IMMERSION DURING DIGITAL MEDIA MULTITASKING

Hao Wang, Chien-Wen Ou-Yang and Chun-Tsai Sun
Department of Computer Science, National Chiao Tung University
1001, Ta Hsieh Road, Hsinchu City, Taiwan

ABSTRACT

In terms of digital media usage, immersion refers to user involvement in and focus on a single activity. It is easy to assume that individuals can only be immersed in one media at any moment, but the commonality of multi-tasking raises questions regarding whether one media source should be considered the true locus of immersion. Self-report questionnaires and eye trackers were used to measure the immersive experiences of a sample consisting of students (ranging from undergraduate to doctoral candidates) from two universities while playing video games and watching a television program at the same time. Their data were compared with those for a similar group of individuals playing games or watching television only. While we found evidence of immersion across the two activities while multitasking, some immersion dimensions were significantly weaker. We also noted that immersion experiences from multiple media might be cumulative. A possible explanation for our results is that the act of switching between two media compensated for any down time—users could abandon a less attractive medium and switch to the other, resulting in an impression of continuous immersion in the overall multitasking experience.

KEYWORDS

Immersion, Multitasking, Digital Media, Eye-Tracking, User Experience

1. INTRODUCTION

Of the many definitions of immersion found in the literature, one of the most cited is from Murray's work (1997): "The sensation of being surrounded by a completely other reality, as different as water is from air, that takes over all of our attention, our whole perceptual apparatus.... Digital game researchers and designers have long acknowledged the importance of immersion. For example, Jennett, Cox and Cairns (2008) note that immersion in the form of "drawing people in" is an important factor in game design. When proposing their SCI (sensory, challenge-based, imaginative) model for analyzing video game immersion experiences, Ermi and Mäyrä (2005) defined the target concept as "becoming physically or virtually a part of the experience itself." McMahan (2003) also posits that immersion sources can be either diegetic or non-diegetic. The first involves narrative elements such as story and atmosphere, the second involves active play—that is, a "player's love of the game and the strategy that goes into it" (p. 68). Jennett, Cox, Cairns, Dhoparee, Epps, Tijs et al. (2008) performed exploratory analysis to decompose the immersion concept into five dimensions: cognitive involvement, emotional involvement, challenge, real world dissociation, and control.

To date, most studies and experiments on various aspects of immersion have focused on situations in which only one type of media is being used. However, we now live in a period where it is very common for individuals to divide their attention between two or more information sources, sometimes involving more than one outlet of the same media type. Results from a digital consumer survey conducted by the Nielsen Corporation (2014) indicate that 84% of all smart phone/tablet users in their sample used their devices while watching television. It is also increasingly common for game players to watch television or monitor other players' live shows on Twitch or YouTube while playing their own games.

Understanding the potential for immersion among individuals who divide their attention between two or more media is the primary motivation for the present study. Toward that goal, we established four research questions involving two groups of study participants—a multitasking experimental group, and a control group focused on one video or one game:

1. Were immersion levels among participants in the multitasking group lower than immersion levels in control group participants?

2. How do study participants divide their attention between more than one type of media? Do multitasking participants use media in different ways compared to single-task participants?

3. What is the relationship between overall immersion level and immersion levels for each of the two activities? Is the overall immersion level for a single activity close to the average for both, or are immersive experiences cumulative?

4. Are multitasking participants concurrently immersed in both media, or do they tend to be immersed in only one at a time?

2. BACKGROUND

Researchers in digital games often analyze immersion as a natural part of the gaming experience. Carr (2006) has proposed two immersion categories: as a perceptual phenomenon, which emphasizes the way that the human sensory apparatus is occupied by a stimulus or experience; or as a psychological phenomenon, which emphasizes the idea that imaginative play encourages extreme player focus and absorption. Breda (2008) emphasizes emotion when describing immersion as the feeling of connection to a game, especially when deep emotional experiences are involved. As part of their effort to clarify different types of game immersion, Johnson and Wiles (2003) define immersion as deep and effortless involvement in a game, and use the term “engagement” to describe effortful and concentrated play.

Two concepts closely linked with immersion are Flow (Csikszentmihalyi, 1990) and presence (McMahan, 2003; IJsselstein, de Ridder, Freeman and Avons, 2000; Lee, 2004). There are important distinctions to note between immersion and presence though. For instance, researchers have noted that it is not necessary for immersion and presence to exist concurrently, and cite as examples those times when players perform repetitive and boring tasks within vivid virtual environments—presence may be strong, but immersion is likely to be low (McMahan, 2003). In contrast, games such as Tetris that are played on handheld devices can be immersive, but without strong feelings of presence.

Csikszentmihalyi (1990) uses the term “flow” to describe optimal experiences when engaging in activities. He summarized optimal experience properties as the existence of conditions for flow to occur (e.g., clear goals, immediate feedback, balance between challenge and skill), plus specific characteristics such as high degree of concentration, sense of control, and the merging of action and awareness, as well as flow-related consequences such as loss of self-consciousness, distorted sense of time, and autotelic activity. Csikszentmihalyi proposed the three-channel flow model shown in Figure 1 to describe changes in mind status among flow, anxiety, and boredom, all of them affected by the balance between challenge and skill.

Figure 1. The three channel Flow

Researchers have used both subjective and objective methods to measure immersion experiences. Subjective methods include self-report questionnaires, interviews, and researcher observations (Brown and Cairns, 2004; Csikszentmihalyi, 1990; Sweetser and Wyeth, 2005; Hamari, Shernoff, Rowe, Collier, Asbell-Clarke and Edwards, 2016). These methods have some well-studied limitations—for example, some respondents find it difficult to answer abstract questions that are commonly found in immersion research (e.g., “Do you feel surrounded by another reality?”) A second challenge is the ephemeral nature of deep

immersion, making it difficult for study participants to be aware of, remember, and report their immersion experiences at the end of game-playing sessions. Objective data collection in immersion studies often entails physiological signal methods (ex. heartbeat rate, perspiration, pupil dilation, electrodermal response, electromyography) that are common to psychophysiological research (Nacke and Lindley, 2009). Objective methods also have shortcomings for gaming experience research, the most important being the complexity and lack of stability in the relationship between physiological signals and psychological phenomena. To overcome the disadvantages of individual methods, researchers suggest using several at the same time to increase analytical effectiveness (IJsselstein et al., 2000; Nacke and Lindley, 2009).

3. METHOD

3.1 Participants

Campus-based electronic bulletin board systems were used to recruit study participants from two universities. The final sample consisted of 38 males and 34 females between the ages of 18 and 38 (mean 23.2). Three groups were established from the initial sample, one labeled “multitasking” (30 individuals), one “video-only” (21), and one “game-only” (21). To develop the questionnaire for the formal experiment, we recruited 61 additional participants prior to the formal experiment via the same BBS (37 male, 24 female, age range of 19 to 30, 23.5 year mean).

3.2 Game and Video Selections

We designed our experiment to study a specific multitasking situation: playing a digital game and watching a video at the same time. For selecting specific video and game, several factors dictated our decision. First, the game had to be suitable for multitasking; we rejected real time strategy and multiplayer online battle arena games due to the demands they make for continuous player attention. Puzzle games were considered suitable depending on the level of difficulty in problem solving. The same motivation guided our video selection—watchers had to be able to avert their eyes occasionally and catch up with the video storyline when they returned, therefore programs with intricate plots and exceptionally fast pacing were rejected. FEZ (a casual platformer game that allows for relaxed exploration) and The Mythbusters (a long-running TV program requiring less continuous attention, but with a key question saved for the end) fit our criteria.

3.3 Questionnaires

The game and video immersion-measuring questionnaires used in this study were largely based on the work of Jennett et al. (2008) and Sweetser and Wyeth (2005) plus two additional dimensions: “merging of action and awareness” and “loss of self-consciousness” (Csikszentmihalyi, 1990). The finalized game immersion questionnaire (Cronbach’s α .914, proportion of variance explained 60.9%, all question item factor loadings $>.400$; we didn’t append the questionnaires due to page number limitation) has six factors according to the question items they contained: (a) transport, meaning feelings of disconnection with the real world and of being surrounded by a virtual world; (b) enjoyment, or having fun and interest in the activity; (c) cognitive involvement, with a strong focus on thinking and processing in-game information; (d) emotional involvement, including empathy for game characters, anticipation about how a plot will unfold, and emotional changes tied to the game; (e) loss of self-consciousness, such as lower levels of self-awareness and interest in the real-world environment; and (f) merging of action and awareness so that in-game actions feel spontaneous and natural. In light of the study goals, we added a simple statement to measure the participants’ sense of immersion: “I felt deeply immersed in the game.” This item could be used to check whether questionnaire responses actually reflected the participants’ feelings. For the multitasking group, the question “I felt deeply immersed during the activity just completed” was used to measure overall feelings of immersion rather than immersion in either the game or video alone.

The video immersion questionnaire used in the formal experiment (Cronbach's α .893, proportion of variance explained 56.8%, all question item factor loadings $>.400$). The four extracted factors were labeled according to their associated question items: (a) cognitive involvement, with its focus on thinking and processing information presented in the video; (b) emotional involvement and enjoyment, tied to the content that made the video interesting or that triggered an emotional reaction; (c) loss of self-consciousness, indicating lowered self-awareness of or interest in real world surroundings; and (d) transport, meaning feelings of disconnection from the real world accompanied by a sense of presence in the TV program. Members of the multitasking group were requested to complete two additional questionnaires, one designed to measure their feelings about multitasking, the other a list of open questions for collecting data on their feelings about the experimental setting.

3.4 Apparatus

A 24-inch LCD display was used to present the dual media content. Eye tracking was performed with a SR Research EyeLink 1000 (1 kHz sample rate). The infrared eye-tracking camera was placed in front of the screen so that the participants' heads could move freely within a limited range. Figure 2 shows the experiment screen containing game and video stimuli.

Figure 2. Multitasking setting screenshot

3.5 Eye Movement Data Analysis

Eye movement data analysis required definitions for three areas of interest (AOI): the game, the main video area, and the video subtitle area. We then used the following features to summarize eye movement data: (a) total length of time that each participant's line of sight fell within an AOI, including fixation and saccades (eye movements across a field without focusing on an object); (b) fixation count, meaning the number of times participants "looked at" a certain AOI; (c) fixation duration, or total length of time spent gazing at an AOI; (d) average fixation duration, calculated as fixation duration divided by fixation count; (e) in-out count, meaning the number of times a participant's eye fixation position moved away from an AOI but returned later; (f) total saccade count; (g) total number of blinks during a session; and (h) average pupil dilation while gazing at an AOI.

4. RESULTS

4.1 Immersion Score Comparison

As shown in Table 1, both instinctive feelings (i.e., responses to the item, "I felt deeply immersed in the game") and overall game immersion scores from the questionnaire were significantly lower for the multitasking group compared to the game-only group ($\alpha=0.05$)—in other words, a decrease in immersion while multitasking. The

largest score differences were for “loss of self-consciousness” (17.4% lower) and “cognitive involvement” (17.1% lower). The video-related data shown in Table 2 indicate significantly lower instinctive feeling and total questionnaire scores for the multitasking group, with “cognitive involvement” and “transport” having the most significant differences compared to the video-only group (35.8% and 16.6% lower, respectively).

Table 1. Game immersion score comparison between multitasking and game-only groups. (*p < .05, **p < .01, ***p < .001)

Factor	Game-only		Multitasking		t-value	p-value
	M	SD	M	SD		
Game Instinctive Feeling	7.33	1.24	6.40	1.48	2.3700*	.022
Game Cognitive Involvement	8.71	.56	7.00	1.98	4.4860**	.000
Game Emotional Involvement	20.29	4.16	17.30	4.55	2.3880*	.021
Game Transport	17.90	4.81	14.43	4.56	2.6170*	.012
Game Loss of Self-consciousness	14.29	2.43	10.80	3.08	4.3250**	.000
Game Merging of Action and Awareness	10.14	2.56	10.33	2.72	-.2520	.802
Game Enjoyment	24.57	3.92	20.77	4.60	3.0850**	.003
Game Total Immersion Score	95.90	14.61	80.63	15.51	3.5430**	.001

Table 2. Video immersion score comparison between multitasking and video-only groups. (*p < .05, **p < .01, ***p < .001)

Factor	Video-only		Multitasking		t-value	p-value
	M	SD	M	SD		
Video Instinctive Feeling	7.19	1.63	4.67	2.20	4.4590**	.000
Video Cognitive Involvement	12.48	1.97	7.10	2.51	8.2040**	.000
Video Emotional Involvement and Enjoyment	23.00	4.49	19.43	6.05	2.2920*	.026
Video Loss of Self-consciousness	13.43	2.99	12.70	2.39	.9640	.340
Video Transport	16.90	4.45	12.77	3.95	3.4940*	.001
Video Total Immersion Score	65.81	11.63	52.00	12.24	4.0450**	.000

4.2 Instinctive Feelings of Immersion

Instinctive feelings of immersion were measured according to the statement, “I felt deeply immersed during the activity just completed.” We looked for correlations between response scores for this question and total scores from the multi-dimensional immersion questionnaire to determine if the questionnaire accurately measured instinctive feelings about immersion. For the single task groups, Pearson correlation coefficients for the instinctive feeling and total questionnaire scores were .715 for the game-only group and .869 for the

video-only group. Among the multitasking study participants, the Pearson correlation coefficients between instinctive feeling and total questionnaire scores were .782 and .863 for the game and video, respectively. These results indicate a high correlation between the instinctive feeling and total questionnaire scores, suggesting that instinctive feeling can serve as an indicator of overall immersion.

Although game and video immersion scores were lower for the multitasking group, the overall instinctive feeling score for the multitasking group was higher (4.04) than those for both single task groups (game=3.67, video=3.60), indicating that immersion values from multiple sources can be summed to some extent, and suggesting that individuals can have strong immersive experiences when multitasking using digital media, even though the degree of immersion from each source is reduced.

4.3 Eye movement and Immersion

AOI time distribution data are shown at Table 3. For multitasking group participants, proportions of time spent in each AOI were .80 for game, .07 for video_main, and .13 for video_subtitle—that is, study participants tended to spend more time playing the game than watching the video. For the video-only group, time proportions were .56 for video_main and .44 for video_subtitle. According to these data, multitasking group participants spent more time reading subtitles than watching the characters in the video—opposite of the video-only group. A likely explanation is that the multitasking participants needed a more efficient method for collecting and processing information.

Comparisons of eye movement data among multitasking and single-task groups are shown in Tables 4 (game) and 5 (video). Total number of blinks was significantly lower for the multitasking group, suggesting greater interest among those study participants who divided their time between the video and the game.

Table 3. Focus time distribution in percentage

AOI	M	SD
Multitasking AOI_Game	.80	.13
Multitasking AOI_Video	.19	.13
Multitasking AOI_Video_Main	.07	.05
Multitasking AOI_Video_Subtitle	.13	.10
Video-only AOI_Video	.99	.01
Video-only AOI_Video_Main	.56	.11
Video-only AOI_Video_Subtitle	.44	.11

Table 4. Eye movement feature comparison between multitasking and game-only groups. (*p < .05, **p < .01, ***p < .001)

Factor	Game-only		Multitasking		t-value	p-value
	M	SD	M	SD		
Total Number of Saccades	3011.39	454.54	3451.60	439.30	-3.0340**	.004
Total Number of Blinks	451.39	298.94	356.65	286.50	.9970	.325
Average Fixation Time (AOI_Game)	401.93	79.08	386.47	44.98	.7500	.458
Average Pupil Size (AOI_Game)	1408.06	1377.78	1432.88	1366.85	-.0560	.956

Table 5. Eye movement feature comparison between multitasking and video-only groups. (*p < .05, **p < .01, ***p < .001)

Factor	Video-only		Multitasking		t-value	p-value
	M	SD	M	SD		
Total Number of Saccades	3785.24	605.53	3451.60	439.30	1.938	.061
Total Number of Blinks	780.12	710.52	356.65	286.50	2.303*	.032
Average Fixation Time AOI_Video	299.78	69.18	225.27	45.61	3.795***	.001
Average Fixation Time AOI (Video_Main)	378.99	111.32	256.20	78.64	3.919***	.000
Average Fixation Time (AOI_Video_Sub title)	236.49	47.23	213.55	36.30	1.669	.104
Average Pupil Size (AOI_Video)	1475.25	1429.61	1444.63	1446.30	.065	.949
Average Pupil Size (AOI_Video_Main)	1479.08	1431.68	1486.72	1447.17	-.016	.987
Average Pupil Size (AOI_Video_Sub title)	1467.37	1424.16	1425.26	1439.33	.089	.929

5. CONCLUSION

In this paper we compared levels and qualities of immersion in single-tasking and multitasking scenarios involving a game (FEZ) and a popular television program (The Mythbusters). Both self-report questionnaires and eye tracking data were used to measure immersion. We found that immersion levels among the multitasking study participants were significantly lower in most dimensions, especially in dimensions associated with feelings of separation from the real world and level of concentration. We also found that even though most aspects of immersion in two or more kinds of media were negatively affected in the multitasking setting, instinctive feelings of overall immersion were higher in the multitasking group. We interpret this finding as meaning that a cumulative sense of immersion can emerge from multiple media, depending on certain conditions. Our eye-tracking data indicate that multitasking participants spent more time than the video-only group participants reading video subtitles for efficient information consumption. Game/application designers may want to foster multitasking by improving user interface.

We acknowledge that our experiments were limited in terms of material and apparatus, and that results would likely have been different had we used other games or videos. For example, if we chose online chess as the game, participants may have spent more time focusing on the video while their opponents considered their next moves. Factor analysis results for immersion dimensions may have differed because chess matches do not involve storylines or action beyond moving pieces on a board. Another study shortcoming is the use of a single computer display containing more than one task, since most multitasking involves multiple devices and screens.

REFERENCES

- Brown, E. and Cairns, P. 2004. "A grounded investigation of game immersion" Human Factors in Computing Systems, pp. 1297-1300.
- Breda, L. 2008. "Invisible Walls" Game Career Guide, available at http://www.gamecareerguide.com/features/593/invisible_.php.
- Carr, D. 2006. "Games and narrative" Computer games: Text, narrative and play, Carr, D., Buckingham, D., Burn, A. and Schott, G. eds, Cambridge, UK: Polity Press, pp. 30-44.

- Csikszentmihalyi, M. 1990. *Flow: the psychology of optimal experience*. New York, NY: Harper & Row.
- Ermi, L. and Mäyrä, F. 2005. "Fundamental Components of the Gameplay Experience: Analysing Immersion" *Worlds in play: Int. perspectives on digital games research*, S. D. Castell and J. Jenson, eds, Bern, Switzerland: Peter Lang, vol. 37.
- Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J. and Edwards, T. 2016. "Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning" *Computers in human behavior*, vol. 54, pp. 170-179.
- Ijsselstein, W. A., de Ridder, H., Freeman, J. and Avons, S. E. 2000. "Presence: concept, determinants, and measurement" *Proc. SPIE 3959, Human Vision and Electronic Imaging V*, pp. 520-529.
- Jennett, C., Cox, A. L. and Cairns, P., Dhoparee, S., Epps, A., Tijds, T. and Walton, A. 2008. "Measuring and defining the experience of immersion in games" *International journal of human-computer studies*, vol. 66, no. 9, pp. 641-661.
- Johnson, D. and Wiles, J. 2003. "Effective affective user interface design in games" *Ergonomics*, vol. 46, pp. 1332-1345.
- Lee, K. M. 2004. "Presence, explicated" *Communication theory*, vol. 14, no. 1, pp. 27-50.
- McMahan, A. 2003. "Immersion, engagement and presence" *The video game theory reader*, Wolf M. J. P. and Perron, B. eds, Psychology Press, pp. 67-86.
- Murray, J. H. 1997. *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*. Cambridge, MA: MIT Press.
- Nacke, L. E. and Lindley, C. A. 2009. "Affective ludology, flow and immersion in a first-person shooter: Measurement of player experience" *Loading...*, vol. 3, no. 5.
- Nielsen Corporation, 2014. *The Digital Consumer February 2014*, available at <http://www.nielsen.com/content/dam/corporate/us/en/reports-downloads/2014%20Reports/the-digital-consumer-report-feb-2014.pdf>
- Sweetser, P. and Wyeth, P. 2005. "GameFlow: a model for evaluating player enjoyment in games" *Computers in Entertainment (CIE)*, vol. 3 issue 3.