Watching Movies on Netflix: Investigating the Effect of Screen Size on Viewer Immersion

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Abstract
Film and television content is moving out of the living room and onto mobile devices - viewers are now watching when and where it suits them, on devices of differing sizes. This freedom is convenient, but could lead to differing experiences across devices. Larger screens are often believed to be favourable, e.g. to watch films or sporting events. This is partially supported in the literature, which shows that larger screens lead to greater presence and more intense physiological responses. However, a more broadly-defined measure of experience, such as that of immersion from computer games research, has not been studied. In this study, 19 participants watched content on three different screens and reported their immersion level via questionnaire. Results showed that the 4.5-inch phone screen elicited lower immersion scores when compared to the 13-inch laptop and 30-inch monitor, but there was no difference when comparing the two larger screens. This suggests that very small screens lead to reduced immersion, but after a certain size the effect is less pronounced.

Author Keywords
Immersion; experience; screen size; mobile devices; on-demand video; film; television

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

Introduction

It is now common for applications and services to be used across more than one device, and these multi-device ecosystems allow users to complete tasks at times and places that are convenient for them [14, chap 1]. Devices can be synchronised with personal accounts, with user interfaces sensitive to the benefits and constraints of each particular device. While this offers greater flexibility for users, it also presents a lack of control for developers and content producers over the experience the user has - consider a mobile game that may be easy to control when using a tablet touchscreen, but could be more frustrating on a smaller phone screen and therefore provide a worse experience to the player. An example of this is the popular game Angry Birds, where cartoon birds are catapulted across the screen. Some stages in this game require a high amount of precision, which is easier to achieve on a larger screen where the user can be more accurate with their finger movements when aiming. A study by Thompson et al. [20] investigated the effect of touch screen size on game immersion by comparing a small iPod screen to a larger iPad screen, and found that a higher level of immersion was experienced when playing on the larger screen.

This variety of screen sizes is also present for TV and film. Large screens are often thought of as providing a better experience - moviegoers often pay a premium for large IMAX screens, self-described as “the world’s most immersive movie experience"[1], and large TVs are often purchased for an enjoyable home viewing experience. Furthermore, a number of directors have expressed their belief that watching movies on phones results in a lesser experience[2][3][4]

Despite this, content is being increasingly consumed on mobile devices. A recent UK communications market report [17] showed that subscriptions to on-demand video services are increasing, and that subscribers are using them more and more. On-demand content accounted for 15% of all viewing for adults, with 33% of the online population watching on a computer, 21% on a smartphone, and 23% on a tablet at least once a month. Given this wide variety of devices, it is possible that they may provide the user with differing experiences in the same way as has been shown for games [20]. Does a viewer watching a movie on a smartphone have a comparatively worse experience than if they watch it on a larger screen? In this study, participants watched television content on three different devices to see if screen size correlated with self-reported immersion scores.

Related work

Measuring experience when watching film media on screens of different sizes

Past research has investigated how people respond to different sized screens when watching film and television. Lombard et al. [15] performed a lab study with participants watching content on either a 46- or 12-inch screen, then completing a questionnaire. The results suggested that in some genres screen size did have an effect on responses,

[1] http://www.imax.com/ [Last access Feb 4 2016]

[2] http://www.techinsider.io/george-lucas-discusses-watching-movies-on-phones-2015-4 [Last access May 10 2016]

[3] http://www.theguardian.com/film/2015/may/01/spike-lee-watching-movies-digitally-is-heartbreaking [Last access Feb 4 2016]

[4] http://www.digitalspy.com/movies/news/a491726/david-lynch-watching-movies-on-a-smartphone-is-pathetic/ [Last access May 10 2016]

specifically in clips which contained shorter shots and sudden movements, which elicited more intense responses on the larger screen. In an experiment by Reeves et al. [18], participants viewed clips on either a 56-, 13-, or 2-inch screen, and both arousal and attention was measured. The results showed that screen size could increase both attention and arousal for all types of content, and that for the very large screen arousal was greatly increased when viewing exciting content. The authors suggest that this may explain why viewers seek out large screens to watch exciting content such as sport and films.

The focus of TV experience measurement in prior research has been on *presence*, or a sense of being inside the media. Lombard et al. [16] investigated the effect of screen size on spatial presence when watching rapid point-of-view footage, measured using both self-reported questionnaires and electrodermal activity. A variety of footage was played to participants on either a 12-inch or 46-inch screen. All participants said they experienced sensations which suggested presence when watching the footage, such as a sense of movement, excitement, involvement, and participation, with participants watching the larger screen experiencing these feelings to a greater extent. A study by IJsselsteijn et al. [12] also found that a larger screen elicited a greater sense of self-reported presence when viewing footage on a large screen, but only for footage that contained motion. Bracken and Pettey [1] found that watching content on a 2.5-inch iPod screen showed no significant difference in spatial presence then watching on a 32-inch TV screen, but the smaller screen did lead to a greater sense of immersion, which was reported using 5-item questionnaire. However, the authors note that watching on an iPod was a novel experience for most of the participants at the time, and that the iPod audio was heard through headphones whereas the TV audio was not. Both of these issues may have affected the participants' experience.

While this related work has looked at the effect of screen size on some experiential measures, they are quite narrowly defined and do not give a holistic view of the viewer's experience. A possible solution to this is to look to the field of computer games, where defining and measuring experience has been well-researched. However, fundamental differences between playing computer games and watching television should be noted - watching TV is a "lean back" activity, mostly passive with little interaction, and playing games is a "sit forward" activity, requiring active participation. For this reason, any methods used from the domain of computer games research should be modified accordingly.

Measuring experience for computer games

A number of concepts have been used to operationalise player experience for computer games, including flow [19], presence [21], puppetry [7], and immersion [13]. Some of these concepts have previously been, or could be, adapted for film and television to measure viewer experience. Immersion is frequently referred to in gaming media, and is seen as a highly desirable characteristic for a game to possess. However, the term has often been used loosely and without any agreed definition, even in scientific literature - indeed, immersion is referred to in a number of game experience models, and care should be taken to differentiate between these [5].

Brown and Cairns [2] sought to better define the concept of immersion by interviewing gamers about how they perceived being immersed in a game, and by using grounded theory the authors found that they could define three progressive levels of immersion: *engagement* - investing time and effort into the game in the first place; *engrossment* - becoming interested in the game world, becoming emotion-

ally involved and less aware of real-world surroundings; and finally *total immersion* - becoming entirely separated from reality and existing in the virtual world. Jennett et al. [13] further worked towards defining the concept of immersion, as well as investigating how it could be measured. They developed the Immersive Experience Questionnaire (IEQ) to explore different aspects of immersion, which featured 31 items drawn from a number of areas to cover different aspects of immersion. This questionnaire has been widely used to assess experience in a number of different contexts, such as the effects of different controllers [6], how challenge affects immersion [8], and brain-computer interface games [11]. Particularly relevant to the present study is a study by Thompson et al. [20], who investigated the effect of touch screen size on game immersion by comparing an small iPod screen to a larger iPad screen. Their findings showed a higher level of immersion was experienced when playing on the larger screen.

While there are methods of defining and measuring immersion for computer games, methods for doing so for film and television have not been widely researched. Some of the above research has looked at experiential measures such as presence, and physiological measures such as arousal, but these do not give a broad view of the viewer's experience in the same way as immersion as defined by Jennett et al. [13], which draws from a number of experiential concepts. This research rectifies this by developing a modified version of the IEQ by Jennett et al. [13] which is more relevant to the film and television setting, called the Film IEQ. The flexibility of the IEQ has already been shown through its use in other settings, such as public speaking anxiety [22] and games without graphics for visually-impaired players [9]. The Film IEQ was then used to assess the immersion experienced by participants watching film footage played on three devices with differing screen sizes: a 4.5-inch smartphone, a 13-inch laptop and a 30-inch monitor.

Method

Aims and hypotheses

The aim of this study was to investigate the effect that screen size had on the level of immersion felt by participants when watching film content, which was self-reported by participants using the Film IEQ. As previous work has shown more intense responses to film content shown on larger screens [12, 15, 16, 18], and higher levels of immersion when playing games on larger screens in a study similar to the present study [20], the hypothesis is that larger screens will lead to higher immersion scores in general.

Participants

A total of 19 participants (12 female, 7 male) were recruited through the university psychology subject pool. They were granted course credit for 50 minutes of their time.

Design

The study used a within subjects design. The independent variable was the screen size of the device they were watching the footage on, and there were three levels: a 4.5-inch phone, a 13-inch laptop and a 30-inch monitor. The dependent variable was the level of immersion the participants reported using the Film IEQ.

Materials

The experiment took place in a lab with a desk present for participants to sit at using a fixed chair. 3 devices were used to play the clips using the Netflix online streaming service: a Motorola Moto G smart phone with a 4.5-inch screen (held in the participants' hands with their arms on the desk); a Dell laptop with a 13-inch screen (placed on the desk approx. 50cm away), and a 30-inch monitor (also placed 50cm away). Participants used the laptop to select

a movie from the Netflix website, which was required to be one they wanted to watch but had not yet seen. Complete freedom of choice was given in order to control for differing interest levels, as content chosen by researchers may have been of interest to some participants but not others - this was important because the questionnaire used contains questions directly pertaining to the participants' personal interest in the footage (e.g. "How much would you say you enjoyed watching the footage"). Six participants chose to watch biographical movies (*The Wolf of Wall Street*, *Dallas Buyers Club*), six chose action/adventure (*Captain America, The Hunger Games, 47 Ronin, Hancock*), two chose comedy (*Liar Liar, She's Funny That Way*), two chose drama (*Still Alice, About Time*), one chose horror (*Would You Rather*), and one chose crime (*Once Upon a Time in America*). The first 30 minutes of the chosen movie was split into three 10-minute clips, which were watched in sequence. Audio was played through over-ear headphones to control for sound level. Before the experiment, participants completed a questionnaire to collect demographic information, and after watching each clip they completed the Film IEQ.

Adapting the Immersive Experience Questionnaire for film and television

The IEQ provides an effective way of measuring immersion when playing a game through self reporting. However, there are important issues that must be considered before using it in the context of television. Firstly, when watching film or television there is generally no task that must be explicitly completed as in computer games, and secondly, the viewer generally has no control or agency when watching film or television and cannot influence the outcome. Both of these factors feature in the questions of the original IEQ, and for this reason a modified version of the IEQ was developed for television and film to create the Film IEQ. While games can offer some aspects of immersion that film media cannot (interaction, agency), film media can also provide experiences that games cannot. For example, the pace of the narrative in film media is decided entirely in advance and the creators can manage exactly how tension is built and released, but in a game a player can decide how long to spend in a location, or when to proceed to the next level. Camera angles can be accurately controlled in film, and music can exactly match the events on screen.

To modify the IEQ, all game references were changed to ones specific to TV and film, e.g. "playing" and "game" were changed to "watching" and "footage". However, eight questions did not apply to film and television viewing and were replaced with ones concerning narrative engagement [4, 10] in a similar way to Brumby et al. [3], as well as how well the viewer followed the content and themes (how challenging were the themes instead of how challenging was the game). The final Film IEQ consisted of 31 questions.

Procedure

Participants first read the information sheet and signed a consent form, and were then given the opportunity to ask any questions. To begin the study, participants were seated and told how the study would proceed and what they should do, and then filled in a questionnaire to collect demographic data. They were then asked to choose a single movie from the Netflix catalogue, which they had not seen before but would like to see. They watched the first 10 minutes of their movie on a randomly selected device and filled out the Film IEQ. The following 10 minutes of the movie were then watched on the second randomly-assigned device followed by filling out another Film IEQ, then finally the remaining 10 minutes were watched on the remaining device followed by the final Film IEQ. The order of the devices was counterbalanced to control for order effects. Participants were given another opportunity to ask questions before leaving.

Results

As per the IEQ in Jennett et al. [13], immersion scores were calculated by summing all questions in the Film IEQ. Questions 6, 8, 9, 10, 18, and 20 were scored negatively.

Mean immersion scores were lower in the phone condition ($M = 135.21, SD = 18.46$) than in the laptop ($M = 146.89, SD = 15.08$) or monitor conditions ($M = 149, SD = 16.74$). A one-way repeated measures ANOVA was used to analyse this data, and showed a significant main effect of screen size on immersion score, $F(2, 36) = 5.63, p = .007$. Post-hoc t-tests were performed to examine pairwise differences between each condition, using Bonferroni corrections. Results found a significant difference in immersion score between the phone condition and the laptop condition, $t(18) = 3.07, p = .007$, and the phone condition and the monitor condition, $t(18) = 2.72, p = .014$. There was no significant difference in immersion score between the laptop condition and the monitor condition, $t(18) = .49, p > .99$. These results suggest that watching content on a very small screen results in lower immersion than when watching content on a much larger screen.

Discussion

The hypothesis that larger screen sizes would result in greater immersion was supported. The significant main effect of screen size across conditions suggests more difficulty in experiencing high levels of immersion when viewing very small screens, but after a certain size there is less of a disparity. This fits with the results of the study by Thompson et al. [20], where immersion scores reported using the IEQ when playing a simple game were significantly lower on a 3.5-inch screen than on a 9.7-inch screen.

A confounding factor in this study was the choice that the participants were given when selecting content, as it is likely that some movies could be considered more immersive than others. We considered giving every participant the same video to watch, but as the IEQ is partially based on factors determined by personal preference (e.g. the enjoyment subscale) it was decided that participants should have the freedom to choose content that would give the best experience. However, it remains that some participants may still have watched a more immersive clip than others.

A limitation of this study is that the changes made to the IEQ were not robustly validated prior to use. The original IEQ was validated using a factor analysis, which ensured the questionnaire as a whole was measuring immersion, as well as extracting the underlying factors. Due to the changes made, and because immersion when watching video footage may be different from immersion in games, the questionnaire may not be measuring immersion in the same way and may have different underlying factors. This should be addressed by fully validating the Film IEQ (e.g. factor analysis for validity, Cronbach's alpha for reliability).

A further limitation of this study is that the lab environment may not be considered analogous to the environment in which the devices are likely to be used. It could be considered similar to an office or bedroom where a laptop might be used, but not similar to a living room where a large TV is likely to be viewed and comfortable seating and lighting may affect immersion scores. The lab is also not similar to public transport or other public places where a phone screen is more likely to be viewed, and the distractions present in such environments may affect immersion scores.

Conclusions and future work

With the popularity of on-demand content rising, and with content increasingly being watched on mobile devices, it is important to examine how viewer experience may be af-

fected by screen size. In this study, a lab experiment was conducted to examine the relationship between screen size and self-reported immersion while watching film content on three different screens. Watching on the small 4.5-inch phone screen recorded the lowest immersion scores, and there was a significant main effect of screen size on immersion scores when compared to both the 13-inch laptop and 30-inch monitor screens. There was no significant effect when comparing the laptop and monitor screens. This suggests that watching content on a phone screen results in a worse experience than watching on a medium or large screen, and viewers wanting a more immersive experience should reserve content for larger screens.

Further investigations into the effect of screen size on immersion could include a greater variety of screen sizes, specifically large TV screens and projector screens to mimic a cinema screen. It is common to hear that films are best experienced at the cinema, so adding a much larger screen to a future study could result in an increase in immersion scores for this condition. Different resolutions of screen and content could also be examined to better understand how the move to HD content may affect viewer experience. Furthermore, the changes made to the IEQ to create the Film IEQ should be validated to ensure accurate measurement of immersion. This would make the Film IEQ a robust instrument for measurement of immersion for film and TV, and be a valuable contribution to research in this domain.

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