
Beyond Pointing and Clicking: How do Newer Interaction Modalities Affect User Engagement?

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Abstract

Modern interfaces offer users a wider range of interaction modalities beyond pointing and clicking, such as dragging, sliding, zooming, and flipping through images. But, do they offer any distinct psychological advantages? We address this question with an experiment (N = 128) testing the relative contributions made by six interaction modalities (zoom-in/out, drag, slide, mouse-over, cover-flow and click-to-download) to user engagement with identical content. Data suggest that slide is better at aiding memory than the other modalities, whereas cover-flow and mouse-over generate more user actions. Mouse-over, click-to-download, and zoom-in/out tend to foster more favorable attitudes among power users, whereas cover-flow and slide generate more positive attitudes among non-power users. Design implications are discussed.

Keywords

Interaction modality, interactivity, perceptual bandwidth, user engagement, Web interface design

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design, experimentation, human factors.

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Introduction

Mouse-based modalities of interaction have come a long way since the early days of pointing and clicking. We can now perform a wide variety of actions, such as dragging, scrolling, zooming, hovering and flipping. While each of these modalities offers a unique way of experiencing content, we know very little about their respective psychological effects. Do they lead to different outcomes on users' perception and attitude toward websites? Are they able to enhance or hinder user engagement with websites? If so, how would that be helpful for a designer's decision to deploy a certain modality of interaction for a given interface?

Interaction Modality

In this paper, we use the term "interaction modality" to refer to unique interface tools that offer different "modes" of interactions (or calls for action) to users [7]. Our conception of interactive interfaces is based on a tripartite model of interactivity effects that distinguishes between modality, source and message interactivity [6]. Interaction modality offers different ways of exploring the underlying content. Some of them (e.g., drag) let us experience the content in a spatial way whereas others (e.g., slider) tend to simulate motion. Therefore, different modalities differentially represent content in our perceptual system. According to the "interactivity effects model" [6], interaction modalities serve to extend our "perceptual bandwidth" and thereby lead to greater user engagement with content.

Perceptual Bandwidth

Perceptual bandwidth refers to the range of sensory and preliminary attentional resources available to individuals. This bandwidth may be increased by

perceptual interfaces, which are "machines that can accomplish human-like sensory tasks" [4, p.65]. The result of such expansion of the perceptual bandwidth is enhanced mental representation of information in users' minds and in turn affects memory of the mediated content. Therefore, we conceptualize perceptual bandwidth as users' memory toward interface content.

Multiple resource theory [10] posits that multiple channels (or several sensory modes) are deployed when users process information delivered through rich, interactive features. This suggests that some types of interaction modalities could be more perceptually complex and hence demand a significant share of our cognitive resources, compared to other modalities which are deemed perceptually simpler, and processed more easily. A recent study [8] showed that participants who interacted with the relatively simpler interaction modality of clicking on hyperlinks had better memory in terms of how much information they could recall and recognize, when compared to those who accessed the same information via newer and perceptually richer collection of interaction modalities such as cover flow, slide and animation features.

Given the differential level of complexity among modalities of interaction, and considering their relative differences in the actions they afford, we can expect them to command different levels of cognitive processing. Therefore, we hypothesize that:

H1: Different types of interaction modalities are likely to vary in their effects on perceptual bandwidth, as evidenced by memory for interface content.

User Engagement

In recent years, scholars have emphasized the importance of moving beyond usability concerns toward understanding user experience, by proposing that we design interfaces to make them more engaging [1]. A recent study [8] has shown that adding more interaction modalities can make the same content more absorbing and evoke more positive attitudes among users. Similarly, in a classroom setting, students exhibit greater interest and self-guided learning behavior on class materials that use interactive, pen-based flashcard applications [2]. Therefore, variations in interaction modalities embedded in the interface are able to affect user engagement with the content provided by the interface.

H2: Different types of interaction modalities will vary in their effects on user engagement, as evidenced in the different degrees of user actions (H2a) and attitudes and behavior toward content (H2b) and website (H2c).

Extant theory and research suggest that user engagement is quite contingent upon user skill [9]. In general, so-called “power users” are known to be much more cognizant of interface features and make fuller use of affordances [3]. They are known to exert control over how the interface delivers content. Regular users, on the other hand, tend to be less active in utilizing all the functionality offered by the interface. Therefore, we decided to include power usage as a moderating variable in the current study.

H3: A two-way interaction is likely between the type of interaction modality and level of power usage on perceptual bandwidth, engagement, attitudes and behavior intention.

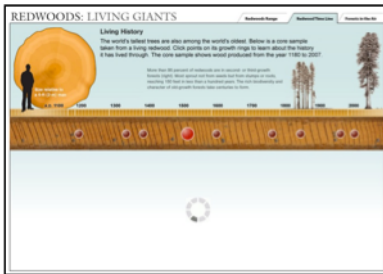


figure 2. Screen capture of click-to-download condition



figure 3. Screen capture of drag condition



figure 4. Screen capture of slide condition

Research Design

To test the above-mentioned hypotheses, we conducted a between-subjects experiment (N=128) in which participants interacted with one of six types of interaction modalities (click-to-download, drag, mouse-over, slide, zoom-in/out, and cover-flow) on a website. The six prototype websites were constructed based on an online magazine story titled “Redwoods: Living Giants,” developed by NationalGeographic.com (<http://ngm.nationalgeographic.com/2009/10/redwoods/redwoods-interactive>). The six prototypes shared the same content, page layout, and color and only differed in the type of interaction modality offered to the users.

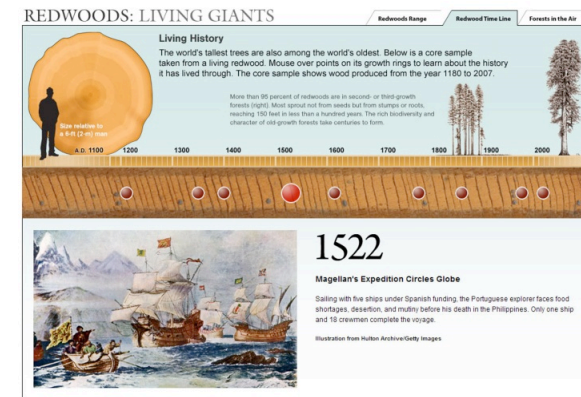


figure 1. Screen capture of mouse-over condition

We embedded the manipulation in a timeline with 9 hotspots along the center of the screen. In the mouse-over condition, the information was revealed when participants placed their cursors over the hotspots on the timeline. The information persisted until participants moved to other hotspots (Figure 1). In the click-to-download condition, participants were able to click on hotspots to access the information of the



figure 5. Screen capture of zoom-in/out condition



figure 6. Screen capture of cover-flow condition

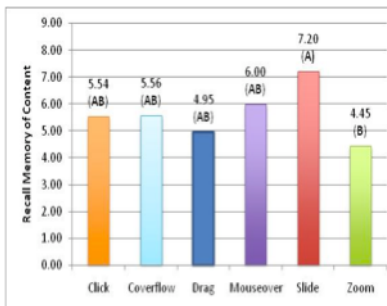


figure 7. Modality effect on recall memory of content (Bars that do not share a letter are significantly different)

relevant historical events emerging in the bottom half of the screen after a one-second wait, indicative of image downloading (Figure 2). In the drag condition, participants were instructed to drag a red dot over points on the growth ring (Figure 3). In the slide condition, the information changed from one to the next when participants moved the slider over hotspots along the timeline (Figure 4). In the zoom-in/out condition, hotspots along the timeline appeared in the form of thumbnails that participants were able to click on along the timeline first. They were also able to zoom-in/out from these thumbnail images by clicking on the magnifying lens (Figure 5). Finally, the cover-flow condition had a 3D effect, but rotating along a vertical axis. Participants were able to control direction and speed of the rotating carousel (Figure 6).

Except for *perceptual bandwidth*, which was measured by both *recall* and *recognition* memory about website content through multiple-choice questions, all other outcome variables were measured on 7-point scales.

Perceived interactivity was measured by three statements such as: "This website is: 'not at all interactive' to 'highly interactive'" ($\alpha=.85$).

User actions was measured via the *number of user actions* (e.g. clicks, drags, and slides) with the hotspots collected by the log data through jQuery.

Attitudes toward content was measured by asking participants to indicate how well 12 adjectives such as believable, accurate, and comprehensive described the content of the Redwoods story ($\alpha=.87$). Items measuring the *attitude toward website* included 11 terms such as comfortable, trustworthy, organized, and

others ($\alpha=.90$). *Behavioral intention toward content* was measured by 5 items such as how likely they would want to know more about the topic of redwoods, to discuss the topic of redwoods with their friends, and to forward the redwoods webpage to their acquaintances ($\alpha=.92$). *Behavioral intention toward website* was measured with four items by asking participants about their intention to bookmark, recommend, forward, and visit the website in the future ($\alpha=.91$).

The moderating variable of *power usage* was measured via 12 questions derived from the literature [3] pertaining to users' liking, skill, and dependence on information technology ($\alpha=.83$).

Results

Perceived interactivity: The type of interaction modalities did not influence the level of perceived interactivity among users ($F_{(5,115)}=.46$, $p=.81$), whereas power usage had a significant positive effect ($F_{(1,115)}=5.52$, $p<.05$). This non-significant main effect for interaction modality indicated that our manipulation was successful, because all six prototypes were perceived to be more or less the same in their level of interactivity, but differed only in the type of interaction modality that each offered to users.

Effects on perceptual bandwidth: For *recall memory*, participants interacting with slide modality showed higher amount of recall than those in zoom-in/out condition, as indicated by Tukey-Kramer post-hoc test ($F_{(5,116)}=2.26$, $p=.05$) (Figure 7). After controlling for the number of user actions, the six modalities significantly differed in *pictorial recognition memory* ($F_{(5,117)}=3.56$, $p<.05$). Post-hoc tests showed that those in slide and click conditions scored higher on pictorial

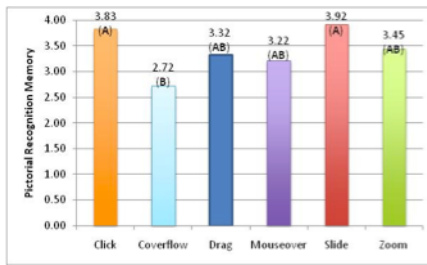


figure 8. Modality effect on pictorial recognition memory of content (Bars that do not share a letter are significantly different)

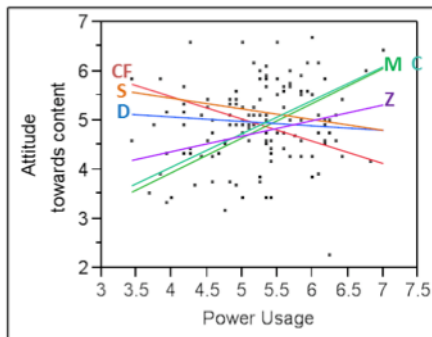


figure 9. Type of modality × power usage interaction on attitude towards content

recognition than those in cover-flow condition (Figure 8). H1 was partially supported.

Effects on user -actions: Participants who interacted via cover-flow and mouse-over modalities showed significantly more user actions on hotspots than the other four conditions ($F_{(5,112)}=24.73$, $p<.001$). Number of user actions was also positively associated with recognition memory across all modalities ($F_{(1,117)}=8.77$, $p<.01$). Therefore, H2a was supported.

Effects on Attitude and behavior intention toward content and website: A significant interaction effect between types of modality and power usage was found for attitude toward content (Figure 9). Those scoring higher on power usage showed more positive attitudes toward the website content while interacting with mouse-over, click-to-download, and zoom-in/out modalities ($F_{(5,116)}=4.29$, $p<.01$), whereas individuals scoring lower on power usage showed more positive attitudes toward the same content when using cover flow and slide modalities. H2b & H3 were partially supported, whereas H2c was not because there was no significant effect for website-related attitudes and behavior.

Discussion

It is clear that our subtle manipulation of interaction modalities led to significant differences in user experience. Participants scored significantly lower on pictorial recognition memory when using cover-flow, which indicates that the attention-getting potential of this interaction modality may actually inhibit encoding of information. Thus, designers should consider the trade-off between the attention-grabbing ability of interaction modalities and learning outcomes, which

can be especially critical in interfaces devoted to education and training. They have to design for the possibility that newer and more appealing modalities of interaction may actually hinder retention of content, because they may lead to perceptual overload.

In contrast, the generally favorable effect of slide modality on both recall and recognition implies that the choice of interaction modality ought to match the characteristic of website content. Such congruency could make the encoding and storage of information more efficient for users. Compared to other modalities, the prominent feature of slide is to align the site's content into a linear dimension. This linearity matched well with the chronological presentation of the site's historical content in our study.

Power users appear to be keenly reactive to variations in interaction modalities. Those scoring higher on power usage showed better attitude toward the same content of the website with click-to-download, mouse-over, and zoom modalities. One explanation could be that power users tend to display a stronger need for control, which leads to better attitude towards the modality that provides more control in viewing the content. Another explanation is that power users are also more utility-oriented, believing in efficient completion of tasks in a quick and easy fashion. In the current study, click-to-download, mouse-over and zoom modalities seemed to give users more control and involve the least effort for accessing content.

However, those scoring low on power usage were more appreciative of interaction modalities that required them to perform an action. Next to cover-flow, slide and drag led to the most positive attitudes, implying

that efficiency of operation is less important than the element of “fun in doing” [5].

Another implication is that the concept of user engagement cannot be reduced to the volume of interactions. Both cover-flow and mouse-over led to relatively large amount of user actions, especially among power users ($F_{(5,112)}=2.61$, $p<.05$), but their impact on attitudes were quite different. Whereas more user actions in mouse-over seemed to result in better attitudes, the user actions required for cover-flow only led to more negative attitudes. Physical interactions with interface, depending on the type of modalities and the consequence of the user actions, can make a difference in more critical variables such as user attitude towards content delivered by the interface.

In conclusion, the modes of interactions can make users experience the same content in different ways and shape the criteria with which they evaluate the same website. Ongoing work in our lab systematically tracks this phenomenon of differential user responses by operationalizing the interaction modalities in different ways on a variety of Websites.

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