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ON-LINE SYSTEMS: CONTROL BUTTON DESIGN AND CHARACTERISTIC EFFECTS ON USER LEARNING AND PERFORMANCE

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ABSTRACT

With the increased use of on-line systems requiring users to interact with an unfamiliar interface after little or no formal training developers must be cognizant of design characteristics that are detriments to success. The introduction of an on-line property tax system in Nashville, TN is seeing numerous implementation snags. Many of the issues preventing people from accomplishing their desired tasks appear to be design related. Many such systems recently introduced are developed and launched without implementing many of the basic design characteristics taught for years by top design experts. This research will examine control characteristics and will attempt to identify potential stumbling blocks to user learning caused by control design. Specifically control color, shape and location will be examined to determine if differentiation between controls aids in the learning of an on-line system.

KEYWORDS

INTRODUCTION

Cue theory (Gibson, 1977 and Allard, 2001) will be used in this proposed research to examine the effects on learning that are observed when cues, such as color, shape, and location are utilized to help users distinguish differences in navigation control tools used in search and selection tasks. This research is an extension of previous work in cue theory (Jones & McCoy, 2003) and attempts to investigate any possible implications on learning and recall resulting from interaction with various navigational controls possessing distinguishable physical characteristics. Infrequent system users rely on learning as a primary means to successfully navigate through an unfamiliar on-line system since formal training is often not provided. Assessing control characteristics that aid in that learning will allow system developers to build systems that allow infrequent users to quickly master the system interface and accomplish their desired goals. This research will gather learning data from users interacting with on-line systems to determine which interface characteristics have the greatest impact on learning and then directly on user performance measured in task completion speed.

RESEARCH QUESTION

What are the effects of navigation control differentiation (color, shape and location) on user learning?

PRIOR RESEARCH

Cognitive psychology is one of HCI's fundamental and foundational disciplines. Within the bounds of HCI cognitive psychology is used to help scientist: 1) gather knowledge about what users can and cannot be expected to do, 2) identify and explain the nature and causes of some of the problems that users encounter and 3) supply modeling tools and methods to help build interfaces that are easy to use. Cue theory becomes important to allow a well established theory to offer predictions for the performance gains expected through the differentiation of control features (Bjorkman 1969; Bjorkman and Nilsson 1982). Cue theory offers the idea that users will take into account all of the available clues offered by the interface and make judgments or assign meanings to the navigational control tools based on these clues (Allard 2000). As the user interacts with the site additional clues will become available and the user will make adjustments to their assigned meanings or confirm their prior assignment. Cue theory offers the possibility to predict that as more cues are available to the user their learning of the system and its controls will be enhanced mainly due to the additional mental cues available to draw from.

In this research, we look to control differentiation, and two distinct properties, shape and color to answer the above research question. In addition we will examine the effect of location and its consistency. It is argued that cues will provide the necessary clues for users to more quickly identify and learn the function of the controls thereby allowing them to fulfill their task more efficiently.

Shape

One of the ways in which designers provide users cues to the function of the controls offered on an interface is through the use of differentiation in shape. Shape is a way that we identify unique places, items or categories to help facilitate our understanding of the item in question and its basic function. Shape is the second quickest recognized differentiation feature immediately behind color according to research (Jubis 1991; Adelson et al. 1993). Shape also facilitates focusing the users eyes on the location the designers wish to emphasize. Shape can allows designers to draw the user's attention to specific controls, certain areas of an interface and even to specific pages within a web-site.

Color

Color and interface design are also integral to cognitive psychology's examination of HCI. Color coding has been shown to aid some cognitive tasks (Christ 1975). One of the studies examined color coding methods and it showed significance positive results for search tasks if the division of the display into colored regions was properly and logically accomplished. This was shown to be more helpful to inexperienced users but showed significance for all users. The study also concluded that if too many colors are utilized on numerous items the users get color saturation (pollution) and performance is degraded. There is considerable HCI research examining color palette and its effect on user trust and user attitudes towards specific web-sites though none have attempted to examine the use of color as a differentiation tool on a web-site to effect learning or performance (Lohse and Spiller 1998; Mandel and Johnson 2002).

Location

Location is also an important characteristic that has been shown to effect performance on follow-up tasks. Users rely on recall to remember the location of controls and performance is shown to improve with the number of trials for any given task. This research will attempt to see if actual learning is positively affected by consistent control location.

PROPOSED STUDY AND MODEL

Control Button Shape Differentiation

Researchers have examined the use of shape to enhance search and selection tasks with positive results (Lucas, 1987; Jubis 1991; Adelson et al. 1993). Some research has touched on the idea of iconic representation differentiation's possible efficiency enhancement during search or selection tasks (Lucas 1987) but most have not been concerned with examining user performance. With the use of shape as a primary distinguishable trait for control design this study will attempt to determine if

user attitudes and performance are enhanced. In aviation research several studies (MacDonald and Cole 1988) have shown that differentiation is critical for accurate and speedy selection of controls especially during critical phases of flight or emergency procedures. In line with this past research and as predicted by ideas from cue theory it is proposed that differentiation in a meaningful way of the control's shape will aid users in making accurate and speedy selections of desired controls.

Therefore, providing shape differentiation will result in more favorable outcomes than providing no differentiation through the use of hypertext only.

H1_a: A web site with controls differentiated by shape will result in more efficient learning of control function than will a web site with non-differentiated controls.

H1_b: A web site with controls differentiated by shape will result in higher user performance than will a web site with non-differentiated controls.

Control Button Color Differentiation

Color's role in speed and accuracy during selection tasks is rather definitive. Many studies have been conducted that examined the effects of color differentiation on search and selection tasks (Shontz et al. 1971 and Christ 1975) and most if not all have shown that when controls are differentiated by color selection is made more accurately and more quickly. While these studies cover some of the leading articles in human factor research on color differentiation there is literature in psychology that also investigated color differentiation's effect on information location and selection task outcomes (Smith and Thomas 1964). There is wide support in both the psychology literature and human factors literature for the benefits of color coding on selection speed for information retrieval and selection tasks.

The following hypotheses were operationalized by providing a monochromatic color scheme for one subject site (standard site) and one site that provided buttons of various colors using the standard Microsoft paint scheme. Therefore, variability of color in controls is expected to have a greater positive effect on attitudes and performance than no control color variability.

H2_a: A web site with controls differentiated by color will result in more efficient learning of control function than will a web site with non-differentiated controls.

H2_b: A web site with controls differentiated by color will result in higher user performance than will a web site with non-differentiated controls.

Control Button Location

Consistency in item location has been shown to improve performance on search tasks. Users tend to recall at least some of the locations and their overall performance is improved on subsequent tasks using the same interface. Learning should be positively affected by consistent control placement on the system interface. To test these hypotheses, two distinct interfaces will be presented, one with controls located in the same location for all pages within the site and one that allows the controls to be arranged in differing spots on each web-page.

It is therefore predicted that, providing a consistent location for all controls will result in enhanced learning of the site as well as more favorable performance results.

H1_a: A web site with controls in a consistent location on each page will result in more efficient learning of control function than will a web site with controls inconsistently located.

H1_b: A web site with controls in a consistent location will result in higher user performance than will a web site with controls inconsistently located.

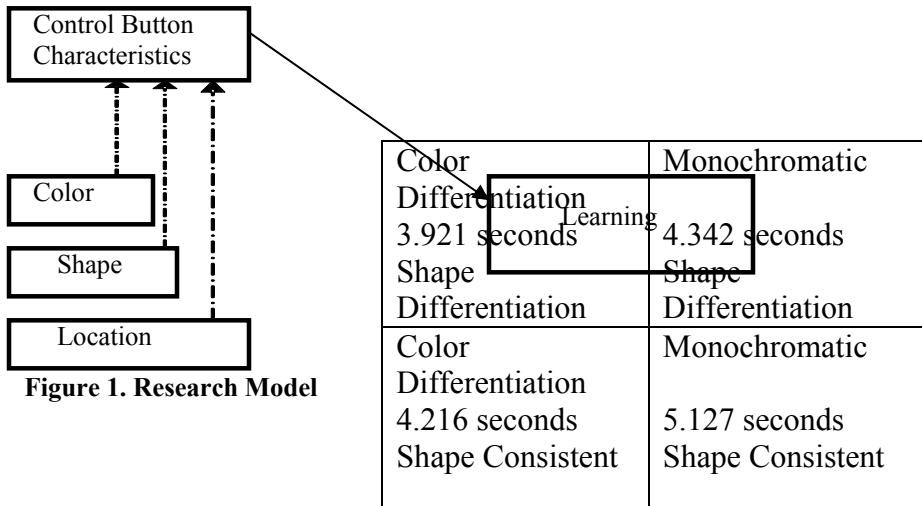


Figure 1. Research Model

RESEARCH METHOD, ANALYSIS AND RESULTS

This study utilized an experimental setting to collect the necessary data to test the research model. The pilot study was conducted with 80 undergraduate students from the business school at a well known university in the Southeast United States. The participants were randomly assigned to groups and then assigned tasks to complete. The nature of the tasks was online site access with search and information capture requirements.

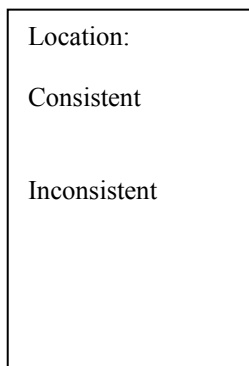


Figure 2. Research Design

A 2x2x2 between subjects full factorial design was employed (See Figure 2.). One group of participants was asked to log onto an e-procurement website that had been designed and launched and is currently available. The other participants will log onto sister websites that while remaining identical to the initial

other site in basic composition and layout but will incorporate the effects under investigation in this research. A total of 8 distinct web-sites will be utilized to conduct this research. The purpose of the task is to determine participant learning and efficiency disparity with the assigned tasks between the eight groups thereby identifying whether or not button differentiation affects user learning and performance. Performance will be measured by taking the time required for each participant to complete their assigned tasks. The times required to accomplish tasks will be analyzed and statistical results computed. Learning will be determined by the change in task time completion as the user completes the tasks. The time required to accomplish task one compared with task 2 and on. Then task 2 times will be compared to other task completion times. Cue theory allows us to predict that cues will aid the user and the task performance results should improve more quickly for those users assigned to interfaces with cues that differentiate the controls.

The pilot study showed main effects in-line with the predictions outlined in the paper for both color and shape differentiation (all hypotheses supported, $p < .05$) as well as control location ($p < .05$). There was also an interaction effect between color and shape on both learning and performance, which is consistent with cue theories idea of a diminishing effect when two or more cues are used in conjunction. This diminishing effect would indicate that if a single cue were used to differentiate a control button and then the results were added to the results of another treatment with a single cue differentiation the summative results, compared to a treatment that consisted of two differentiating cues combined, would be greater. Both interactions showed significance at the $p < .05$ level.

DISCUSSION, CONCLUSION

Much of the HCI research adopted by designers for traditional interfaces continues to be ignored by on-line system developers. This research-in-progress attempts to use control buttons on web pages to test the effects of color and shape differentiation as well as control location on user learning and performance. The results on both the learning that occurs as well as performance improvements that were seen in the pilot study are encouraging and will be replicated with a larger sample. The combined results of the two studies (pilot and main study) could influence developers with the establishment of design standards resulting from these results. This study provides further evidence that when designers and developers fail to follow simple interface design protocols disastrous results for users are seen. This results in potentially significant cost increases for system providers and frustrations and dissatisfaction for system users.

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