Enabling Optimal User Experience for One and Two-Screen Gaming with Smartphones

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Abstract

This experimental research measures user experience quality for one-screen and two-screen gaming with a smartphone. The goal is to understand both quantitatively and qualitatively how to enable continuous gaming experience from a small and private screen on a smartphone to a large and shared screen on TV. The participants demonstrated considerable enthusiasms for two-screen gaming using a smartphone and TV. Gaps in ease of interaction, control responsiveness, and graphic quality need to be addressed for the optimal experience.

Author Keywords

Mobile gaming, two-screen gaming, user experience quality

ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces.

Introduction

Since the debut of smartphones in 2007 from Apple Inc., gaming with mobile phones has rapidly become prevalent and mainstream. Majority of mobile phone owners play games on their phones [2]. In a recent

survey, 50% of mobile gamers in US and UK identify mobile gaming as the primary method of game play at home [1], suggesting mobile devices may surpass other devices, such as consoles and PC, and become dominant gaming platforms. In addition, large technology companies are providing technologies and solutions that allow users to wirelessly connect their mobile devices with larger external displays. With such a wireless connection, a user can play a game with two devices without the need to handle wires: an external display such as TV for viewing the content and a smartphone for hosting and controlling the game. The two-screen usage can potentially complement a mobile device, and enable more ubiquitous gaming experience with smartphones. Users can play games on a smartphone individually or in a private context; in the meantime, with the same device, they can play the same set of games to a large external screen, and share the experience with a group of people in social settings.

There are apparent design challenges in order to support both one-screen and two-screen usages with the same gaming applications -- They will need to be optimized for vastly different usage contexts, screens of largely different sizes, and different interaction models the come with one-screen and two-screen usages. This study seeks to understand differences in user experience quality when same games are played in two settings 1) single-screen with a smartphone; 2) two-screen with a smartphone and TV. The primary objectives are to identify key factors that can significantly impact gaming experience across different screens, thus understand key issues that need to be addressed in design or technology development for two-screen applications.

Methodology
49 participants were recruited and invited to a usability lab to play games. The participants were experienced mobile gamers; they all owned a smartphone, had installed at least five games, and played games at least three times for an accumulated one hour or more per week. 45% owned an iPhone, 53 owned an Android-based phone. 53% were females. All participants were between 18 and 45, considering a national survey suggesting that majority of mobile gamers were 45 or younger.

Devices used in the experiment included an Android smartphone made by Intel, a 55-inch high definition TV, and an adapter that allowed the smartphone to be wirelessly connected to the TV using Intel's Wireless Display (WiDi) technology. The devices were used to create two condition settings for the experiment. 1) one-screen: participants were asked to play different games on the phone. 2) two-screen: the phone was connected to TV wirelessly via the WiDi adapter. The phone's content display was mirrored to TV. Audio from the phone was played to TV's speakers. In the two-screen setting, participants were asked to launch games from the phone, and play the games using the phone as the controller and TV for the content display. In order to select game applications, two researchers conducted research on games available from Android's application store Google Play. Nine were selected and installed on the smartphone on the basis of two criteria: 1) popularity – all games received better than a 4-out-of -5-point user rating in Google Play. 2) suitability for playing on TV. Three kinds of games were deemed suitable for playing on TV: 1) games that could be controlled with motion gestures; tilting the phone in different direction was a common gesture control used

in the games; 2) games that could be controlled with simple touch gestures that did not require accurate finger touch positioning; 3) multiple player games that user could play in turns by passing the phone to each other, using TV for a shared view of the display. Table 1 summarizes the types of games used for the study.

Game types	# of games
Tilting	4
Touch	3
Multi-user	2

Table 1. Types of games used

Two kinds of experiment sessions were conducted:

- Individual – A total of 15 sessions were conducted. Individual participants played two rounds of nine games under the two condition settings; each participant was asked to play nine games in one setting, and repeated the same nine games in the other settings. The three types of games were mixed in order. The order of two settings was rotated for different sessions. For the multiple player games, the individual played against the system.

- Paired – A total of 17 sessions were conducted. Two participants played two rounds of nine games in the two settings. In the first round, one participant played four one-user games. The other participant played three one-user games. They played two multi-user games together. In the second round, they were asked to play the same games in the other setting. The order of the two settings was rotated for different sessions.

Table 2 and Table 3 summarize the setup of the individual and paired sessions.

Settings	games played
One-screen (phone)	9
Two-screen (Phone &TV)	9

Table 2. Setup of individual sessions

Settings	single-user games		multi-user games	Total
	User 1	User 2	Both	
One-screen (Phone)	4	3	2	9
Two-screen (Phone & TV)	4	3	2	9

Table 3. Setup of paired sessions

Participants were asked to play each game for one and half minute, and then rated their experience in the following aspects, using a 5-point scale with 5 being "delightful," 4 being "satisfactory," 3 being "meet expectation," 2 being "below expectation," 2 being "annoying."

- Graphic quality: whether the graphics on screen is sharp, clear and smooth.

- Audio quality: whether the sound is clear and has enough fidelity.

- Responsiveness to controls: how well the application responds to your commands and controls.

- Ease of interaction: how easy it is to play and interact with the game.

- Overall experience: overall how much you are having fun and enjoy playing the game.

All participants were asked to think aloud during the game play and rating. In 12 sessions, in-depth interviews were conducted with the participants to discuss their rationales of the ratings and desired improvements.

Key Findings

Table 4 summarizes participants' average ratings for the one-screen and two-screen gaming experience.

	One-screen (Phone)	Two-screen (Phone & TV)
Graphic	4.1	4.1
Audio	4.1	4.1
Responsiveness	4.2	3.9*
Ease of interaction	4.1	3.9*
Overall experience	4.0	3.8*

Table 4. Mean user rating of experience quality (n=49)
* significant difference from that of one-screen experience ($p<.05$)

Perceived quality of graphic and audio was similar for one-screen and two-screen experience, however, responsiveness, ease of interaction, and overall experience were significantly lower for gaming across two screens. As pointed out by participants in the think-aloud or interviews, challenges with responsiveness was more due to over-sensitivity of controls in the motion-gesture games. The games typically involve continuous movement of objects, for example, a rolling ball, a skiing animal, and a floating bubble. Users desired to have a fine degree control of both speed and direction of the movement. Participants often found a small degree of movement on the phone could lead to over steering or over acceleration on TV, or they found it hard to stop the movement. There are several potential causes of the issues. While playing with two-screens, as participants pointed out, users were not looking down on the phone, thus were less aware of the degree of movements they were making in their motion gestures. They appeared to make larger degree of movements than playing with phone only. The other implication could be that sensitivity of the phone's motion sensor was better calibrated for the one-screen gaming, and needed to be adjusted for the two-screen experience.

Ease of interaction issues were mainly associated with the touch-controlled and multi-user games. Participants frowned upon any interactions that required them to look up-and-down across phone and TV, either for playing or setting up the games. For example, participants disliked the fact that one game required users to take several steps of menu selection in order to start. The participants disliked the two multi-user games because they required them to look down at the phone screen to make a move. In addition, the interaction model of playing a game by passing a phone to each other was not well-accepted. Participants viewed a phone a highly personal device. They expressed large hesitation to pass it to another person, even if the person might be a family member or close a friend. They preferred playing together in front of TV from their own devices.

Even though graphics quality was rated similarly across one-screen and two-screen, participants perceived

advantages for having the graphics on a larger TV screen. Participants mentioned "it felt better" to have the display on TV, or TV made "the games more fun to play with." Participants also mentioned a large TV helped to create more immersive experience or allowed them to see objects and environments in the games much better than on a phone screen. With a large TV, they expected the graphics to have high definitions with details and colors, and desired to see very realistic or 3D graphics.

Summary

Participants demonstrated considerable enthusiasm for two-screen gaming with TV and a smartphone. Key benefits they perceived include:

- Sociability: instead of playing games alone, they could share the experience with family or friends in a group setting. Several participants mentioned the desire to show case their games with friends, without the need to hand over their phones.

- Convenience: they regarded it convenient to have different content including communications, music, video, games and Internet, available from one smart device. A smartphone is ubiquitously with them, and also allowed them to conveniently download latest games from application stores.

- Comfort: participants mentioned that it would be more comfortable and relaxed to play with TV, which would provide better viewing experience. As pointed by participants, TV often came with better audio equipment, thus created an environment with "audio coming toward me (from TV)" instead of "coming directly at me (from phone)"

Responsiveness and ease of interaction issues will need to be addressed by the gaming and device ecosystem for wide adoption of two-screen gaming. A large quantity of games optimized for the two-screen experience will be needed. As participants frequently pointed out, the games they currently had on their phones were not suitable for playing on TV. In addition, ease to create and terminate wireless connection between TV and a phone will be key. As mentioned by participants, they desired an easy-in and easy-out experience, so that they could quickly start to play games on TV when they had a small amount of time, for example, during a commercial break; if needed, they would like to easily disconnect and return to TV watching.

References

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About the Author

Mei Lu received Ph.D. in Communication Studies, and Masters in Human Factor Interaction from the University of Michigan. She works at Intel Corporation as Senior User Experience Researcher. She has researched for different products, including computers, TV, tablets and smart phones. Her work directly impacts the company's strategic roadmaps and product designs. She has published and presented at journals and conferences such as Information Technology Journal, International Conference of Information Systems (ICIS), Computer Human Interaction (CHI).