How People Change Their Social Behaviors around Different Public Displays?

Junko Ichino

Kagawa University, 2217-20 Hayashicho, Takamatsu, Kagawa 761-0396, Japan

Keywords: Public display, Display angle, Museum, Field study, Social behavior

ABSTRACT

In this paper, we investigate through a field study how the angles (horizontal, tilted, and vertical angles) of displays deployed in a public space (at a museum) impact the social behaviors of the people around the display. In the field study, we collected both quantitative and qualitative data of more than 700 museum visitors over a period of approximately three months. Findings of our study include the following: (1) the horizontal and vertical display angles have a higher honeypot effect, i.e., people interacting with a display attract other people, than the tilted display angle, (2) the vertical display angle, compared to the horizontal and tilted display angles, attracts several people to the display and encourages them to stay in the display space and share the space for a short period of time (88 seconds on average), and as a result, people frequently enter and leave the space with a display, and (3) display angles closer to the horizontal promotes the side-by-side arrangement, and display angles closer to the vertical promotes the L-shaped arrangement of F-formation. The findings in our study help design a public display deployed in museums and other public spaces[1].

1. INTRODUCTION

Displays deployed in public spaces such as museums, train stations, airports and shopping malls have not only increased in number at an accelerated pace, but have also become significantly diversified in their styles. When designing a public display, it is necessary to understand the cognitive and social affordances of the display, i.e., to understand how people around a display may interpret content on the display, behave in front of the display, and change their behavior when other people are around.

In this paper, we investigate the impact of the angle—vertical, horizontal, or tilted—of a display on the social behaviors of the people around the display in the context of a museum. In order to compare these three display angles, we conducted a field study using displays commonly used for interactive exhibits held at a museum. These displays were deployed at a special exhibit and set up with each of the three angles for a period of two to three weeks. We analyze the quantitative data (RFID access logs, videos from depth camera, and answers to questionnaires) and qualitative data (data obtained through observing the visitors to the museum) collected from a total of more than 700 visitors to the special exhibit between the ages of 10 and 70, and examine how the three display angles impact visitors' attention, sharing of space, and communication.

2. FIELD STUDY

The goals of the field study are (1) to quantitatively and qualitatively compare how museum visitors behave to three different display angles (horizontal, tilted, and vertical) in-the-wild and (2) to understand, in particular, the impact of the display angles on three primary factors of our analysis, i.e., attention, sharing of space, and communication. We conducted the field study in cooperation with "A Masterpiece of Ancient Greece: a world of Men, Gods, and Heroes", the 10th exhibition of the Louvre – DNP Museum Lab [2], a joint project between the Paris Louvre Museum and Dai Nippon Printing. The 10th exhibition was held for approximately seven months in 2013. We used three months of the seven month duration to conduct the field study [1].

2.1 Deployment

The field study was conducted using one of the interactive exhibits at the 10th exhibition. The 10th exhibition was comprised of three spaces, i.e., an exhibition room, a theater, and a participation space. The participation space consists of four interactive exhibits (Fig. 1). Visitors enter into the participation space from the entrance (A), pass the first interactive exhibit (B), move to the space with the remaining three interactive exhibits (C, D, and E), and exit the participation space from the exit (F).

We used the display of one of the four interactive exhibits, "Recognising Greek Gods and Heroes (hereinafter referred to as Gods and Heroes)" (Fig. 1, C), in the field study. We set up the display with one of the three angles of our interest and maintained the angle for a period of two to three weeks before changing to another angle. The exhibit Gods and Heroes used two displays placed side by side on a table (Fig. 2). Both displays are a 40 inch liquid crystal display with built-in single-touch panel functionality (SAMSUNG 400TS-3). The displays had a resolution of 1920 x 1080.

In order to monitor the behavior of visitors, we installed two antennas for active RFID tags (Matrix

[1] This paper is a summary of the paper [1].

Fig. 1 Overview of the participation space

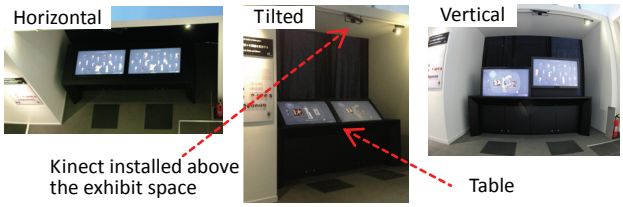

Fig. 2 Displays with 0°, 45°, 90° angles

Fig. 3 Examples of a content screen

Powertag) and two cameras (Microsoft Kinect) around the exhibit Gods and Heroes. An RFID tag antenna was placed in front of each of the two displays (Fig. 1). Each visitor received a card with a RFID tag attached at the entrance (Fig. 1, A) and wore the card hanging from their neck while in the participation space. Of the two cameras, one was placed on the ceiling above the two displays to monitor the behavior of visitors approaching, passing and leaving the displays, and the other was placed on the wall in front of the two displays to monitor the behavior of the visitors who stood before the displays (Fig. 1, 2).

2.2 Displayed Content

We used the contents used in the exhibit Gods and Heroes in the field study. The contents explain features of gods and heroes in ancient Greece and how to recognize them (Fig. 3). When a user touches an image of artwork on a detailed content page, a magnifying glass appears, allowing a user to view details of the artwork image.

2.3 Conditions

We examined one variable: the display angle (Horizontal (0°) vs. Tilted (45°) vs. Vertical (90°)).

2.4 Data Collection and Analysis

We collected both quantitative and qualitative data and analyzed the social behavior of the people around public displays (i.e., in front of the displays and near the displays) with respect to the three aspects (attention, sharing of space, communication). As for the quantitative data, we collected RFID access logs, depth videos, and answers to the questionnaires distributed to the visitors. The data for our analysis consisted of a total of RFID access logs of 122 hours and 730 visitors, depth videos of 102 hours and 714 visitors, and answers to the questionnaires from 472 visitors. As for the qualitative data, we observed the visitors and collected data for approximately 9 hours through direct observation and for approximately 15 hours through indirect observation.

RFID Access Logs

We collected the following RFID access log data: date, time, visitor ID, RFID tag in, and RFID tag out. When a visitor wearing an active RFID tag either enters or exits the RFID detection area of approximately 750 mm radius with the center of the detection area located on the floor in front of the displays (Fig. 1), the active RFID tag transmits a signal to the receiver. The receiver then transmits the tag information on a real time basis to the data storage PC. The PC stores RFID tag in and out logs along with the visitor ID.

Depth Videos

We collected the following data from the depth videos (i.e., videos obtained through depth cameras): transitions of a visitor between three types of activity spaces [4] for each and every visitor as well as social communication among two individuals for each and every two individual pairs.

Activity space is a concept introduced by Brignull et al. [4]. They identified three distinct types of activity spaces based on the activities that take place around the display; peripheral awareness activities, focal awareness activities, and direct interaction activities. We classified the state of the individuals who passed by the exhibit Gods and Heroes into three types of activity spaces.

When there are multiple individuals in front of the display, their social communication is defined by a set of the following communication indicators; the type of F-formation arrangement (i.e., vis-a-vis, L-shaped, or side-by-side) [3], the presence (or absence) of physical contact, and the presence (or absence) of visual contact (i.e., eye contact).

3. RESULTS

3.1 Statistical Results from the Depth Video Analysis: Honeypot effect [4]

The analysis of the depth videos showed that, when there were already existing visitors, 46.5% (Horizontal), 37.1% (Tilted) and 54.1% (Vertical) of all new visitors entered focal awareness activity space (Fig. 4, third left). A chi-square test showed that the display angle had a significant effect on the frequency ($\chi^2(2)=17.741$, $p=0.00014$). Ryan's multiple comparison test showed that the ratio was significantly higher for Vertical and

Horizontal than for Tilted. When there were existing visitors, the ratio of new visitors showed a similar distribution among different display angle conditions before and after their entering focal awareness activity space. Here, the ratio of new visitors who entered peripheral awareness activity space (Fig. 4, second left), and the ratio of new visitors who entered direct interaction activity space (Fig. 4, rightmost).

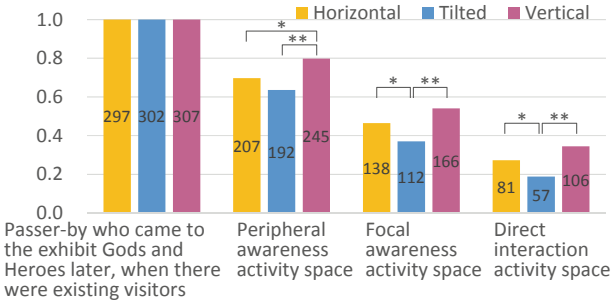

Fig. 4 Behaviors of new visitors with existing visitors

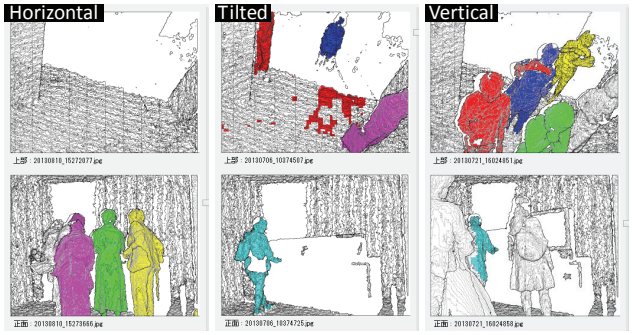

Fig. 5 Honeypot effect attracting new visitors to the display

3.2 Statistical Results from the RFID Access Log Analysis: Sharing of Space

The analysis of the RFID access logs showed that, out of the time when there were one or more visitors in the RFID tag space (i.e., when one or more visitors were logged as RFID tag in), two or more visitors co-existed in the RFID tag space for 19.5% (Horizontal), 19.8% (Tilted) and 23.7% (Vertical) of the time (Fig. 6, left). This time interval of two or more visitors sharing the space around the display is referred to as the space sharing time interval. A chi-square test showed that the display angle had a significant effect on the ratio of the space sharing time interval ($\chi^2(2)=320.041$, $p=2.2E-16$). Ryan's multiple comparison test showed that the ratio was significantly higher for Vertical than for Horizontal and Tilted.

After completing the analysis described in the above paragraph, we then calculated the average space sharing time interval of two visitors who entered the RFID tag space successively and shared the space for a certain time period. It was 127 (Horizontal), 103 (Tilted) and 88 (Vertical) seconds (Fig. 6, right). A one-way ANOVA revealed no significant main effect of the display angle ($F(3,227)=0.819$, $p=0.484$). Although there was no significant difference between display angles, the space sharing time interval of exactly two visitors is longer for Horizontal, Tilted, and Vertical in this order, on the contrary to the results of the ratio described in the above paragraph.

The analyses described in the above two paragraphs collectively reveal the following. Although the ratio of the space sharing time interval of two or more visitors was significantly higher for Vertical than for Horizontal and Tilted, there was no significant difference in the average space sharing time interval of exactly two visitors between different display angles. Note that, although there was no significant difference, the average space sharing time interval of exactly two visitors was shorter for Vertical than for Horizontal and Tilted. In other words, in the Vertical condition, visitors share the space more frequently but for a shorter period of time in each sharing of the space.

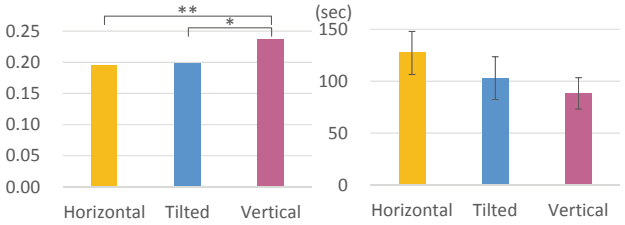

Fig. 6 Left: the ratio of the space sharing time interval of two or more visitors. Right: the average space sharing time interval of two successive visitors, with standard error bars.

3.3 Statistical Results from the Depth Video Analysis: F-formation

We analyzed spatial and orientational behavior of two individuals. With respect to the F-formation that two individuals formed with each display angle, we observed both L-shaped and side-by-side arrangements. We did not, however, observe any instances of the vis-a-vis arrangement. The analysis showed that 14.3% (Horizontal), 55.3% (Tilted) and 82.3% (Vertical) of the two individual pairs we observed formed the L-shaped arrangement (Fig. 7, left). A chi-square test showed that the display angle had a significant effect on the frequency of the L-shaped arrangement ($\chi^2(2)=54.809$, $p=1.254E-12$). Ryan's multiple comparison test showed that the differences were significant among all pairs of the display angles. Namely, the ratio of the L-shaped arrangement is higher for Vertical, Tilted, and Horizontal in this order (i.e., the ratio of the side-by-side arrangement is higher for Horizontal, Tilted, Vertical in this order).

We examined the presence (or absence) of physical and visual contact. The analysis showed that 47.8% (Horizontal), 30.4% (Tilted) and 3.5% (Vertical) of all two

individual pairs we observed had physical contact at least once (Fig. 7, center). A chi-square test showed that the display angle had a significant effect on the frequency of the physical contact ($\chi^2(2)=41.125$, p=1.175E-09). Ryan's multiple comparison test showed significant differences both between Horizontal and Vertical and between Tilted and Vertical, namely a higher chance of physical contact with the smaller display angle (i.e., a display angle closer to the horizontal). With respect to visual contact, 1.4% (Horizontal), 5.4% (Tilted) and 18.6% (Vertical) of the two individual pairs we observed had visual contact at least once between the two individuals; the order was reversed from the physical contact case (Fig. 7, right). A chi-square test showed that the display angle had a significant effect on the frequency of the visual contact ($\chi^2(2)=14.641$, p=0.0007). Ryan's multiple comparison test showed significant differences both between Horizontal and Vertical and between Tilted and Vertical, namely, a higher chance of visual contact with the larger display angle (i.e., a display angle closer to the vertical).

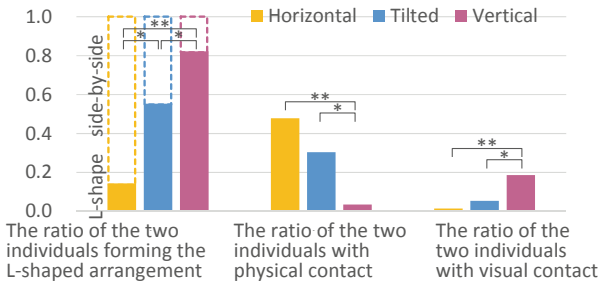

Fig. 7 F-formation arrangement (left), physical contact (center) and visual contact (right) of two individuals in front of a display

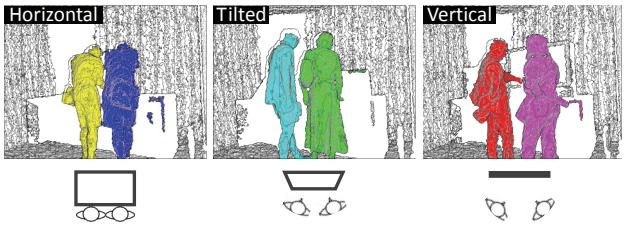

Fig. 8 Social communication through a display

4. SUMMARY OF FINDINGS

4.1 Display Angles Impact the Honeypot effect

When there were already existing visitors, the display in the Vertical and Horizontal conditions attracted more new visitors than in the Tilted conditions. We expected a high honeypot effect in the Vertical condition, as the display had a large area that allowed visitors to see the content from the front of the display. We did not anticipate, however, that it was as high as in the Horizontal condition. In the Horizontal condition, a new visitor sees the display content only when he/she comes near the display, and as such, we conjecture that existing visitors enhanced new visitor's motivation of wanting to approach the display and see its content.

4.2 Display Angles Impact Sharing of the Space

The display in the Vertical condition promoted more continuous sharing of space than in the Horizontal and Tilted conditions. With respect to the relationship between the visitors sharing the space around the display, we observed that, in the Horizontal and Tilted conditions, they were normally acquaintances, and that, in the Vertical condition, they were occasionally strangers. These findings suggest that the Vertical condition promotes formation of a highly public space with several strangers sharing the space and that Horizontal and Tilted conditions promote formation of a highly private space with people who are close to each other sharing the space.

4.3 Display Angles Impact F-formation

In the Horizontal condition, users stood side by side next to each other in front of the display and very close to each other with their bodies almost touching, while experiencing the display. In the Vertical condition, users stood in front of the display in the L-shaped arrangement and looked at each other, while experiencing the display. In the Tilted condition, users stood side-by-side for a half of the cases and in the L-shaped arrangement for the other half of the cases.

5. CONCLUSION

In this study, we installed a display of the flat and touch type in a public space (at a museum) and investigated, through observations in the field study and analyses of the collected data, the impact of three display angles on people's social behaviors in a natural setting. We confirmed that different display angles have significantly different impacts on the honeypot effect, sharing of space and F-formation arrangements. We also found that, through collectively considering our results and a previous work that conducted a laboratory experiment for single users, users do not actively interact with the tilted display when they are in a public space with others. Our findings are expected to help design public displays in various types of public spaces, such as concert halls, shopping malls, exhibition halls, movie theaters, libraries, and hospitals.

REFERENCES

[1] Ichino, J., Isoda, K., Ueda, T. and Satoh, R., "Effects of the Display Angle on Social Behaviors of the People around the Display: A Field Study at a Museum," Proc. ACM CSCW '16, pp.26-37 (2016).

[2] http://www.museumlab.eu/exhibition/10/

[3] Brignull, H. and Rogers, Y., "Enticing people to interact with large public displays in public spaces," Proc. INTERACT '03, pp. 17-24 (2003).

[4] Kendon, A., "Conducting Interactions". Patterns of behavior in focused encounters, Cambridge Univ.Press (1990).