Designing Trustworthy Situated Services: an Implicit and Explicit Assessment of Locative Images' Effect on Trust

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ABSTRACT

This paper examines a visual design element unique to situated, hot-spot style, services: locativeness. This is the extent to which the media representing a service relates to its immediate physical environment. This paper explores the effect of locativeness on trust with two studies assessing user attitudes in depth. The first is an implicit, or preconscious, test and the second an explicit test based on voiced value judgments. To provide a richer context, the second study contrasts locativeness with other traditional aspects of design: branding and quality. The results indicate users have a strong implicit association between locative images and trust, and that this is partially reflected in their explicit choices. This is an important interface aspect that designers should consider in order to create trustworthy situated services.

Author Keywords

Trust, situated services, phishing, empirical evaluation

ACM Classification Keywords

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

INTRODUCTION

The proliferation of mobile devices capable of wirelessly accessing services has raised significant issues of trust. The role of service design is particularly important since on the one hand users may be "phished" into unwillingly accessing malicious situated services, while on the other hand users may choose to distrust a genuine service. Our work is focused on designing trustworthy situated services and understanding the role of design in conveying trustworthiness in situated services. This paper examines a visual design element unique to situated services, locativeness, and its role in building trustworthy situated services. According to [6], locative images and media are "embedded within the service's content, and […] represent the location where the (source of the) service is situated".

RELATED WORK

Trust decisions are an everyday aspect of browsing the Internet. Users regularly encounter and assess the veracity

of new shopping, banking and networking sites. Exploring the mechanisms underlying these choices is an active research area. For example, Fogg et al. [2] suggest a number of guidelines to improve the credibility of websites such as information transparency, "ease of use" and "real-world feel". Steinbruck et al. [9] report that the addition of author or staff photographs to journalistic content and banking sites increases visitor's perceptions of trustworthiness.

Although the popularity and availability of situated wireless services is rising, there is little literature on designing for trustworthiness in such situations. Existing research has predominantly considered system security as a mechanism to increase users' trust. For example, Sharp et al. examined novel architectures for mobile commerce in peer-to-peer scenarios [8] and Kamar et al. discuss enhancing security by explicitly splitting procedures between a user's mobile device and a public system [5]. Research has recently begun to explore approaches orthogonal to security, considering how trust is conveyed through the design and visual presentation of services. Kindberg et al. [6] report that the use of locative images (meaning those depicting the environment immediately around a situated service) increased the willingness of users to divulge personal information to receive free WiFi access in a cafe.

Although an interesting observation derived from a laudably ecologically valid method, Kindberg et al.'s work was effectively a binary decision and the authors themselves acknowledge the uncontrolled nature of the participant group. The present study addresses these weaknesses and explores some factors that contribute to images increasing users' perception of trustworthiness of services. This was achieved through a multi-pronged online study investigating users' attitudes towards locativeness and its relationship to trustworthiness.

The study of trust in situated services is a methodologically challenging task. Lab studies inherently suffer from weak ecological validity and potential experimenter effects. Furthermore, determining a user's attitude – an internal, vaguely defined mental state – to a concept such as locativeness is qualitatively different problem to those of task performance and usability that typify the HCI literature. However, established methods in psychology offer a solution. These suggest the adoption (and post-hoc correlation) of multiple independent methods is a key mechanism to increase objective reliability [3]. An important distinction is made between implicit and explicit

assessment. The former refers to techniques that assess cognitions and biases not necessarily subject to conscious control. Explicit methods, in contrast, involve directly asking users to make value judgments. Uncovering a positive correlation between two such distinct approaches is seen to substantially increase the reliability of the results.

In line with this observation, the study reported here combined the Implicit Association Test (IAT) [4], which explores concept associations at a preconscious level, with a conjoint analysis [1], an in-depth explicit assessment technique widely employed in marketing.

METHOD
The study was fully online and consisted of a website which delivered three distinct experimental stages: demographics capture, implicit assessment tool, and explicit assessment tool. All data was stored on a server. Participants were recruited through our University's email lists and bulletin board and each used an Internet-enabled computer of his or her choice to complete the study. Study 1 was developed using Adobe Flex, while Study 2 was developed using Java. In both, participants used a keyboard to interact with our software and timings were recorded with millisecond accuracy. All materials were in Portuguese, the native language of the participants.

Demographics Capture
Participants first visited a welcome page introducing the study and its likely duration of 40 minutes. A questionnaire captured demographic data on gender, age, and occupation.

Study 1: Implicit Assessment
The IAT is an established tool for examining associations between two lexical concepts at a preconscious level. Typically, the first concept is embodied by polar opposites of an abstract unambiguous value judgment (e.g. *good/bad*). The second concept is more objective in nature (e.g. *flower/weapon*) and the experiment seeks to determine the mapping of the latter onto the spectrum of the former. The categories used in this study translate to *trustworthy/untrustworthy* and *local/foreign* (the more neutral Portuguese term "exterior" was actually used in the study). Terms such as such as locative vs. anti-locative were explicitly considered but discarded as it was felt these would confuse participants.

The test involves participants performing repeated binary categorizations of stimuli relating to one of the two concepts. A typical stimulus set contains 20-30 items and those that reference the abstract concept are represented by words while those concerning the concrete concept take the form of images. This study used 12 images and 12 words (illustrated in Figure 1) that were manually selected by the authors. The "foreign" stimuli were derived from an existing IAT image set and the "local" images selected to be a close conceptual match to those pictures.

The IAT employs seven blocks of trials, five of which are dedicated to practice or counter-balancing (as in [7]). The experimental interface for a trial in the remaining two

blocks is illustrated in Figure 2 and includes both conceptual categories spread along top left and right of the screen and the stimuli to be categorized in the center. In each trial, participants press a key indicating left or right to associate the stimuli with one of the concepts.

Both blocks feature two presentations of each experimental stimulus: 48 trials in total, delivered in a random order. The difference between the blocks is in their presentation of the conceptual categories: in the first, *local* and *trustworthy* are paired on one side and *foreign* and *untrustworthy* on the other (subsequently referred to as LT-FU). In the second this pairing is inverted: *local* with *untrustworthy* and *foreign* with *trustworthy* (referred to as LU-FT)

The assumption underlying the IAT is that the time it takes to perform a categorization reflects the level of preconscious association between the concepts grouped on each side of the screen: faster categorizations indicate stronger associations. In this way, a comparison of temporal performance between the two blocks reveals the presence, direction and magnitude of any link. The experimental hypothesis was that there would be faster task times, indicating a stronger association, in block LT-FU.

Figure 1. Stimuli used in the IAT study, shown in their respective categories.
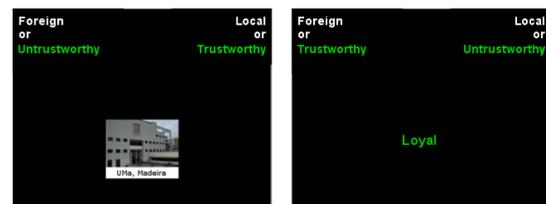
Figure 2. Two translated screen shots of the IAT study. The stimuli are in the center and the concepts at the top left and top right. Left: an image stimulus and LT-FU concept pairing. Right: a word stimulus and the LU-FT concept pairing.

Participants
Study 1 was completed by 29 students at our university, 23 male and 6 female, aged between 17 and 50.

Results

Data from three participants was not analyzed due to high error rates. The remainder were subjected to standard IAT procedures [e.g. 4]. Mean task completion times are shown in Table 1. An ANOVA revealed a more rapid trial time (corresponding to a significantly stronger association) in the LT-FU condition $(F(1,25)=8.79, p<0.005)$. A measure the size of this effect, d, was calculated as 0.822 (indicating a large influence [3]) and was found to be significantly different from zero $(F(1, 26)=18.27, p<0.0001)$.

	LT-FU	LU-FT
Task Completion Time	824.8 [157.5]	975.85 [206.6]

Table 1. Task times and standard deviations in IAT study.

Study 2: Explicit Assessment

Study 2 was a conjoint analysis [1] with a between subjects design. This is a multi-factor binary forced choice method in which participants make repeated selections of one stimulus over another. Three factors were used, each with two levels: locativeness (low/high), branding (strong/weak) and quality (high/low). Branding refers to the use of logos, while quality was controlled by adjusting image resolution rather than size. Eight experimental stimuli were created to represent all factor combinations (Figure 3). In the study all (non-identical) pairs of stimuli were shown to participants resulting in a total of 56 trials, which were presented randomly. It was predicted that locativeness would be the strongest factor affecting participants' decisions.

Participants

Study 2 featured 12 participants, 10 male and 2 female, aged between 17 and 50, all of whom had previously completed Study 1.

Procedure

Participants were presented with instructions providing a context for the study: that they were to be shown pairs of websites representing the welcome page of a free WiFi network at the University's cafeteria. Their task was to indicate, for each pair of websites shown to them, the website they would feel most comfortable giving their credit card details (Figure 4).

Results

The experimental measures were response (participant's choice of website) and time as measured from the moment the stimuli were displayed until the press of a valid key. A regression analysis using quality, branding and locativeness as dummy variables calculated the relative impact of each variable on participants' data. Across all participants, the relative impact of each factor on participant response was: quality 45.6%, locativeness 35%, and branding 19.4%. Within each factor there was a significant difference between levels, as shown in Figure 5 (all at $p<0.05$). Figure 6 shows a ternary plot of the relative weights for each participant for both experimental measures. Each corner represents a factor, each dot a participant. The distance from the dot locations to the corners indicates the relative weight of the three factors: a shorter distance corresponds to a stronger influence.

**Figure 3. The eight images used in Study 2.**
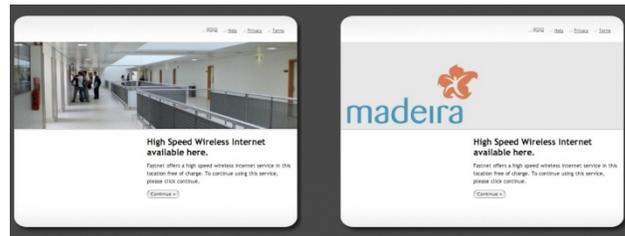
Figure 4. In Study 2, participants had to indicate which web page they would feel more comfortable giving their credit card details.
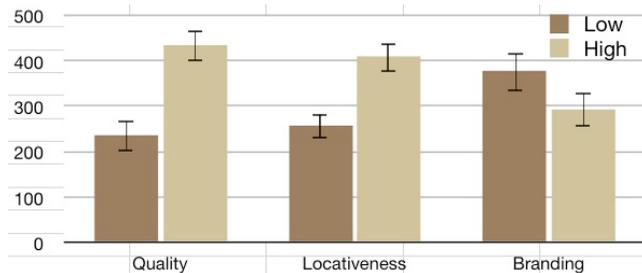

Figure 5. Participants' cumulative responses in Study 2 broken down by factor and level.
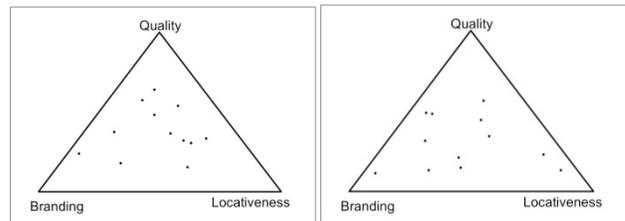

Figure 6. A ternary plot of the relative effect of the three variables on participants' choice of website (left) and response time (right).

Comparative analysis

We carried out post-hoc analysis comparing the results of both studies. Two of the participants who completed Study 2 were removed as outliers in Study 1. In the remaining pool of 10, there was a correlation between participants' measure of association between trust & locativeness (Study 1) and the weight of locativeness in participants' choice in Study 2 $(r(8)=0.64, p<0.05)$. Furthermore, an ANOVA revealed a significant effect of participants' highest impact

choice factor (encoded as categories "locative", "branding", "quality") (i.e. profile) and participants' association between trust & locativeness in study 1 $(F_{(2,9)}=17.63, p<0.05)$, while a regression showed that this association is best predicted by locativeness (96%) followed by quality (4%) and branding (0%).

DISCUSSION

Study 1 shows participants have a strong preconscious association between the concepts of locativeness and trust, confirming the experimental hypothesis. Study 2 used conjoint analysis, a powerful exploratory method that examines a range of factors and returns the relative importance of each in users' decision processes. Contrasting the impact of locativeness against that of quality and branding revealed that quality played the dominant role; the main experimental hypothesis in study 2 was rejected.

In terms of design implications, this paper suggests that i) designers must cater to the various trust assessment strategies that users follow, and ii) locativeness is an important design feature. Users' strategies can be seen in Figure 6, where participants are profiled in terms of their performance. A few participants are clearly brand-oriented, while most appear to be influenced by quality and then locativeness. For some participants, however, locativeness is the strongest influence. This observation was borne out by a significant post-hoc correlation between the magnitude of the implicit association captured in Study 1 and the relative importance of locativeness as captured in Study 2. This provides solid evidence that the two studies observed complementary aspects of the same phenomenon. Interestingly, an ANOVA showed a significant effect of participants' profiles (Study 2) on their performance in Study 1, while a regression indicated that this effect is strongest for locativeness. This result is unlikely to be due to priming effects as the IAT (which is typically administered in conjunction with explicit measures of attitude) has been shown to be relatively immune to such inter-measure transfer [4].

Study 2 also recorded strong within factor effects. High locativeness and quality exceed their low counterparts, but the opposite was found to be true for branding: photographic representations were trusted more than logos, an interesting design implication. These results highlight the importance of traditional values of quality but also that "real-world feel" [2] is essential to building trustworthy situated services. This paper also confirms a strong association between locativeness and trust and that some users explicitly make choices based on this factor; it is an important design element. However, the spread of results in Study 2 suggests that in order to build successful situated services, designers are likely to have to cater to a range of user trust assessment strategies.

Finally, this paper highlights the need for the development and adaptation of appropriate experimental methods for studying trust in situated services. While previous work has strived for strong ecological validity [6] here we show how carefully adapted methods from the social sciences can provide deeper insights. Our combined study contrasted implicit and explicit user attitudes to create a balanced perspective. We also note that implicit attitudes are acknowledged to be relatively resistant to the weak ecological validity inherent in a lab based study. While the IAT and conjoint analysis are not widely adopted within the HCI community, their combination of implicit and explicit assessment offers a valuable balance of control and validity. They are promising techniques for the HCI community as it incorporates increasingly subjective concerns into its mandate and sphere of interest.

CONCLUSION AND FUTURE WORK

As part of our ongoing work we are exploring further experimental methods that we can use in order to effectively uncover trust issues in situated services. In addition, we are interested in developing mechanisms that help service providers build more trustworthy services, yet detain malicious agents from taking advantage of these mechanisms in order to trick and "phish" end users.

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