Information Voyeurism: Social Impact of Physically Large Displays on Information Privacy

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ABSTRACT

A common observation when working on physically large displays, such as wall-sized projection, is that a certain amount of information privacy is lost. A common explanation for this loss in privacy is the higher legibility of information presented on large displays. In this paper, we present a novel paradigm for measuring whether or not a user has read certain content. We show that, even with constant visual angles and legibility, visitors are still more likely to glance over a user's shoulder to read information on a large wall-projected display than on a smaller traditional desktop monitor. We assert that, in addition to legibility, there are more subtle social factors that may contribute to the loss of privacy on physically large displays. Implementing hardware and software ideas for mitigating this loss of privacy remains future research.

Keywords

Privacy, social factors, large displays, implicit memory

INTRODUCTION

We believe that there is an emerging trend in the workplace towards large wall-sized displays, typically used in conjunction with traditional desktop displays [3,6]. In some projects, such as Bishop & Welch's *Office of "Real Soon Now"* [1], researchers have gone so far as to completely replace desktop displays with large-screen projection displays. Most of these researchers have observed that visitors treat information on these large displays as being public and do not hesitate to read or comment upon it.

A common explanation for this loss in privacy is the higher legibility of information presented on large displays. Because these large displays are typically viewed from a distance that is not proportionally scaled with the increase in display size, they often provide a larger visual angle, making them easier to see and read. While we agree that this contributes to the loss of privacy, we assert that there are more subtle social cues that may also contribute to this effect. Swaminathan & Sato [4] realized that "when a display exceeds a certain size, it becomes qualitatively different". We believe that social convention prescribes that people have certain personal zones within which objects (information included) are deemed private. With few exceptions, any object outside of this zone is assumed to be public. Also, culturally, objects placed on walls are typically considered public. Large wall-sized projected displays exhibit both sets of public cues.

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CHI 2003, April 5–10, 2003, Ft. Lauderdale, Florida, USA.
ACM 1-58113-630-7/03/0004.

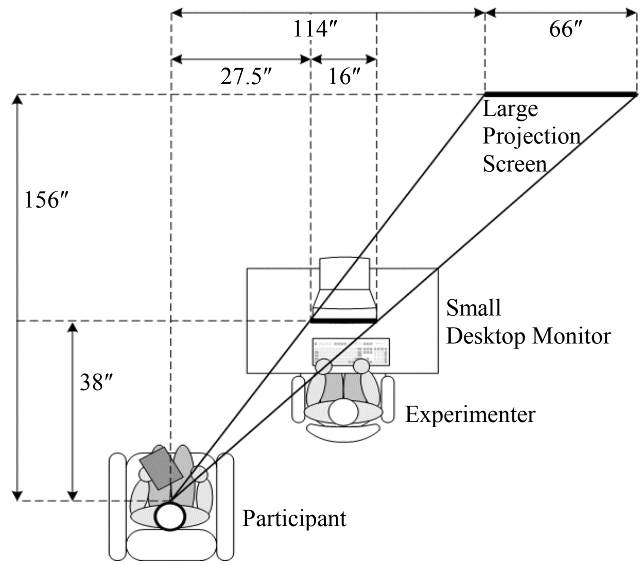

Figure 1: Visual angle held constant between the small display and large display conditions.

MATERIALS

We used two displays, an NEC MultiSync FE1250 22″ monitor and a Sanyo PLC-XP30 LCD projector. Both displays ran at a resolution of 1024 x 768 and were calibrated to be of roughly equivalent brightness and contrast. The image on the monitor was 16" wide by 12.5" tall. The image projected on a wall-mounted screen was adjusted to be exactly 66" wide by 49.5" tall. We set the displays up so that when either display was viewed from the participant's seat, the visual angle and the size of the retinal image would be identical (Figure 1). With a similar setup, Tan et al. found that reading performance did not significantly differ on two such displays [6]. Additionally, we ensured that someone using the system would not occlude any part of either displays from a participant.

We measured whether participants had read content on the displays with an implicit priming paradigm, usually employed to study learning without awareness [4]. In this paradigm, participants are presented with target words and are later tested, for example with stem completion, on their

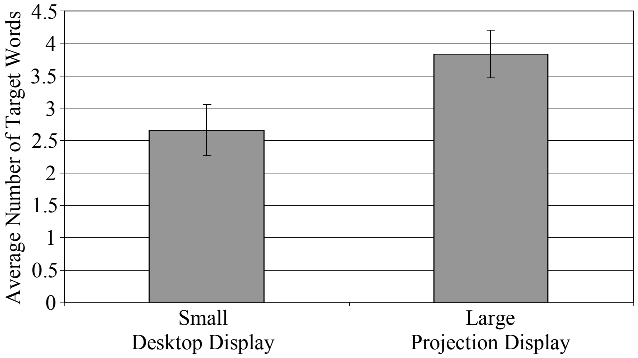

Figure 2: Users responded with target words more in the large display condition than the small.

implicit memory for these words. In stem completion, participants are given the beginning of a word (e.g. mil___ for military) and must complete it with the first appropriate word that comes to mind. Priming is reflected by an enhanced tendency to complete stems with target words.

In our study, we constructed seven e-mail subject lines and two e-mail messages that included a total of 30 target words selected from the Kucera & Francis norms [2]. These words were selected to be between 5 and 12 letters in length and of medium frequency (mean: 87 per million). The initial three letters, or stem, of each word was unique to all other text given to the participant and each had at least 8 different completion possibilities. Additionally, 33 filler words were selected with the same criterion.

PROCEDURE

Participants were seated in the armchair and handed a survey on multiple monitor preferences. They were informed that they would have exactly seven minutes to complete this survey and should look over their answers if they got done earlier. The survey, consisting of one open answer and ten multiple-choice questions, was designed to take less than seven minutes to complete.

We used a between-subjects design, with participants balanced by gender and assigned randomly to one of the two display conditions: small display vs. large display. While the participant completed the survey, the experimenter read the prepared target content on one of the two display setups. Each e-mail message was viewed in the Microsoft Outlook e-mail client for three and a half minutes. The seven subject lines remained visible in the inbox for the entire seven minutes. The participant was video taped during the experiment.

After the survey, the participant performed the stem completion test. The test consisted of 63 stem completions: 3 practice questions, 30 filler questions, and 30 target questions. The 3 practice questions were followed by the 60 filler and target questions presented in random order. Following the test, participants completed a questionnaire explicitly asking whether or not they had read content on the experimenter's display while doing the survey.

RESULTS

Twenty-four (12 female) intermediate to advanced windows users with normal or corrected-to-normal eyesight participated in this study. Participants ranged from 18 to 55 years of age (mean: 36.9). They received software gratuity.

We found significant differences between conditions in the number of stems completed with target words, suggesting that users had read more information displayed on the large display (M=3.83 words) than on the small one (M=2.67 words). This was true with both a loose metric that permitted different forms of the target words, as well as a concise one that allowed only exact forms that had been presented ($t(22)=2.0739$, $p=0.04$) (Figure 2).

On post-test surveys, more users admitted to having read text on the display in the large screen condition (7 of 12) than in the small one (3 of 12), marginally significant by Fisher's Exact Test ($p=0.089$). Additionally, video tapes showed users spending longer periods, on average, viewing material on the large screen (M=19 seconds) than the small (M=14 seconds), though this difference was not significant.

CONCLUSION

In this paper, we have described the novel application of an implicit memory test to measure whether a participant has read information on a given display. We have also presented results showing that, even given constant visual angles and similar legibility, participants were more likely to read sensitive text on a large display than on a small one. This suggests that there exist other cues that make information displayed on wall-sized, wall-mounted displays more public. In future work, we will investigate individual factors that contribute to this effect, as well as explore user interface solutions for mitigating this loss of privacy.

ACKNOWLEDGEMENTS

We thank Shelly Farnham, Brian Meyers, Patrick Baudisch, and Greg Smith for their stimulating discussions.

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