

Evaluating Immersive User Experience and Audience Impact

SUMMARY REPORT

A report produced by Nesta and i2 Media Research
for Digital Catapult, June 2018

CONTENTS

1	Executive summary
5	Introduction and research context
6	Methodology
13	Background, literature review and focus groups
21	Research findings
36	Key predictors of impact in immersive experiences
38	Toolkit development
41	Conclusion
43	Appendices
44	References & Footnotes

REPORT AUTHORS

Dr Jane Lessiter
Sam Mitchell
Eva Ferrari
Polly Borden
Hasan Bakhshi
Professor Jonathan Freeman

This report was produced by Nesta and i2 Media Research for Digital Catapult, and funded by Innovate UK.

Digital Catapult, Immerse UK and the High Value Manufacturing Catapult have been working together on a large-scale programme of business support, funded by Innovate UK, for the UK's immersive technology industries since September 2017.

This report forms part of that work along with the following complimentary reports:

- [The Immersive Economy in the UK](#)
(Innovate UK, Immerse UK and Nesta)
- [Growing Your VR/AR Business in the UK: A business and legal handbook](#)
(Digital Catapult and PwC)
- [Immersive Content Formats for Future Audiences](#)
(Digital Catapult & Limina Immersive)
- [Creative Tools and Workflows for Immersive Content Creation](#)
(Digital Catapult, Opposable Group and TechSpark)
- [Immersive in manufacturing - the adoption and use of immersive technologies in manufacturing and a report covering the feasibility of the use of immersion in a digital twin](#)
(High Value Manufacturing Catapult)

Innovate UK is part of UK Research and Innovation, a non-departmental public body funded by a grant-in-aid from the UK government. We drive productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class research base.

Contact us

immersive@digicatapult.org.uk
www.digicatapult.org.uk

Working with
Innovate UK

INTRODUCTION

The emerging UK immersive economy looks set to grow rapidly over the next few years. Research by Nesta for Immerse UK shows that there are currently 1,000 immersive specialist companies working in the UK, with an estimated turnover of £660m¹. Government and industry are increasingly emphasising the need for investment in this area, so that the UK is best placed to secure an early international competitive advantage².

Despite the growth and interest in this area, how and where immersive experiences are likely to be consumed by future audiences, and what distribution channels will consolidate those experiences, are still being established. YouGov, for example, estimates that only 6% of UK consumers own any form of VR headwear, including low budget options such as Google Cardboard³. The assumptions and market indicators are that consumer VR in particular and immersive technology more generally will penetrate into home usage. There may be other widespread applications and use cases too – through cinemas, arcades⁴ and one-off installations and experiences.

Creative producers, whether from the nascent immersive specialist sector or within the arts, media and film sectors, are rapidly developing VR as a medium, and there are already several notable pieces of cultural content that have reached wide audiences⁵. For example, in 2017, the National Theatre partnered with the National Film Board of Canada for a VR story entitled Draw Me Close which received widespread critical acclaim. In the same year, Google Spotlight Stories funded Pearl, an animation that became the first VR story to be nominated for an Oscar⁶. There are now several festivals and showcases dedicated to promoting VR as an art form in a similar manner to film or music⁷.

The context, then, is of a growing supply of VR and immersive storytelling content in the UK and globally, an as yet undefined market for how this content will be consumed.

THE PROJECT'S RESEARCH QUESTIONS AND METHOD

Nesta and i2 Media Research were commissioned by Digital Catapult to explore how immersive experiences impact upon audiences and propose a toolkit to evaluate audience reactions to this content. In particular, the focus was on uncovering:

"...how can we test and evaluate experimental immersive content that is being made now, in a way that will help us predict the potential audience appetite, cultural impact, and commercial opportunity in the future."⁸

To answer this question, the team developed a research protocol that was tested using a controlled lab trial whereby users experienced and evaluated immersive content. The research also included focus groups and interviews with content creators, stakeholders and target end-users.

Each trial participant experienced two pieces of immersive content and completed pre-and post-test surveys to gauge their psychological, cultural and economic responses to the work. Follow-up surveys with the trial participants explored their longer-term reactions to the immersive content. The content creators themselves were also surveyed about what psychological impact on audiences they intended to elicit with their work. The research protocol was applied to three pieces of 'room scale' VR content that allowed 6 degrees of freedom in relation to movement, and gave varying levels of interactivity. The three pieces of content chosen had all received some form of critical acclaim, were all under fifteen minutes in length and all were operational on the HTC Vive platform. These were:

1. Content A

A narrative-driven, short fantasy story in VR. While too structured in form to be considered a game, there are elements of gameplay within this experience and several points at which

the user is able to make a specific choice to influence the story (not the case in either Content A or C).

2. Content B

A short animated piece that allows the user to interact with a range of situations that a single character guides you through, to showcase some of the functionality of VR. Users travel through a variety of different landscapes and conduct a few simple tasks (e.g. picking up items in VR). While there is interactivity in Contents A and B, there is no jeopardy or ability to 'lose' as in a conventional video game.

3. Content C

A short, non-narrative conceptual VR experience which emphasises human relationships with nature. The user is able to interact with their surroundings, but in a non-linear format (for example, there is no plot exposition or levels). In the full version of this piece of content, the experience is augmented with a physical, haptic experience: the trial only allowed the users to engage with the VR component of the full experience.

The method and measures of impact used in the research protocol drew on a significant body of academic and industry research into consumer psychology, cultural value and willingness to pay. Impact measures were also validated as relevant to VR experiences from the results of three focus groups with content creators, industry stakeholders and potential audiences. The literature and focus groups are considered in detail in the full report.

THE RESEARCH SPACE

The project focuses on the area of 'pre-testing' which typically involves evaluation of an experience, in this instance, creative content in an immersive form with a small representative sample of a given target audience population, in order to understand and predict the wider audience response.

This research broadly carves the media experience space (see Figure 1) conceptually into the following interacting elements or components:

- Media form (in this instance, the immersive technology system and what functionality it affords).
- Media content (the creative elements, e.g. narrative, story, genre; note: the media form influences the extent to which content can capitalise on interaction.)
- The media user and their characteristics (e.g. user attitudes to the form and content; their propensity to feel immersed in a mediated display, e.g. suggestibility; their mood state).
- The context of use (e.g. home/public, alone/social etc.).

What, how and where content is presented interact with person factors. This framework supports an understanding of how different elements influence an end user's experience with immersive content. Immersive content can have impact and value in a variety of domains, including the psychological, social, cultural, and economic. There is a time dimension relevant to impact too. This means there may be differences between impact measured in the short-term (immediate) and long-term.

UX IN CONTEXT

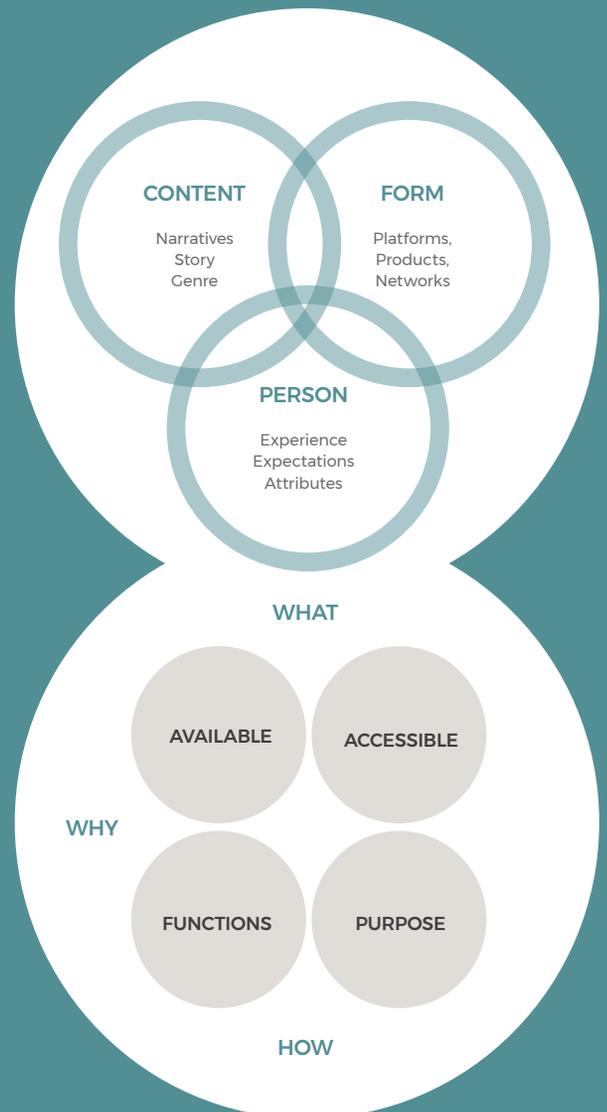


Table 1 below outlines the different types of data gathered both before, during and after the user trials took place.

DATA CATEGORY	DESCRIPTION OF DATA	DESCRIPTION OF WHAT THE DATA IS ATTEMPTING TO CAPTURE
PRE-test measures		
Socio-demographic data	Age group, Gender, UK/Region residence, Children in HH, Marital Status, Education, Work Status, Ethnicity, General Health, Household income.	Socio-demographic information on trial participants.
Interests in, and attitudes toward, arts, culture and technology	Arts and Cultural Event Visits, 10 items (e.g. a museum or gallery; some items derived from the DCMS Taking Part Survey). Lifestyle Engagement, 13 items (e.g. Eat out, Sports/ Gym/Exercise). Generating/Performing Arts and Culture Content, 14 items (e.g. written music, performed play). Attitudes to technology and social media, 9 items (some items derived from i2-Technology Experiences questionnaire, measuring 4 sub-scales: Tech Gadget; Positive Image as Technology User, TechnoAngst and Traditionalism). Previous VR experiencesexperience, 1 item. Previous Research Trial experience, 1 item.	Cultural attendance and participation, general lifestyle and attitudes towards technology and VR. With larger sample sizes in the future, audience experience can be segmented by (for example) familiarity with technology or levels of cultural engagement.
Adoption of technology	Digital technology ownership, including any VR headsets and type (8 products, e.g. Games Consolegames console). Use of Digital Services (4 services including streaming services and MMOGs).	Whether trial participants are early or late adopters of technology, and VR hardware and software specifically.

POST-test measures - General experiential and cultural value qualities (immediate reflections post test)

Global experiential quality evaluation	11 items generated by i2 to evaluate overall quality of experience, to reflect perceived sum of detailed experiential experience e.g. Good, Powerful, Worth Paying For.	Overall sense of UX. Combined, these responses provide one of the proxies for 'impact'.
Perceptions of cultural value	14 items derived from two measures: Arts Council England's Quality Metrics and Nesta's previous research with NT Live e.g. Interesting Idea, Well Presented and Produced; Engaged me on an Intellectual Level.	The underlying 'cultural value' of the experience. Combined, these responses serve as another proxy for 'impact'.

DATA CATEGORY	DESCRIPTION OF DATA	DESCRIPTION OF WHAT THE DATA IS ATTEMPTING TO CAPTURE
---------------	---------------------	---

Detailed experiential qualities

Intensity of affects/emotions	<p>29 emotions and affective (mood) states experienced during the content, items derived from:</p> <p>Positive and Negative Affect Schedule (PANAS, e.g. Excited, Watson et al., 1988, 20 items).</p> <p>Discrete Emotions Questionnaire (DEQ, e.g. Disgust, Harmon-Jones et al. 2016, 6 items),</p> <p>Profile of Mood States. (POMS, e.g. Confusion, McNair et al. 1971, 2 items).</p> <p>One additional state not covered in the above scales: 'Surprise'.</p>	<p>The emotional quality and intensity of the experience and the overall mood (affect) that people are left with. Many content creators intend from the outset to elicit particular emotions and affects/moods. We draw on a range of widely used published scales.</p>
Presence related experiences	<p>9 items derived from the ITC-SOPI (Lessiter et al., 2001) measuring 4 subscales:</p> <ul style="list-style-type: none"> • Sense of Physical Space (4 items). • Engagement (3 items). • Ecological Validity (3 items). • Negative Effects (5 items e.g. headache, eyestrain). 	<p>Users' sense of 'being there' (presence), which is typically elicited in immersive displays mediated by technology (Sense of Physical Space). It also measures related but distinct components of that 'presence' experience. 'Engagement' includes measures of enjoyment and losing track of time. 'Ecological Validity' measures the users' perceived naturalness and believability of the immersive experience. 'Negative effects' measures adverse reactions to being immersed, particularly when technology is not optimised for the UX e.g. non-optimal inter-pupillary distance for 3D displays may cause eyestrain and headaches.</p>
Unusual perceptual experiences	<p>8 items derived from Altered States of Consciousness questionnaire (Dittrich, 1998).</p>	<p>The extent to which the user experiences unusual sensations and perceptions, some of which may be associated with transcendental, almost spiritual and perhaps even magical experiences e.g. floaty, at peace, a sense of self-disappearing.</p>
Meaning/Sense Making (Conceptual Sense)	<p>1 item from i2's unpublished Saliency Scale (It made sense to me).</p> <p>2 items measuring elements of Preparedness/Self explanatory content.</p>	<p>The focus group research indicates that audience experiences of immersive content are not always self explanatory or conceptually meaningful (or salient) to the user as intended by the creator, and in some instances e.g. exhibitions, audiences are prepped for their experiences.</p>
Expectations	<p>2 items measuring Expectations (met, unexpected).</p>	<p>Related to preparedness, the focus group research highlights a distinction between the experience of having expectations met, and the experience of something unexpected. Both aspects could be considered positive and/or negative, e.g. meeting expectations could be boring as well as satisfying, and experiencing something unexpected could be unpleasant and shocking or pleasing and relieving but nevertheless incredibly impactful.</p>

Table 1. Data gathered for user trials

DATA CATEGORY	DESCRIPTION OF DATA	DESCRIPTION OF WHAT THE DATA IS ATTEMPTING TO CAPTURE
Repeatability	3 items measuring Repeatability.	Impactful experiences may or may not be related to a desire to repeat the experience, perhaps depending on the content design and whether different storylines seem possible. Three inter-related items (being glad they had the experience, and desire to experience similar or indeed the same content again) were generated to evaluate the ‘stickiness’ of the content and style, which may hold potential for cumulative impact.
Experience of technology in this context	3 items measuring aspects of perceived quality of technology implementation (Clever Use, Glitchy, Gimmicky). 3 items derived from the System Usability Scale (Digital Equipment Corporation, 1986; e.g. “I thought this technology was easy to use”).	Psychological impact of content can be ‘broken’ or diminished by poor technology implementation, for instance in terms of poor usability or noticeable glitches e.g. recall the days of ‘snowy’ pictures in the analogue TV world, or the ‘blockiness’ of digital signals.
Reputation	3 items measuring interest in the Production Team and Funders.	As an emerging medium, immersive content funders and producers in the focus groups are understandably keen to know whether and how their projects reflect on them. This type of impact is perhaps akin to an audience following a particular film director’s work.
Shareability	2 items measuring intention to share/knowing others would like it.	Shareability of content, combined with the power of social media, have crucial implications for a Content’s content’s impact. These two items were developed to measure actual intent of trial users to share their experience, and the social power of being an originator of a socially appealing experience.
Self-consciousness	1 item: “I felt self-conscious”.	Literature review and the focus groups highlighted the conflict between the personal immersive experience and being witnessed by others in the real social world beyond their headset. We wondered if speculate that self-consciousness might perhaps weaken experienced impact.

Table 1. Data gathered for user trials cont.

DATA CATEGORY	DESCRIPTION OF DATA	DESCRIPTION OF WHAT THE DATA IS ATTEMPTING TO CAPTURE
Economic Value measures		
Willingness to Pay - home-use scenario for the content	Van Westendorp's Price Sensitivity Meter, 4 items comprise price points to be specified: too expensive, too cheap, not too expensive, valued bargain.	Users are given a scenario (outlined in Section 5) and then asked whether they would be willing to pay in order to experience that scenario. If they indicate that they are willing to pay, they are directed to answer the 4 questions that make up the Price Sensitivity Meter – which, according to Van Westendorp, creates a set of boundaries at which the acceptable price of a product can be found.
Willingness to Pay - arcade scenario for watching content	Van Westendorp's Price Sensitivity Meter, as above.	Same as above.
14/21-day follow-up survey		
Memorability and actual sharing	<p>Free recall: What about the contents do they remember? e.g. colours, title.</p> <p>Prompted recognition of the contents they viewed from the descriptions.</p> <p>Global experiential quality indicators (10 items, as for Post- and recalled negative effects e.g. ill, nauseous, dizzy).</p> <p>Shared (2 items: told/discussed in positive/negative/neutral way and whether shared on social media).</p> <p>Note that none of the respondents are forewarned that they will be re-contacted.</p>	The main purpose of the follow-up survey is to establish the longer term impact and 'memorability' of the immersive content experiences, and to measure behavioural sharing of those experiences following the trial. As free recall is cognitively more demanding than using prompts to recognise memories of experience, the survey begins by asking users what they remember (free recall) before providing prompts. They are asked again about the global experiential items, and some negative effects items from the SOPI to identify if there has been any changes in perceived impacts (positive or negative) over time.

RESEARCH FINDINGS

The UX trials were conducted at i2 Media Research's research lab at Goldsmiths University of London and ran from December 2017 to January 2018.

SAMPLE DESCRIPTION AND USER EXPERIENCE TRIAL

The UX trials were conducted at i2 Media Research's lab at Goldsmiths University of London between December 2017 and January 2018. The trials involved 84 participants, each of whom experienced and evaluated two of three test contents, which are anonymised and referred to as Contents A, B and C. This gave 168 content views and 168 corresponding participant evaluations. The protocol adjusted for first/second order effects of experiencing two contents.

Participants first completed a pre-test measure (comprising a short survey of socio-demographics and prior engagement with technology, the arts, and cultural attendance), before being prepared for their immersive experiences. Participants then engaged with two pieces of VR content. After each content experience, participants completed self-report evaluations. Additional data on intended audience impacts were acquired from the content creators, and a follow-up survey with the participants issued 2-3 weeks after their trial, exploring content memorability.

The trial participants were generally younger than the whole UK population, and were highly culturally engaged (for example through trips to museums, art galleries and so forth), but were less familiar with VR. Specifically, only a very small proportion owned VR headsets in their home; approximately one-third had no previous VR experience, whilst 42% had experienced VR once or twice, and 18% had had three or more previous VR experiences.

KEY DESCRIPTIVE FINDINGS OF INDIVIDUAL CONTENT

The results from the survey suggest that the research protocol was sensitive to different content types. That is, the overall experience of Content C scored better than Content A which, in turn, scored better than Content B. Users were therefore able to respond in different ways, and to various different degrees, to the individual pieces of content. The research protocol therefore showed that for different pieces of content evaluated, each of which had been considered noteworthy or exemplary in some way by their industry peers, there was clear variation in audience ratings on the evaluation scales developed by the project.

A key finding of the research was that the three content pieces also shared some similar global experiential and cultural value attributes. For instance, all had high scores on qualities such as whether the user found the content Memorable, Transporting, Good & Impressive, Different and Shareable. When examining the dimensions that the users felt described the content least well, there is consistency in that Worth Paying For and Emotionally Moving were common across all three contents, although they still received positive net scores (over 50 out of 100 for each).

When exploring these overall ratings in more depth by looking at each content's detailed experiential qualities, we detected more variation, both within and across contents. Both Content A and B left users feeling Self-Conscious, but Content C did not. Glitchy and Gimmicky use

of technology may have influenced Content B's ratings impact, whilst Content C offered a more Unusual Perceptual Experience, which may have appealed to the users. It is worth noting that there was only one negative (sub-50) score in the whole test – Content B scored only 42 out of 100 for being Emotionally Moving.

ECONOMIC VALUE OF IMMERSIVE EXPERIENCES

A key part of the research was based on finding an approach to testing the economic value of content when audiences may not be accustomed to purchasing that content. Based on a mainstream methodology for testing willingness-to-pay, the questionnaire asked participants to indicate price points at which the experiences would be considered: too expensive; too cheap; quite expensive but not out of the question; and a bargain⁹. The scenarios were described as follows:

Virtual reality home use scenario

'Think forward to 2-3 years in the future, when virtual reality headsets are more mainstream with consumers. You own a virtual reality headset such as the one you used in the trial today. Within your home, along with activities such as watching television or listening to music, there is the option to have virtual reality experiences by renting them through an online store for a few days. Once you have rented the content, you can use it again at your discretion for the rental period.'

Virtual reality arcade use scenario

'In future, virtual reality might be showcased in a setting where you and a few friends visit a virtual reality 'Arcade'. This Arcade would be similar to a multi-room cinema, in which there are a variety of similar-length (10-15 minute) experiences that you can pick and choose to partake in, shown in different rooms. In this way, you watch four pieces of content of a similar standard to the one you just had. The total time within the Arcade, with breaks in between content, would be around two hours.'

Over half of participants (58%) indicated they would be willing to pay to have immersive experiences at home and 70% indicated they would pay to take part in the arcade scenario. The optimal price point for all three contents on average was £9 for the home scenario and £17 for the arcade scenario. There was some variation in the optimal pricing across contents. Of the three contents tested, Content A commanded highest average prices in home and arcade scenario. The optimal prices for all three pieces of content are outlined in table 2. These optimal prices are calculated based on how the pricing data (when considered too expensive/cheap and quite expensive/cheap) were distributed for each scenario. The Overall Willingness to Pay charts for Home and Arcade use are presented in figures 2 and 3:

Table 2. Optimal prices for each content in Home and Arcade Scenarios

CONTENT	HOME USE	ARCADE USE
Content A	£12 (range £9-£15)	£17.50 (range £15-£18)
Content B	£7 (range £6-£8)	£16.00 (range £12-£18)
Content C	£8.50 (range £8-£11)	£11.50 (range £11-£18)
Across all Contents	£9 (range £8-£12)	£16 (range, £12-£18)

MEMORABILITY OF IMMERSIVE EXPERIENCES

The follow-up survey with users was conducted 2-3 weeks after the research trial had taken place. The survey revealed that almost every participant was able to recall accurate details of their experience and all but two reported on them in the correct order they had experienced them.

It can be inferred that that Content B was less memorable for the two participants who prioritised recall of the other content they had experienced. Consistent with this finding, Contents A and C tended to be discussed with others by the participants in a positive light, relative to Content B, for whom almost a quarter reported having discussed in a negative light.

There was reduced impact over time: the lasting, longer term impact ratings of each content as measured at follow-up were significantly lower than ratings given immediately after the experience. However, in terms of their global experiential quality ratings, the general pattern of overall quality remained the same with Content C scoring higher than Content A which in turn scored higher than Content B. This suggests that the post-test measures were accurate metrics for the comparative impact levels of each piece of content.

COMPARISONS BETWEEN CONTENT CREATOR INTENTIONS AND USER EXPERIENCES (UX) OF CONTENT

The creators of the three tested contents were each asked to complete a short survey stating their intentions with regards to the emotional and psychological impacts on users of their immersive experiences. How closely their intentions to target particular qualities aligned with actual user experience was explored.

There was very strong general correspondence between the direction of participants' experiential ratings and the content creators' intentions. Indeed, the specific emotional and psychological impacts targeted by content creators tended to be

the qualities rated most intensely by participants (see table 3). Unlike for Contents A and B, the creators of Content C had a more nuanced emotional intention with some emotions and moods expected to diminish and some expected to heighten. The results show that these dual intentions were indeed experienced by users.

KEY PREDICTORS OF IMPACT IN IMMERSIVE EXPERIENCES

The data was further explored to address the questions: Which of the more detailed experiential components influenced people's overall global impact judgements? Can we predict which experiential qualities make a content Good for instance? Of course, people will have different tastes and genre and quality preferences, but are there consistent generalities across pieces of immersive content that more strongly or significantly predict impact?

Overall, the best predictors of global impact and value were Positive Affect (a sub-scale computed from ten mood state items such as Interested, Excited, Strong), and Engagement (this includes measures related to enjoyment, and the experience of losing track of time). Testing more individual pieces of content would enable us to further explore how general this finding is across content.

When the contents were considered separately, there were slight variations in the main predictors of global experiential impact: for Content A, Positive Affect most consistently predicted impact; for Content B, it was Engagement (consistently) and Sense of Presence (less consistently); and for Content C, Unusual Perceptual Experiences was the strongest predictor.

Table 3. Comparison of content creator intention with participant responses

	EMOTIONS EXPECTED TO INCREASE	EMOTIONS EXPECTED TO DECREASE	SUCCESSFULLY ELICITED	TOP SCORING
Content A	Excited, Interested, Surprised, Inspired, Relaxed (5)	None	5 out of 5	4 out of 5
Content B	Interested, Excited, Attentive, Enthusiastic, Happy, Inspired, Surprised, Active, Determined, Relaxed (10)	None	10 out of 10	9 out of 10
Content C	Inspired, Interested, Excited, Attentive, Happy, Enthusiastic, Relaxed, Active (8)	Upset, Angry, Distressed, Anxious, Fatigued, Afraid (5)	14 out of 14	10 out of 14

Figure 1. Overall willingness to pay: Home Scenario

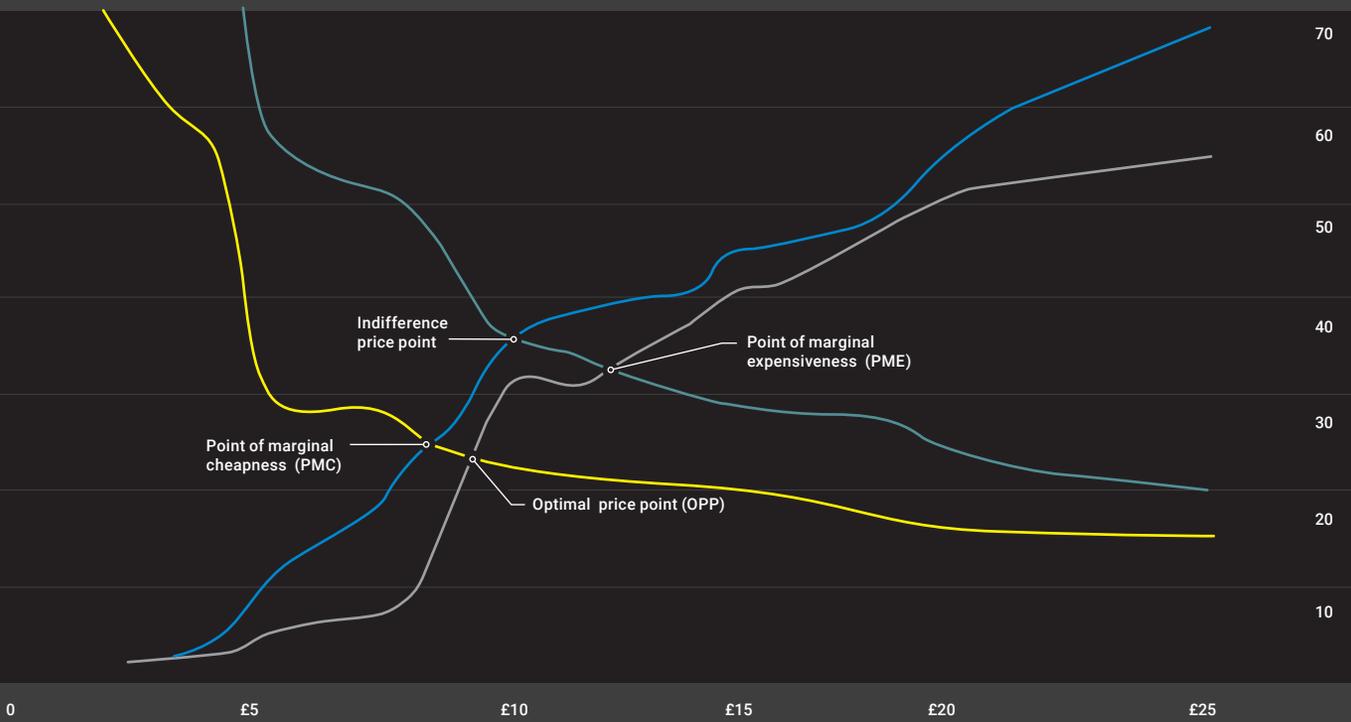
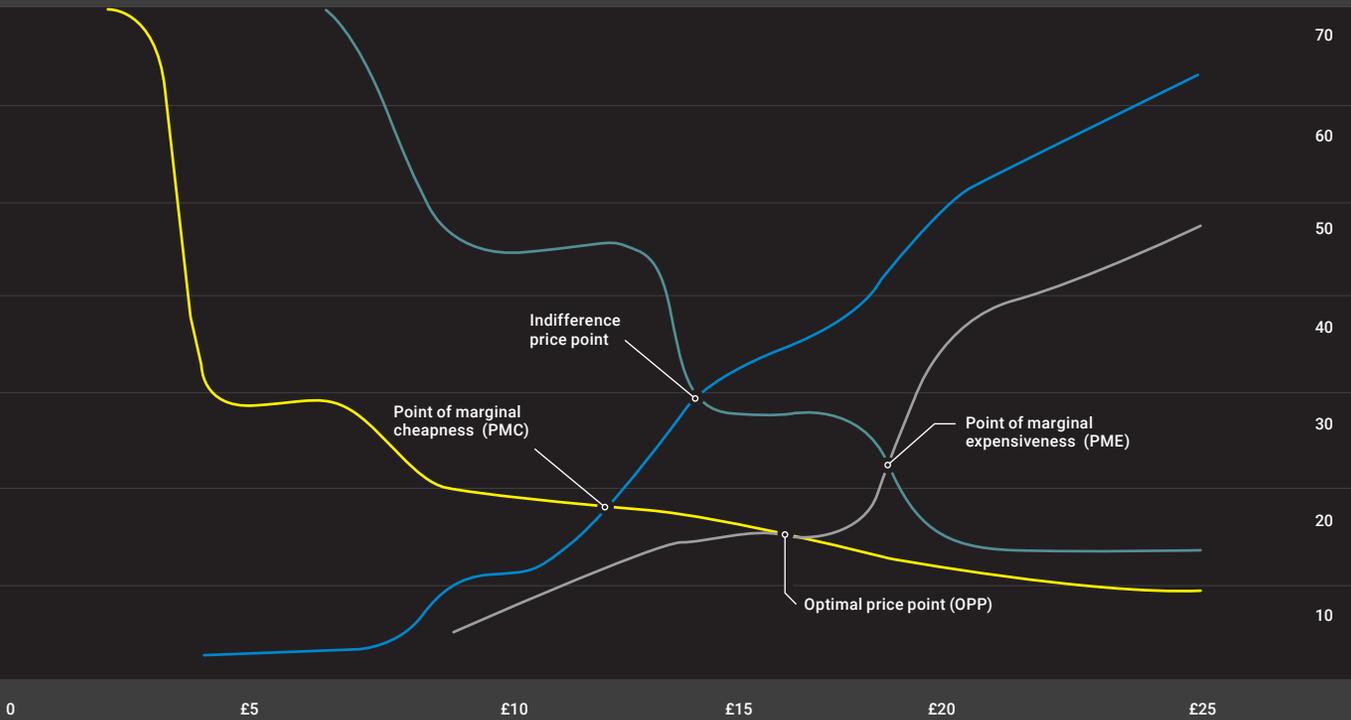


Figure 2. Overall willingness to pay: Arcade Scenario



TOOLKIT DEVELOPMENT

Alongside testing the research protocol formally on three pieces of content, a toolkit has been developed from the research, to allow content creators and immersive sector stakeholders to proactively develop their own evaluations of immersive experiences.

The toolkit can be used formatively to help guide the development of impactful experiences. It can also be used to build a bank of evaluations against which any piece of content can be benchmarked. If the banked evaluation data includes enough variation in media form, content, people and contexts, evaluations of new content could be compared both overall (with all other content previously evaluated) and more specifically for instance within its genre, or with content containing particular affordances. This will create a potentially effective resource in predicting the likely experiential impact and cultural value of the content as it is developed.

Despite these valuable use cases for the toolkit, there remain several limitations, which beg further study. The research has been unable to test more fully and rigorously the influences on impact evaluations of some potentially important person and content variables. For instance, personality (traits) such as openness to experience, and the impacts of novelty and of particular content affordances, such as the level of interactivity within the individual piece of content may also be relevant to subjective evaluations of any given content.

New scoring methods and the development of more bespoke forms of the toolkit will build on the findings that Engagement and Positive Affect are important determinants of at least experiential and cultural value. Further development of the methodology will also focus on identifying reliable objective indicators of users' Engagement and positive affect, using biometric and behavioural measures.

It is important to note that the value in these measures is not simply in assessing the relative performance of single pieces of content. We see a real opportunity to test the toolkit and research protocol across a wider set of immersive formats and genres including immersive gaming and Augmented Reality applications, in order to identify wider trends. A content's unique impact could also be traced over time, to better identify characteristics that predict the longevity of impact, and perhaps support predictions of distinguished and timeless, classic productions as the sector develops.

CONCLUSIONS

This paper reports the findings of an experiment to assess user experiences of immersive experiences, specifically the impact of content on users from a social, cultural, and psychological perspective.

The likely future economic impact of particular immersive content through valuation techniques was also explored. As the market for immersive content diversifies, it seems likely that forms of audience evaluation (content testing) will proliferate, as has occurred across other forms of media. While many content developers are still in the early stages of development with these technology forms, there has been little prior research looking at formal audience evaluation in this field.

Despite the lack of specific studies about immersive experiences of VR on audiences, there are adjacent areas of both academic and industry research that are significant for the field. Notably, there is a widespread literature on cultural value which relates to virtual and digital experiences, and there is a range of psychological literature on the effects of video games, film and other media forms that consider the immersion of the participant. This study has shown that the practical application of various measures drawn from these fields are relevant and applicable to immersive content.

Our specific results offer encouraging evidence that the different components of the research protocol elicited nuanced responses from the user group. Similarly, the data collected on users' willingness to pay for immersive experiences in different settings has a strong level of validity with what we currently know about markets for VR consumption in the wider economy.

In examining what drives the overall perception of positive impact on audiences, we report early evidence that two sets of questions are particularly strong predictors of quality for the user. These are the set of metrics on Positive Affect, and the set of metrics related to Engagement. Interestingly, even within quite a small range of VR content, there were several other predictors, such as Unusual Perceptual Experiences, that also drove impact.

The set of measures used in this study is lengthy for a user trial, however our findings suggest that many of the particular questions and scales used in the study were sensitive to different content types, albeit through a relatively small study of three pieces of content. A shortened version of the toolkit (including only main items for each of the scales we particularly recommend at this stage) should be similarly sensitive.

REFERENCES

Bailey, P., Garnham, R. (2017). Shakespeare still has power to shock. Ipsos MORI.

Bakhshi, H. (2012). Measuring Cultural Value: Keynote speech delivered at Culture Count: Measuring Cultural Value Forum, Customs House, Sydney, Australia, Tuesday 20th March 2012, Nesta.

Bakhshi, H., Dolan, P., Fujiwara, D., Lawton, R., Mourato, S. (2015). Measuring Economic Value in Cultural Institutions: A report commissioned by the Arts and Humanities Research Council's Cultural Value Project. AHRC.

Baños, R. M., Botella, C., Rubió, I., Quero, S., García-Palacios, A., & Alcañiz, M. (2008). Presence and emotions in virtual environments: The influence of stereoscopy. *CyberPsychology & Behavior*, 11(1), 1-8.

Barger, V., Barger, V., Peltier, J. W., Peltier, J. W., Schultz, D. E., & Schultz, D. E. (2016). Social media and consumer engagement: a review and research agenda. *Journal of Research in Interactive Marketing*, 10(4), 268-287.

Blachnio, A., Przepiorka, A., & Rudnicka, P. (2016). Narcissism and self-esteem as predictors of dimensions of Facebook use. *Personality and Individual Differences*, 90, 296-301.

Boyle, E. A., Hainey, T., Connolly, T. M., Gray, G., Earp, J., Ott, M., ... & Pereira, J. (2016). An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. *Computers & Education*, 94, 178-192.

Brown, A., Carnwath, J.D. (2014). Understanding the Value and Impacts of Cultural Experience. Arts Council England.

Crossick, G., Kaszynska, P. (2016). Understanding the value of arts & culture: The AHRC Cultural Value Project. AHRC.

Danielson, K., Jenkins, J., Phillips, M., Jensen, E. (2015). Cheltenham Festivals: Real-time Event Feedback. Digital R&D Fund for the Arts Final Report. Nesta.

Dittrich, A. (1998). The Standardized Psychometric Assessment of Altered States of Consciousness (ASCs) in Humans. *Pharmacopsychiatry*, 31, 80-84.

Edwards, J., Rae, J. (2015). Virtual reality at the British Museum: What is the value of virtual reality environments for learning by children and young people, schools, and families?. *Museums and the Web Conference 2016*.

S. Engeser and F. Rheinberg. (2008). Flow, performance and moderators of challenge-skill balance. *Motivation and Emotion*, 32, 158-172.

Freeman, J., Avons, S. E., Meddis, R., Pearson, D. E., & IJsselstein, W. (2000). Using behavioral realism to estimate presence: A study of the utility of postural responses to motion stimuli. *Presence: Teleoperators and virtual environments*, 9(2), 149-164

Harmon-Jones, C., Bastian, B., & Harmon-Jones, E. (2016). The discrete emotions questionnaire: A new tool for measuring state self-reported emotions. *PloS one*, 11(8), e0159915.

Hu, J., Janse, M., & Kong, H. J. (2005). User experience evaluation of a distributed interactive movie. In *HCI International*. (http://www.idemployee.id.tue.nl/j.hu/publications/HCI2005_icecream.pdf)

Fiennes, T. (2017). Putting audiences at the heart of VR. BBC internet Blog. Friday 21 July 2017. <http://www.bbc.co.uk/blogs/internet/entries/c438a2cd-fcd4-42f3-ab69-244d3c579011>

Knell, J., Whitaker, A. (2016). Quality Metrics Final Report: Quality Metrics National Test. Arts Council England.

Kunter, M., (2016). The Van Westendorp Price-Sensitivity Meter As A Direct Measure Of Willingness-To-Pay.

Lyon, D. W. (2002). The Price is Right (or is it?). *Marketing Research*, 14(4), 8-15.

Lessiter, J., Freeman, J., Keogh, E., & Davidoff, J. (2001). A cross-media presence questionnaire: The ITC-Sense of Presence Inventory. *Presence: Teleoperators and virtual environments*, 10(3), 282-297.

McNair, D. M. (1971). Manual profile of mood states. Educational & Industrial testing service.

Ravaja, N., Salminen, M., Holopainen, J., Saari, T., Laarni, J., & Järvinen, A. (2004, October). Emotional response patterns and sense of presence during video games: Potential criterion variables for game design. In *Proceedings of the third Nordic conference on Human-computer interaction (339-347)*. ACM.

Suzuki, K., Roseboom, W., Schwartzman, D. J., & Seth, A. K. (2017). The Hallucination Machine: A Deep-Dream VR platform for Studying the Phenomenology of Visual Hallucinations. *bioRxiv*, 213751.

Unknown Author (2017). How virtual reality facilitates social connection. Facebook and Neurons Inc.

Vorderer, P., Wirth, W., Saari, T., Gouveia, F. R., Biocca, F., Jäncke, L., ... & Klimmt, C. (2004). Development of the MEC spatial presence questionnaire (MEC-SPQ). Report to the European Community, Project Presence, MEC.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of personality and social psychology*, 54(6), 1063.

FOOTNOTES

1. Innovate UK (2018), The Immersive Economy in the UK: The Growth of Virtual, Augmented and Mixed Reality Technologies.
2. Innovate UK, (2017) Industrial Strategy Challenge Fund – more challenges, more opportunities. See, <https://innovateuk.blog.gov.uk/2017/11/30/industrial-strategy-challenge-fund-more-challenges-more-opportunities/>
3. YouGov (2017), VR headsets more popular than tablets and wearables were at same stage. See, <https://yougov.co.uk/news/2017/05/19/vr-headsets-more-popular-tablets-and-wearables-wer/>
4. CNN Travel, (2017) How VR Theme Parks are Changing Entertainment in Japan. See, <https://edition.cnn.com/travel/article/vr-parks-on-japan/index.html>
5. Digital Catapult have commissioned research into emerging content forms by the consultancy Limina, which will be published in Spring 2018.
6. Mashable,(2017), Google's 'Pearl' is first VR film to be nominated for an Oscar. See, <https://mashable.com/2017/01/24/google-pearl-vr-oscar-nomination/#UyPmRsCqaqK>
7. See, for instance, Venice Virtual Reality at Lazzaretto Vecchio Island: <http://www.labiennale.org/en/cinema/2017/venice-vr>
8. Digital Catapult (2017), Request for Proposal: The Supply of Research and Consultancy to the Digital Catapult. Contract Reference: CON-BEI-WP10/2
9. The Van Westendorp price sensitivity meter - first published in 1976.

ACKNOWLEDGEMENTS

Many thanks go to all of the focus group participants and interviewees at the outset of the project. Our thanks also go to all of the participants that took part in the lab trials at i2 media research's facilities at Goldsmiths University between December 2017-January 2018, and the companies who kindly provided their content for testing.



Nesta is a global innovation foundation. We back new ideas to tackle the big challenges of our time. We use our knowledge, networks, funding and skills - working in partnership with others, including governments, businesses and charities. We are a UK charity but work all over the world, supported by a financial endowment.



i2 Media Research is the expert consumer insight and user experience research and strategy consultancy based at Goldsmiths University of London, delivering rigorous research and innovation to business - since 2002. The research base on which i2 was founded was on user experience of immersive media, starting in the 1990s. Fully self-funded through commissioned projects and through collaborative R&D, i2 media has successfully completed more than 250 commissions for clients spanning the commercial, public and third sectors.



Digital Catapult is the UK's leading advanced digital technology innovation Centre, driving early adoption of technologies to make UK businesses more competitive and productive to grow the country's economy.

We connect large established companies, startup and scaleup businesses and researchers to discover new ways to solve big challenges in the manufacturing and creative industries. Through this collaboration businesses are supported to develop the right technologies to solve problems, increase productivity and open up new markets faster.

Digital Catapult provides physical and digital facilities for experimentation and testing that would otherwise not be accessible for smaller companies.

As well as breaking down barriers to technology adoption for startups and scaleups, our work de-risks innovation for large enterprises and uncovers new commercial applications in immersive, future networks, and artificial intelligence technologies.

CATAPULT
Digital

Digital Catapult
101 Euston Road
London
NW1 2RA
0300 1233 101
www.digicatapult.org.uk

