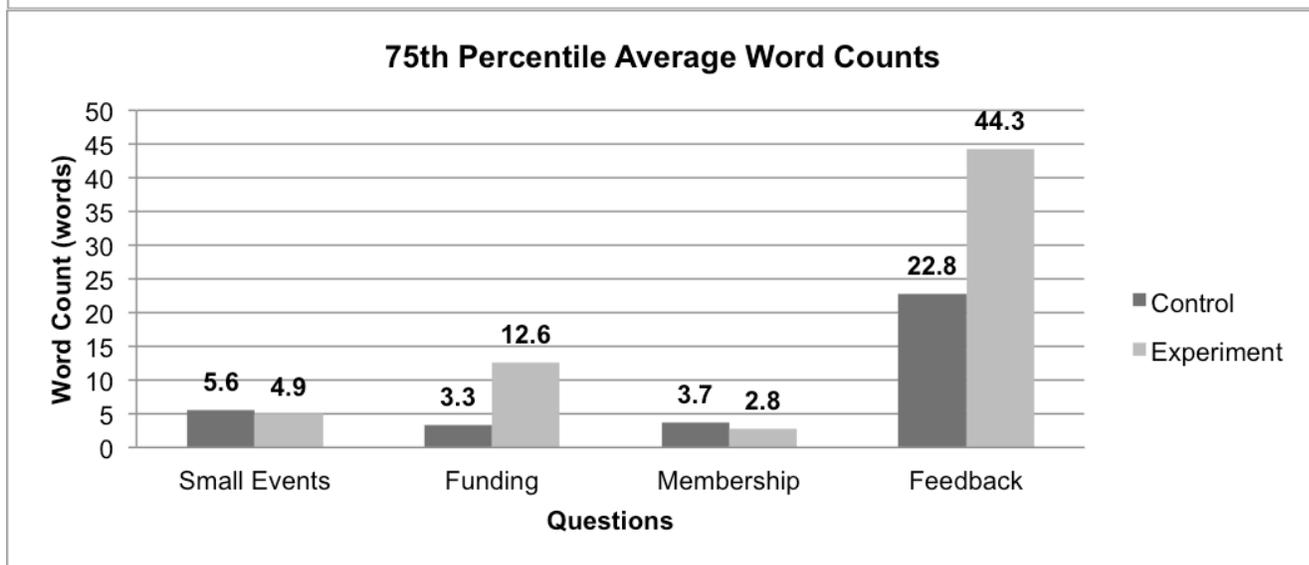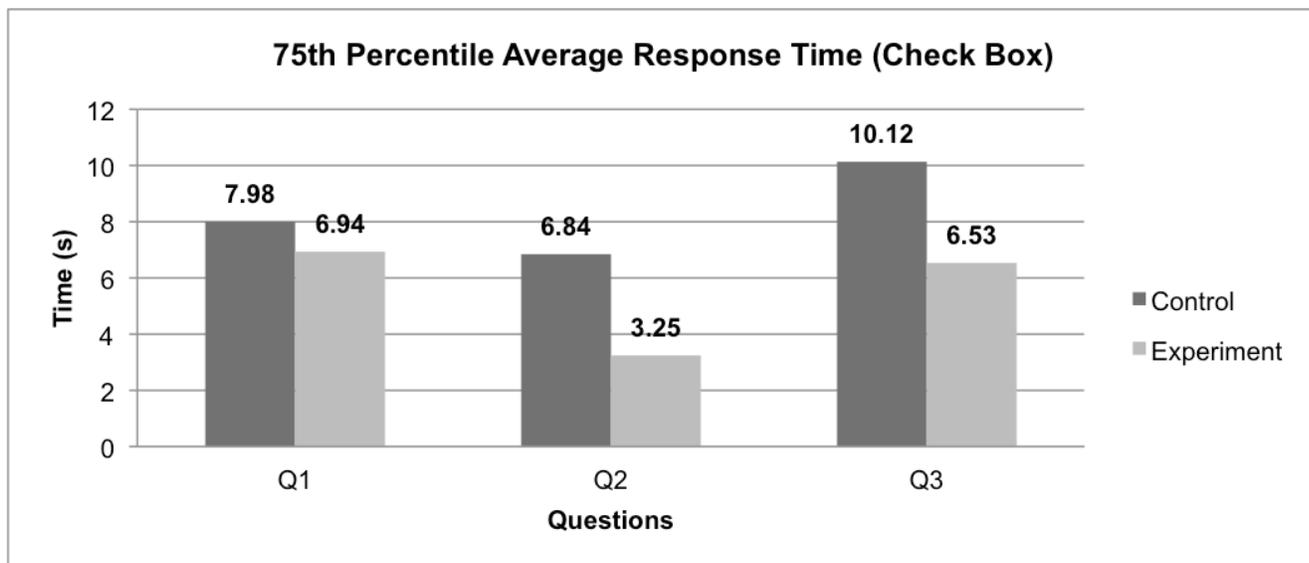
following two styles would you prefer to use if you were doing another survey?" The answers to the opinion questions are then compared with the results from the control-experiment questions.

Results

There are 262 survey submissions received in total, and these submissions are evenly divided into a control group and an experiment group, each of 132 thanks to the alternating mechanism set up in the survey system. There are 14 empty surveys (3 experiments and 11 controls) that do not contain answers to any questions because not all questions are required. These 14 empty surveys are therefore abandoned and not included in the analysis. Additionally, not all questions have the same number of responses in the control and experiment group.

The statistics are summarized in the following charts. (All of the results are based on the middle 75th percentile of the standard deviation curves such that the outliers are eliminated from all of the results.)

75th Percentile Average Response Time (Radio Button)

75th Percentile Average Response Time (Check Box)

75th Percentile Average Word Counts

Analysis

Radio button and checkbox

In the radio button group, the difference between the control and the experimental group is more significant in questions that take less time. The response time discrepancy comes from the difference between questions that do not take much time to think (e.g. "Which year in school are you?") and questions that require more thinking (e.g. "How many FAC sponsored events have you been to this semester?"). In the latter case, the insignificance in time is mostly likely diluted because of the longer thinking process that is not tightly associated with the interface affordance.

The difference in the checkbox group is significant only in the latter two questions but not the first one because the non-conventional checkbox component may not seem intuitive until a user sees the different states of the checkbox buttons. In other words, facing an interface that does not align well with previous experience with HTML form elements, participants may get confused and need extra time to adapt to a new setting. However, the results also reveal that once

they have had experience with the new interface design, the difference in response time between two groups becomes significant.

Text area and text input

In this group, the results reveal that the way the questions are phrased up affects how much response the participants are likely to provide. More specifically, in questions that are intending for phrases as responses (e.g. "What smaller events do you want FAC to sponsor?"), the response time is indifferent to the interface difference and not significant. One of the reasons is that these responses can be filled inline in the text input element, and thus the two interface designs are effectively the same. Another way to interpret this result is that the form directs the function of this web element.

As for questions that suggest long responses (e.g. "Do you have any feedback / suggestions"), the difference between the control and experimental group is significant because text area element allows spanning multiple lines thus resulting in a significant improvement in terms of the response length by 50%.

Opinion questions

Results show that participants from the control group do not have a significant preference for one over the other, whereas participants from the experimental group have a significant preference for the experimental version.

Conclusion

The results show that both the Gibson's affordance theory and Fitts's Law can be applied to web survey interface design to improve the response quality and effectiveness of web surveys. When combined with Fitts's Law, the affordance theory used in web survey forms allows users to quickly identify features of the forms, and offers users the sense of "intuitiveness". By enlarging interactive elements on the forms, users can easily move their pointing devices to the elements, and spend less time on average when they are giving responses. The benefits of these improvements include an improvement in response time, a decrease in the chance of getting survey fatigue, and a better utilization of physical space on the webpage.

Moreover, the difference between adopting the affordance theory and Fitts's Law and not adopting them can be more significant in other groups of population. The participants in this research are college students who must receive a pass grade in computer literacy at the beginning of their freshman year. Their education and experience of computer software and applications may help them navigate through intricate systems that lack affordances. However, as for people with less computer proficiency, they may find affordances offered by the experimental interface easier to use than the traditional interface.

The research also indicates that web users are accustomed to how the Web elements work by conventions and in certain ways. Creative user interface design may bring users enhanced affordance or usability but may also obstruct the existing pattern and workflow with which users are comfortable. However, it does not necessarily mean that new user interface design patterns are always interrupting or confusing. As the results indicate, users may easily pick up and understand new patterns if the interface does provide better usability. Besides, the finding also suggests that when new interface is in presence, it would be extremely helpful if the interface itself can guide users to quickly learn and understand how it works, thus minimizing the side effect of innovative user interface design.

References

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