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Rigby, Jacob M.; Brumby, Duncan P.; Gould, Sandy J. J.; Cox, Anna L.

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Development of a Questionnaire to Measure Immersion in Video Media: The Film IEQ

Jacob M. Rigby
UCL Interaction Centre, University College London
London, UK
j.rigby.14@ucl.ac.uk

Duncan P. Brumby
UCL Interaction Centre, University College London
London, UK
d.brumby@ucl.ac.uk

Sandy J.J. Gould
School of Computer Science, University of Birmingham
Birmingham, UK
s.gould@cs.bham.ac.uk

Anna L. Cox
UCL Interaction Centre, University College London
London, UK
anna.cox@ucl.ac.uk

ABSTRACT

Researchers and practitioners are keen to understand how new video viewing practices driven by technological developments impact viewers' experiences. We detail the development of the Immersive Experience Questionnaire for Film and TV (Film IEQ). An exploratory factor analysis based on responses from 414 participants revealed a four-factor structure of (1) captivation, (2) real-world dissociation, (3) comprehension, and (4) transportation. We validated the Film IEQ in an experiment that replicated prior research into the effect of viewing on screens of varying size. Responses captured by the Film IEQ indicate that watching on a small phone screen reduces the viewer's level of comprehension, and that this negatively impacts the viewing experience, compared to watching on a larger screen. The Film IEQ allows researchers and practitioners to assess video viewing experiences using a questionnaire that is easy to administer, and that has been empirically validated.

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CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**; *Human computer interaction (HCI).*

KEYWORDS

Video, film, TV, experience measurement, immersion, exploratory factor analysis

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1 INTRODUCTION

New technologies are changing the way people consume video media. The advent of on-demand video services has transformed how people access content, from the devices used, to the contexts in which people watch. For example, many people now routinely watch video on small screens when commuting on public transport or relaxing in bed [38]. In the living room, there has been a trend for consumers to purchase larger TV screens [24]. Furthermore, it is now common for people to watch TV while also using their mobile devices [22, 37]. How can researchers and practitioners easily measure and assess different kinds of viewing experiences?

Designers of new video-based experiences would benefit from understanding which designs improve a user's viewing experience and which detract from it. Currently, developing our understanding of viewing experiences in a systematic manner is difficult, as we lack standardised measurement tools and methods. There is little in the way of standardised metrics that allow the impact of different viewing experiences to be measured and compared. Moreover, some methods require specialist equipment, such as measuring physiological signals (e.g., [33]). This can make deployment difficult and costly.

Having a consistent and empirically validated measure of viewer experience would allow researchers to assess the effect of technological interventions, from incremental (e.g., higher definition displays) to highly disruptive (e.g., ubiquitous mobile devices). Computer games researchers make effective use of questionnaires to measure player experience, and we seek to mirror this to evaluate viewer experience. While some concepts may be similar to those in games research, there are important differences between playing games and watching video media — primarily, computer games are interactive while watching video is not. Therefore, games questionnaires cannot be effectively used to assess viewer experience, and thus we seek to develop a specialised questionnaire which is sensitive to these differences.

Aside from academic researchers, there are a number of other stakeholders who can benefit from such a tool. Networks and content producers are having to compete with technology-driven disruptions to traditional viewing habits, as well as wishing to develop new media experiences. Advertisers are also keen to exploit new technologies as emergent revenue streams, and have a need to measure the impact of this.

This paper presents the Immersive Experience Questionnaire for Film and Television (Film IEQ), a questionnaire for measuring *immersion*, a multi-faceted measure of experience taken from computer games research. The questionnaire is based on the Immersive Experience Questionnaire (IEQ) by Jennett et al. [26], and adapted to apply to video viewing. An exploratory factor analysis revealed four factors: (1) involvement, (2) captivation, (3) comprehension, and (4) real-world dissociation. Furthermore, we demonstrate its use through an experiment investigating the effect of screen size on immersion. This provides both validation of our questionnaire and a better understanding of this phenomenon.

2 RELATED WORK

Before describing the development of the Film IEQ, we review previous research concerned with measuring and assessing media experiences. We examine the closely-related theoretical concepts of immersion, presence, and flow, and the ways these concepts have been measured during media experiences. From this review, we focus our attention on questionnaire tools that have been developed to measure immersion, particularly in the field of computer games research, and consider how these can be adapted to assess TV and film viewing experiences.

Concepts for Describing Media Experiences

Several closely-related concepts have been developed to describe media experiences. These include *immersion*, *presence*, and *flow*. Each of these concepts has been used to assess user experiences when consuming media (e.g., when reading books, playing computer games, watching films, or using virtual reality (VR) systems).

Immersion tends to refer to a sense of being highly engrossed in a mediated experience across multiple dimensions [34]. While this typically describes a subjective psychological response, it should be noted that some VR researchers, such as Slater [41], use the term to describe an objective measure of a system in terms of how much the technology can replicate real-world experiences. In this case, a system that provides both video and audio to the user would be objectively more immersive that one providing only video. However, this does sometimes disagree with other VR researchers, such as Witmer and Singer [49], who describe it as a subjective psychological state. Furthermore, in other work Slater also suggests immersion is by nature participatory, and necessitates a match between the users actions and the feedback of the system (e.g. when the user moves their head, the feedback should change accordingly) [42]. This is generally not possible in non-participatory media experiences, such as watching video.

For the purposes of this paper, we are interested in people's subjective media experiences in general, including experiences that are non-participatory and relatively low-tech in comparison with VR systems. Therefore, we focus our attention on prior research that focuses on subjective media experiences, which seems to be the consensus outside of the VR domain.

A basis for the resulting questionnaire featured in this paper is a definition of immersion developed by Jennett et al. [26], and the questionnaire they developed for computer games research. This describes immersion as a subjective experience which is based on multiple concepts. In order to fully understand this, we first describe related concepts and show how immersion can be experienced in non-participatory media, thus making immersion a suitable measure for describing video media experiences. We then focus on experience measurement in video games research, further detailing Jennett et al.'s model of immersion and how it provides a suitable basis for adaptation to video media.

Murray [34] has provided a useful and widely cited definition that describes immersion in media as follows:

> "*A stirring narrative in any medium can be experienced as a virtual reality because our brains are programmed to tune into stories with an intensity that can obliterate the world around us... The experience of being transported to an elaborately simulated place is pleasurable in itself, regardless of the fantasy content. We refer to this experience as immersion. Immersion is a metaphorical term derived from the physical experience of being submerged in water. We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean or swimming pool: 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.*" (Murray [34], p. 124)

Multiple elements make up Murray's definition of immersion, including a sense of transportation to another reality, and a high level of attention to the media. The sense of transportation could be interpreted as presence.

Presence has been used as a measure of experience, it typically refers to spatial presence and the feeling of being physically located somewhere other than the real world [39]. Questionnaires have been developed to measure presence [30, 49]. Studies have been conducted to assesses the level of presence people have when watching video. For example, Lombard et al. [33] investigated the effect of screen size on spatial presence when watching rapid point-of-view footage, which was measured using both self-reported questionnaires and physiological skin conductance measures. Similarly, a study by IJsselsteijn et al. [25] examined self-reported presence in relation to screen size, measured using subjective questionnaires and postural response. We build on this prior research later in this paper by similarly investigating the effect of screen size on viewing experiences.

A limitation of presence measurement that we seek to remedy, is that it gives undue attention to the feeling of physical transportation to another place. By focusing on this aspect of transportation it fails to capture other important qualities of a viewing experience. For example, consider watching a TV quiz show. It could be argued that one can have positive viewing experience without the feeling of being transported to the TV studio. An important question then is how to capture a more holistic measure of the user's viewing experience.

Murray's definition of immersion [34] also incorporates a high level of attention when engaging with a media source. This idea encompasses the concept of *flow* — a state of intense involvement and concentration, where task difficulty is perfectly matched to the skill of the person performing it, and actions become almost automatic [16]. Examples include playing sport (being "in the zone") and musical improvisation.

Immersion in Non-Participatory Media

Expanding on her definition of immersion, Murray [34] described immersion as being participatory, i.e., when immersed, one should be able to perform tasks in the virtual world as if it were real. For media such as games, this seems like a reasonable expectation of an immersive experience — the player has agency to make decisions about the actions they wish to take. How is it then, that it is common for people to report feeling immersed in a book or film? Biocca [3] defined the "the book problem" to ask how it was that people can report high levels of presence when reading books, even though books are low fidelity and do not involve sensorimotor stimuli, which is considered a large part of presence in the virtual reality domain. Biocca argues that the level of presence experienced does not sit on a two pole continuum between the physical space and the virtual space, and proposed a 3-pole model instead. This introduced the notion of "mental imagery space", and Biocca suggested that people use imagery to fill in missing pieces.

Definitions of immersion are sometimes linked to task performance, where states of flow [16] (implying a high level of task performance) can feature. If immersion is partially defined in relation to task performance, how can one feel immersed in a book or film if there is no real task to be performed, other than reading or watching? Busselle and Bilandzic [6] describe how flow can be experienced when viewing or reading media, through focus on comprehending the media and constructing mental models of a narrative.

Sherry [40] also argues that interpreting media is a task in itself, allowing for states of flow to occur. Film conventions of shot composition and editing convey meaning to viewers, and deviating from these can make interpreting messages difficult. Furthermore, Sherry [40] argues that there are varying skill levels in the task of interpreting media. For instance, experimental films may be more difficult to understand than Hollywood movies, but this could be improved by watching more or taking film appreciation classes. Similarly, some books and other printed texts are more accessible than others. Also, some media requires prior knowledge to be fully understood and interpreted, such as the final episode of a serial drama; a viewer who has not seen previous episodes may not fully understand the plot.

Immersion in Computer Games

Experience measurement has been widely studied for computer games, operationalised through concepts such as flow [43], presence [48], puppetry [9], and immersion [26]. Immersion is seen as a desirable quality in computer games, and has itself been widely researched. However, there are differing definitions and care should be taken to differentiate between these [8]. While some metrics are quite narrowly defined, Jennett et al. [26] defined immersion as a generalised concept. This draws from multiple related concepts: flow; cognitive absorption; and presence. However, Jennett et al. specifically highlight how immersion is distinct from these (e.g. a player can be immersed in a game of Tetris without feeling like they are physically present in a world of falling blocks). Furthermore, they developed a questionnaire to measure immersion in the form of the IEQ. This has been widely used in games research (e.g. [1, 5, 7, 11, 15, 45, 46]), and also successfully adapted to other domains such as public speaking anxiety [50] and games without graphics for visually-impaired players [18].

Given its broader insight into experience, robust development, and wide usage, the IEQ presents a promising way of measuring immersion in video media. However, there are important differences between gaming and watching video. Firstly, watching video is mostly a "lean back" activity, where the viewer observes without interacting. Conversely, playing games is a "lean forward" activity, where the player interacts with the game.

Secondly, Jennett et al. [26] definition of immersion incorporates flow, which is concerned with the extent to which a user's ability is matched to the task at hand. However, as previously mentioned, there is generally no task to be completed when watching TV and film. Despite this, Busselle and Bilandzic [6] argue that flow can apply to narrative media — focusing one's attention, and the act of processing the media and updating mental models, are tasks in themselves which can be subject to states of flow. Additionally, Busselle and Bilandzic posit that narrative media can lead to loss of awareness of the passage of time, much like when flow is experienced in non-narrative activities. Furthermore, Sherry [40] argues that there are varying skill levels with regard to interpreting media, much like in other tasks.

Though there are differences between gaming and watching video, the theoretical grounding of the IEQ provides a basis for usage in non-game domains. It measures experience in mediated environments, and many of the questions contained within the IEQ are general enough to apply to other media. Taking this into account, we detail the development of a modified version of the IEQ to measure immersion in video media. An exploratory factor analysis was also performed to establish the underlying factor structure of the questionnaire.

3 QUESTIONNAIRE DEVELOPMENT

To develop our questionnaire for measuring immersion in video media, the original IEQ was used as a basis. Firstly, the questions from the IEQ were reviewed to find game-specific wording. These questions were reworded to apply to video media, providing the essence of the question remained the same, e.g. "to what extent did the game hold your attention?" became "to what extent did the movie, TV show, or clip hold your attention?".

Some questions intuitively do not apply to the mostly passive experience of viewing video, e.g. those concerning a game's controls. Unable to be reworded or modified, they were replaced. Some replacement questions concerned how the viewer had followed the content and themes of the video ("how challenging were the themes?" instead of "how challenging was the game?"). Others concerned narrative engagement [6], similar to Brumby et al. [4]. These incorporated elements of transportation [19], presence, flow, and cognitive and emotional investment as in the IEQ.

After modifying the original IEQ, the questionnaire consisted of 31 items measured using a 1–7 Likert scales (see Table 1). The questionnaire was piloted with a small sample to ensure clear wording. It was also found that the questionnaire took less than five minutes to complete.

4 EXPLORATORY FACTOR ANALYSIS

After developing the questionnaire, and as in Jennett et al. [26], we wished to examine the underlying factor structure to better understand how the concept of immersion is constructed and measured. To do this, an exploratory factor analysis (EFA) was performed, which

#	Original question	Modified question
1.	To what extent did the game hold your attention?	To what extent did the **movie, TV show, or clip** hold your attention?
2.	To what extent did you feel you were focused on the game?	To what extent did you feel you were focused on the **movie, TV show, or clip**?
3.	How much effort did you put into playing the game?	How much effort did you put into **watching the movie, TV show, or clip**?
4.	Did you feel that you were trying you best?	Did you feel that you were trying you best **to follow the events of the movie, TV show, or clip**?
5.	To what extent did you lose track of time?	*Unchanged*
6.	To what extent did you feel consciously aware of being in the real world whilst playing?	To what extent did you feel consciously aware of being in the real world whilst **watching**?
7.	To what extent did you forget about your everyday concerns?	*Unchanged*
8.	To what extent were you aware of yourself in your surroundings?	*Unchanged*
9.	To what extent did you notice events taking place around you?	*Unchanged*
10.	Did you feel the urge at any point to stop playing and see what was happening around you?	Did you feel the urge at any point to stop **watching** and see what was happening around you?
11.	To what extent did you feel that you were interacting with the game environment?	**To what extent could you picture yourself in the scene of the events shown in the movie, TV show, or clip?***
12.	To what extent did you feel as though you were separated from your real-world environment?	*Unchanged*
13.	To what extent did you feel that the game was something you were experiencing, rather than something you were just doing?	To what extent did you feel that the **movie, TV show, or clip** was something you were experiencing, rather than something you were just **watching**?
14.	To what extent was your sense of being in the game environment stronger than your sense of being in the real world?	To what extent was your sense of being in the environment **shown in the movie, TV show, or clip** stronger than your sense of being in the real world?
15.	At any point did you find yourself become so involved that you were unaware you were even using controls?	**While watching the movie, TV show, or clip, could you easily picture the events in it taking place?***
16.	To what extent did you feel as though you were moving through the game according to you own will?	**To what extent did you find yourself thinking of ways the story could have turned out differently?***
17.	To what extent did you find the game challenging?	To what extent did you find the **concepts and themes of the movie, TV show, or clip** challenging?
18.	Were there any times during the game in which you just wanted to give up?	Were there any times **when you just wanted to give up watching**?
19.	To what extent did you feel motivated while playing?	To what extent did you feel motivated while **watching**?
20.	To what extent did you find the game easy?	To what extent did you find the **concepts and themes of the movie, TV show, or clip easy to understand**?
21.	To what extent did you feel like you were making progress towards the end of the game?	To what extent did you feel like you were making progress towards **understanding what was happening during the movie, TV show, or clip, and what you thought might happen at the end?**
22.	How well do you think you performed in the game?	How well do you think you **understood what happened in the movie, TV show, or clip?**
23.	To what extent did you feel emotionally attached to the game?	To what extent did you feel emotionally attached to the **movie, TV show, or clip**?
24.	To what extent were you interested in seeing how the game's events would progress?	To what extent were you interested in seeing how the **events shown in the movie, TV show, or clip** would progress?
25.	How much did you want to "win" the game?	How much did you want **the events in the movie, TV show, or clip to unfold successfully for the main characters involved?**
26.	Were you in suspense about whether or not you would win or lose the game?	Were you in suspense about **how the events would unfold in the movie, TV show, or clip?**
27.	At any point did you find yourself become so involved that you wanted to speak to the game directly?	At any point did you find yourself become so involved that you wanted to speak to the **movie, TV show, or clip** directly?
28.	To what extent did you enjoy the graphics and the imagery?	*Unchanged*
29.	How much would you say you enjoyed playing the game?	How much would you say you enjoyed **watching the movie, TV show, or clip**?
30.	When interrupted, were you disappointed that the game was over?	When interrupted, were you disappointed that **you had to stop watching**?
31.	Would you like to play the game again?	Would you like to **watch more of this in the future**?

Table 1: Modifications made to the original Immersive Experience Questionnaire (IEQ) to create the Film IEQ (changes in bold). Questions marked with * are taken from Green and Brock [19]

is used to find a smaller set of latent factors that represent the variables measured in the questionnaire [21].

Method

Participants. The questionnaire was completed by 415 participants. The first 213 were recruited via forums, social media, and university mailing lists. After exhausting these channels, it was listed on websites where participants were rewarded for participation to increase the sample size. The remaining participants received either course credit for participants recruited through a university psychology subject pool, or a payment of £0.90 ($1.20) for participants recruited through a crowdsourcing website. Participants were required to have watched a movie or TV show in the previous three days. Though sample size guidelines for EFA vary, our sample size is in line with recommendations in prior research [13].

Materials. The Film IEQ was administered using an online form, and consisted of a single page featuring all of the questions. At the very top was a section detailing the study to allow participants to give informed consent.

Procedure. The questionnaire was distributed to participants through websites, email, social media, and crowdsourcing platforms, as detailed above. They were invited to help with a scientific study about how immersed people feel when watching video media. Participants were asked to fill in the questionnaire while thinking about about the last thing they watched in the previous three days. To aid recall, participants were asked to provide some information about what they watched: the title; one of the main actors, characters, presenters or other personnel that featured prominently; a location that featured prominently; and a brief synopsis of what happened. These were only to help participants remember what they watched, and were not used in the analysis.

Results

Prior to analysis the data were checked for missing values, resulting in the removal of one questionnaire response. This left 414 responses on which the EFA was performed. Total immersion scores were computed for each of the participants. Responses to negatively scored items (Qs 6, 8, 9, 10, 18 and 20) were first inverted (7 becomes 1, 6 becomes 2, 5 becomes 3, etc.), and then the responses to all questions were summed to give a value between 31 and 217. Observed immersion scores ranged from 48 and 182 (M =139.61, SD =16.36).

As there are many subjective decisions when performing an EFA, recommendations and guidance from prior research were followed [2, 35]. Prior to conducting the EFA, the sampling adequacy was tested to ensure the factorability of the variables. The result of a Kaiser-Meyer-Olkin test was .85 (above the recommended .6) and Bartlett's test of sphericity was significant ($p < .001$), suggesting the data's suitability for EFA [2].

Factor Extraction and Retention. One of the first and most important steps in performing an EFA is to decide how many factors to extract. Multiple methods exist to achieve this, though two are most commonly used [35]. First, the eigenvalue-one criterion ("Kaiser's criterion"), which discards factors with an eigenvalue < 1 [27]. Second, the scree test method [10], which plots the factors and their eigenvalues on a graph, then retains only those before the point where the line starts to level off horizontally. A less common, though arguably better method [29], is Horn's Parallel Analysis [23], where random datasets are generated and compared to the current dataset. Due to the inherently subjective nature of deciding on the number of factors, researchers have been advised to assess multiple criteria and use reasoned reflection when deciding on the number of factors [21].

The eigenvalue-one criterion, the scree plot method, and Horn's parallel analysis were all considered for our study. The eigenvalue-one criterion suggested five factors, and the scree plot suggested three factors. A parallel analysis was also performed, suggesting eight factors.

As parallel analysis is shown to be one of the best methods for establishing the number of factors [29], an eight factor solution was first considered. However, this resulted in a number of crossloaded items (items loading onto multiple factors) which were removed, leading to some factors containing fewer than three items. As guidance suggests that factors with fewer than three items are unstable [52], these were then further removed. As this resulted in removal of a large number of items which compromised the sensitivity of the immersion measure, the number of factors to extract was then repeatedly reduced by one and the analysis repeated until a satisfactory solution was obtained with four factors — i.e., without a large amount of crossloaded items, without factors with fewer than three items, and without a large amount items that did not load onto any factor. The five and three factor solutions of the other methods were also attempted, but the four factor solution offered to most logical solution for our data.

Researchers also have to decide on a factor extraction and factor rotation method, to make interpreting the data easier and reveal a simple structure [14]. Again, there are no absolute guidelines for this. Multiple factor extraction and rotation methods were attempted, until the four-factor solution was arrived at which seemed to best fit the data. This used the maximum likelihood method of extraction, and a direct Oblimin rotation which allows factors to correlate. This four-factor solution explained 56% of total variance. A .32 cutoff value was used for factor loadings (as recommended by Tabachnick et al. [44]), resulting in items 5, 7, 10, 15, and 16 being removed. Crossloaded items 18 and 23 were also removed. The analysis was then repeated and four factors were extracted. This resulted in a 24-item scale (see Table 2), giving overall immersion scores between 24 and 168. Resulting factors and loadings, as well as item descriptives, are shown in Table 3.

Factor Identification. After retaining four factors, the questions were examined and the factors were titled appropriately: *captivation, real-world dissociation, comprehension,* and *transportation*; described below (Table 2 shows an overview of the factors and their questions):

(1) *Captivation.* Twelve items (Qs 1–4, 13, 17–19, 21–24) regarding the viewer's enjoyment, how interested they were, and their motivation to watch.

(2) *Real-world dissociation.* Three items (Qs 5–7) regarding how much the viewer was aware of their real world surroundings.

(3) *Comprehension.* Four items (Qs 12, 14–16) asking about how well the concepts and themes of the video were understood.

(4) *Transportation.* Five items (Qs 8–11, 20) describing how much the user felt like they were experiencing events for themselves, and how much they felt they were located in the world portrayed in the video.

Internal consistency of the scale was measured using Chronbach's Alpha. A value of .859 indicated a high level of internal consistency. This was also computed for each subscale; captivation = .852, real-world dissociation = .824, comprehension = .658, transportation = .793.

Finally, it is possible that some participants being rewarded for participation could affect responses. The reward and non-reward sample groups were therefore compared to check for any disparities. Immersion scores were plotted on a graph and assessed visually, revealing no obvious differences between the groups. An independent samples t-test was also conducted, and there was no evidence that these groups differed significantly in terms of total immersion scores, $t(413) = .943$, $p = .346$.

Using the Questionnaire

To use the Film IEQ, participants should answer all questions in Table 2 using 1–7 Likert scales. This typically took less than five minutes in our experience. Calculate overall immersion scores by first inverting responses to items 5, 6, and 7 (1 becomes 7, 2 becomes 6, 3 becomes 5, etc.) then summing all responses. Individual subscale scores are calculated in the same way, first inverting responses where necessary then summing the responses to all questions within that subscale.

5 VALIDATION EXPERIMENT: THE EFFECT OF SCREEN SIZE ON IMMERSION

The previous section of this paper showed how the Film IEQ was developed, using statistical techniques to uncover the underlying factor structure. However, this does not fully demonstrate its intended use. For the EFA, participants were asked to recall something they watched recently, but to show its usefulness we wished to use it to evaluate differences in viewing experiences.

Previously, researchers have looked at how screen size affects video viewing experiences. Lombard et al. [32] performed a lab study with participants watching content on either a 46-inch screen or a 12-inch screen, and found that screen size had an effect on questionnaire responses. Reeves et al. [36] found that arousal and attention increased when viewing on larger screens, measured using skin conductance and heart rate respectively. Studies by Lombard et al. [33] and IJsselsteijn et al. [25] both found that larger screens could increase the sense of presence felt by participants.

The ubiquity of technology in our everyday lives means that interactions with technology occur on a variety of different screen sizes. These can be linked to personal accounts and services, offering flexibility and convenience for users. However, this also presents a lack of control for developers and content producers over the experience provided to the user; e.g. a game may be easy to control when using a tablet touchscreen, but could be more frustrating on a phone screen, providing a diminished experience to the player. Thompson et al. [46] 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.

The variety of screen sizes in everyday computing is also present in the domain of video consumption. Rigby et al. [38] found that the rise in popularity of on-demand video services meant that people are now watching

#	Question	Factor
1.	To what extent did the movie, TV show, or clip hold your attention?	1
2.	To what extent did you feel you were focused on the movie, TV show, or clip?	1
3.	How much effort did you put into watching the movie, TV show, or clip?	1
4.	Did you feel that you were trying your best to follow the events of the movie, TV show, or clip?	1
5.*	To what extent did you feel consciously aware of being in the real world whilst watching?	2
6.*	To what extent were you aware of yourself in your surroundings?	2
7.*	To what extent did you notice events taking place around you?	2
8.	To what extent could you picture yourself in the scene of the events shown in the movie, TV show, or clip?	4
9.	To what extent did you feel like you were separated from your real-world environment?	4
10.	To what extent did you feel that the movie, TV show, or clip was something you were experiencing, rather than something you were just watching?	4
11.	To what extent was your sense of being in the environment shown in the movie, TV show, or clip stronger than your sense of being in the real world?	4
12.	To what extent did you find the concepts and themes of the movie, TV show, or clip challenging?	3
13.	To what extent did you feel motivated to keep on watching?	1
14.	To what extent did you find the concepts and themes easy to understand?	3
15.	To what extent did you feel like you were making progress towards understanding what was happening, and what you thought might happen at the end?	3
16.	How well do you think you understood what happened?	3
17.	To what extent were you interested in seeing how the events in the movie, TV show, or clip would progress?	1
18.	How much did you want the events in the movie, TV show, or clip to unfold successfully for the main characters involved?	1
19.	Were you in suspense about how the events would unfold?	1
20.	At any point did you find yourself become so involved that you wanted to speak to the movie, TV show, or clip directly?	4
21.	To what extent did you enjoy the cinematography, graphics and/or imagery?	1
22.	How much would you say you enjoyed watching the movie, TV show, or clip?	1
23.	When it was over, were you disappointed that you had to stop watching?	1
24.	Would you like to watch more of this, or similar content, in the future?	1

Table 2: Film IEQ questions, numbered by factor (1: captivation, 2: real-world dissociation, 3: comprehension, 4: transportation). Negatively scored items marked with an asterisk (*).

video content on a variety of devices and screens. However, it was also found that participant would generally prefer to watch on larger screens if they were available.

This section details an experiment investigating the effect of screen size on viewer immersion. This demonstrates the usage of the questionnaire, as well as providing validation by showing its sensitivity to previously studied phenomena using related measures. As the results of previous work showing that larger screens often elicit a stronger response to various measures, we expect that smaller screens will lead to lower immersion scores. Furthermore, we intend to develop a better understanding of exactly how the viewing experience is affected by examining the subscales of the questionnaire factors.

Method

Participants. Nineteen participants (12 female, 7 male) were recruited through a UK university's subject pool. They earned 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 video 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 immersion score 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. Three 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'

#	Captivation	Real-world dissociation	Compre-hension	Transport-ation	Mean	SD	Range
1.	.832				5.99	.99	5.0
2.	.780				5.76	1.19	6.0
3.	.426				4.56	1.64	6.0
4.	.472				5.07	1.70	6.0
5.		-.704			3.54	1.69	6.0
6.		-.803			3.43	1.57	6.0
7.		-.735			3.97	1.66	6.0
8.				.597	3.41	1.88	6.0
9.				.652	3.76	1.71	6.0
10.				.797	3.64	1.84	6.0
11.				.872	3.18	1.70	6.0
12.			.509		3.14	1.79	6.0
13.	.698				5.81	1.26	6.0
14.			.803		5.63	1.16	5.0
15.			.364		6.33	1.00	6.0
16.			.729		5.97	1.16	6.0
17.	.623				5.63	1.48	6.0
18.	.375				4.67	1.80	6.0
19.	.354				2.90	1.96	6.0
20.				.366	5.33	1.45	6.0
21.	.509				5.99	1.07	5.0
22.	.806				4.43	1.98	6.0
23.	.441				6.12	1.17	5.0
24.	.662				5.97	1.17	6.0

Table 3: Pattern matrix showing factors and factor loadings (values below 0.32 omitted), and item descriptives.

hands with their arms on the desk); a Dell laptop with a 13-inch screen (placed on the desk approx. 50 cm away), and a 30-inch monitor (also placed 50 cm away). All screens were directly in front of the participant, and this viewing angle was keep consistent throughout.

Participants used the laptop to select a movie from the Netflix online streaming website, which was required to be one they wanted to watch but had not yet seen. Four participants chose *The Wolf of Wall Street*, two chose *The Dallas Buyer's Club*, two chose *She's Funny That Way*, and two chose *The Hunger Games: Mocking Jay Part 1*, and the remaining participants chose something that no one else chose. The first 30 minutes of this was split into three 10-minute clips. Audio was played through Sony over-ear headphones in order 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.

Procedure. Participants were greeted, and then asked to read the information sheet and sign a consent form. They were then given the opportunity to ask any questions they had. To begin the study, participants were seated at the desk and were told how the study would proceed and what they should do, then they filled in a questionnaire to collect demographic data. They were then asked to choose a movie to watch from the Netflix streaming catalogue, which they had not seen before but would like to see. They watched the first 10 minutes of their chosen movie on their first assigned device and filled out the Film IEQ. The next 10 minutes were then watched on the second 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. Finally, participants were given another opportunity to ask questions before leaving.

Results

Immersion scores were calculated by summing all questions in the Film IEQ. Questions 5, 6, and 7 were scored negatively. Prior to data analysis, Shapiro-Wilk tests and Q-Q plots confirmed a normal distribution.

Mean immersion scores were lower in the phone condition (M = 106.05, SD = 15.53) than in the laptop (M = 114.47, SD = 12.42) or monitor conditions (M = 116.89, SD = 13.55). A one-way repeated measures ANOVA was used to analyse this data, and showed a significant main effect of screen size on immersion score, $F(2, 36) = 5.09$, $p = .011$, $\eta_p^2 = .22$. Post-hoc t-tests were performed to examine pairwise differences between conditions, using Bonferroni corrections. The results showed a significant difference in immersion score between the phone condition and laptop condition, $t(18) = 2.65$, $p = .048$, $d = 0.61$, and the phone condition and monitor condition, $t(18) = 2.69$, $p = .045$, $d = 0.62$. There was no significant difference in immersion score between the laptop condition and monitor condition, $t(18) = .48$, $p > .99$, $d = 0.16$. This suggests that viewing content on a very small screen results in lower immersion than when watching on a much larger screen.

We were also interested in the various subscales of the Film IEQ factors. To examine this we performed a series of one-way repeated measures ANOVAs on responses to each subscale of the questionnaire. As can be seen in Table 4, there was a significant main effect of screen type on comprehension, $F(2, 36) = 5.48$, $p = .008$, $\eta_p^2 = .23$. However, there was no effect of screen size on captivation, real-world dissociation, or transportation, all p values > 0.05. Post-hoc tests were again performed on the significant subscale. Paired sample t-tests revealed significant differences in the phone-monitor conditions of the comprehension subscale (see Table 5).

Factor	F (2, 36)	p	η_p^2
Captivation	2.14	.132	.11
Real-World Dissociation	2.01	.15	.1
Comprehension	5.48	.008*	.23
Transportation	2.49	.098	.12

Table 4: Repeated measures ANOVA results for Film IEQ subscales. p values $< .05$ marked with *.

Conditions	$t(18)$	p	d
Phone - Laptop	2.09	.153	.48
Phone - Monitor	3.48	.008*	.8
Laptop - Monitor	1.09	.867	.25

Table 5: Post-hoc paired-sample t-test results for comprehension subscale. p values $< .05$ marked with *.

Discussion

The hypothesis that larger screen sizes would result in greater immersion was supported. The significant main effect of screen size across conditions suggests that it is more difficult to experience high levels of immersion when viewing very small screens. This fits with the results of the study by Thompson et al. [46], where immersion scores reported using the IEQ when playing a simple game were significantly lower on a smaller screen than on a larger one. It also agrees with other studies examining the response to screen size on other measures, such as presence [25, 33]. Furthermore, it is consistent with qualitative research on mobile viewing, where people often express a preference for larger screens [38]. Therefore, this result further validates the Film IEQ as an immersion measure — it is sensitive to the interventions that related measures are also sensitive to.

Why larger screens provide an enhanced experience is not well understood when looking at previous work observing responses to screen size. Hatada et al. [20] found that viewers perceived a greater sense of realism when viewing on larger screens. Furthermore, some research argues that increased responses could be due humans perceiving objects on screen as larger [47], and that images in a video are not just representational, but are objects themselves [17]. Therefore bigger images are bigger objects, which can cause a reaction at a primitive level and generate different emotions and actions.

In addition seeing how overall immersion is affected by screen size, the Film IEQ also allows us to develop a more nuanced understanding by examining the questionnaire factor subscales. In this experiment, only the comprehension factor was significantly affected by screen size. This suggests that the smaller screen size leads to a lower level of viewer understanding — this may be due to missing small details that may be critical to the plot, or because a small screen fills less of the visual field, potentially allowing more distractions from outside (though an impact on the real-world dissociation factor may be expected in this case). Some research has suggests that larger images can improve memory for content, which may aid comprehension when remembering something previously seen [31]. Additionally, having to physically hold the device may have introduced some discomfort, which could also be distracting. We also note that the only statistically significant pairwise comparison within the comprehension subscale was phone-monitor. This is likely due to the relative size difference between those two devices being particularly large (4.5-inch screen versus a 30-inch screen), whereas the phone-laptop and laptop-monitor comparisons are more incremental. This could have made the effects described above more apparent, and therefore more easily detectable.

Examining the remaining subscales other than comprehension revealed no statistically significant results. This could explain why watching content on smaller screens is fairly common — while some elements of immersion are affected (comprehension), it is still possible to have a enjoyable and immersive experience.

A possible confounding factor in this study was the freedom of choice of content that participants were given, as it is possible that some movies, or sections of them, could be considered more immersive than others. When designing the experiment, we considered giving every participant the same stimuli. However, as the questionnaire is partially based on personal preference, showing all participants the same content would have made personal interest a confounding factor. For this reason, it was decided that participants should have the freedom to choose content that would give an enjoyable experience, as well as something they had not seen before.

A possible limitation is the lab setting, which could be seen as unsuitable for studying living room behaviour. This reflects the tension between experimental control versus ecological validity when considering research methods in this domain. Both lab studies and situated studies offer pros and cons, and both serve useful purposes. Therefore, careful thought should be given when choosing a methodology. Lab experiments, such as the one detailed here, are useful for understanding specific behaviours and phenomena in detail.

6 GENERAL DISCUSSION

This paper has examined the concept of immersion, and transferred a well-used definition from computer games research to the domain of video consumption. Even given the similarities due to using much of the same source material and questionnaire items, immersion when watching video appears to be different from immersion when playing games. When examining the factor structure, the Film IEQ revealed a four-factor structure rather than the five principle components in the IEQ, suggesting that this definition of immersion in video media constitutes fewer latent variables. Such differences may be due to the "lean back" nature of video consumption, where the user has little or no interaction or autonomy. This is in contrast to the "lean forward" nature of playing games where the player interacts directly, which is reflected in the control and challenge factors extracted from the IEQ by Jennett et al. [26].

There are some similarities between the IEQ and Film IEQ. Both measure a real-world dissociation factor, suggesting that escapism is a common element. This has been shown to be a motivation for playing games [51] for some players who prefer the exploration and roleplaying elements of gaming, and it has been suggested that the psychological detachment that these experiences can afford is beneficial to players, potentially aiding post-work recovery [12]. Similarly, Kubey [28] notes that television is often chosen as an activity to escape negative feelings caused by work and other areas of life.

The captivation factor contains many of the items measuring cognitive involvement and emotional involvement in the IEQ, suggesting that both cognitive and emotional investment is a common indicator of immersion across both media. This is supported by Busselle and Bilandzic [6], who argue that following a narrative in non-interactive media requires both cognitive and emotional processes, and can result in a state of flow.

Due to the Film IEQ having one fewer factor than the IEQ, some items from different factors of the IEQ loaded onto the same factor in the Film IEQ. E.g., the Film IEQ factor comprehension was loaded with items from challenge and cognitive involvement factors of the IEQ. This seems logical — the comprehension factor is concerned with how well the viewer understands and follows the video, would would involve cognitive resources and could also present a challenge in some cases.

7 CONCLUSION

This paper details the development of the Film IEQ, a questionnaire to measure viewer immersion when watching video. After modifying a well-used gaming questionnaire, an exploratory factor analysis revealed a four factor structure. When comparing immersion in games and video, we see that the two concepts are related but distinct. For validation, we also conducted an experiment demonstrating the intended use of the questionnaire. The Film IEQ provides a standardised method to investigate the effects of interventions in an easily deployable way, typically completed in less than five minutes.

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