

# From Director's Cut to User's Cut: to Watch a Brain-Controlled Film is to Edit it

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## ABSTRACT

Introducing interactivity to films has proven a longstanding and difficult challenge due to their narrative-driven, linear and theatre-based nature. Previous research has suggested that Brain-Computer Interfaces (BCI) may be a promising approach but also revealed a tension between being immersed in the film and thinking about control. We report a performance-led and in-the-wild study of a BCI film called *The MOMENT* covering its design rationale and how it was experienced by the public as controllers, non-controllers and repeat viewers. Our findings suggest that BCI movies should be designed to be credibly controllable, generate personal versions, be watchable as linear films, encourage repeat viewing and fit the medium of cinema. They also reveal how viewers appreciated the sense of editing their own personal cuts, suggesting a new stance on introducing interactivity into lean-back media in which filmmakers release editorial control to users to make their own versions.

## CCS CONCEPTS

• **Human-centered computing** → **Interaction paradigms.**

## KEYWORDS

BCI, Film, Interactive Cinema, EEG, Control

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## 1 INTRODUCTION

Can films become interactive and if so, what kind of interaction is appropriate to the distinctive experience of watching them? Introducing interactivity to films presents challenges due to the nature of the medium: the narrative-driven, linear and often theatre-based nature of exhibition give it characteristics that appear to defy the 'upfront' approaches employed by other interactive storytelling media such as computer games. The emergence of commodity Brain-Computer Interfaces (BCI) offers a promising route forward as the idea of sitting in a movie theatre and concentrating on a film that responds to one's attention or emotions appears to be a good fit with the medium, potentially enabling a more 'lean-back' style of experience [15, 48]. And yet, early experiments have revealed that there remains a tricky balancing act between viewing and interacting, with viewers being caught between immersing themselves in a film and becoming aware of their own thoughts as they try to control it and/or control draws their attention away from the film [34].

In what follows, we describe the design and study of a brain-controlled film called *The MOMENT* that reveals how a filmmaker tried to establish a more lean-back approach to interaction with film and how audiences responded. Our findings reveal key challenges for BCI film, including meeting the expectations of film, supporting lean-back interaction, being credibly controllable, and being watchable by non-controllers. They lead us to the idea that BCI enables viewers

to generate personal cuts of movies that they can reflect on and compare with others afterwards.

## 2 RELATED WORK

Filmmakers have experimented with interaction since the early days of cinema. Notable instances are *As You Like It* (1926) [54], *Kino Automat* (1967) [50], *Mr Payback* (1995) [19] to more recently *Late Shift* (2016) [14] and Netflix's *Bandersnatch* (2018) [39]. Common criticisms stem from the interactive film positioned in a liminal space between film and game [23]. As a lean-back medium for entertainment, as opposed to lean-forward user-controlled media like games [26], some see an inherent tension in interactive film between active decision making and the flow of narrative immersion [3, 35].

Research using BCI to explore what happens in film watching emerged through the field of Neurocinematics [21, 24], which has since been taken up by market research firms [33] and movie studios [37]. Neurocinematics attempts to grade the effectiveness of a film by how many people react in the same way while viewing it [21]. However the approach has been critiqued for excluding cases of complex and divergent responses to films [36]. Rather than evaluating a mediated experience, however, interactivity turns film into a form of performance [43]. In this regard, research has investigated the implications of working with physiological data within filmmaking [38], the visibility and feasibility of user inputs within interactive performances and cinema [18, 41] and the aesthetic and technical challenges of interactive cinema and performance [22, 47].

The emergence of commercially available and affordable BCI devices has enabled digital artists to experiment with creating new kinds of interactive entertainment including installations [28], music [31], games [1, 32] and, as we consider here, film. Several interactive movies have used BCI to drive interaction. Kirke et al. used various sensors, including ElectroEncephaloGraphy (EEG) and Galvanic Skin Response (GSR), captured from multiple viewers, to make an unconsciously interactive film that had 2 branching decision points [29]. Polina Zioga employed EEG from multiple viewers and a performer to feedback their cognitive load as changes of colours of a pre-made film [53]. Karen Palmer used EEG to control a pass/fail mechanism as part of a consciously gamified film [33]. Pia Tikka's *enactive film* [46] called *Obsession*, which she describes as emotion driven cinema, shares the concept of the real-time feedback loop with the film presented here.

But what do people do when interacting with these films? And can a film retain its value with interaction in place? This question is explicitly posed by critics when they suggest that films like CtrlMovie's *Late Shift* are more of a big-screen

video game than a movie [44]. Some have argued that conscious control breaks narrative immersion in a film when, unlike in a game, ludic immersion is not part of the experience [3]. From an HCI perspective, Pike et al. reported a study of a BCI film called *The Disadvantages of Time Travel*, which used blinking to switch between an internalised and external view of the narrative, and measures of attention and meditation derived from a consumer-grade EEG sensor to blend video layers [34]. They described how many viewers moved between voluntary and involuntary control and being aware and unaware of being in control as part of an engaging, thought provoking, but also a somewhat disrupted, engagement with the film. The design presented below is an attempt to respond to their findings by creating a BCI film that is driven by a more lean-back form of interaction, so as to deliver a more conventionally immersive film viewing experience while still gaining the benefits of control.

## 3 RESEARCH METHODOLOGY

We follow the approach of performance-led research in-the-wild as introduced Benford et al. [4]. This falls under the broad umbrella of Research Through Design [52], being a practice-led methodology in which research findings emerge from reflection on the making of specific interactive artefacts. Being performance-led means the practice is led by an artist and co-researcher, who follows an artistic process and delivers a professional artistic product, in our case a film. Being in-the-wild means this artistic product is experienced by public audiences under realistic conditions, in our case being screened at a major festival. The approach involves documenting both the artist's rationale for the work and audiences' experience of it, before reflecting on both perspectives to draw out wider lessons for the field. We begin with the artist's rationale, then describe our in-the-wild data collection.

### The Design of *The MOMENT*

*The MOMENT*<sup>1</sup> is an interactive brain-controlled film that employs a single NeuroSky headset to provide live EEG data that drives the edit, sound mix and scene combinations of a 24-minute-long movie. This hardware has been used previously to deliver touring brain-controlled films [34] and, while it only provides low resolution EEG from a single dry head-worn sensor, has proven sufficiently responsive, robust and cheap to support the delivery of an interactive narrative to a public audience as part of a touring screening. The reader is recommended to watch the accompanying video.

The filmmaker chose to make a Genre film, specifically a Sci-Fi Thriller as it is a well-known type of film with its own distinctive tropes [27] that would encourage audience

<sup>1</sup><https://www.imdb.com/title/tt7853742/>

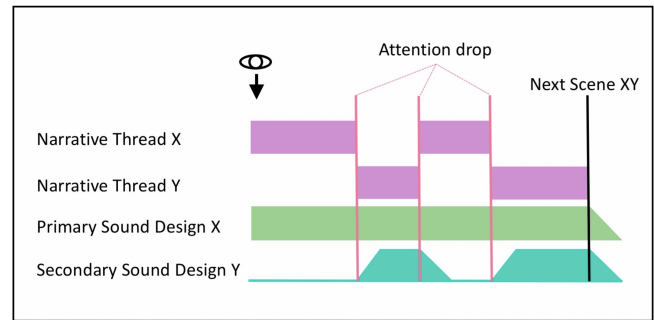
understanding of an otherwise unfamiliar experience, and so enable easier investigation of narrative comprehension. Subtly counterbalancing this, however, one of the three threads of narrative content is set within the fictional world of a data network of connected minds, using abstract graphics to represent what is happening, and is intended to be more open to interpretation.

Structurally, *The MOMENT* blends three narrative threads in one story world. The film is scripted as 17 distinct scenes that are always presented in the same order, running to a fixed length (this is important to fit in with the scheduling and ticketing requirements of venues). Across the 17 scenes, each thread is written from the perspective of one of three different lead characters (Andre, Astrea and Telema). Therefore, three parallel narrative threads span across all 17 scenes. Each of these threads has two alternate sound designs: a primary design that includes foley (sound effects) and main musical themes and a secondary design that is predominantly atmospheric soundscapes.

From the viewer's perspective, a screening's narrative for each scene is constructed from the combination of two of these narrative threads, one with a primary sound design and the other with a secondary. The combination for each scene is chosen by rules (described later in Table 1) based upon measured EEG attention data in the previous scene. These varied combinations create different possibilities for tension, relationships between characters, and character drama arising from the combination chosen.

The director wanted the algorithm to encourage continuity while allowing for variation, to allow subconscious control, and to produce a watchable film for viewers not controlling. Indeed, the design was therefore informed by grammatical cinematic techniques which were deconstructed to allow for recombination, e.g. shot, reverse shot in dialogue, or matching compositions to allow for match cutting.

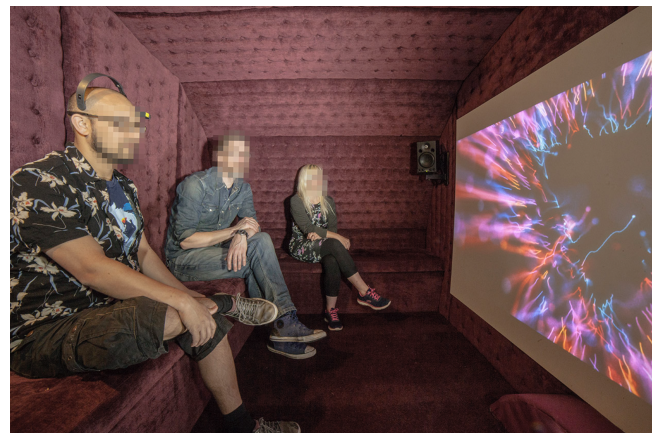
*Interaction within a Scene.* This is a continuation of Pike et al.'s prior research which revealed how viewers of a BCI film often tipped back and forth between a) attending to the film and b) thinking about their own control of the film [34]. To do this, we began by creating a more lean-back form of brain-controlled interaction. Within a scene, a drop in attention data triggers a cut (between the primary and secondary threads chosen for this scene). If the EEG consumer device records a maintained or increased level of attention, the scene maintains its view of the currently active thread. As shown in Figure 1, if attention is recorded to drop, it cuts the visuals and audio to the alternate thread chosen for the scene; e.g. from the primary to the secondary, or back again. Audio for sound design and music is maintained from the primary thread across cuts to the secondary and back again; this is an established technique to maintain continuity in



**Figure 1:** Within a scene, attention drops create cuts between two active threads, but the film is produced to keep continuity between them using sound design.



**Figure 2:** *The MOMENT* at Sheffield DOC/FEST.



**Figure 3:** Inside the caravan. Photo credit: Studio Softbox.

film [8] as it e.g. cuts between the views of two characters talking in a scene.

*Interaction between Scenes.* At the end of each scene, the cutting behaviour described in Figure 1 is analysed in order to determine the choice of primary and secondary threads (from the three narrative threads) for the next scene. After a creative and iterative process, which aimed at creating a good film experience through fine tuning-continuity and balance, the algorithm shown in Table 1 was designed. Attentiveness was defined as a sum of the duration of periods of NeuroSky attention data per narrative thread. Described informally, Rule 2 for example, means that, if a user *appears interested* in the current primary narrative thread, and *uninterested* in the current secondary thread, it keeps the primary thread and exchanges the secondary thread for the character's narrative that was not used in the current scene. In this case, if a viewer were seeing Andrea's thread as primary and Telema's thread as the secondary in Scene 1, Scene 2 would keep Andrea's thread as primary, but see Andre's thread as secondary. Rules 5 and 6 focus on making sure that participants do not enter a stalemate situation between characters, and purposely 'mixes things up' for the viewer.

### In-the-Wild Data Collection

The *MOMENT* is presented in a small caravan (Figure 2) converted into a plush cinema (Figure 3), seating a maximum of seven audience members, designed especially for the film, to encourage intimate screenings in a familiar viewing environment. One audience member volunteers to control the experience and be fitted with the NeuroSky headset upon entering the caravan. Before the screening the full audience is briefed: told that changes in the controller's attention will produce cuts between narratives of the film, and that at the end of each scene a new narrative combination will be selected based on interactions in the previous scene. Controllers are made aware they will not be determining character or scenario, but that the film content will combine itself based on their neural responses.

We report on the data collected from 56 screenings at the world premiere at Sheffield Doc/Fest. The caravan cinema was located in the city centre, where free screenings were open to film festival attendees and the public. 279 individuals experienced the film, where some people watched it more than once to see variation in films created by different controllers. We characterise the diversity of the different versions of the film content presented using interaction records from 29 cleanly logged screenings.

After screenings, 204 viewers filled out questionnaires (41 as controllers; 163 as audience members). The questionnaire asked respondents to characterise the film experience, content, interactivity and likelihood of repeat viewing. Responses were received from 82 female, 102 male, and 1 non-binary participant (with 19 preferring not to say); the age

**Table 1: The decision algorithm between scenes.**

Where  $[X]$  is the primary perspective,  $[Y]$  the secondary, and  $[Z]$  the inactive perspective in the current scene then:

- 1 If  $[X]$  was viewed the most but with frequent cuts to  $[Y]$ , then retain the same configuration for the next scene as the viewer still seems to be attending to  $[X]$  and  $[Y]$ .
- 2 If  $[X]$  was viewed the most but with infrequent cuts to  $[Y]$ , then swap in  $[Z]$  instead of  $[Y]$  as the secondary layer to introduce a new narrative possibility, while retaining general continuity with  $[X]$ 's perspective.
- 3 If  $[Y]$  was viewed the most with frequent cuts to  $[X]$ , then swap to  $[Y]$  for the primary thread and introduce  $[Z]$  as the secondary, with  $[X]$  becoming inactive. Frequent cuts denote that no single thread is being greatly attended to triggering the action to bring in another thread with the aim of raising attention again.
- 4 If  $[Y]$  was viewed the most but with infrequent cuts to  $[X]$  then make  $[Y]$  the primary and move  $[X]$  to being the secondary. Infrequent cuts mean that longer periods of attention are happening triggering the action of switching the current primary and secondary threads so as to introduce some variation while generally maintaining continuity with presumably interesting material.
- 5 If  $[X]$  and  $[Y]$  were viewed approximately evenly, with frequent cuts, then retain  $[X]$  as the primary but swap the secondary to be  $[Z]$ . We assume neither  $[X]$  or  $[Y]$  are preferred, and so bring new  $[Z]$  in for variation.
- 6 If  $[X]$  and  $[Y]$  were viewed equally but with infrequent cuts, then to disrupt a status quo and make  $[Y]$  the primary and swap  $[Z]$  into being the secondary.

distribution of these viewers, excluding those choosing not to say, ranged from 18-74, with 141 being below 35.

Semi-structured interviews were conducted with a self-selected sample of users to probe areas of research interest in greater depth. A protocol of questions was used by different researchers across the duration of the festival and for simultaneous interviews. For example, audience members were asked to recount the story and describe the most memorable moment for them; while controllers were asked whether they tried to actively control the film, and if they felt under pressure to produce a good film for others to watch.

>1000 minutes of interviews produced 78 transcripts. Review of this sample allowed the large volume of qualitative material to be organised according to interview characteristics: type (individual or group); (for group interviews) interviewee relationships (known, unknown or mixed); role (controller or non-controller); viewing instance (first time or repeat). A sub-sample of 27 transcripts, representing the



diversity of interviews conducted, were coded in depth for emergent themes [10]. Coding was carried out by two researchers, who compared and refined the analytic approach regularly for consistency. This process produced 17 codes across 3 top level themes: ‘Controlling the Film’ (137 references in 25 transcripts); ‘Viewing without Controlling’ (99 references in 25 transcripts); ‘Repeat Viewing’ (90 references in 24 transcripts). Results are reported discursively according to these themes. Quote IDs refer to the screening discussed. An overview of coding is provided in the Appendix.

#### 4 EXPERIENCING THE MOMENT

Overall, people rated the movie 3.83 out of 5, with controllers, on average, giving it a significantly higher score (4.14) compared to audience members (3.82,  $U = 2632$ ,  $p < 0.05$ ). As shown in Figure 4, results from the subjective responses about the experience indicate that participants enjoyed the uniqueness of the films being viewed, and that, while some found that the continuity was not as smooth as a linearly pre-edited film, most agreed that it retained their interest.

The variety of films seen in these screenings were widely divergent. Figure 5 shows the different viewpoint combinations seen in each scene. Combination 1, in red, for example, is when Andrea was the primary thread and Telema was the secondary (see caption for the combinations for each colour). The number of screenings that passed through each combination varied from scene to scene, with no combination being given significantly more weighting across all scenes by the interaction algorithm. Figure 5 also shows that the transitions varied dramatically between different scenes (top to bottom), meaning that screenings did not become locked in certain thread combinations.

No two of the logged screenings were identical in how they transitioned across these combinations from scene to

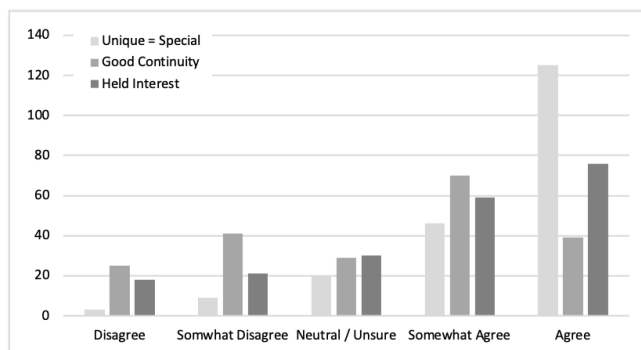


Figure 4: Responses to a) Seeing a unique version of the film based on the controller’s brain data makes it special, b) The film kept continuity I would expect from a Narrative film, and c) The film held my interest.

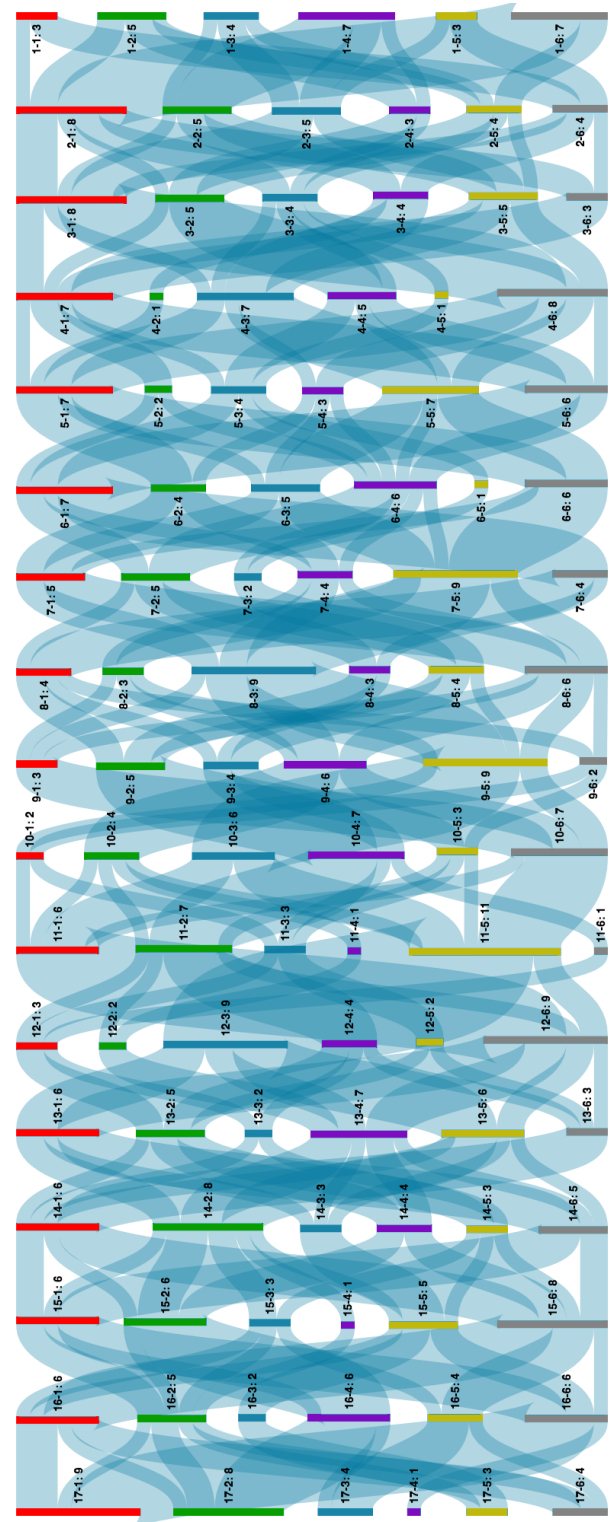


Figure 5: Flow of screenings through scenes and in viewpoint combination. Scenes 1-17 go from top to bottom. Combination 1 (leftmost) = Astrea-Telema, 2 = Astrea-Andre, 3 = Telema-Astrea, 4 = Telema-Andre, 5 = Andre-Astrea, 6 (rightmost) = Andre-Telema.

scene, supporting the idea that the algorithm delivers variety, and that this variety was invoked by different attentional data. The trillions of possible content combinations across 17 scenes mean that each screening is effectively unique. This confirms the views of those that saw multiple viewings that “it seemed like a completely different story from the previous time I watched it, despite the fact that it’s both the same film in a way” (2.5).

### Controlling the Film

The algorithm was designed to encourage subconscious control. Questionnaire responses indicate that the majority of controllers tried to exert conscious control, but only experienced partial control (Figure 6). Four controllers described their sense of partial control, e.g. “This was something not really I created, but something I let happen” (2.5); “It felt less like control and more like influence” (2.7). The conviction that control is being exerted, even if the nature of that control is unknown, is sufficient to generate pleasure: “When I thought that yes, okay, I think I’m doing something that makes a cut, it’s great! It’s cool.” (1.2). For the controller the fact of interaction, rather than its mechanisms, can be valuable: “It’s a really exciting experience to think that on a very, almost unconscious or becoming conscious way, your brain is interacting with a piece of art someone else has made” (1.2).

We interviewed users who actively tried to control but gave up after they found that experimentation did not produce direct feedback from the system, e.g. “At the beginning I felt it cut a lot and I was like, oh, I’m cutting it a lot. At the beginning, I wanted to control it more because I wanted to figure out what’s going on with the film. And then I was just like, right, I’m just going to just watch it and see what happens. And then that’s when the third character came in and I think things made sense for me a bit more” (2.9). For this controller, the decision to relax was associated with better engagement with the film as a narrative experience.

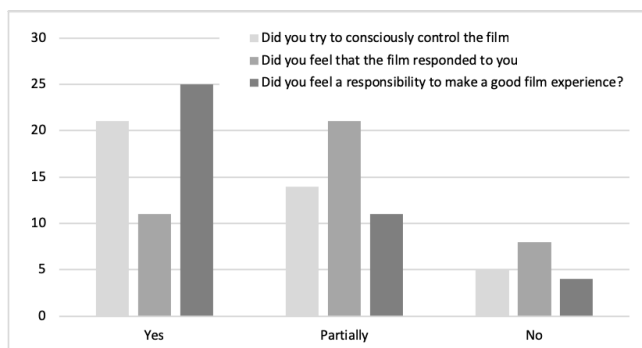


Figure 6: Responses about feelings of control.

In the film festival context, the role of controller became privileged: “I feel like I was lucky because I got to be the controller and I suppose everybody wanted that opportunity” (4.8). However, lack of explicit feedback from the BCI caused one user to question the interactivity of the experience entirely: “I was just doubting myself, was I in control?” (4.0). For another, the interaction was a source of anxiety: “I just felt stressed. I didn’t fully understand exactly how I was controlling it or to what degree it’s making those decisions” (2.5). So the experience of exerting unknown control over the film was not necessarily experienced as a comfortable interaction. Figure 6 shows that the majority of controllers felt responsibility for the quality of the film experience.

Controlling *The MOMENT* did not directly correspond to familiar film viewing experiences: “I sat more attentively than I would have done normally if I was watching a film” (5.5). The expectation that films are made up of pre-recorded audio-visual content was destabilised. One viewer was unsettled by correspondence between the controller’s reactions and the images on screen, perceiving one as the cause of the other: “You laughed out loud and then she laughed on the screen and that freaked me out!” (3.4). One of the controllers used the interview after the screening to think through the constraints of the system: “It’s not going to throw in a dinosaur for us because I imagine it” (6.6).

While the subconscious interaction in this case lessens any impression of direct ‘choice’ about the film’s narrative, one viewer feels that controller input undermines the artistry that has gone into producing it. “[The director]’s filmed the whole thing, but he’s filmed it from different people’s point of view and the way that you watch it with the controller is skipping between those views. So, that can sometimes detract away from the message that he originally intended.” (4.6). In this respect the views of a knowledgeable controller, who had been involved in the film’s production, are interesting: “I remember thinking, like at the end, that I’ve missed a lot but I can’t think, now, for the life of me what” (6.3). This retrospective observation does not seem to have intruded upon the viewing itself. Moreover, this viewer also expressed an attachment to the version they controlled and the particular selection of content it contained: “This is my version of it, so it’s really cool the way that happened.” (6.3).

Controllers talked about the films that they controlled as ‘their’ versions, connecting how they felt their brain worked whilst watching and controlling the film with the qualities of the film. A common view expressed was that the existing mental state of the controller influenced the construction of the film, in terms of editing and coherence: “I’m in a pretty calm mood because early I just woke up, I had a good breakfast, so maybe it reflected on the pace of the film” (2.1). In the case quoted, the controller’s perception of a link between

their state and the quality of the film caused them to self-moderate: *"I might have been close to dozing off a bit. Which is why I started fumbling with my bag and started trying to wake myself up."* (2.1).

As well as prompting physical reactions such as the one described, the BCI also encouraged mindfulness or self-reflexiveness in the controllers. In interviews they commented on how they felt before the screening, what they thought during it, and how this influenced their assessment of the BCI experience. For example, *"I'd had weird anxiety this week. I was wondering how much that was going to affect it, and then being aware that people were around me, I think that made me even more anxious. But then realising that I just didn't really know what my brain was controlling. I think knowing something is doing something but not quite knowing why is alright."* (3.2).

While the BCI works by using EEG data to select and cut between content, controllers understood their relationship with what appeared on screen in different ways. For one interviewee, it involved a personally meaningful contribution, not just mechanistic control: *"You are able to input yourself, your own ideas into it"* (1.2). Moreover, it is this cognitive investment that is an added feature setting interactive film apart: *"Interactive film just is amazing to me, just because it's not only some medium that is entertaining but also can pose a lot of questions and make you think a lot"* (1.3).

### Viewing without Controlling

This interactive film was designed to be seen by viewers who were not controlling - the audience - as well as for the interactors. Here we report on interviews with non-controllers reflecting on their viewing experience.

Coding revealed the value interactivity adds to the film experience, even for the viewing audience (23 references). One user said: *"It's like an art form where if you ask three different people to paint a vase of flowers, you get three really different outcomes. With this, there's a real sense of ownership I think. There is a sense that you do have a stake in what comes out at the end of this."* (1.2). Thus, this user saw value in the uniqueness of the created films, likening the controllers to artists who produce an individual depiction. It is appealing to viewers to see a live, authored narrative: *"I definitely think the idea of choosing the story is really interesting. And even just watching it for the first time it's still crazy that the person sitting next to me was controlling, was the puppet master of sorts the whole time."* (2.5). The qualities of this form of film are seen highly positively: *"I mean, absolutely nothing compares to the experience of that, compared to just going to see a regular movie, you're completely not in control of a regular movie. Whereas this, at least there's a sense that the controller is in control of it. Brilliant, absolutely excellent. Really loved it."* (4.6). More practically, an unintended attribute of the film

is that the audience find themselves reacting in sync with the interactor; as the patterns of shots and edits are created by the rhythms of the interactor's attention: *"It keeps you interested. You want to know what's coming next, so you've got to be interested in it"* (3.3).

The audience was aware of the particular qualities of the interaction: *"I feel like she could have been passively controlling it but not actively, so it's just reading signals"; "like sub-consciously"* (6.4). Therefore, we asked people if they would rather have been able to choose their own ending. The following answer was typical in sentiment from controllers and non-controllers: *"Not really because I don't think that's the experience of watching a film. And the point of watching it, at least for me anyway, is to try and disengage with what I would want and experience someone else's vision and then think about that afterwards. So I wouldn't want to choose my own ending really. It reminded me a lot of when I was little - I used to read a lot of the adventure books where you got the choice as to what you did. And even though I read quite a lot of them, I didn't find them that satisfying because you could muddle it yourself, you know, once you knew what you were doing, and I much prefer to be out of control in that situation, rather than decide"* (5.5).

One pitfall of previous interactive films is that they are seen as games. If a film is different on each viewing, then how does that affect its meaning and narrative comprehension? *"It kind of started to make sense as you went. In the beginning it felt like a few scenes here and there and it didn't really feel like there was a coherent story. But then as you get more and more into it with more and more detail, I think a story really started to form."* (2.5). *"It was almost like a jigsaw puzzle in a way, where at the beginning you sort out the pieces into the various colours. And then as you progress further on, they start to come together and form a cohesive whole."* (2.5). One of the filmmaker's aims was to maintain film continuity rather than present explicit choice points like a game. Therefore, filmic techniques were designed to be revealed in the interaction, to construct the narrative. *"But there was a really nice cut in there where we see her jumping out and her face lighting up blue when she's outside the flat, and we know some bad shit's going on. There's a really quick cut to Lance, where he's got the mask on so we know that he means something to her."* (1.2).

As described above, controllers linked the interactive construction of the film to their own moods. Similarly, the audience also sees the variations in the films as representing or even mirroring the state of mind of the interactor: *"The person who tends to be the most frantic about things, apparently, had the most non-linear storyline. And the people who seem more stable seem to have very linear storylines"* (2.8). Perhaps interestingly, just over half of the non-controllers answered 'Yes' (28) or 'Partially' (59) to the question: Did you feel like the experience gave you insights into the controller's mind?

**Table 2: How participants would like to see the film again.**

New live version that I create	New live version controlled by someone else	Replay using someone else's brain data	Replay of the version I saw	Replayable Director's Cut	As a live performance	No
139	95	59	36	61	36	12

### Repeat Viewing

Controlling the film was not necessarily viewers' only grounds for interest. While some audience members returned to control the film at a subsequent screening, some controllers wanted to experience it again as an audience member or in other ways (Table 2). Seeing the film first as a non-controller could be beneficial to the experience of controlling, as a framework for understanding interactivity: *"For me, since I've seen it multiple times, I kind of realised which scenes I have and haven't seen. So, I think that helps when it comes to knowing which parts feel like they were more controlled over others"* (2.7).

Repeat viewings allow users to judge the extent of control, regardless of whether they controlled the film or not. Those who have watched someone else controlling the film want to *"watch it again as controller and see how it changes"* (2.1), or are even interested in *"watching another to see how somebody else has done theirs"* (6.7). Some controllers wanted to compare versions to judge the extent of their control and its significance: *"At the moment, it's the only version I know. So it's as if I've just watched it and I wasn't controlling it"* (2.2).

The value of expanded perspectives on the narrative does not apparently rely on being in control of those perspectives: *"I think, after being the viewer and the controller, it'd be interesting to be either one again. Probably, the viewer. Just so I get a different perspective."* (2.7). It is important to note that not all controllers of the film preferred the version they created to a different version they viewed without controlling. Having personally generated the version does not necessarily mean the controller feels it is inherently comprehensible: *"I loved seeing it again and I want to see it again. Because I know for a fact that if I went in knowing nothing about it, and I saw my edit first, I'd be like, okay, I'm a bit confused. If I went in and saw the second one, I'd be able to put those two together which is amazing"* (1.2).

Some users felt it was necessary to see more than one version of the film in order to make sense of the content and get 'the big gist of it'. Getting more information about characters through repeat viewing changed this interviewee's interpretation: *"I think with the addition with the new characters that I mentioned it really changed my perspective on just who the characters were themselves"* (2.5). For another viewer who had also seen the film twice, there were still more things to find out about particular characters: *"The woman with the*

*curly hair is often the one who's least in the things. The first time, I saw like a bit more of her and I really liked that. So I would like to explore like different characters a bit more."* (4.0). Over the course of the festival, it appeared that audience members derived value across multiple viewings: *"Even after seeing it three times, I'm still curious to see how piecing it in different directions goes"* (2.7).

Two users in different interviews talked about how *The MOMENT* conforms to the three act structure of a 'normal film' but will deliver different content within that framework each time, e.g. *"I'd thoroughly enjoy watching the film probably another dozen times. And then I'd get to see a different start, middle and end. It's all going to pull together to make a different story, different narratives and give an overarching meaning to the message and everything."* (4.6). One interviewee pointed out that attention to elements of film construction requires multiple viewings: *"There was this task in high school when we had to basically discuss how music was used in the film. And since then, I've always paid attention to it, but to be honest, I only noticed it after like two or three times watching. So you have to see it a couple of times"* (4.0).

Understanding what the film means could be something that accrues over multiple viewings: *"The cut I saw the other day, I didn't quite fully get the story but this time, going in with that pre-knowledge of what some of the story is about, I've got a bit more. I think it's a really good experience."* (3.0). In this respect there's a parallel with immersive theatre, where the audience have to 'do some work' in order to discover the narrative: *"There's a company called Punch Drunk and it's really hard to get at the story even though there's one there, but if you want you can fill in the blanks"* (2.3).

Actions of characters are more compelling when the back-story is clear, which may only happen after repeat viewings in this case: *"There was more context. There was more emotional engagement because I understood the motivations behind the characters this time."* (3.0). At the climax of the film, there is a shot in which a character thought to be dead opens his eyes and is revived. In many versions, this shot does not feature, and the variation creates an 'alternate ending' for viewers who have seen the film both with and without that single shot: *"He didn't wake up in the first version, and this one, he wakes up. And you think, was he pretending to be dead or did he wake up after? But yes, that was a totally different ending."* (3.5).

Because of audience demand and limited capacity at the festival, especially for the role of controller, no one had the opportunity to control the film more than once. Interviews probed whether viewers would be interested in accessing recordings of all the versions generated during the festival. This would allow controllers to review their versions again; e.g. *“I’m really interested in my own edit and watching that again because I want to see those points really where I think it changed because of what I was thinking at the time”* (5.5). It would also allow comparative meta-analysis with other viewers, by way of their narratives: *“I would like to see my version in the first place from start to finish in order to remind myself what I was thinking at the time. And then I would like to see other people’s cut as well because it might be changing according to gender, according to type of roles they’re having in the community. So that might be having an impact on the narrative.”* (3.4). One keen viewer expressed interest in *“watching them all. [I’m] just fascinated with how different people will bring different things out of it, I really am.”* (3.0).

## 5 DISCUSSION

Our study reveals distinctive aspects of designing interaction with BCI films and potentially with other BCI experiences too. While we do not yet have sufficient experience with this new approach to propose specific guidelines on how to make BCI films (there is plenty of scope yet to explore alternative kinds of films and interaction mechanisms), we are able to draw on *The MOMENT* to reveal a set of opportunities and/or challenges that others entering this arena may wish to consider. We revisit our findings in the light of both the HCI and Media Studies literature to draw these out.

### Meeting the Expectations of being a Film

Adding interactivity to films moves them closer towards other media forms such as games or social media such as YouTube. However, we argue that film remains a distinctive media form with its own important characteristics that need to be honoured even as a degree of interactivity is introduced.

Films can of course be experienced in many ways beyond theatrical exhibition - ranging from on-demand viewing at home and on mobile devices to large-scale live events involving costumes, props and performers - and we will consider how BCI-controlled films could function across these contexts. However, the essential characteristics which define film as a medium are often summed up as ‘lean-back’, with connotations of admiring artistry on display, rather than discovering or creating content (lean-forward) [15]. This distinction applied to media hinges on consumer control: the extent to which duration, circumstances and content can be manipulated [26]. In the case of conventional film, once a ticket or recording is purchased, all consumers receive an

identical product, fashioned according to a director’s overarching artistic vision, which they lean-back and take in.

In the context of its premiere at Sheffield Doc/Fest, *The MOMENT* was carefully framed and presented as a film. The content is strongly narrative-driven and conforms to Genre conventions of Sci-Fi Thrillers (dystopian politics, body horror, renegade AI). Though interactive, the film retains a set running length so that it can fit the scheduling constraints of movie theatres and festivals. It was projected onto a large screen in a dedicated, darkened space in which an audience viewed the same content together. In short, while being interactive, *The MOMENT* fitted the context of a film festival, according to our study participants.

### Enabling Lean-back Interaction

From an HCI point of view, the lean-back nature of the experience presents an interesting challenge, suggesting new modes of interaction that do not demand users being in control all of the time, or even being conscious of control, and yet that also immerse them in the narrative. Indeed, this was a motivator for considering Passive BCI [51] in the first place, as it raises the possibility of a more contemplative and internalised form of control that connects to thoughts and feelings more than physical actions. Previous work showed that it was possible to achieve interactions like this, but that these were often transient, with viewers journeying around a space of voluntary control and awareness of control, and frequently tipping back and forth between different modes [34]. In response to these findings, control in *The MOMENT* was designed to be less direct, avoiding explicit feedback from a trigger-like blinking mechanism.

While a direct comparison is not possible, our sense was that *The MOMENT* did deliver a less overtly conscious form of control for much of the time, but that a tension remained with people sometimes becoming conscious of control or trying to exert direct control.

This poses an unusual design challenge to HCI as it requires designing interactions that are neither direct and immediate or entirely calm [40] and ambient [49] computing in the sense that the overall digital experience remains very much in the foreground, even if the control does not. At first sight, it also raises something of a paradox; how can one be in control of something and not be aware of it? The answer, as argued by Pike et al. [34], lies in thinking in terms of flow experiences [13] in which one controls at a subconscious level while attending to experience at a more conscious one. How to achieve these kinds of lean-back interactions in practice, however, remains a key tension.

When applying the lean-back characterisation it is important to note that engagement with a film is not a ‘passive’ experience, in the pejorative, vernacular sense of ‘mindless’. Following a film requires concentration, which is one of the



reasons they are traditionally watched in the dark on a large screen. Looking beyond HCI, film theory details the complex cognitive processes involved in film viewing: “Meanings are not found but made” [6]. Communication theory challenges the apparently homogeneous nature of mass media by demonstrating the diverse ways in which audiences interpret and integrate media in their own lives [25]. The brain-controlled interaction in this case is designed to support a lean-back experience, not transform it into a lean-forward one. It foregrounds the interpretive ‘work’ involved in film viewing. As our data shows, controllers of this film are aware that their attention matters.

Our study reveals moments where people felt conscious of control and tried to experiment with the system, especially early on in the experience. However, we also have evidence that people experienced lean-back interaction: were willing to influence the content without understanding how, and to concentrate on the content presented. Interviewees themselves argued that deliberate narrative choice is undesirable because users could game the system and undermine artistic intention. Film history teaches us that technical developments of the medium can initially be a source of uncertainty and anxiety for audiences [9]. However, over time, new modes of interaction may be absorbed (just as sound and colour once were) into the formal systems for constructing and interpreting film meaning [7].

### Being Credibly Controllable

While we are arguing for less overt and immediate control, our findings reveal that it is important to audiences that there is credible interaction taking place; that they believe that brain data is influencing the film they see, even if how this works is ambiguous to some extent. The degree to which the BCI system needs to be explicit or known in advance to film viewers, or can be more ambiguous, is therefore also something of a tension. Some controllers wanted to go into the experience ‘a bit blind’ whereas others felt ‘put at ease’ by information about how their brain data would be used.

We suggest that a degree of uncertainty and ambiguity in this regard is in keeping with the lean-back experience of a film during which viewers ‘go about finding their own pleasures’ [45]. Gaver et al. [16] have proposed that ambiguity can be a powerful resource for designing interactive systems while Sengers et al. built on this to argue that interactive systems might be ‘open to interpretation’ [42], a view buttressed by concepts from literary scholars who proposed that meaning is actively co-constructed by the reader [11]. These arguments lead us to suggest that credible BCI interaction might involve enabling viewers to make meaningful interpretations of control that is credible, and accounts of how they controlled the film that allow them to reflect on its

content and their relationship to it, and so invest meaning into the experience.

### Being Watchable when Non-Interactive

*The MOMENT* was booked out to full audiences across the film festival, the majority of whom did not get to interact directly, but witnessed a brain-controlled film based on someone else’s EEG data. That proved to be a largely enjoyable experience, which is important because it shows that the experience accommodated the social aspects of filmgoing. On this basis, we believe that BCI film could still potentially play well in a conventional movie theatre with a larger non-interacting audience provided certain design tensions are accounted for.

We know from our questionnaire that some audience members found it harder to follow the narrative of *The MOMENT* than they would expect for a conventional film. We note that this might relate to a more rapid pace of brain-controlled editing. This highlights the importance of continuity editing norms in terms of making sense of shot combinations [8]. However, higher cognitive demands do not appear to have made the BCI film unwatchable. In our interviews, people spoke about satisfaction associated with building comprehension about the story and characters depicted in the film. This points to another important respect in which the film could be watchable when non-interactive: watched back after the event as a way of making sense of the interactions (that were not being thought about so much at the time) and/or the narrative.

### Generating the User’s Cut

Although the film was watchable for non-controllers, among the audiences we studied, being a screening controller was characterised as both a privilege and responsibility. Those who took this role rated the film more highly than other audience members did. This could be built upon so that the controller’s particular perspective, and the film that it generates, become a focus for the audience. In much the same way as a Director’s Cut is a saleable version of a pre-existing film, the experience of witnessing a notable (for some reason, e.g. featured actor, renowned critic, superfan, someone whose experience mirrors the themes in the film) controller’s version of an interactive film might be appealing the viewing audience, and invite them to make alternative interpretations. In practical terms, screenings that revolve around a celebrity interactor would fit with broader trends in the film industry towards exploiting live, experiential, participatory aspects of film going practices (e.g. Secret Cinema), analogous to immersive theatre [2].

Such celebrity cuts are likely to be viewed as somehow authoritative, according to auteurist views of cinema as ultimately authored by a singular artistic vision [17]. However,

the personal associations that were often made when viewing *The MOMENT* suggest the potential to extend this approach to every controller so that each generates their own cut of the film in which they are personally invested. This relies on: the BCI interaction mechanism generating sufficient variation to make many distinctively different versions of the film; viewers feeling ownership over the specific film that they have controlled; and viewers feeling that the resulting ‘user cuts’ reveal insights into the controllers and their responses to the film.

Such an approach may encourage repeat viewing, which is already a feature of film consumption over time, especially among fans [30]. Enabling each viewer to generate a user’s cut may encourage people to re-experience the film in different modes (controller and non-controller), compare their cuts with others, and try to interpret the film through other’s eyes. It suggests maintaining an archive of all versions along with visualisation that allow people to compare their own experience to others as discussed by Benford et al. [5].

### Editing a Film rather than Controlling its Screening

Finally, broadening our perspective somewhat, this notion of the User’s Cut leads us to speculate about an interesting reversal of perspective. Up to now, we have seen brain-controlled film as being about audiences interactively controlling a movie while it is screened. However, our experience in this paper suggests that this may remain a knotty challenge, even with the more lean-back forms of interaction we have introduced here. On the other hand, we have raised the alternative prospect that experiencing *The MOMENT* might be thought of as users investing in generating their own personalized cuts. This suggests to us that we might shift our view of brain-controlled film to consider the idea that our viewers are actually making films rather than only watching them. The Director provides a pool of material and a narrative and interactional structure, but it is the viewers who then complete this to generate personal cuts that can also be enjoyed by others. In fact, this idea reflects the above argument that to watch (even a traditional ‘passive’) film is to actively engage in an act of co-construction [11]. BCI control of the kind proposed here may make this feedback loop more explicit and bring it into the repertoire of techniques that can be employed by filmmakers.

Such a shift of perspective potentially has implications for how HCI reconceptualises brain-controlled films, and perhaps other BCI or even generally interactive, media experiences. Recognizing that we are enabling viewers to complete the making of films naturally emphasises the ideas of designing films to be personalised, divergent, archived, shareable and repeatable experiences. While it may still be important to design appropriately lean-back interactions as part of this,

the bigger picture is perhaps about how we ultimately capture and share generated versions of experiences, so that people can comprehend both the versions they have edited, and the edits that they want to see.

## 6 CONCLUSIONS

A long-term challenge for creating interactive film has been that interactivity appears to conflict with the lean-back nature of the medium; to relax and enjoy a movie is a different experience from controlling a game. From prior work, we know that even feedback from passive interactions with a movie can disrupt immersion. We therefore explored how Passive BCI can be employed to create more subconscious lean-back interactions with a film, and what people’s experiences of watching it were, whether as controller or as an audience member.

We found that controllers reflected on the versions they had created at the same time as reflecting on what the film was about, making it important for a brain-controlled film to support retrospective understanding of Passive BCI interactions, rather than immediate understanding of it that might disrupt immersion. We found that people felt ownership of the films they had ‘created’, due in part to the filmmaker’s choices for making a highly variable experience from viewing to viewing. We also found that people wanted to see the film again and again, even if not as the controller.

We conclude that BCI does have a role to play in addressing the tension between viewer and directorial control in interactive film and that one way of seeing this might be to think of viewers as being given greater editorial control. In the case of *The MOMENT*, the filmmaker retained directorial control, creating a single narrative, and recording multiple threads through it for different characters. However, they then designed a Passive BCI interaction that gave a degree of editorial control to the viewer, where they had control over cuts rather than choices within the film.

This observation has broader implications for the filmmaking process, which is normally a process of controlling the envisioned viewer’s experience, where facilitating a designed interaction extends back through the filming and production all the way to the scripting of the film. If producers can create content that is then selected from and combined - in other words edited - by audiences at the point of consumption, the numbers of possible perspectives on a film might multiply. The scale and speed of the resulting feedback might lend itself to agile creative responses from producers, who could alter existing content or be inspired to create new content based on more granular audience data. Perhaps this kind of interactive feedback loop between artists and audiences might eventually completely change types of stories and ways they are told.

We finish with a final thought on where we hope this work may take us in the future. Control over media content usually resides with creative producers, often governed by multinational conglomerates, with audiences exerting interpretive agency within limited parameters (indirectly feeding back into what gets made). The upshot is that particular cultural perspectives dominate normative storytelling. Media scholars have long evidenced [12] and argued against a lack of diversity in media representations [20]. In the film industry, movements like #blacklivesmatter and #timesup are being used to campaign for better representation in front and behind the camera. Perhaps ultimately, important and overdue moves towards greater equality and more varied storytelling might be enabled through interactive technologies that open up editorial control? Real-time editing platforms, like the one developed for *The MOMENT*, can allow artists to make available more content and, by extension, more varied perspectives within their stories. Lean-back interactivity through BCI can offer audiences greater agency by reflecting their internal attention and preferences on screen.

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## A FULL THEMES TABLE

Table 3 shows the full themes and codes generated from the thematic analysis performed on the interview data.

Table 3: Full theme table from thematic analysis.

Themes	Codes	Sources	Refs
<b>Controlling the Film</b>		<b>25</b>	<b>137</b>
	<b>Expectations:</b> Prior knowledge/ideas before the experience, and imagining control (themselves or other people)	17	43
	<b>Experimentation:</b> Deliberate attempts/techniques to try to control the film or understand how it works	17	28
	<b>Intention:</b> How they make sense of interactivity/what the system does	17	44
	<b>Ownership:</b> Identifying the version they've controlled as theirs (or not theirs)	9	13
	<b>Self-reflection:</b> Speculating about how their thoughts/mental processes influenced the system	18	46
	<b>Variety:</b> How the version they controlled differs from other versions	10	17
<b>Viewing without Controlling</b>		<b>25</b>	<b>99</b>
	<b>Added value:</b> What makes this film different from conventional films/cinema even when they're not controlling it	14	23
	<b>Comparative:</b> Later discussion of how this version they watched differs from other versions (they've controlled or watched)	10	17
	<b>Comprehension:</b> Making sense of the story and what it means, especially in regard to the editing	9	21
	<b>How it works:</b> How non-controllers think the system produces the film	10	16
	<b>Insight:</b> What non-controllers speculate about what the controller was thinking	16	35
<b>Repeat Viewing</b>		<b>24</b>	<b>90</b>
	<b>Contrast:</b> Comparing between multiple versions the participants have seen	12	29
	<b>Necessity:</b> If the meaning or value of the film is dependent (or not) on more than one viewing	9	12
	<b>Novelty:</b> Imagining other versions and why these might be interesting (for them or other people)	13	20
	<b>Personalised:</b> How a version someone controlled reflects them in a way that's different from versions they didn't control	10	17
	<b>Perspective:</b> Seeing different story content on repeat viewing	8	17
	<b>Understanding:</b> Interpreting the film differently (or not) as a result of repeat viewing	9	19