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Brain Controlled Cinema

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This paper is a proposal for PhD level research into brain controlled film. I place brain computer interfaces (BCI) in a historic and then an artistic context before exploring instances of research where film and BCI overlap. I then define what has not been covered by research and propose a way to contribute to that gap in knowledge. I explain my interest in the subject, and the methodologies I plan to undertake in order to complete the research.

BCI. HCI. Practice Led Research. Embodiment. Film Studies.

1. INTRODUCTION

In the 1890s Hans Berger was enlisted in the German army. He was almost crushed to death by an artillery wheel when he was thrown from his horse. Later that day he received a telegram from his father; his sister had a feeling of dread that morning and was convinced that something was going to happen to Hans. This started a lifelong search for telepathy, the phenomenon of thoughts being transmitted from one person to another. Hans Berger studied the small electrical signals given off by the brain and in 1929 discovered the electroencephalogram (EEG). [1]

Grey Walter, a pioneer of cybernetics continued Bergers' work and discovered Delta and Gamma waves. In 1963 Grey Walter, wrote 'The Living Brain'- which was influential on the beat artists, particularly William Burroghs and Brion Gysin. [2] In 1963 Walter wrote 'The Living Brain', which describes the "Flicker following response" where brainwave responding to a flashing light and also producing visual hallucinations [3]. This caught the attentions of the Beat artists [2]; Brion Gysin who had previously experienced visions from lights through trees read Grey Walter's Book and with William Burrows created the dreamachine, which produced a strobe light effect with a piece of paper and a record player. The machine produces hallucinations and was used by writers and artists such as Aldus Huxley and Tony Conrad. Tony Conrad later produced a film called 'The Flicker' [4] which exploited this phenomenon. Herrmann also found these hallucinations present when studying steady-state visual evoked potentials (SSVEP) [5].

The first implementation of a BCI in the artistic sphere, is in 1965. Alvin Lucier performed his seminal piece "Music For A Solo Performer". The performances consisted of Lucier, assisted by John Cage, fitted with EEG electrodes, he sat motionless for 40 minutes while his brain signals amplified through speakers reverberating through percussion instruments (and a piano) [6]. One could argue this is an example of the experimentation and innovation of artists preceding technological implementation.

In the 1970s DARPA starts funding its ongoing research to develop Brain Computer Interface technologies to support Americas warfighters.[7] In 1972 Jacques J Vidal coined the term BCI in his paper "Towards Direct Brain-Computer Integration" [8] where he sets out the terms of which the field of BCI would follow. He creates a BCI which users control a cursor through a maze [9].

EEG was used by Psychologists to collect a vast amount of data in the years to come and eventually employed computers to analyze. Brain Computer Interfaces (BCI) were originally developed because of the need to help people that have lost control partially, or completely of their body. Wolpaw et al [10] defines BCI as "communication channels that do not depend on peripheral nerves and muscles" In other words, the technology allows users to communicate not via their usual path ways of brain to motor movements, but from brain to computer which then interprets the intention into movement or communication. While developed for disabled users, technology and research aimed towards able bodied users is also being pursued. Opening BCI technology to general users has allowed the exploration of general system interactions, an extra modality in HCI research, and innovation within design spaces.

Thom Blum reviews Rosenboom's 1972 essay, Homuncular Homophony [11] and says Rosenboom calls to bring together creativity and neurology, calling for artists to use neuro-physiological data as a method of creating interactive music, in order to study "the astounding

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ability to consciously experience and bring under self-control many of the hitherto unconscious neural processes on which mental life is founded". In his review, Blum continues the historic narrative through to the 80s; he highlights a connection of the work musicians were making using neurophysicalogical interfaces and the minimal electronic music that was to follow.

2.1 Artistic BCI

There has been a spate of new BCI inspired interactive artworks since the turn of the millennium [12]–[15] and so the study of interactive art process becomes useful. Edmonds' definition of 'dynamic interactive' or 'dynamic interactive (varying)' art systems allow the viewer to be the 'catalyst for creativity',[16] which means that the viewer is central to the work. Structured creative processes such as Shneiderman's Genex, may also inform process [17].

Simon argues for the theorizing of the artistic work by the artist: as interactive art by definition exists outside traditional art forms the artist should be aware of what it is and what it isn't, and should be able to use theory as a creative medium. He argues that this method is mutually exclusive from an intuitive approach of the autonomous artist, and that interactive art in a way removes the ego from the work.[18]

2.2 Embodiment

The epistemology laid out by Varela et al [19] is relevant to both my practice and research. In contemporary film studies, embodied simulation is a concept that relies on mirror neurons; that the same neurons fire in our brains when we are watching someone move as when we move ourselves. It is that when watching a body move on film our brain fires the same neurons as if we ourselves were moving that way or crying that way [20]. This theory can be exploited when creating enactive cinema as there is a known affect on the viewer from the film content. Embodiment in brain computer interaction widens the scope of looking at just the brain [21]. But when viewing a movie we are usually still, in the dark; it is the optimum mode for engaging with a film. This disconnect may be able to be reconciled by combining, comparing and contrasting theories of embodiment from both fields.

2.3 Neurocinematics and Enactive Cinema

The idea of Neuro Coupling is a concept in neuroscience which it explains the phenomenon of 2 or more brains demonstrating similar measurable patterns when performing the same task or interacting with each other [22], [23]. Hassan puts forward the idea that we cannot study the brain in isolation as how we learn, communicate and interact with the world is dependent on other brains. This is also reflected in Gallese and Goldman's study in neuro mirroring [24]. Perhaps where the proverb 'being on the same wavelength' comes from [25]. Neuro coupling is also a core concept of Neurocinematics and described as Inter Subject Correlation [26] which is in turn based on the Inter Subject Synchronization, where Hasson et al explore peoples tendency for their brains to 'tick together' in their perception and association cortices[27]. I talk about the idea of a 2 way affect loop in a previous paper [28]. To further that discussion the two way affect loop could be likened to neural coupling but where the computer becomes the 2nd person. It follows that people will be drawn towards a piece of work that mirrors their internal state of mind as it is mirroring the internal mechanisms of communication.

"The phenomenon and theory of brain-to-brain coupling is not only innovative for the fields of neuroscience and psychology, but the potential applications in the frame of multi-brain interactive works of new media art, computer and serious games is apparent and has already attracted the attention of researchers, artists and developers." - Polina Zioga [29]

Building on the findings of Neurocinematics, Tikka et al. [30] use film and BCI to study social interactions in the field of neuroscience and coin the phrase enactive cinema. This is differentiated from interactive cinema which requires the controlling individual to make decisions about the direction of the story. In Tikka's enactive cinema the individual's agency is passively sensed and used to inform the ongoing action; in a way that the authors believe is analogous and powerful enough to mirror real life interaction. The research shows the two way affect of the film and the agent is an advantage to passive narrative film.

2.4 Immersion and Effect and Affect

Affect is a relevant component of control. It can be defined as experiencing emotions and how they respond to usability problems, a high effect allows users to be indulgent towards problems, [31].

Hakvoort's study suggests that using a BCI as a control method is more immersive than more commonly used input devices [32]. He cites Picard's three dimensions of effect: valence, arousal and dominance and maps a space of arousal and valence as critical to recreational applications.

In Pike et al 's position paper on the nature of the affective two way loop that BCI offers he defines key research questions in experience design, individual differences, and physiology.

Mahlke et al defines a research approach to measuring non specific instances of user experience (UX) based on pleasure and emotion. Measuring emotions pertaining to specific design elements can be done using existing frameworks [33]

There are many ways of measuring emotion, from self reports to computer vision to multi modal GSR and BCI combinations. Eliciting emotion in people via music may give some insights in how to go about designing emotionally valid BCI implementations [34]

Neural correlates of emotion are studied by Daly et al [35]. He uses music to elicit emotion and reads that data as emotion. Daly also found functional connectivity networks of those emotions within EEG.

3. RESEARCH GAP

To my knowledge, in the fields of HCI and Film Studies there has been no formal research into the process of making brain controlled films, of defining the potentials for said films over traditional film, how these films can be scaled to fit a greater audience, or how public audiences react to brain controlled film.

4. RESEARCH PROBLEM

Just as the introduction of sound into silent movies of the 1920s allowed for new ways to tell stories, this new form of film has the potential to tell new stories in new ways. In order to account for these potentials, the whole film making process must be re assessed, not only from writing through production to post production but the actual concepts of film itself can be interrogated and challenged.

It is not just the film maker who is in new territory, audiences also have a journey of discovery in interacting with a film that is controlled by his/her brain. Forgoing the novelty of the experience, an active viewer must choose in what proportion they attend to the interaction and to the content of a brain controlled film. How the system and content are designed and made will relate to how a viewer interacts, but it will not be until the work is screened and data is collected and analyzed that we will have a way to start to understand how audiences actually interact. The system is designed with an interaction in mind, but what actually happens may be quite different.

Film school is not enough, existing literature is insufficient, we need to make the tools to make a brain controlled film a possibility. Existing theories in embodiment when applied to the fundamental elements of film may provide new insights for and brain controlled cinema.

5. RESEARCH STATEMENT

As a practicing artist my work has existed in the intersection between film and interactive art. My most significant series of installations- umbrella titled #Scanners- explored artistic, screen based work controlled by a BCI. In my transition into researcher I have co-written several papers exploring control and affective aspects of the brain controlled film ‘The Disadvantages of Time Travel’. I propose to continue the narrative of this research in three ways

1. By further studying interactions with brain controlled films via screenings; I will conduct four studies. I also plan to conduct workshops with artists and film makers which will explore how artists could make content for these brain controlled film systems.
2. Unpacking and discovering knowledge form these studies. By doing quantitative analysis, conversational analysis, and grounded theory the findings of which will find them selves written up as papers which will be submitted to journals and conferences, building up the content of the thesis.
3. Practically applying findings by producing a film and by creating filmic vignettes in order to test hypotheses. I believe that to holistically study how people interact with films we need a variety of different films to study. As film making is so time intensive I plan to curate and nurture film makers who have not made brain controlled films before to do so. These films will be collected and screened at a specially organized film festival.

6. RESEARCH QUESTIONS

Each of three nodes of the methodology of this research have their own domain specific, nested questions:

Practice

- How do you produce a brain controlled film that is interactive and open to repeat experience?
- What is the relationship between content, design and control of a brain controlled film?
- What is the motive from artists or film makers to create brain controlled film?

Study

- How do audiences interact with brain controlled interactive film?
- What methods of brain controlled interactivity are best used?

- How do brain controlled interactive films affect viewers?
- Can films be scaled to work for larger audiences?

Theory

- What advantages can a brain controlled interactive film have over a standard one?
- How can implicit control be used effectively within brain controlled film?

7. METHODS

I will be following the method of performance-led research in the wild as laid out by Benford et al. [36] This method consists of three interacting and self reflexive parts; Practical Film Production and Film Design, Screenings and Practical Theory. The theory discourses within the disciplines of Film Studies and Human Computer Interaction, epistemologically based in Enaction and Embodiment which will influence the direction and scope of investigation engaged within practice. My practice can be separated into two distinct interrelated methods, that of content creation (in this case film) and that of interactive design. A careful consideration of practice alongside observations from studies will be key to discover new knowledge relevant to the afore mentioned disciplines. I will also account for current thoughts in practice as research in the arts [37]. Studies will take place within public performances where I will be collecting data about people's interactions, and the artworks themselves in both qualitative and quantitative methods. To list; interviews, questionnaires, inbuilt measurements, recordings of interactions and created artworks will be used to collect information for analysis. Doing research during a live event can be risky, both to the integrity of the work in question and to the quality of data due to the one-off nature of a performance, to mitigate these risks I propose to do a number of pre-performance lab studies which will provide a opportunity to fine tune both the work and research methods.

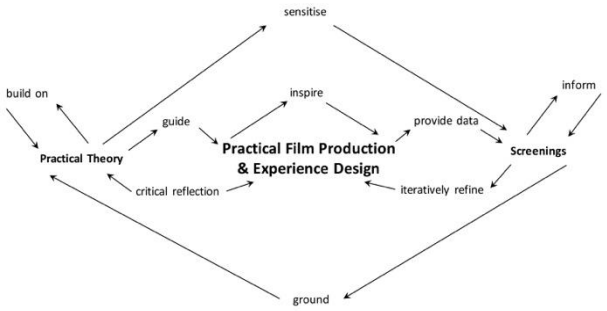

***Figure 1**. Adapted from performance led research in the wild* [36]

I plan to thoroughly explore what constitutes practice as research as it relates to interactive art [38], [39]. I also plan to design a number of lab studies that will look in detail at what is happening within interactions of these prototype designs. These studies will look at very fine grain interaction with systems, and will derive quantitative and emotional data [33]. It will be an aim of the research to produce results that will be publishable within HCI and artistic conferences and journals.

The reason for facilitating the creation of a multitude of films via a film festival is two fold, firstly to study a spectrum of possible designs and approaches to brain controlled film and secondly to expand the publics exposure to a verity of brain controlled film, empirical and ethnographically informed audience research methods can then be used. I will draw on methods from participatory design [40], and conversation analysis to run a series of workshops with artists and film makers where we will explore interactions with filmic Brain Computer Interfaces and discuss the issues and opportunities present for artists. These workshops will also encourage artists and film makers to make their own films. I have experience developing software for interactive art and I will explore existing roadmaps [41] as well as the possibility to work with other computer scientists to develop interactive software.

My industry partners FACT and B3 Media are committed to supporting this research and artistic project, FACT has set aside financial help both in cash and match funding and will supply space for activities, presentations and exhibitions.

8. TIMELINE

The plan for my PhD is shown separated into three sections, Practice, Study and Theory, but here I will run it chronologically, Experiment One will focus on alternative methods of control, repeat experiences and multiple controlling persons. I will then write up the findings from these studies. The findings will inform the design for a brain controlled film and research, during the pre production the more practice driven Experiment Two and a series of workshops with artists and film makers will be conducted. Experiment Three happens during the post production of the film process and will allow different configurations of the film to be tested. The film made as part of the PhD will be screened and studied. From the beginning of year two I will have been curating a brain controlled film festival, which will happen in June of 2018, I will then have 2 months to analyse and write up findings from studies from the festival before my year of writing up my thesis proper.

9. CONTRIBUTION TO KNOWLEDGE

In my thesis I plan to set out frameworks for designing films and screening systems for brain

controlled film: practical worked examples of how to go about making content for such systems which will include design recommendations to film makers. By studying and unpacking interactions with audience I will devise taxonomies of factors for control, content and interaction.

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