Towards Understanding the Cognitive Effects of Interactivity

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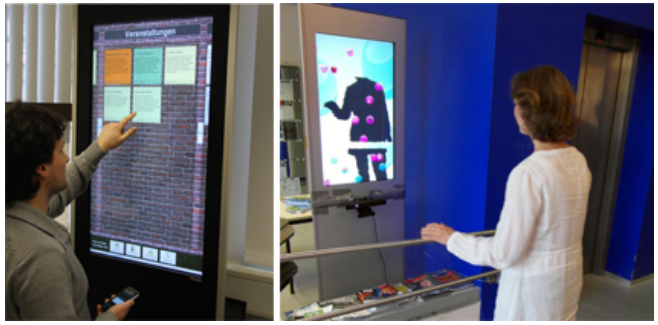

Figure 1: Examples of interactive applications in public spaces with direct touch based (left) and indirect gesture based (right) interaction. For more examples see [2].

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Abstract
Cheap and easy-to-deploy consumer hardware, such as the Microsoft Kinect, touch screens, and smartphones drive an increasing proliferation of public space with interactive applications. Such applications include artistic, playful, and informative content on public displays. Though such applications are in general positively perceived by users, their benefit is in many cases not clear. In this paper we argue that while most current (advertising) content on public displays aims at stimulating user action (e.g., making a purchase), interactive applications are also suitable to support cognition. In our work, we focus on awareness as one particular form of cognition and assess it by measuring recall and recognition. This is not only interesting for advertising but for any type of applications that requires the user to remember information. We contribute a design space and map out directions for future research.

Introduction
Public displays have become an essential part of the urban landscape. They are widely deployed by large outdoor advertisers as well as increasingly by smaller retailers, restaurants, bars, and public institutions. The main use cases for setting up public displays are advertisement (e.g., in airports, railway stations, and high streets), signage solutions (e.g., in public buildings), and attractiveness of locations (e.g., screens in bars and cafes).

Undoubtedly, there is nowadays a tiredness among passersby of public displays that show pure, static advertising content. This led to what has previously been termed the *display blindness* [12]. Providers of public displays have recognized this problem and increasingly try to create more suitable content consisting of small chunks of information that are displayed in a time-multiplexed way. For example, displays in subway stations show news content, followed by the weather forecast, and short cartoons. Occasionally there is interlacing with (contextual) advertisements. Though this makes public displays more attractive to passersby, it still does not exploit the full capabilities of interactive displays that actively engage the user [1]. Devices such as the Kinect or touch-enabled displays allow interactive applications to be deployed (see Figure 1). In previous research, it is shown that interactivity has the potential to increases the user experience [8]. Examples exists today, where display owners are experimenting with such applications, but the majority of outdoor display owners are still reluctant to deploy interactive displays.

In this paper we present an early design space for interaction with public displays. We outline the necessary dimensions and discuss their possible values.

Background and Related Work

In this work we are interested in how the effectiveness of public displays for communicating information and creating awareness can be increased. Prior work on interactive television [9] and on web pages [14] indicates that interactivity of content may have a positive impact on cognition. However, these results are specific for these media types and cannot easily be applied to public displays. Nevertheless they inspired us to investigate the impact of interactivity on recall and recognition on public displays.

Researchers have investigated different aspects that influence cognition, including personalization and participation [5], comprehension [17, 18], and feedback [7]. Bezjian-Avery et al. investigated the effect of the presentation and nature of the message as well as the user's personality characteristics [4]. From these publications it can be deducted that interactivity engages the users and hence has a potentially positive effect on cognition.

Further research looked into this effect. Risden et al. showed that interactive Web games are more likely to increase brand awareness compared to a TV ad [15]. Cho et al. [6] found that interactivity has a positive impact on attitudes whereas no influence on user satisfaction can be attributed [16]. Bezjian-Avery et al. [4] showed, that interactive ads in many cases do not outperform traditional ads. These findings partially contradict our expectations and motivated us to investigate this in more detail.

In order to understand cognitive effects (particularly awareness) it is important to know how to measure them. We draw upon the S-O-R paradigm [3], which today forms the basis of many models [10]. In contrast to the classic Stimulus-Response paradigm that considers cognitive processes as a 'Black Box', the neo-behavioral S-O-R paradigm considers hypothetic constructs, including involvement, emotions, motives, attitude, values, and lifestyle as intervening variables that affect cognition.

Design Space

This paper focuses on interactive public display applications, that enable playful interaction with objects on the screen. We expect such applications to be suitable for displays deployed in public spaces.We believe that interactivity makes public display applications more interesting and creates a benefit for both, display providers and users.

	Dimension	Values
User Occupation	Weak occupation	In these situations, people are open to perceive the content of displays, are relaxed, and are more likely to be taken in. Examples include waiting situations occurring at bus / train stations, next to the coffee maker, or the copy machine.
	Strong occupation	In many situations where people encounter public displays, they are in a hurry and are on a schedule. Generally, this leads to shorter interaction times and content usually needs to be specifically designed for such situations.
Interactivity of Content	Non-interactive Content Only	Non-interactive content does not enable interaction but constitutes a static, constantly visible part of the application.
	Mixed Content	Particularly for complex scenes, applications may consist to varying degrees of interactive and non-interactive objects.
	Interactive Content Only	In applications with only interactive content, users can interact with any object shown in the application.
Interaction Type	Direct Interaction	Direct interaction describes techniques where users directly control the object they are interacting with (e.g., touchscreen).
	Indirect Interaction	Indirect interaction refers to techniques that involve sensors and processing to translate the user's motion into a representation on the screen (e.g., Kinect, mobile phone).
Integrating the Message	Message only	In the simplest case, users are only interacting with the message, e.g., the latest Nike basketball.
	Message & Content (Separated)	A scene can contain further content apart from the message, e.g., static background and Nike basketball.
	Message & Content (Integrated)	Message and content can be interweaved making the distinction not obvious to the user, e.g., a brand logo on the interactive object.
Expressiveness	Low Expressiveness	People only interact with their hands and do not make any expressive movements (e.g., touch).
	High Expressiveness	People make whole body gestures and move in front of the displays as they interact (e.g., gestures)
Knowledge	Prior Knowledge	The message shown on the display is not new to the user (e.g., an ad they have seen before).
	No Prior Knowledge	The user does not know the message (brand or product) a priori.

Table 1: Design space for interactive public display apps.

To understand the design space for interactive public display applications, three researchers and one student reviewed prior work on interactive public display applications (papers, videos, project websites). Based on the material, a set of dimensions was extracted that potentially affects recall and recognition. We discuss each of the dimensions and identify relevant values (Table 1). Note, that the values for each dimensions are in most cases not discrete but should rather be considered as a continuum.

User Situation
Public displays are deployed in various locations. This leads to people encountering them in very different situations, e.g., while waiting, while passing by, while eating, or during shopping. In weak occupation situations, people usually have more time to engage as compared to strong occupation situations such as while en route to work.

We discussed whether it would be sufficient to simply consider the time users are interacting with the display. However, we feel that further aspects, such as stress or current cognitive load, may have an influence. Hence, we suggest a continuum between weak and strong occupation situations.

Interactivity of Content
We found that scenes on public display often contain many different objects, of which some are interactive and others are static and non-interactive. We expect a difference in recall and recognition, depending on whether an object can be manipulated or not. Hence, the following cases are distinguished: (1) the screen contains only non-interactive content (this is the case for all current, non-interactive public displays), (2) the screen contains (to varying degrees) interactive and non-interactive content (e.g., interactive foreground, static background), or (3) all objects on the screen are interactive.

Interaction Type
The technology deployed usually determines the type of interaction. Whereas touch-enabled screens enable direct interaction (i.e., dragging/dropping an object), gesture-based techniques are indirect and require a mapping of the user interaction to the feedback on the screen. Thus, the expressiveness of the interaction can be controlled, e.g., by implementing a transfer function that requires the user to move more or less in front of the screen.

Integrating Content and Message
According to Alt et al. [1] we identify three ways a message can be placed within an application. Messages could be shown exclusively (i.e., with no other content on the screen), with other content on the same screen but separated, or they could be integrated with other content.

We believe that additional content could indeed influence memorability. Prior work shows that people remember content around interesting magazine articles less than content around less interesting articles [13].

Expressiveness of Interaction
Nowadays, various interaction techniques exist that have a potential influence on recall and recognition. Such techniques include touch, gestures, presence, etc. A comprehensive overview can be found in Müller et al. [11]. These different interaction techniques require different levels of expressiveness – for example, applications that use the presence of the passerby require less expressive movements than a game that uses whole body movements. Hence, we distinguish low and high expressiveness.

Prior Knowledge of the Message
We believe that the user's knowledge about a message could have a strong influence on recall and recognition. For example, if a user knows the brand advertised, this might positively affect whether or not they can remember the message on the display. An application that can identify the user in front of the display could exploit this and adapt the presentation. Hence, we distinguish between prior knowledge and no prior knowledge of the message.

Discussion and Conclusion
In this paper, we propose a design space and describe important dimensions that need to be taken into account when developing interactive public display applications

that aim at having a cognitive effect on the user. We see the design space as a basis for future research that looks at cognitive effects of interactivity in more detail. As an ultimate goal of our research we envision concrete guidelines for (1) display providers in order to understand how to ideally place public displays, and (2) for content designers, in order to understand how to best integrate the message they want passersby to remember.

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