Effects to be taken into account in the design and evaluation of (semi-)public displays

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ABSTRACT

Psychological effects can influence the active as well as the passive usage behavior of users of (semi-)public displays, and thus can lead to inaccurate results in evaluations. In this paper, we aim to gather the current knowledge about known and relevant effects in the deployment and operation of (semi-)public screens, so that they can be taken into account when designing or evaluating (semi-)public display applications. Additionally, we collect possible approaches to deal with these effects. The objective of this paper is to support the HCI community in understanding and planning the impact of the enumerated effects in future work.

KEYWORDS

Evaluation, Design, Public displays, Novelty effect, Spotlight effect, Display blindness, Interaction blindness, Display avoidance, Honeypot effect, Hawthorne effect

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1 Introduction

Due to the far-reaching deployment of large displays, such displays have received much attention in HCI recently. Research, which focuses on the usage behavior of passers-by, faces the challenge of environmental influences and social bias, which can change conscious or unconscious behavior [1]–[4]. While such effects often do not occur in laboratory tests or in short-term studies, they definitively have to be considered in the design of the long-term evaluation.

Many phenomena have been observed in psychological studies since the 19th century and the list of unexpected behavioral observations grows steadily [5],[6]. It is surprising, that these effects are often neglected in studies, which can lead to incorrect findings. So, for the research of large screens in (semi-)public spaces, it is strongly recommended to design evaluations in a way that such effects can be prevented, minimized or actively controlled.

In addition to considering them in designing evaluations, the knowledge of these effects can also offer a handle in designing successful (semi-)public display applications. One example for this is the honeypot effect that can be actively used to motivate potential users to engage with displays.

The following chapters will introduce known and relevant effects in the design and evaluation of (semi-)public display applications. On this basis, suggestions, and possibilities of how to cope with these effects or how to use the knowledge of the effects to design applications are shown. After presenting the effects, we try to propose a way to structure them. The work is concluded with a short summary and an outlook.

2 Effects in (semi-)public display usage

For gathering an overview of the current state of knowledge on effects in (semi-)public display usage we did literature research. In order to limit the broad spectrum in the context of public display engagement to relevant work, different digital libraries were searched for publications that match the terms display effect, display phenomena, effect evaluation and the keywords of the paper.

The terminology 'effect' and 'phenomena' were used to describe perceivable impact in order to understand specific usage behavior of (potential) display users or conscious as well as unconscious behavioral changes of study participants in an evaluation. The observations of effects are usually reproducible under the same study conditions. In the following, we will list the effects we found in the literature – and briefly describe what is known about them in the context of large screen projects.

2.1 Honeypot effect

The term 'honeypot effect' has been defined by Brignull and Rogers [7] and refers to a situation in which a single user or multiple users interacting with a display may motivate the passive

audience to attend. This phenomenon has been observed and studied in plenty of previous works [8]–[11].
Researchers justify this effect on the one hand with the social atmosphere created around the public display installation and on the other with the users' expression that they are open for social interaction [12]. Different study set-ups may increase or decrease this effect. Flat formed displays, for example, produce a greater effect than hexagonal or concave shaped ones, because people can better track user actions [12]. Also in display usage, results indicate that mid-air gestures seem to cause a stronger honeypot effect than touch [11].

The set-up has to consider, in which extent the different zones around a display [13] affect the behavior of the audience e.g. if users standing in front of the screen are blocking the other´s view on it. Also, the number of people simultaneously interacting in front of displays may influence the motivation of observers.

In a field study, Wouters et al. [14] analyzed the influence of various concurrent participants in a public installation and identified the rolling average value as the 'honeypot sweet spot' and explains that the potential reach of display installation is usually not achieved. In addition to those insights, a honeypot model based on observations and interaction logs has been presented. The model consists of six user roles, trajectories, influences and shows which triggers affect the audience when interacting with displays. Depending on the evaluation question, this effect can be strengthened or weakened. If, for example, a greater use of a public display is to be achieved, it would be desirable to intensify and plan this effect in the study design. The behavior could be caused intentionally by periodically placing one or more users in front of the display and let them interact with them during the study period in order to provoke this situation. Contrary, the potential display usage will not be achieved without the honeypot effect as the attention of passers-by will not be drawn to the display(s).

2.2 Novelty effect

Detection of high utilization of large interactive screens in certain examination periods can often be attributed to the 'novelty effect' - especially when deploying a new system or when changing existing systems [15].

New systems or system modifications can arouse the curiosity of people and motivate passers-by to interact with displays without even being necessarily interested in their content or functionality. In order to clarify statements regarding usage, it is important to consider if the measured display usage is attributable to this effect [16].

Although the effect is typically perceptible after the deployment of new systems, the novelty effect needs to be considered throughout its operational lifespan. Especially in long-term deployment studies, novelty is repeatedly caused by changing a system's state, e.g., adding new features, drawing attention to the installation, or simply updating its content. Existing research recommends conducting deployments for a sufficient period of time in order to ensure that results are not tainted by the novelty effect [15]. The question of how long the initial novelty effect lasts is difficult to answer since the examination of the factors influencing the novelty effect is limited in current research. While Prochaska and DiClemente proposed in an early work that the effect can take up to six months to mitigate the novelty effect [17], Hazlewood et al. reported that the timeframe adequate for most people to notice the display was four weeks, i.e., the novelty effect diminished during that time [18].

Koch et al. found that the novelty effect took ten weeks to subside in an ambient surface project. However, the work also concludes that the duration of novelty-based behavioral change depends on two categories of dimensions combined (1) factors related to the user, usage, and value to the user and (2) factors related to novelty-inducing changes, including, e.g., changes to the setup, functionality, and the displays' contents in particular. For example, a notable distinction is, if display usage is mandatory for its users e.g. when used in business operations, or if it can be used voluntarily [15].

Recent work [19] shows how this effect can be handled methodologically on the example of the evaluation of an ambient display through the application of practical systematization of the grounded theory [20] and its two core concepts: constant comparison and theoretical sampling. Again, it is necessary to examine which study goal to achieve and how the novelty effect might affect it. Since an interesting question in this research environment is, how greater displays usage in (semi-)public spaces can be obtained, it should be investigated which changes arouse interest among the passers-by, so that the interest and thus the usage remains constant.

2.3 Spotlight effect

Shaped by prior work from Gilovich et al. [21] the situation in which humans see themselves more in focus of attention than they actually are, is referred to as the 'spotlight effect'.

In fact, this effect could be observed in a couple of works. For example, studies have shown that individuals of minority groups felt they were the center of others' attention when topics related to their group membership were handled, even when they were not [22]. Another finding is that those who have felt watched, combine negative feelings with this experience [22]. By manipulating the study setup, this phenomenon can be intentionally induced, prevented or reduced [23].

Due to the apparent negative impact of the spotlight effect the study design could reflect on how passers-by feel more comfortable while interacting with the display(s), such as adapting a more appropriate positioning, which gives the display user less feeling of observation.

2.4 Display blindness

The phenomenon was first documented by Huang [24] and describes the situation in which passers-by do not perceive

display installations in their environment. Termed as 'display blindness' [25] this effect could be reproduced in several studies [26]–[29]. Results of other work, however, indicate that the level of impact of the display blindness effect can vary and further usage after the initial deployment of public displays can be recorded, albeit a lesser one [19]. Researchers also claim that the effect does not always occur since at least a quick look at the displays is thrown, which was the result of the measurement through the use of mobile eye-tracker [10].

The reasons for the occurrence of display blindness is not empirically proven yet. One common assumption is that users classify the content as uninteresting [25]. Many further factors such as the positioning of the display [24], the shown content [24] or the study setting itself [30] can influence the attraction of situated public displays.

Many efforts have been made to overcome the effect. For example by interactivity that aims to motivate people to use public displays [31], sound support [32], physical tangible objects [33] or emotional attachments through personal and memorable content [34].

Moreover, it is important to distinguish different types of public displays, as some types are more overlooked than others. Large banner displays seem to attract the most attention of the audience, even if passers-by were distracted regardless of the displays´ content [35].

2.5 Interaction blindness

If the audience perceives public displays but does not notice its interactivity, the situation is referred to as 'interaction blindness' [30]. Many considerations to overcome this issue were made. A study of touch-driven interaction with displays concludes that text, color, and static content are more effective than icons, greyscale or animations to attract to interact [36]. Further promising approaches to consider in the study design are to introduce curiosity objects [37], acoustic paths [32] or displaying users' silhouettes [29] to convey interactivity with the displays. The latter method should take into account that passers-by need a short time to realize the user representation [29], [38].

Findings in a work researching suitable interfaces for touchless interactions emphasize that choices may depend on the content the users are interacting with and that hybrid solutions can address both users' preferences and reduce interaction blindness issues. Nonetheless, the authors also refer that in terms of reducing the interaction blindness effect, avatar-based interfaces seems suited [39].

Another work comparing methods for gesture-based public displays concluded that animation-based method attracted more users than video-based methods, although users might better understand through video how the operation with the display works. The authors highlight that two phases must be considered to overcome interaction blindness: raising the awareness of interactivity of situated displays and to educate users on how to perform the correct interaction [40].

In a field study, Ghare et al. [41] found out that random triggers were more effective than proximal triggers. The presented proxemic interface consisted of three distance zones, which responded to users who came closer to the display. In zone 3, items on the shelf have moved back and forth. In zone 2, the booked opened up and showed their content. In the closest zone 1, the users were encouraged to touch the display. The researchers have also conducted a study with 35 participants to understand which elements made users think, the display was interactive. Most frequent answers were 'button-like objects' (51%) and 'moving objects' (43%).

2.6 Display avoidance

Kukka et al. [36] observed how passers-by noticed situated displays but then "turned their head in the other direction, and then turn back once they had passed the display" and named this behavior 'display avoidance'. According to interviews, this behavior might be attributed to information overload. So far, there are surprisingly limited findings in the HCI literature on this topic leaving much space for further research. Whether if display blindness, interaction blindness or display avoidance, in order to investigate display engagement, the urgency to draw the attention of passers-by on the (semi-)public displays is given. Similar actions from the blindness effects, such as study setting and eye-catching content could be promising.

2.7 Landing effect

The phenomenon, known as 'landing effect', describes the situation in which passers-by need a specific time to understand the interactivity of a display. Usually, interested passers-by return after passing the display to discover its content and functionality [29]. This behavior often occurs in studies dealing with interactive (semi-)public displays of limited sizes. By the time passers-by perceive the possibility of interaction, they have already passed the display [10], [38]. To decrease this effect, it is recommended to install multiple displays in a row so that users have time to understand its interactivity [29] or to install a very large display [42]. Another recommendation is to place the display in a way so that users walk directly towards them. Müller et al. also found that for conveying interactivity, a real-time video image (mirror) or the users´ silhouette are more effective than an avatar-like or more abstract representation [29].

2.8 Hawthorne effect

The 'Hawthorne effect' dates back to studies in the 1930s, studying the increase of work productivity of factory workers through different lighting conditions. Psychologists have found in their test results that participants increased their performance even without changing the lighting conditions but solely because of their awareness of participating in the study [43]. Therefore, this behavior has particular relevance for evaluations in general - regardless of the research goal. Indeed, the phenomenon seems very similar to the spotlight effect, where users see themselves at

the center of attention. A possible distinction could be, whether users actually are participants in a study or merely suspect that they might participate. For example, if the phenomenon is observable after study participants have previously been informed about participating in it, the observation should be attributed to the Hawthorne effect. Otherwise, if users are part of the study, but have not been informed about it, it will be difficult to justify a behavioral change to the right phenomenon. In order to avoid the change of users' behavior, observations can be made out of sight of the user. Memarovic et al. have been investigating from a "hideout" [44] for passers-by behaving naturally.

3 Structuring the effects

One possibility to structure the effects listed in the previous section is by distinguishing effects that have to do with social interaction (among users) and expectations of users (e.g. the honeypot effect) – and those that have to do with the perception of the display (e.g. the different blindness effects). The first class of effects might be addressed with expectation management and is relevant for interaction design, the second class of effects is relevant for designing the displays themselves.

Another possibility to structure the effects is by the phase of the field study execution and analysis in which they play a role. Display- and interaction blindness and display avoidance, for example, justify the non-usage of the displays by potential users and are thus of particular interest at the beginning of the observations. The landing-, spotlight- and honeypot effect are also relevant in the early stages of data collection but differ in terms of usage, as these effects do not preclude interaction with the display. Although the novelty effect can also be perceived in early stages, it usually manifests itself in the late data analysis, if (further) strong usage of a new or changed system can be recorded. These effects usually only occur under natural conditions. The Hawthorne effect, however, mainly occurs when users know they are part of a study. The behavioral change is therefore not apparent in the evaluation and makes it difficult to attribute to the effect. So, the Hawthorne effect does not seem to have dependencies on the research object itself. This shows that in addition to a temporal classification, its motivation would be useful. For example, effects might be classified into effects, that occur due to social interaction (e.g. spotlight-, honeypot effect), social expectation (e.g. Hawthorne effect) or based on the perception of the artifact (e.g. display-/interaction blindness, display avoidance, novelty-/ landing effect). In the research design, this classification should help to estimate when or whether certain effects are to be expected. By this means, the effects can be timely planned in. Furthermore, knowledge about drivers for effects is important in order to take appropriate action.

4 Summary and Outlook

For many years, researchers have been addressing the questions of how, when and why behavior occurs in given situations, and how this can be considered in future research. The current state of research indicates that there is substantial progress in research to answer these questions. Nevertheless, the enormous complexity of human behavior in combination with many other (environmental) factors and the interplay of the different effects makes it difficult to find a holistic approach to cope with the listed effects.

The design suggestions listed with the effects describe possibilities to deal with the different effects, bearing in mind that other research goals require different study design.

By highlighting existing knowledge of phenomena in the domain of public displays, we hope that our contribution (i) increases the researchers' awareness of existing behavioral effects (ii) supports the understanding about the possible influences on research (iii) raises the consideration of the introduced effects in study design and evaluation.

Future work in the field should try to create a common understanding of the different effects. For example, the HCI literature seems to have different understandings of the display blindness effect. Is it still display blindness when a very short glance is thrown at a display? Can this scenario also be assigned to the display avoidance effect? Therefore, it seems that the distinction of effects is not always clear. Also, to give another example, the spotlight effect, seems to be closely related to the 'watching eyes' phenomenon [45]. It is necessary to examine if and to what extent these effects differ.

Moreover, the summary of relevant effects should be supplemented with new knowledge about other psychological effects, as some effects have not been described or adequately explored in relation to public displays such as change- or inattentional blindness yet.

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