Mood Glove

Enhancing mood in film music
through haptic sensations
for an enriched film experience

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Statement of Originality

I, Antonella Mazzoni, confirm that the research included within this thesis is my own work or that where it has been carried out in collaboration with, or supported by others, that this is duly acknowledged below and my contribution indicated. Previously published material is also acknowledged below.

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Details of collaboration and publications:
A list of publications and the authors contributions therein can be found in Section 1.5

Abstract

This research explores a new way of enhancing audience experience in film entertainment, presenting the design and implementation of a wearable prototype system that uses haptic sensations to intensify moods in film music.

The aim of this work is to enrich the musical experience of film audiences and might also have implication on the hearing-impaired, providing them with a new enhanced emotional experience while watching a movie.

Although there has been previous work into music displays of a visual and haptic nature, and on the importance of music in film, there is no documented research on musical enhancement experience in film entertainment.

This work focuses on the mood conveyed by film music in order to understand what role it plays in creating the film experience, and also explores the possibility of enhancing those feelings through haptic sensations. Drawing on HCI and interaction design principles, the design of a piece of haptic wearable technology is proposed and used as the tool for user studies.

This research contributes to the fields of: HCI, interaction design, user experience design, multimodal interaction, creative technology, wearable technology, haptics, entertainment technology and film music.

This work also provides a set of design suggestions to aid future research and designers of haptic sensations for media enhancement. Proposed guidelines are based on a number of empirical findings that describe and explain aspects of audience emotional response to haptics, providing some first evidence that there is a correlation between vibrotactile stimuli (such as frequency and intensity) and perceived feelings.

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List of abbreviations

EAI	European Alliance for Innovation
EECS	Electronic Engineering and Computer Science
EUDL	European Union Digital Library
HCI	Human Computer Interaction
ID	Interaction Design
IEEE	Institute of Electrical and Electronics Engineers
INTETAIN	Intelligent Technologies for Interactive Entertainment
MAT	Media and Arts Technology
POV	Point-of-view shot
SAM	Self-Assessment Manikin

Chapter 1

Introduction

Film is a multimodal form of entertainment that blends together moving pictures and music to tell a story and create an experience for audiences (Bordwell and Thompson, 2008). Cinema is a form of inclusive art through which filmmakers design the viewers' experience.

> *"A film takes us on a journey, offering a patterned experience that engages our minds and emotions."* (Bordwell and Thompson, 2008, p.2)

French film theorist and semiotician Metz (1991) identifies five channels of communication in film (two visual and three auditory): the visual image, print and other graphics, speech, music and sound effects. While the visual images, graphics and speech are descriptive and narrate the story, ambient sounds provide additional information on the surroundings, and film music, as asserted by Frith (1984), can convey and clarify the emotional significance of a scene.

Over the years techniques have been developed to enhance the film experience through stimulation of the visual and auditory senses. Advanced Digital 3D projections create the illusion of depth perception, IMAX allows widescreen cinematography and surround sound gives a multidirectional perspective. Most recently, technological innovation has made the spectators' experience even more immersive by involving other senses, such as the MX4D® Motion EFX Technology[1], where movie theatre seats perform motion to augment the action on screen, as well as generating special effects such as pokes and tickling, water blasts, puffs of wind and scents, etc. It is worth investigating this further in order to find new ways of enriching emotions in film entertainment through the stimulation of other senses, and attempting doing so in an innovative manner, by amplifying aspects within the film other than the physical - those elements which are significant but are not shown.

In his enquiry into narrative film music, Frith (1984) writes about the purpose of music according to Wagner, who argued that its purpose was *"to amplify what can't be shown"*, adding that "what can't be shown is what we call *atmosphere* or *mood*" (Frith, 1984, p.83).

This work explores the possibility of enhancing moods in film music through haptic sensations to enrich the film experience in the context of cinematic entertainment, both in cinemas and home viewing scenarios, as well as movie watching on portable devices.

1.1 Motivation

> *"The motion picture is an art form, but we must not suppose that it is solely an affair of the mind. Motion pictures address our bodies as well. [..] Movies can reach under our skin and stir up our feelings"* (Carroll, 2008, pp.189-190)

The motivation behind this work arose from considering the emotional and cognitive roles that film entertainment plays in the lives of its viewers and reflecting on how current technology improves the cinematic experience. By cinematic experience we refer to *"the interplay among the movie on the screen, the viewer confronting it, and the social and material configurations that inflect how this encounter is understood and felt"* as in Rogers (2013, p.2).

[1] http://www.mx-4d.com/

Technological advances exist to highlight action and physical events in motion pictures with the intent of bringing spectators closer to the story and intensifying their sense of presence and their emotions. This work intends to expand on current research, exploring new creative and intuitive ways of enhancing the film experience.

Film developed into an art form to tell stories and music is a key part of this process (Kalinak, 2010). Film music is able to establish settings, recall audiences' attention to particular elements on screen, shape moods and create atmosphere (Kalinak, 2010). Although music is an essential part in film, there is no documented research directed to amplify mood in the film score. Some previous work translated musical features into vibrotactile feedback, presenting interfaces to enjoy music as vibrations on the body. Since sound is essentially vibrating air, vibrotactile feedback seems a plausible medium to associate with music. Also, it can be experienced by everyone, including the hearing-impaired.

However, is it possible to go a step further, and rather than presenting music features as vibrations, try to encode some other subtle elements within the music instead? If, as asserted by Wagner and highlighted by Frith (1984) the purpose of music is to intensify mood, then why not amplify this even further? Therefore, the main objective of this work is: *enhancing mood in film music through haptic sensations.*

1.2 Aim and approach

The aim of this study is to enrich the film experience through expressive haptic sensations designed to intensify moods in the film score. In order to do so we first conducted a study to assess whether vibrotactile stimuli would be able to suggest moods and then proceeded to explore audience response when combining haptic sensations with movie clips. We also propose a set of guidelines for creating expressive haptic sensations for media enhancement.

The design of a haptic wearable technology prototype is proposed as the tool to deliver the haptic sensations. By *haptic* this work refers to kinesthetic and cutaneous stimulation as in Eberhardt et al. (1993).

This research addressed whether haptic sensations are able to suggest moods and if certain elements of vibrotactile feedback, such as frequency and intensity, could play a part in suggesting specific feelings to the user. Valence and arousal are the two basic dimensions that define emotions (Oliver and Bartsch, 2010) and therefore we gather participants' valence and arousal values to assess our approach. Valence and arousal also describe emotions in their simplest form: moods.

This work focussed on moods in music rather than music and emotions, and by the term *mood* this study refers to a temporary feeling or state of mind, whereas *emotion* refers to a natural instinctive sentiment or reaction. The term *mood music*, which appears throughout this report, refers to the pervading tone, atmosphere or feeling induced or suggested by the music.

This work may contribute to existing research towards the creation of new forms for enhancing film entertainment and might also have implications on hearing-impaired audiences.

We propose that vibrotactile stimuli can complement music as a medium for conveying moods and that this use of haptic sensations could represent an added tool effect in film entertainment, as both a sensory substitute medium to mood in film music (in those cases where the audio channel is not accessible), as well as to complement the sound and enhance the film experience.

This work positions itself among the fields of: HCI, multimodal interaction, haptics, wearable technology, creative technology, entertainment technology and film music.

1.2.1 Research question

The overall question this work addresses is: *how can haptic sensations be designed to become an integrating part of the film experience.*

Other questions this thesis examined in order to address the overall research question are: *how can the cinematic experience be enriched through stimulation of another sense; can haptic sensations suggest or enhance moods? Can haptic sensations enhance moods in film music?*

In order to address the research question we started with acquiring a knowledge of the affective role that film entertainment plays in the cinematic experience of its viewers. By *affect* this work refers to any state that involves feelings or sensations, such as moods as in Carroll (2008).

As this thesis will examine in the upcoming chapters, film music guides spectators to the images on screen, conveying emotions and engaging them in a process of identification, which ultimately resonates with the film's audience (Kalinak, 2010). As film music represents a key element in shaping spectators' cinematic experience, we based our approach on complementing moods in film music to further enhance the experience and turned perceived moods into haptic sensations.

This work will also present the design of a haptic wearable prototype, proposed to deliver haptic sensations to the viewers and observe their affective reaction to the multi-sensory experience proposed.

Furthermore, we will propose guidelines for creating expressive haptic sensations for film entertainment enhancement.

1.2.2 Methodological approach

This work adopted an iterative design approach, designing and evaluating at each stage of the model a wearable haptic prototype and a series of haptic sensations directed at intensifying moods. The data was acquired through induced behaviour under controlled settings and was based on a dimensional approach to emotional stimuli (valence and arousal). In the first study, participants reported on their perceived mood (in terms of valence and arousal) when sensing a series of haptic sensations. In the second user study, haptic sensations were paired with movie clips and participants' affective reaction to the multi-sensory experience designed was recorded. Findings from the first two user studies informed the design of a third and final study, where haptic sensations were employed to target the build up of suspense in the film excerpts shown to participants.

1.3 Contributions

This work contributes to the fields of:

- HCI, Interaction Design, User Experience Design
- Creative technology
- Entertainment technology
- Wearable technologies
- Haptic interfaces
- Multimodal interaction

1.4 Thesis structure

Chapter 2 presents an overview in the areas of Film Entertainment, with focus on Film Music and its emotional role on the audience, and discusses past work done in Music and Haptics, and on Haptic Technologies for Entertainment.

Chapter 3 provides details on the methodology adopted in this study and introduces the first three glove prototypes designed for this study.

Chapter 4 presents the design of the fourth glove prototype and describes the first user study undertaken in this work, which was aimed at exploring initial effects of haptic sensations on mood.

Chapter 5 introduces the design of the fifth and final glove prototype, reporting on the second user study where haptic sensations were paired with movie clips in order to observe audience emotional reaction to the sensory addition.

Chapter 6 describes the third and final study of this work, where, informed by findings from the second study, haptic sensations have been employed to intensify suspense in movie scenes.

Chapter 7 draws conclusions from this work, providing an overview of the studies undertaken and major findings, as well as discussing limitations. It also suggests guidelines for designing haptic sensations for media enhancement and proposes future work for this research.

1.5 Associated publications and exhibitions

Portions of the work detailed in this report have been presented in international scholarly publications and exhibited in a number of events.

1.5.1 Publications

- Chapter 4 was published as a full paper at the 7th International Conference on Intelligent Technologies for Interactive Entertainment (INTETAIN), Turin, Italy, June 10-12, 2015 (Mazzoni and Bryan-Kinns, 2015); and it was also selected based on quality of work to appear in the EAI Endorsed Transaction in the EUDL.
- Chapter 5 and parts of 6 were published at the 2016 ACM Conference on Designing Interactive Systems (DIS), Brisbane, QLD, Australia, June 04 - 08, 2016 (Mazzoni and Bryan-Kinns, 2016a)
- Chapters 4 and 5 were published as journal article for a Special Issue of Elsevier Journal Entertainment Computing, Volume 17, November 2016, Pages 9-17 (Mazzoni and Bryan-Kinns, 2016b)

1.5.2 Exhibitions

- The Wearable Technology Show 2015, ExCel London, March 10-11, 2015
- Sharing Design: Utopia of Culture Makers. International Culture Makers Joint Design Exhibition. Milan, Italy, April 14-May 8, 2015
- Digital Shoreditch. London, May 11-15, 2015
- Wear It. Wearable Technology Festival. Museum of Science and Industry. Manchester, 10-13 March 2016
- INTER/SECTIONS. Experiments in Media, Arts and Technology. London, 10-16 September 2016

- Supersenses. Free Temporary Exhibition. The National Science and Media Museum. Bradford, 15 July - 8 October 2017

Chapter 2

Background

This section provides an overview of past work in the areas of: film, affect, music and emotions, and haptics.

2.1 Film entertainment and emotions

> *"Film is a narrative medium, an art form that delivers stories"* (Kalinak, 2010, p.18)

Theorists, as described in Monaco (2009, p.252) differentiate between *film*, *cinema*, and *movies*, such that:

- *film* represents the aspect of the art concerning its relationship with the world around it;
- *cinema* refers to to the aesthetics and internal structure of the art;
- *movie* denotes the motion picture as an economic commodity.

This work adopts the same differentiation as in Monaco (2009) when mentioning the above terms.

Entertainment often relies on combinations of senses to convey emotions. Film is a multimodal form of entertainment that blends together audio and visual stimuli to tell a story and create an emotional experience for those watching (Bordwell and Thompson, 2008).

> *"Emotion characterizes the experience of film, as it does the experience of music"* (Cohen, 2010, p.249)

Music is an integral part of the film experience, and even before sound, film-makers were working closely with musicians, having live music played during silent movie shows, empowering music to lead and define the images (Monaco, 2009).

Gorbman (2003) explains how in the silent era music accompanied films as it complemented the on-screen movements and rhythms of editing, and was able to bond spectators to the spectacle. Gorbman (2003) reports that, according to different writers, the use of film music before early 1930 was considered unacceptable as it represented nondiegetic sound that couldn't logically be associated in a film. However, the role of music in silent film was perceived as a "sonic compensation for lack of actual diegetic sound" (Gorbman, 2003, p.38). Diegetic sound is sound that exists within the fictional world, whereas nondiegetic sound is the sound coming from a source external to the fictional world (Bordwell and Thompson, 2008). Film music is a type of nondiegetic sound.

The addition of sound to film can be considered the first technological evolution. Recorded sound was first introduced in 1926 (Bordwell and Thompson, 2008), and Warner Brothers with the use of the Vitaphone sound-on-disc system marked the sound revolution (Kalinak, 2010). The use of recorded sound replaced live entertainment, eliminating the need for the orchestra (Burke, 2009). The introduction of sound in film had a destructive effect in that it stopped the development of silent film, but it also offered artistic opportunities (Arnheim, 1957).

Music is a conduit of emotion between the audience and the screen. It engages spectators in the identification process, ensuring that the film resonates with them (Kalinak, 2010). Music in cinema is a signifier of emotion (Gorbman, 1987) and it is common for music to signify both mood and identification at one time (Kassabian, 2001).

Film music interprets the image, supplying information that complements potentially ambiguous diegetic images and sounds. It provides the viewer with cues in the narrative, for example: the 'shark' theme in Jaws gives the viewer advance knowledge of the narrative threat (Gorbman, 1987).

> *"Film music is at once a gel, a space, a language, a cradle, a beat, a signifier of internal depth and emotions as well as a provider of emphasis on visual movement and spectacle. It bonds: shot to shot, narrative event to meaning, spectator to narrative and spectator to audience."* (Gorbman, 2003, p.39)

From a study conducted to assess the impact of music on perceived emotions in film (Parke et al., 2007) it was observed that changing the music in a movie clip could alter the audience's emotions, leading this study to deduce that music in a film plays an essential role in the way the audience feels towards the scene on screen.

Simon Boswell (2012), a film music composer proposes that there are two ways of using music in cinema:

1. as a way of expressing the same emotions transmitted by the scene (e.g. a gloomy scene accompanied by melancholic music), with the scope of intensifying a certain emotion;

2. to draw the opposite emotions drawn by the scene (e.g. a gloomy scene accompanied by a beatific score), in order to accentuate an emotion. For instance, playing uplifting music in a vivid horror scene to make it bearable for the audience to watch.

Reflecting on the main elements in a film from an audience standpoint, there is the visual (i.e. motion picture) and the sound, both diegetic and nondiegetic.

When watching a movie, vision and hearing are the primary senses involved, but what about other senses? Could other senses be stimulated to complement or enhance the experience for the audience?

Arnheim (1957) in his analysis of the dynamics of cinema defining film art, talks about *the absence of the nonvisual world of the senses* and how sensations of equilibrium, smell, or touch in a film are never directly conveyed through the stimuli, but instead suggested through sight, positing the theory that making a film whose main features can't be visually expressed would be against the rules (Arnheim, 1957, p.34). This work will discuss how technological innovation has changed this perspective, with multiple senses being employed to create ever more immersive experiences in order to draw spectators into the auteur's fictional world.

With this in mind, if we were to complement the role of film music with multimodality, how could this be achieved? As sound is essentially vibrating air, it can be felt, not just heard, so the sense of touch represents an interesting possibility to explore, as this thesis discusses in the next section.

Barker (2009) explored cinema's tactility, arguing that cinema is an intimate experience rather than merely a visual medium.

> *"Touch is a 'style of being' shared by both film and viewer, and particular structures of human touch correspond to particular structures of the cinematic experience"* (Barker, 2009, p.2)

Some research has been undertaken on stimulating the tactile sense through vibrotactile feedback, proposing the design of haptic interfaces as a tool of multimodal interaction within Virtual Environments (VR) (Nijholt et al., 2005). Other work employed the use of haptic interfaces to convey non-verbal communication cues to people deprived from visual or auditory senses, as the haptic belt system for blind people in McDaniel et al. (2008) and the haptic display for speech perception for the deaf in Eberhardt et al. (1993). However, the use of haptic interfaces is not limited to providing an alternative sensory substitution, but vibrotactile feedback is also widely used in video game entertainment to enhance physical events (e.g. car crashes and collisions) and to provide discrete alerts via mobile phones, other mobile devices and wearable devices. This raises the question of whether haptic sensations can also be designed to enhance the film experience and poses the challenge as to how haptic sensations could be employed within cinema. Perhaps rather than crudely matching the on-screen action, they could become an integrating part of the film experience.

Cohen (2009, p.109) reports on the purpose of the film score according to American film producer and screenwriter Selznick, "to unobtrusively help the mood of each scene without the audience being even aware that they are listening to music", hence the subtle approach of film music on audience affective perception. Could the same subtle approach be followed by haptic sensations?

Some argue that as both audio and visual elements in a film are essential to create the experience for the audience, these should be accessible to everyone enjoying this form of entertainment, but how does this work for deaf movie lovers? Even though captioning or sign language can make speech more accessible, music and background noises are not included in subtitles (Karam et al., 2009). In addition, silent movies have no dialogue between characters, the film score is the sole audio element, representing a valuable source of emotion, which means that those not able to hear are left out.

Drawing on the aforementioned, we assume that if someone is unable to hear the music (due to hearing impairment or because they are watching the movie muted), the emotions experienced while watching a movie are purely based on the motion pictures within the movie scenes. Thus, without the emotions sourced from the score, the outcome experience of the viewer may differ from the one originally intended by the movie director.

This work aims to enhance the film experience of audiences through haptic sensations designed to intensify the mood music of the film score. This might also have implications for the hearing-impaired, by providing them with a new way of experiencing music in a movie.

In the next section we discuss past related work in music and haptic interfaces.

2.2 Past work in music and haptic interfaces

> *"All sounds that occur at a given moment fuse into one complex vibration"* (Arnheim, 1957, p.190)

The association between music and vibrations has been explored by both researchers and artists.

Evelyn Glennie, a deaf solo percussionist, explains how hearing is essentially a specialized form of touch (Glennie, 1993). She argues that since sound is simply vibrating air picked up by the ear, converted into electrical signals and interpreted by the brain, hearing is not the only sense able to do this, but touch can too. Glennie reports to experience sound as vibrations she feels on her body while playing an instrument, and how we are all able to both hear and feel vibrations coming from sound.

Work has been undertaken in presenting sound as vibrations, but mainly as aiding tools for the hearing-impaired, e.g. to provide awareness of ambient sounds at home or in an office environment (Matthews et al., 2005) and as a musical experience for the deaf (Karam et al., 2009)-(Nanayakkara et al., 2009).

Nanayakkara et al. (2009) designed a vibrating haptic chair and a computer musical display that provided deaf users with informative visual effects corresponding to music features such as pitch, amplitude, key changes and timbre. Their results suggested that the Haptic Chair had a significant effect in enhancing the musical experience of a deaf user.

In the same year a similar study by Karam et al. (2009) proposed a sensory substitution technique called The Human Cochlea (MHC) for presenting music as multiple distinctive channels of vibrotactile stimuli, with the aim of exploring techniques for communicating emotional information from music using a tactile display. The resulting prototype had some vibrotactile components embedded into the back of a canvas chair to produce vibrations that reflected the music and corresponded to instruments, voices, and melodies of the music. It was noted from their observation that all users who tried the chair expressed some forms of movement, hand gestures, or facial expression that hinted they were enjoying the vibrations coming from the chair and often changed their movements to reflect the type of music they were feeling.

Electronic composer and sound artist Kaffee Matthews in her ongoing collaborative research project "Music for Bodies" (M4B) (Matthews, 2006) also explored the relation between music and vibrations. M4B is dedicated to the making of new 3D music and physical interfaces that allow people to enjoy music as vibrations directly through their bodies. Since 1997, with the creation of Sonic Armchair, Matthews has designed a number of sonic vibratory furniture pieces (sonic armchairs, sonic beds, and sonic benches) open to public display around the world. Figures 2.1 and 2.2 show a version of a Sonic Bed and a Sonic Bench respectively.

During the making of Sonic Bed Scotland in 2007, Matthews explained in an interview that the real idea of the project was to create music that people listen through their bodies, rather than just a listening experience (Matthews, 2007). The project makes use of vibrations to enhance the musical experience by converting sound waves into vibrotactile stimuli, similar to the work previously discussed of Nanayakkara et al. (2009) and Karam et al. (2009).

Other work in music and haptic interfaces include the Mobile Music Touch (MMT) (Huang et al., 2010), a wireless haptic music instruction system for passive learning composed of a golf glove and a bluetooth-enabled computing device as a mobile phone or a laptop. The MMT had small vibration motors embedded for each finger in the glove, as well as other electronics and its scope was to passively teach users to play piano while performing other tasks throughout the day. The passages to be learned were loaded into a computing device and played repetitively while the user engaged in other tasks. As each note from

Figure 2.1: Sonic Bed Scotland, 2007.

Figure 2.2: Sonic Bench Mexico, 2007

the music passage was played, the vibration motors in the glove cued the user with vibrations on the finger to be used to play the note. As well as a system for passive learning, researchers concluded that the application might have potential in the area of hand rehabilitation following a trauma and explored this option in further work (Markow et al., 2010).

Additional work on vibrotactile systems has also been done over the past few years, for virtual contact and information display (Lindeman et al., 2006), to enhance non-verbal communication over the internet by adding a haptic channel to a foot device (Rovers and Van Essen, 2006), as well as in affective haptics for emotional communication (Tsetserukou et al., 2009) - (Yohanan et al., 2005). However, none of these studies was directed to enhance the film experience or other types of media entertainment, nor did any of them attempt to use touch as an alternative sense to convey or to enhance moods in music.

Rehman and Liu (2008) tried addressing the challenge of expressing emotions through vibrations, however the work was aimed at enhancing the social interactive ability of the visually-impaired and the resulting interface worked as information coding, analysing others' facial expressions and formulating a tactile message to deliver to the user (almost like braille). The interface was a tactile display which encoded information for the visually-impaired and therefore required training.

Other work by Rehman et al. (2014) aimed at increasing immersion of audio-video content through vibrotactile coding in a mobile phone and findings reported that the use of haptics increased participants' involvement and immersion levels. However, the method employed still utilised information coding and required users to be trained. Furthermore, the study only involved scenes from thriller and horror movies and was limited to the reporting of the vibration signals, without recording how the extracted video-audio emotional information was used to generate the 'affective-haptics'. The work shows an interest in the use of haptic sensations within media content, however further research is needed to find a meaningful method for the use of vibrotactile stimuli to truly become an integrating part of the entertainment experience.

2.3 Haptic technology for enhancing user experience in entertainment

In recent years haptic feedback has proven promising in enhancing users' experience in various forms of entertainment, such as games, amusement rides, movies, virtual simulations, education and social media (Schneider et al., 2015a), and Schneider et al. (2015b) defined it as a "key ingredient of immersive media experiences".

Research closer to this work, within technologies for entertainment, includes a vibrotactile display for movie viewing enhancement proposed in the form of a wearable jacket (Lemmens et al., 2009). The jacket contained 64 coin motors distributed on the torso, aimed at recreating certain bodily reactions to enable viewers to experience what the main character in the movie was experiencing. The resulting tactile jacket worked by adding haptic stimulation specifically targeted to influence viewers' emotions by trying to recreate specific bodily reactions (e.g. shivers down the spine) to stimulate the wearer into feeling a certain emotion (e.g. fear). The study was based on the premise that distinct emotions are accompanied by distinct bodily reactions and presumed that triggering a similar bodily reaction could produce the desired emotion.

Another version of the tactile jacket system in Lemmens et al. (2009) was also proposed by Dijk et al. (2009), with the attempt of intensifying movie experiences through a personalised tactile actuation blanket.

Both the systems in Lemmens et al. (2009) and Dijk et al. (2009) were aimed at providing the audience with some sort of emotional immersion by linking physical events in a movie (e.g. explosions, car crashes, etc.) to the haptic system designed. The system would then stimulate the desired bodily reaction in order to project onto the audience feelings of fear, for example, as experienced by the character in the movie, creating a sort of *identification*. In fiction the term *identification* is used to express that one cares for the character (Gaut, 2006), and according to Gaut (2012) film identification is one of the most important tools of emotional engagement in cinema.

In recent years there has been a growing interest in researching new methods to enhance users' experience in entertainment.

Disney Research has dedicated part of its latest work to pursuing advances in haptics in order to enhance entertainment.

Israr and Poupyrev (2010) presented the design of a two dimensional tactile surface display to enhance the experience of theme parks rides and movies by creating the illusion of continuous motion, a concept introduced as *Haptic Blur*. The display consisted of a 3x4 matrix of actuators stimulating the skin of users' backs. Although identified as a less sensitive body area when compared to hands and fingers, the back had the advantage of providing a large surface area for the haptic display proposed. The study presented participants with two types of haptic patterns and perceptual effects created by Haptic Blur, referred to as 'creeping' (like the movement of a snake) and 'circular' motion. Results from a preliminary evaluation study showed that blurred patterns were perceived as more continuous than the non-blurred versions, suggesting that haptic feedback was able to add another dimension to perceptual experiences.

Haptics are used by artists to enrich user experiences in various forms of entertainment (e.g. movies, games, shows, etc.), becoming over the past few years a new addition to the toolbox of special effects (Israr et al., 2014). In a recent study Israr et al. (2014) aimed at enriching storytelling with haptics by creating expressive and realistic haptic representations of content events in the narrative. The study defined a *Feel Effect* (FE) as a synthetically created haptic pattern that enriches media content through vibrations on users' skin and proposed a library of those FEs for artists to create meaningful haptic content for their media. The study used the back as the surface for stimulation. Although the authors themselves acknowledged this to be an area with a low density of receptors, they recognised its advantages of being large, usually unused during interactions, and freely accessible in theatre or cinema seats, park rides and gaming chairs. The stimuli consisted of 23 Language Phrases (LP) describing sensations and when a user read a LP they would experience the related sensation. LPs were grouped into six semantic families: rain, travel, strike, brush, pulse and motor sound. Rain, for instance, contained 4 LPs: "light rain", "sprinkle", "heavy rain", and "downpour". The corresponding sensation experienced was of water droplets as multiple points of contact in a random location on the user back. The underlying mapping of the system relied on the association between haptic representations and the mental interpretation of physical events, as participants read an LP and matched the evoked sensation against what they felt.

The library of FEs proposed by Israr et al. (2014) has been adopted for other work in Yannier et al. (2015), Zhao et al. (2015), and Schneider et al. (2015a). Yannier et al. (2015) made use of the FEs to enhance children's early reading, presenting *FeelSleeve*, an interface allowing children to experience haptic effects on their hands. These effects would be meaningfully associated with story events they would come across while reading. Their studies involved children between 6 to 9 years of age and provided evidence that haptic effects had the potential of enhancing children's reading experience by making it more comprehensible and memorable.

Zhao et al. (2015) also made use of the library of FEs to enrich children's story listening experience. The study implemented a haptic vest generating FEs related to the narrative content of the story children were listening to. Results from user studies conducted with children between 4 and 6 years old showed the potential of enhancing the story listening experience to facilitate story comprehension and memorability.

Schneider et al. (2015a) presented *FeelCraft*, a media plugin allowing downloading of FEs, their customization and sharing with other users via an online repository. The proposed plugin was applicable to a wide range of social, entertainment, and educational media.

A tactile animation object prototype, *Mango*, was introduced by the work of Schneider et al. (2015b). Mango is an editing tool allowing professional animators to create rich and expressive haptic media on grid displays.

Other work by Hanamitsu and Israr (2017) presented the design of a haptic system, the *Haplug* for rich control of haptic effects in VR and other interactive settings. The *Haplug* rendered a variety of haptic feedback such as feelings to colours, objects' interaction, surface texture and dynamic object behaviours. The haptic effects played by *Haplug* are low-to-mid frequency sensations and high-frequency vibrations. The variety of surface textures are generated by turning the actuators on and off.

The use of haptic feedback is also featured in VR and other virtual environments (VE), to provide users with vibrotactile feedback emulating the illusion of touch. However this work will not discuss the use of haptics in VR and VE as its current use within these environments serves mainly to cue users when performing tasks in the virtual world and handle virtual contacts, and therefore quite different from the haptic-semantic pairing this work has been examining.

The work by Israr and Poupyrev (2010), Israr et al. (2014), Schneider et al. (2015a), Yannier et al. (2015), Zhao et al. (2015), Schneider et al. (2015b), and Hanamitsu and Israr (2017), all studies supported by Disney Research, emphasise the interest and possibly also the need for creating expressive haptic sensations for media enhancement, which is what the research in this report aims to address.

2.4 Summary

This work is interested in assessing whether haptic sensations are able to suggest moods for a possible use within the context of film entertainment with the purpose of enriching audiences' film experience.

This chapter provided an overview of film entertainment and its technological evolution with the introduction of recorded sound and other technological advances, considering the emotional and cognitive roles that film plays in the lives of its viewers. It also discussed past work in the field of music and haptic interfaces and haptic technologies for entertainment.

Previous work on vibrotactile feedback and haptic interfaces mainly focussed on non-verbal cues communication (McDaniel et al., 2008), (Eberhardt et al., 1993); multimodal interaction in virtual environments (Nijholt et al., 2005); vibrotactile feedback based on direct mapping in works which aimed to enrich users' experience in entertainment (Lemmens et al., 2009), (Lindeman et al., 2006), (Rovers and Van Essen, 2006), (Tsetserukou et al., 2009), (Yohanan et al., 2005); and in some studies, served to simulate bodily reactions in an attempt to trigger certain emotions (Lemmens et al., 2009), (Tsetserukou et al., 2009). Over recent years there has been an increasing interest in the use of haptic sensations to enhance media, as in works by Israr and Poupyrev (2010) in the design of a 2D haptic display, creating the illusion of motion to enhance users' experience in theme park rides and movies; Israr et al. (2014) proposing a library of haptic patterns identified as *feel effects* (FEs) aimed at enriching storytelling for children; Yannier et al. (2015) who incorporated FEs into *Feel-Sleeve*, an interface allowing children to experience FEs on their hands while reading; Zhao et al. (2015) who extended the use of the FEs library to enhance children's story-listening experience; Schneider et al. (2015a), who allowed the customisation and sharing of FEs through a media plugin; Schneider et al. (2015b) who introduced an editing tool for animators to create haptic media on a grid display; and very recently work by Hanamitsu and Israr (2017) with *Haplug* haptic system for the rendering of haptic effects in VR and other interactive settings.

However, most of the haptic interfaces work through direct mapping, meaning that they use cues from existing media and directly map them into haptic feedback (Schneider et al., 2015b). Furthermore, there hasn't been any documented work thus far on the possibility of using vibrotactile patterns to enhance moods and as recent research in Israr et al. (2014) and Schneider et al. (2015b) recognised haptic sensation to have become a new feature to enrich media content, the possibility of employing haptic sensations to amplify the audience's emotional experience in film entertainment is an area worth exploring.

Chapter 3

Methodology

The work described in this thesis aims to enhance audience emotional experience in film through haptic sensations. The methodology of this work is based on the one adopted by Parke et al. (2007) as both works similarly investigate audience emotional response to film when paired together with another medium (music segments in the case of Parke et al. (2007), haptic sensations in the case of this study). In Parke et al. (2007) multiple music segments annotated with distinct emotions were taken and paired with ambiguous movie clips in order to investigate the effect of music on audiences' emotional response to film. We adapted their methods in order to explore participants' emotional response to haptic sensations rather than to music.

The overarching methodology is an iterative design approach and comprises a series of pilots and three user studies as below:

1. Discovery through past works' analysis how vibrotactile stimuli could be employed to enhance media elements
2. Design and implementation of a series of haptic sensations to test the hypothesis, and a haptic wearable prototype to deliver the stimuli
3. User testing on the interface
4. Results analysis, evaluation of findings and identification of limitations

5. Re-design of the interface to overcome limitations

The pilot studies served as an exploration of textiles and electronics possibilities in order to design a haptic prototype able to deliver the stimuli to the users and study the effects. Three prototypes informed by users' feedback were designed during iterative pilots and the design further evolved over the first two user studies, producing two more prototypes and making a total of five different designs built throughout the course of this work. The pilot studies also served as an early stage observation of people's emotional response to haptics.

It is worth mentioning at this stage that by emotional response to haptics we do not refer to inducing emotions through haptics, but rather suggesting moods as simple affective states. Therefore is not a case of "emotion induction" but "emotion perception" as discussed by Juslin and Västfjäll (2008), where a person is able to perceive or recognise expressed emotions (moods in the case of this work) in music without necessarily feeling an emotion.

The first user study explored effects of haptic sensations on mood, and involved 16 participants wearing prototype 4 and self-reporting their emotional response (in terms of valence and arousal) to a series of vibrotactile patterns, administered as a repeated measure design. The second study examined the effects of haptic sensations when paired together with clips from movies. There were two versions of the movie scenes, with and without the audio, and this was to test whether the addition of haptic sensations in a silent clip would influence audience perception of the clip, in the same way the film score draws emotions and can change the way the audience feels towards a scene. It followed a repeated measure design, where 23 participants watched and rated 14 movie clips under different conditions (audio movie clip, audio movie clip with haptic sensations, silent movie clip, silent movie clip with haptic sensations) while wearing prototype 5. The last and final study, study number 3, observed whether the addition of haptic sensations increases suspense in film. It followed a mixed factorial design, where 30 participants watched and rated 16 audio movie clips while wearing prototype 5 and experiencing haptic sensations directed at increasing

their perceived arousal towards the movie clip.
All studies presented in this work have been audited by Queen Mary University of London Research Ethics Committee (Reference: QMREC1469).

3.1 Prototype Design

In this work we made use of the review on measures, capabilities and limitations of tactile sensitivity for the human body in Myles and Binseel (2007) as guidance in choosing a suitable body area and developing a wearable tactile interface suitable for the purpose of this research. The tactile modality review (Myles and Binseel, 2007), as summarized by table 3.1, included the work conducted by Wilska (1954), who placed a vibrator driven by a sinusoidal alternating current on various body regions in an attempt to report vibration sensitivity associated with different body sites. Wilska (1954) found (in order of most sensitive to least sensitive) the hands, the soles of feet, the larynx region, the abdomen, the head region and the gluteus region to be the body regions most sensitive to vibrations due to the high density of receptors in those areas. Hence the decision of this work to design a wearable prototype for the hand, as it is reported to be the most sensitive body part to vibrations (Myles and Binseel, 2007) (Wilska, 1954), and it also represents the most sensible design choice (among the body areas identified) in terms of product design for ease of use within the context of movie-watching whether in a cinema, at home, or worn 'on the go' paired with a portable viewing device. We excluded investigating fingers and concentrated our design for the main area of the hand, trialling both the palm and the back. However, we recommend future studies to examine fingers as well. After designing the first two glove prototypes for the right-hand, this work decided to implement future designs for the left hand. This decision was simply due to the fact that participants were required to self-annotate on a pen-and-paper evaluation method their emotional response and it was observed during pilots that participants found it hard to write while wearing the prototype on the same hand (as the majority were right-handed). However, in the final prototype left-handed participants found it comfortable writing even while wearing the glove prototype on their left hand.

Some previous work (Levnen and Hamdorf, 2001) within the human nervous system's cross-modal plasticity found that tactile sensitivity is enhanced in congenitally deaf humans. The study was based on the premise that when input from one sensory modality is deprived, associations from other modalities may be increased. Related user testing, conducted with both hearing and deaf subjects to detect frequency changes in repetitive sequences of vibration stimuli proved non-hearing subjects to better detect sudden tactile changes. The study in Levnen and Hamdorf (2001) therefore suggests that the use of vibrotactile stimuli for media enhancement in this work could have a positive impact on the hearing-impaired too.

Table 3.1: Summary of body sites listed in order of most sensitive to least sensitive for tactile sensitivity measures (adapted from Myles and Binseel (2007))

Tactile Sensitivity Measures	**Body Site (listed in order of most sensitive to least sensitive)**
Pressure Sensitivity	Forehead (face), trunk, fingers, lower extremities (Weinstein, 1968)
Two-Point Discrimination	Tongue, lips, finger/palm, toes, forehead (Weber, 1978) Fingers, forehead/face region, feet, arms, lower trunk (Weinstein, 1968)
Point Localization	Face region, fingers, hallux, palms, abdomen, arms, lower legs, upper chest, thigh (Weinstein, 1968)
Vibration Sensitivity	Hands, soles of feet, larynx region, abdomen, head region, gluteus region (Wilska, 1954)

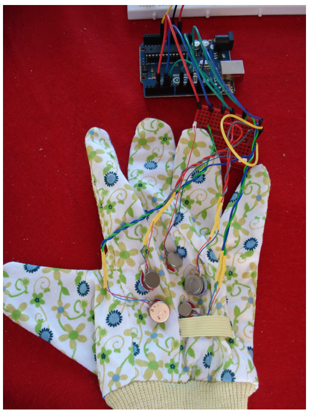
3.1.1 Exploration through design

The prototype design of a haptic system for the hand started with the experimentation with electronics such as Arduino Uno, wires and coin vibration motors for the first two prototypes and then passed onto experimenting with electronics for wearables (LilyPad Arduino) to refine the design and create a compact system, comfortable, lightweight and easy to wear for the user.

Table 3.2 displays the five prototypes built for this work during different stages of the design process, summarising the components used (garment material, electronics), advantages and disadvantages of each prototype. This report will discuss each prototype in more details in its related section.

At the time of conducting this research and to the author's knowledge at present, there is no set of haptic sensations correlated with feelings or any guidance in designing intuitive affective vibrotactile stimuli for media enhancement. Therefore, one of the challenges faced by this work was in designing haptic sensations that could amplify the mood music experienced by the audience when played along with film clips. In order to satisfy this purpose, multiple haptic sensations have also been iteratively designed and tested during the different prototyping stages. Feedback to inform the design process have been gathered through multiple pilots. At the early stages of the design iteration with prototypes 1 and 2 we invited volunteers to take part in the design choices, especially with the motors arrangement, where they would experience vibrations under different motors arrangement and verbally report their feeling to the researcher during this exploratory experience.

Table 3.2: Prototype designs (continued overleaf)

No.	Prototype	Components	Advantages	Disadvantages
1	 used for pilots	Fabric: cotton garment. Technology: Arduino Uno	Loose fitting and soft fabric allow comfortable wear for both men and women	Garment fit is too loose for some people, resulting in loss of sensitivity to vibrotactile feedback. Wires and the Arduino board make the design intrusive

Continuation of Table 3.2

No.	Prototype	Components	Advantages	Disadvantages
2	 used for pilots	Fabric: 97% Cotton, 3% Lycra. Technology: Arduino Uno	Garment fits comfortably and addresses loss of sensitivity setback in prototype 1	Technology components result intrusive as in prototype 1
3	 used for pilots	Fabric: Soft felt, designed and stitched. Technology: LilyPad Arduino	Embedded technology components made the design more robust and easy to wear	Loose fit resulted at times in a lack of perception of the haptic stimuli
4	 used in study 1	Fabric: 90% Polyester, 10% Elastane glove with exterior additional soft felt fabric stitched on, where electronics were sewn. Technology: LilyPad Arduino	Stretchable fabric makes fitting as ‘second skin’ on user’s hand	The high stretch property of the fabric makes it hard to sew electronics directly on it, due to the change of resistance when conductive thread is subject to strength

Continuation of Table 3.2				
No.	Prototype	Components	Advantages	Disadvantages
5	 used in studies 2 and 3	Fabric: 97% Cotton, 3% Lycra. Technology: LilyPad Arduino	Comfort fit, some degree of stretch allowing easy wear across different users, material allows components to be directly sewn on, resulting in higher sensitivity to vibrotactile stimuli without affecting the circuit's resistance	Only a few male users with large palms found the garment a little tight, however none reported discomfort
End of Table				

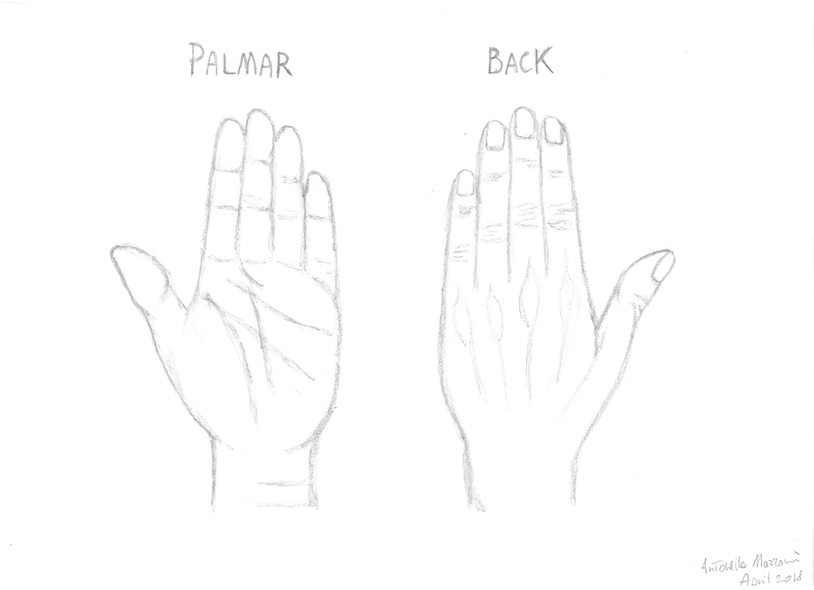


Figure 3.1: Hand representation

3.1.2 Prototype 1 - Arduino Uno

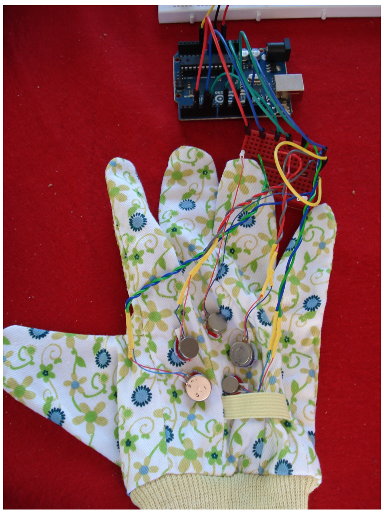


Figure 3.2: Glove prototype 1

The technology components used in this first prototype were: an Arduino Uno board, a breadboard, hook-up wires, transistors, resistors, diodes, and 5 coin vibration motors with body diameter 8mm and rated voltage of 3V.

This first prototype was designed to understand:

1. whether vibrotactile stimuli on participants' hands were well received

2. if there was a preference in the motors' arrangement

For this prototype it was decided to position the vibration motors on the dorsal of the glove as in the MMT glove interface reviewed in chapter 2. The dorsal corresponds to the back of the hand as in figure 3.1. This design choice was made to enable users to still be able to hold objects in their palm or rest their hand without worrying about damaging the interface.

Three different dorsal places were considered and trialled, such as on the knuckle of each finger, just above the knuckle of each finger and at the centre of the dorsal. No particular vibrotactile patterns were designed for this prototype as these first pilots were conducted to test how participants would respond to vibrotactile feedback on their hands. At different stages motors played from their lowest intensity up till their maximum (in the range of 0-255), first one by one, then building up from one until they played all simultaneously. This was done to understand:

- a) at which intensity the vibrotactile stimuli start to be perceivable
- b) what intensities and frequencies people would consider low, and which high
- c) how many motors could be played simultaneously, and at what intensity, without the stimuli becoming a discomfort for the users

After testing the interface with 6 subjects, it was realised that the motors' positioning would change depending on the hand size of the participant. When by design the motors were supposed to be on the participants' knuckles, for those participants with relatively small hands, the motors sat above their knuckles instead, whereas in subjects with long, larger hands the motors sat below their knuckles. Similarly, when the design intended for the motors to be felt just above the knuckles, participants with short fingers found that the motors sat way above their knuckles, whereas participants with long fingers found that the motors were positioned exactly on top of their knuckles. Following this observation it was decided that centring the motors on the dorsal was the best resolution as it would ensure people experienced the vibrations in the same way no matter the size of their hand or how long their fingers were.

Various possible arrangements presented in figures 3.3 to 3.6 were trialled once we decided to trial the motors arrangement around the central region on the back of the hand.

Figure 3.3: Motor arrangement 1

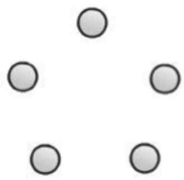


Figure 3.4: Motor arrangement 2

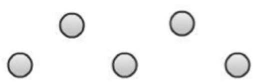


Figure 3.5: Motor arrangement 3

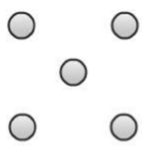


Figure 3.6: Motor arrangement 4

Another small pilot with 8 participants took place to decide on the motor arrangement. All participants experienced vibrations in each of the arrangements. 6 participants out of 8 preferred motor arrangement 2, whereas the other 2 participants expressed a preference for arrangement 3 and arrangement 4 respectively. Participants expressed their preference verbally to the researcher who registered their response.

3.1.3 Prototype 2 - Arduino Uno

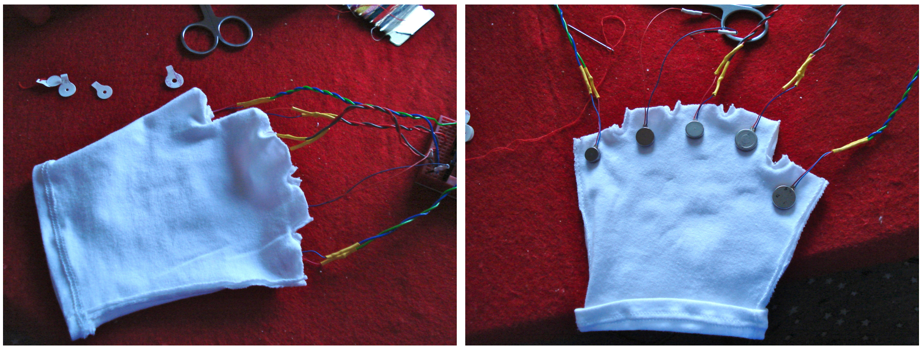


Figure 3.7: Glove prototype 2. Left: palmar, right: dorsal of the glove.

The technology components utilized for this second glove prototype were: an Arduino Uno board, a breadboard, hook-up wires, transistors, resistors, and 5 coin vibration motors with body diameter 8mm and rated voltage of 3V.
Following users' feedback about the 1st prototype built, the new glove fit had to be tighter than the previous one and the fabric needed to be able to stretch in order to perfectly fit different hand sizes. To overcome the issue of finger length, the second prototype was designed fingerless.
Different fabrics were considered: wool (soft), synthetic materials (which can be very thin, light, and extremely stretchy), and cotton (light, soft, and with some degree of stretch). All these fabrics are able to stretch (to different degrees), but in order to find out what fabric was preferred by users, a poll was created and invitation to take part was sent by email. Participants were asked the following: *"If you were to wear a glove indoor (e.g. in a gallery, cinema, or at home) for*

approximately 2 hours, what would you choose among these?"

1. *sport glove*
2. *wool glove*
3. *cotton glove*

Poll participants were given a picture for each garment option, as well as a picture of an indoor environment to facilitate representation of a realistic scenario on which to base their answer.
15 people answered the poll, and preferences were: 10 for the cotton glove, 4 for the sport glove, 1 for the wool glove. Following this finding, it was decided to implement a second prototype with a cotton garment.
The finger parts of the glove were cut off, making the garment fingerless (as shown in figure 3.7) to trial a different fit. The arrangement of the vibration motors was also changed and we trialled placing the actuators on the palm. This design decision was to explore users' responses to the possibility of receiving the haptic sensations on the palm of the hand. The hypothesis was that as this area is more sensitive than the dorsal, due to its high density in receptors (Myles and Binseel, 2007), the response to the vibrotactile stimuli would have been better received. Therefore in the second prototype design, the coin vibration motors were placed on the palm of the glove (see figure 3.7 right).

Pilots were run with 10 volunteers to assess an initial response to a vibrotactile device worn on the hand, with stimuli on the palm. Feedback were verbally given to the researcher during the trials. Tests found mixed feelings with a number of participants being intimidated by the electronics and fearing that they would be harmed by the device. Just over a third of participants (4 people) appeared intrigued by the use of vibrotactile stimuli integrated into a wearable device, however all participants agreed that the device was intrusive due to the wires and the fact that they restricted their movements.
Therefore the need to explore different options for prototyping emerged, moving

onto testing electronics designed for wearable use, before being able to conduct user studies to evaluate people's emotional response to haptic sensations alongside film. The next section presents the third prototype design and the first made entirely with wearable electronic components.

3.1.4 Prototype 3 - LilyPad

Figure 3.8: Glove prototype 3. Left: front, right: back of the glove.

Following findings from previous pilots run with the Arduino Uno, which gave users' the feeling of being restricted in their movements, this study moved onto prototyping for wearables, adopting the LilyPad Arduino wearable electronics.

The technology components employed in the third glove prototype were: a LilyPad Arduino Main Board ATmega328, conductive thread, a LilyPad Power Supply for AAA batteries, and 5 LilyPad Vibe Boards with 20mm outer diameter and 0.8mm PCB (printed circuit board) thin. The vibration motors present on the vibe board are 310-101 10mm Shaftless Vibration Motor 3.4mm button type, with a voltage range of 2.5-3.8V, a rated speed of 12000 rpm, vibration amplitude 0.8G, and weight as little as 1.2g.

The glove was entirely designed from a layer of felt fabric and sewn together into a mitten with uncovered fingers. The design combined the idea of prototype 1 and 2, placing the vibration motors on both sides of the glove. After sketching the circuit, hard components such as the LilyPad Main Board, the Vibe Boards, and the LilyPad Power Supply were first glued onto the felt material (to avoid them moving and changing the circuit design) and then stitched and connected to one another through conductive thread. This circuit building technique proved to be robust and therefore has been maintained for future prototype design.
This third prototype investigated:

1. users' attitudes towards the new design with components made for wearable use
2. users' initial response to vibrotactile stimuli on both sides of their hand
3. any sign of correlation between vibrotactile stimuli and feelings such as prevailing mood

A total of 10 new volunteers took part in a short informal pilot, during which we observed a change in users' perception towards the wearable design: all participants found the design aesthetically pleasing and were not intimidated by it anymore. Feelings about haptic stimuli were still mixed, with 2 participants expressing their dislike towards vibrotactile stimuli while the others appeared fascinated by feeling the little coin motors buzzing on their hand.
This pilot also started the process of designing haptic sensations to explore a possible emotional response to the stimuli. The patterns iteratively changed, trialling combinations of different intensities (0 to 250pwm) and frequency values (100 - 500ms), as well as the sequence in which the motors were played and the duration of the vibrotactile stimuli. The first method adopted for evaluating users' emotional response was the Valence-Arousal space model (as shown in figure 3.9 combined with briefly asking participants for a verbal feedback at the end of the session. The Valence-Arousal space model is populated by adjectives

that refer to different emotional states. Participants were asked after sensing the haptic stimuli to position whereabouts in the space model they felt they were. They were instructed to either place a circle around one or more adjectives, or a sign (e.g. a cross) anywhere in the space. However, this method did not prove efficient as a common feedback among participants was they found it hard to define their prevailing feeling by choosing one of the adjectives in the space. Following participants' difficulty in self-assessing their emotional response through the Valence-Arousal model, we researched other possible assessment techniques, which will be discussed in section 3.2.

The haptic sensations designed and trialled in the pilots with prototype 3 were randomly generated and iteratively changed, and are not included in this report as participants' subjective response to them was very different, possibly in part due to the difficulty in self-assessing the experience through the Valence-Arousal 2D space model. The created vibrotactile sensations were therefore re-designed in the subsequent studies.

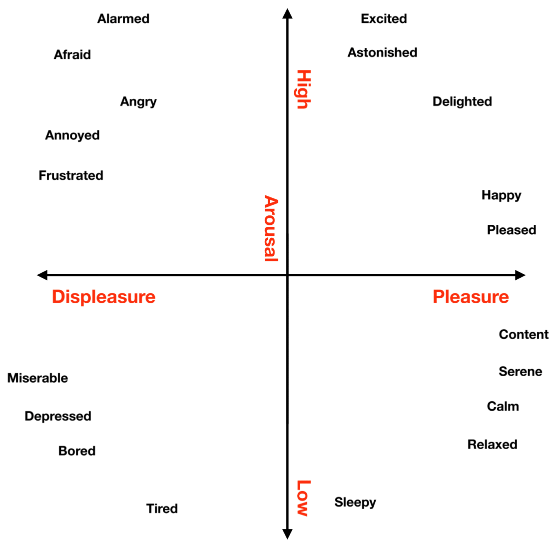


Figure 3.9: The Valence-Arousal space model

3.2 Evaluation of the emotional response

Following participants' difficulties encountered using the Valence-Arousal model during pilots, we examined other assessment techniques for evaluating users' emotional response to the haptic sensations.

The techniques examined were: the Semantic Differential Scale discussed in Bradley and Lang (1994), Galvanic Skin Response (GSR) and the improved Valence-Arousal emotional space as proposed in Sun et al. (2009). Physiological signals (also known as bio-signals) as GSR are used in research on affect sensing for emotions identification (Gunes and Pantic, 2010). Other physiological signals include electrocardiogram (ECG), respiration rate (R), electromyography (EMG), Blood Volume Pulse (BVP), and skin temperature (ST). From the review provided by Gunes and Pantic (2010) GSR seems to be the more suited physiological signal to provide measurement of the level of arousal of an individual. Emotional arousal provokes a sweat reaction and GSR measures skin conductance (SL), which indicates sweat level at the surface of the skin. Due to large concentration of eccrine sweat glands in the palmar surface of the hands and soles of the feet, the sweat reaction is particularly prevalent in these areas (Dawson et al., 2007). However, Gunes and Pantic (2010) discussed the problems related to affect sensing using bio-signals, reporting about their invasive nature as the sensors require direct contact with the human body, and identified that the invasive nature of the bio-signals sensors within experimental settings do not encourage spontaneity. Since the data acquisition of this work occurs through induced behaviour (meaning that it takes place in a controlled setting and is designed to elicit an affective reaction in the participants), the use of bio-signal affect recognition systems (such as GSR and ECG) would involve ethical and privacy concerns, as well as technical issues concerning the cumbersome nature of the sensors, and these factors would discourage spontaneity as reported by Gunes and Pantic (2010). Also, the use of bio-signal sensors would have restricted participants movements. Although participants were required to wear the glove prototype on their hand, in order to encourage spontaneity the researcher instructed all participants to act freely as they normally would in a movie-watching scenario and forget about the prototype they were wearing. Wearing bio-signals sensors would have prevented participants moving freely. For all the reasons just mentioned we concluded that the use of bio-signal affect recognition systems was not suitable for this work.

Taking into consideration the aforementioned techniques for emotion recognition, we concluded that the valence-arousal space model was too detailed, too intrusive in the case of the sensors necessary to measure GSR, too time consuming and therefore heavy on effort for participants (consequently affecting the emotional assessment) in the case of the Semantic Differential Scale. The evaluation method, which proved most suited for this work, is the Self-Assessment Manikin (SAM) (Lang, 1980)-(Bradley and Lang, 1994). The next section discusses the SAM, comparing it to the Semantic Differential Scale.

3.2.1 The Self-Assessment Manikin (SAM)

The Self-Assessment Manikin (SAM) (Bradley and Lang, 1994)-(Lang, 1980) is a non-verbal picture-oriented assessment technique to assess the pleasure, arousal, and dominance associated with a person's affective reaction to an object or event. The SAM was introduced by Lang (1980) as a new sentiment analysis model addressing the issues related to Mehrabian and Russells' Semantic Differential Scale (Mehrabian and Russell, 1974) a widely used method for assessing the three-dimensional structure of situations, events and objects. The Semantic Differential scale consisted of a set of 18 bipolar adjective pairs, each rated on a 9-point scale. Drawbacks of this method were found to be: heavy investment of time and effort needed to measure the 18 distinctive ratings for each stimulus during experiments and the fact that it relied on a verbal rating system that made it difficult to use with people speaking a language different from English (Bradley and Lang, 1994). SAM's nature as a non-verbal pictorial instrument overcomes those issues and provides an inexpensive and easy method for rapidly assessing affective response.

The SAM, as represented in figure 3.10, comprises 5 graphic illustrations of a manikin at different points along each of the three fundamental emotional dimensions, which are valence, arousal, and dominance. In the valence dimension (top panel), the manikin ranges from being smiley and happy to frowning and sad, and it refers to how positive or negative the emotion is. The arousal dimension (middle panel), refers to how excited or apathetic the emotion is, and the manikin ranges from excited and wide-eyed to relaxed and sleepy. Finally, for the dominance dimension, which represents changes in control (bottom panel), the size of the manikin refers to the sense of control over the emotion, e.g. the large manikin indicates maximum control. The SAM was originally introduced by Lang (1980) as a 9-point rating scale, where the subject could choose any of the five figures in each panel by placing an 'x' over them, or in-between any two figures in the same dimension (Bradley and Lang, 1994). However, 5-, 7-point and other variants of the SAM also exist (Betella and Verschure, 2016). The SAM, both the 5- and 9-point versions, has been successfully employed in other studies (including Parke et al. (2007)[1], Soleymani et al. (2008), Oliver and Bartsch (2010), Carvalho et al. (2012), Rehman et al. (2014), Williams et al. (2016)[1]), with different subjects and populations, including non-English speakers, adults as well as children, anxiety patients, analogue phobics, psychopaths and other clinical populations, to measure emotional response in different situations, such as reactions to pictures, images, sounds, advertisements, painful stimuli and more.

This work adopted a modified version of the SAM as shown in figure 3.11, which includes valence and arousal dimensions, as opposed to the original three that included dominance. The reason for this was that valence and arousal represent the two basic dimensions of emotional experience (Oliver and Bartsch, 2010), and are the dimensions assessed in studies trying to determine enjoyment levels. The modified version of the SAM adopted was also employed by

[1] used a 5-point version of the SAM

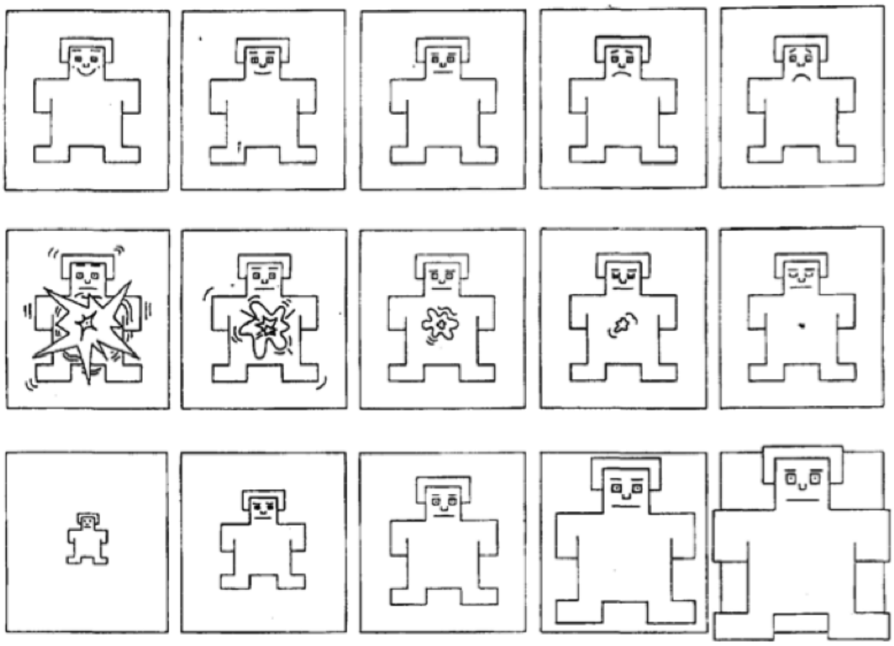


Figure 3.10: The Self-Assessment Manikin (SAM) used to rate the affective dimensions of valence (top panel), arousal (middle panel), and dominance (bottom panel). Adapted from Bradley and Lang (1994)

Soleymani et al. (2008) for affective ranking of movie scenes, Oliver and Bartsch (2010) in assessing enjoyment and appreciation of cinematic entertainment using full-length movies as stimuli, and also recently by Williams et al. (2016) for film scene annotation during a study conducted to investigate potential links between audiovisual cues in films and audience emitted biochemical responses through Carbon Dioxide (CO_2) measurement.

In the first user study we adopted the SAM as a 5-point scale and for visual representation we normalised the scores 1-5 along the valence and arousal dimensions to range from 2 to -2 as per Parke et al. (2007), making the origin corresponding to the middle figure of the SAM, interpreted as the neutral or ambiguous rating. Participants in the first user study were instructed they could place a mark (e.g. cross, tick, circle) on any of the manikin figures on the valence and arousal panels. In the second and third user studies we decided to extend the scale to the 9-point version of the SAM to allow participants a greater degree of choice. However, for consistency in the visual representations we kept the score normalisation of 2 to -2 used by Parke et al. (2007), meaning the scores 1-9 became 2, 1.5, 1, 0.5, 0, -0.5, -1, -1.5, -2. Participants in the second and third user study were instructed to place a mark on any of the manikin figures or in-between manikin figures for each of the panels. We employed the pen and paper version of the SAM for all user studies. This option seemed better than displaying the SAM on the same screen where participants were watching the movie clips, in order to maximise their focus on the presentation.

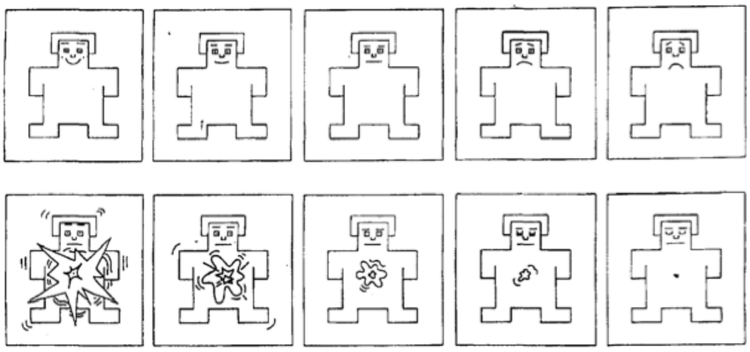


Figure 3.11: Modified version of the SAM used in this study

3.3 Other methods

Other methods were also trialled and are reported as follows.

3.3.1 Linear likert-type scale

Additionally to the SAM, in the second user study a linear likert-type scale was also used (see appendix E) in order to have a second set of self-reported data to compare against the SAM. We decided to trial this scale following some informal feedback given from participants during pilots prior to the second user study, who had difficulty interpreting the manikin figures. We therefore decided to test whether a simple linear likert-type scale was easier to use for participants than the SAM.

3.3.2 Spatial Presence Experience Scale (SPES)

In the second user study as well as the SAM used to assess participants' self-reported levels of valence and arousal, we also trialled the Spatial Presence Experience Scale (SPES) (Hartmann et al., 2015) with the intent of measuring participants' engagement and sense of presence.

By adding haptic sensations to film, we created a new form of multi-sensory media entertainment for the audience, therefore making the experience more immersive. To assess the effectiveness of the new media proposed, we searched for key elements when measuring audience engagement. The sense of 'presence' appeared to be a good indicator for evaluating audience engagement in cinema and other forms of interactive media.

Schubert et al. (2001) argued that cinema, virtual environments, and interactive three-dimensional media, all build on the same cognitive processes that lead to a sense of *presence*. Burch (1979) explains how in film, spectators experience the diegetic world as an environment (a process known as diegetic effect), but how this diegitic effect is not always permanent, but might instead be intermittent, for example in movies where the status of the diegesis changes from one moment to the next. When this happens, it is harder for the audience to permanently enter the imagery space-time created through the diegetic process (Burch, 1979, p.19).

> *Could haptic sensations enhance the sense of presence in film? How to measure the sense of presence in film entertainment?*

The SPES (Hartmann et al., 2015) is a scale recently proposed for self-report measures of spatial presence, based on Wirth et al. (2007)'s process model on the formation of spatial presence experiences. Spatial presence is described as the "sense of being there", and identified as a potential facilitator and amplifier of media effects (Wirth et al., 2007), therefore it represents a good indicator for the effectiveness of new media. The SPES is made of eight items, four of which reflect users' self location (SL) and four their perceived possible actions (PA). These eight items come from an original set of twenty questions: ten relative to SL, and ten to PA. The SPES was proposed as an alternative to other existing Spatial Presence scales, and it is reported as being applicable to measure spatial presence across diverse media settings, not just Virtual Environments (VE). Experiments conducted in Hartmann et al. (2015) to test the validity of the new proposed self-report measure in film as medium, consisted in participants watching a film showing a pre-recorded walk through a museum recorded in first person, a video perspective showing only what the character in the movie would see. Their experiments did not include film media with a storyline as is the case for film entertainment. Since this research looks at film as a form of art and medium for entertainment, as opposed to film as a purely pre-recorded material for navigation purposes, we tested the applicability of the SPES to measure participants' spatial presence and engagement with the media environment created in the second user study. For this purpose all 10 original questions from the SPES (Hartmann et al., 2015) referring to spatial presence were used in a post-task questionnaire (see appendix C) to assess spatial presence in the media environment of the second user study, comprising: movie clips from films with a plot and featuring multiple characters, and haptic sensations.

3.3.3 SHORE™ computer vision software

In the second user study we also experimented with a computer vision software for automatic sentiment detection. Fraunhofer IIS SHORE (Sophisticated High-speed Object Recognition Engine) (Ernst et al.)-(SHORE Fraunhofer IIS) is a framework for face detection and sentiment analysis used in computer vision research. The engine is able to rapidly detect faces in images from picture or video recordings (identifying eyes, nose, and mouth positions) and analyse them, providing age and gender classifications, and an estimation of some facial expressions (angry, happy, sad, surprised). SHORE™ has been successfully used in Katevas et al. (2015) for detecting audience response in live stand-up comedy performances delivered by a robot. The framework reports to be also able to perform sentiment analysis based on extracted features of facial expression. We therefore decided to trial the software to measure participants' emotional reaction to the new media environment created, and used the demo version of SHORE™ [2].

3.3.4 Interviews and thematic analysis

In the second user study participants were interviewed at the end of the task to allow the possibility of expressing their opinion about the experience. However, a formal analysis was not conducted.

In the third user study a structured interview was conducted with each volunteer at the end of the task and thematic analysis was used to analysed the data. Interviews gathered qualitative data about the experience and asked participants the following open-ended questions:

1. In a few words, how would you describe the experience?
2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice?
3. What did you most enjoy about the experience and why?
4. What did you least enjoy about the experience and why?
5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
6. Any further feedback you would like to leave?

Before asking question 5 participants were briefed about the underlying approach of the system and some details were disclosed about how it worked.

[2] http://www.iis.fraunhofer.de/en/ff/bsy/dl/shore.html

Interviews from the third user study were transcribed and inductive thematic analysis was conducted to identify recurring themes within the data. The inductive thematic analysis was performed at the latent approach following the six phases in Braun and Clarke (2006).

Thematic analysis is a qualitative research method for identifying, analysing, and reporting recurring themes within the data (Braun and Clarke, 2006). According to Braun and Clarke (2006) themes do not reside in the data, the researcher plays an active role in identifying them, selecting which are of interest, and describe them in a final report of the analysis. The key is not represented in the number of recurrence of a theme in a dataset, researcher's judgement is necessary in establishing whether a theme captures something relevant to the overall research question (Braun and Clarke, 2006). We followed this approach to thematic analysis and presented the final report as in work by Wu et al. (2017).

3.4 Summary

This chapter discussed the methodology adopted in this work. The SAM method discussed in section 3.2.1 has been adopted throughout this work in study 1 Chapter 4, study 2 Chapter 5, and study 3 Chapter 6. The following methods: linear likert-type scale (section 3.3.1), SPES (discussed in section 3.3.2), and SHORE™ (reviewed in section 3.3.3) were tried out and used in study 2 Chapter 5. Formal interviews were conducted in study 3 Chapter 6 and thematic analysis at the latent approach was performed.

This chapter also reported on some exploratory pilots undertaken as part of the user-centred design process, aimed at the design of a haptic prototype to use for the studies, introducing the first three prototype designs. Reflecting on the design process the limitation of our approach lies in not exploring different parts of the hand, as fingers and fingertips, and focus our design on the main area of the hand (both the palm and the back). From the experience gathered we found it challenging designing a glove that would fit participants with the same level of fitting size and comfort. Both the choice of fabric properties and size had to keep in consideration electronics requirements such no to affect their correct use. Particularly, although the use of the LilyPad wearable electronics facilitated the product design, the use of conductive thread combined with the individual fabrics' stretch properties proved challenging, due to change in resistance when a force is applied to the thread and resulting in unstable powering of the circuit. This is discussed in more details in Chapter 4 section 4.1.1. We therefore recommend taking into consideration the choice of fabric used when developing wearable prototypes with embedded electronics and the use of conductive thread.

The next three chapters will present three user studies undertaken during this work, and the further prototype evolution and implementation towards a final robust design.

Chapter 4

Study 1: Exploring the effects of haptics on mood

The study reported in this section was presented and published in the Proceeding of the INTETAIN 2015 International Conference (Mazzoni and Bryan-Kinns, 2015).

4.1 Context and study settings

This study aimed to assess whether haptic sensations are able to suggest moods. This step was necessary before trying pairing haptic sensations with mood music in film. Therefore this preliminary study did not make use of movie clips. The glove prototype also evolved its design to overcome limitations found in prototype 3, where participants could not perceive the haptic stimuli due to the loose fit of the design. A new design was implemented and it is discussed in the next section.

4.1.1 Prototype 4 - LilyPad

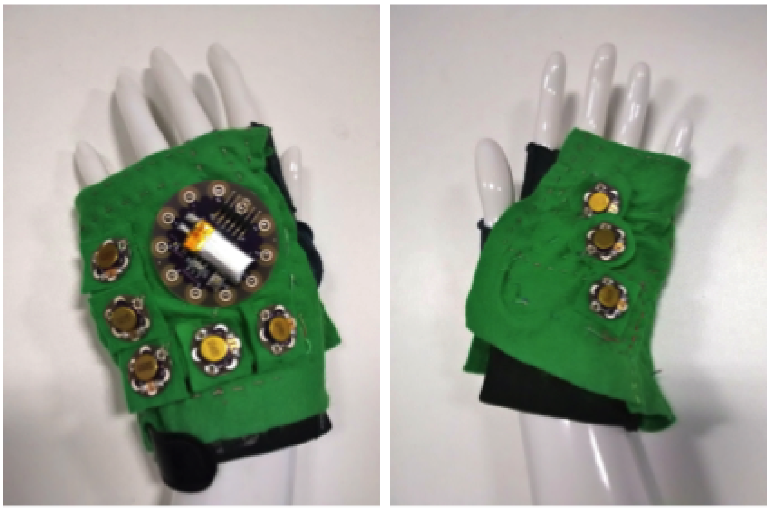


Figure 4.1: Glove prototype 4. Left: back, right: palmar of the glove.

The technology components utilized in the make of the fourth prototype were: a LilyPad Arduino SimpleSnap Board ATmega328, conductive thread, and 8 LilyPad Vibe Boards with 20mm outer diameter and 0.8mm PCB thin with mounted 310-101 10mm Shaftless Vibration Motor 3.4mm button type (with a voltage range of 2.5-3.8V, a rated speed of 12000 rpm, a vibration amplitude of 0.8G, and weighting as little as 1.2g).

For this new design a fitted glove was trialled, usually employed for sports outdoor activities, purchased in a sports store, in size women XL, made out of 90% Polyester and 10% Elastane. However, due to the extremely stretchy property of the material, it was hard to implement the circuit directly onto the glove. When the garment stretched, the conductive thread resistance would change due to the force applied to the thread, resulting in unstable powering of the vibe boards. To overcome this issue the whole circuit was designed on a layer of felt fabric and then applied to the glove through hand sewing. Also, this prototype experimented with a different board version of the LilyPad Arduino, the SimpleSnap. Benefits of this type of board are: a lithium battery mounted directly onto it (so no need for an additional power supply) and connectivity to the circuit through snap buttons (offering the possibility of easily removing the board for replacement and code reconfiguration).

The design maintained the coin motors on both sides of the glove, and vibe boards were mounted 5 at the back of the hand, and 3 on the palm (see figure 4.1). Each vibe board has a 20mm outer diameter and it is 0.8mm PCB (printed circuit board) thin. The vibration motors present on the vibe board are 310-101 10mm Shaftless Vibration Motor 3.4mm button type, with a voltage range of 2.5 3.8V, a rated speed of 12000 rpm, vibration amplitude 0.8G and weight as little as 1.2g.

4.1.2 Haptic sensations

For this study two distinct vibrotactile designs (see figure 4.3) were formulated, *design* α and *design* β which were further developed and combined with different motors' Pulse Width Modulation (PWM) values (i.e. low and high duty cycle), as well as directional order, to finally result in a set of 8 vibration patterns. The intensity and frequency of the actuators is recreated through manipulation of the PWM signal, as described in figure 4.1 and as used in Frid et al. (2014).

Patterns 1-4 lasted 10 seconds and patterns 5-8 lasted 15 seconds in duration, with PWM values that ranged between 64 and 127 (25%-50% duty cycle) for the low values, and between 191 and 255 (75%-100% duty cycle) for the high values. The directional order followed by the sets of patterns was: left to right, and right to left. Vibrotactile patterns 1 to 4 had directional order left to right, whereas patterns 5 to 8 had the opposite directional order of right to left. Also, as visible from figure 4.3, at times the actuators played simultaneously, and at other times one at the time. To simulate a low frequency of the signal the actuators were on for 400ms followed by 500ms of inactivity. In order to simulate high frequency instead, actuators were on for 400ms and off for 200ms. The haptic patterns had the following intensities and frequencies:

- 1 and 5: low intensity, low frequency

- 2 and 6: low intensity, high frequency
- 3 and 7: high intensity, low frequency
- 4 and 8: high intensity, high frequency

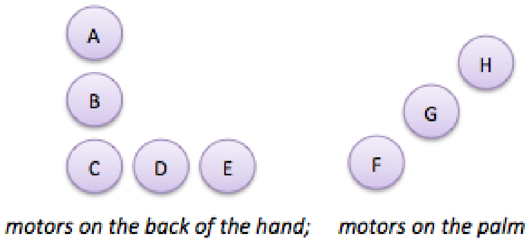


Figure 4.2: Schematic of the motors

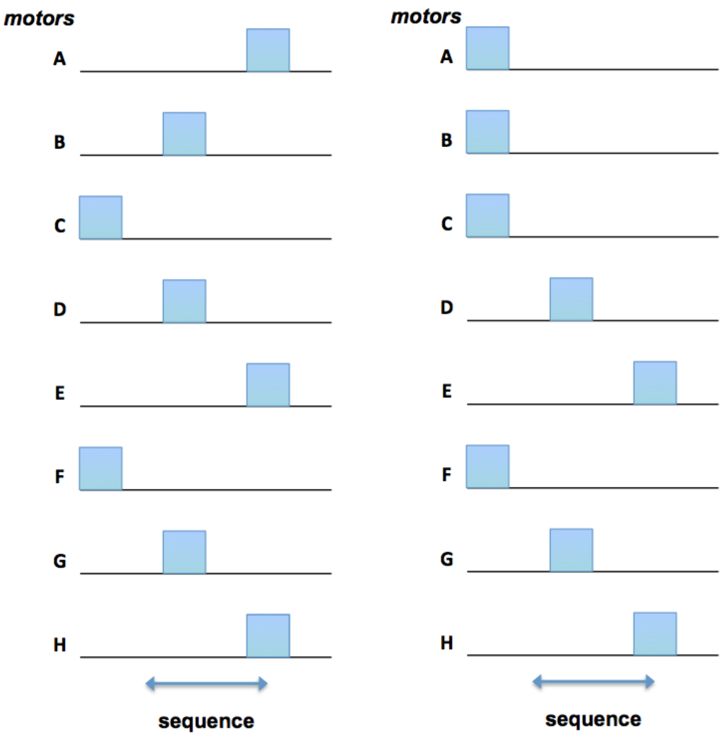


Figure 4.3: Left: vibrotactile design α, used in patterns 1,3,5,7; Right: vibrotactile design β, used in patterns 2,4,6,8. The above is a schematic of the sequence in which actuators A to H played. It does not express PWM duty cycle nor time. The arrows refers to the directional order left-to-right and right-to-left.

Table 4.1: Average Ratings of Valence and Arousal Dimensions

Intensity in Pulse Width Modulation (PMW)		**Frequency in ms**	
		ON	**OFF**
LOW	64(25%) - 127 (50%)	400ms	500ms
HIGH	191 (75%) - 255 (100%)	400ms	200ms

4.2 Method

The study took place in one of the University research laboratories, under controlled conditions, with one participant at a time.

4.2.1 Participants

16 participants took part in the study, recruited within the University institution, through advertisement, without any offered incentives. None of the recruited participants had taken part in the pilots run prior to the study. Participants were normal-hearing people, all post-graduate students, 9 males and 7 females, aged from 22 to 38; mean age: 27.5.

4.2.2 Measures

Acquired data was evaluated through the SAM self-reported scale discussed in section 3.2.

4.2.3 Procedure

Each participant was briefed on the study and given a consent form to sign, together with a demographic questionnaire to fill in. Following this, each participant was asked to wear the glove prototype fitted with small vibration motors, sense all 8 haptic patterns and self-assess the experience in terms of pleasure and activity (i.e. how active or energetic the vibrations felt) onto the modified version of the SAM, represented in figure 3.11 and discussed in section 3.2.
To reduce ordering effects the first 8 participants were presented with the haptic

patterns in order 1 to 8, whereas the remaining 8 participants were presented with the patterns in the reverse sequence (8 to 1). Each pattern was played in a loop twice, then the participant was given 30 seconds to mark the experience on the modified version of the SAM as discussed. At the end of the task participants were verbally asked for any feedback on the experience.

4.3 Results

All 16 participants completed the session in full, which lasted approximately 15 minutes. Table 4.2 and 4.5 illustrate the results of the participants' ratings for the arousal and valence dimensions.

A Wilcoxon Signed-Ranks Test was used to test the significance of the difference between the ratings from the SAM for pairs of patterns, with level of significance $p<0.05$. The statistical test identified that 14 out of 28 possible pairs of patterns led to significantly different results in terms of arousal, while 13 out of the 28 possible pairs showed a significant difference in the valence ratings. Significantly different pairs of patterns are described in table 4.3, whereas the confusion matrix in figure 4.4 provides a visual representation of significantly different patterns from all possible pairings.

Table 4.2: Average Ratings of Valence and Arousal Dimensions

Pattern	**Arousal Avg rating**	**Valence Avg rating**
1	1	0
2	0.5	-0.25
3	0.125	0.1875
4	-0.625	-0.625
5	1.375	0.625
6	0.375	-0.4375
7	-0.0625	0.625
8	-0.1875	-0.625

Table 4.3: Ordinal Data Tests Results with Wilcoxon Signed-Ranks p<0.05

Patterns	**Wilcoxon test - Arousal**			**Wilcoxon test - Valence**		
	W	**z**	**P(1-tail)**	**W**	**z**	**P(1-tail)**
1,3	**94**	**2.66**	**0.0039**	-9	-0.33	0.3707
1,4	**105**	**3.28**	**0.0005**	47	1.62	0.0526
1,5	-22	—	—	**-48**	**-1.86**	**0.0314**
1,7	**66**	**2.91**	**0.0018**	**-48**	**-1.86**	**0.0314**
1,8	**102**	**2.88**	**0.002**	**40**	**1.76**	**0.0392**
2,4	**91**	**3.16**	**0.0008**	26	1.13	0.1292
2,5	**-58**	**-2.56**	**0.0052**	**-47**	**-2.07**	**0.0192**
2,7	32	1.61	0.0537	**-64**	**-2.22**	**0.0132**
2,8	**54**	**2.1**	**0.0179**	18	—	—
3,4	**47**	**2.37**	**0.0089**	**34**	**1.71**	**0.0436**
3,5	**-85**	**-2.65**	**0.004**	-25	-1.09	0.1379
3,8	25	1.09	0.1379	**55**	**1.9**	**0.0287**
4,5	**-120**	**-3.39**	**0.0003**	**-66**	**-2.57**	**0.0051**
4,7	-40	-1.55	0.0606	**-93**	**-2.63**	**0.0043**
5,6	**66**	**2.91**	**0.0018**	**51**	**2.57**	**0.0051**
5,7	**97**	**3.03**	**0.0012**	3	—	—
5,8	**91**	**3.16**	**0.0008**	**74**	**2.88**	**0.002**
6,7	27	—	—	**-67**	**-2.32**	**0.0102**
6,8	**46**	**1.78**	**0.0375**	14	0.23	0.2981
7,8	9	—	—	**66**	**2.91**	**0.0018**

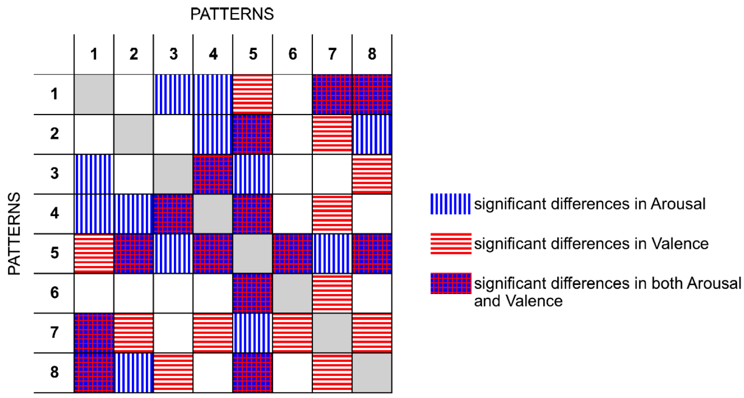


Figure 4.4: Confusion matrix for the 8 vibrotactile patterns with cells representing pairs of patterns with significant differences in Arousal and Valence.

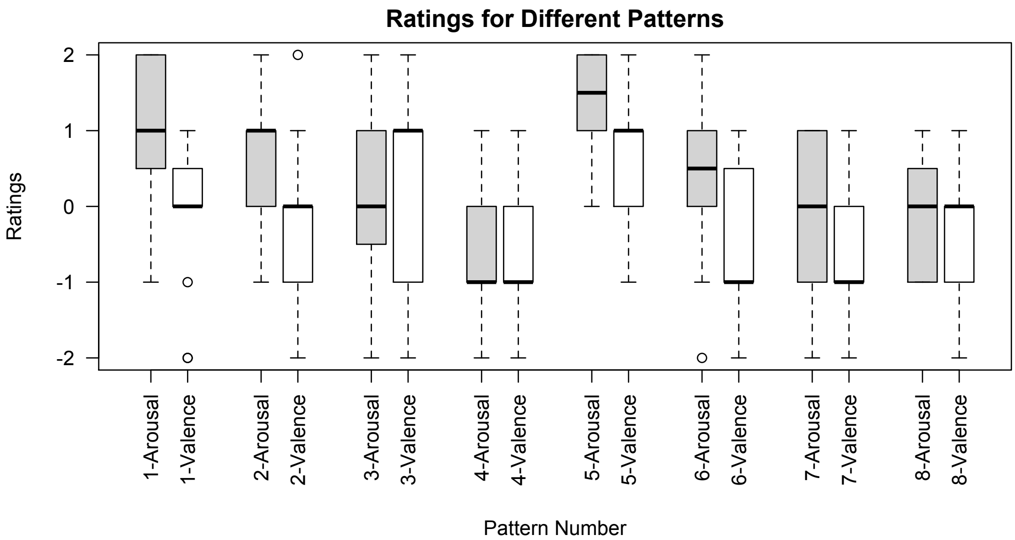


Figure 4.5: Box plot of the arousal and valence ratings.

4.4 Discussion

In this study, vibration patterns 1, 4, 5, 7, and 8 were the most statistically different. As outlined in section 4.1.2, patterns 1 and 5, and patterns 4 and 8, were set to the same level of vibration intensity and frequency, but the motors vibrated in a different sequence. This data suggests that the sequential order of the vibration patterns does not contribute to identifying a certain arousal and valence state, but instead suggests that the key elements which define those states are the intensity and frequency at which the stimulus plays. Haptic pattern 7 had high intensity and low frequency values, with participants associating it with low valence. Results show that participants reliably associated a high level of valence and arousal (coding scale <0) to vibration patterns with high intensity and high frequency, and low valence and arousal (coding scale >0) to those patterns with low intensity and low frequency. The results possibly suggest a natural mapping, where participants associate higher vibrotactile signals to higher valence and arousal rating. However, some verbal feedback about the experience were left by participants at the end of the task, suggesting also the possibility for another mapping. Some participants reported associating the vibrations to rhythm and consequently to associate this last one to music or other ambient sounds, e.g. ambulance or police sirens and therefore evoking in them a sense of alarm. This kind of association (as the one in Lemmens et al. (2009) between haptic sensations and the mental interpretation of physical events) could serve as a direction in designing intuitive haptic sensations. However, this interrelation could be limited only to the hearing and not hearing-impaired people. A further study involving both normal-hearing and hearing-impaired people could help determine if the vibration-to-rhythm, rhythm-to-music and ambient sound, and sound-to-emotional state associations span across the different hearing abilities. However, this is outside the scope of this work, so will not be examined.

A recurring feedback among participants was also that even though the glove prototype provided a tight fit, the extra layer of felt fabric on which the circuit was integrated slightly decreased their sensibility to the haptics. This limitation could potentially justify the possibility of participants mapping higher levels of PWM values to higher valence and arousal ratings. Some participants also reported experiencing a tickling sensation from the motion of the actuators on the palm of the glove.

4.5 Reflective summary

In this study, conducted with normal-hearing participants, patterns 1, 4, 5, and 8 most reliably conveyed moods (in terms of valence and arousal), with most participants associating patterns 1 and 5 to low levels of valence and arousal and patterns 5 and 8 to high levels of valence and arousal. Whereas pattern 6, as visible from figure 4.4, appeared to be the pattern with the least significant differences, scoring very similar averages to pattern 2, which had the same frequency and intensity (see table 4.2 and figure 4.5), and resulting significantly differently to pattern 5 in terms of both valence and arousal, and pattern 7 in terms of valence, exactly as scored from paired patterns 2, 5 and 2, 7. This reinforces our belief that the sequential order in which vibrations are presented does not influence participants arousal and valence states.

The results from this first study suggest that vibrations at low intensity and frequency can suggest a mood equal to low valence and low arousal, whereas vibrations applied at high intensity and frequency can suggest to people a high state of valence and arousal. A limitation of the prototype was a reduced sensibility to the haptic sensations attributable to a layer of felt fabric on which the circuit was integrated. Due to the high stretch properties of the fabric of the glove garment, it proved challenging designing a stable circuit directly on the glove, as the stretching of the fabric applied force to the conductive thread powering the circuit, consequently resulting in a change of resistance and unstable powering of the actuators. Because of this reason it was necessary to sew the circuit on another layer of fabric and integrate this last one on the glove garment. However, this limitation might have affected the results, and possibly suggest that participants mapped higher haptic signals to higher ratings of the SAM, reporting a more natural mapping rather than valence and arousal feelings experienced while sensing the haptic sensations. Further investigation is therefore needed for determining whether it is a matter of natural mapping being reported by participants rather than suggestions of moods.

The study presented in the next section incorporated movie clips alongside haptic sensations to investigate whether the sensory addition could enrich the film experience. A new prototype was designed and consequently new haptic sensations too, to suit the new system configuration, while retaining the vibrotactile properties observed in study 1.

Chapter 5

Study 2: Haptics to enhance mood music in Film entertainment

The study reported in this chapter was presented and published in the Proceeding of the 2016 ACM Conference on Designing Interactive Systems (DIS) (Mazzoni and Bryan-Kinns, 2016a), and in the Special Issue of Elsevier Journal Entertainment Computing, Volume 17, November 2016, Pages 9-17 (Mazzoni and Bryan-Kinns, 2016b).

5.1 Context and study settings

The aim of this experiment was to test whether watching movie clips accompanied by haptic sensations would result in participants self-reporting an increase of valence and arousal as opposed to watching the video clips without the haptic stimulation. A new haptic glove prototype was implemented to improve the previous design and a dataset of affective movie clips was also collected to test the hypothesis. We specifically decided to collect affective movie clips rather than neutral ones in order to observe a possible shift of participants valence and arousal. Our approach aims at augmenting self-perceived valence and arousal, not inducing them. To this end, we found it appropriate that the movie clips in our dataset already conveyed affect. The movie clips corpus assembled will be discussed in section 5.2.

5.1.1 Prototype 5

Prototype 5 was the final design implemented over the course of this work. It retained positive aspects of prototype 4, such as the use of a lightweight fabric with the ability to stretch, making the garment comfortable and able to easily adapt to different hand sizes, whilst addressing shortcomings such as the decrease in sensibility to the haptic stimuli caused by the additional layer of felt fabric in between the glove and the actuators. The limitation of prototype 4 possibly suggests that in study 1 participants mapped the strength of the vibrotactile signals to levels of valence and arousal rather than reporting their perceived mood when sensing the haptics. Another iteration of the prototype design is therefore essential for providing participants with an improved haptic experience.

New fabric materials were tested and a cotton-lycra garment proved the best solution for the design, providing lightweight comfort for the wearer together with a certain degree of stretchability, while allowing the circuit to be built directly on the garment as the stretch properties of the fabric were moderate and would not interfere with the electrical resistance.

5.1.2 Materials, electronics, and design

The technology components utilized for the design of the fifth and last glove prototype were: a LilyPad Arduino Simple Board ATmega328, conductive thread, a Polymer Lithium Ion 110mAh battery, and 5 LilyPad Vibe Boards with 20mm outer diameter and 0.8mm PCB thin with mounted 310-101 10mm Shaftless Vi-

Figure 5.1: Glove prototype 5

bration Motor 3.4mm button type (with a voltage range of 2.5-3.8V, a rated speed of 12000 rpm, a vibration amplitude of 0.8G, and weighting as little as 1.2g). The program sketch of the interface was written in Processing 3[1], with Firmata firmware for Arduino[2].

This prototype design uses a 97% Cotton and only 3% Lycra glove opposed to the synthetic material of prototype 4. The properties of the Cotton fibre makes the glove lightweight and comfortable to wear, providing some degree of stretch and enabling at the same time the circuit to be placed directly on the glove garment itself without compromising the loss of power that can be caused by applying excessive stretch to the conductive thread.

The version of the LilyPad Arduino employed in this prototype has a built in power supply socket to plug Polymer Lithium Ion batteries (LiPo). LiPo batteries are very slim (some also very small) and lightweight batteries based on Polymer Lithium Ion chemistry, which was the highest energy density in production at the time of developing this design. The LiPo battery used in glove prototype 5 has dimension of 5.7x12x28mm, and weight as little as 2.65g.

The new design of the prototype removed the coin motors from the palm of the

[1]https://processing.org/
[2]https://www.arduino.cc/

glove, as participants in the first user study reported that the vibration stimuli on the palm tickled their hands. In this latest design, the 5 vibe boards were therefore positioned on the back of the glove as shown in figure 5.1. The actuators were placed in a circle and were equally distanced from one another, so that from the centre of the board there was a vibe board for every 72 degrees arc (*360°= degrees in a full circle, 5 motors: 360°/5 motors = 72°).*

This rearrangement was purely a design choice. Findings from early pilots of this work showed that different motor arrangements among the ones proposed did not impact participants' response to the stimuli. In the early stages of this work, participants reported to be experiencing the stimuli as a whole, without being able to clearly identify different design patterns only based on the vibrotactile stimuli perceived on their hand. Thus, we considered that the newly proposed rearrangement would not affect participants' perceived mood from the haptic sensations.

Following findings in the first user study (reported in chapter 4), which showed a primary association between different combinations of intensity and frequency of vibrotactile stimuli and perception of valence and arousal in participants, four new haptic sensations were designed to fit the new prototype with intensities and frequencies of vibrotactile stimuli that ranged from low (120-150 PWM) to high (200-250 PWM). Representations of the haptic patterns are not reported as findings from user study 1 highlighted that it was the combination of the intensity and frequency through manipulation of the PWM values to suggest moods, while the order in which the stimuli were received did not affect participants' perceived feelings. The new set of haptic sensations will be further discussed in section 5.3.

5.2 Film clips corpus

A dataset of affective movie clips was required in this work to assess whether haptic sensations could enhance mood music in film.

This section describes the search done within Film corpora to find a standard corpus of affective movie clips, where the emotional classification was based on the mood resulting from the musical score in the scene. The following journals on cinema and film studies were consulted in search of an existing movie clips database: the Cinema Journal, and Screen. Cinema Journal is the peer-reviewed, scholarly publication by University of Texas Press and sponsored by the Society for Cinema and Media Studies (SCMS)[3], which is the largest professional organization of moving image media scholars; and Screen[4] is the leading international journal of academic film and television studies published by Oxford University Press. Both journals are available online, and online searches for movie clips databases within these two journals' archives did not produce any results, aside from references to the Internet Movie Database (IMDb)[5]. Other online searches for movie or film clip databases within scholarly articles were performed, and within the results examined two databases were found provided collections of clips: the Emotional Movie Database (EMDB) and Film Stim.

The Emotional Movie Database (EMDB) (Carvalho et al., 2012), is a collection of non-auditory film clips with different valence, arousal, and dominance ratings. The database was developed using a dimensional approach and assessed valence, arousal, and dominance through both the SAM self-assessment technique, and psychophysiological responses (SL and HR). Although the database comprises film clips from multiple categories and eliciting different emotional states, the fact that the clips in the collection have no auditory content presented a limitation for its use in this work. The EMDB provide a collection of visually affective film clips, but as the intent of this work is to enhance the mood in the film score, the presence of the auditory element within the clip is essential to test this hypothesis, and therefore the use of the EMDB was excluded.

Film Stim (Schaefer et al., 2010) is a comprehensive collection of emotional film excerpts. Film clips were rated through self-reported measures in terms of mul-

[3]http://www.cmstudies.org/
[4]https://academic.oup.com/screen
[5]http://www.imdb.com/

tiple dimensions and then ranked for 24 classification criteria across valence, arousal, emotional discreteness and mixed feelings. The database provided a selection of emotion-eliciting film scenes covering a wide range of emotional dimensions. As the study was conducted in a French-speaking country, all film excerpts were in the French language (whether they were French movies or dubbed versions for non-French movies). This represented a limitation for this work, which required the film excerpts to be in English or at least have English subtitles. As the database was made freely available in a website[6], we proceeded onto analysing the clips within the database to investigate its usability for this study. It emerged that the selection was based on the affective content of the narrative, not of the film score and that the clips featured mostly dialogue between characters and no music. The absence of the score within the film excerpts proved the database unsuitable for this work.

It appeared that at the time of running this study there was not yet a standard corpus of affective movie clips where the affective indexing referred to the musical score of the clip.

5.2.1 Assembling a corpus of affective film clips

We also examined existing techniques to aid the classification of movie clips. Current audio-video analyses automatically classify contents by extracting information from multimedia, and affective content analysis constitutes the automated extraction of the affective content information from audiovisual signals (Hanjalic, 2006). Works in the field of automated extraction of affect in film comprise Salway and Graham (2003), Chan and Jones (2005), Hanjalic and Xu (2005), Xu et al. (2005), and Hanjalic (2006). Hanjalic and Xu (2005) attempted to extract affect in film scenes, where affect was based on the two-dimensional emotion space, characterised by the valence and arousal dimensions. However, their indexing of affective content of a clip was based on a combination of automatic data extraction of motion activity in each frame, shot length and sound-

[6]http://nemo.psp.ucl.ac.be/FilmStim/

track in terms of changes in sound energy, based on the premise that these features could aid automated indexing to skip to more 'interesting' parts of a video.

As also acknowledged in Hanjalic (2006), affect is very subjective. Since this work concerns the feelings and mood evoked in the audience by the film score in a clip, rather than the classification that a computer algorithm performs on extracted multimedia information, we adopted a manual labelling approach as used in Soleymani et al. (2014), as opposed to automated extraction methods.

Through self-assessed annotation of the feelings elicited by the film score in the clips, this study aimed to obtain a dataset of movie clips that reliably represented the mood music in the scene.

This manual labelling approach was maintained in the third and final study to create another collection of affective film clips based on suspense. Three films were selected based on reviews of their film score in both Film Studies literature available in the library of the author's institution and film critics. All elements in a movie (images, dialogue, score) contribute in creating emotions and setting the mood for a scene. We specifically extracted movie scenes where we felt the score was playing a part in establishing the mood of the scene, and recruited volunteers for rating the extracts in terms of valence and arousal. However, our selection contained both movie clips with only the score and clips with also some dialogue. Perhaps we should have controlled for this and limited our selection to only movie extracts containing no dialogue at all in order to avoid an extra confounding factor.

The movie clips featured in the study described in this chapter were edited from the following films:

- Edward Scissorhands (1990), scored by Danny Elfman
- Memento (2000), scored by David Julyan
- Amélie (2001), scored by Yann Tiersen

The first movie selection was made following research within the disciplines of

Film Art and Film Music, where Edward Scissorhands (1990) was extensively discussed in Russell and Young (2000) for the importance of its score. Music composer Danny Elfman explains how in the film the storyline was told from the internal viewpoint of this one character and that the music had to follow that. The score in Edward Scissorhands was *"very sappy and romantic and emotional"* (Russell and Young, 2000, p159).

Amélie (2001) and Memento (2000) were then considered as they both featured in a study conducted in assessing the effect of music on perceived emotion by Parke et al. (2007), on which the methodology of this work was based. After analysis of the films' screen plots and musical scores, we assessed that, as was the case for Edward Scissorhands (1990), the storyline is told from the interior standpoint of one character and the music reflects this one character's feelings (journey and discovery in Amélie, and yearning and feeling adrift in Memento), therefore they were selected to feature in the study.

A total of 42 movie clips were excerpted from the selection of the three movies aforementioned. All movies were available in the university library of the author's institution. The extracted movie clips, 14 for each movie, had duration of approximately 30 seconds to 2 minutes and contained an emotional event judged by the author. A similar approach where the scene's selection had been made upon the author's judgement was adopted by Soleymani et al. (2008). In the case of this study the emotional event was characterized by the presence of the film score setting the mood in the scene. Scenes selected had therefore little or no dialogue at all, covered a range of different moods, tones, actions, and imagery, but in all of them the author judged the film score to be the prevailing source for setting the mood. Final Cut Pro X[7] software was used to extract the scene excerpts. A pilot was run where 10 participants watched all 42 movie clips in a randomized order, and self-rated the prevailing mood of each clip in terms of valence and arousal on the pen and paper version of the modified SAM. From the collection of 42 we selected 12 clips where at least two thirds of par-

[7] https://www.apple.com/uk/final-cut-pro/

ticipants agreed on the valence and arousal ratings. Plots for the final 12 clips are reported in figures 5.2 to 5.13. These 12 movie clips constituted the final dataset collection for our second study. Table 5.1 describes the visual content of each movie clip in the final selection, and reports the duration and average of the SAM's valence and arousal ratings from participants.

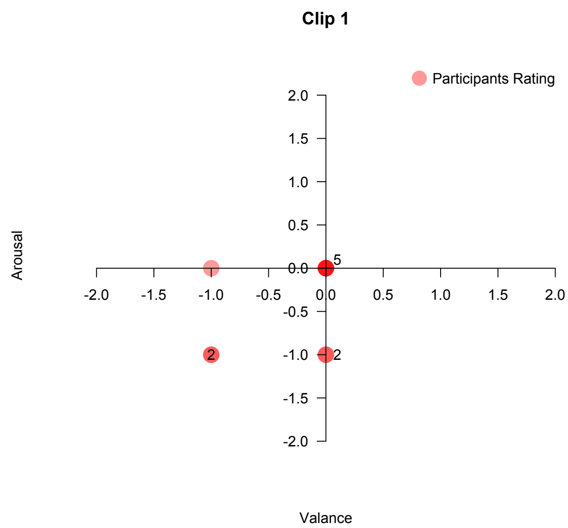


Figure 5.2: Participants ratings for clip 1

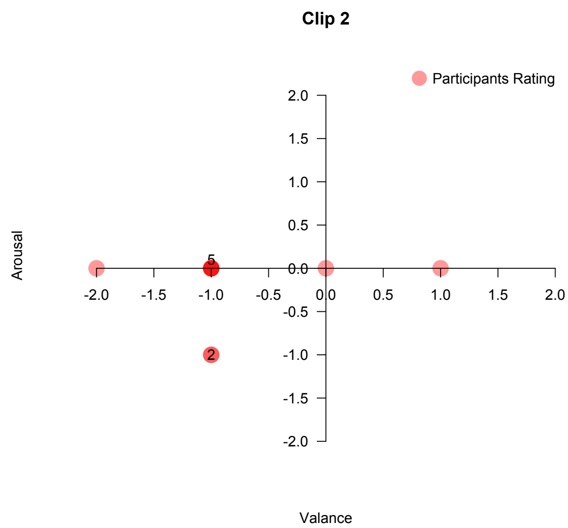


Figure 5.3: Participants ratings for clip 2

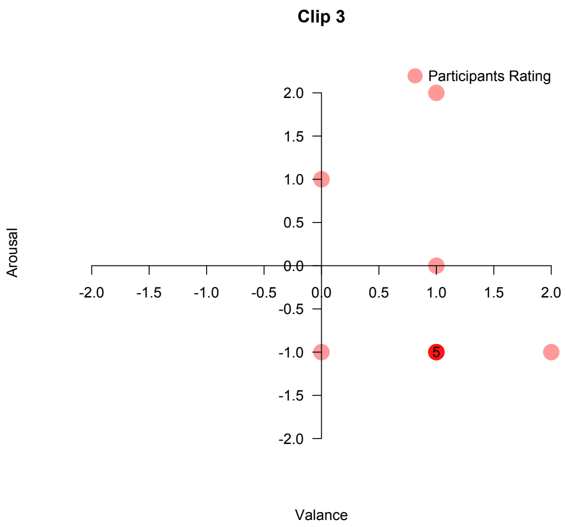


Figure 5.4: Participants ratings for clip 3

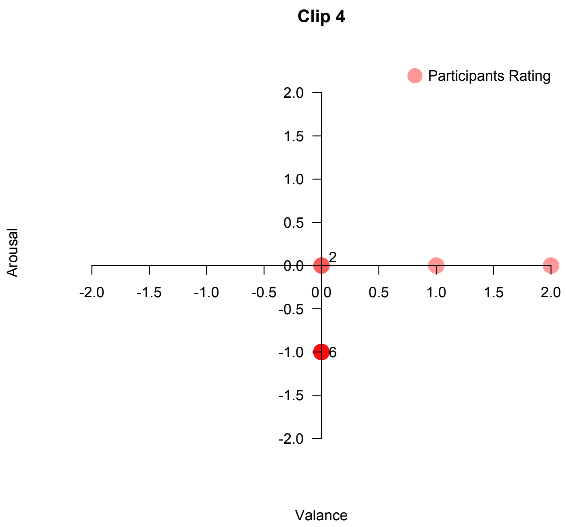


Figure 5.5: Participants ratings for clip 4

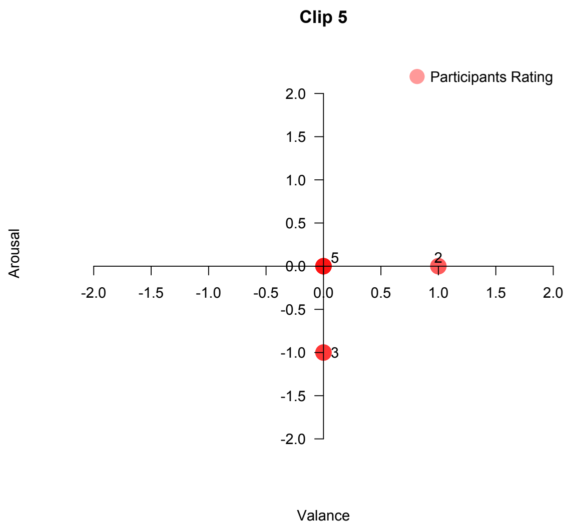


Figure 5.6: Participants ratings for clip 5

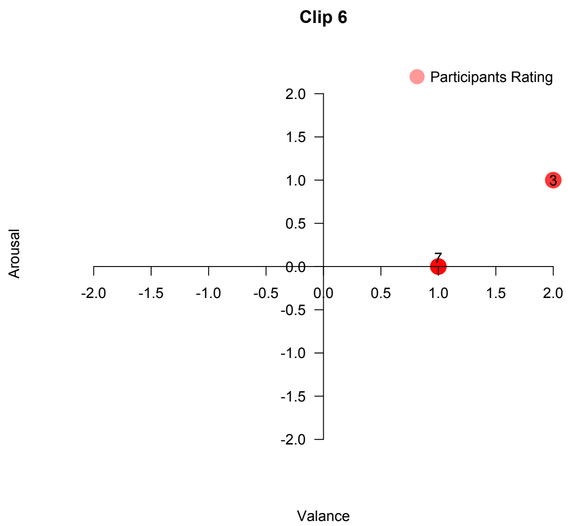


Figure 5.7: Participants ratings for clip 6

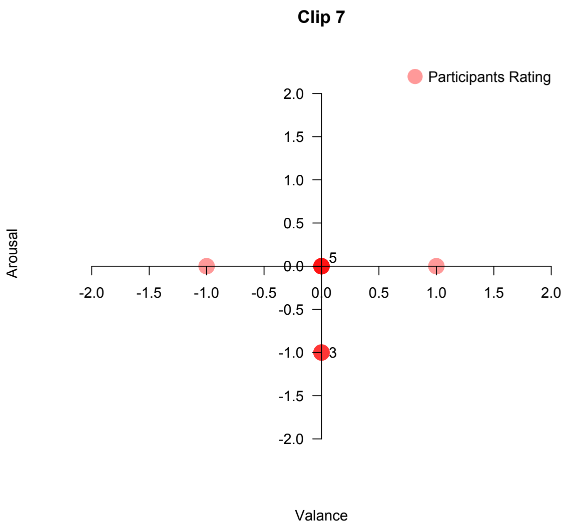


Figure 5.8: Participants ratings for clip 7

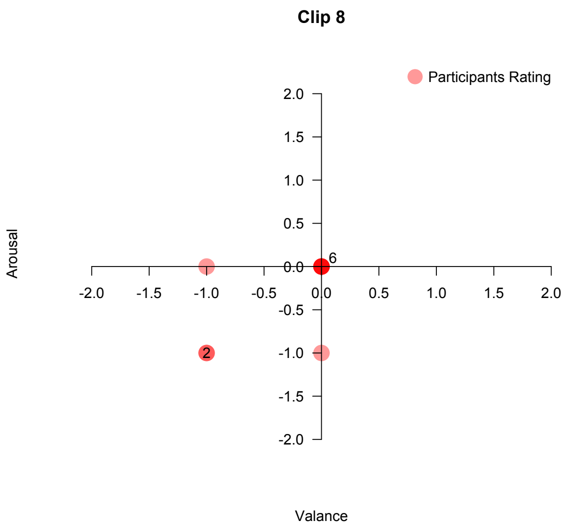


Figure 5.9: Participants ratings for clip 8

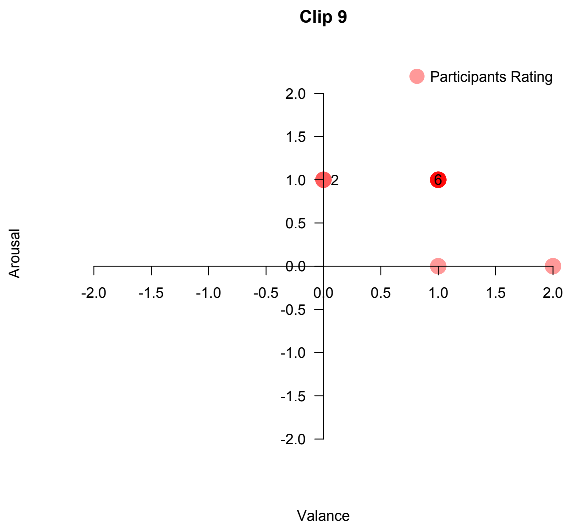


Figure 5.10: Participants ratings for clip 9

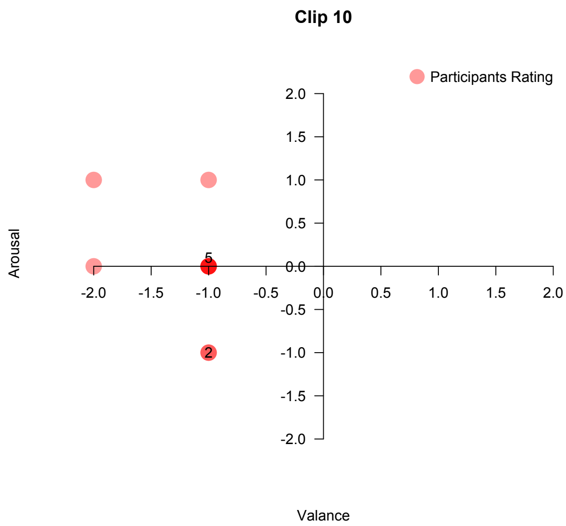


Figure 5.11: Participants ratings for clip 10

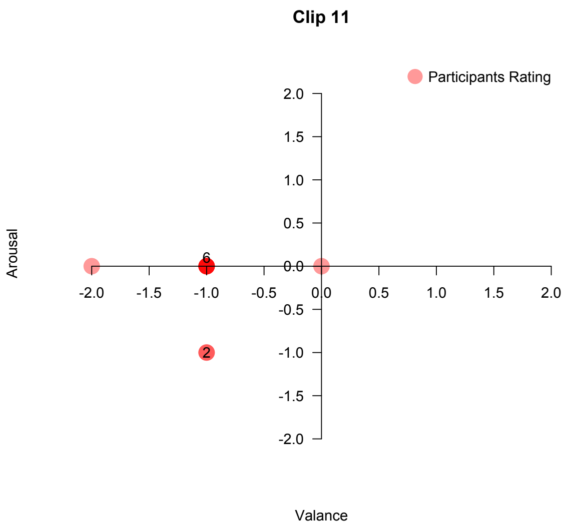


Figure 5.12: Participants ratings for clip 11

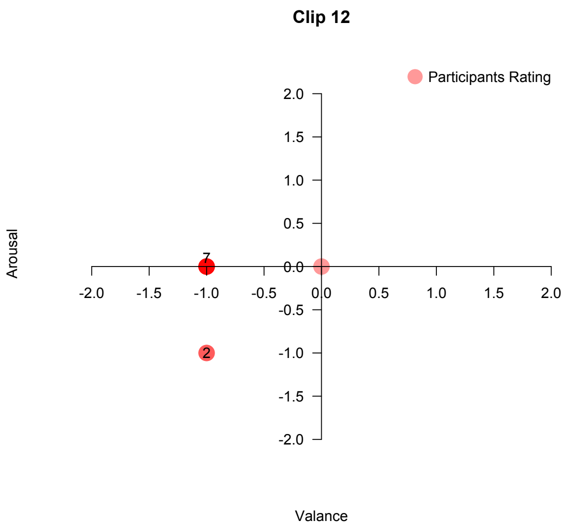


Figure 5.13: Participants ratings for clip 12

Table 5.1: Movie clips description and SAM Valence (V) and Arousal (A) average ratings from volunteers who took part in the pilot

Clip	**Duration** (in minutes)	**Movie**	**Scene description**	**SAM rate**
1	00:42	Amélie	A car drives by a road, wind makes two glasses 'dance' on a table, man erases contact from phone book.	V= -0.3 A= -0.4
2	00:29	Amélie	Young Amélie watches her mum throw her goldfish in a river. It starts raining.	V= -0.8 A= -0.2
3	00:29	Edward Scissorhands	It's evening. Neighbours are in the streets gossiping. Cars drive by. The neighbours disperse.	V= 0.9 A= -0.4
4	00:30	Memento	A truck drives through an industrial area and pulls up by an old shack. A man gets out and walks towards the shack. *(black and white)*	V= 0.3 A= -0.6
5	00:56	Amélie	Amélie walks down the stairs in an underground station.	V= 0.2 A= -0.3
6	00:29	Edward Scissorhands	Edward is in a car with Peg. They drive through a neighbourhood.	V= 1.3 A= 0.3
7	01:11	Amélie	Amélie plunging her hand into a sack of green lentils; cracking créme brûlèe; skimming stones on the river; watching from her window an old man painting in his home.	V= 0 A= -0.3
8	00:30	Edward Scissorhands	Peg enters Edward's house for the 1st time.	V= -0.3 A= -0.3
9	00:51	Amélie	Nino collides with Amélie while running after a man in the train station. Nino runs out the station, Amélie runs after him.	V= 0.9 A= 0.8
10	00:28	Edward Scissorhands	Edward walks along the corridor while scratching off the wallpaper with his scissorhands. He enters the bathroom and keeps scraping his hands against the wall while looking at his reflection in the mirror.	V= -1.2 A= 0
11	01:57	Amélie	Phone in a phonebooth rings, a man walks by, enters the phone booth and picks up. Amélie on the other side hangs up. The man sees a metal box, he opens it and finds old belongings that bring back memories from his childhood.	V= -1 A= -0.2
12	00:30	Edward Scissorhands	Edward sees Kim and her boyfriend sharing a hug and getting into a van together.	V= -0.9 A= -0.2

5.3 Haptic sensations

Four new haptic sensations were designed (A, B, C, and D) to fit with the new prototype version, with the same PWM signal values used in the first user study of this work and presented in a clockwise sequential order. Findings from the first user study (as presented in chapter 4) showed that manipulation of the PWM values of the actuators suggested moods (as combinations of self-reported valence-arousal values), whereas sequential order in which the vibrotactile stimuli were presented did not influence users' emotional perception of the stimuli (as reflected in the results of the first study). Therefore we assumed that the new adaptation of the haptic sensations consistently suggests the same levels of valence and arousal.

Movie clips annotated in our first user study were paired with the new haptic sensations in order to create a cross-modal experience (see Table 5.2 for pairings). Haptic sensations with PWM duty cycle simulating low frequency and intensity, and suggesting low valence and low arousal were paired with those clips participants had rated as low valence and low arousal during the labelling pilot described in section 5.2. In the same way, haptic patterns associated with high valence and high arousal were paired with those clips participants had labelled as high valence and high arousal. This approach was chosen as the aim of this work was to amplify the mood of certain movie scenes, not suggest a different one.

5.4 Method

This section describes the method adopted in this second user study, presenting the settings of the experiment, the task required from participants, the procedure, and the measures for analysing the results.

Table 5.2: Haptic sensations and film clips pairing

Haptic Sensation	sensation frequency	sensation intensity	Clip
A	low	low	2
			7
			11
B	high	low	1
			5
			12
C	low	high	4
			8
			10
D	high	high	3
			6
			9

5.4.1 Experimental settings

The study was carried out in the Performance Lab within the EECS Department of the University. The Performance Lab is a large space with a high ceiling of approx 9x8m, and all surfaces (walls, ceiling, and floor) painted in matte black. A section was created at the centre of the lab, with 2 room divider screens and black curtains covering the divider screens and a desk on which a 27-inch Apple cinema display was positioned. The reason for using black curtains was to keep surfaces covered in black in line with the rest of the space and leave the screen display as the point of focus for participants. The mouse and keyboard were present to allow user interaction with the system. An office chair was also part of the set up. A small camera was placed on top of the screen to record the sessions to later perform facial analysis on the video recordings for emotion recognition using SHORE™ discussed in section 3.3.3. In order to obtain a clear recording where facial features were visible, the participants' faces had to be kept clear of obstructions. Participants were therefore instructed not to cover their face with their hands and the environment had to be lightened. Therefore participants experienced the task with some lights on (similar to a home setting) rather than in darkness (like in a cinema setting). Sound was played through speakers rather than headphones to avoid covering part of the participants' faces and to also keep in line with a home setting.

During user testing the doors of the lab were closed and a sign was displayed advising people not to enter as testing was in progress, in order to maintain controlled environment settings and ensure that no external factors could influence the experiment.

5.4.2 Task

Each session lasted approximately one hour. Participants were required to wear the haptic glove prototype 5 (see figure 5.1), watch in a randomized order the 12 movie clips described in table 5.1, and rate their experience after watching each clip using first the pen and paper version of the 9-point modified version of the SAM (as described in section 3.2.1), then on the a 9-point linear likert-type scale for both valence and arousal (as described in section 3.3.1). A practice movie clip was used before performing the task to demonstrate to participants how the rating should be performed and allow for any eventual clarification before the start of the procedure. Work by Carvalho et al. (2012) also presented participants with a practice clip. The practice clip was selected from the discarded 30 clips from the pilot run prior to this second study. We selected a clip that over two third of the volunteers had scored with both valence and arousal ratings equals to 0 (corresponding to the middle figure of the SAM manikin, the neutral state).

In this user study we intended observing whether the addition of haptic sensations to movie clips would enhance viewers' perceived valence and arousal. Specifically, the haptic sensations we designed were meant to complement the mood music of the clips. As we hypothesize that such an approach could also have implications for hearing-impaired spectators, we decided to also observe the effects of adding haptic sensations to muted (or silent) movie clips. Unfortunately we were unable to recruit any hearing-impaired participant for this study, therefore the task was performed by normal-hearing volunteers and we edited the clip corpus to also include the 12 clips in a silent version. A silent version of the practice clip was also edited. Silent versions of the clips featured closed captions. As both the images and the score play a part in setting the mood, observing the addition of the haptics on both silent clips (characterized therefore only by the images) and audio clips (images and sound) allowed us to better understand the effects of haptics on the experience.

Each movie clip was edited and accordingly accompanied or not by the corresponding haptic sensation for that clip in order to fulfil the following conditions:

- audio movie clip (M)
- audio movie clip & haptic sensations (M+H)
- silent movie clip (SM)
- silent movie clip & haptic sensations (SM+H)

The task was divided into 2 parts:

- part A) participants watched 12 audio clips, 6 with and 6 without haptic sensations (conditions M and M+H)
- part B) participants watched 12 silent clips (where the audio was excluded when editing the clips), 6 with and 6 without haptic sensations (conditions SM and SM+H)

Prior to each task participants experienced the practice clip, first without haptic sensations followed by a few seconds where they were informed that during the task this was the time they should rate the experience. Shortly after, participants were presented again with the practice clip, this time with haptic sensations. This was done to provide volunteers with an example of the task, in order to demonstrate that even though they were wearing the glove for the whole duration of the task, not all clips would have featured haptic sensations. For task A the practice clip had audio, whereas for task B it was silent. Task order was randomised among participants. The order of clips within each task

was also randomized for each participant.
During each task participants first watched a given clip, then self-rated their emotional experience on both the SAM and the linear likert-type scale. Once participants had finished rating the experience, they had to press the space bar key on the keyboard to pass on to viewing the next clip.

5.4.3 Participants

Participants were recruited through an open email invitation sent to the departmental email list at Queen Mary University of London, and also by an open event invitation through social media channels. The open call requested any participant (with no distinction to gender, age, position, race or nationality) willing to travel to the author's institution to take part in the study without any money incentives or monetary compensations. Participants were offered beverages, popcorns, and sweets at the end of the session as a form of thank you for taking part in the study. The call advertised that the study involved watching movie clips while wearing a small piece of wearable technology and was aimed at assessing viewers' experience.
23 participants took part in the study, 2 of which did not complete the task fully as they reported to have involuntarily skipped through some of the clips.

5.4.4 Measures

The data for this study have been collected through three different methods:

- SAM and linear likert-type self-report scales
- SPES self-report measure
- SHORE™ computer vision software

5.4.5 Procedure

Each participant was greeted upon arrival, given an information sheet containing details of the study and a consent form to sign. Participants were also informed that the session would be captured on video for research purposes and that all data capturing and handling procedures were audited by the Queen Mary University of London Research Ethics Committee (Reference: QMREC1469).

After signing and agreeing to take part in the study, each participant was briefed on the task they had to perform for about 5 minutes, and was asked to take a seat in front of the display to complete an online pre-task questionnaire (see appendix A) to gather some demographic information. Completion of the pre-task questionnaire took approximately 3-5 minutes. Once they had completed the questionnaire, participants were asked to wear the glove prototype on their left hand and they were asked if it fitted comfortably before proceeding. Participants fitted the glove prototype themselves, the task took under a minute and did not require assistance from the facilitator (although present in case they had required any assistance). Two participants were left handed but were happy to wear the glove on their left hand and also use the same hand for rating the experience on the SAM throughout the experiment. We did not control this factor by asking for right handed volunteers only, and these two left handed participants were part of the same group. Perhaps future studies should consider controlling for this factor when recruiting participants or alternatively design two prototypes one for each hand. Participants were also advised they could move the hand wearing the device as they wished, just as they would normally do without the device, this meant that they were not restricted to resting it on the desk or leaving it flat open. They were just asked not to cover their face with either hand.

Participants experienced the practice clip with or without audio depending on the task they were going to perform (2 minutes), then passed on to performing one task (A or B), watched the 12 clips and self-rated their experience for each clip on both the SAM and the linear likert-type scale. Performing each task took participants approximately 20 minutes. After terminating one task, participants were interviewed for about 5 minutes to gather further feedback from the experience. Following the short interview, each participant was required to perform the other task, starting by experiencing the practice clip (with or without audio depending on the task they were going to perform), and then continue into the rest of the experiment, watching the 12 clips under the conditions required for the task. Once finished performing the second task participants were interviewed about their experience in the second part of the session, and also about their overall experience. Following the interview participants were asked to complete a post-task questionnaire, which was composed of the 10 questions in the SPES scale (see appendix C) that refer to spatial presence, in order to measure the degree of immersion in the media environment proposed in the study. Following completion of the questionnaire participants were thanked, offered some snacks, and dismissed.

5.5 Results

This section presents the results from the experiment for the self-reported measures, and the SHORE™. Statistical analysis was performed on the data from both the SAM and the linear likert-type scale. A series of tables and graphs summarising results from the statistical tests are reported in the next section.

5.5.1 Statistical analysis

Mann-Whitney was the non-parametric test for ordinal data chosen for the significance of the difference between the distributions of the two independent samples, M and M+H, and, SM and SM+H, where U is a statistic distribution under the null hypothesis, z is the significance of an observed value of U associated with the occurrence, and P represents the probability of obtaining the observed data under the null hypothesis, with a significance level of $p<0.05$.

Table 5.3: Mann-Whitney Non-parametric Ordinal Data Test Results for M vs M+H *from SAM ratings* (note: significant differences are highlighted in **bold**)

Pattern	Clip	Mann-Whitney - Valence			Mann-Whitney - Arousal		
		U	**z**	**P**	**U**	**z**	**P**
A	2	56.5	0.23	0.409	50	0.66	0.2546
	7	46.5	0.89	0.1867	75.5	-0.95	0.1711
	11	62	-0.87	0.1922	**81**	**-2.31**	**0.0104**
B	1	56.5	-0.45	0.3264	66	-1.17	0.121
	5	37	0.94	0.1736	55.5	-0.38	0.352
	12	46.5	0.23	0.409	58	-0.57	0.2843
C	4	45	0.34	0.3669	66.5	-1.21	0.1131
	8	55	-0.34	0.3669	65.5	-1.13	0.1292
	10	52	-0.11	0.4562	51.5	-0.08	0.4681
D	3	39.5	0.76	0.2236	63.5	-0.98	0.1635
	6	52.5	-0.15	0.4404	60.5	-0.76	0.2236
	9	52.5	-0.15	0.4404	63	-0.94	0.1736

Table 5.4: Mann-Whitney Non-parametric Ordinal Data Test Results for M vs M+H *from linear likert-type scale ratings* (note: significant differences are highlighted in **bold**)

Pattern	Clip	Mann-Whitney - Valence			Mann-Whitney - Arousal		
		U	**z**	**P**	**U**	**z**	**P**
A	2	71.5	-0.69	0.2451	60.5	0.03	0.488
	7	50	0.66	0.2546	84	-1.51	0.0655
	11	53.5	-0.23	0.409	**88.5**	**-2.87**	**0.0021**
B	1	66	-1.17	0.121	75	-1.63	0.0516
	5	33.5	1.21	0.1131	58.5	-0.6	0.2743
	12	60	-0.72	0.2358	49	0.04	0.484
C	4	48.5	0.08	0.4681	65.5	-1.13	0.1292
	8	43	0.49	0.3121	65	-1.1	0.1357
	10	47	0.19	0.4247	43	0.3121	0.6241
D	3	49.5	0	0.5	56	-0.42	0.3372
	6	75	-1.85	0.0322	53.5	-0.23	0.409
	9	48.5	0.08	0.4681	56	-0.42	0.3372

Table 5.5: Mann-Whitney Non-parametric Ordinal Data Test Results for SM vs SM+H *from SAM ratings* (note: significant differences are highlighted in **bold**)

Pattern	Clip	Mann-Whitney - Valence			Mann-Whitney - Arousal		
		U	**z**	**P**	**U**	**z**	**P**
A	2	42.5	0.53	0.2981	67.5	-1.29	0.0985
	7	58	-0.57	0.2843	**80.5**	**-2.27**	**0.0116**
	11	51.5	-0.08	0.4681	**75**	**-1.85**	**0.0322**
B	1	66	-1.71	0.121	65	-1.1	0.1357
	5	40	0.72	0.2358	68	-1.32	0.0934
	12	45	0.34	0.3669	60	-0.72	0.2358
C	4	64.5	-1.06	0.1446	**77.5**	**-2.04**	**0.0207**
	8	43.5	0.45	0.3264	**83.5**	**-2.49**	**0.0064**
	10	34	1.17	0.121	62.5	-0.91	0.1814
D	3	53	-0.19	0.4247	**92.5**	**-3.17**	**0.0008**
	6	67	-1.25	0.1056	**87**	**-2.76**	**0.0029**
	9	40.5	0.68	0.2483	71	-1.55	0.0606

Table 5.6: Mann-Whitney Non-parametric Ordinal Data Test Results for SM vs SM+H *from linear scale ratings* (note: significant differences are highlighted in **bold**)

Pattern	Clip	Mann-Whitney - Valence			Mann-Whitney - Arousal		
		U	**z**	**P**	**U**	**z**	**P**
A	2	30	1.47	0.0708	69	-1.4	0.0808
	7	57	-0.49	0.3121	59	-0.64	0.2611
	11	49	0.04	0.484	**75**	**-1.93**	**0.0268**
B	1	61.5	-0.83	0.2033	70.5	-1.51	0.0655
	5	50	0.04	0.484	57.5	-0.53	0.2981
	12	41	0.64	0.2611	51.5	-0.08	0.4681
C	4	45	0.34	0.3669	67	-1.25	0.1056
	8	38	0.87	0.1922	**83**	**-2.46**	**0.0069**
	10	49	0.04	0.484	60	-0.72	0.2358
D	3	44	0.42	0.3372	**88.5**	**-2.87**	**0.0021**
	6	77.5	-2.04	0.0207	**81**	**-2.31**	**0.0104**
	9	49	0.04	0.484	65.5	-1.13	0.1292

Table 5.7: Mann-Whitney Non-parametric Ordinal Data Test Results for M vs SM+H *from SAM ratings* (note: significant differences are highlighted in **bold**)

Pattern	Clip	Mann-Whitney - Valence			Mann-Whitney - Arousal		
		U	**z**	**P**	**U**	**z**	**P**
A	2	51.5	-0.08	0.4681	41	0.64	0.2611
	7	35	1.1	0.1357	67.5	-1.29	0.0985
	11	67	-1.25	0.1056	**73**	**-1.7**	**0.0446**
B	1	51.5	-0.08	0.4681	46	0.26	0.3974
	5	37.5	0.91	0.1814	61	-0.79	0.2148
	12	46.5	0.23	0.409	53.5	-0.23	0.409
C	4	54	-0.26	0.3974	**76**	**-1.93**	**0.0268**
	8	45.5	0.3	0.3821	61.5	-0.83	0.2033
	10	54.5	-0.3	0.3821	51.5	-0.08	0.4681
	3	27.5	1.66	0.0485	**73**	**-1.7**	**0.0446**
	6	47.5	0.15	0.4404	**79.5**	**-2.19**	**0.0143**
D	9	34.5	1.13	0.1292	65	-1.1	0.1357

Table 5.8: Mann-Whitney Non-parametric Ordinal Data Test Results for M vs SM+H *from linear ratings* (note: significant differences are highlighted in **bold**)

Pattern	Clip	Mann-Whitney - Valence			Mann-Whitney - Arousal		
		U	**z**	**P**	**U**	**z**	**P**
A	2	50	0.04	0.484	46	0.26	0.3974
	7	38.5	0.83	0.2033	52	-0.11	0.4562
	11	54	-0.26	0.3974	**79**	**-2.15**	**0.0158**
B	1	54	-0.26	0.3974	53	-0.19	0.4247
	5	37.5	0.91	0.1814	59.5	-0.68	0.2483
	12	56	-0.42	0.3372	49	0.04	0.484
C	4	50	0.04	0.484	66.5	0.1131	0.2263
	8	36.5	0.98	0.1635	52.5	-0.15	0.4404
	10	58.5	-0.6	0.2743	42	-0.57	0.2843
	3	30	1.47	0.0708	**76.5**	**-1.97**	**0.0244**
	6	68	-1.32	0.0934	68.5	-1.36	0.0869
D	9	45.5	0.3	0.3821	60.5	-0.76	0.2236

Table 5.9: Mean and standard deviation of clips for *Valence* under conditions: M, M+H, SM, SM+H

Clip	**M**		**M+H**		**SM**		**SM+H**	
	mean	**SD**	**mean**	**SD**	**mean**	**SD**	**mean**	**SD**
1	-0.4	0.8	-0.1	1.22	-0.7	0.715	-0.25	0.755
2	-0.7	0.483	-0.85	0.747	-0.55	0.685	-0.65	0.58
3	0.55	0.687	0.35	0.669	-0.2	0.423	-0.1	0.738
4	-0.1	0.539	-0.3	0.675	-0.35	0.474	0	0.707
5	0	0.866	-0.35	0.883	0.05	0.725	-0.3	0.856
6	0.85	0.95	0.95	0.497	0.4	0.516	0.8	0.715
7	0.3	1.059	0.1	0.994	-0.05	0.725	0.1	0.658
8	-0.35	0.45	-0.35	0.747	-0.3	0.483	-0.45	0.864
9	0.25	0.602	0.4	0.658	0.1	0.737	-0.15	0.883
10	-1.1	0.735	-1.05	0.497	-0.6	0.516	-1	0.707
11	-1.1	0.7	-0.55	1.257	-0.55	1.066	-0.4	1.174
12	-1	0.387	-1.05	0.896	-0.9	0.876	-1.1	0.738

Table 5.10: Mean and standard deviation of clips for *Arousal* under conditions: M, M+H, SM, SM+H

Clip	**M**		**M+H**		**SM**		**SM+H**	
	mean	**SD**	**mean**	**SD**	**mean**	**SD**	**mean**	**SD**
1	-0.5	0.837	0.05	1.117	-1.15	0.747	-0.6	1.101
2	0	0.943	-0.35	0.818	-0.95	1.212	-0.35	0.944
3	-0.55	1.106	0.05	1.257	-1.45	0.832	0.35	0.747
4	-0.8	0.98	-0.25	0.89	-0.9	1.075	0.2	0.888
5	-0.4	0.8	-0.15	0.883	-0.55	0.926	-0.1	0.907
6	-0.212	0.873	0.25	0.979	-0.8	1.111	0.7	0.537
7	-0.3	0.949	0.15	1.156	-1.1	1.022	0.35	1.029
8	-0.1	1.02	0.45	0.926	-1.1	1.22	0.35	0.784
9	0.25	1.365	0.95	0.926	0.05	1.301	1	1.155
10	0.25	1.209	0.4	1.049	-0.25	1.23	0.35	1.248
11	-0.5	1.049	0.65	0.58	-0.5	0.972	0.4	0.937
12	-0.5	0.949	-0.2	1.033	-0.7	0.823	-0.3	0.823

We provide a graphical representations of the mean values for both valence (figure 5.14) and arousal (figure 5.15) of all clips under each of the examined conditions, and also box plots for both valence and arousal ratings (figure 5.16). See Appendix G for a detailed representation of the valence-arousal ratings for each clip, as well as Appendix H and I for graphical representations of the mean values for both valence and arousal for each clip. Figure 5.14 shows that the addition of haptics to silent clips (SM+H) and audio clips (M+H) did not have much impact on the valence ratings of the same clips without the haptic sensations (SM and M), with the ratings across the different conditions often overlapping. Also findings from statistical tests did not show any significant differences for the valence ratings of the 12 clips across the different conditions. Whereas no difference was found for the valence ratings, figure 5.15 displays some differences in the arousal ratings when haptic sensations were paired to movie clips both in the silent version and the audio. Clips displaying greater differences when haptics were paired to silent clips (SM vs SM+H) and with audio clips (M vs M+H) are clips 3, 4, 6, 7, 8, and 11. Those clips are also the clips which were significantly different.

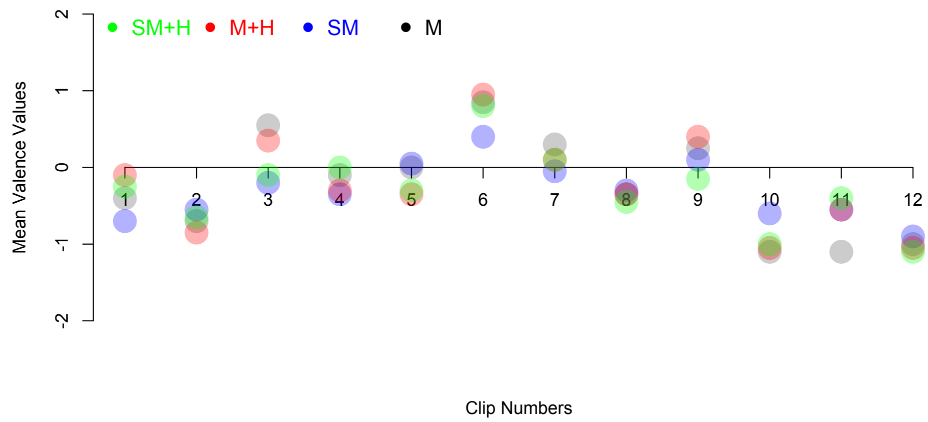


Figure 5.14: Mean for Valence ratings (note: some circles overlap, and might appear missing, as the means for some clip ratings across different conditions are similar)

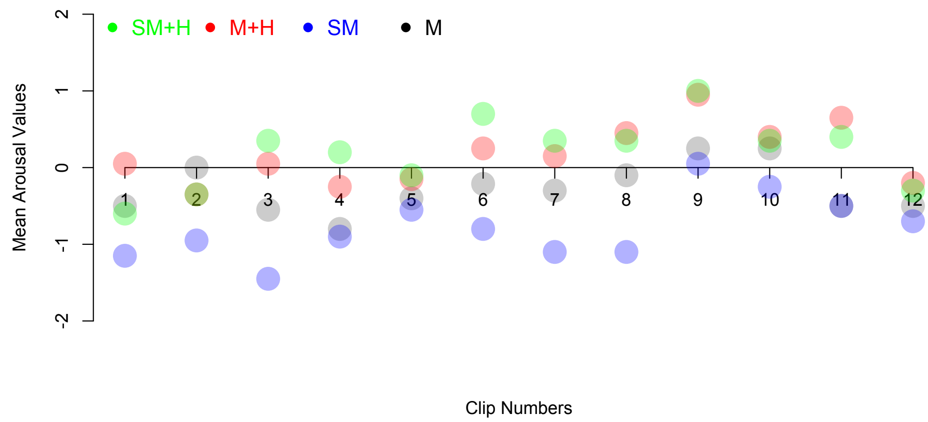


Figure 5.15: Mean for Arousal ratings (note: some circles overlap, and might appear missing, as the means for some clip ratings across different conditions are similar)

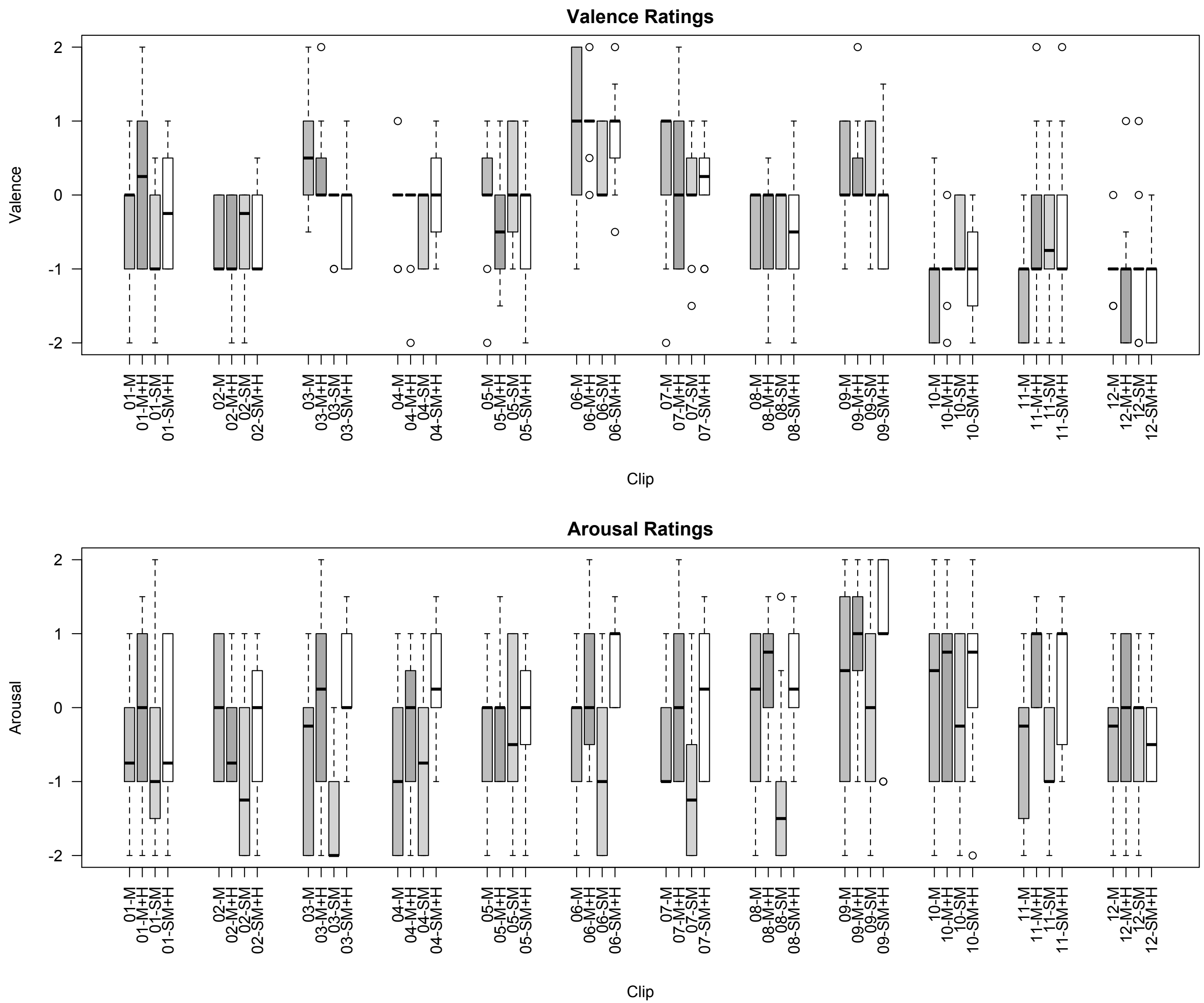


Figure 5.16: Box plots for Valence and Arousal ratings

5.5.2 Other findings

SHORE™

Video recordings from the study sessions for 20 out of 21 participants, for a total of approximately 25 hours, have been analysed through SHORE™ (SHORE Fraunhofer IIS). The video recording from one session was lost as the camera software failed while the participant was performing the task and this was noticed only at the end of the session. However, we did not remove data from this participant from the whole study as a result since the whole data recording collected for the SHORE™ was ultimately disregarded since, as it will be discussed further in this section, the software did not provide an accurate analysis of our data. SHORE™ provided for each video frame an analysis of detected faces, with age and gender classification, and an estimation of sentiment based on facial expression. Log files with the data frame by frame were generated by the software. In the following we describe the behaviours observed while analysing data recording through the SHORE™ framework.

1. SHORE™ successfully recognised participants' gender except in one case, where a male participant was classified as female for the whole duration of the session;

2. the software classified participants' 'neutral' facial expression as 'angry';

3. even though participants were briefed to not cover their faces or place their hands on their face during the session, some did anyway and this could have possibly influenced the sentiment analysis conducted by the software;

4. at times even if participants' faces were not blocked and fully traceable, the software did not detect them;

5. at other times, even objects were detected as faces and sentiment analysis was performed on those too;

6. sentiment estimation appeared to be more accurate when facial features were at their peak, and seemed inaccurate in other cases;
7. participants' mouths were not always correctly recognised as being open or closed.

From the above list of observed behaviours, points 2 and 6 raised the most concerns for the applicability of the SHORE™ framework to the scenario proposed in this study. During testing some people seemed to be more expressive than others in displaying their reaction to the media proposed, however it can be argued that when people are engaged in a certain activity, as the one proposed in the study run, rather than a facial display of emotions, other features, such as gaze and body posture for example, could be observed to better understand the level of engagement with the media. As the findings from the SHORE™ were not accurate and therefore did not prove suitable to measure social engagement in facial display of emotions in the user study examined in this work, further analysis of the log files was not performed.

Findings from interviews

At the end of each task volunteers were interviewed for about 5 minutes to express their opinion regarding the experience. No formal analysis was run, however we report on some comments left by participants as follows:

Participant 7. *"It's very nice, I **felt relaxed**"*

Participant 8. *"I noticed more details in the scenes without sound. Things I never noticed before, and I felt more focused on the colours"*

Participant 9. *"The vibrations **helped building up suspense**"*

Participant 11. *"I noticed the visual events didn't match the vibrations"* [...] *"the vibrations **calmed me down**"*

Participant 13. *"Some clips were funny, some others less, but I was concentrating on the (haptic) patterns. They were different, at times slower or faster, heavier, and in that case it **builds up your emotions, expectations**"*. During the second session, with audio clips this time, we noticed the participant moving her head along the music in the last clip (in that session that was clip number 3 in table 5.1)

Participant 16. *"Sometimes the vibrations made me a bit **more excited**, at some points, even if I felt sad I was feeling more positive"*

Participant 18. *"I think the vibrations add some effects, which make me **feel more active**, no matter how sad or how happy I was towards that movie, but it would make me feel more active"*

Participant 19. *"I like the vibrations because sometimes, I find when, especially when the music is very calm and the vibration is very tiny it feels very very good"*

SPES

Nearly all participants verbally reported at the end of the session to have had difficulty applying the questions from the SPES (Hartmann et al., 2015) (available in Appendix C) to the experience in the study scenario, and for this reason it was decided to not further analyse the related findings, however participants' responses to the SPES are included in Appendix D. Although the SPES is reported to be applicable to multiple media and not just virtual environments (VE), we found it not suitable for evaluating participants' level of engagement with the media scenario proposed in this study. One possible cause for this could be that SPES, despite claims of its applicability to various media not only VE, might still require a certain level of interactivity and immersion with the media environment proposed.

5.6 Discussion of the results

As shown in tables 5.3, 5.4, 5.5, 5.6, 5.7, and 5.8 movie clips 3, 4, 6, 7, 8, and 11 reported significant difference with $p<0.05$ in arousal values across at least one of the three different conditions observed: M versus M+H, SM versus SM+H, and

M versus SM+H. We observed the behaviour while controlling for one variable at a time, therefore we did not compare SM versus M+H as this comparison would include differences deriving from the addition of two variables: audio and haptics. Table 5.11 summarises the findings across the three conditions observed.

Table 5.11: Summary of clips showing significant arousal difference when paired with haptic sensations under different conditions

Clip	**pattern**	**M vs M+H**	**SM vs SM+H**	**M vs SM+H**
3	D		✔	✔
4	C		✔	✔
6	D		✔	✔
7	A		✔	
8	C		✔	
11	A	✔	✔	✔

The data reported in 5.5 show that arousal is significantly heightened in those silent movie clips summarised in 5.11 that were accompanied by haptic sensations. The haptic patterns corresponding to these clips are A, C, and D, which respectively are relative to low intensity and low frequency, high intensity and low frequency, and, high intensity and high frequency. In the study reported in section 5.5 these were the patterns users associated with a calm sensation (pattern A), intense positive sensation (pattern D), and intense negative feeling (pattern C). Analysing tables 5.1 and 5.11 it is possible to identify a relation between the clips and the corresponding haptic sensations:

- clips 7 and 11, with haptic pattern A, are slow scenes, narrate a character's short story or memory sharing their feelings, and whether happy or sad the musical score in them is generally calm, although nostalgic at times.
- clips 4 and 8, with haptic pattern C, are scenes with just one character, and in both scenes the character walks towards or enter a new, and what appears mysterious, place. The music score in these scenes builds up

tension.

- clips 3 and 6, with haptic pattern D, features multiple characters, at times ambiguous, and the music that accompanies the scene is of quick pace and elicits a sense of curiosity and excitement.

Haptic sensations were able to suggest to participants' feelings of calmness, suspense, and tension especially in those movie clips where there was no audio. Participants reported experiencing these feelings also during interviews conducted at the end of each session (see section 5.5.2 for some comments from participants). This could indicate that haptic sensations could help in experiencing certain feelings and moods usually conveyed by the musical score, if this last was not accessible (e.g. for deaf film audiences).
Statistical tests did not show a significant difference for the rest of the clips in this study, however arousal levels were slightly heightened in all movie clips when these were paired with haptic sensations as showed in figure 5.15. This trend of slight positive results might indicate that it is worth conducting further studies with larger group sizes.

5.7 Limitations

A main limitation of the experiment was the fact that participants were administered both conditions of the treatment and watched each clip twice, once with and another one without audio. This might have led to repetition effects from remembering the previous experience of watching the same clip (even if under a different condition). However, the repeated measure design of the experiment showed some interesting details as some participants who first experienced part B of the task (condition with silent movie clips) verbally reported during an informal post-task interview to notice the difference in how they perceived the clip when they watched it again with the audio in task A. Another feedback from many participants was they were feeling more engaged when they could feel the haptic sensations on their skin, especially when there was not audio. Many also verbally reported that the haptic sensations increased their anticipation while watching the clips compared to when they watched a clip without any haptic sensations. These comments were informally left by participants at the end of their session, no formal analysis was performed, however participants' feedback might suggest that haptic sensations could be directed to augment feelings of anticipation and we decided to further investigate this in our last study.

Most participants had already watched the movies featured in the movie clips edited for this user test, and this possibly represented another limitation since their experience could have been affected from previous memories of the movies, although all but three participants reported to have last seen the movies over a year before the experiment (see responses in Appendix B). Moreover, participants might have been biased by the novelty of the experience, as they all reported during informal interviews to have never experienced haptic sensations while watching a film. However, some verbally declared that they had come across vibrotactile feedback while playing video games. Only 6 out of 23 participants who filled in the pre-task questionnaire declared to not enjoy special effects in entertainment, such as digital 3D projections and MX4D® Motion EFX Technology[8] discussed in chapter 1.

A number of biases could have also affected the study. Response bias could have constituted a limitation. Although we did send an open call invitation through different channels in order to obtain a wide spread of the population, many of the volunteers who responded to the call came from within the author's institution. Therefore our sample group might have not represented the larger population. Another limitation might have been subject bias. Although we did not disclose what the study aimed to observe, participants might have consciously or subconsciously acted or said what they thought the researcher would have wanted them to say or do.

[8] http://www.mx-4d.com/

5.8 Reflective summary

This second user study paired haptic sensations alongside movie clips, and explored participants' affective response to the media experience proposed.

Two types of self-reported measures were tested, a likert-type scale and the SAM. Only small differences resulted between the two sets of measures, and as the pictorial nature of the SAM allowed easier interpretation for participants we decided to adopt it as the sole measure in the next study.

Results from self-reported measures indicated that the addition of haptic sensations to the movie clips does not influence participants' perceived valence towards the clip, but it may enhance their sense of arousal. Many participants commented feeling a stronger build up of sensations during movie clips in which the haptic sensations were more active. This translated into higher arousal ratings. Since haptic sensations appeared to be able to intensify audience arousal, we reflected on how this finding could be further applied. This led to the question of what feeling conveyed by mood music in film is particularly subjected to arousal. This thought, together with participants' feedback gathered during interview sessions where *'the sense of build up of suspense/expectations'* was a recurring comment, led us to explore whether the addition of haptic sensations could increase suspense in film.

In the next chapter we will provide a brief overview of suspense in film entertainment and its affective role on the audience, and will present the final study of this work, designed to intensify suspense in film through haptic sensations.

Chapter 6

Study 3: Haptics to increase suspense in film entertainment

This third and final user study had the objective of assessing whether haptic sensations could enhance the build up of suspense in movie scenes, similarly to the way composers construct the film score to build up tension and expectation. Why choose *suspense*? It emerged from film studies literature that suspense films are particularly able to provoke certain emotional and anxious responses in the spectator (Derry, 2001). In film, suspense is a narrative construction whereby spectators are made aware of certain facts in the plot before the fictional characters involved, allowing the audience to anticipate developments in the plot before the characters themselves (Derry, 2001). Therefore this work refers to the term *suspense* within a film as the feeling that arouses excited expectation or uncertainty about what may happen in the fictional work. These anticipations can refer to both harmful as well as humorous events (De Wied, 1995), and therefore generate positive and negative feelings. Suspense does not require a resolution and it does not relate to the curiosity of what will happen next, but to the expectation that a specific action might happen (Derry, 2001). It concerns probabilities, it isn't simply a matter of uncertainty (Carroll, 2006), and it is the anticipation of possible outcomes that leads the audience to feel suspense (De Wied, 1995).

The fact that spectators are appraised of the facts involved before the characters results in the audience identifying with the protagonists (Derry, 2001), and as it was discussed in section 2.3, identification according to Gaut (2012) is one of the most powerful elements of emotional engagement in cinema, as it promotes our emotional connection with the characters (Carroll, 2008).

The film score plays an essential part in creating suspense. It promotes the build up of tension and expectation in the audience, as it cues the viewers about potential threats before the image does (an example of this is provided by Gorbman (1987) with the shark theme in the movie *Jaws*).

Film studies literature supports the view that spectators' affective responses appear to reach their peak for suspense scenes. Through the manipulation of sound and image filmmakers create an emotively significant experience for their audience (Carroll, 2008), and the fusion of visual images and the film score in suspense scenes appears to throw cinematic audiences into heightened affective states. This poses the question of whether it would be possible to further enhance this inseparable fusion during suspense scenes through involving still another sense into the artistic mix. This is the reason why we decided to experiment with the use of haptic sensations to complement suspense, to further enhance spectators' emotional experience.

6.1 Context and study settings

For this experiment a new collection of affective movie clips was required, where the affect was characterised by a build up of suspense. This final user study was divided into two parts. In the first part participants watched and rated 60 short movie clips. Research into suspense within film studies was carried out to select movies known for building up suspense through their score. Thirteen films were selected from various genres, and movie clips were extracted from sections in the movies where the film score was present and contributed, together with the motion picture, in building a sense of suspense in the audience. Ratings were done in terms of valence and arousal through the modified version of the SAM discussed in chapter 3.2 and adopted throughout this work.

We described suspense as a feeling that can be derived from pleasant or unpleasant events (De Wied, 1995), therefore it has valence and provokes an anxious response (Derry, 2001), which can be classified as levels of stress or arousal. Oliver and Bartsch (2010) showed that arousal represents the strongest predictor for suspense, therefore in this final user study we focused only on arousal and not valence.

This first part of the study built a corpus of suspense film clips to serve as the baseline in the second part of the study, where it was tested whether adding haptic sensations to the movie clips would increase participants' perceived level of arousal.

6.1.1 Settings

This last user study had similar experimental settings to the second user study. It was carried out in the Performance Lab of the author's University, a space with a high ceiling of approx 9x8m, and all surfaces (walls, ceiling, and floor) painted in matte black. A desk and an office chair were positioned in one of the corners of the lab. On the desk there were a 27-inch Apple cinema display and a wired Apple keyboard and mouse. Two wall dividers blocked another side of the space and black curtains surrounded the walls and dividers, creating a confined space that would leave the cinema display as the central focus point. A pair of over-ear headphones, the glove prototype 5 (used only in the second part of the study), and a MacPro were also part of the set up. This last one allowed the glove prototype and the user interface to run through Processing[1].

[1]https://processing.org/

6.2 Part 1: Film clips corpus based on suspense

The aim of this first part of the study was to collect a corpus of suspenseful movie clips to be used in the second part of the study. The approach used was like the one adopted when creating a movie clip corpus for the second user study described in chapter 5. The author chose 13 movies covering various genres and extracted a total of 60 movie clips where the author judged the score in the scene to be suspenseful. 10 volunteers watched and rated all 60 movie clips through the SAM, and the clips that scored the most agreement among participants were chosen for the final collection.

6.2.1 Movie clips selection

Sixty movie clips were extracted from thirteen movies, covering various genres. Film selection is summarised in table 6.1, reporting film title, year of release, genre[2], and clips selected (with a coding represented by a letter from the alphabet A-M, identifying the movie, and numerical numbers in ascending order).

Table 6.1: Films selection

Film Title	**Year**	**Genre**	**Clips**
Amélie	2001	Comedy, Romance	K1,K2
Deep Red	1975	Horror, Mystery, Thriller	B1,B2
Edward Scissorhands	1990	Drama, Fantasy, Romance	M1-M7
E.T. the Extra-Terrestrial	1982	Family, Sci-Fi	G1,G2
Gravity	2013	Drama, Sci-Fi, Thriller	C1-C4
Inception	2010	Action, Adventure, Sci-Fi	E1-E13
Jaws	1975	Adventure, Drama, Thriller	A
Memento	2000	Mystery, Thriller	L
North by Northwest	1959	Action, Adventure, Mystery	F1-F5
Harry Potter and the Deathly Hallows - Part 2	2011	Adventure, Drama, Fantasy	D
The Bourne Ultimatum	2007	Action, Mystery, Thriller	I1-I5
The Sixth Sense	1999	Drama, Mystery, Thriller	H1-H7
Vertigo	1958	Mystery, Romance, Thriller	J1-J10

[2]Movie genre classification taken from the Internet Movie Database (IMDb): http://www.imdb.com/

6.2.2 Participants

10 participants took part in part one of the study, 4 males and 6 females, aged between 27 and 57 (mean age: 32.5). Participants had not taken part in previous studies, and were recruited through an advertisement sent via email to postgraduates students within the University and also shared via social media. Each session lasted around 40-50 minutes. All 10 participants completed the session in full.

6.2.3 Task

At the beginning of the session each participant was briefed about the study, given an information sheet to read and a consent form to sign. The task had participants watching and rating 60 clips in a randomised order. After watching each clip participants expressed their rating on a pen-and-paper modified version of SAM (also used in user studies 1 and 2). This task did not involve haptic sensations and therefore did not require participants to wear the glove prototype designed.

At the end of the task each participant was requested to fill in a post-task questionnaire which gathered some demographic data on the participant, as well as other information relevant to the study (i.e. whether they had already heard or seen certain films). This questionnaire was presented to participants after the task in order to not reveal information about the films from which the movie clips they were going to see were selected. Participants' responses to the questionnaire are included in Appendix K and are also viewable at the following web address[3].

6.2.4 Results

Plots of the valence-arousal ratings relative to the SAM for each of the 60 clips were generated. The 16 clips that scored most agreement among participants

[3]https://goo.gl/forms/ePPH97wWx0fQ6Kaq2

were selected for the second part of the study. Statistical tests of levels of agreement were not performed, instead clips were selected only when more than half of the individuals agreed in the scoring as in Williams et al. (2016). We establish the participants' agreement by identifying those clips where the plotted points mostly concentrated in one out of the four quadrants of the valence-arousal 2-dimensional space. Figures 6.1 to 6.16 show the plots of the 16 final movie clips selected for the film corpus for the second part of this final study. Plotted data for the remaining 44 clips is available in Appendix J. Table 6.2 describes the final 16 movie clips in the collection.

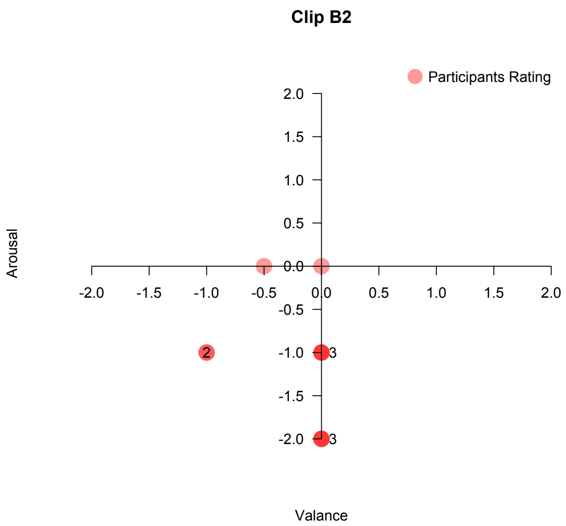


Figure 6.1: Participants ratings for clip B2

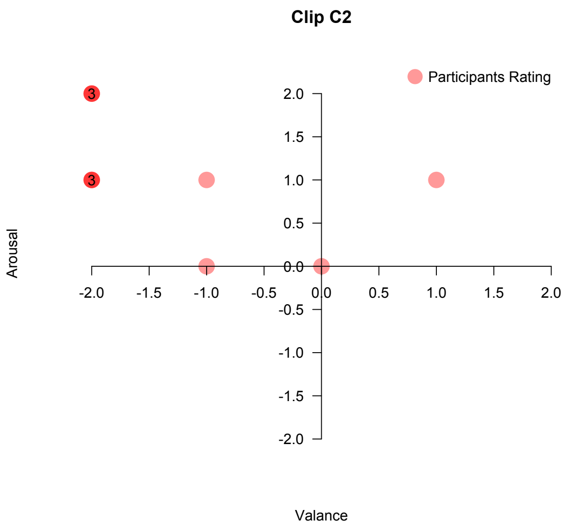


Figure 6.2: Participants ratings for clip C2

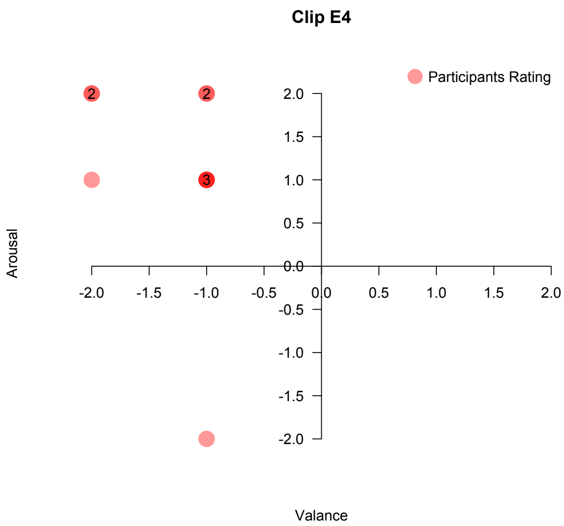


Figure 6.3: Participants ratings for clip E4

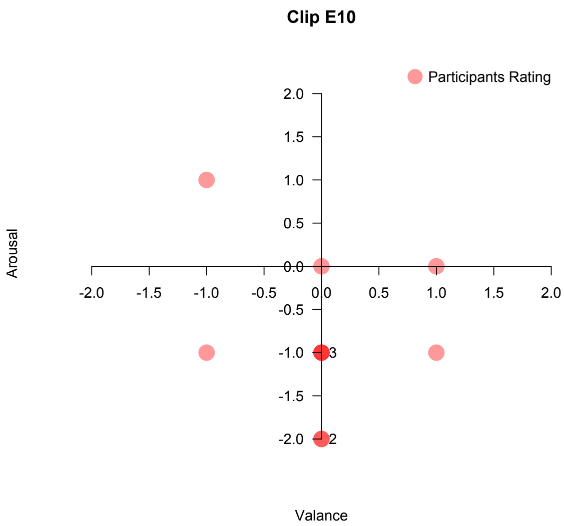


Figure 6.4: Participants ratings for clip E4

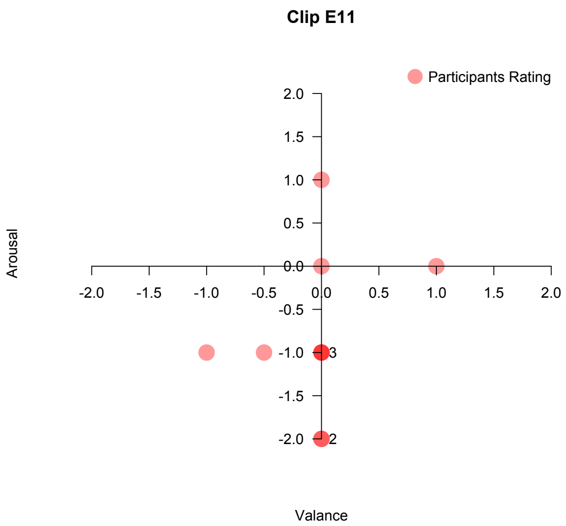


Figure 6.5: Participants ratings for clip E11

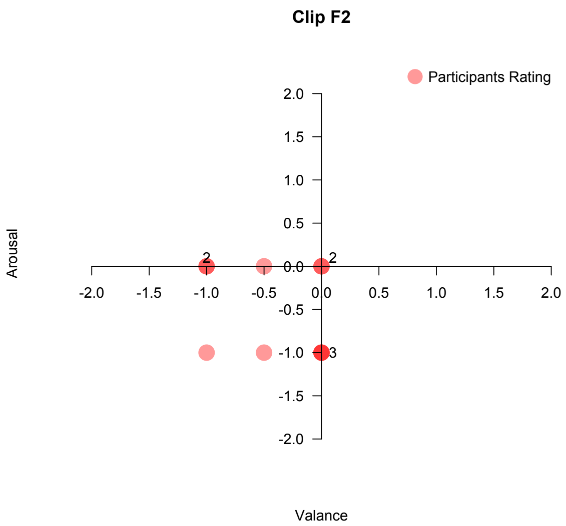


Figure 6.6: Participants ratings for clip F2

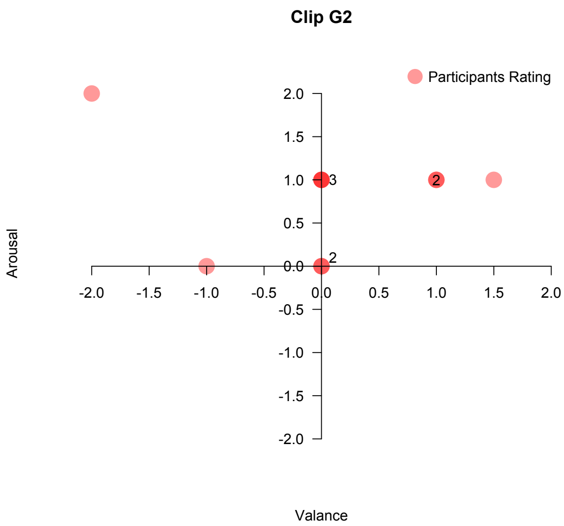


Figure 6.7: Participants ratings for clip G2

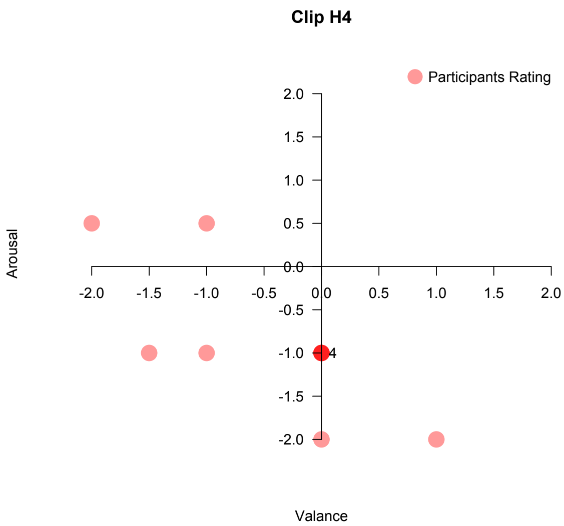


Figure 6.8: Participants ratings for clip G2

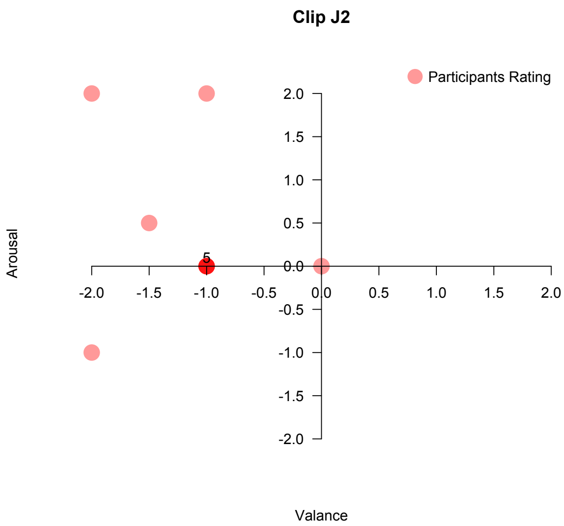


Figure 6.9: Participants ratings for clip J2

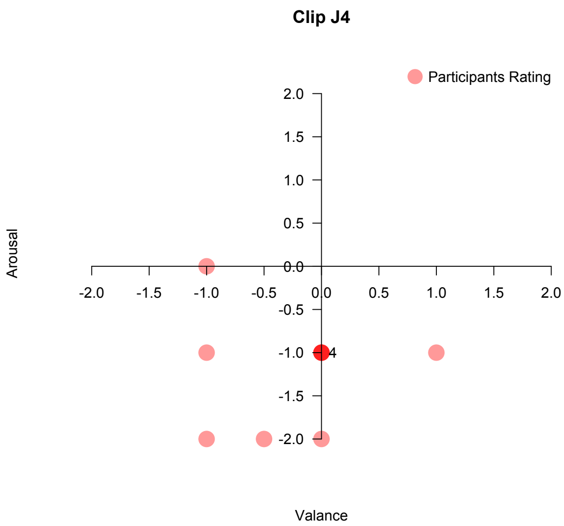


Figure 6.10: Participants ratings for clip J4

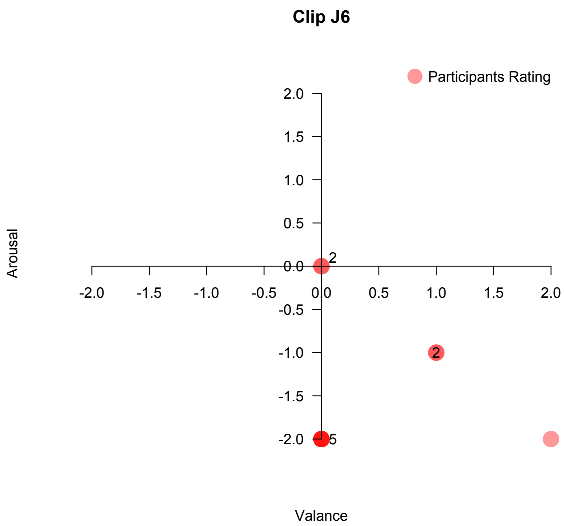


Figure 6.11: Participants ratings for clip J6

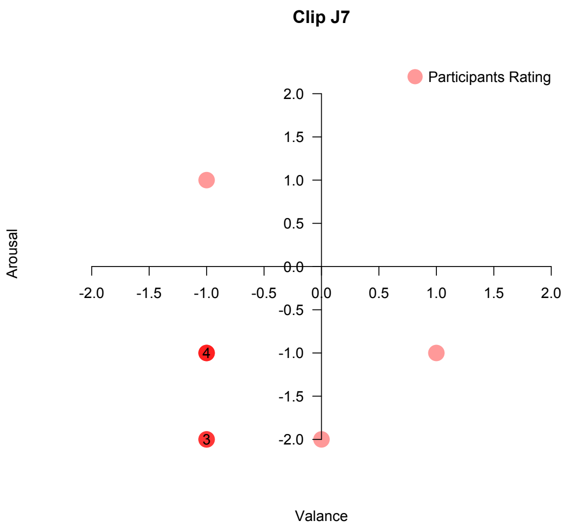


Figure 6.12: Participants ratings for clip J7

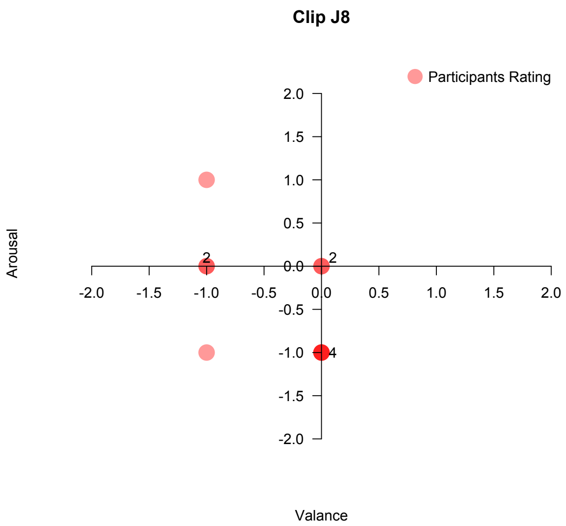


Figure 6.13: Participants ratings for clip J8

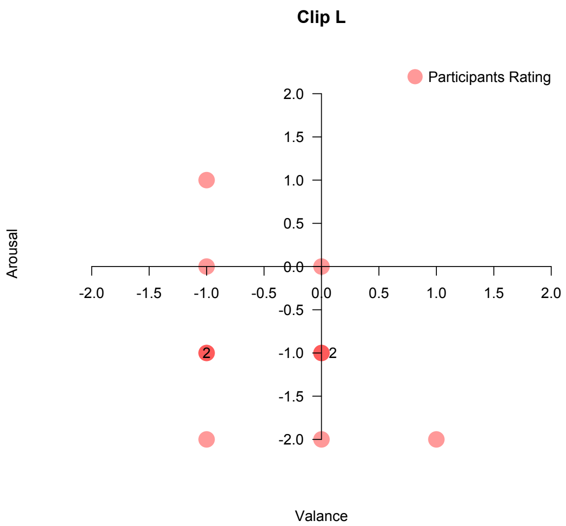


Figure 6.14: Participants ratings for clip L

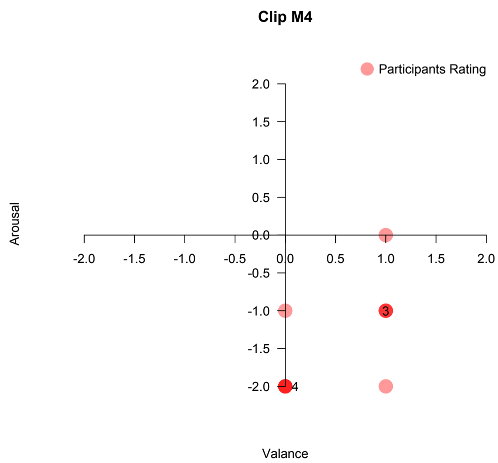


Figure 6.15: Participants ratings for clip M4

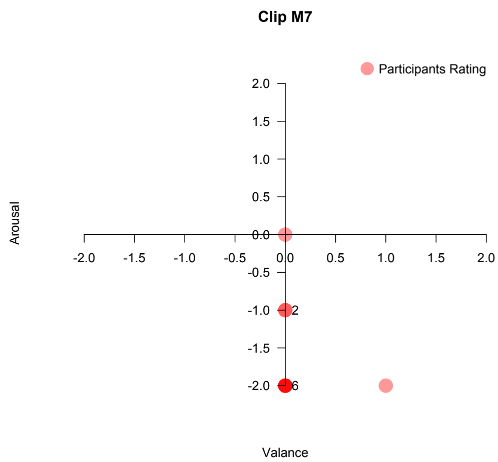


Figure 6.16: Participants ratings for clip M7

Table 6.2: Movie clips description, with SAM Valence (V) and Arousal (A) average ratings from volunteers who took part in the pilot

Clip code	**Duration** (in seconds)	**Movie**	**Scene description**	SAM ratings
B2	25s	Deep Red	A man stands in a deserted area. He shakes his head and puts his hand to his brow before pulling it away. He puts his hand to his mouth and says, "No, it's impossible".	V= -0.25 A= -1.1
C2	28s	Gravity	Two astronauts float in space while docked to their spacecraft. They loose radio connection to the earth space centre. An explosion hits a third astronaut in the distance. The spacecraft begins to break apart and starts to rotate. One astronaut floats away. The other, unable to detach herself, gets flung around as the spacecraft spins faster.	V= -1.3 A= 1.1
E4	55s	Inception	A man leaps onto a table and shoots another man. The man is dead but wakes up in a different dimension and starts pulling a wire out of a suitcase. Back in the other dimension the shooter keeps shooting at others in the building as the walls and ceiling start to crumble. A woman hands a man an envelope, he opens it and finds a blank paper. The shooter hides, opens an envelope and finds documents marked 'confidential'.	V= -1.3 A= 1.1
E10	37s	Inception	Three men are in a bustling street and enter a building. One of the men sits opposite a chemist and tries to persuade him to join them and concoct powerful chemical compounds.	V= 0 A= -0.8

Continuation of Table 6.2				
Clip code	**Duration** (in seconds)	**Movie**	**Scene description**	SAM ratings
E11	17s	Inception	A woman sands down a chess piece. She then places it on the table and deliberately knocks it over. She hears a noise, stands and walks through the room.	V= -0.05 A= -0.8
F2	27s	North by Northwest	A man and a woman are in the woods at night. They see torches approaching and run. They reach the top of Mount Rushmore and begin to climb down.	V= -0.4 A= -0.5
G2	38s	E.T. The Extra-Terrestrial	Teenaged boys on bicycles (one with an alien in the front basket) are being chased through a construction site by police cars. Members of the public begin to chase the boys down a road. Police cars start to form a blockade in the distance. The boy carrying the alien closes his eyes while still pedalling.	V= 0.05 A= 0.8
H4	20s	The Sixth Sense	Someone walks down a dark corridor towards a kitchen (POV shot). It is a young boy who appears in the kitchen doorway.	V= -0.45 A= -0.9
J2	32s	Vertigo	A man jumps onto the side of a roof and clambers up to the top. A policeman follows. A third man attempts the same, but slips and is left clinging to the gutter, dangling in the air. The policeman looks back and turns around. The dangling man looks down at the steep drop below and starts having vertigo.	V= -1.15 A= 0.35
J4	44s	Vertigo	A man walks into an art gallery. He spots a wo-	V= -0.25

Continuation of Table 6.2				
Clip code	**Duration** (in seconds)	**Movie**	**Scene description**	SAM ratings
			man in the distance who is sitting down, staring at a painting. The man walks behind her. He sees she has a bouquet lying next to her. His eyes are drawn to a similar bouquet in the painting.	A= -1.2
J6	29s	Vertigo	A black car is followed by a white car as it drives past a cliff side and some houses. The white car stops. The black car has also stopped, closer to the Golden Gate Bridge. A man gets out of the white car.	V= 0.4 A= -1.4
J7	40s	Vertigo	A woman stands underneath the Golden Gate Bridge. A man is watching her in the distance. As she walks he begins to follow. He watches her while she drops flowers from a bouquet into the river.	V=-0.7 A= -1.2
J8	21s	Vertigo	A woman looks up and starts to run. A man looks up and sees a church tower. He calls the woman's name and runs after her. She enters the church. The man follows, but when inside he loses sight of her.	V= -0.4 A= -0.4
L	30s	Memento	A truck drives through an industrial area and pulls up by an old shack. A man gets out and walks towards the shack *(black and white)*	V= -0.4 A= -0.9
M4	30s	Edward Scissorhands	It's evening. Neighbours are in the streets gossiping. Cars drive by. The neighbours disperse.	V= 0.5 A= -1.4
M7	29s	Edward Scissorhands	A woman is driving up a hill. She reaches a dark-looking house. She steps out of the car.	V= 0.1 A= -1.6
End of Table				

6.3 Part 2: Haptic sensations to enhance suspense in film

6.3.1 Haptic sensations

Previous user studies showed that in the scenarios proposed the direction in which the haptic stimuli were presented to participants did not affect their response to the stimuli, but it was the amplitude and frequency modulation of the haptics to determine users perceived affective sensations. However, in order to understand whether the effect previously observed would also apply to the scenario proposed in this final study, we designed two modes of haptic sensations: *circular* and *artistic*. The *circular* mode was similar to the one adopted in the work of Israr and Poupyrev (2010) and consisted of a circular motion effect presented in anticlockwise direction. Under the *artistic* mode instead, the haptic patterns were designed for each movie clip just as a movie composer would compose the score for the scene. The reason for presenting participants with the two modes was to verify whether one mode would result in a stronger perceived arousal compared to the other, in order to have a better understanding of the possibilities when designing haptic sensations to integrate media content. In particular, we assessed whether designing haptic sensation could be considered an artistic process, and therefore, possibly propose a new role, the *haptic composer*, who would compose haptic sensations for a film, just as music composers score a film, and special effects artists design a film's illusions and effects.

Both *circular* and *artistic* haptic designs maintained frequency and intensity (or amplitude) parameters as defined in the first and second user study presented in chapters 4 and 5. Frequency and amplitude moudulation were achieved through manipulation of PWM values as in the previous two studies. Three modulation effects were also introduced: *build up*, *fade in* and *fade out*. The *build up* effect performed linear modulation of both amplitude and frequency of the haptic stimuli from the start level to the final level of the haptic pattern. The *fade in* effect linearly raised the amplitude of the haptic stimuli, whereas the *fade out* effect linearly decayed it.

The perceived motion sensation across the skin was created by controlling the time two adjacent motors were active between two successive haptic stimulations, in such a way to induce the illusion of fine motion as in Israr and Poupyrev (2010). This perceived motion combined with the *build up*, *fade in* and *fade out* effects, which controlled amplitude and frequency modulation, formed the base for creating the haptic patterns in both *circular* and *artistic* modes.

6.3.2 Task

At the start of the session each participant was greeted and briefed about the study and made aware that the session would be recorded. Participants were also provided with an information sheet containing details about the study and a consent form to sign. The task involved participants watching 16 movie clips (selected during part 1 of this final experiment and described in table 6.2) while wearing the Mood Glove and experiencing haptic sensations, and rate their perceived valence and arousal after watching each clip on the pen-and-paper version of the modified SAM.

There were two versions for each movie clip, one under a *circular* haptic design, the other under the *artistic* design. Each participant was randomly presented with 16 trials (covering all 16 different movie clips), half with a *circular* haptic design and half with the *artistic* haptic design. This experiment had therefore a mixed factorial design, where the movie clip represented the independent variable, the circular and artistic modes corresponded to the control variables and arousal was the dependent variable that this experiment intended to measure.

The task lasted approximately 15 minutes, followed by completion of a post-task questionnaire and a short interview.

6.3.3 Participants

33 participants took part in the second part of this final study, 23 males and 10 females, aged between 24 and 48 (mean age: 32.7). Participants were recruited through an advertisement sent via open email invitation, flyers and also publicly shared via social media channels. Participants' movie watching habits gathered through a post-task questionnaire are included in Appendix L. All participants completed the session in full, however responses from three participants were discarded as in one case one participant had accidentally skipped through some clips and asked to repeat part of the session; in another, the participant revealed they had already taken part in a previous study by this work and therefore they were already aware of how the interface worked, but they were interested in experiencing the glove again. In the last case, the participant reported during the interview following the experiment that the hand on which the glove was worn had suffered a trauma that led to a loss of sensibility and therefore they did not perceive the haptic sensations quite so much.

6.3.4 Results

For consistency, participants rated the movie clips on the modified version of the SAM used throughout the studies, which measures both valence and arousal. As findings from Oliver and Bartsch (2010) show, arousal represents the strongest predictor for suspense. Thus, we performed statistical analysis for this study on participants' arousal response.

SAM analysis

Tables 6.3, 6.4, and 6.5 report results from non-parametric ordinal data using the Mann-Whitney test with a level of significance of $p<0.05$. Tests for significant difference have been performed across the following conditions: M vs MHC; M vs MHA; and MHC vs MHA, where:

- M = movie clip
- MHC = movie + haptic sensations in circular mode
- MHA = movie + haptic sensations in artistic mode

Tables 6.3 and 6.4 show that the addition of haptic sensations to movie clips (M), whether in the haptic circular mode (MHC) or the haptic artistic mode (MHA) generated a significantly different level of arousal for clips F2, H4, M4, and M7. By contrast, the use of the haptic circular mode (MHC) against the haptic artistic mode (MHA) resulted in a difference only in one instance, for clip M7 (as results reported in table 6.5). As the same clips were significantly different under both MHC and MHA conditions when compared against M, this suggests that there might be a pattern for which the addition of haptic sensations does augment participants' arousal. This is worth investigating in further studies.

Table 6.3: Non-parametric ordinal data test results for the arousal ratings in M vs MHC (note: significant differences are highlighted in **bold**)

Film	**Clip**	**U**	**z**	**P**
Deep Red	B2	100.5	-1.39	0.0823
Gravity	C2	96	-1.14	0.1271
Inception	E4	72.5	0.11	0.4562
	E10	96.5	-1.16	0.123
	E11	96	-1.14	0.1271
North by Northwest	**F2**	**107.5**	**-1.78**	**0.0375**
E.T. The Extra-Terrestrial	G2	88.5	-0.72	0.2358
The Sixth Sense	**H4**	**107**	**-1.75**	**0.0401**
Vertigo	J2	103	-1.53	0.063
	J4	**114**	**-2.14**	**0.0162**
	J6	98	-1.25	0.1056
	J7	97	-1.19	0.117
	J8	80.5	-0.28	0.3897
Memento	L	90	-0.8	0.2119
Edward Scissorhands	**M4**	**119.5**	**-2.44**	**0.0073**
	M7	**135**	**-3.3**	**0.0005**

Table 6.4: Non-parametric ordinal data test results for the arousal ratings in M vs MHA (note: significant differences are highlighted in **bold**)

Film	**Clip**	**U**	**z**	**P**
Deep Red	B2	86	-0.58	0.281
Gravity	C2	72.5	0.11	0.4562
Inception	E4	88	-0.69	0.2451
	E10	70.5	0.22	0.4129
	E11	81	-0.31	0.3783
North by Northwest	**F2**	**122.5**	**-2.61**	**0.0045**
E.T. The Extra-Terrestrial	G2	91.5	-0.89	0.1867
The Sixth Sense	**H4**	**129**	**-2.97**	**0.0015**
Vertigo	J2	105	-1.64	0.0505
	J4	103	-1.53	0.063
	J6	86	-0.58	0.281
	J7	103	-1.53	0.063
	J8	97	-1.19	0.117
Memento	L	86	-0.58	0.281
Edward Scissorhands	**M4**	**133**	**-3.19**	**0.0007**
	M7	**110.5**	**-1.94**	**0.0262**

Table 6.5: Non-parametric ordinal data test results for the arousal ratings in MHC vs MHA (note: significant differences are highlighted in **bold**)

Film	**Clip**	**U**	**z**	**P**
Deep Red	B2	90	0.91	0.1814
Gravity	C2	78.5	1.39	0.0823
Inception	E4	139.5	-1.1	0.1357
	E10	80.5	1.31	0.0951
	E11	94	0.75	0.2266
North by Northwest	F2	118.5	-0.23	0.409
E.T. The Extra-Terrestrial	G2	115.5	-0.1	0.4602
The Sixth Sense	H4	137	-1	0.1587
Vertigo	J2	122	-0.37	0.3557
	J4	105	0.29	0.3859
	J6	94.5	0.73	0.2327
	J7	124	-0.46	0.3228
	J8	132.5	-0.81	0.209
Memento	L	106	0.25	0.4013
Edward Scissorhands	M4	112.5	0.02	0.492
	M7	**58.5**	**2.22**	**0.0132**

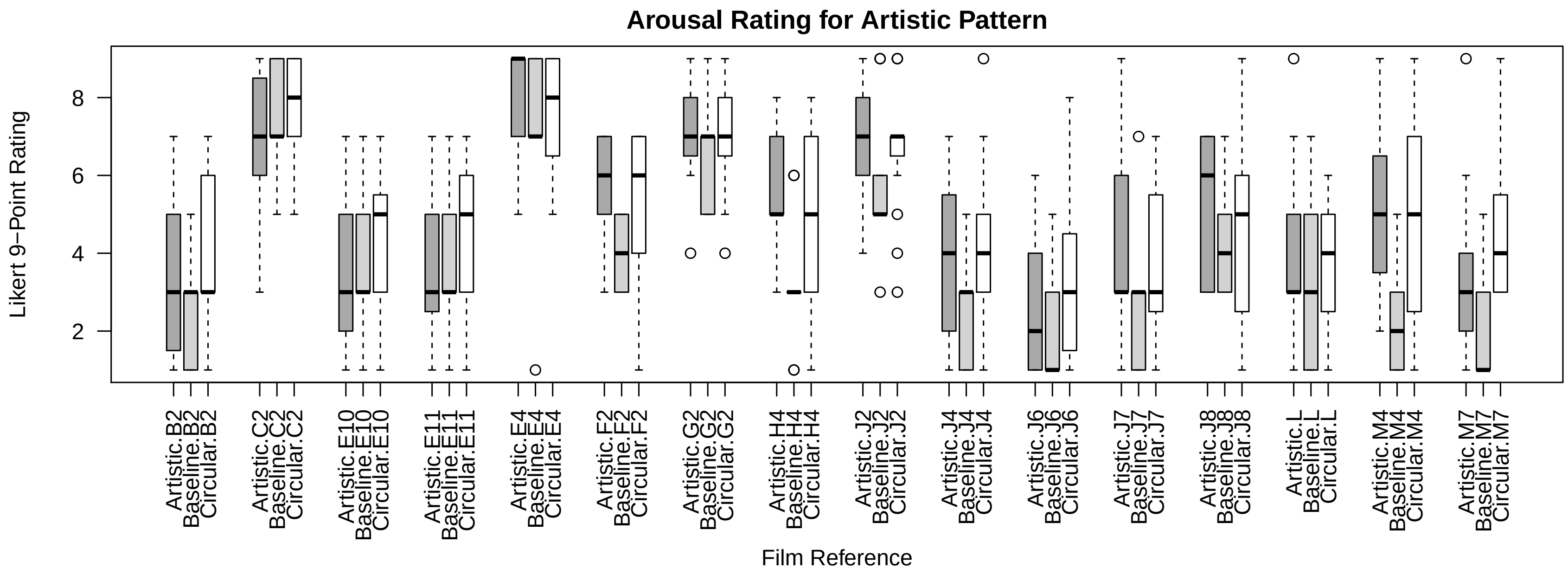


Figure 6.17: Box plot of the arousal ratings for each movie clip across all conditions

Findings from interviews: thematic analysis

Interviews with the 30 participants who took part in the user study were transcribed. Interviews were directed at gathering qualitative data about the user experience and volunteers were asked the set of questions described in section 3.3.4.

Interview transcripts are included in Appendix M. Inducted thematic analysis was performed at the latent approach following the method of Braun and Clarke (2006) as discussed in section 3.3.4. Data extracts with initial coding are available in Appendix N. The codes identify a feature of the data (at the latent level) that was judged of interest by the author conducting the analysis. A thematic map displaying the themes that emerged from the data was generated and it is included in Appendix O. The analysis was then refocused at a broader level, sorting different codes and collating all relevant coded data within identified themes as in Braun and Clarke (2006) to then obtain the main themes included in the report.

The final report is presented in table 6.6, which introduces and discusses the main themes that resulted from the analysis. A similar approach in the presentation of the analysis was also adopted by Wu et al. (2017).

Table 6.6: Thematic analysis of participants feedback from study 3

Theme (no of codes)	Discussion
1. Interest/ Curiosity (21)	Most participants expressed interest in the creative process ("here the cues are emotional, which is very interesting") and in trialling the experience for a full-length movie ("really curious about what would it be like to watch an entire movie with one of these"), and also for extending the sensation to other body locations ("I want a whole suit with those on, that'd be awesome"), and to other mediums ("I also could see it like listen to some music and have haptic feedback", "Video games, would be amazing!")
2. Enhancement/ Engagement (15)	Participants found the addition of haptic sensations enhanced their experience ("you get more into the movie", "it was immersive", "when it was more intense I was more involved in the scene", "when there was action or suspense it became part of the whole experience", "I felt that when combined with other senses it blended together", "when it started speeding up that has really added to the experience", "when it was vibrating it was bringing my attention to the movie more")
3. Sensory Augmentation/ Sense of presence (15)	Many participants reported that the haptic sensations increased their feelings of tension, suspense, excitement,and their sense of presence in the movie during action scenes ("on some clips it complemented a lot what I was seeing", "my feelings of excitement or tension were mirrored to a certain degree by what was going on on the hand","it was very effective 'cause I could feel the soundtrack and the vibrations mirroring", "it added an extra dimension to the level of tension you wanted", "it was kind of connecting to your body, it is like the action in the scene is touching your hand in a sense", "it's like being inside the movie", "I was more involved with the different sensations")
4. Distraction/ Confusion (14)	Some participants felt the haptic sensations became a distraction when they could not relate them to the scene or their expectations ("sometimes the focus went more to my hand than to the movie", "I felt there was a relationship between the content and the vibrations, to the point that when it wasn't I noticed it", "why is this vibrating?", "it felt like its interfering with my feelings, my mood"), or when the haptic sensations became obvious ("Sometimes I thought that it was trying to warn me that something bad was going to happen", "when [the scene] is quiet and it's vibrating, it's obvious it's vibrating") whereas other times participants felt distracted because the sensation was localized ("slightly distracting because only on one hand")
5. Novelty/ Originality (13)	Many participants were enthused by the novelty of the experience ("it was unique", "it was new") and the originality of the approach ("this other layer of expression", "it's interesting the choice of attaching it to the music rather than the scene", "it's like this other layer of composition", "like a fourth dimension sensation")
6. Pleasure/ Enjoyment (12)	Many participants expressed their enjoyment in experiencing the haptics ("it felt quite soothing", "surprisingly emotional")

6.4 Reflective summary

This chapter described the final user study of this work, aimed at enhancing suspense in film through haptic sensations. Findings indicated that in some instances haptic sensations were able to heighten users' perceived arousal towards the movie clips. As De Wied (1995) pointed out, suspense can build up through the anticipation of dramatic outcomes or good fortunes, thus can refer to both feelings of excitement or tension. This would allow the use of haptics to enhance those feelings of 'positive' or 'negative' suspense in a variety of film genres, not limiting it to the horror or thriller genres. De Wied (1995) also declared that a raised level of arousal intensifies the emotional response. Results from both self-reported measures and feedback gathered during interviews indicated that on some occasions participants' arousal was heightened when haptic sensations were integrated into the experience. These results indicate that haptic sensations might potentially enhance audiences' emotional experience and further work is necessary to further investigate the applicability of the findings.

A few thoughts arose from the datasets from the interviews' transcripts. Participants found the approach of the association between haptics and the mood music more interesting than direct mapping of automated extracted audio-visual content. Users felt the approach of this study formed part of an artistic process and this increased their interest in the experience.

Envisioning the design of haptic sensations as an *artistic process* rather than a *tool effect*, would possibly lead to introducing the role of the *'haptic composer'*. From the interview data it also emerged that the participants had an interest in extending the experience to other body locations. Some talked about wearing a second glove on the other hand similar to a 'stereo effect'. Others mentioned wearing the haptic device on their head. Others discussed the possibility of a whole body suit.

We are interested in the design of expressive haptic sensations more than the physical haptic display itself. However, we acknowledge that the choice of the device as well as the body area chosen for tactile stimulation, can affect the design of the haptic sensations and consequently, the resulting experience. It would then be interesting to conduct future work in exploring the design of multiple haptic prototypes stimulating different body areas, as well as experimenting with design possibilities for composing haptic sensations with each haptic prototype.

This study only involved short movie clips, further work should be conducted to observe the effects over a full-length movie. A recurring theme among participants was the interest in trialling the experience over an entire movie.

Chapter 7

Conclusions

7.1 Overview and major findings

This thesis presented the work done in an effort to advance ongoing studies of haptic effects for media enhancement. In particular, this work explored the question of how haptic sensations could be designed to become an integrating part of the film experience and approached the research question by proposing the use of haptic sensations to complement moods in film music. No previous work has attempted enhancing the emotional experience of film audiences through haptic sensations designed to augment moods in the film score. Our findings indicate the potential of augmenting viewers' perceived feelings by taking a new approach to the design of haptic sensations, and this is our original contribution to knowledge.

Three user studies were presented together with the iterative design of a haptic wearable prototype, *Mood Glove*, as the proposed interface to deliver haptic sensations to the users during the studies. Findings indicated that in some instances haptic sensations paired together with movie clips were able to heighten participants' perceived sense of arousal during the experience. Haptic sensations at low intensity and low frequency suggested in participants affective states characterised by low arousal (such as a calm feeling), whereas haptic stimuli at higher intensities and frequency better conveyed moods of excitement and tension. During the last user study it emerged that introducing haptic sensation design effects, named after their semantic meaning, *fade in*, *fade out*, and *build up*, facilitated the subtleness of the approach. Blending the haptic sensations with the film score and the motion picture augmented in some occasions the build up of expectations, excitement and tension in participants during suspense movie clips.

7.2 Comparison of studies

This work included three user studies directed at exploring whether the addition of haptic sensations in film entertainment could enhance audiences' affective cinematic experience.
The first user study described in chapter 4, was aimed at exploring preliminary affective responses of users to haptic sensations, with the aim of employing haptics to augment moods in music. This is in contrast to the previous literature examined in chapter 2 on music and haptics, which focussed on direct mapping and presenting musical features as haptic feedback (as works in Matthews (2006), Nanayakkara et al. (2009), Karam et al. (2009)). Findings from the first experiment indicated that haptic sensations at low intensities and frequencies were able to suggest moods equal to low valence and low arousal, whereas haptic sensations with high intensities and frequencies suggested to participants moods with high valence and arousal.

The second user study, discussed in chapter 5, evaluated the effects of haptics on participants' perceived moods when watching movie clips. A corpus of affective movie clips was developed and haptic sensations were paired to the selected clips in order to evaluate participants' affective reaction to the combination of media proposed. The corpus of movie clips developed was a collection of film excerpts with little or no dialogue where the film score was the prevailing element. The movie clips corpus was different from the ones assembled in the works examined in chapter 5 section 5.2, such as research by Carvalho et al. (2012), which comprised non-auditory film clips, and Schaefer et al. (2010), whose film excerpts were in the French language and contained no film score. Moreover, the affect classification of the movie clips corpus we developed was through manual annotation of self-perceived valence and arousal levels and in contrast with previous research in Salway and Graham (2003), Chan and Jones (2005), Hanjalic and Xu (2005), Xu et al. (2005), and Hanjalic (2006) that employed automated extraction of affect through the monitor of audiovisual signals.

Also, this second user study paired clips from the corpus developed together with haptic sensations designed to suggest moods, in contrast to previous work in Lemmens et al. (2009) and Dijk et al. (2009), reviewed in section 2.3, in which the haptic sensations were associated with the action and physical events in the movie scenes and relied on semantic meaning.

In the second user study, participants experienced a mixture of movie clips with and without sound, accompanied or not by haptic sensations. Results from this second user study indicated that the addition of haptic sensations to the movie clips did not influence participants' perceived valence but it did in some instances enhance their sense of arousal. Also a recurring feedback left by participants during interviews, was that haptic sensations facilitated the build up of tension and expectation *(suspense)* towards the clips.

The haptic sensations designed in the second study built on findings from the first study, which had revealed that moods could be suggested through the manipulation of intensity and frequency of the haptic stimuli.

Although we expected to find a more consistent response of heightened arousal across all clip variations whenever haptic sensations were present, results showed that perceived arousal was significantly heightened in various silent movie clips, compared to movie clips with sound. This suggests that haptic sensations have the potential of enriching the emotional experience of hearing-impaired audiences, although further research is needed to test this hypothesis and should involve hearing-impaired participants.

An interesting finding was that many participants reported experiencing a more intense build up of sensations for those movie clips where the haptic sensations were more active. They described feeling an increased sense of excitement or tension when the haptic sensations were more intense and more frequent. This build up of feeling of excitement or tension, is what is referred to as *suspense*.

The third and final user study reported in this thesis in chapter 6, was informed by findings from the second study and proposed the use of haptic sensations to intensify *suspense* in film. A new corpus of movie clips was acquired and haptic sensations were designed in two modes, *circular* (as previous work in Israr and Poupyrev (2010)) and *artistic*, together with *fade in*, *fade out*, and *build up* effects to facilitate the subtleness of the approach, intensify the build up of expectations and tension in participants and complement the role of the film score. Results indicated a significant difference for some of the clips across both haptic *circular* and *artistic* design. Moreover, from thematic analysis performed on participants' feedback gathered during a post-task interview, it emerged that participants felt the haptic sensations augmented their feelings of tension and excitement, increasing their sense of presence and therefore resulted in an enhanced experience.

An unexpected finding, which arose from the thematic analysis, was that some participants felt the haptic sensations also had a connection to the images, not just the score of the film. Since the score composed for a film usually matches the picture and the haptic sensations designed matched the mood in the score, this impression could be described as a 'carry-over' effect. Participants also reported that they started noticing the haptic sensations when they could not relate them to either the image or the score, which indicates that if the addition of the media does not fuse together with the rest of the elements, it could potentially constitute a distraction.

We expected to find statistical difference between participants' perceived arousal under the two modes of haptic design, *circular* and *artistic*, hypothesising the effect to be more intense for the *artistic* design. However, tests showed a significant difference between the two haptic designs in only one instance. During interviews most participants expressed their preference towards the *artistic* design, justifying that an *artistic* approach would be more interesting with respect to a recurring pattern, as it would add *"another layer of composition"* and augment engagement and a sense of presence through multi-sensory elements. The differences in responses between the data from self-reported measures and participants' feedback during interviews could be related to the novelty of the experience and also to participants bias. Another factor that might have affected participants' ratings about the experience could be fact that the haptic sensations were designed by the author of this work, who does not identify herself as an expert in designing haptic sensations nor as a music composer. Perhaps, the design of haptic sensations for a film would have to be composed by a professional *haptic artist*, just as the music for a film is scored by a movie composer.

Overall, the results obtained in the studies presented by this work suggest that haptic sensations have the potential of enhancing audiences' cinematic experience, therefore this is worth investigating with further studies.
Preliminary results in the first study indicated that haptic sensations were able to suggest basic moods. Therefore frequency and intensity ranges of the haptic stimuli in the first study were kept consistent for the second and third user studies. Although the design of the haptic sensations iteratively changed, the intensity and frequency values range, achieved through manipulation of PWM vaules, were kept consistent. In the second and third studies haptic sensations were paired with movie clips and the addition of haptic sensations intensified participants' arousal during the experience. The corpus of affective movie clips developed in the second study was not maintained for the third study, but a new corpus of movie clips was assembled, as the clips required elements that built feelings of excitement or tension, *suspense*. However, the same manual labelling

approach was maintained when developing the corpus, where participants in both study one and two self-annotated perceived levels of valence and arousal for each movie clip they watched.

7.3 Design suggestions for media enhancement through haptic sensations

> *"What the audience want is to take part in exciting events as fully as possible"* (Arnheim, 1957, p.226).

How could haptic sensations become an integrating part of film entertainment or another type of media?

Arnheim (1957) discussed the conditions for the combinations of artistic media, asserting that *"it must serve to express something that could not be said by one of the media alone. [..] [The compounding of different media] will make sense only if the components do not simply convey the same thing. They must complete each other in the sense of dealing differently with the same subject"*.

This work suggests that when creating experiences relying on mixing multiple senses, this artistic fusion needs to be inseparable. Each sensory element involved has to conform to the other for the experience to make sense. Otherwise, the risk is to create a multi-sensory experience that is surplus to requirements. For affective haptic sensations directed to enhance media, from a designer point of view, we propose the following design suggestions:

1. Control intensity and frequency of the haptic stimuli through manipulation of actuators' PWM values, within the ranges proposed in chapter 4 depending on the affect the sensations intend to suggest.
   Findings from study one of this work suggest that frequencies and intensities at which the stimuli are played can suggest different basic moods.

2. Apply a subtle approach. Create an association between the haptic sensations and the media content that goes beyond the direct mapping. Fuse

the addition of the tactile sensory stimulus to the other senses in such a way that makes them complement each other. Try conveying or augmenting specific affective states that could not be enhanced otherwise, almost creating another dimension in which the senses are liberally mixed and inseparably fused together.

As considered by Arnheim (1957) the compound of different media requires artistic reasons and the components will integrate and fuse together only if they complement each other. This principle is supported by findings in the final study, where participants reported feeling the haptic sensations in some clips complemented what they were watching and mirrored their feelings of excitement and tensions, as a 'fourth dimension sensation'. Most participants expressed interest in the creative process and the emotional association between the haptic sensations and the film with respect to direct mapping approaches. Some participants revealed they felt a connection between the film and the haptic sensations, to the point that when the connection was not there they started noticing the elements as separate. This supports the design suggestion of this second point, *apply a subtle approach*. When the different components stop completing each other their singularity becomes evident to the audience, with the risk of disrupting the experience.

3. Make use of *fade in* and *fade out* effects to smooth the sensations and facilitate their subtleness, as well as other effects that users could easily associate with semantic meaning.

   This builds from point 2. The use of haptic sensations as proposed in this work, should enhance the media without the audience noticing they are there. As film producer and screenwriter Selznick discussed, the purpose of the film score is "to unobtrusively help the mood of each scene without the audience being even aware that they are listening to music" (Cohen, 2009, p.109). Use effects within the haptic design that will smooth the sensations and blend them with the other media components, in a way that will make them seamless to the audience, who will not identify the tactile sensations as 'the haptic element' but instead perceive the experience as a whole.

Other methodological recommendations we can make based on the approaches trialled during the course of this work are:

- the SHORE™ is not suitable for analysing participants' emotional response in a movie-watching context;
- the SPES scale is not applicable for measuring participant's level of engagement in non-immersive experiences such as the one created in this work;
- the implementation of any wearable with embedded electronics has to take in consideration a number of factors, such as fabric properties and possible interferences with conductive thread, positioning of the electronics on different body parts in relation to the sensitivity threshold of each body area.

7.4 Limitations

A limitation of the methodological approach adopted in this work is the use of self-reported measures to assess users' responses to the media experience proposed. Different methods were considered for assessing participants' affective responses, as discussed in chapter 3. We decided not to use physiological data as it was considered too intrusive, adopting the SAM self-assessment measure instead. Even though the SAM proved an efficient method, data from bio-signals could have provided additional results to support the findings and aid further research in this direction.

Another limitation is represented by the novelty of the experience. Although haptics are integrated in various technological devices and in 4DX cinema theatres, and even though all participants reported that they had already experienced haptics, the novelty lay in the prototype designed for the study. Even though we focussed the design of affective haptic sensations and not as much on the haptic device itself, the choice of physical prototype would have an effect. Wearing the haptic glove, Mood Glove, while watching movie clips was a novel experience and the glove itself represented a limitation in exploring differences among different patterns, as well as restricting the design possibilities for the sensations due to the relatively small surface area for the haptic display.

Also, another limitation is represented by sampling bias. Despite our attempts in recruiting a wide spread of the population, participants would have to travel to the author's institution, where the experimental study took place. This had some impact on the range of participants who took part in the study. Also no monetary incentives were offered and monetary compensation could have possibly attracted a wider spread of the population to participate, and also could have justified requiring participants to perform the task for a longer period of time. However, large incentives also constitute bias. Another bias that probably represented a limitation is participant bias as during studies volunteers might have consciously or subconsciously acted in the way they believed the researcher wanted them to act. Participants bias might have affected not only data from the self-reporting scales, but also the thematic analysis based on data from participants' interviews in the final user study.

Some of the participants were not used to study procedures as they had never taken part in a research study before and found the evaluation part of the task (through self-assessment measures) quite bothersome, which might also have an impact on the results.

The choice of the movies also constituted another limitation, as participants' personal preference with genres, as well as likes and dislikes, previous knowledge, preconceptions for certain movies might have affected their responses. Also the length of the movie clips, which participants found 'too short' in the final study, might have affected the results. The length of the studies, especially study 2 and the studies run to establish a corpus of movie clips for studies 2 and 3, required participants to perform the task for an extended period of time, which might have led to fatigue and boredom.

Another limitation is represented by the experimental settings in which the study was carried out, rather than in more natural settings as in a field study. Another limitation is represented by the fact that the effect was studied over short movie clips and not observed over a full-length movie. Also, the equipment used was more similar to a home watching scenario rather than a movie experience in a cinema theatre. A final limitation is also the fact that the studies were carried out with one participant at the time, whereas *"going to the movies"* is a social experience, in the words of a journalist "is a personal and cultural through-line, an ever-shifting ritual" McNamara (2017).

7.5 Future work

In recent times there has been an increasing interest in finding new ways to make experiences more immersive, involving multi-sensory elements. The addition of haptic sensations to enhance media is growing, however work so far has associated haptic sensations with direct mapping or semantic meaning. The work described in this thesis expanded ongoing research efforts in the design of expressive haptic sensations for media enhancement.

Future work of this research would address the limitations reported above, as well as exploring the vision of haptics as an artistic medium.

To address the limitations encountered, we wish to conduct future studies in the field, in a cinema theatre with an audience, over the period of a full-length movie. This would also allow study of how the shared social experience contributes to the affective side of the haptic media within the proposed scenario. It would also be adequate to explore the findings of this research with hearing-impaired audiences too.

Although our interest lies in the design of expressive haptic sensations rather than the physicality of the haptic device itself, we would also like to trial a wider range of haptic displays, both wearable and non wearable, in order to expand design possibilities for the *haptic compositions*.

We refer to *haptic compositions* as we envision the role of haptics within entertainment as an artistic medium, not a gimmicky automated effect. This proposes a future vision that would lead to the creation of a new job role: the *haptic composer*, who would compose haptic sensations for a film just as a film composer would score its music.

7.6 Closing Remarks

> "The simplest and most correct definition of poetry, that it is the art of bringing into play the power of imagination through words." (Schopenhauer, 1966, p.425)

Perhaps cinema can now be viewed not merely as the art of the moving image, but the art of stimulating the power of the senses through an artistic compound of multiple media.

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Appendix A

Pre-task Questionnaire

About you

*Required

1. **1. Gender** *

   Tick all that apply.

   - [ ] Male
   - [ ] Female

2. **2. Age** *

   ....

3. **3. Occupation** *

   ....

4. **4. Do you enjoy watching movies?** *

   Tick all that apply.

   - [ ] Very much
   - [ ] Sometimes
   - [ ] No

5. **5. What genres of movies do you like? (You can select multiple genres)** *

   Tick all that apply.

   - [ ] Action and adventure
   - [ ] Animation
   - [ ] Comedy
   - [ ] Documentary
   - [ ] Drama
   - [ ] Horror
   - [ ] Romance
   - [ ] Science fiction and fantasy
   - [ ] Thriller
   - [ ] Western

6. **6. How often do you go to the cinema?** *

Mark only one oval.

- ( ) more than 1 a week
- ( ) at least 1 a week
- ( ) at least 1 every two weeks
- ( ) at least 1 a month
- ( ) less than 1 a month
- ( )

7. **7. How often do you watch movies at home?** *

Mark only one oval.

- ( ) more than 1 a week
- ( ) at least 1 a week
- ( ) at least 1 every two weeks
- ( ) at least once a month
- ( ) less than 1 a month

8. **8. Do you enjoy special effects in entertainment (e.g. 3D, vibrations,..)** *

Tick all that apply.

- [ ] Yes
- [ ] No

9. **9. Have you already seen or heard about the following movies?** *

Mark only one oval per row.

	Yes	No
Amélie (2001)	( )	( )
Edward Scissorhands (1990)	( )	( )
Memento (2000)	( )	( )

10. **If yes, when did you see them last?**

Mark only one oval per row.

	Recently (in the past 3 months)	In the past year	Over a year ago
Amélie	( )	( )	( )
Edward Scissorhands	( )	( )	( )
Memento	( )	( )	( )

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Appendix B

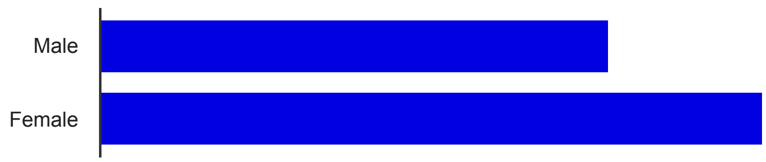
Pre-task Questionnaire Responses

23 responses

View all responses Publish analytics

Summary

1. Gender



Male	**10**	43.5%
Female	**13**	56.5%

2. Age

30

29

28

42

25

31

36

34

24

27

39

3. Occupation

PhD student

Student

student

PhD Student

Researcher

Worker

Cabin Crew

Phd student

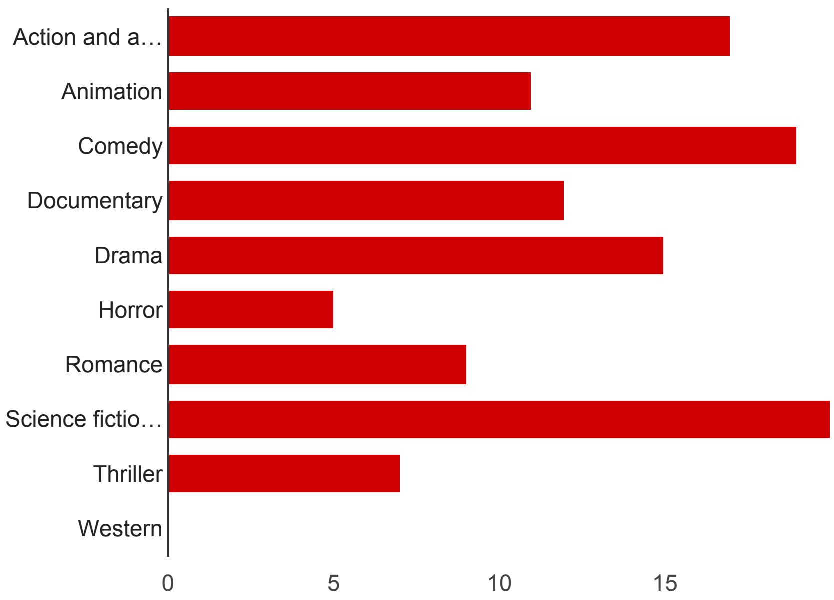
PDRA

database annotator

4. Do you enjoy watching movies?

Very much	**17**	73.9%
Sometimes	**6**	26.1%
No	**0**	0%

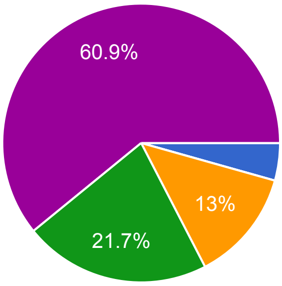
5. What genres of movies do you like? (You can select multiple genres)



Action and adventure	**17**	73.9%
Animation	**11**	47.8%
Comedy	**19**	82.6%

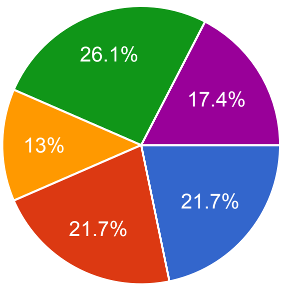
Documentary	**12**	52.2%
Drama	**15**	65.2%
Horror	**5**	21.7%
Romance	**9**	39.1%
Science fiction and fantasy	**20**	87%
Thriller	**7**	30.4%
Western	**0**	0%

6. How often do you go to the cinema?



more than 1 a week	**1**	4.3%
at least 1 a week	**0**	0%
at least 1 every two weeks	**3**	13%
at least 1 a month	**5**	21.7%
less than 1 a month	**14**	60.9%
	0	0%

7. How often do you watch movies at home?



more than 1 a week	**5**	21.7%
at least 1 a week	**5**	21.7%
at least 1 every two weeks	**3**	13%
at least once a month	**6**	26.1%
less than 1 a month	**4**	17.4%

8. Do you enjoy special effects in entertainment (e.g. 3D, vibrations,..)

Yes	**17**	73.9%
No	**6**	26.1%

Amélie (2001) [9. Have you already seen or heard about the following movies?]

Yes	**16**	69.6%
No	**7**	30.4%

Edward Scissorhands (1990) [9. Have you already seen or heard about the following movies?]

Yes	**18**	78.3%
No	**5**	21.7%

Memento (2000) [9. Have you already seen or heard about the following movies?]

Yes	**13**	56.5%
No	**10**	43.5%

Amélie [If yes, when did you see them last?]

Recently (in the past 3 months)	**1**	6.3%
In the past year	**0**	0%
Over a year ago	**15**	93.8%

Edward Scissorhands [If yes, when did you see them last?]

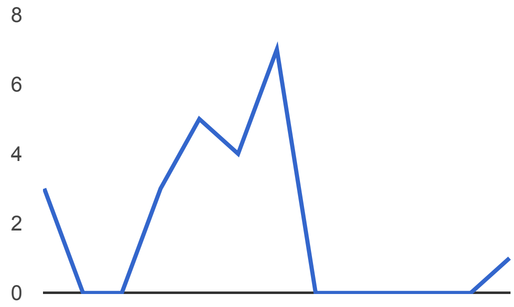
Recently (in the past 3 months)	**0**	0%
In the past year	**2**	10%
Over a year ago	**18**	90%

Memento [If yes, when did you see them last?]

Recently (in the past 3 months)	**0**	0%
In the past year	**2**	14.3%

Over a year ago	**12**	85.7%

Number of daily responses



Appendix C

Post-task Questionnaire

Post-test Questionnaire

*Required

1. **SL5. I experienced the environment in the presentation as though I had stepped into a different place** *
   Mark only one oval.

	1	2	3	4	5	
I do not agree at all	◯	◯	◯	◯	◯	I totally agree

2. **SL9. I experienced both the confined and open spaces in the presentation as though I was really there** *
   Mark only one oval.

	1	2	3	4	5	
I do not agree at all	◯	◯	◯	◯	◯	I totally agree

3. **SL10. I was convinced that the objects in the presentation were located on the various sides of my body** *
   Mark only one oval.

	1	2	3	4	5	
I do not agree at all	◯	◯	◯	◯	◯	I totally agree

4. **SL7. I had the feeling that I was in the middle of the action rather than merely observing** *
   Mark only one oval.

	1	2	3	4	5	
I do not agree at all	◯	◯	◯	◯	◯	I totally agree

5. **SL4. I felt as though I was physically present in the environment of the presentation** *
   Mark only one oval.

	1	2	3	4	5	
I do not agree at all	◯	◯	◯	◯	◯	I totally agree

6. **SL6. I was convinced that things were actually happening around me** *
Mark only one oval.

	1	2	3	4	5	
I do not agree at all	◯	◯	◯	◯	◯	I totally agree

7. **SL3. It was as though my true location had shifted into the environment in the presentation** *
Mark only one oval.

	1	2	3	4	5	
I do not agree at all	◯	◯	◯	◯	◯	I totally agree

8. **SL2. It seemed as though I actually took part in the action of the presentation** *
Mark only one oval.

	1	2	3	4	5	
I do not agree at all	◯	◯	◯	◯	◯	I totally agree

9. **SL8. I felt like the objects in the presentation surrounded me** *
Mark only one oval.

	1	2	3	4	5	
I do not agree at all	◯	◯	◯	◯	◯	I totally agree

10. **SL1. I felt like I was actually there in the environment of the presentation** *
Mark only one oval.

	1	2	3	4	5	
I do not agree at all	◯	◯	◯	◯	◯	I totally agree

Appendix D

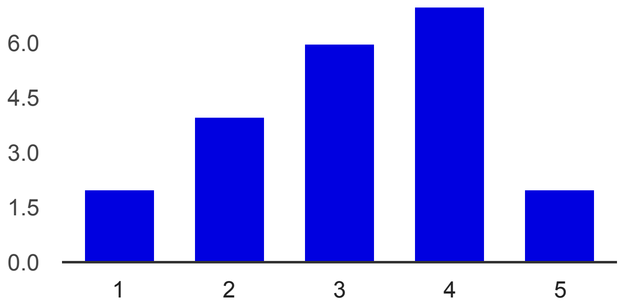
Post-task Questionnaire Responses

21 responses

View all responses

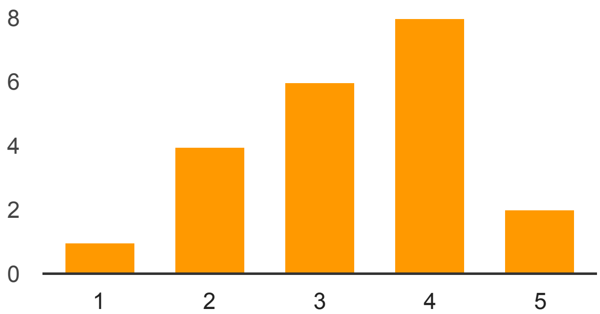
Summary

SL1. I felt like I was actually there in the environment of the presentation



I do not agree at all: 1	**2**	9.5%
2	**4**	19%
3	**6**	28.6%
4	**7**	33.3%
I totally agree: 5	**2**	9.5%

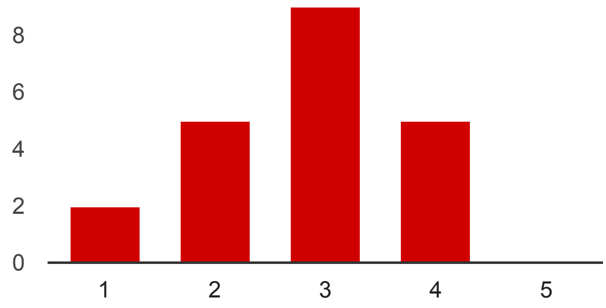
SL2. It seemed as though I actually took part in the action of the presentation



I do not agree at all: 1	**1**	4.8%
2	**4**	19%

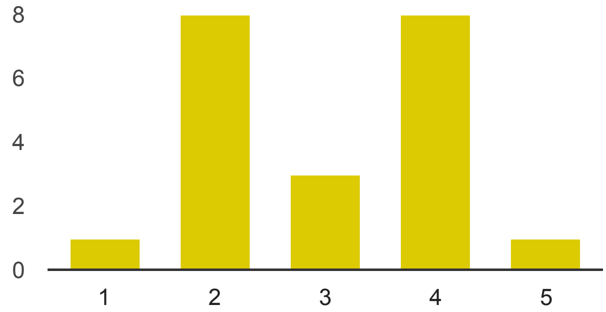
3	**6**	28.6%
4	**8**	38.1%
I totally agree: 5	**2**	9.5%

SL3. It was as though my true location had shifted into the environment in the presentation



I do not agree at all: 1	**2**	9.5%
2	**5**	23.8%
3	**9**	42.9%
4	**5**	23.8%
I totally agree: 5	**0**	0%

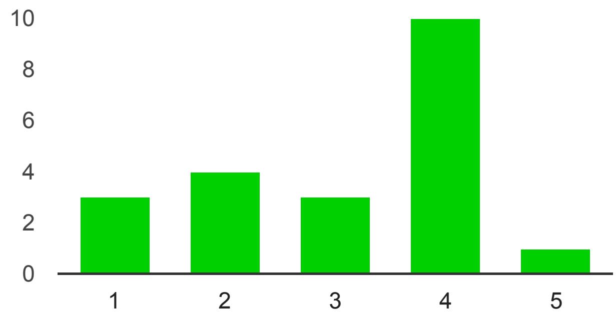
SL4. I felt as though I was physically present in the environment of the presentation



I do not agree at all: 1	**1**	4.8%
2	**8**	38.1%
3	**3**	14.3%
4	**8**	38.1%

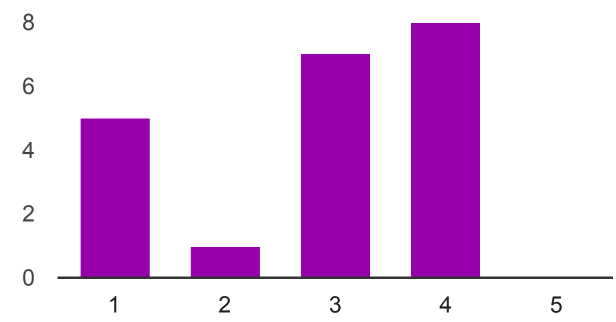
I totally agree: 5	**1**	4.8%

SL5. I experienced the environment in the presentation as though I had stepped into a different place



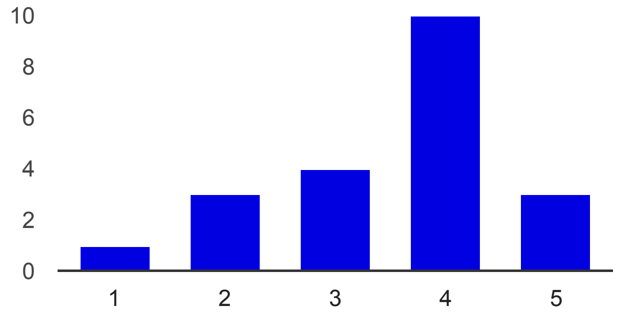
I do not agree at all: 1	**3**	14.3%
2	**4**	19%
3	**3**	14.3%
4	**10**	47.6%
I totally agree: 5	**1**	4.8%

SL6. I was convinced that things were actually happening around me



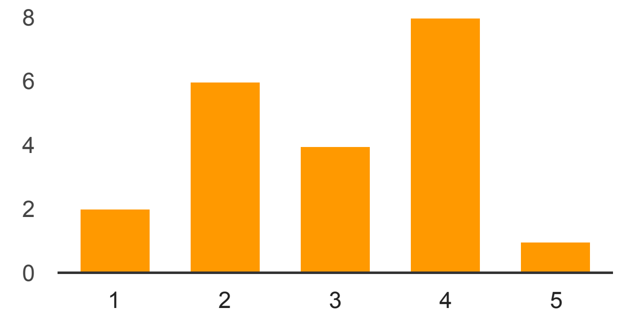
I do not agree at all: 1	**5**	23.8%
2	**1**	4.8%
3	**7**	33.3%
4	**8**	38.1%
I totally agree: 5	**0**	0%

SL7. I had the feeling that I was in the middle of the action rather than merely observing



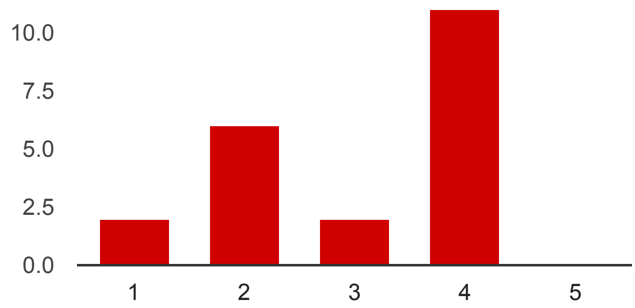
I do not agree at all: 1	**1**	4.8%
2	**3**	14.3%
3	**4**	19%
4	**10**	47.6%
I totally agree: 5	**3**	14.3%

SL8. I felt like the objects in the presentation surrounded me



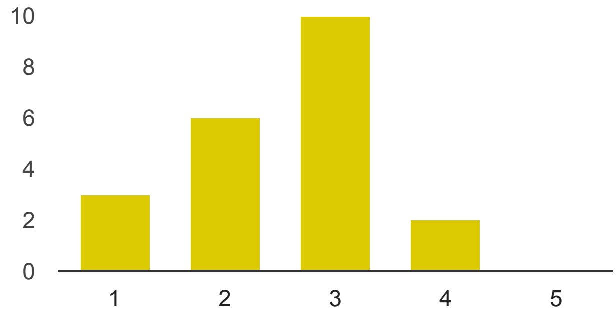
I do not agree at all: 1	**2**	9.5%
2	**6**	28.6%
3	**4**	19%
4	**8**	38.1%
I totally agree: 5	**1**	4.8%

SL9. I experienced both the confined and open spaces in the presentation as though I was really there



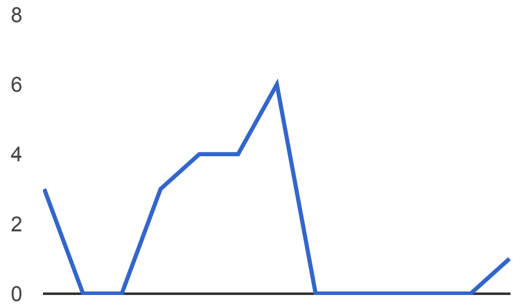
I do not agree at all: 1	**2**	9.5%
2	**6**	28.6%
3	**2**	9.5%
4	**11**	52.4%
I totally agree: 5	**0**	0%

SL10. I was convinced that the objects in the presentation were located on the various sides of my body



I do not agree at all: 1	**3**	14.3%
2	**6**	28.6%
3	**10**	47.6%
4	**2**	9.5%
I totally agree: 5	**0**	0%

Number of daily responses


8
6
4
2
0

Appendix E

Participants linear likert scale sample

Participant...

Training

V	A
Very Happy	Very Active
Happy	Active
Neutral	Neutral
Sad	Calm
Very Sad	Sleepy

Training With Haptic Feedback

V	A
Very Happy	Very Active
Happy	Active
Neutral	Neutral
Sad	Calm
Very Sad	Sleepy

1

V	A
Very Happy	Very Active
Happy	Active
Neutral	Neutral
Sad	Calm
Very Sad	Sleepy

2

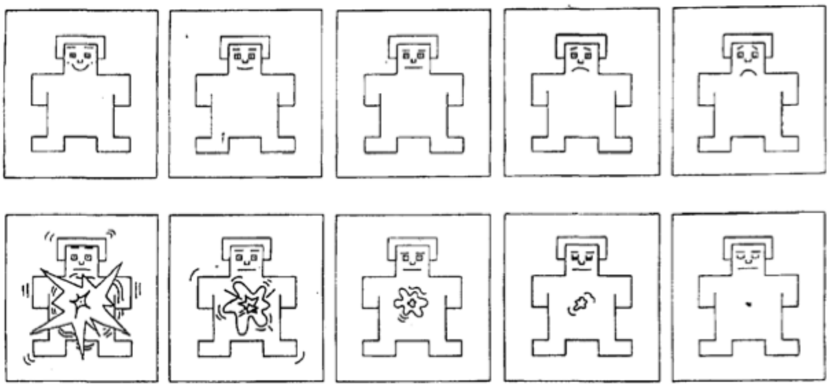
V	A
Very Happy	Very Active
Happy	Active
Neutral	Neutral
Sad	Calm
Very Sad	Sleepy

Appendix F

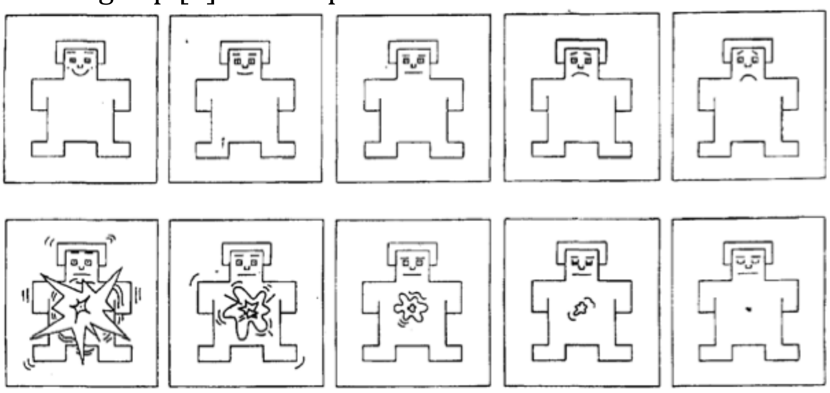
SAM questionnaire sample

PARICIPANT: …………………………..

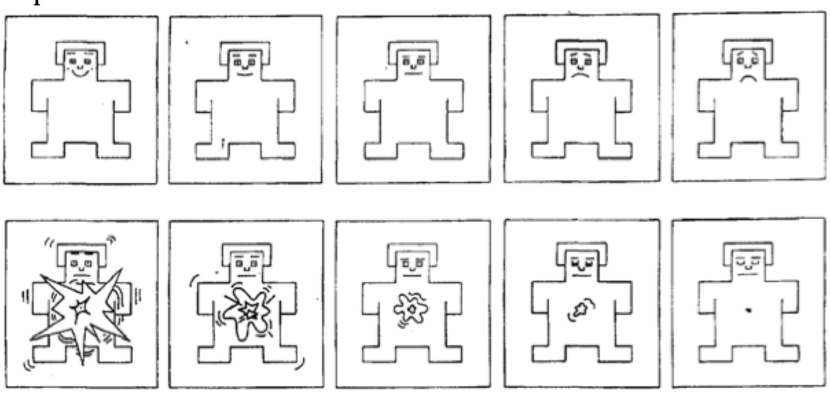
Training clip [a]



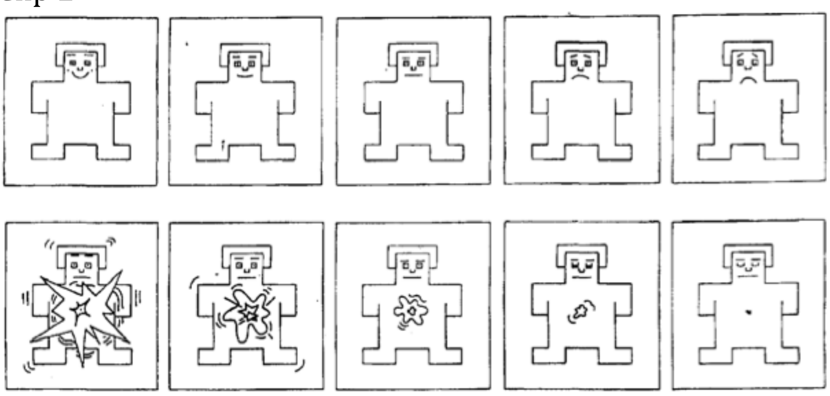
Training clip [b] with haptic



Clip 1



Clip 2



Appendix G

Valence-Arousal values for each clip

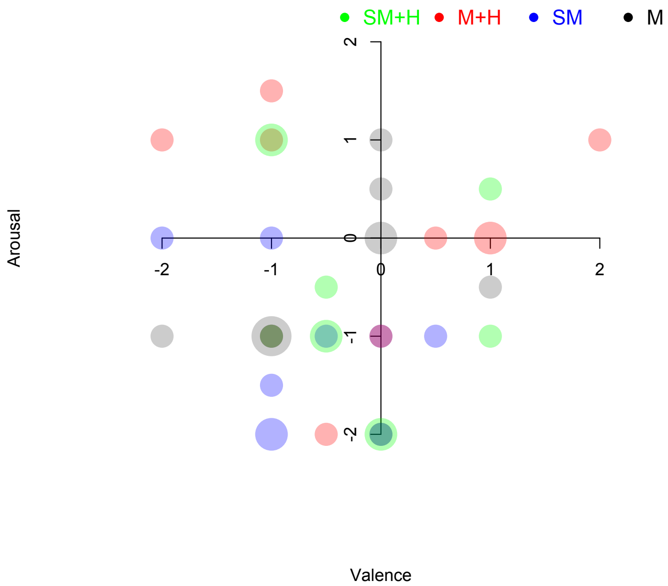


Figure G.1: Clip 1

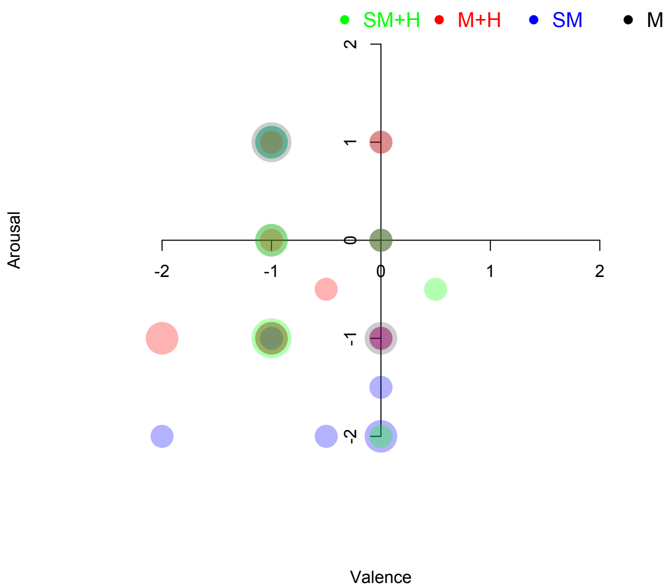


Figure G.2: Clip 2

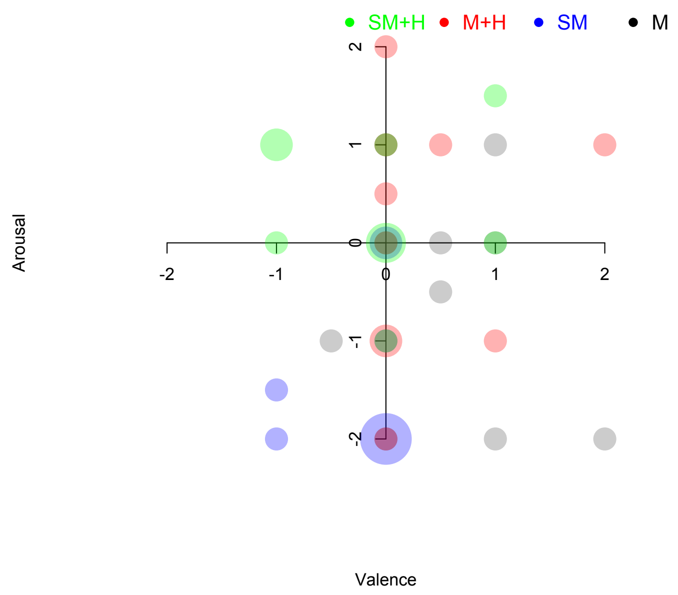


Figure G.3: Clip 3

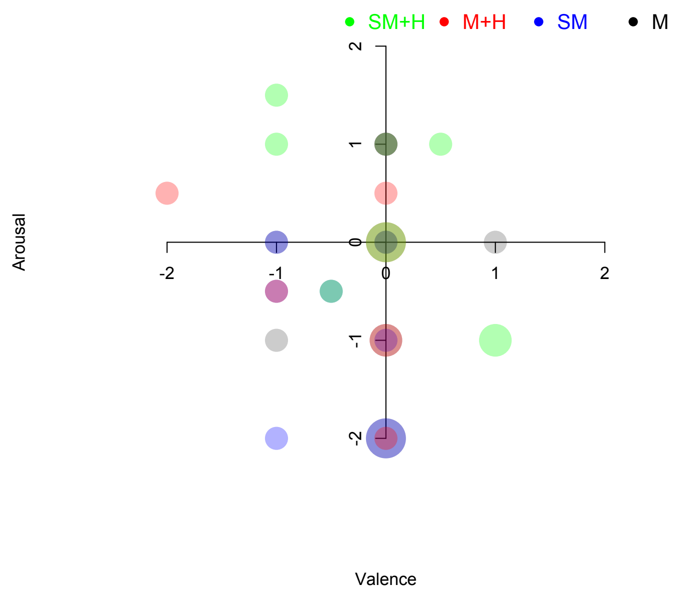


Figure G.4: Clip 4

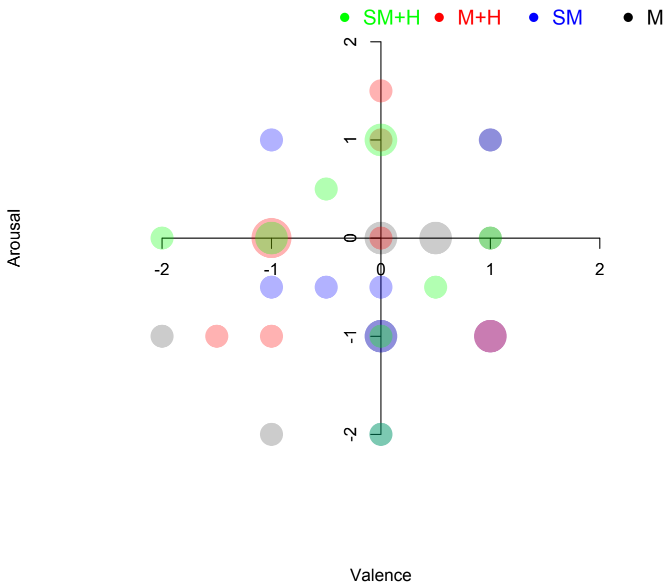


Figure G.5: Clip 5

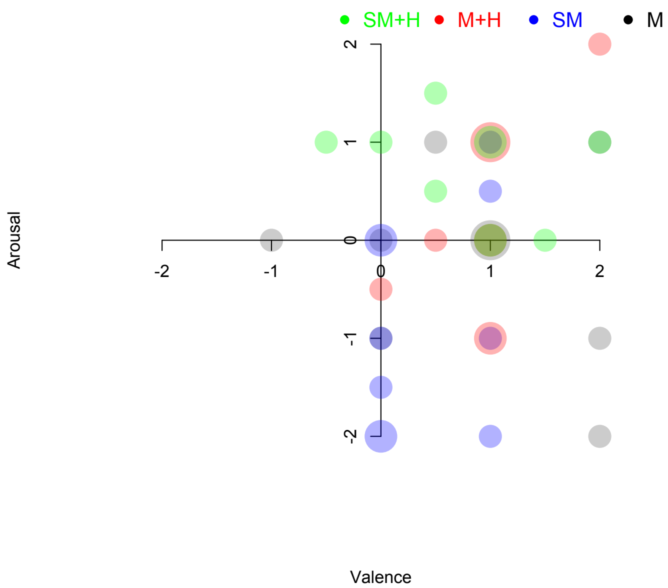


Figure G.6: Clip 6

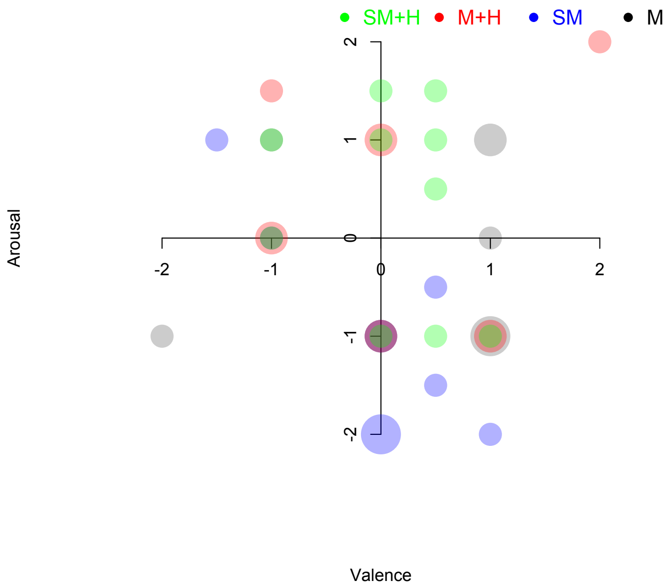


Figure G.7: Clip 7

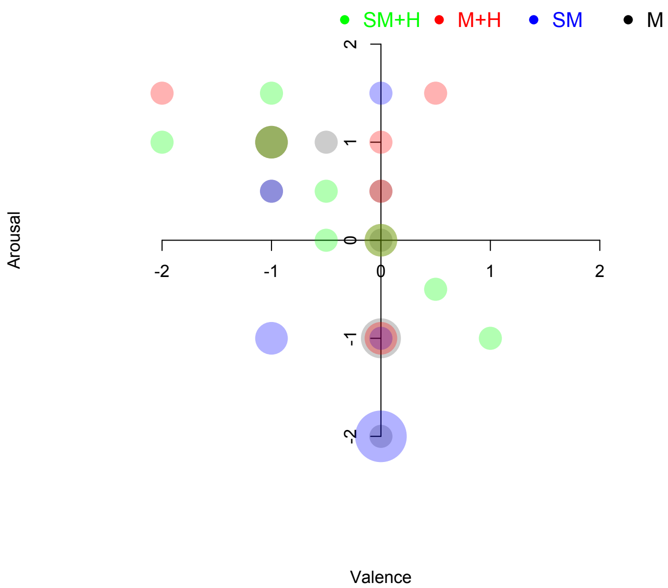


Figure G.8: Clip 8

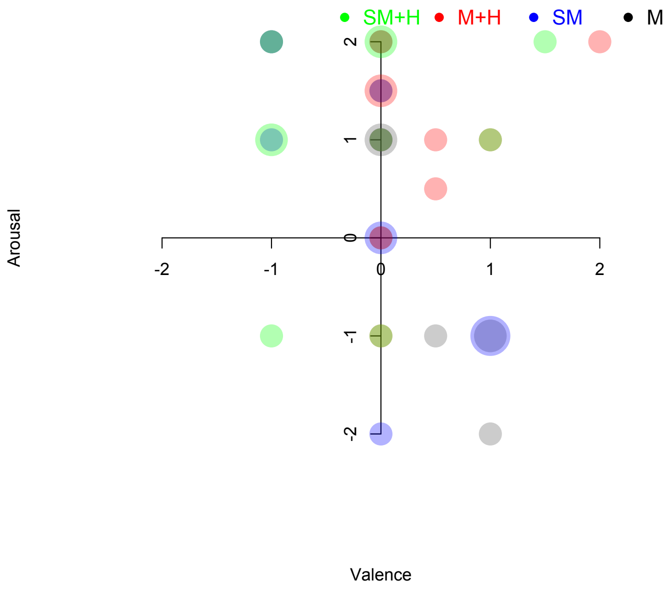


Figure G.9: Clip 9

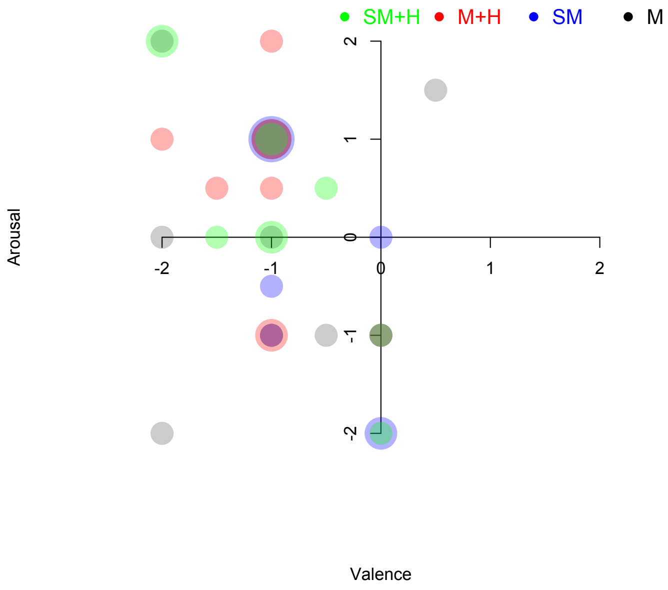


Figure G.10: Clip 10

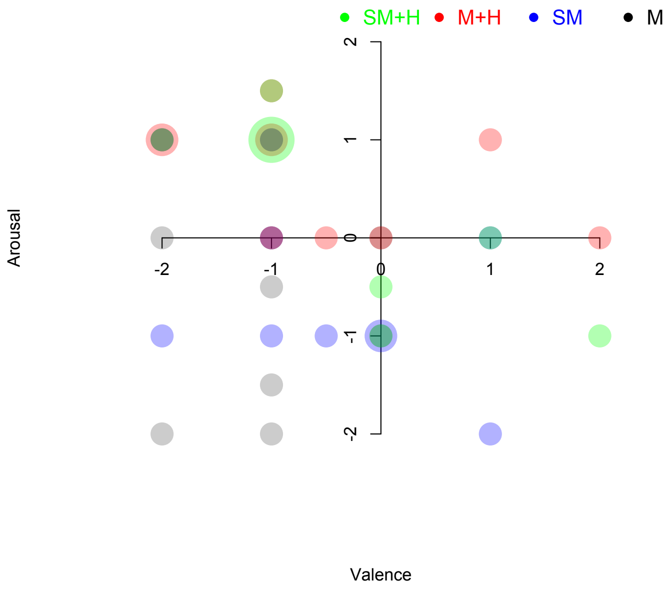


Figure G.11: Clip 11

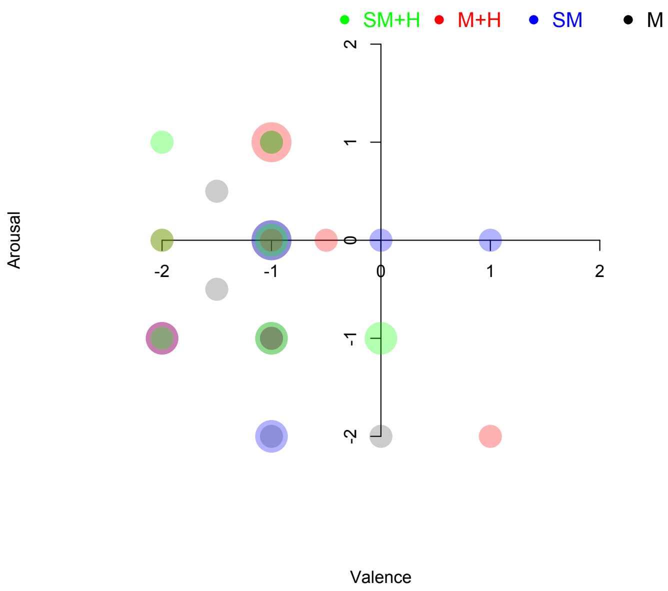


Figure G.12: Clip 12

Appendix H

Mean Valence values

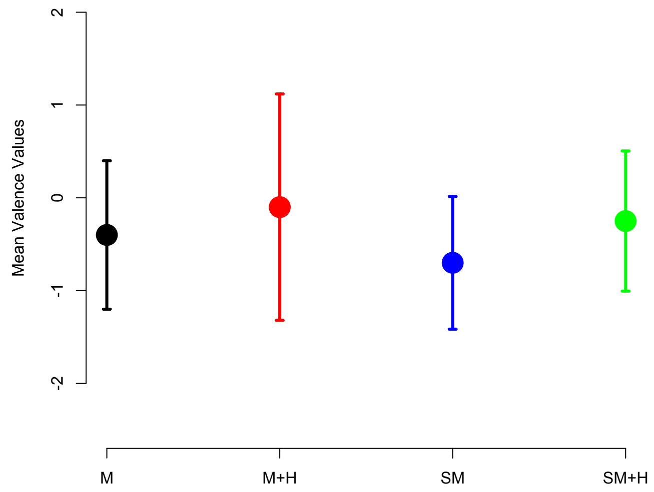


Figure H.1: Clip 1 mean for Valence values

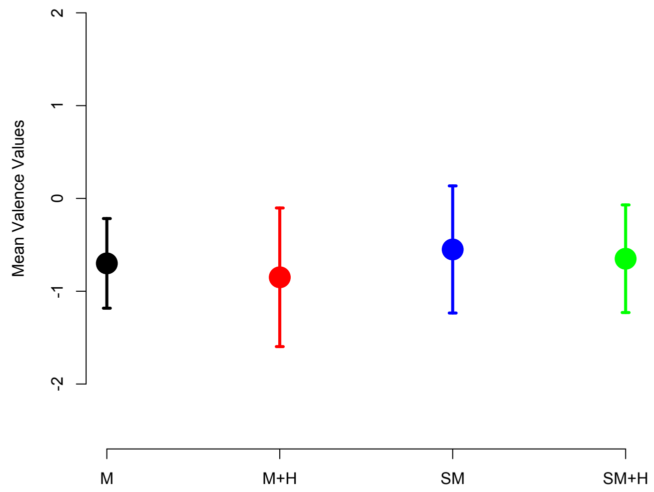


Figure H.2: Clip 2 mean for Valence values

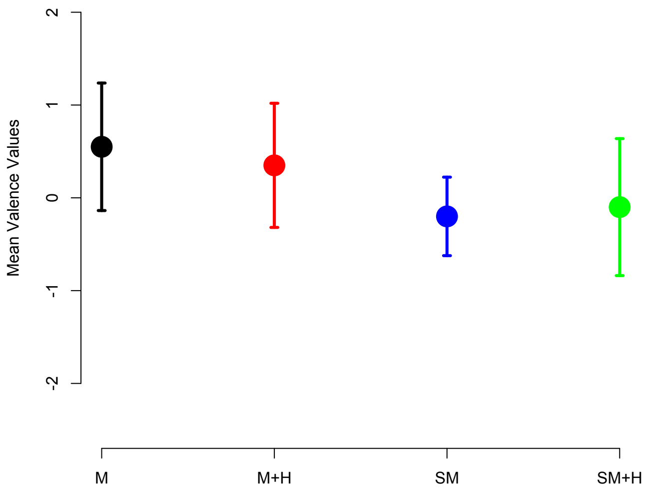


Figure H.3: Clip 3 mean for Valence values

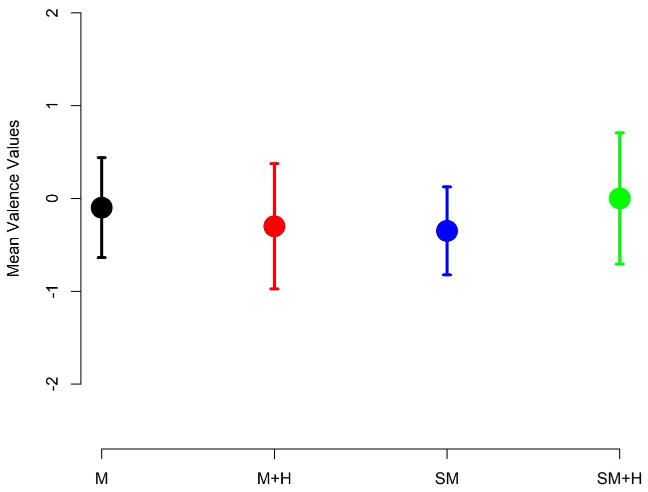


Figure H.4: Clip 4 mean for Valence values

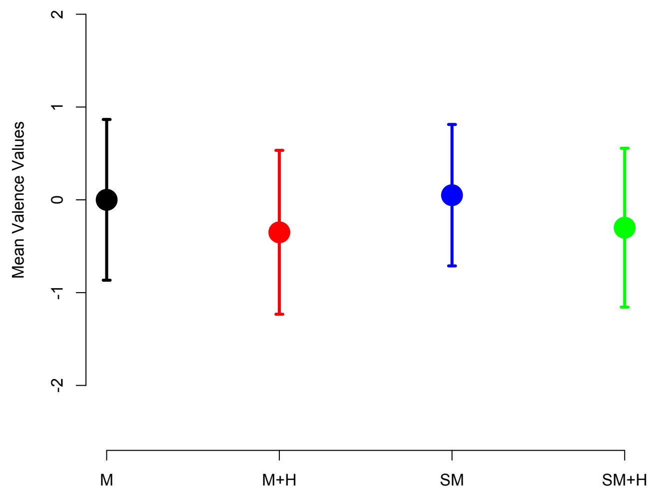


Figure H.5: Clip 5 mean for Valence values

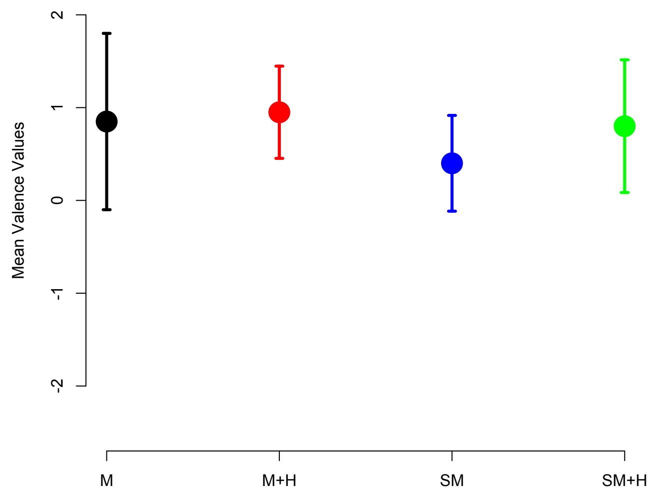


Figure H.6: Clip 6 mean for Valence values

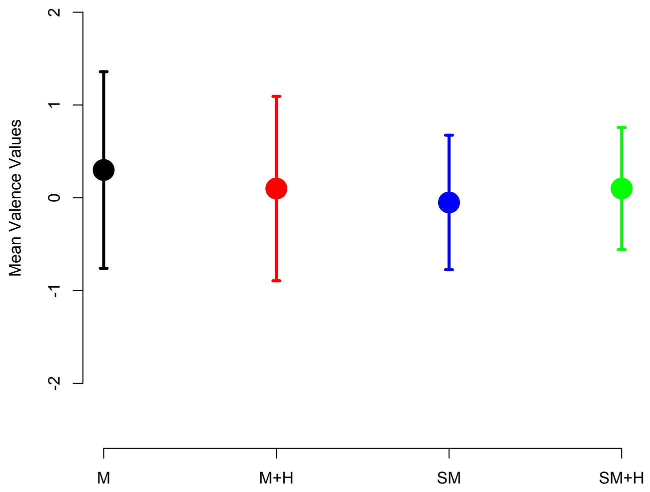


Figure H.7: Clip 7 mean for Valence values

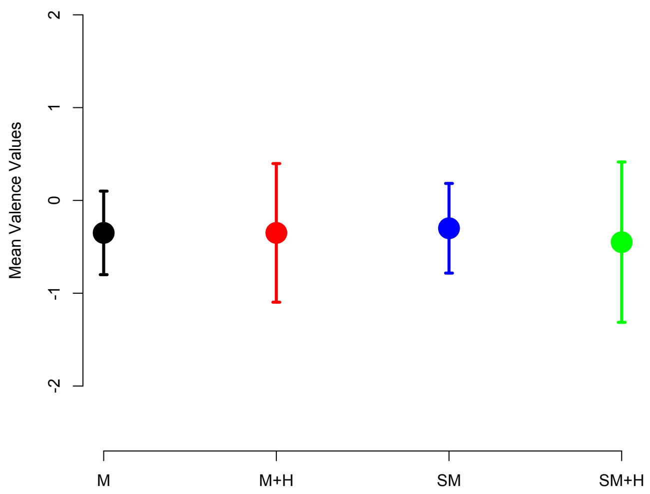


Figure H.8: Clip 8 mean for Valence values

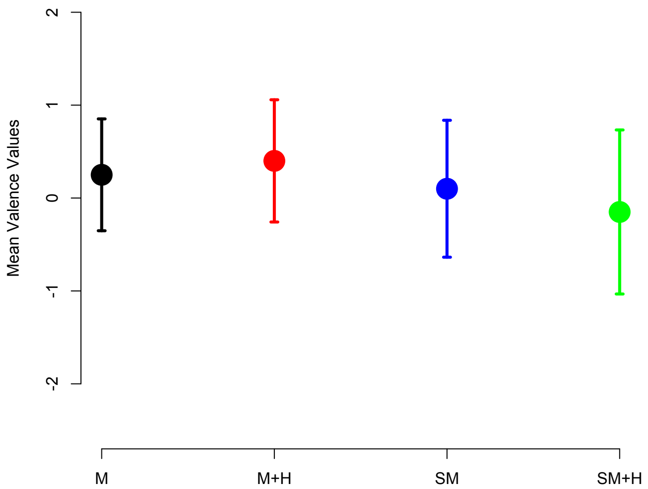


Figure H.9: Clip 9 mean for Valence values

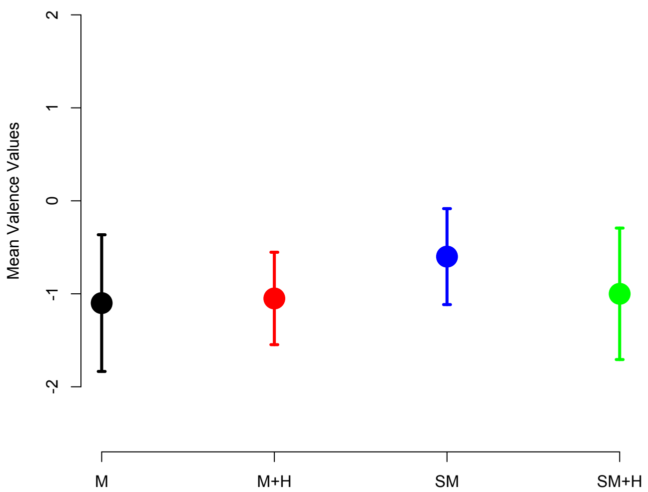


Figure H.10: Clip 10 mean for Valence values

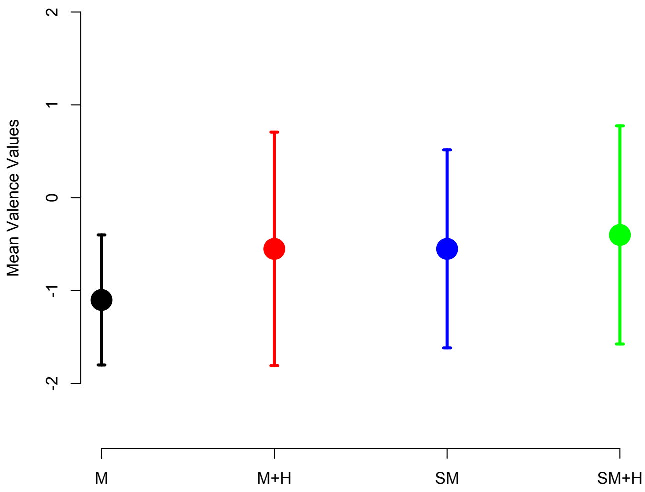


Figure H.11: Clip 11 mean for Valence values

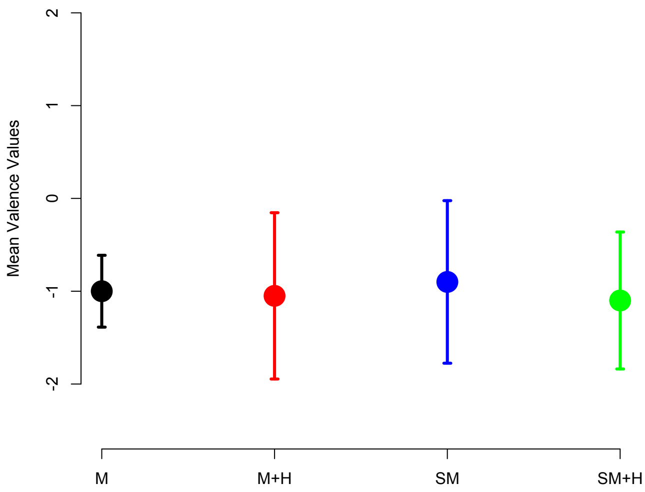


Figure H.12: Clip 12 mean for Valence values

Appendix I

Mean Arousal values

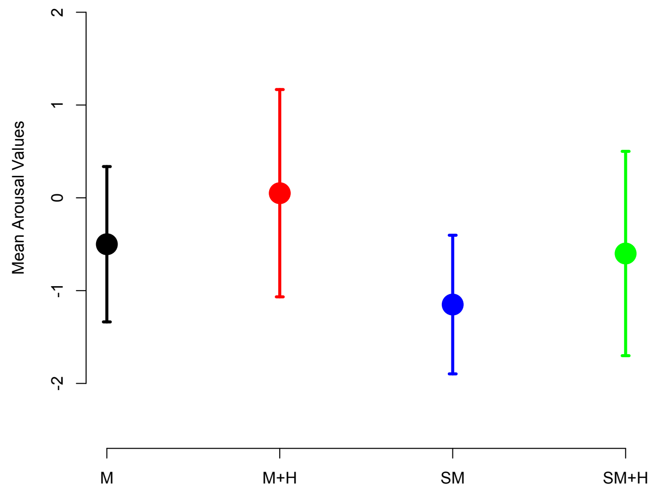


Figure I.1: Clip 1 mean for Arousal values

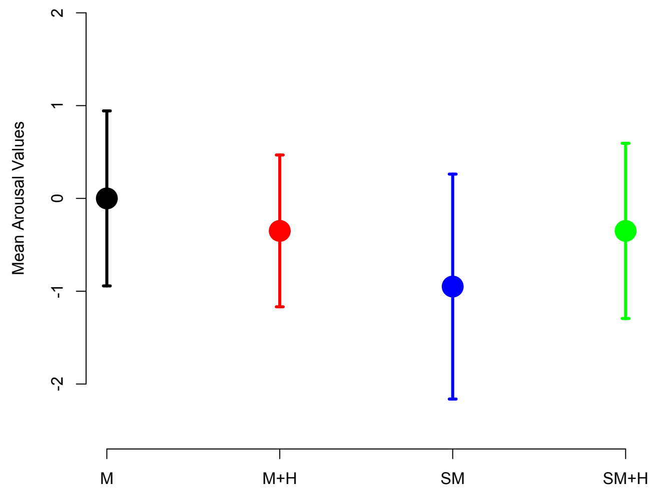


Figure I.2: Clip 2 mean for Arousal values

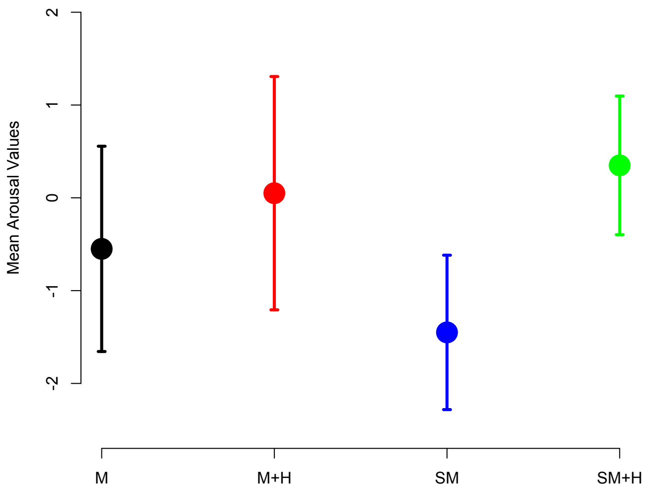


Figure I.3: Clip 3 mean for Arousal values

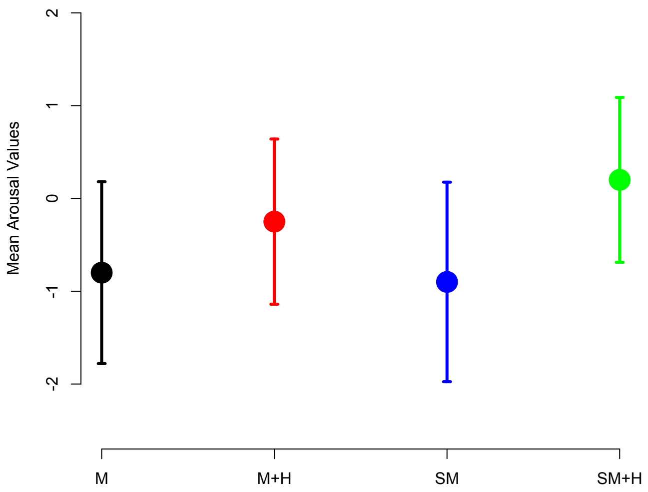


Figure I.4: Clip 4 mean for Arousal values

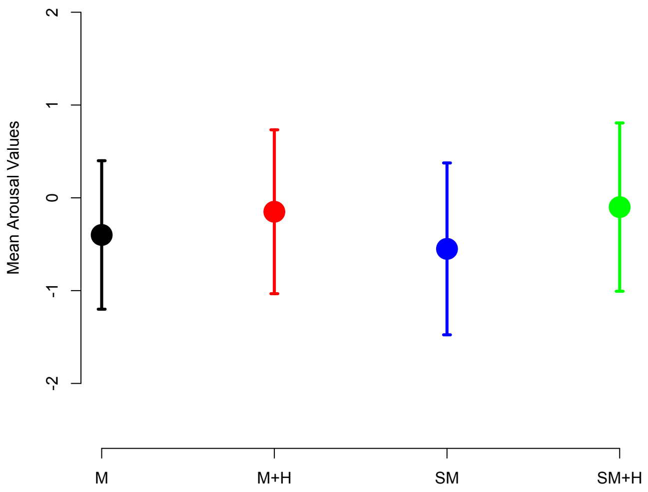


Figure I.5: Clip 5 mean for Arousal values

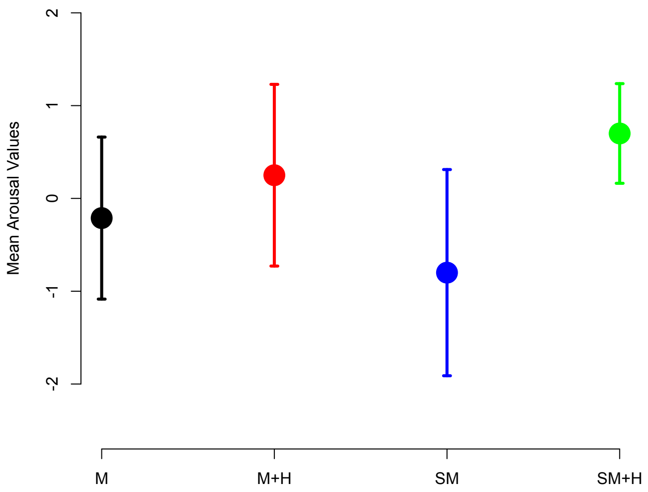


Figure I.6: Clip 6 mean for Arousal values

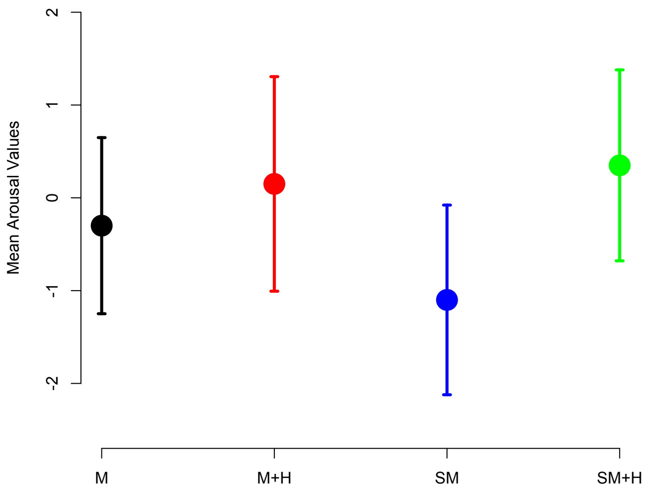


Figure I.7: Clip 7 mean for Arousal values

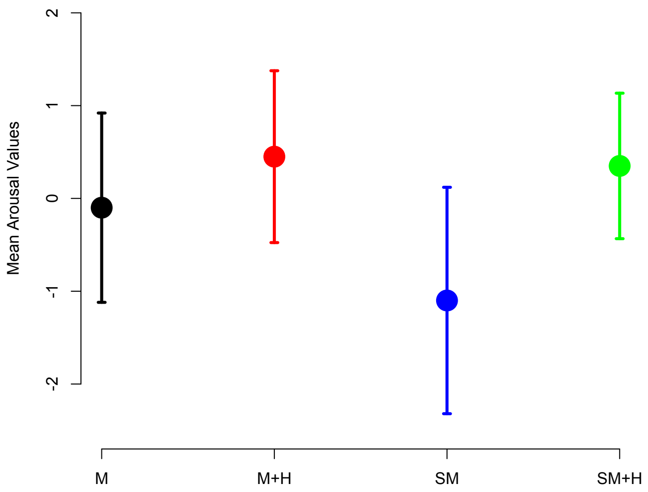


Figure I.8: Clip 8 mean for Arousal values

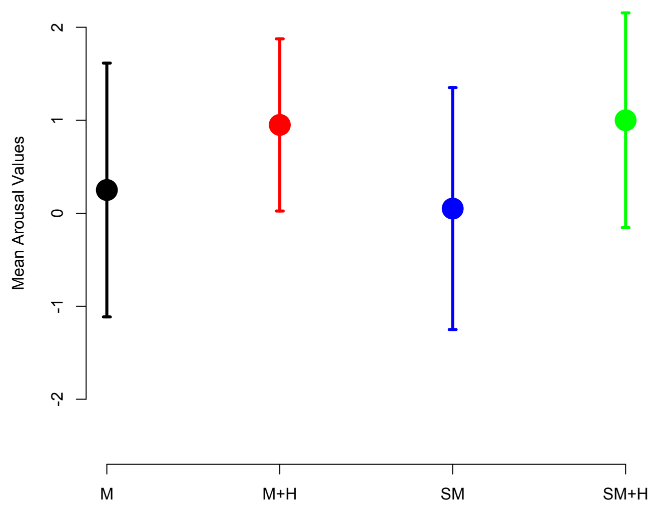


Figure I.9: Clip 9 mean for Arousal values

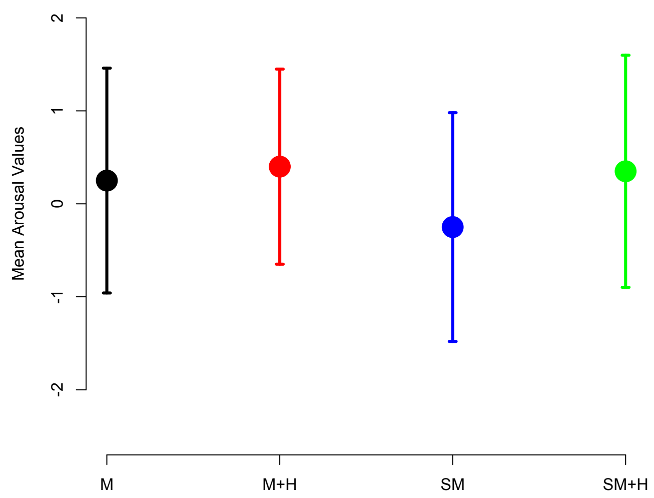


Figure I.10: Clip 10 mean for Arousal values

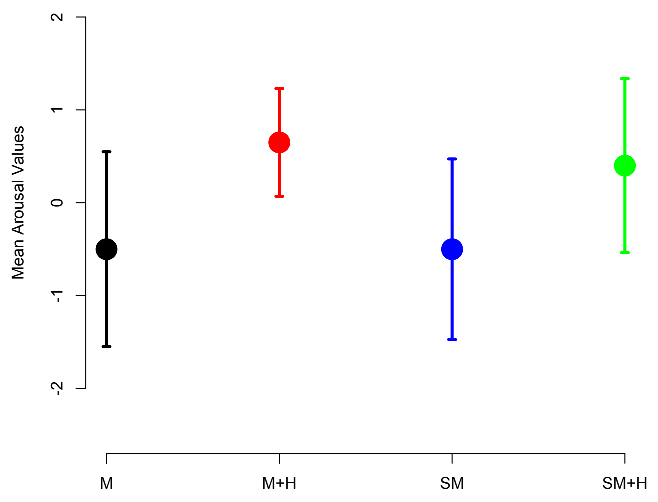


Figure I.11: Clip 11 mean for Arousal values

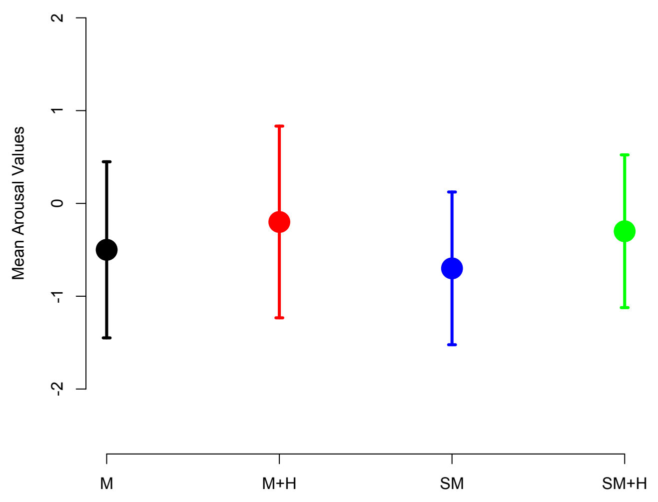


Figure I.12: Clip 12 mean for Arousal values

Appendix J

Valence-Arousal plots of suspenseful movie clips

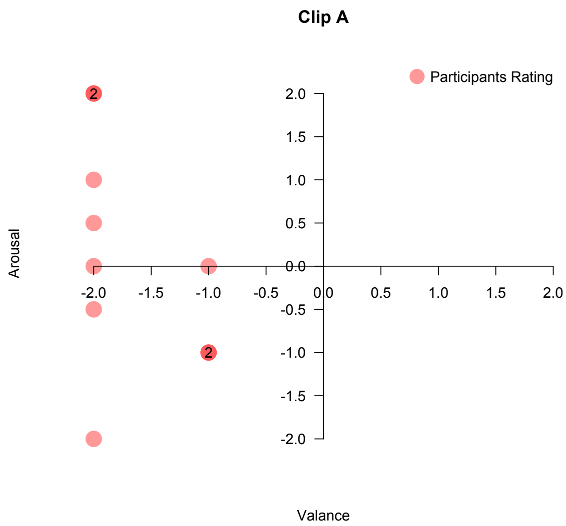


Figure J.1: Participants ratings for clip A

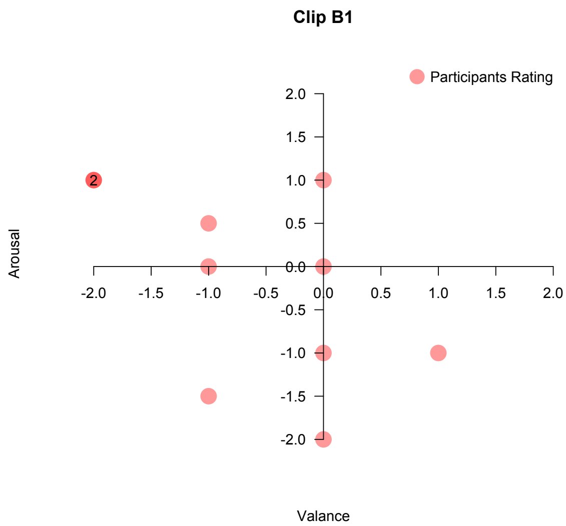


Figure J.2: Participants ratings for clip B1

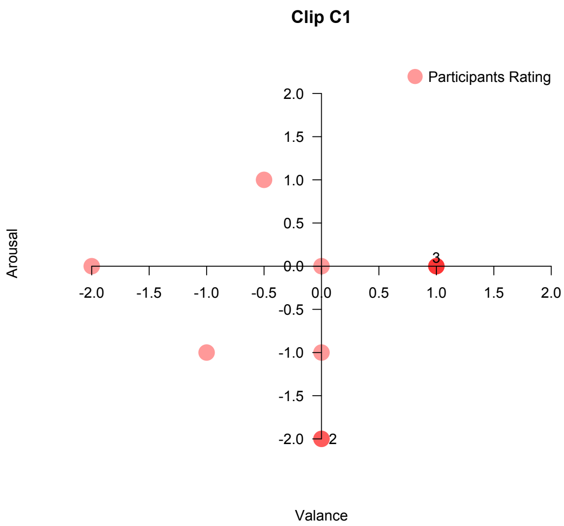


Figure J.3: Participants ratings for clip C1

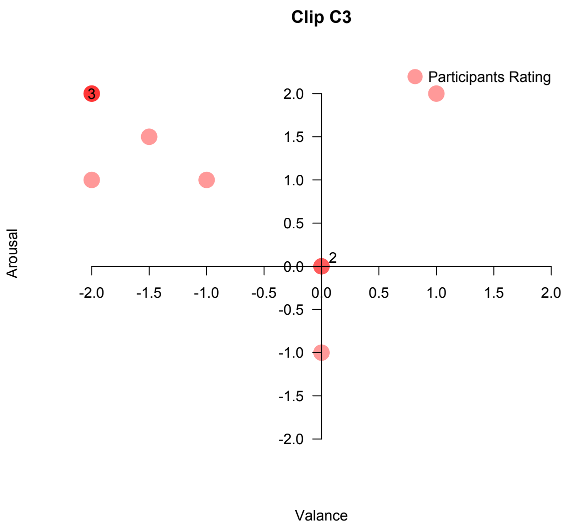


Figure J.4: Participants ratings for clip C3

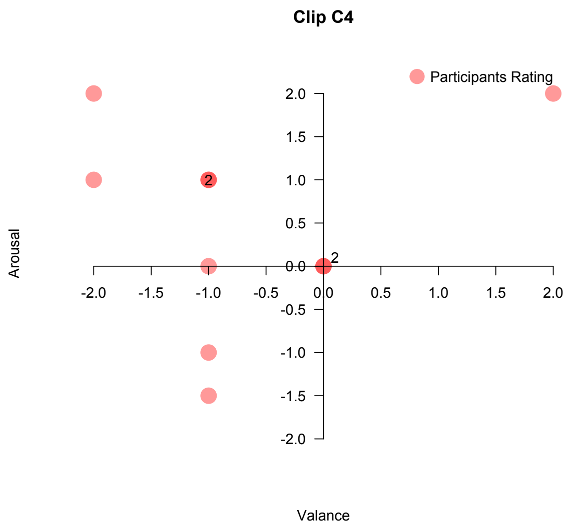


Figure J.5: Participants ratings for clip C4

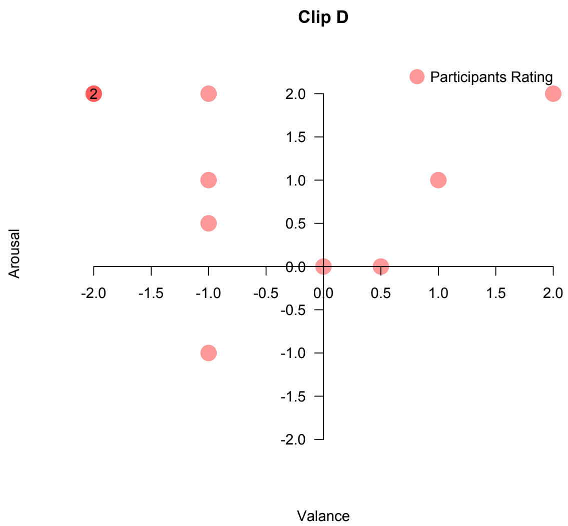


Figure J.6: Participants ratings for clip D

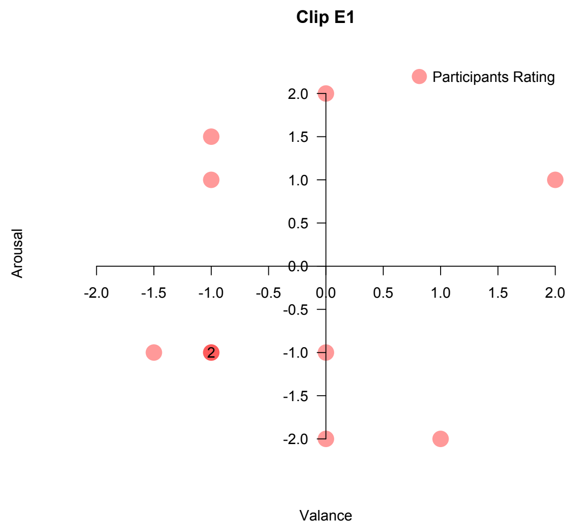


Figure J.7: Participants ratings for clip E1

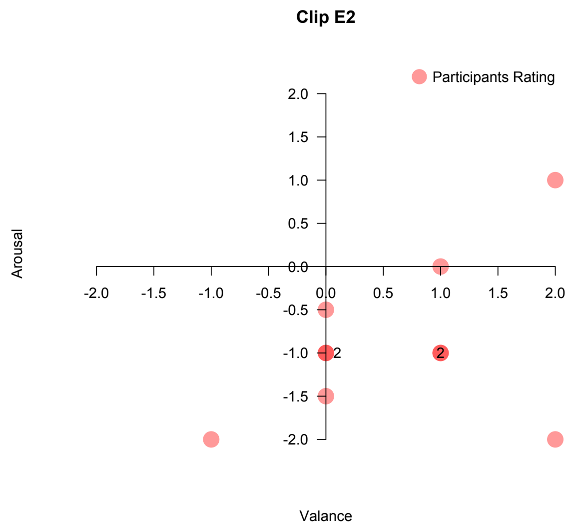


Figure J.8: Participants ratings for clip E2

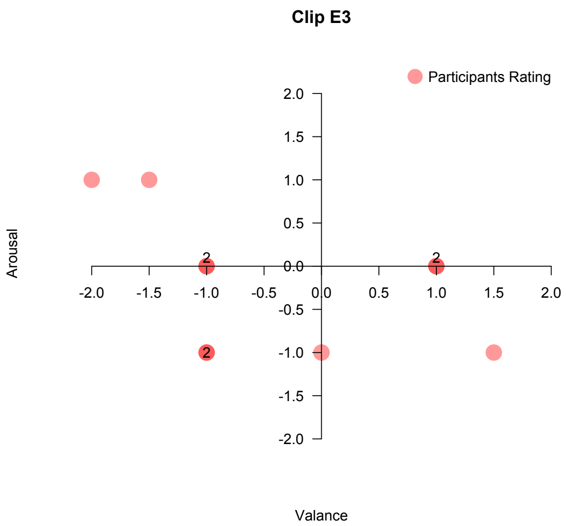


Figure J.9: Participants ratings for clip E3

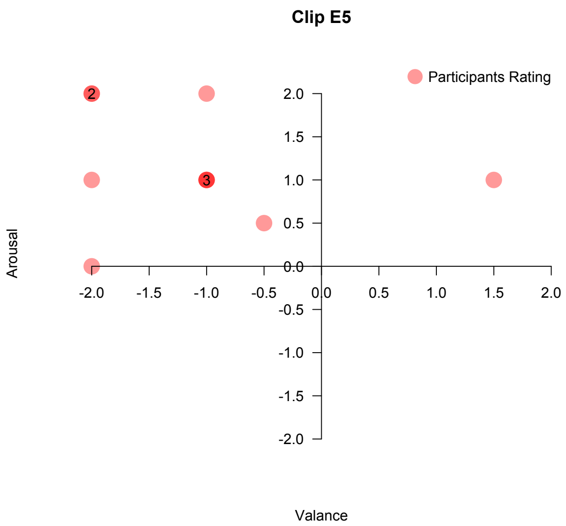


Figure J.10: Participants ratings for clip E5

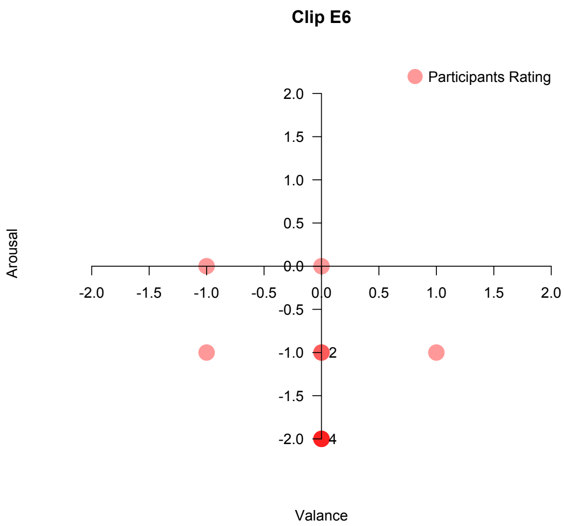


Figure J.11: Participants ratings for clip E6

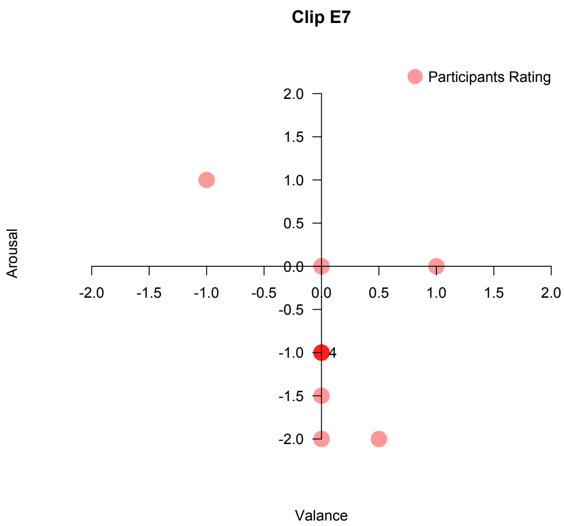


Figure J.12: Participants ratings for clip E7

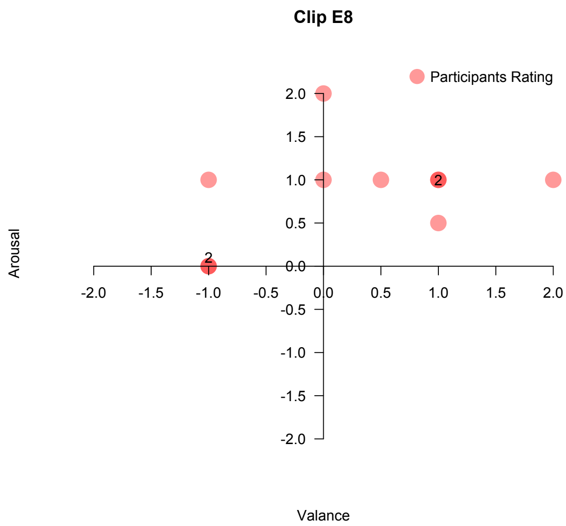


Figure J.13: Participants ratings for clip E8

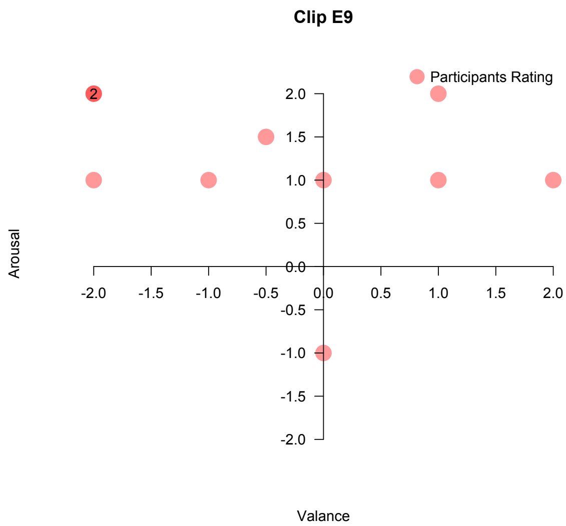


Figure J.14: Participants ratings for clip E9

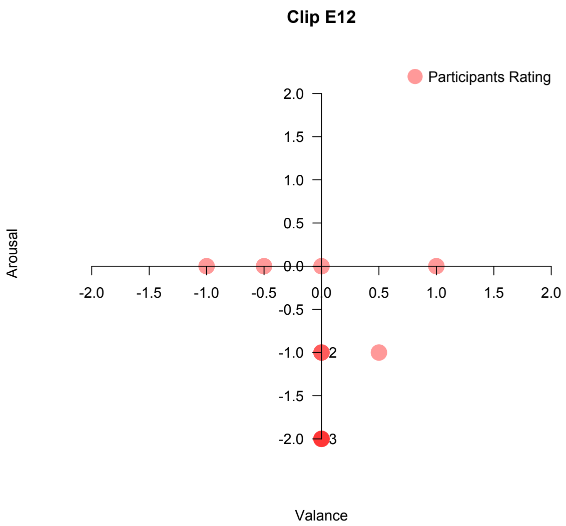


Figure J.15: Participants ratings for clip E12

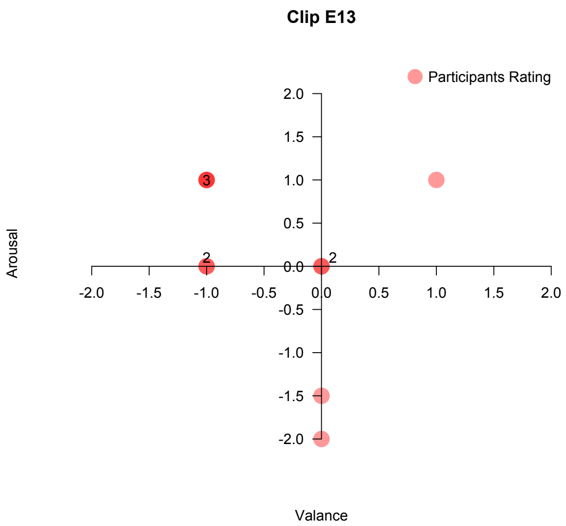


Figure J.16: Participants ratings for clip E13

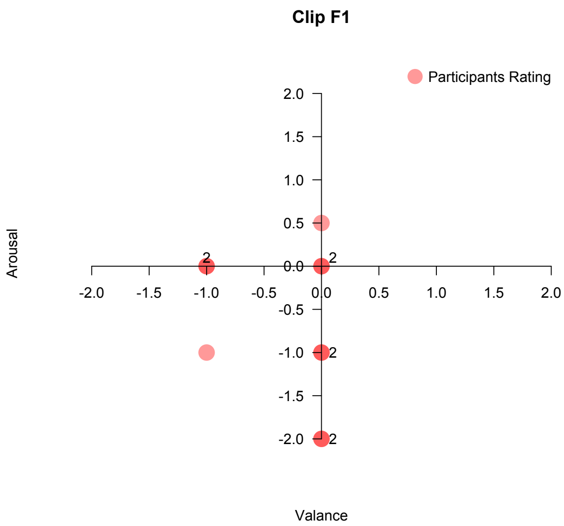


Figure J.17: Participants ratings for clip F1

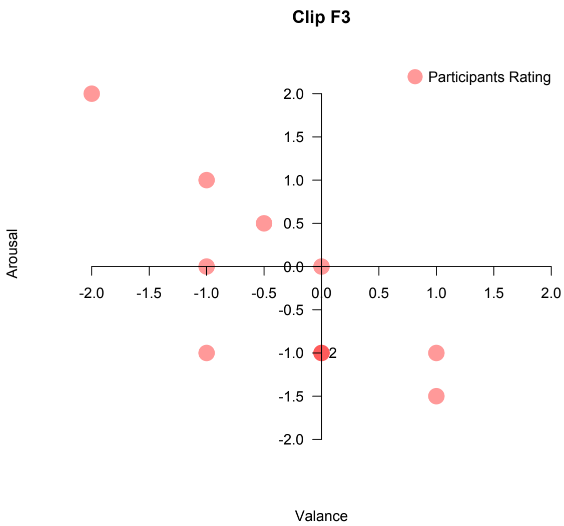


Figure J.18: Participants ratings for clip F3

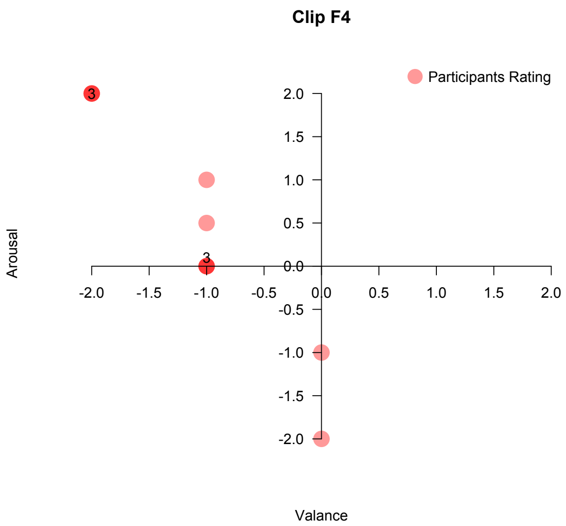


Figure J.19: Participants ratings for clip F4

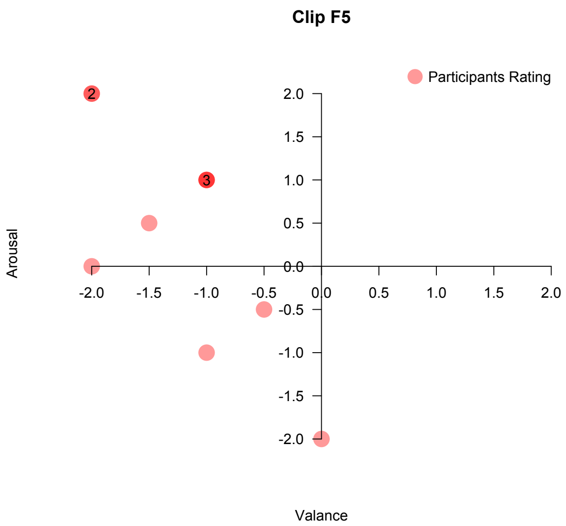


Figure J.20: Participants ratings for clip F5

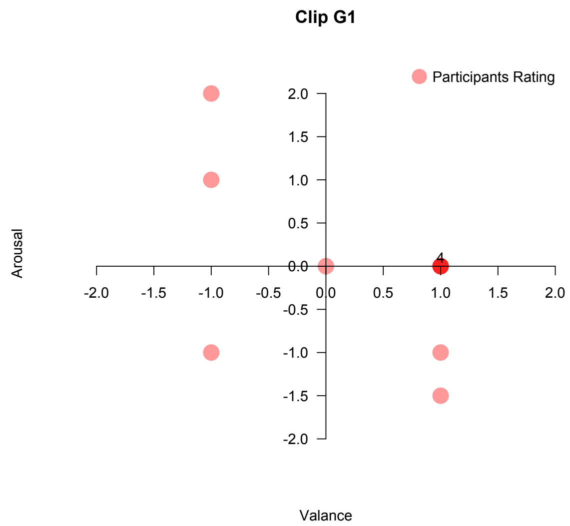


Figure J.21: Participants ratings for clip G1

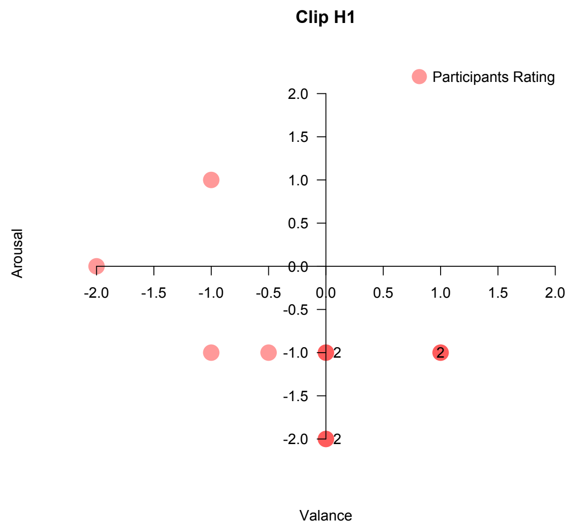


Figure J.22: Participants ratings for clip H1

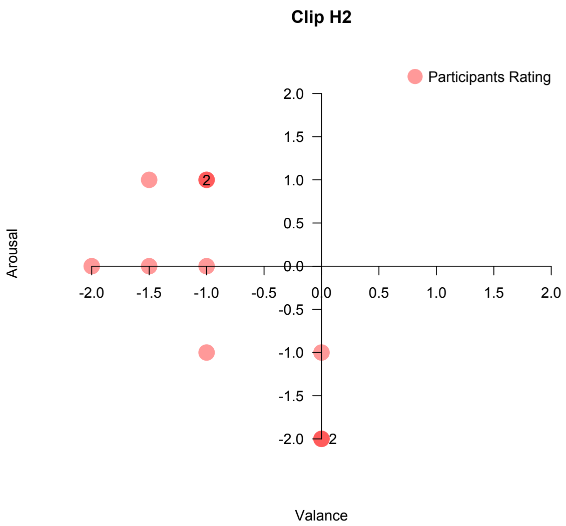


Figure J.23: Participants ratings for clip H2

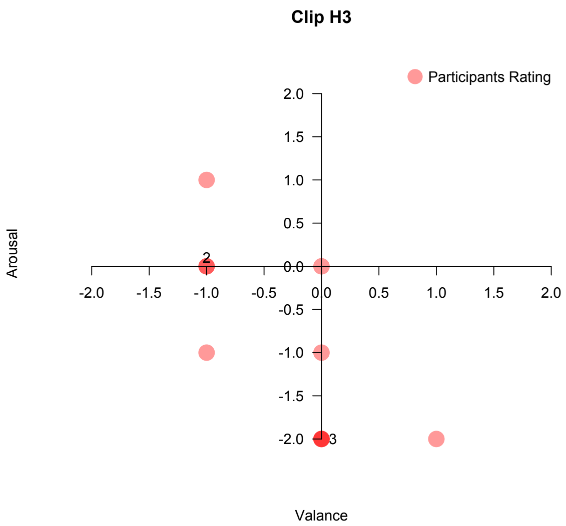


Figure J.24: Participants ratings for clip H3

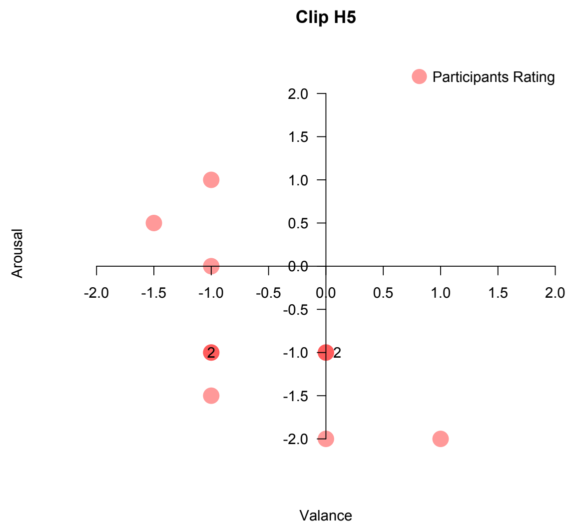


Figure J.25: Participants ratings for clip H5

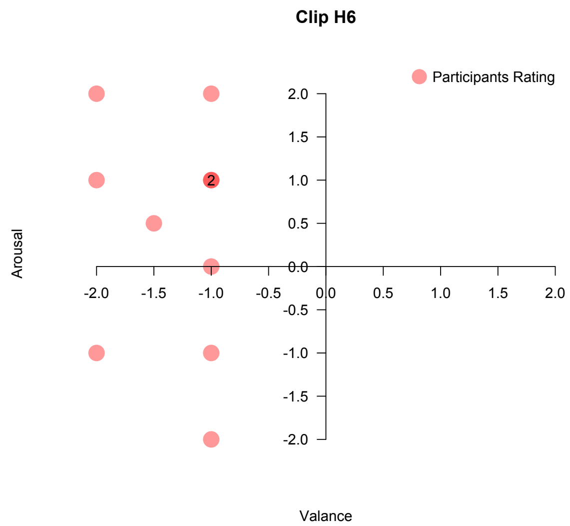


Figure J.26: Participants ratings for clip H6

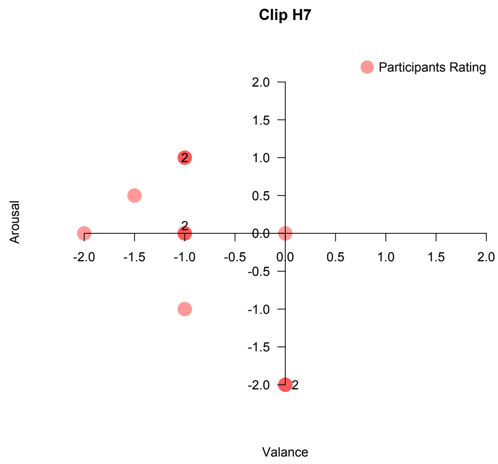


Figure J.27: Participants ratings for clip H7

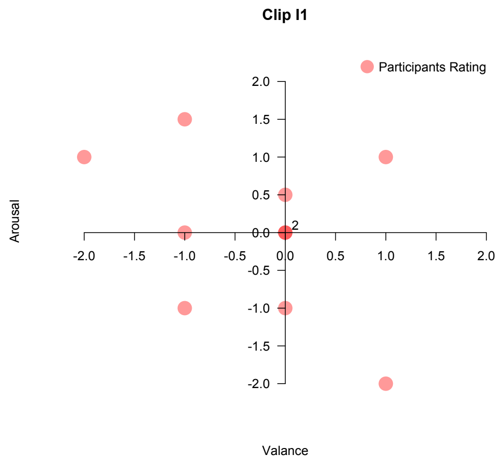


Figure J.28: Participants ratings for clip H7

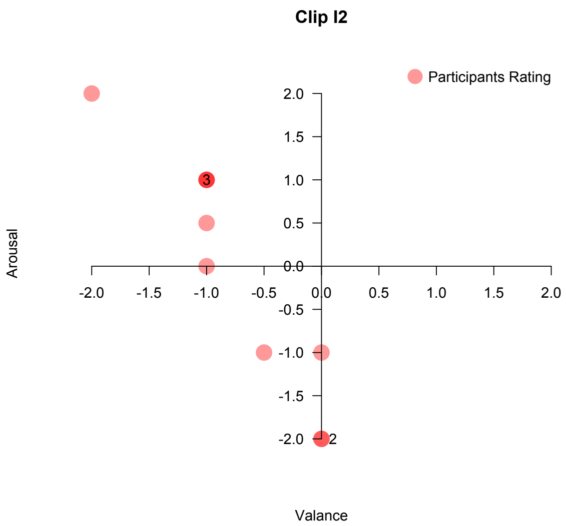


Figure J.29: Participants ratings for clip I2

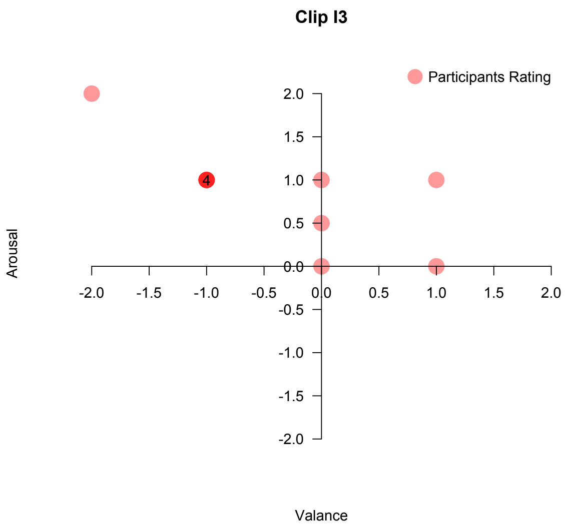


Figure J.30: Participants ratings for clip I3

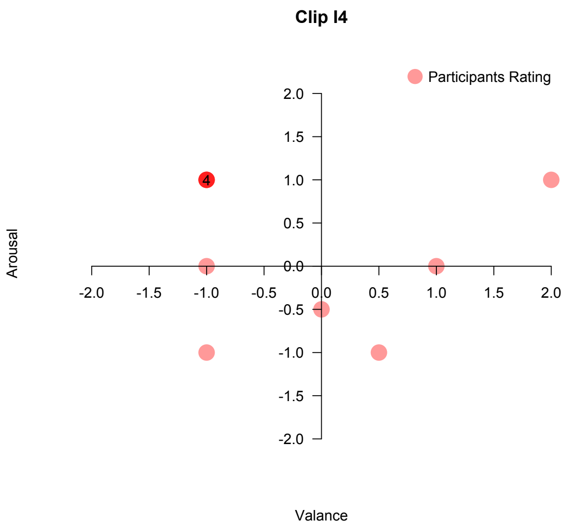


Figure J.31: Participants ratings for clip I4

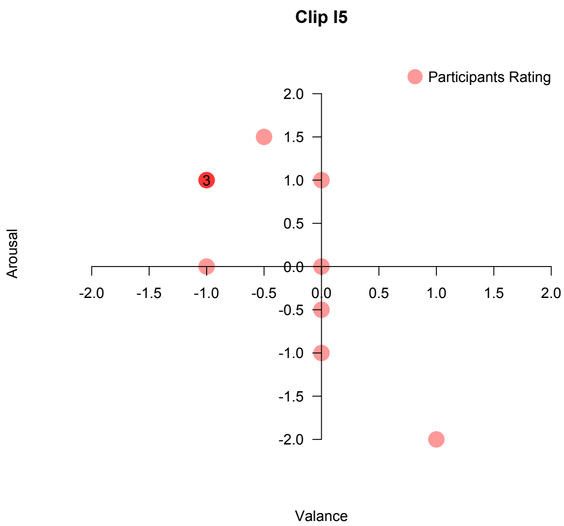


Figure J.32: Participants ratings for clip I5

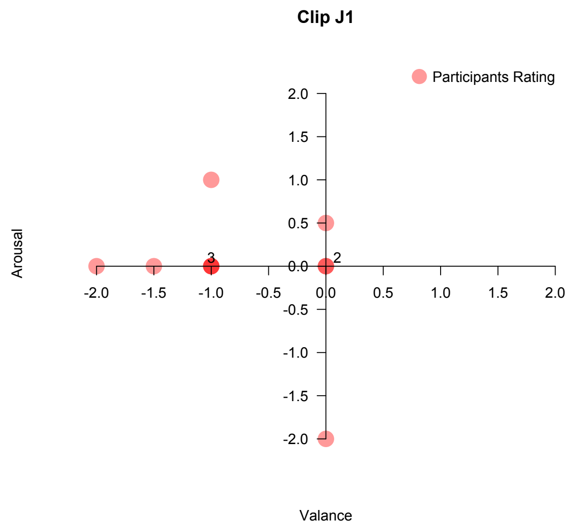


Figure J.33: Participants ratings for clip J1

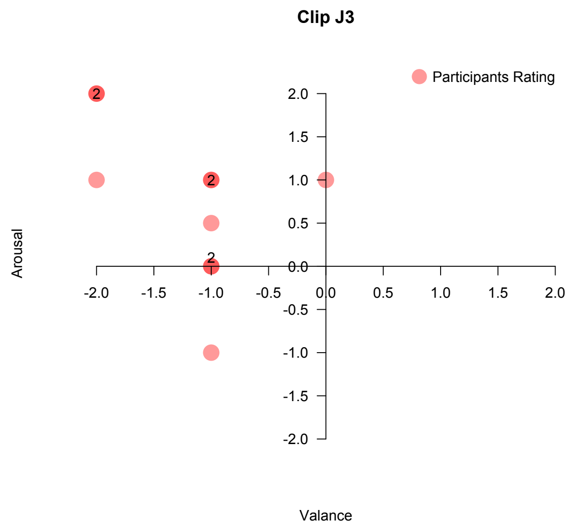


Figure J.34: Participants ratings for clip J3

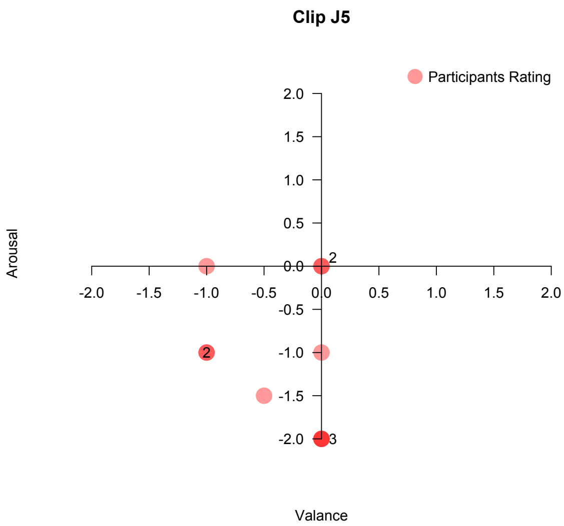


Figure J.35: Participants ratings for clip J5

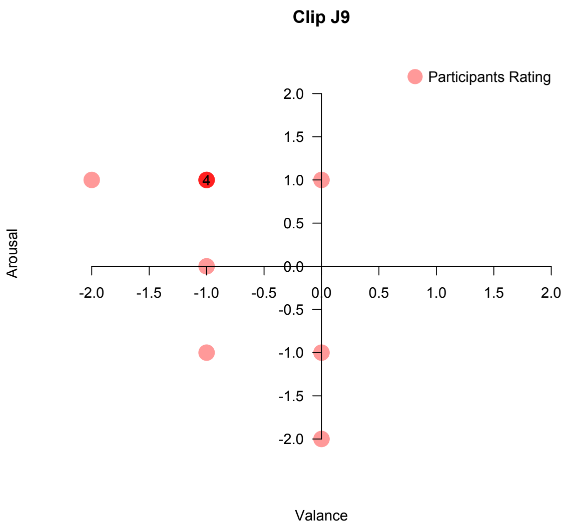


Figure J.36: Participants ratings for clip J9

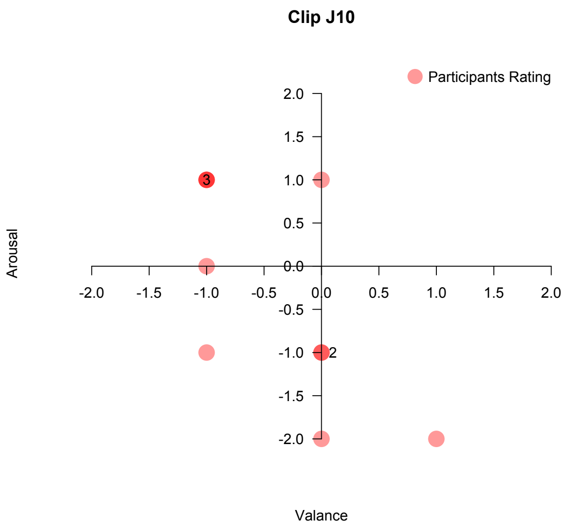


Figure J.37: Participants ratings for clip J10

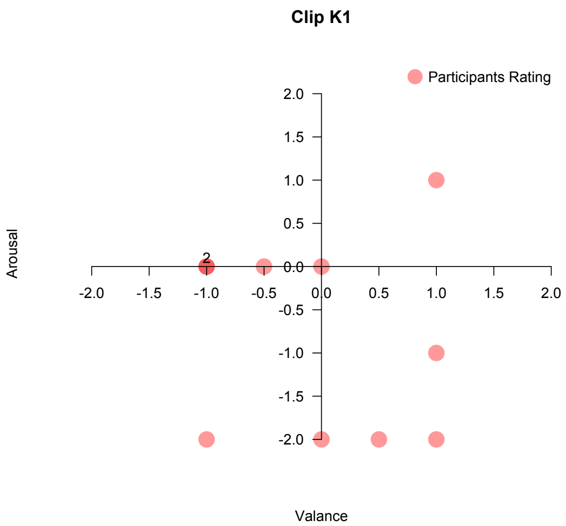


Figure J.38: Participants ratings for clip K1

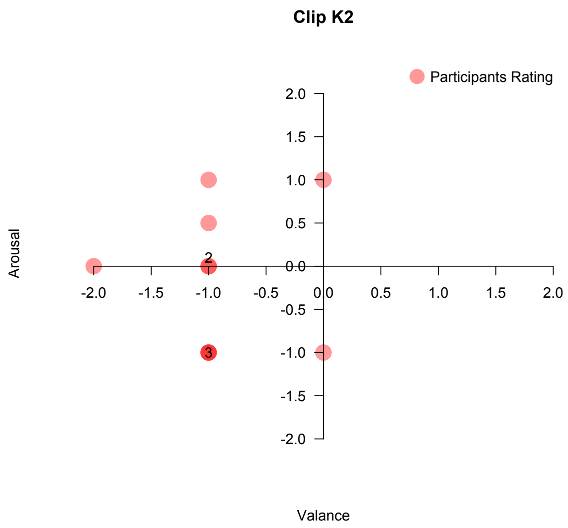


Figure J.39: Participants ratings for clip K2

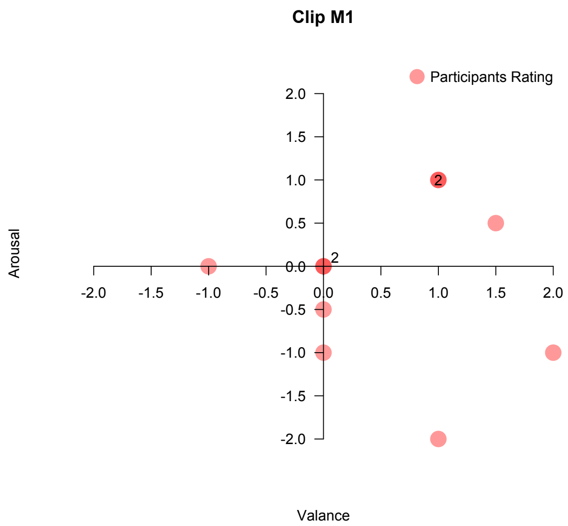


Figure J.40: Participants ratings for clip M1

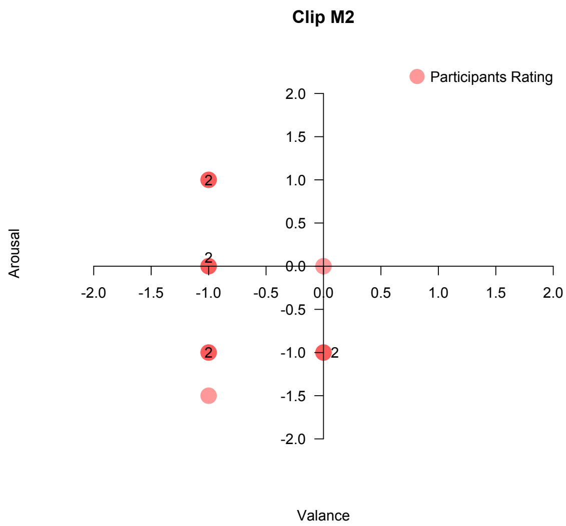


Figure J.41: Participants ratings for clip M2

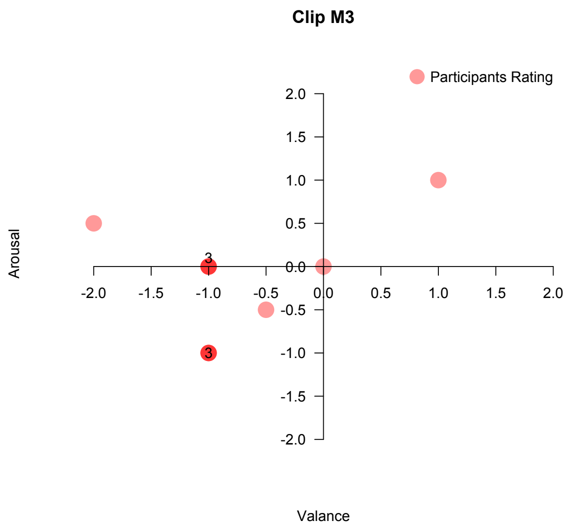


Figure J.42: Participants ratings for clip M3

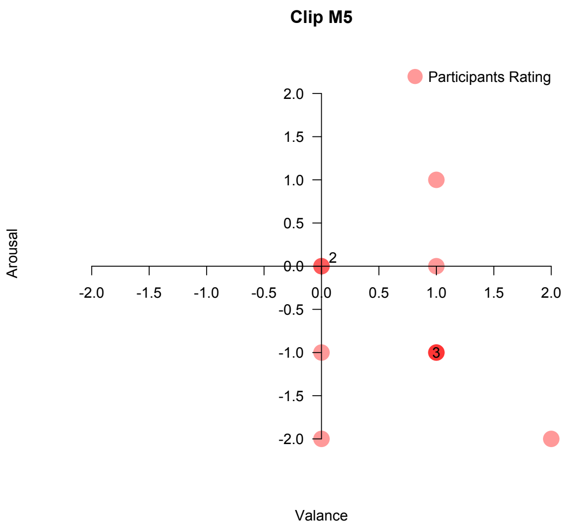


Figure J.43: Participants ratings for clip M5

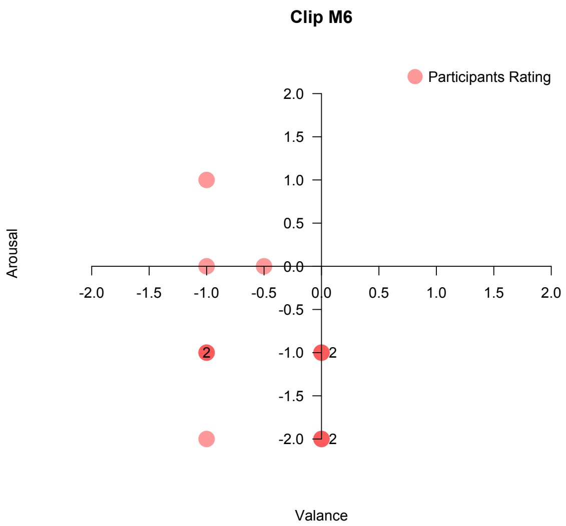


Figure J.44: Participants ratings for clip M6

Appendix K

Suspense Study-Part 1: Post-task Questionnaire

Questionnaire: About You *All changes saved in Drive*

QUESTIONS RESPONSES 10

10 responses

Not accepting responses

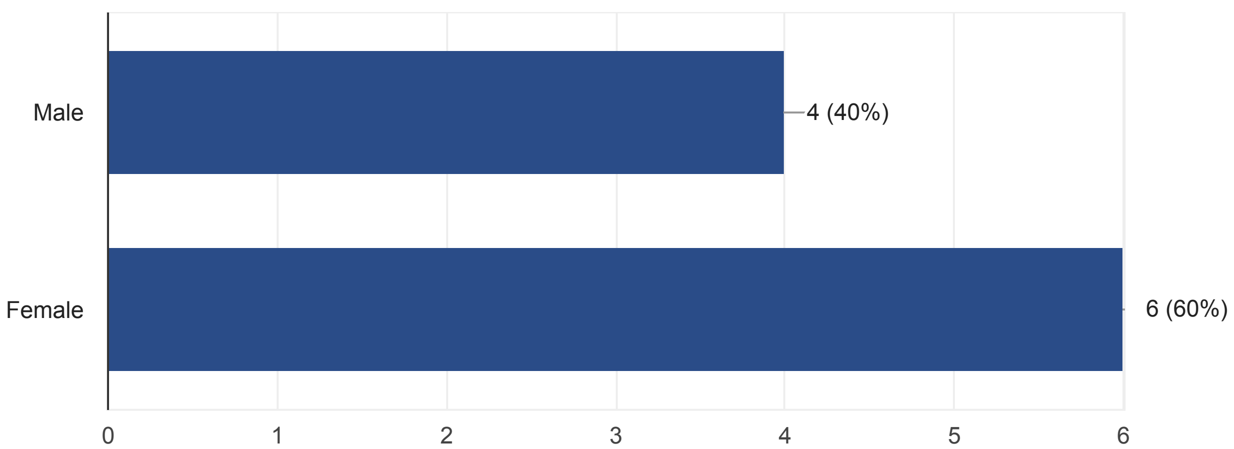
Message for respondents

This form is no longer accepting responses

SUMMARY INDIVIDUAL

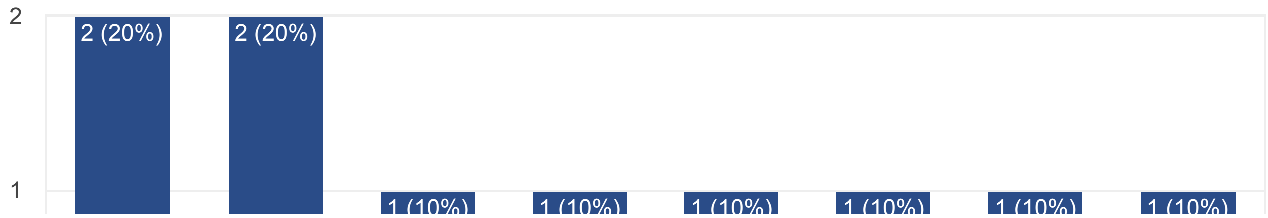
1. Gender

10 responses



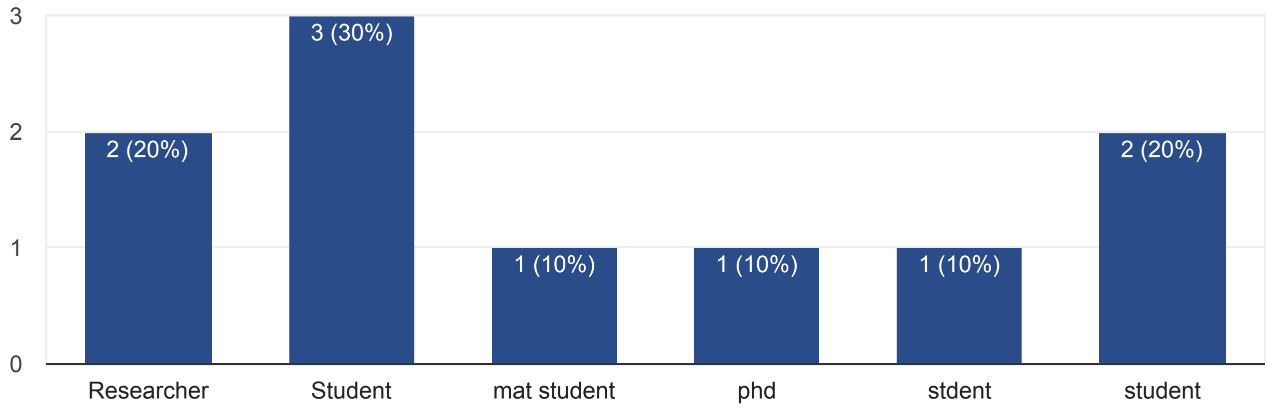
2. Age

10 responses



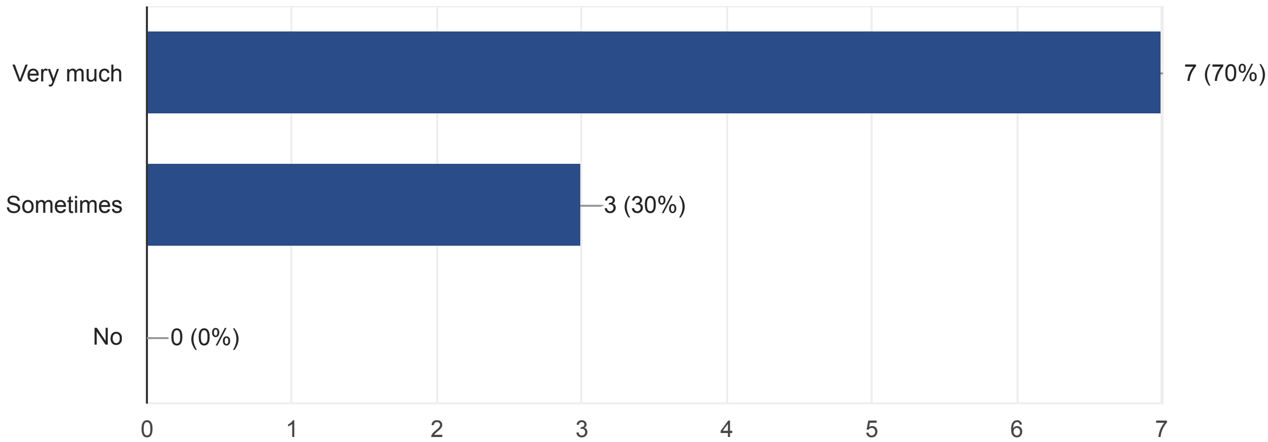
3. Occupation

10 responses



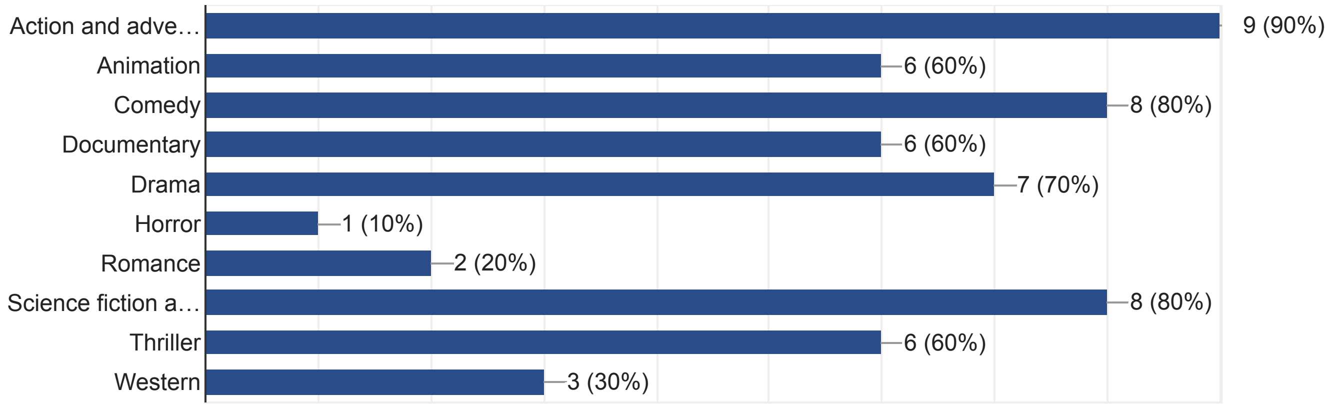
4. Do you enjoy watching movies?

10 responses



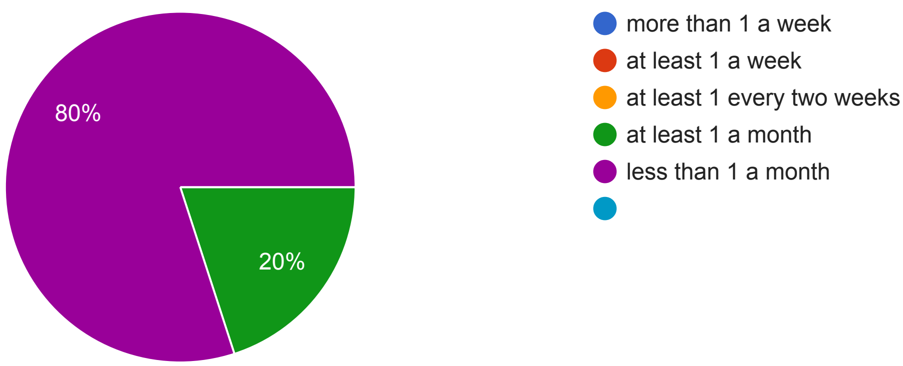
5. What genres of movies do you like? (You can select multiple genres)

10 responses



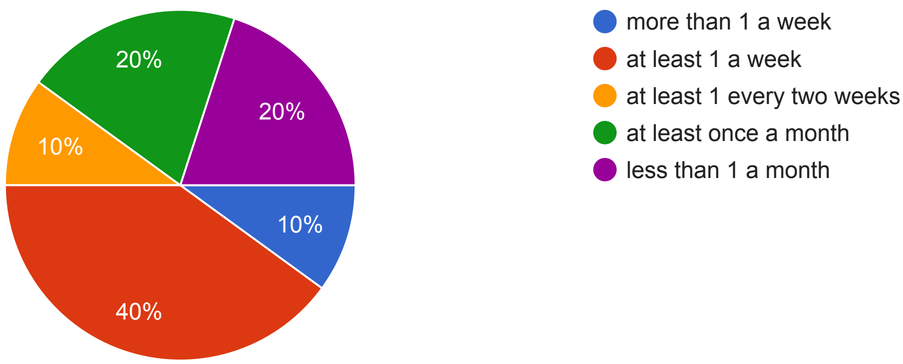
6. How often do you go to the cinema?

10 responses



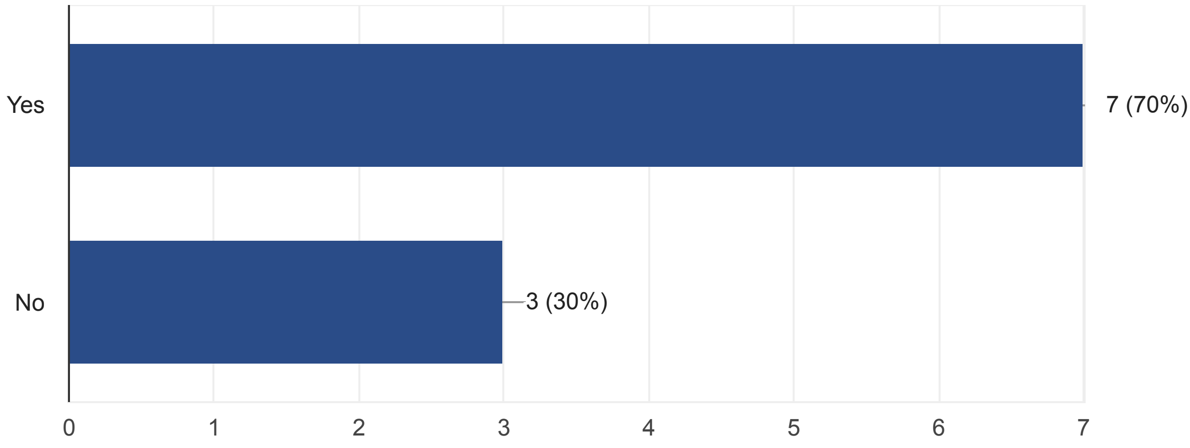
7. How often do you watch movies at home?

10 responses

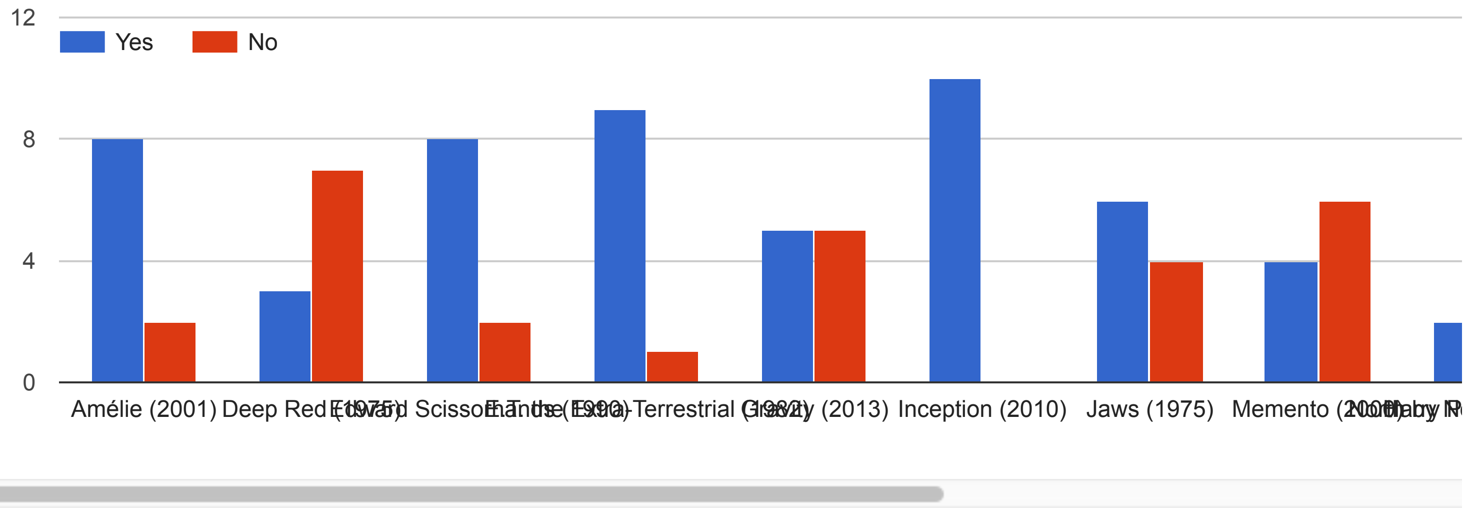


8. Do you enjoy special effects in entertainment (e.g. 3D, vibrations,..)

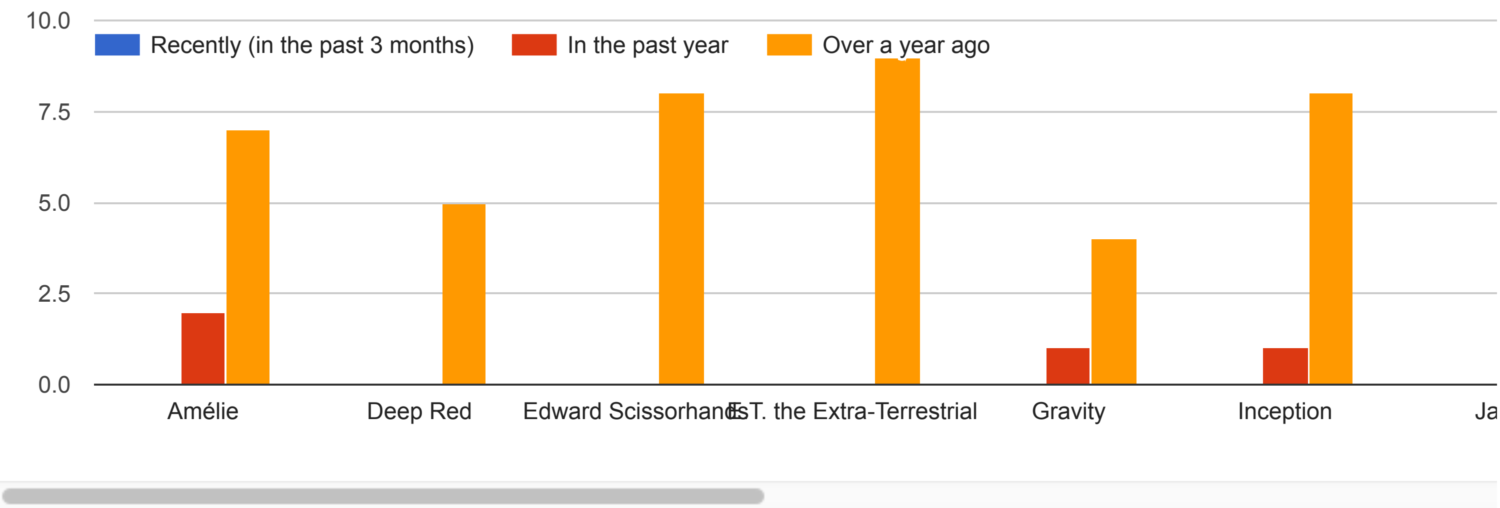
10 responses



9. Have you already seen or heard about the following movies?

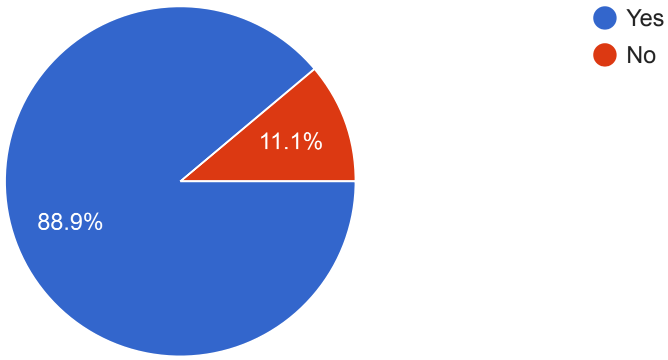


If yes, when did you see them last?



Did you enjoy taking part in this short study?

9 responses



Appendix L

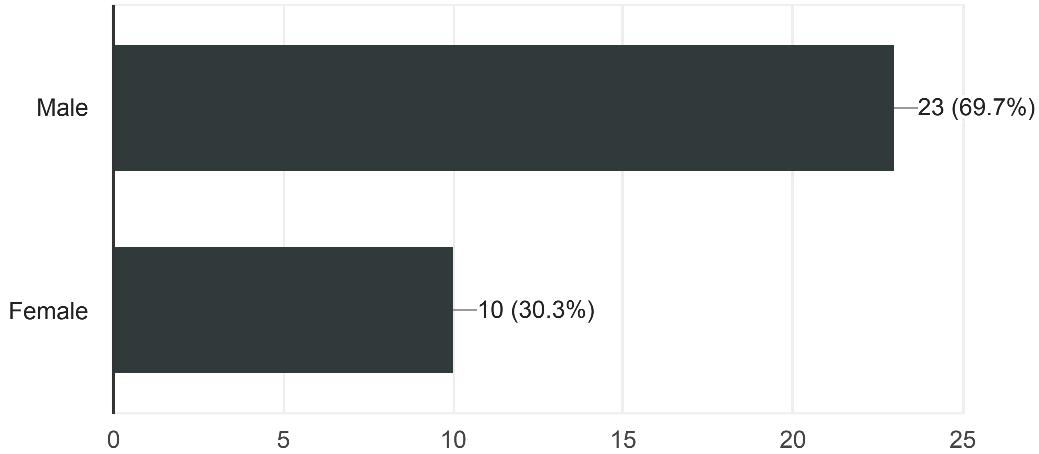
Suspense Study-Part 2: Post-task Questionnaire

About you

33 responses

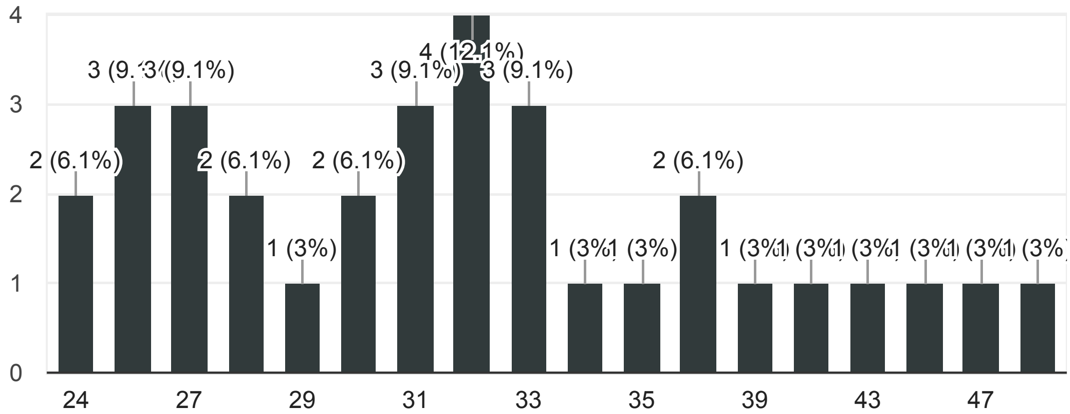
1. Gender

33 responses



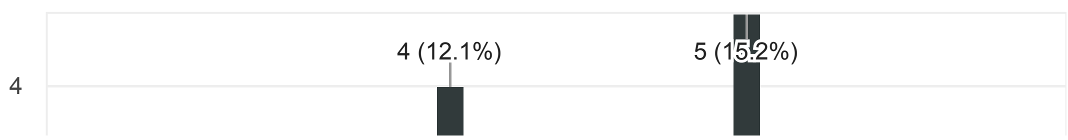
2. Age

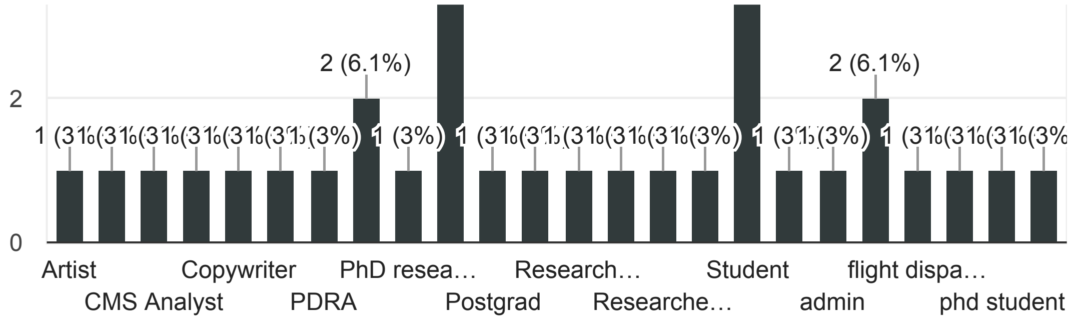
33 responses



3. Occupation

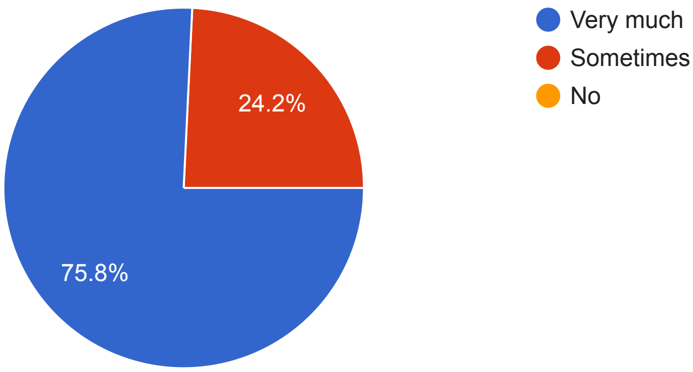
33 responses





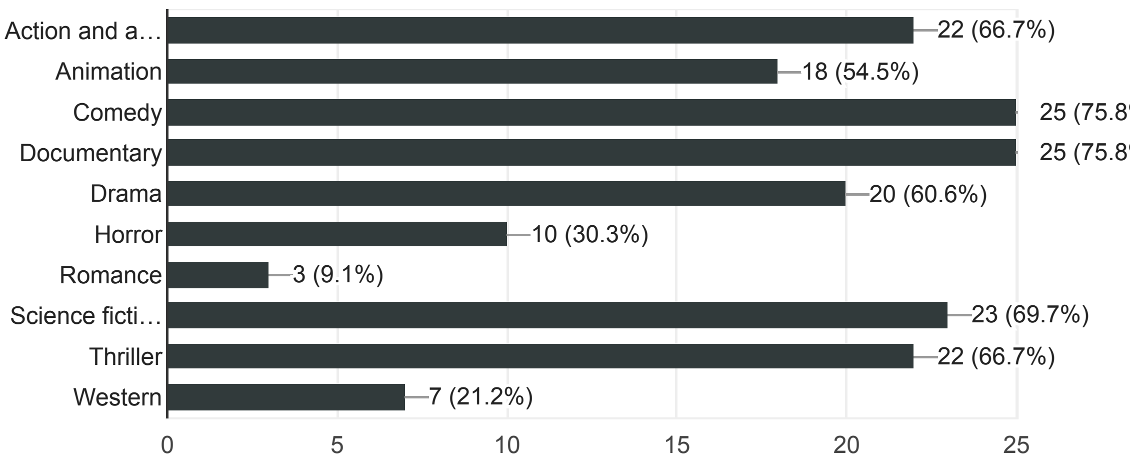
4. Do you enjoy watching movies?

33 responses



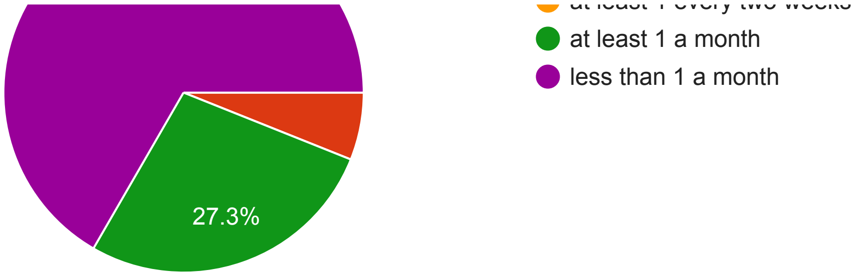
5. What genres of movies do you like? (You can select multiple genres)

33 responses



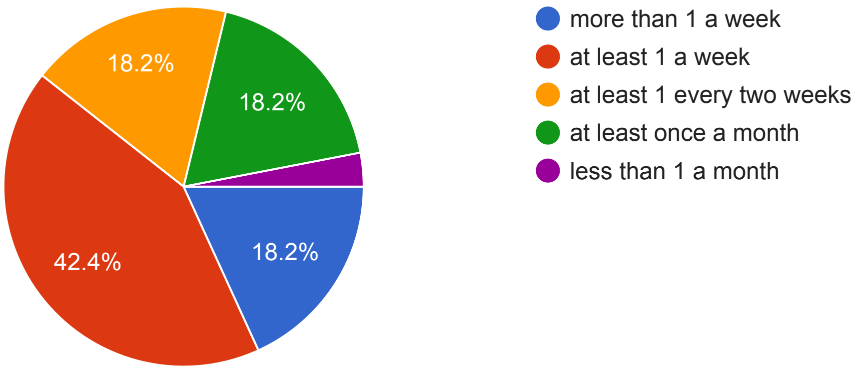
6. How often do you go to the cinema?

33 responses



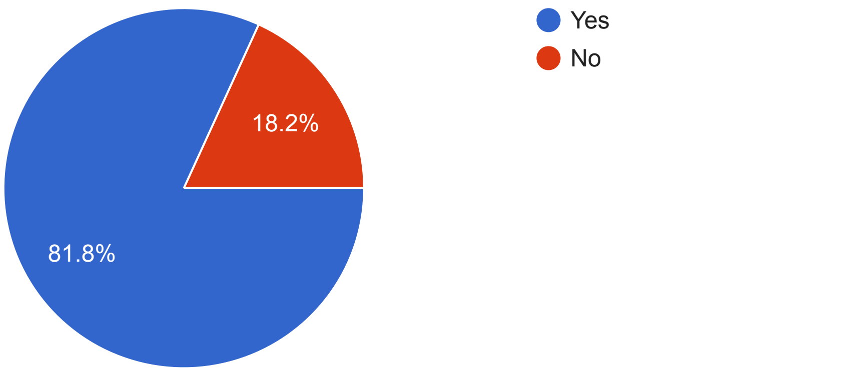
7. How often do you watch movies at home?

33 responses



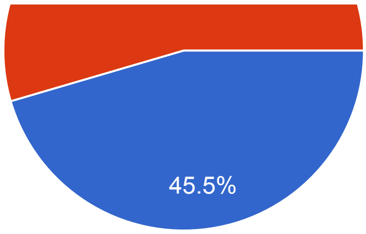
8. Do you enjoy special effects in entertainment (e.g. 3D, vibrations,..)

33 responses



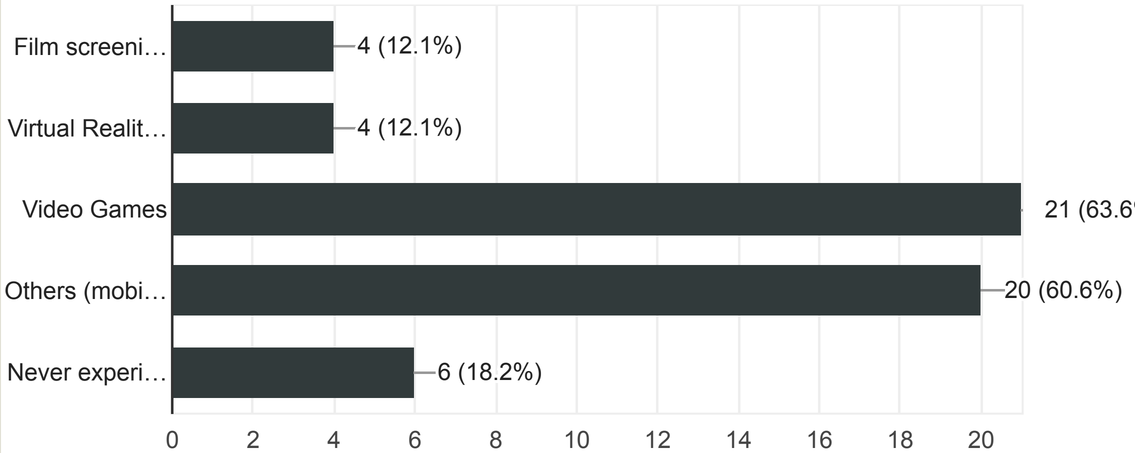
9. Have you ever been to a 4DX Film screening (4DX includes motion seats and special effects such as wind, fog, water, scents)?

33 responses

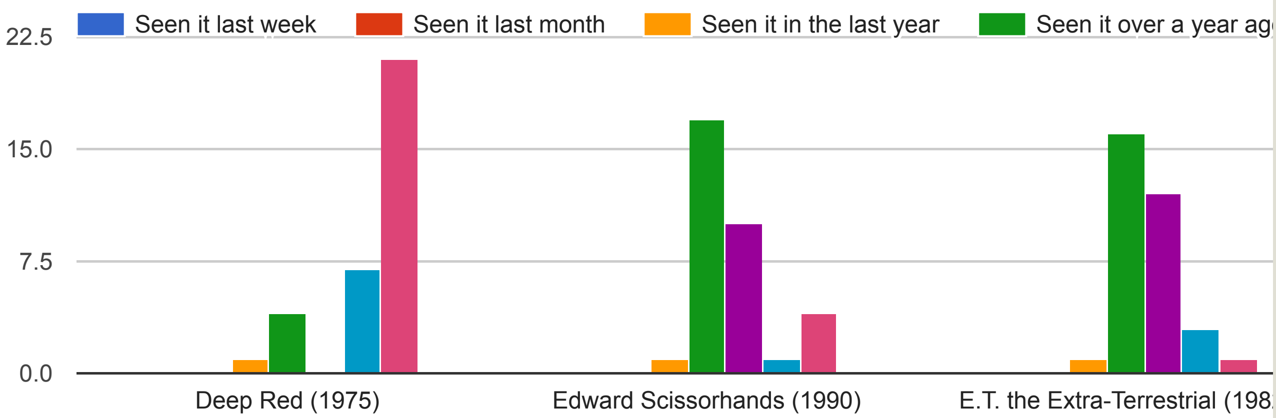


10. In which environment have you experienced haptics before?

33 responses

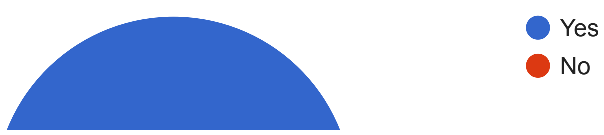


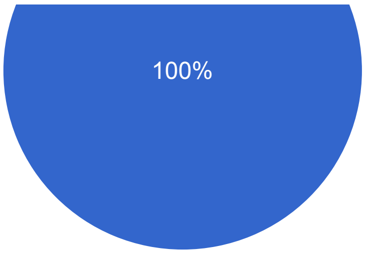
11. Have you already seen or heard about the following movies?



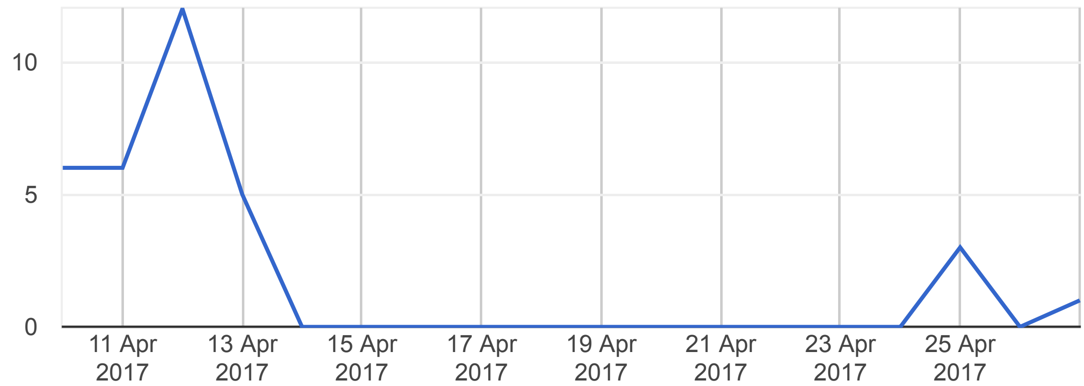
12. Did you enjoy taking part in this study?

33 responses





Number of daily responses



Appendix M

Thematic Analysis: Interview transcripts

Suspense Enhancement Study

Participant 1

- Q1. In a few words, how would you describe the experience?
- A1. I'm not sure. First of all it was fun because most of those films i have not seen in like 3-4 years, and 1 i haven't seen before maybe, 2 haven't seen before, which was fun. I guess the glove was **interesting** 'cause the clip i found most suspenseful was a film i didn't know, i think maybe this was in part related, it wasn't like yeah i remember that scene.. It was […] [she describes the scene from the clip of The Sixth Sense] And the glove wasn't doing very much in that actually, but that also was good for me because it was this empty scene, nothing happens in that clip but it was what i found most uh uuuuh and everything was very **interesting**. There were parts instead i was like uh uhh i love the scene and there was a lot going on with the glove and it kind of seemed **correlated** for me. Yeah the experience was **interesting** yeah.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yeah basically i felt when there were more reactive scenes there seemed to be more vibrations basically [she explained later that by 'more vibrations' she meant more instances of vibrations and more intense]. And then there were a few that were quite quiet and that's when there seemed to be less.
- Did you find it distracting? *Answer:* ehm only when it was quite intense but in the clip there wasn't a lot going on, so there was like the Inception clip [she describes the clip] ..the woman is doing nothing effectively but the glove was vibrating quite a lot, [she laughs] and you're just like this doesn't match in my mind, but then in more busy clips where there was a lot of stuff going on i didn't realise it was happening, i wasn't paying attention to it.
- Did you notice changes in direction? *Answer:* I know there were different points in my hand, but didn't notice anything pattern-wise no.
- Q3. What did you most enjoy about the experience? and Why?
- A3. I enjoy watching clips in general, and i enjoyed rating quite a lot as well because i guess i was quite conscious when i was watching the clips. I wasn't thinking about the glove that much or the experiment, but <u>I was thinking about how i felt while i was</u>

watching, that way i could give you an answer, which is nice to do, is quite nice to think about how you feel

- Q4. What did you least enjoy about the experience? and Why?
- A4. It's quite frustrating when you watch something for like 10 seconds [laughing] and it cuts and you're like i wanna watch more [more laughing]. That's it, it was quite enjoyable, nothing really, it was fine.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yeah i think it's **interesting** because it's not a literal haptic feedback, which is something that happens in VR, where most of the haptics even if it's not literal in terms of the sensation is not the same as what you're meant to be experiencing, the cues are still literal, where here the cues are **emotional**, which is **very interesting**. […] I think the hand for me feels quite **intimate**, you know, i think when you have a chair is less ehm, there is a kind of metaphor if you're like strapping into an experience you know, whereas the hand maybe you kind of, i don't i don't think if I was like watching a film in bed i'd wanna put something on my hand, you know what I mean? Whereas if i were in a space where my environment allowed me to, like the seat for example, where they'd generate haptic feedback, then i'd probably be much more up for it.

- Q6. Any further feedback you would like to leave?
- A6. No i think it was very simple and very clear, it was a good experiment.

- *After Q4 participant was briefed on how the glove works*
- If it helps, as i said, i definitely felt with some clips where it was mhm, i had no idea about the score but i definitely kind of felt there was there was a relationship between the content and the vibrations, to the point that when it wasn't i noticed it. You know? it was surprising to me. And it's good to know that some are randomised 'cause that feels more like what i experienced in some of them.

Monday, 22 May 2017

Suspense Enhancement Study

Participant 2

- Q1. In a few words, how would you describe the experience?
- A1. I enjoyed it. It's just different, sometimes i felt ehm the glove like kind of melted into the background especially in the, i'd say the more active bits, it kind of, you know, especially [inaudible] different patterns

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Sometimes yes.. ehm i mean, i tried to do what, you know, i tried to just watch the movie, ehm, but sometimes for example I've noticed if not the patterns the tempo, you know, that kind of rise between you know, flicking through different patterns, quicker or slower, which kind of moved nicely with the scenes.

- Q3. What did you most enjoy about the experience? and Why?
- A3. Ehm, I quite like that it kind of added an extra dimension to, to kind of, the level of tension you wanted. Maybe tension is too narrow of a descriptor, but the kind of the speed of things happening on screen it kind of added, things like that so it was like, i felt like when things started happening you know, it add to that, or when things start calming down again you know, things would slow down yeah.
- Did you feel it was linked to something?
- Sometimes i felt it was cued to the music, ehh but not always. so i felt it was almost a combination between music and then and visual cues.

- Q4. What did you least enjoy about the experience? and Why?
- A4. Ehm.. i mean wearing a glove in general it can be quite you know? (*me:* weird?) yeah! but to be honest you know, by like clip 4 or 5 i pretty much forgotten about it, i wasn't aware of it, it was just part of the experience.

- Q5. Is the addition of haptic sensations, as you experienced it today, (interruped) a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. I would say so, i mean it kind of confirms what i thought, that i thought that it was synced to the music, and i guess sometimes the music is synced to the visuals so you end up with kind of by proxy [?]. I particularly enjoyed the circular one. I mean, it's the only time i really noticed it during the E.T., maybe because i'm more familiar with the film so you know, getting a bit more excited about what is gonna happen and when it started speeding up you know, i said that, that has really added to the experience.
- After asking again the question w/o interruption this time:
- Yeah, I'd definitely be interested in how to do a [inaudible] full length. i mean, the only time I've ever experienced anything like this is when i went to see "Gravity" in the 4DX. I mean, my girlfriend felt sick but i enjoyed it so i think it's the sort of thing that i could enjoy you know. I'm the type of person who enjoys a 3D movie and i'd enjoy this probably as well, yeah. And and i thought this, you know, this is definitely cool.

- Q6. Any further feedback you would like to leave?
- A6. No i think i said all.

Monday, 22 May 2017

Suspense Enhancement Study

Participant 3

- Q1. In a few words, how would you describe the experience?
- A1. Ehm i was interested in the eh watching the clips, like [inaudible] i forgot that i was wearing the wearable, so, i think it adds to the experience but for me, i mean it's my personal taste, is what i do for a living but I could not separate it from the music so, every time like i was feeling like tense or excited or like calm or not calm it had to do a lot with the score of the movie, and, yeah for example in the "Inception", "Inception" clips i was [inaudible] really cool, when i was feeling the vibrations that go with the music, so i liked that.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yeah. Different intensities, and of course different patterns, and..yeah i think the rate of the patterns and the intensity.

So when you say pattern, did you notice like the direction or like the way they were moving?

Yes exactly, i do I didn't kind of got the pattern like these are really happen, i don't know, maybe i felt it was going this way or maybe not even in a circular direction so.. but i didn't recognise patterns.

- Q3. What did you most enjoy about the experience? and Why?
- A3. What i enjoyed most.. yep probably this like feeling that I see can get, the experience can get broader or augmented by by having this sensory exp. like experience but is not something that you focus on, so it's something that is there and can go through the sound or what is happening in the scene or.. i don't know if maybe, i felt at some point that the clips were too short.

- Q4. What did you least enjoy about the experience? and Why?

- A4. Probably the clip of “Gravity”, just because i don’t like that movie so.. nothing like negative feeling but because of my personal opinion about the movie - laugh- [inaudible]

After being briefed on ow the system works:

I think that’s really.. like for example i don’t know like a circular pattern like in a .. increasing of intensity cool, i see it working i don’t know in a scene when somebody is chasing somebody and it’s like reaching the climax but i don’t know, in a scene where you have an explosion or something happens it has to be towards that kind of action happen

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?

- A5. Yes definitely, and even like, because you said that, well i’m not sure how do you extract like the kind of pattern and it would be to match the sound of the movie, but i also could see it like that, music is really like, listen to some music and have haptic feedback. Of course i would like that, that’s really cool.. and that’s a question, so how do you extract the mood of the soundtrack? [i tell him] Ok thanks. In my experience I just noticed it because of video games. [i talk about the use of haptics in games and also VR, and how different it is with how i developed the glove system] Yeah yeah, interesting, how to make it subtle. [go on talking about 3D movies and now the 4D experience] Yeah i haven’t tried 4D movies but maybe like, i don’t know like yeah it can be like right in your face but within reason like it has to work like yeah let’s do everything 3D or now all haptic vibrations on the movie, like if it goes like at the maximum intensity because there is a reason and, yeah also i was expecting the horror scenes [i start explaining why: that’s the thing, so trying..] he goes ‘that’s too obvious’ and laughs.

- Q6. Any further feedback you would like to leave?

- A6. Ehmm no, i think is really cool, i like it. Maybe just, when i play this video game, “Fifa”, you know “Fifa”? So when is like the last penalty of the football match and if you miss it you lose and if you score it you win, so i think they put the controller of the playstation like at the maximum of the vibrator, is like really intense and i think that increases the pressure a lot because it’s the last goal of the match and is like vroo vroo [tries imitating vibration on playstation controller] like so maybe that’s a way that being on your face works because it really works i think. And with music i don’t know like, also all the music that i like i like to feel the low frequencies and if i go to a good sound system and i feel the base really vibrating. So maybe having that like just something that goes with the base, well it doesn’t have to be the base that’s just, that’s my personal taste again, i could really like that. Maybe i wait that you can equalise it to, i don’t know because it could be yeah that music producers that want their music to be experienced like that or maybe is the user that wants, i want this to vibrate in this way with this kind of music because i like it like that.

Monday, 22 May 2017

Suspense Enhancement Study

Participant 4

- Q1. In a few words, how would you describe the experience?
- A1. I really liked it, ehm especially some of the patterns where was kind of circling around the hand and getting faster, that were my favourite ones. Yeah i enjoyed it.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yeah the direction. It felt like some of them were speeding up as well, like as things got more tense. Eh yeah you'd feel the speeding up pattern on your hand, it felt like **it worked pretty well**, ehh whereas the other ones it stayed a bit more still and i find it didn't work quite as well, but yeah **i really liked this feeling of going around in a circle**.

- Q3. What did you most enjoy about the experience? and Why?
- A3. Ehhh yeah i m.. **i was surprised how well it worked** in a way, like i wasn't expecting it to actually get so much, it's amazing how you can ignore that it's on one hand and you just don't..you stop really thinking about where the vibration is and just..yeah, how it affects what you're watching, yeah.

[me: was it distracting at any point or?] *answer:* no, no no.

[me: so you actually forgot about it?] *answer:* yeah, kind of. Huh huh.

- Q4. What did you least enjoy about the experience? and Why?
- A4. I don't know, i enjoyed it! there wasn't anything, yeah.

Participant is briefed on how the system works and is told he experienced 8 patterns in a circular way and 8 'artistically' composed. [me: so you did notice that there was a difference in the patterns, [*participant:* yeah i noticed that, yeah yeah definitely.] and you said you preferred more the circular one..] *participant:* i felt that kind of way it worked really well yeah, just 'cause it was, it was **simple**, and like i didn't, yeah i didn't really..all i got from it was this like raising speed you know, that went, yeah. Yeah, it was nice rather like, i didn't, with that i felt **it didn't focus too much on the individual points of**

vibration, it was **more just like the general sensation, 'cause you know what's happening**. Yeah. Yeah, that's what i felt, yeah.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yeah i could imagine if you had like, you know, **watches or something, that could vibrate and do it**, yeah. Yeah, it would be **interesting**

- Q6. Any further feedback you would like to leave?
- A6. No i don't think so.

Monday, 22 May 2017

Suspense Enhancement Study

Participant 5

- Q1. In a few words, how would you describe the experience?
- A1. Ehm ok. To be honest I didn't.. i think it would be..i don't know if I, if it would make much more impact if i had both hands with that, because right now it was a bit ehhm, something massaging my hand, not really something kind of..correlated very much with the movie ehhm that's what i felt ehhm.

[me]: do you feel it would be more effective if it was more like a full body experience?

[participant]: yeah probably, probably something like that, because right now maybe it's also because of my hands or anything I..i didn't feel very much the glove on there, it was doing some things but i don't know, at some point it started taking the beat of..the music, i think, something like that, but..i'm not quite sure and..usually i don't know, I..i just don't know really but.. i don't know how to describe the experience..I mean, ehm.. usually when i'm matching the movie i see big screen and i'm like that and so..and usually i'm not very much into different kinds of you know..except seeing the movie and listening to it, i haven't got much experience with other [inaudible] or vibrating seats or whatever and..i really can't..i'm trying to comment on that but i really can't, can't think of something, sorry.

[me]: No it's ok, don't worry! Ehm.. [onto next question]

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. I..so, at some points i had.. so it was a movie and..which based on the music and the ehh..what was going to ehh..I was going to describe it as..so it gave me something exciting but then..or viceversa, but then because of the rhythmic hit on the hand i felt that something bad was going to happen, so there was this kind of contradiction at some point i feel, but apart from that ehm not really..

[21.41]me: do you remember what clip that was?

[21:44]participant: ahh..i'm trying to.. it was an old movie, that's for sure.. and..i don't really know the movie and i think either it was when the ehhm.. I'd have to see the movie again to to remember it, i can't really remember it sorry.

[22:12]me: it's ok. do you remember the characters?

[22:14]participant: ehm i think the was a man driving.. and that was a lady throwing..

[me]: ok, that was the scene from Vertigo at the Golden Gate bridge in San Francisco.

- Q3. What did you most enjoy about the experience? and Why?
- A3. Ehm..first of all, i like watching movies so..and i like trying to figure out..this is something i usually do, i try to figure out what's going to happen based on the music, mostly, and based on others so..i noticed watching all those ehm consequent movie clips actually it made me kind of think of those bit of correlation between ..anyway yeah so i'm also thinking out hmm i don't know, other things as well.

[23:50]me: ok, so you said that usually when you're watching a movie you focus more on the music to try figuring out what's going to happen [24:01]participant: yes yes yeah, and also i tell you this, **there were some cases where this glove actually gave me a hint** hmm so yeah.

- Q4. What did you least enjoy about the experience? and Why?
- A4. Mmm I'm not sure actually about that..least..the small screen! Yeah

Participant is briefed about how the system works. [25:38]participant: I remember now, because you said that, i remember what i didn't like very much, i don't know if it was the least.. I felt that the, so usually when i had..i've only had haptics in video games so [inaudible] I was having the controller or sometimes the joystick controller and starts moving or this in arcade you know ehm a wheel, this was very positional, i think it was going a bit like this (points at different points on his hand in a circle) and **at some point i remember it kind of distracted me**, this thing that was going tuc tuc tuc tuc tuc tuc tuc

[26:21]me: ok, so you noticed that there was a direction

[26:24]participant: yes, so i don't know

[26:27]me: did you notice whether it was always that direction?

[26:29]participant: no ah i think it went like that (makes a rotary movement with his finger pointing on the back of the other hand) but i'm not quite sure because i didn't pay attention in..every time when it was going, but at some point i had to pay attention, **it made me actually pay attention** because it was going like that (makes same movement with his finger) i think

[26:46]me: so it bacame distracting when it was [26:48]participant: yes - me: going in a circle?

[26:50]me: ok. -then i finish briefing participant about how he experienced the patterns, 8 in a circle and 8 composed.

[27:55]participant: yeah **i think this was a bit more distracting, when it was going in a circle**..ehm because i can't remember the other ones.. Yeah and the other thing is that i would like to have both gloves maybe, to have some kind of symmetry you know.. ehm yeah, i enjoyed in general, i enjoyed the..i like watching movies.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. [28:50] Mmm yes but not just a glove

[28:54]me: yes, not just with a glove, i'm talking more about the underlying mapping, idea

[28:57] yeah I think it would be..it would be good i mean having a more experience, usually with those, i don't know, with those extra effects like 3D and surround sound and..everything i've noticed is that **i enjoy them once they're well implemented**, and i don't enjoy them as much when they're not very well implemented. So, it's kind of a threshold, for me at least. **I want it to be very good or not at all**.

- Q6. Any further feedback you would like to leave?
- A6. Ahm no, not really, i don't have anything else to say. It was nice watching some movies.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 6

- Q1. In a few words, how would you describe the experience?
- A1. Yeah it was quite interesting. I felt like… at first I thought the glove was synced to the soundtrack and then I realised that wasn't the case. So, part of the time I was thinking about the vibration and than watching the clip. I wouldn't say it was distracting me, I was just interested more in the glove at some points. I almost wanted the vibrations to be… to rise and fall very subtly instead of just buzzing on and off quickly, because I think that's too much like an alert on your phone. It would be nice if it was just like very subtle and just faded in and out. That would give it a bit more tension or realism.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Some of the clips felt more intense, or just like quicker. I was thinking why was it sometimes really quick, like short little bursts and sometimes why was it longer. So I kind of wondered what the difference was or what it was trying to highlight. It felt like it was synced to something, or maybe it was synced to the words or the emotions or what was being said. So I felt like it was sort of noticeable.

- Q3. What did you most enjoy about the experience? and Why?
- A3. Just the idea of the glove, the vibrations, the extra sensory element to watching the movie. It was quite sort of engaging. I mean I loved the E.T. clip, I thought it worked really well with that. I'm not sure why, maybe it's just a personal favourite. I was kind of wondering if you could wear it on your head or maybe have both hands involved.

- Q4. What did you least enjoy about the experience? and Why?
- A4. The clips were too short. I just wanted to see what was going to happen next. I felt like tension was building and then it just kind of stopped. The glove was kind of helping that tension. It would've been nice if the clips were a bit longer.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yeah, quite possibly. Maybe if there were two gloves and a headset or something.

- Q6. Any further feedback you would like to leave?
- A6. No, I think that's it. Really interesting experiment. I think it's a really great idea and it'll be interesting to see what happens next.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 7

- Q1. In a few words, how would you describe the experience?
- A1. Pleasant and stimulating for my sensory properties in my hands. Yeah, enjoyed it.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes, I noticed sometimes they were circulating. Sometimes they had something at the beginning which was changing during the clip. So, it looked like they were designed somehow so they were not just the same pattern over and over. Sometimes they were highlighting some words. I remember there was Leonardo DiCaprio was saying something and the thing moved and so the sensor vibrated, so it made me curious how they were designed because I thought they were following the music. But sometimes the music had its own structure and they had a different structure, so they were really adding some interesting feedback.

- Q3. What did you most enjoy about the experience? and Why?
- A3. I really liked the choice of the clips because it was a nice selection of very well made movies, so it was nice to listen to the music as well because the music was important in these clips. So it was interesting to have this addition of the hand that was kind of connecting to your body a bit more because the music already does, but it is like the action in the scene is touching your hand in a sense.
- Q4. What did you least enjoy about the experience? and Why?
- A4. Well, just that the clips were cut at some point so I wanted to keep watching.
- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. I guess so. Yeah, because it's another form of design in a sense. If someone is thinking of how the vibrations are affecting someone else's state it's the same thing that a film does which is kind of telling a story, so it's just another language I think.
- Q6. Any further feedback you would like to leave?
- A6. I hope you keep working on it.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 8

- Q1. In a few words, how would you describe the experience?
- A1. It was nice. I kind of knew some of the movies already, but it was a nice experience. Sometimes they were creating some expectancy and I was expecting the scene to resolve and it was nice. I mean when there are movies that I know, I know how the tension's gonna be. When there are movies I don't know, I don't know what's going to happen afterwards. So I guess that's the difference. Sometimes when you see a movie you don't know you get more excited because you don't know the result. But on the other hand, when you see a movie you know you also get excited because you know what's going to happen. So you're expecting that to happen.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yeah. On some of them they were like, the haptic patterns were also in rotation around the hand. On others they were really soft and calm and they weren't increasing the tension of the scene. Different intensities and rotations.

- Q3. What did you most enjoy about the experience? and Why?
- A3. I don't know it's hard to tell. The variety of different scenes and sensations across the whole experience, I guess.

- Q4. What did you least enjoy about the experience? and Why?
- A4. Maybe not being able to watch all the movies again. There's nothing that I didn't like. If I had to say something, basically in some of the scenes I was expecting something to happen and then it cut out.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yeah, I can see it would be nice, especially in a movie theatre for some movies when you pay more attention to the soundtrack because of the whole setup. Then it

definitely would make a difference, make it more enjoyable. Or if you were watching like a 3D movie, that would be very nice.

- Q6. Any further feedback you would like to leave?
- A6. If the clips were slightly longer it would be amazing.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 9

- Q1. In a few words, how would you describe the experience?
- A1. Yeah it was interesting. It was fun. It didn't feel like it was annoying or anything. It felt like it fit comfortably so it wasn't intrusive or anything like that.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes, definitely. It felt very much on the level of the music, if it was base heavy or suspenseful. Yeah, if there were bassy notes you could feel it a bit more if it was louder, more rumbling kind of stuff. I couldn't figure out exactly what the relationship was but I could definitely feel a difference [in the direction].

- Q3. What did you most enjoy about the experience? and Why?
- A3. I just enjoy watching movies, so I suppose that was it.

- Q4. What did you least enjoy about the experience? and Why?
- A4. I'm not really into old movies, I suppose. I do like some of them, but generally I prefer more modern stuff.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yeah, yeah. I think any of these extra senses to movies is a cool addition anyway. I've been to the 4D thing and I thought it was really cool. I like the chair thing.

- Q6. Any further feedback you would like to leave?
- A6. No, no, that's it.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 10

- Q1. In a few words, how would you describe the experience?
- A1. It was a lot like the first time, but actually the procedure was different, so it was like my first time actually, even though I did it before. It was different actually. Different from the other kind of movies, 3D, even if I want to the IMAX for the effects. It was different. Something new actually.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yeah, yeah, of course there was a difference. Sometimes they were related to how tense, more tense or excited the scene. Other times not seems totally related or less related to the scene. When it was tense it was vibrating a lot, the intensity was bigger, when it was calmer it didn't vibrate or vibrate less. Also in the direction, especially from clockwise or anticlockwise in the pattern.

- Q3. What did you most enjoy about the experience? and Why?
- A3. Some scenes from Inception. I like the movie. At the time when I saw the movie I didn't fully understand it, so I'm going to see it again. It was like being inside, especially with the Inception movie with all the walls falling down and with the vibration it's like being inside the movie.

- Q4. What did you least enjoy about the experience? and Why?
- A4. I don't know. Probably the fact that sometimes I felt, from my point of view, sometimes I felt that the vibrations weren't so much related to the scenes. Sometimes the tension came from the hand instead of the scene itself.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?

- A5. I think it can add additional experience to the scene of the movie. For example, like the 4D experience with chairs moving or whatever, even vibration can add more to the movie. So, yes.

- Q6. Any further feedback you would like to leave?
- A6. No, no.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 11

- Q1. In a few words, how would you describe the experience?
- A1. Interesting. Positive and engaging.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes. Sometimes it felt like the intensity was different. Other times I could tell the rhythm was different. Sometimes it would happen in different pulses.

- Q3. What did you most enjoy about the experience? and Why?
- A3. It was unique. It was new. I'd never done something like this before. So mixing that with the music, it didn't feel strange. That was the weird thing. It didn't feel it was foreign. It felt like it fit together.

- Q4. What did you least enjoy about the experience? and Why?
- A4. Probably the questionnaire. I just got a bit confused at the beginning. I understood it, but I just had to double think and it took me away from the clip. I had to come out of it and think a bit. I know you have to measure it, but it took me out of the experience.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yeah I think I'd like to try it again. I think it did, the first time I felt it, it felt a bit weird, but then I got used to it very quickly. It's like you said with the video games, you stop noticing it and it does start enhancing the experience a bit. I just enjoyed it as well, it felt quite soothing as well. Not in an relaxing kind of way. I don't know, it just felt quite nice. I liked it.
- Q6. Any further feedback you would like to leave?
- A6. No.

Saturday, 1 July 2017

Suspense Enhancement Study

Participant n 12

- Q1. In a few words, how would you describe the experience?
- A1. It was immersive. I think I had a little bit of problem with the glove, that it wasn't tight enough, so I didn't feel it as much because you've probably stretched it out. But I could feel everything. I thought it was very interesting. I thought that it did enhance some of the clips. So it's something I'd like to experience again. It was a good thing.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes. There were different patterns and I realised that with, I don't know, like a crescendo kind of that pattern, it got to be more… Sometimes I thought that it was trying to warn me that something was going to happen and then the clip stopped. There were some patterns that kind of took my attention more than others, where I didn't, I don't know how else to say it.

- Q3. What did you most enjoy about the experience? and Why?
- A3. I thought on some of the clips it complemented a lot what I was seeing and I can't explain why it did that, but it was really interesting. It was really, really interesting to have something that is maybe feeling the way you're feeling and mirroring it a bit. It really did enhance your natural… with the music and your own emotion, enhancing it, it made you feel things more.

- Q4. What did you least enjoy about the experience? and Why?
- A4. The only thing I would say, the clips are small so it wasn't as immersive, but that's it really. That was the only thing. If the screen was bigger, it could have had a bigger impact.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. I would, yeah. I thought it was really interesting. I had a great time.

- Q6. Any further feedback you would like to leave?
- A6. No, no. I thought it was cool to try something that other people don't get to try. I feel very privileged.

Saturday, 1 July 2017

Suspense Enhancement Study

Participant n 13

- Q1. In a few words, how would you describe the experience?
- A1. I think it was interesting. I never did any kind of [inaudible] film experience. I think that it mostly focussed on the images and the sound to be honest. But when on the few occasions the haptic feedback was matched very well with what I was seeing, especially with what I was hearing. The car that was approaching the Golden Gate Bridge, it was actually very nice. These clips, all these movies had a lot of suspense so I was absorbed in the scene itself.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes. I think that sometimes there were they matched quite well with the music to some extent. At least the rhythm. Not sure about the pattern in the hand. I think sometimes if the music was kind of circular, the pattern in the hand was kind of circular. Other times, I tried to pay attention specifically to that, but I didn't really get why it was vibrating like that. What was the idea. Different yeah.

- Q3. What did you most enjoy about the experience? and Why?
- A3. I think it has great potential. Even for just listening to music I think it has great potential. Documentation with haptic vibrations, even just with the bass, putting your speakers on your chest, like having your body as a vibrating, resonating body. That is great. So if you can [inaudible]. I think it has great potential. The mapping, I tired not to pay too much attention to not be distracted too much.

- Q4. What did you least enjoy about the experience? and Why?
- A4. Sometimes it was really frustrating because I could not get the mapping. It was not intrusive. It was just ten minutes, fifteen minutes, whatever it was, I'm not sure if two hours movie, with a constantly vibrating hand. Or maybe, I probably would've enjoyed having both hands. So a kind of stereo effect, would've been great. [inaudible… two hands].

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. I think so, yeah. I would like probably not sure about in my hand. I think that maybe… it's not uncomfortable. But if it's a hot day, you know these kind of practical things. I think I'd probably give it another try.

- Q6. Any further feedback you would like to leave?
- A6. No, I don't think so.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n14

- Q1. In a few words, how would you describe the experience?
- A1. So yes first of all I saw similar experiences, yes…but this was more you know more the emotions and the device..and more elaborated than what I experienced in the 4D movies. I actually enjoyed it a lot.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes, I mean..I can't describe it but yes. Yes yes, intensity and frequency of the vibrations. And also in same clips there are particular motions, the kind of direction yes.

- Q3. What did you most enjoy about the experience? and Why?
- A3. Yes, I mean like..it was new, something new experience, I wanted to enjoy more. For example [for] the all movie or something yes. And I also think it was only the hand right? But if it were like both hands and also on other parts of the body it would be more effective, and yes so I was thinking imagine how.. I think it would be like very interesting if the devices are extended in different part of the body.

- Q4. What did you least enjoy about the experience? and Why?
- A4. No, I didn't find anything bad

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yes yes certainly, it is very interesting.

- Q6. Any further feedback you would like to leave?

- A6. Yes, of course I was expecting how it works during the.. watching the clips, of course I expected that the emotion was created according to that music so, yes but.. But in some clips yeah so the emotion was quite in accordance with the music like in synchrony yeah but.. I don't remember which ones but, in some clips, maybe by intention but, but it wasn't. In sync, obviously it was better.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n15

- Q1. In a few words, how would you describe the experience?
- A1. It was good. I mean I haven't had much experience with haptics before..ehm it was like… it made me think like a massage…I wanted it more on that side of my hand [indicates the left side on the back of the hand] [laughs] but yeah it was enjoyable, it was something new for me. Yes.. I used to play videogames a lot when I was young, not so much anymore..and VR not so much but yeah in the use of the phone right we get haptic feedback.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes for sure. One was in more regular spatial pattern across the hand, I think it was across the hand and it was working really well with the music, but yeah like a couple of them was just random in the hand and it was interesting as well. So I notice differences for sure.

- Q3. What did you most enjoy about the experience? and Why?
- A3. Seeing how the haptics worked with the other elements of the film ehm.. because I studied film studies for a long time so it was interesting to me see how these different elements interact. I used to write about sound and how sound interacts with narrative so..seeing how the haptics worked in these kind of ways it was interesting to me.

- Q4. What did you least enjoy about the experience? and Why?
- A4. I really don't like horror films so like a couple of them I was like..mm this is really scary..

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. I don't know, it depends on the type of movie..ehm..If it was like a big kind of a blockbuster, roller-coaster type of movie, then yeah maybe I'd try, but I don't think I

want to try enough to pay a lot of money to try. Yeah, but generally most of the films I watch are a lot calmer, slower, do you know what I mean? Kind of house film so maybe it'd be kind of weird in that situation.. I feel it goes well with more hectic Hollywood films.

- Q6. Any further feedback you would like to leave?
- A6. Nothing.

Monday, 22 May 2017

Suspense Enhancement Study

Participant 16

- Q1. [26:56] In a few words, how would you describe the experience?
- A1.[27:01] Ahm..at one point i started getting..wait I..**it was really natural**, and then <u>at one point, about half way through, i started like wondering where the motors were, and started looking at the glove, and kind of **got distracted**</u> by the glove, not because it was vibrating but because i was like ‘oh wait, how’s that work?’ and started like looking at motors and stuff like that, then i was like ‘no no no, back to movies’ so..

[27:30]me: is that any reason why you started looking at the glove and the motors half way through?

[27:38]participant: because at the beginning i think the vibrations were very **motor by motor**, and towards the end they seemed to be like **blended and using multiple motions**, and that kind of made me think ‘how does that work?’ Or ‘am I actually feeling that?’ And then i started like, you know, watching them and stuff like that. Yeah so, that was the only thing.

- Q2. [28:01] Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. [28:04]Yes. They were much ehm more **complicated**, **much more intricate**, eh **much more composed** than at the beginning where they were very very..i’m assuming that was like, that was the idea, you don’t have to tell me! [laugh] No spoilers!

[28:22]me: ok so, as you noticed this difference, is there a way you preferred it?

[28:26]participant: **definitely the composed ones**. I thought they were **really nice** and that made it seem less like it was supposed to follow the music and more like it was supposed to be like eh, **like a fourth dimension sensation**, and eh ‘cause when it’s very like eh slow or they’re very very separate then it feels like motors, whereas when they’re all together..like there were some, some that were really really nice and i was, and i was like that’s actually, **it’s like this other layer of composition**. And i thought that was really actually **quite beautiful**, some of them were really really nice.

[29:01]me: can you remember any of the clips in particular?

[29:03]participant: there was one, the Edward Scissorhands one was really nice, the second one, you know where kids are running around the street? That one i really like. Ehm..There's also one at the end with Leonardo Di Caprio, with the cat in the background, ehh what movie is that?

[29:18]me: Inception.

[29:18]participant: Inception! That's right. And eh, there was stuff in there that was really nice, it seemed to be..ehh i guess the challenge is not making it seem like a [inaudible] to the music or that is supposed to be following what's going on on the screen, because it would be really easy to just make it like kind of bubble on with the music to do some sort of audio analysis and you know..how interesting is that? (sarcastic) But **the idea of it being like this other layer of expression i thought it was really actually quite interesting and and successful**, in..the ones that were really like composed, where's using all 5..was it 5 motors?

[29:54]me: Yeah

[29:54] 5 motors, and it starts like to go around your hand and be like, 'cause it's it's non, it's **noticeable but not intrusive**

- Q3. [30:04]What did you most enjoy about the experience? and Why?
- A3. [30:08] I think eh..ehh, that it was **very natural**, that **it kind of blended into the background**, that **it wasn't distracting**, it was **subtle enough** that it wasn't distracting.

- Q4. [30:23]What did you least enjoy about the experience? and Why?
- A4. [30:25] Probably the early clips, when it was just like, you know (makes circular gesture with her finger on the back of the left hands.) 'cause it feels very..ehm..the ones that were like, that were not composed, that were just like here are some motors, or here's perhaps random motors, or random amount of time, whatever it was, it **feels very gimmicky**, whereas the ones near the end, which were like much more ehm..to me appeared to be **much more thought out**, much more **composed**; those **started to feel like something else**, instead of just like 'here are some motors'

Participant is briefed on how the system works.

[33:06]participant: Yeah yeah **super cool**! I **found myself wanting to watch more of the movie clips**, like i wanted to like..especially the ones where you know, the sort of moments the i remembered, and going I'd like to watch this with this thing to like to get a more complete idea of what of, of **how it would add to the experience of a movie that i already knew**. So that was, yeah **it was cool.** I **want to watch more**! (laughs)

[33:34]me: did you feel that it was more with movies that you knew already rather than ones you didn't, or?

[33:38]participant: ehm, no no necessarily. I mean i just thought that it was like **really interesting** and and of course you're picking these like clips of the movie that are like, you know, either really tense or have a lot of plot, or that have this important conversation or lot of action, and, in that way, i mean, you kind of, **i was curious to see how it would be used in the moments between action.** And, what, what would the possibilities be in like not this super like this watershed moments in these films but, you know, between that, and how would you tie the two together, so maybe **really curious about** not necessarily the technology but the experience, like **what would** it **be like to watch** mov- like **an entire movie with one of these**.

- Q5. [34:24] Is the addition of haptic sensations, as you experienced it today, a feature/ effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. [34:30] **Yeah! For sure**. or video games! **Video games, would be amazing**! And i **love the fact that looks like a big Mickey Mouse glove!** (laughs) Yeah **awesome**!

- Q6. [34:52] Any further feedback you would like to leave?
- A6. [34:54] No no it's **really cool**! I'm i'm really, i'm **so excited about your work**, it think it's, i think **it's awesome**!

Monday, 22 May 2017

Suspense Enhancement Study

Participant 17

- Q1. [19:05]In a few words, how would you describe the experience?
- A1. [19:24] It was very interesting. Ehh i did notice myself trying to figure out what it was doing. I'm wondering if you were looking at the music score..and if you had the motors vibrate in base of that..but it wasn't linked to the frequencies..and..i got slightly distracted by this bit..

[20:04]me: Because you were trying to figure out how it works?

[20:07]participant: yes (laughs). You told me to forget it, but i did forget it sometimes, i did forget the glove sometimes, but i did..i did continue thinking about the way it worked.. which wasn't very distracting [inaudible]

[20:33]me: did you find the glove annoying?

[20:36]participant: no it wasn't annoying, 'cause I..i was expecting it to ehh..actually..no, not the same. I was expecting..you know, if you get this for an hour (mimics a pulsing movement with a finger) it starts to become annoying.. i was expecting my hand to..sort of..notice it less over the course of the experiment, so maybe less at the end..or get more annoyed, but was alright.

- Q2. [21:10]Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2.[21:14] Yes..this is what i was trying to figure out..

[21:17]me: ok, if you noticed any differences you can just simply tell me what kind of differences you noticed, like if they were in the direction, the intensity, the frequency of the stimuli..

[21:28]participant: I noticed sometimes it was quicker..there were different patterns..sometimes you had pairs (indicates 2 points pulsing simultaneously), we had a sequence, a rotating sequence..ehh..and then ehh.. that's about it.

- Q3. [21:57]What did you most enjoy about the experience? and Why?
- A3. [22:13] Hard question to answer.. if there is no least enjoyable thing..

[22:21]me: yes there is the least, i'm going to ask you in a minute. You can answer anything. Even if it was just watching the movie clips.

[22:38]participant: I liked watching the movies, and..the haptics were interesting.. slightly distracting because only on one hand..

[23:03]me: ok. do you think it would have made a difference if it was on both hands? would it have been less distracting?

[23:13]participant: maybe. Maybe, because there was focus on one side..ehmm

- Q4. [23:20] What did you least enjoy about the experience? and Why?
- A4.[23:23] It's not necessarily least but the..the contrast between old and new movies.. and..so the old movies had very..you know..instrumentation on every single step..and then..stuff like 'Inception' just has a soundtrack. And.. i don't also watch the..like movies that old..so..i had to, i had to get used to the instrumentation a little bit.. ehmm and i wanted to turn up the volume..of the music.

[24:19]me: oww. i did say at the start of the study to make yourself comfortable and adjust the chair height, screen brightness, and the volume! I thought you did, sorry.

[24:30]participant: mmm..oh you did..mmm, ok. It was fine. And i wanted the movie to be bigger.

Participant is briefed on how the system works.

VIDEO RECORDING CUTS AT THIS POINT.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5.

- Q6. Any further feedback you would like to leave?
- A6.

Monday, 22 May 2017

Suspense Enhancement Study

Participant 18

- Q1. [13:40] In a few words, how would you describe the experience?
- A1. Ehm..**interesting but slightly limiting**. I found that it was..haptic feedback is always very interesting when it gets with VR and all the development that we've got at the moment, it's a necessity and i've sort of been looking forward to new developments in terms of that..ehm..i feel **it did work to certain extent**, 'cause the sort of ramble **did match sort of patterns of excitement or tension** ehm..i felt i couldn't translate very further than on/off however with it..ehm..i was trying to find links between what was going on in the film and what was going on on my hand, so thinking about was it the contrast light or dark thing or was it music.. **it seemed to be quite linked with music, but then i couldn't find direct correlations**.. ehm it seemed to work in a similar way to a SUBPACK when you have it on your chair for movies and stuff, so it was quite similar.. ehm i felt the mappings could be a little bit tighter mmh but i don't know.
- Q2. [14:45] Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. [14:48] Yeah definitely, completely. So difference in **movement**, **direction**, and **sort of intensity**.
- Q3. [14:56] What did you most enjoy about the experience? and Why?
- A3. [14:58] Ehm..I enjoyed the fact **that my feelings of excitement or tension were mirrored to a certain degree by what was going on on the hand** but..the initial stage was there but it didn't follow through afterwards so..yeah i liked the fact that it was actually picking up a little bit how i was feeling but yeah..i was there wanting more, but that's always the way.
- Q4. [15:24] What did you least enjoy about the experience? and Why?
- A4. [15:27] Ehm..**when it was unnecessary**, ehm so..one of the films had, it was a clip of three guys jumping over a roof and the third guy gets stuck, didn't find it very exciting but the hand was going mental for it, and it was a bit of a **mismatch in terms of my personal expectations and what was going on on the hand**

[15:47] Participant is briefed on how the system works.

[16:54]participant: Interesting. So how did you get it matching the score? Have you got like a score reader or did you rescore or..?

[17:00]me: Through manual annotation.

[17:08]paticipant: Interesting. Yes. I wonder how much like using films from like the ‘50s..i guess if you were generating this from the score, and scores are cultural..how much does our understanding of ‘50s and ‘60s here affects that.. […]Yeah good system. What..How are you..exerting these? Are these just surface transducers here?

[18:52]me: they’re coin vibration motors, actuators. They don’t sense or take anything in, they simply output vibrations.

[18:56]participant: oh ok, so it just vibrates. So, is there a tiny thing in here turning them or?

[19:03]me: yes so there is a little mass in each motor and a disc. When the disc rotates it makes the mass move, making the motor vibrate.

[19:06]participant: right, so a tiny little..ok. And what frequencies can you access with them?

[19:11]me: they have a nominal voltage of 3V, typically around 2.3V, but it also depends on the pin that they’re attached to.

[19:29] Cool. **I want a whole suit with those on, that’d be awesome**, like a whole full on body suit with all [inaudible] up, yes.

- Q5. [19:39] Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. [19:50] Yeah it is, **it is definitely**. But in a way is..as your questions were indicating at the end, **it’s sort of more modern movie experiences** are sort of getting that way with dynamics, movement in your seat, and sort of olfactory response, and heating, and all sorts of things and..so yeah **i think it’s heading that way**, i think..there should be a system that doesn’t rely on the soundtrack, actually **i thought it was very effective ‘cause I could feel the soundtrack and the vibrations mirroring**, and then was trying to work out how it was working but..**i’d** almost **like to see that** done separately, sort almost like a separate curve altogether **throughout a whole movie** of intensity or whatever you’re gonna call it, to slightly build you up to these moments, **i think that could be interesting**. So yeah, **very good**.

- Q6. Any further feedback you would like to leave?
- A6. \\

Monday, 22 May 2017

Suspense Enhancement Study

Participant 19

- Q1. [13:47] In a few words, how would you describe the experience?
- A1. [13:50] Ehh i think it was **interesting**. I think, i guess at some point i was sort of wondering if the vibrations were synchronised with the music, [inaudible] at some point i was even wondering if the music was added on top of the film and it's not the music from the clip [inaudible] exactly. Ahh yeah it was **good**, it was **interesting**.

- Q2. [14:13] Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Eh so i tried not to focus too much on it, i think it was going in circles quite a lot..and..ehh no i couldn't say, no i don't remember [inaudible] any differences, i think it was stronger at certain points but..yeah.

- Q3. [14:38] What did you most enjoy about the experience? and Why?
- A3. [14:40] Ehh just sort of **relaxing** a little bit [laughs] watching some clips. Ehh i wouldn't say, i don't know, it's quite a **nice feeling** actually, [inaudible] sort of vibration..on the hand, i guess that's nice.

- Q4. [15:43] What did you least enjoy about the experience? and Why?
- A4. [15:46] Ehh..can't really think of anything in particular..i mean..yeah..is there any specific aspect you would expect or..? No i mean, wan't stressed, sitting back, watching some of these movies, with some music and the glove on, it was **really nice and easy**, so yeah, can't think of anything.

[16:13]Participant is briefed on ow the system works.

[18:02]participant: oh yes, now that you mention i can recall a little bit more the differences..

[18:06]me: ok so now that you know, did you prefer one mode better than the other?

[18:08]participant: I mean i guess yeah, **if** it's **just going in circle it's** like..you know..almost **a bit distracting** really. Ehmm the other one..i don't know, i'm not sure..yeah i'm not sure i would say adds so much to the movie experience, but maybe that's just me, i don't know. I think, yes i think that's preferable to the other one, which may be too distracting after a period of time, you know if you watch a movie for two hours and it gets in circle..it could be a bit annoying..ehmm yeah no, possibly the second one, is the better one.

- Q5. [18:50]Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5.[18:57] Possibly. I'd be, **i'd be curious to see how's implemented** yeah in a..you know, **in a full length movie** how it's used. 'Cause i guess, this like everything **you wouldn't want to overdue it** aahhh so i guess maybe does **add a bit of element of surprise or suspense** or..[inaudible] Yeah definitely up for try it and see how it goes with a full movie a full experience. Then ehh you know, as to whether i would experience every movie like that in the future i don't know.

- Q6. Any further feedback you would like to leave?
- A6. It's **almost as an editing device**.

Monday, 22 May 2017

Suspense Enhancement Study

Participant 20

- Q1. [15:33] In a few words, how would you describe the experience?
- A1. [15:37] Ehm **interesting** definitely. The first clip was pretty **fun because of the vibrations**. Ehh..Yeah **interesting experience**.

[15:50]me: did you experience anything like this before or..?

[15:53]participant: ehh..something similar but not exactly like this one, yeah

- Q2. [15:59] Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. [16:05] Yeah yeah. So I definitely, after like one clip I recognised that there was some specific pattern which was sometime a bit off off topic you know..[inaudible] **not synchronised**..but yeah

[16:25]me: ok, so you noticed some patterns. did you also notice the intensity of the motors?

[16:27]participant: yeah, yeah, yeah.

- Q3. [16:34] What did you most enjoy about the experience? and Why?
- A3. [16:40] Ehmm so the first clip was definitely the funniest one because i didn't expect it and, it was quite **new** definitely, yeah

- Q4. [16:54] What did you least enjoy about the experience? and Why?
- A4. [18:58] Ehh the patterns.

[17:02] me: so when you say patterns, do you mean the direction or the way they played or..?

[17: 06]participant: yes so basically ehm sometimes it was that **the focus went more to my hand than to the movie** so yeah..

[17:15]me: did you find it distracting then?

[17:17]participant: yes exactly.

[17:18]me: was this just sometimes or was it always?

[17:20]participant: ehm sometimes but most of the pat- so at the beginning of the movie it was ehh because i didn't ehh have the pattern already, but as soon as repeated or something, then i was like a bit focused sometimes so..so i had to actively focus on the movie again so i don't focus on my hand [laughing]

[17:45] participant is briefed on how the system works.

- Q5. [20:15] Is the addition of haptic sensations, as you experienced it today, a feature/ effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. [20:28] Yeah definitely. **If** it's ehm very **good synchronised to the movie** definitely yeah

- Q6. [20:38] Any further feedback you would like to leave?
- A6. [20:41] It was **interesting** [laughs] yeah it was, it was **fun**.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 21

- Q1. In a few words, how would you describe the experience?
- A1. I would like to watch more because it is like I was into it and then it suddenly finished.. I found it is interesting with the glove, because it's kind of…I don't know if it's related to the sound or the emotions but I can feel there is a link between the content and the vibrations but I am not sure how it is linked. So sometime I feel confused because some of the movies.. because I didn't watch. I don't feel that excited about it because at that moment I don't have any previous knowledge of what they did..so I can't feel the intensity of the drama in it, and I feel a bit confused about the vibration, so I was like.. what's this for? It's like I can't link the content so.. [with the movies I watched] I have the idea of what is going on and I feel it makes sense to have the vibration as well, to make me feel more connected in a sense. But with some of the movies..with old movies I didn't have a clue..I feel kind of distracted..

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. I feel there is, like for some of them I find it relates to the emotions for example the 'Gravity' one, the girl was like spinning and the vibration was going very fast. But for some of them I cannot really see what's the link, how does it happen? For example there was one like.. there's a street and a lot of people on the street, that one..I think maybe is related to the music but I don't know, I just.. I'm confused about the vibration.

- Q3. What did you most enjoy about the experience? and Why?
- A3. I feel like for the nervous one, it can make me feel more nervous in a sense.. ahh, maybe more engaged because it's like.. the people in the movie are running or in a really nervous situation..this thing makes me feel I am doing that kind like running or escaping in some sense so I find it helped me to be involved in a sense. I prefer with the attention of course.. I am just starting.. how to make sense of the vibrations.

- Q4. What did you least enjoy about the experience? and Why?

- A4. The least.. about the confusion I think, it ‘s just for some clips I was like what’s this for..so it is made me kind of distracted. For some of them really I can really feel the thing I can, like I was like really nervous for some reason.. maybe because of this [points at the glove] or maybe because of.. the movie, and I can really feel it, but for some of them I feel like why is this vibrating?

I kind of noticed the difference from the circle one and the random one. For me it’s like a random like vibration so I feel the random one makes sense more in a certain way because it is related to the creator like the inception is related to the creator. I think that one I feel really good with the glove. Also I think because I watched that movie before so I kind of know what’s is going on and I think the glove kind of makes sense and I feel more engaged with it.

I remember the ‘Gravity’ and the ‘Inception’ was really good and also the one with the little boy…I thought it’s ‘The Shining’.. I feel it is kind of related. This is, I can remember, it is really good about the experience. Others I can not really remember. And especially the one where there was like the big bridge and the guy tries to come down and there is like.. also the church, the man went into the tall building. I feel that two it was like why I can’t feel the link between the vibration, I feel kind of distracted. I feel if the link between the vibration and the content is not related so I feel distracted.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Not in a horror movie I think, because it’s gonna be terrible! But maybe action movies. Ehm..I would be like if.. I have this thing for me to watch a horror movie I’d think about it because if it’s too horrible I would be crying I think. So I think about horror movies you know, because personally I’m not really into horror movies, but I’m interested, but maybe I’m afraid to..to try..too terrible I guess. But for the others, maybe comedy, or drama, or like romantic movies.. or maybe like action movies it will be good to kind of have this vibration.

- Q6. Any further feedback you would like to leave?
- A6. No really. Just I feel maybe in summer it will be hot with the glove!

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 22

- Q1. In a few words, how would you describe the experience?
- A1. I was excited and I was concentrated on the vibrations.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. I think I did, I recognized it but I don't remember the differences.. and in some movies that I saw before I expected to be, the vibration to be more, more vibrating and the intensity to be great. I think because I knew about the movie and I have some expectations. **Did you find in the vibration some differences?** Definitely yes and different position. **Did you find the direction as well?** Yes, especially the one that is close to the pinky I felt that very much, much more than the others. I didn't know if it was the intensity of the vibration on that one it was greater than others or not, but I felt like that.

- Q3. What did you most enjoy about the experience? and Why?
- A3. I think when the vibration….First at all I enjoyed most on the time when I felt the vibration synchronized with the pace of the music and the events in the clips, that..that I think the vibration enhanced my feelings. But when it came to same point that I realized..I just felt now I think it should be more intense or something like that, and that was when I started thinking about vibration. I didn't just wear the glove, I felt this is part of my film watching..you know.

- Q4. What did you least enjoy about the experience? and Why?
- A4. I guess it was when I didn't expect the vibration to be that high and it became very high, and if felt like..like it's interfering with my feelings, my mood. Anyway, most clips that I've seen today I found they were too short.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?

- A5. Yes, when I first started watching and..say the first, the second clip, then I thought..I was thinking this is quite intrusive..because it was my first time you see.. then I started thinking where should it be, where else should it be you know? If my hand, if I feel it was too much for my hand..then I thought [pause] probably no. I think maybe hands should be for..if you start using it I think hands is the most part I would prefer to try it on. Because.. I was thinking, should it be on the feet? No, I wouldn't like that..no I don't like that..I'm not sure, I said I wouldn't but I'm not sure, if I tried I might then, you know?

- Q6. Any further feedback you would like to leave?

- A6. Again at the first when I was thinking about the machine and then my attention was.. to find.. between try to follow the clip and the music and then the vibration, at first I didn't enjoy, I didn't enjoy the movie at all because my attention was divided. Then once you know, I saw more and then I became slightly more and more familiar with the clips, and I just enjoyed the clips but I also had to remind myself to try to think about how I feel about the vibration so..again I think the attention was divided, but not all, not when it's closer to the end you know, just the second, third or fourth.

Saturday, 1 July 2017

Suspense Enhancement Study

Participant n 23

- Q1. In a few words, how would you describe the experience?
- A1. It was exciting. I wasn't expecting that experience. I never experienced vibration in this way. First time.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes. Sometimes they were more intense, more faster or slower.

- Q3. What did you most enjoy about the experience? and Why?
- A3. I think because I was trying to understand how it works or see the difference between one clip and other of my emotions.

- Q4. What did you least enjoy about the experience? and Why?
- A4. No, I don't think there was anything I didn't like. Some clips were quite [bland?…]

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yeah I think so. I think you get more into the movie. Less distraction, more focus.

- Q6. Any further feedback you would like to leave?
- A6. I can't think.

Saturday, 1 July 2017

Suspense Enhancement Study

Participant n 24

- Q1. In a few words, how would you describe the experience?
- A1. It is really interesting to see something different. It was really exciting and just very new.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes. Sometimes it was more intense and sometimes it was a bit more mild or quieter or less involved. When it was more intense I was more involved in the scene. I noticed that some of them were going in a circle and they were also quite strong. Also in some other clips they were also quite strong vibrations, but they weren't going in a circle. I think they were both quite involving, but I can't tell the difference whether one was more than the other one. I think it just depended on the different clips whether one worked better than the other.

- Q3. What did you most enjoy about the experience? and Why?
- A3. I think the fact that it was interesting to see that I was more involved with the different sensations. I was wondering whether I was also more involved with the vibration as well, because I could tell it was something different. To see if it was working, getting me more excited with the music, working together.

- Q4. What did you least enjoy about the experience? and Why?
- A4. The fact that I wanted to see the end of the movie. The cliffhangers.
- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yeah, yeah, definitely. It would be nice to watch a whole movie and see how it is in different parts of the movies.
- Q6. Any further feedback you would like to leave?
- A6. No.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 25

- Q1. In a few words, how would you describe the experience?
- A1. Slightly strange. Surprising. Surprisingly emotional. I wasn't expecting to have such a physical response to what I was seeing. Normally when I watch films, I am quite a visceral person anyway. So I have quite a strong reaction to stuff and music affects me a lot, I know that, emotionally as well, and that combined with the glove as well. I don't know, it was just quite intense in a way that I wasn't expecting it to be. Not in a bad way.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes. Like different areas seemed to be going off and different sort of strength of vibrations in different areas.

- Q3. What did you most enjoy about the experience? and Why?
- A3. I guess seeing films that I've already seen, but then having a different experience while watching it.

- Q4. What did you least enjoy about the experience? and Why?
- A4. With the films that I haven't seen, I thought it was hard to have the same reaction to it because the clip is taken out of context and I feel that if I was watching the whole film in context then I would've got more out of it. But I got more out of the ones that I've already seen.
- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. I'd definitely try it. They were only short clips, so I don't know whether it would be too intense for two hours. But I'd definitely give it a go.
- Q6. Any further feedback you would like to leave?
- A6. No, don't think so.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 26

- Q1. In a few words, how would you describe the experience?
- A1. Something new which I haven't done before. I have never been watching something, listening to music and experiencing vibrations, so definitely new experience for me. Interesting.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yeah. There was like, to be honest the biggest thing I noticed was the parts of my hand, where the knuckles are that was the most powerful for me. I don't know why, but that was the most powerful. When it was vibrating it was kind of… [makes surprised face] it was bringing my attention to the movie more. It was nice. Not distracting. Bringing more attention to the movie.

- Q3. What did you most enjoy about the experience? and Why?
- A3. I wasn't expecting that. I was expecting something different. I think that's the thing that I liked the most. The unknown. I never done something like this before.

- Q4. What did you least enjoy about the experience? and Why?
- A4. On the second clip I didn't feel anything at all, so I couldn't rate it properly.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. [Not asked.]

- Q6. Any further feedback you would like to leave?
- A6. No, I think I'm happy. That's all.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 27

- Q1. In a few words, how would you describe the experience?
- A1. Different. It adds to the visual. You know, it adds to the experience so, makes it better I think.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes, yes, yes. In action scenes it was vibrating more. If something was happening more intense it was vibrating more.

- Q3. What did you most enjoy about the experience? and Why?
- A3. As I said, it improves the visuals, so I think that's what I liked. That you have something else apart from the visuals. An extra sense.

- Q4. What did you least enjoy about the experience? and Why?
- A4. The scenes were too short.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yes, yeah, yeah. I would wonder how it would be to watch the whole movie with the glove. Using the glove, but the whole movie.

- Q6. Any further feedback you would like to leave?
- A6. Not really, no.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 28

- Q1. In a few words, how would you describe the experience?
- A1. Unusual. Interesting how the effect was more prominent for stuff that wasn't particularly busy, but when things were… when there was action or suspense or whatever, it became part of the whole experience, whereas, when something was quiet and it's vibrating, it's obvious it's vibrating. When it's not obvious, it's like 3D, it's the kind of same feeling I have with 3D. When it's really obvious and they throw stuff at you, it's kinda like, ahhh, but done nicely it actually looks really good. It just makes the whole thing pop a little more than it would in 2D. So, I feel similar about that.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. I noticed a circular one was the most prominent one, it felt almost like a finger motion. But other than that, I didn't really specifically notice any kind of pattern.

- Q3. What did you most enjoy about the experience? and Why?
- A3. Apart from the fact that there's a bunch of stuff in there that I need to go back and watch again because it's been a while, particularly E.T. I just thought it was kind of interesting to see what other senses could be brought into it. The whole reason I came and did it was because I was curious and a little bit skeptical and I wanted to experience it for myself. I enjoyed just seeing how it worked and if it worked. I felt that when it combined with the other senses, so the visual and the sound, I think it kind of blended together and therefore I feel it probably worked better than it did than when it was quieter. Because you know if something's calm or whatever and there's something pressing away in your hand, it's obvious that it's there. But when it came to the suspenseful stuff, you know, the kind of gripping the edge of the seat thing, you're gripping the edge of the seat because something's bad's happening, but your hand's also vibrating. That's kind of interesting.

- Q4. What did you least enjoy about the experience? and Why?

- A4. Hard to say really. I didn't think there was anything particularly unenjoyable about it. Some of it worked better than others. But there was no part of it that wasn't enjoyable. It was just some film clips. Same point really, it's kind of like there was some stuff that didn't kind of fit, it just kind of took me out of it of it a little bit. But, I also felt early on, there's a period of adjustment because this is a new thing, so it's like, ok, so that's how it feels for like two or three clips. It took a while for the really sort of, on my list of films, for the actiony stuff to really kick in towards the end. For that it was kinda cool. But yeah, it was just a little bit distracting I guess for Edward Scissorhands, you know, driving around and not really doing much, just some establishing shots and [makes gesture on hand mimicking the vibrations of the glove and imitates vibrating noise].

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yeah, I think it's something that's definitely worth kind of investigating. It's interesting the choice of attaching it to the music rather than the scene. Like the circular pattern would be perfect for a suspenseful moment in a horror film. So you're waiting for something to jump out and you get something going errr on your hand. That would have been perfect for that. But then again that's playing it like a gag which is exactly what they did with 3D films, for the bloody Saw films. Somebody's guts spilling out towards you in three dimensions. Great. But it's just a gag, it doesn't add anything to the film necessarily. It's just kind of fun for a bit. But yeah, in terms of a thing, whether it's something that people would adopt is questionable by itself, but it's certainly interesting and if it's tightly linked to what's going on in the scene I think it could work really well, or the music, whatever you're trying to…

- Q6. Any further feedback you would like to leave?
- A6.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 29

- Q1. In a few words, how would you describe the experience?
- A1. Watching the movie on its own is nice. But I think that's not what the study is about right? I mean, I don't mind the haptics, but in that particular occasion it felt like it wasn't really related to the movie. So it felt like you know when you're at the cinema and your phone is ringing, vibrating in your pocket. I forgot about it sometimes, because you know when the scene is really intense, it's still vibrating, but it's like, environmental stuff that's happening, you don't really perceive it anymore. Sometimes when the scene was quieter and the thing was buzzing all around I noticed it a bit more.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. I tried and at the beginning I looked at the thing and I could see five dots and a big wheel in the middle and I was like it's 5.1, so I listened to the correlation with the sound but it didn't seem to work that way. I don't know. It's hard to tell because it moves. Obviously there was something happening with the location, but because I couldn't figure out what it's relating to it's quite hard to keep track of the patterns. Plus, I mean the sensitivity of location on the back of the hand is not the best because you can feel the whole thing vibrating so, I mean, I can't tell which one's vibrating. Sometimes it was a bit more intense. I kind of noticed it, but it's not very striking, so I couldn't tell you when it was. It could be [distracting], I think it's just like, we are both scientists, so we try to understand how shit works, right? So basically I had this thing working so I was trying to understand what's the relationship. So I found myself being distracted from the film in a few places. It's like, when you're listening to music and you're trying to transcribe one part of the music, you might miss some other ones. Say you want to transcribe the guitar part or whatever, you pay less attention to the vocalist or the drummer or whatever.

- Q3. What did you most enjoy about the experience? and Why?
- A3. It's interesting, you're gonna see on my sheet, I never ticked the middle one on the tension. You only picked scenes that have some tension in it. Actually the thing I enjoyed, it made me realise, I mean I knew that already, but it made it very obvious

how important the music is in films. Because it's all about the music. Every time I was trying to answer the question is there tension or not, if you just look at the picture, not necessarily, but when you listen to the music, it's striking and you picked most of the movies I knew, which might be a bias as well because you know there's something coming up for that scene. [The score] is a huge influence and that's how directors use it actually. [In a horror film] it's the music that makes you jump. The music and the sound. I knew that already. But like when you're just seeing a short clip and you have the thing buzzing all around so if you have the buzz and the music you can pretty much get it done. But I think the way it would make it more compelling for me because I didn't really understand the correlation. So for me, because I didn't really understand it and it didn't work in sync I had this thing happening and there was the movie happening at the same time. I didn't feel it was really an integrated experience. Even if it's something very simple would make a big difference. If you have something like which is more, you know, ground vibration when you're on the Tube. Let's say the scene is on the train and the camera is vibrating and you can vibrate as well. The same thing as the music. If the scene is all over the place and the music is going crazy plus the haptics is going crazy, you might go crazy as well.

- Q4. What did you least enjoy about the experience? and Why?
- A4. Tough question. I like movies and I hate it when I just see a snippet of it and then it stops.

- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Why not? Like I said earlier, if there's a real artistic intention, why not? It's not something that I'm going to actively seek, but if it's there and it makes sense, then why not? I'm not opposed to it. That's the message I'm trying to deliver.

- Q6. Any further feedback you would like to leave?
- A6.

Monday, 22 May 2017

Suspense Enhancement Study

Participant n 30

- Q1. In a few words, how would you describe the experience?
- A1. It was a good experience because I feel the sensation was in sync with what is happening in the movie which was exciting.

- Q2. Did you notice any difference in the haptic patterns across the different clips? If so, what difference did you notice in the haptic patterns across different clips?
- A2. Yes, I did. I basically noticed the difference between two kind of clips. So when it was more calm and serene the kind of signals which I'm getting in my hand, is like they're not very frequent, so slowly they're moving, so it's like one pulse then it takes some time to get another pulse. But when it is exciting it's like a bunch of pulses are moving the way it is moving in those scenes.

- Q3. What did you most enjoy about the experience? and Why?
- A3. What I liked is one clip I think somewhere, the second or third clip, where there was some fighting scene going on and that was the first time I actually felt that thing properly on my hand. I was feeling it throughout but it was moving very fast and I was like, I was happy there was a huge sync between the two. That was exciting.

- Q4. What did you least enjoy about the experience? and Why?
- A4. I don't think anything bad about it. It was exciting. It was good.
- Q5. Is the addition of haptic sensations, as you experienced it today, a feature/effect you would like to feel when you watch a film (both in a cinema or at home)?
- A5. Yeah, sure. That would be exciting at least to see how it happens. It was exciting, but I don't know because it's a short clip, as an engineer, you have to pick out those parts where it is differentiable, you can design, but when it is not differentiable I don't know how well it works. But it is exciting stuff.
- Q6. Any further feedback you would like to leave?
- A6. It would be good if we see other emotions also. [Other than suspense].

Appendix N

Thematic Analysis: codes

Participant 1

Data extract	**Coded for**
The glove was **interesting** 'cause the clip i found most suspenseful was a film i didn't know. […] There were parts instead i was like uh uhh i love the scene and there was a lot going on with the glove and it kind of seemed **correlated** for me.	1. Found the experience interesting. 2. Felt in some parts that the glove was correlated to the content of the scenes.
I felt when there were more reactive scenes there seemed to be more vibrations. And then there were a few that were quite quiet and that's when there seemed to be less.	3. Noticed different instances of vibrations depending on the scenes.
(I found it **distracting**) only when it was quite intense but in the clip there wasn't a lot going on […] and you're just like 'this doesn't match in my mind', but then in more busy clips where there was a lot of stuff going on I didn't realise it was happening, I wasn't paying attention to it.	4. Found it distracting when the activity of the haptic sensations didn't match the level of activity in the movie clip.
I know there were different points in my hand, but didn't notice anything pattern-wise.	5. Did not notice patterns direction.
I think it's **interesting** because it's not a literal haptic feedback, which is something that happens in VR, where most of the haptics even if it's not literal in terms of the sensation is not the same as what you're meant to be experiencing, the cues are still literal, where **here the cues are emotional**, which is **very interesting**.	6. Found the novelty of the approach in using haptic feedback to express emotional cues interesting.
I think **the hand for me feels quite intimate** […] I think when you have a chair there is a kind of metaphor like strapping into an experience […] whereas the hand maybe, I don't think if I was watching a film in bed I'd want to put something on my hand.	7. Feels the hand an intimate area and would prefer the haptic design to be for a different area e.g. a seat.
I definitely felt with some clips […] there was a **relationship between the content and the vibrations**, to the point that when it wasn't i noticed it.	8. Felt a correlation between the vibration and the content in the scenes 9. It became noticeable when the relationship between the content and the vibration wasn't there (mismatch of feelings)

Participant 2

Data extract	Coded for
I enjoyed it. It's just different, sometimes I felt the glove melted into the background especially in the more active bits	1. Found it enjoyable and different 2. In more active scenes the glove melted in the background
Sometimes I've noticed if not the patterns the tempo […] quicker or slower, which kind of moved nicely with the scenes.	3. Did not noticed particular patterns, but the tempo (frequency) of the vibrations
I quite like that it kind of **added an extra dimension** to the level of tension you wanted […] I felt like when things started happening you know, it adds to that, or when things start calming down again you know, things would slow down.	4. It added an extra dimension 5. It augmented the level of tension/calmness of the scene
Sometimes I felt it was cued to the music, ehh but not always. So I felt it was almost a combination between music and visual cues.	6. Felt it was cued to a combination of music and visual
Wearing a glove in general it can be quite you know? *(interviewer: "weird?")* Yeah! but to be honest you know, by like clip 4 or 5 i pretty much forgotten about it, I wasn't aware of it, it was just part of the experience.	7. Wearing the glove at first felt unusual 8. Got used to the experience after a few clips
It confirms what I thought that it was synced to the music, and I guess sometimes the music is synced to the visuals so you end up with kind of by proxy	9. Felt it was synced to the music, and consequently to the visuals (*similar to code 6)*
I particularly enjoyed the circular one. I mean, it's the only time i really noticed it during the E.T., maybe because i'm more familiar with the film so you know, getting a bit more excited about what is gonna happen and **when it started speeding up** you know, i said that, t**hat has really added to the experience**.	10. Particularly enjoyed the circular pattern. 11. The 'crescendo' of the vibrations added to the experience
I'd definitely be interested in how to do a [inaudible] full length. I think it's the sort of thing that I could enjoy. I'm the type of person who enjoys a 3D movie and I'd enjoy this probably as well, yeah. And I thought this is definitely cool.	12. Interested in trialling the experience over a full-length movie 13. Enjoys 3D and 4DX movies, and thinks he/she could enjoy this experience too

Participant 3

Data extract	Coded for
I forgot that I was wearing the wearable. I could not separate it from the music so, every time I was feeling tense or excited or calm or not calm it had to do a lot with the score of the movie, and, yeah for example in the "Inception" clips it was [inaudible] really cool, when I was feeling the vibrations that go with the music, so I liked that.	1. Forgot to be wearing the glove 2. The score was affecting his/her feeling, and felt that the vibrations played along the music sometimes complemented those feelings
(I noticed) the different intensities […] maybe i felt it was going this way (gestures a circle) or maybe not even in a circular direction so..but I didn't recognise patterns.	4. Noticed frequency and intensity of haptic sensations 5. Noticed circular pattern
I enjoyed the most this feeling that **the experience can get** broader or **augmented by having this sensory experience** but is not something that you focus on, so it's something that is there and can go through the sound or what is happening in the scene.	6. Enjoyed the subtleness of the multisensory experience
I felt at some point that the clips were too short.	7. Clips too short
I think a circular pattern like in a increasing of intensity cool, I see it working […] in a scene when somebody is chasing somebody and it's like reaching the climax but I don't know, in a scene where you have an explosion or something happens it has to be towards that kind of action.	8. He/She thinks the experience would work in scenes where the 'crescendo' of vibrations matches the action or certain event on screen (e.g. explosions), until reaching the peak
Yes definitely [I would like to experience this again in a movie settings] and […] I also could see it like **listen to some music and have haptic feedback**. Of course i would like that, that's really cool. […] Yeah i haven't tried 4D movies but maybe […] it can be like right in your face […] but within reason like it has to work.	9. He/She would like to experience the addition of haptics to movies again and also when listening to music 10. He/She thinks that the addition of special effects in film has to be within reason for it to work.

Participant 4

Data extract	Coded for
I really liked it, especially some of the patterns where was kind of circling around the hand and getting faster, that were my favourite ones.	1. Enjoyed circular patterns and the crescendo of the haptic sensations
[I noticed] the direction. It felt like some of them were speeding up as well as things got more tense. […] the speeding up pattern on your hand, it felt it worked pretty well, whereas the other ones it stayed a bit more still and I found it didn't work quite as well, but yeah I really liked this feeling of going around in a circle.	2. He/she noticed the direction of the patterns. 3. Felt the frequency of vibrations increased together with the tension in the scene 4. Felt that the patterns with a crescendo worked better than the more calm and steady ones. (1.) Enjoyed the feeling of the circular pattern
I was surprised how well it worked in a way […] it's amazing how you can ignore that it's on one hand and **you stop really thinking about where the vibration is and** […] **how it affects what you're watching.**	3. Surprised by the effectiveness of the approach 4. Forgot about the body location where the stimulus was perceived and how it affected what he/she was watching
i felt that [the circular pattern] worked really well yeah, just 'cause it was simple […] all I got from it was this like raising speed you know […] with that I felt it didn't focus too much on the individual points of vibration, it was more just like the general sensation, 'cause you know what's happening.	5. Found the circular pattern simple and effective because it didn't focus on specific points but felt instead as a general sensation
I could imagine if you had like watches or something, that could vibrate and do it, yeah. Yeah, it would be interesting.	6. Thinks that the addition of haptics in film would be interesting if could be integrated in a watch or other wearables people already use

Participant 5

Data extract	Coded for
I think it would […] make much more impact if I had both hands with that, because right now it was a bit ehm, something massaging my hand, not really something […] correlated very much with the movie. […] right now I didn't feel very much the glove on [the hand], it was doing something but I don't know, at some point it started taking the beat of the music I think.	1. Would have liked if the experience had involved both hands as he/she didn't feel the glove as much 2. Wasn't sure what the glove was doing, at times thought it was following the rhythm of the music, but didn't feel correlated very much with the movie
At some point there was a movie and based on the music and what was going on I was going to describe it as […] exciting but then […] because of the rhythmic hit on the hand I felt that something bad was going to happen, so **there was this kind of contradiction at some point** I feel.	3. In one instance felt there was incongruity between the mood music in the scene and the mood induced by the haptic pattern
i like watching movies and i like trying to figure out what's going to happen based on the music, and I also tell you this, **there were some cases where this glove actually gave me a hint** hmm so yeah	4. Felt at times the glove hinted what was going to happen in the scene
[The glove] was very positional […] and at some point i remember it kind of distracted me, this thing that was going tuc tuc tuc tuc […] at some point I had to pay attention, it made me actually pay attention because it was going [in a circle] I think. Yeah i think this was a bit more **distracting, when it was going in a circle**..ehm because i can't remember the other ones.. Yeah and the other thing is that **i would like to have both gloves** maybe, to have some kind of symmetry.	5. The haptics became noticeable and intrusive when the pattern was playing in the circular mode (1.) Would like the experience to involve both hands to provide some symmetry
I think it would be good, I mean having a more [immersive] experience. I don't know, with those extra effects like 3D and surround sound […] I've noticed that I enjoy them once they're well implemented. I want it to be very good or not at all.	4. Thinks the experience could provide a level of immersion if well implemented

Participant 6

Data extract	**Coded for**
[The experience] was quite interesting [..] I was just interested more in the glove at some points. I almost wanted the vibrations to rise and fall very subtly instead of just buzzing on and off quickly, because I think that's too much like an alert on your phone. It would be nice if it was just like very subtle and just faded in and out. That would give it a bit more tension or realism.	1. Found the experience interesting 2. Sometimes found to be more interested in the glove and how it worked 3. Wanted the haptics to be more subtle rather than buzzing on and off as alerts on mobile phones. 4. Thinks a more subtle approach would be more effective
Some of the clips felt more intense, or just like quicker. [..] It felt like it was synced to something, or maybe it was synced to the words or the emotions or what was being said. So I felt it was sort of noticeable.	5. Noticed different intensities and frequencies of the haptics 6. Felt the haptics were linked to something in the movie and that was noticeable across different clips
[I enjoyed] the **idea of the glove**, the **vibrations**, the **extra sensory element to watching the movie**. It was quite engaging. [..] I was kind of wondering if you could wear it on your head or maybe have both hands involved	7. Enjoyed the addition of an extra sensory element to watching the movie 8. Found the experience engaging 9. Wondered if could be worn on both hand or on the head
The clips were too short. [..] I felt like tension was building and then it just kind of stopped. **The glove was kind of helping that tension**. It would've been nice if the clips were a bit longer.	10. The glove helped in building tension 11. Would have liked to have trialled the experience with longer clips
Quite possibly [it's an experience I'd like to repeat]. Maybe if there were two gloves and a headset or something.	12. Would possibly repeat the experience (9.) Wondered if could be worn on both hand or on the head
Really interesting experiment. I think it's a really great idea and it'll be interesting to see what happens next.	(1.) Found the experience interesting 13. Curiosity/interest for further work

Participant 7

Data extract	Coded for
Pleasant and stimulating for my sensory properties in my hands. Yeah, enjoyed it	1. Pleasant sensory stimulation
I noticed sometimes they were circulating. Sometimes […] **it looked like they were designed somehow** so they were not just the same pattern over and over. […] so it made me curious how they were designed because I thought they were following the music. But sometimes the music had its own structure and they had a different structure, so **they were really adding some interesting feedback.**	2. Noticed patterns mode (circular and composed) 3. Felt the haptic sensations were designed and had their own structure 4. Felt the addition of haptic sensations added to the experience
It was interesting to have this addition of the hand that was kind of **connecting to your body** a bit more because the music already does, but **it is like the action in the scene is touching your hand in a sense**.	5. The sensory addition created a connection between the movie scene and the viewer's body
Yeah [I would like to experience this again] because it's **another form of design** in a sense. If someone is thinking of how the vibrations are affecting someone else's state it's the same thing that a film does which is kind of telling a story, so **it's just another language** I think.	6. Haptic sensations as a form of design/language for storytelling

Participant 8

Data extract	**Coded for**
It was nice. [..] **Sometimes [the haptic sensations] were creating some expectancy** and I was expecting the scene to resolve and it was nice.	1. Sometimes haptic sensations created expectations
On some of them the haptic patterns were also in rotation around the hand. **On others they were really soft and calm and they weren't increasing the tension of the scene**. Different intensities and rotations.	2. Noticed different intensities and the direction of the circular mode. 3. The less active patterns felt 'soft' and 'calm' and did not increase tension
[I enjoyed] variety of different scenes and sensations across the whole experience	3. Enjoyed the variety of sensations across the whole experience
It would be nice [addition], especially in a movie theatre for some movies when you pay more attention to the soundtrack. Then it definitely would make a difference, make it more enjoyable. Or if you were watching like a 3D movie, that would be very nice	4. Thinks the addition of haptics to movie would be a nice addition in a movie theatre as surround sound is more felt

Participant 9

Data extract	Coded for
It was interesting, It was fun. [..] It fit comfortably.	1. The experience was interesting and fun. 2. The glove was comfortable
It felt very much on the level of the music, if it was base heavy or suspenseful. Yeah, if there were bassy notes you could feel it a bit more if it was louder, more rimbling kind of stuff. **I couldn't figure out exactly what the relationship was but I could definitely feel a difference.**	3. Felt there was a link between the music and the haptics 4. Noticed differences in the haptic sensations across different clips
Yeah [this is an effect I'd like to experience again]. I think any of these extra senses to movies is a cool addition anyway.	3. Thinks the addition of sensory experiences to movies is 'cool'

Participant 10

Data extract	Coded for
It was different actually. Different from the other kind of movies, 3D, even if I w[e]nt to the IMAX for the effects. It was different. Something new.	1. The experience felt different and novel compared to other effects experienced in 3D and IMAX screenings.
Sometimes **they were related to how tense**, more tense **or excited the scene [was]**. Other times [did] not seem totally related or **less related to the scene**. **When it was tense it was vibrating a lot**, the intensity was bigger, **when it was calmer it didn't vibrate or vibrate less**. Also in the direction, especially from clockwise or anticlockwise in the pattern.	2. Sometimes felt a relation between haptic sensations and the mood of the scene (tense/ excited) 3. Sometimes the haptics seemed less related to the scene 4. Noticed pattern in circular mode
It was like being inside, especially with the Inception movie with all the walls falling down and with the vibration **it's like being inside the movie**.	3. In some scenes the haptic sensations aided the sense of presence
[..] sometimes I felt that the vibrations weren't so much related to the scenes. **Sometimes the tension came from the hand instead of the scene itself**.	4. Sometimes felt there was a mismatch between the mood of the scene and the one suggested by the haptic sensations 5. Sometimes the haptics but not the scene induced tension

Participant 11

Data extract	Coded for
Interesting. Positive and engaging.	1. Found the experience was interesting and engaging
Sometimes it felt like the intensity was different. Other times I could tell the rhythm was different. Sometimes it would happen in different pulses.	2. Noticed different intensities and rhythms
It was unique. It was new. I'd never done something like this before. So mixing that with the music, **it didn't feel strange. That was the weird thing. It didn't feel it was foreign. It felt like it fit together.**	3. The experience felt novel 4. The haptics fitted together with the music
Yeah I think I'd like to try it again. I think it did, the **first time I felt it, it felt a bit weird**, but then I **got used to it very quickly**. It's like you said with the video games, you stop noticing it and it does start enhancing the experience a bit. I just enjoyed it as well, it felt quite soothing as well. Not in a relaxing kind of way. I don't know, it just felt quite nice. I liked it.	5. Got used to the experience quickly 6. The addition of haptics slightly enhanced the experience 7. The haptic sensations felt nice

Participant 12

Data extract	**Coded for**
It was **immersive**. I think I had a little bit of problem with the glove, that it wasn't tight enough, so I didn't feel it as much because you've probably stretched it out. But I could feel everything. I thought it was very interesting. I thought that it did enhance some of the clips.	1. Found the experience immersive 2. The glove fit wasn't as tight 3. Found the experience interesting 4. Felt it enhanced some the clips
There were different patterns and I realised [..] a crescendo kind of that pattern [..] **Sometimes I thought that it was trying to warn me that something was going to happen** [..] some patterns that kind of took my attention more than others.	5. Noticed a crescendo in some patterns 6. Felt sometimes the glove was trying to warn something bad was about to happen 7. Some patterns took his/her attention more than others
I thought on some of the clips it complemented a lot what I was seeing and I can't explain why it did that, but it was really interesting. It was really, really interesting to have something that is maybe feeling the way you're feeling and mirroring it a bit. It really did enhance your natural... with the music and your own emotion, enhancing it, it made you feel things more.	8. Found interesting that the device was mirroring the mood 9. Felt the device was mirroring his/her perceived mood 10. Felt the haptics paired with the music enhanced their feeling
I would [like to repeat the experience]. I thought it was really interesting. I had a great time.	(3.) Found the experience interesting

Participant 13

Data extract	Coded for
It was interesting. [..] on the few occasions the haptic feedback was matched very well with what I was seeing, especially with what I was hearing.	1. Found the experience interesting 2. Felt sometimes the haptics matched well both the visual and the sound in the clips
Sometimes they matched quite well with the music to some extent. At least the rhythm. [..] I think sometimes if the music was kind of circular, the pattern in the hand was kind of circular. Other times I didn't really get why it was vibrating like that. What was the idea	3. Felt sometimes the haptics matched the rhythm of the music well. 4. Noticed the circular pattern 5. Sometimes couldn't understand what the haptics were linked to
Sometimes it was really frustrating because I could not get the mapping [..] I'm not sure if two hours movie, with a constantly vibrating hand. Or maybe, I probably would've enjoyed having both hands. So a kind of stereo effect, would've been great.	6. Found it frustrating when couldn't figure out the mapping of the haptics 7. Not sure how the experience would be during a full movie screening 8. Would have liked to trialled the experience on both hands simultaneously as a 'stereo effect'
I would like [to try the experience again] probably not sure about in my hand.	9. Would like to try the experience again 10. Would probably prefer the interface to be for another body location rather than the hand

Participant 14

Data extract	Coded for
This was more you know more the emotions and the device..and more elaborated than what I experienced in the 4D movies. I actually enjoyed it a lot.	1. Enjoyed the experienced 2. Found it more elaborated than the 4D effect
Yes, intensity and frequency of the vibrations. Also [..] particular motions, the kind of direction	3. Noticed different intensities, frequencies, and motions/direction
It was [a] new experience, I wanted to enjoy more. For example [for] the all movie [..] And I also think [..] if it were like both hands and also on other parts of the body it would be more effective, [..] I think it would be like very interesting if the devices are extended in different part of the body.	4. Would have liked to extend the experience to a full movie 5. Thinks it would be more effective/interesting if the device would extend to different body areas
Yes certainly [I would like to try it again], it is very interesting	6. Would like to try the experience again
I expected that the emotion was created according to that music so, but in some clips yeah so the emotion was quite in accordance with the music like in synchrony yeah but [..] in some clips, maybe by intention but, but it wasn't. In sync, obviously it was better.	7. Expected the feeling to be mirroring the mood music 8. Noticed in some clips the feelings weren't mirroring the mood music 9. Preferred when the glove was in sync with the mood music

Participant 15

Data extract	Coded for
It made me think like a massage [..] it was enjoyable, it was something new for me.	1. It felt like a massage 2. Found the experience novel
One was in more regular spatial pattern across the hand, I think it was across the hand and it was working really well with the music, but yeah like a couple of them was just random in the hand and it was interesting as well.	3. Noticed spatial differences in the patterns 4. Thought some patterns worked really well with the music 5. Thought some patterns were random
[I most enjoyed] seeing how the haptics worked with the other elements of the film.	6. Enjoyed seeing how the haptics worked together with the different film elements
I don't know, it depends on the type of movie..ehm..If it was like a big kind of a blockbuster, roller-coaster type of movie, then yeah maybe I'd try, but I don't think I want to try enough to pay a lot of money to try. [..] I feel it goes well with more hectic Hollywood films.	7. Thinks whether he/she would try the experience again depending on the movie 8. Wouldn't invest money to experience it again 9. Feels the experience best fits Hollywood movies

Participant 16

Data extract	Coded for
It was really natural, and then at one point, about half way through, i started like wondering where the motors were, and started looking at the glove, and kind of got distracted.	1. The experience felt natural 2. Got distracted to try understand where the motors were positioned
At the beginning i think the vibrations were very **motor by motor**, and towards the end they seemed to be like **blended and using multiple motions [..]** They were much ehm more **complicated**, **much more intricate**, eh **much more composed** than at the beginning [..] I **definitely [preferred] the composed ones**. I thought they were **really nice** and that made it seem less like it was supposed to follow the music and more like it was supposed to be like eh, **like a fourth dimension sensation**, and eh 'cause when it's very like eh slow or they're very very separate then it feels like motors, whereas when they're all together [..] **it's like this other layer of composition**. And i thought that was really actually quite beautiful, some of them were really really nice.	3. Noticed the difference between the circular pattern and the composed ones 4. The composed ones felt more intricate and like they blended more with the movie clips 5. Preferred the composed patterns 6. The composed patterns felt like a fourth dimension sensation, another layer of composition.
I guess the challenge is not making it seem like a [inaudible] to the music or that is supposed to be following what's going on on the screen, because it would be really easy [..] But the idea of it being like this **other layer of expression** i thought it was really actually quite interesting and and successful.	7. Thinks the approach of composing haptic patterns rather than having them following data extracted from the music or the visual to be more interesting 8. Felt it to be another layer of expression
I it was very natural, that it kind of blended into the background, that it wasn't distracting, it was subtle enough.	(1.) Felt the experience was natural and subtle, it blended in the background
The early clips, when [..] the ones that were like, that were not composed it **feels very gimmicky**, whereas the ones near the end, which were like much more ehm..to me appeared to be **much more thought out**, much more **composed**; those **started to feel like something else**	9. The circular pattern felt gimmicky 10. The composed patterns felt more thought out
[I wondered] how it would add to the experience of a movie that i already knew [..] it was like really interesting [..] I was curious to see how it would be used in the moments between action [..] really curious about not necessarily the technology but the experience, like what would it be like to watch an entire movie with one of these	11. Curious to try how the experience would be with a movie already seen 12. Curious to try the experience during a full length movie
Yeah! For sure [I'd like to try it again]. Or video games! **Video games, would be amazing!**	13. Would like to try the experience again 14. Thinks it would work in a video game environment

Participant 17

Data extract	Coded for
It was very interesting. Ehh I did notice myself trying to figure out what it was doing [..] and I got slightly distracted by this bit.	1. The experience was interesting 2. Got distracted as trying to figure out how the interface worked
I was expecting..you know, if you get this for an hour it starts to become annoying..[..]but [it] was alright.	3. Thought feeling the haptics for a prolonged time would have become annoying, but it felt ok for the duration of the session
I noticed sometimes it was quicker..there were different patterns [..] we had a sequence, a rotating sequence.	4. Noticed differences in the frequency and motion 5. Recognised the circular pattern
The haptics were interesting..**slightly distracting because only on one hand**.	6. Found the haptics interesting 7. Found the experience slightly distracting because involved just one hand

Participant 18

Data extract	**Coded for**
Interesting but slightly limiting. [..] I feel **it did work to certain extent**, ‘cause the sort of ramble **did match sort of patterns of excitement or tension** ehm..I felt I couldn’t translate very further than on/off [..] I was trying to find links between what was going on in the film and what was going on on my hand [..] it seemed to be quite linked with music, but then I couldn’t find direct correlations. [..] I felt the mappings could be a little bit tighter.	1. Found the experience interesting but slightly limiting. 2. Felt to some extent the haptics matched feelings of excitement or tensions 3. Felt couldn’t translate the haptics beyond on/off switch 4. Felt the haptics were linked to the music but couldn’t find a direct correlation 5. Felt the mapping could be tighter
[I noticed] difference in movement, direction, and sort of intensity.	6. Noticed differences in movement, direction, and intensity of the patterns
I enjoyed the fact that my feelings of excitement or tension were mirrored to a certain degree by what was going on on the hand [..] but it didn’t follow through afterwards	7. Enjoyed that the sensations on the hand mirrored his/her feelings of excitement and tension to certain extent. 8. If felt the mirroring of the feelings wasn’t consistent
[I found it least enjoyable] **when it was unnecessary** [..] and it was a bit of a mismatch in terms of my personal expectations and what was going on on the hand	9. Did not enjoy when the haptics mismatched personal expectations
I want a whole suit with those on, that’d be awesome, like a whole full on body suit	10. Would like the experience to be extended to the whole body e.g. bodysuit interface
It is definetely [something I'd like to repeat. [..] I thought it was very effective ‘cause I could feel the soundtrack and the vibrations mirroring, but..i’d like to see that [..] throughout a whole movie of intensity or whatever you’re gonna call it, to slightly build you up to these moments, i think that could be interesting.	11. Would like to repeat the experience 12. Felt the haptics mirroring the soundtrack 13. Would like to try the experience over a full length movie

Participant 19

Data extract	Coded for
I think it was interesting.	1. Found the experience interesting
I think it was going in circles quite a lot [..] I think it was stronger at certain points.	3. Recognised the circular pattern 4. Felt the intensity of the haptics was higher some times
It's quite a **nice feeling** actually, [inaudible] sort of vibration..on the hand, I guess that's nice.	5. Liked the feeling of the vibrations on the hand
If it's **just going in circle it's** like..you know..almost **a bit distracting** really. Ehmm the other one..i don't know, I'm not sure i would say adds so much to the movie experience [..] I think, yes i think that's preferable to the other one, which may be too distracting after a period of time.	6. Thinks the circular patter can become distracting 7. Prefers the composed patterns to the circular one but not sure whether the they add to the experience.
Possibly [I'd like to try it again]. **I'd be curious to see how's implemented in a full length movie** you wouldn't want to overdue it aahhh so i guess maybe does add a bit of element of surprise or suspense.	8. Would like to trial the experience over a full length movie
It's almost as an editing device.	9. Feels the use of haptics act as an editing tool

Participant 20

Data extract	**Coded for**
[It was an] interesting experience.	1. The experience was interesting.
I recognised that there was some specific pattern which was [..] **not synchronised** [..] [also noticed the intensity].	2. Noticed some patterns lacked of synchronisation
[I enjoyed that] it was **quite new**	3. Enjoyed the fact that the experience was novel
[I didn't enjoy that] **sometimes [..] the focus went more to my hand than to the movie**	4. Sometimes felt distracted
Yeah definitely [I would like to try it again]. If it's very [well] synchronised to the movie definitely.	5. Would like to repeat the experience if well implemented

Participant 21

Data extract	Coded for
I found it is interesting with the glove, because it's kind of...I don't know if it's related to the sound or the emotions but **I can feel there is a link between the content and the vibrations** but I am not sure how it is linked. So **sometime I feel confused because some of the movies [..] I didn't watch** [..] I can't feel the intensity of the drama in it, and I feel a bit confused about the vibration, so I was like.. what's this for? It's like I can't link the content so.. [with the movies I watched] I have the idea of what is going on and I feel it makes sense to have the vibration as well, to **make me feel more connected in a sense.**	1. Found the expereicne interesting 2. Feels there is a link between the content of the movie and the haptics - however not sure whtether the link is between the sound or the emotions 3. The haptics felt confusing for those movies he/she hadn't seen before 4. For the movies already seen before felt the haptics made him/her feeling more connected to the movie/engaged
I feel there is [a difference in the patterns across different clips], like for some of them I find it relates to the emotions [..] But for some of them I cannot really see what's the link.	(2.) Feels some of the haptic patterns relate to emotions
I feel like for the nervous one, **it can make me feel more nervous in a sense.. ahh, maybe more engaged** because it's like.. the people in the movie are running or in a really nervous situation..this thing makes me feel I am doing that kind like running or escaping in some sense so **I find it helped me to be involved in a sense.**	5. For some of the action scenes the haptics aided the sense of presence
The confusion I think [it's what I least enjoyed about the experience] [..] it made me kind of distracted. For some of them [..] I was like really nervous for some reason.. maybe because of this [points at the glove] or maybe because of.. the movie, and I can really feel it, but for some of them I feel like **why is this vibrating?**	6. Felt confused when couldn't relate the haptics to the clip, and that led to distraction
I kind of noticed the difference from the circle one and the random one. For me it's like a random like vibration so I **feel the random one makes sense more in a certain way because it is related to the creator** [..] Also I think because I watched that movie before so I kind of know what's is going on and I think the glove kind of makes sense and I feel more engaged with it. [..] I feel if the link between the vibration and the content is not related so I feel distracted.	7. Noticed the two modes of haptics: circular and composed 8. Felt the composed one was more adequate as part of a creative process (4.) Felt more engaged for movies already seen (6.) felt distracted when couldn't relate the haptics to the content of the movie
Not in a horror movie I think [..] But for the others, maybe comedy, or drama, or like romantic movies.. or maybe like action movies it will be good to kind of have this vibration.	9. Wouldn't like to try the experience with a horror movie 10. Thinks the haptics would work well in rom-com, drama, and action movies

Participant 22

Data extract	Coded for
I was excited and I was concentrated on the vibrations.	1. Felt excited about the experience
I think I did [recognise differences in the patterns] [..] different position [..] the intensity of the vibration.	2. Recognised differences in position and intensity of the haptic patterns
I most enjoyed **when I felt the vibration synchronised with the pace of the music and the events in the clips, that..that I think the vibration enhanced my feelings.** [..] I didn't just wear the glove, **I felt this is part of my film watching**.	3. Enjoyed when felt the haptics were synchronised with the rhythm of the score and the action in the clips 4. When felt the haptics were synchronised with the content of the clips, believes the haptics enhanced his/her feelings. 5. Felt the glove was part of the movie-watching experience
[I enjoyed the least] when I didn't expect the vibration to be that high and it became very high, and **it felt like..like it's interfering with my feelings, my mood**.	6. When the intensity of the haptics didn't match expectations felt the device was interfering with his/her feelings/mood
When I first starting watching..the first, the second clip [..] I was thinking this is quite intrusive..because it was my first time you see.. then I started thinking where should it be, where else should it be you know? If my hand, if I feel it was too much for my hand..then I thought [pause] probably no. [..] If you start using it I think hands is the most part I would prefer to try it on. Because.. I was thinking, should it be on the feet? No, I wouldn't like that..no I don't like that..I'm not sure, I said I wouldn't but I'm not sure, if I tried I might then, you know?	7. For the first few clips the device felt intrusive as the experience was unfamiliar 8. Thinks the hand is a suitable body part for the haptic experience 9. Wouldn't exclude trialling the experience on other body sites
At first when I was [..] try[ing] to follow the clip and the music and then the vibration [..] my attention was divided.	10. During the first few clips of the task felt the attention was split

Participant 23

Data extract	Coded for
It was exciting. I wasn't expecting that experience. **I never experienced vibration in this way.** First time.	1. Found the experience exciting 2. Had never experienced haptics in this context before
Yes [I noticed differences across the patterns]. Sometimes they were more intense, more faster or slower.	3. Noticed differences in the haptic sensations across different clips: intensity, frequency
[I enjoyed the most about the experience that] I was trying to understand how it works or see the difference between one clip and other of my emotions.	4. Enjoyed being aware of how the haptics affected his/her feelings across different clips
Yeah I think so [I would like to repeat the experience]. **I think you get more into the movie.** Less distraction, more focus.	5. Would like to try the expericne again 6. Thinks the addition of the haptics enhance the level of engagement

Participant 24

Data extract	**Coded for**
It is really interesting to see something different. **It was really exciting and just very new.**	1. The experience was interesting and exciting 2. The experience was novel
Yes. Sometimes it was more intense and sometimes it was a bit more mild or quieter or less involved. When it was more intense I was more involved in the scene. I noticed that some of them were going in a circle and they were also quite strong. Also in some other clips they were also quite strong vibrations, but they weren't going in a circle. I think they were both quite involving, but I can't tell the difference whether one was more than the other one. I think it just depended on the different clips whether one worked better than the other.	3. Noticed differences in the haptic sensations across different clips: intensity, motions (circular and composed) 4. Felt more involved when the haptics were more intense 5. Wouldn't know whether one mode is preferable than the other, thinks it depends on the clip
I think [what I enjoyed the most about the experience is] the fact that **it was interesting to see that I was more involved with the different sensations.** I was wondering whether I was also more involved with the vibration as well, because I could tell it was something different. To see if it was working, getting me more excited with the music, working together.	6. Found interesting to see how the multi-sensory experience affected the different senses
Yeah, yeah, definitely. **It would be nice to watch a whole movie and see how it is in different parts of the movie.**	7. Would like to repeat the experience over a full length movie

Participant 25

Data extract	Coded for
Slightly strange. Surprising. Surprisingly emotional. I wasn't expecting to have such a physical response to what I was seeing [..] I don't know, it was just quite intense in a way that I wasn't expecting it to be. Not in a bad way.	1. Was surprised to find the experience emotional 2. Didn't expect the experience to produce a physical effect
Yes [I noticed differences]. Like different areas seemed to be going off and different sort of strength of vibrations in different areas.	3. Noticed differences in the haptic sensations: intensity, locations
[what I most enjoyed was] I guess seeing films that I've already seen, but then having a different experience while watching it.	4. Enjoyed seeing how different was the experience for movies already seen
With the films that I haven't seen, I thought it was hard to have the same reaction to it because the clip is taken out of context and I feel that if I was watching the whole film in context then I would've got more out of it.	5. Found hard to react to clips from unseen movies
I'd definitely try it. They were only short clips, so **I don't know whether it would be too intense for two hours**. But I'd definitely give it a go.	6. Would like to try the experience again 7. Has doubts whether extending the experience over a full length movie would result too intense

Participant 26

Data extract	Coded for
Something new which I haven't done before. I have never been watching something, listening to music and experiencing vibrations, so definitely new experience for me. Interesting.	1. Found the experience novel. Had never experienced haptics within movies or music 2. Found the experience interesting
The biggest thing I noticed was the parts of my hand, where the knuckles are that was the most powerful for me. [..] **When it was vibrating it was kind of… it was bringing my attention to the movie more.** It was nice. Not distracting. Bringing more attention to the movie.	3. Noticed the vibrations on different locations on the hand 4. The addition of haptics enhanced engagement
I was expecting something different. I think that's the thing that I liked the most. The unknown. I never done something like this before.	(1.) Liked the novelty of the experience

Participant 27

Data extract	Coded for
Different. It adds to the visual. You know, **it adds to the experience** so, makes it better I think.	1. Found the haptics added to the visual 2. Found the addition of haptics enhanced the experience
Yes, yes, yes. In action scenes it was vibrating more.	3. Felt that during actions scenes haptics were more frequent
[I liked the most] That you have something else apart from the visuals. **An extra sense.**	4. Liked the involvement of another sense into the experience
Yes, yeah. I would **wonder how it would be to watch the whole movie with the glove.**	5. Would like to experience it again over a full length movie

Participant 28

Data extract	Coded for
Unusual. Interesting how the effect was more prominent for stuff that wasn't particularly busy, but [..] **when there was action or suspense or whatever, it became part of the whole experience**, whereas, **when something was quiet and it's vibrating, it's obvious it's vibrating**.	1. Found the experience unusual 2. During more active or suspenseful scenes the haptics blended and it became part of the experience 3. For more quieter scenes the haptics became obvious
I noticed a circular one was the most prominent one, it felt almost like a finger motion.	4. Noticed the circular pattern
I felt that when it combined with the other senses, so the visual and the sound, I think **it kind of blended together** and therefore I feel it probably worked better than it did than when it was quieter. Because you know if something's calm or whatever and there's something pressing away in your hand, it's obvious that it's there. But when it came to the suspenseful stuff, you know, the kind of gripping the edge of the seat thing, you're gripping the edge of the seat because something's bad's happening, but your hand's also vibrating. That's kind of interesting.	(2.) Felt the haptics blended in with visual and sound better in more active/suspenseful scenes
There's a period of adjustment because this is a new thing, so it's like, ok, so that's how it feels for like two or three clips.	5. It took 2-3 clips to adjust to the novelty of the experience
Yeah, I think it's something that's definitely worth kind of investigating. **It's interesting the choice of attaching it to the music rather than the scene.** Like the circular pattern would be perfect for a suspenseful moment in a horror film. So you're waiting for something to jump out and you get something going errr on your hand. That would have been perfect for that. But then again that's playing it like a gag which [..] doesn't add anything to the film necessarily. [..] but it's certainly interesting and if it's tightly linked to what's going on in the scene I think it could work really well, or the music.	6. Thinks it's something interesting and worth investigating 7. Thinks it's interesting the choice of linking the haptics to the music rather than the visuals 8. Although believes the circular pattern would work well in a horror movie, also thinks there could be the risk of it to act as a gimmicky effect

Participant 29

Data extract	Coded for
I don't mind the haptics, but **in that particular occasion it felt like it wasn't really related to the movie**. So it felt like you know when you're at the cinema and your phone is ringing, vibrating in your pocket. I forgot about it sometimes, because you know when the scene is really intense, it's still vibrating, but it's like, environmental stuff that's happening, you don't really perceive it anymore. Sometimes when the scene was quieter and the thing was buzzing all around I noticed it a bit more.	1. Felt the haptics in some occasions weren't related to the clips, and felt like having a mobile phone vibrating in your pocket 2. Forgot about the device in more active scenes 3. Noticed the device more in quieter scenes
Obviously there was something happening with the location, but because I couldn't figure out what it's relating to it's quite hard to keep track of the patterns. Plus, I mean the sensitivity of location on the back of the hand is not the best because you can feel the whole thing vibrating so, I mean, I can't tell which one's vibrating. Sometimes it was a bit more intense	4. Noticed the patterns moved along different locations on the hand, and noticed different intensities 5. Perceived the haptics as a whole, couldn't distinguish different motors vibrating - believes this is due to the fact that the back of the hand is less sensitive
So for me, because I didn't really understand it and it didn't work in sync I had this thing happening and there was the movie happening at the same time. **I didn't feel it was really an integrated experience.**	6. Didn't feel the experience was well integrated
Why not? Like I said earlier, if there's a real artistic intention, why not? It's not something that I'm going to actively seek, but if it's there and it makes sense, then why not?	7. Would try the experience again if given the chance - although wouldn't actively seek it

Participant 30

Data extract	**Coded for**
It was a good experience because I feel the sensation was in sync with what is happening in the movie which was exciting.	1. Felt the sensations experienced were in sync with the content of the movie clips 2. Found the experience exciting
Yes, I did. [..] when it was more calm and serene the kind of signals which I'm getting in my hand, is like they're not very frequent, so slowly they're moving, so it's like one pulse then it takes some time to get another pulse. But **when it is exciting it's like a bunch of pulses are moving the way it is moving in those scenes**.	3. Noticed in quieter clips the haptic sensations were less frequent, in more 'exciting' clips the haptics were more frequent
I liked one clip [..] where there was some fighting scene going on and that was the first time I actually felt that thing properly on my hand. I was feeling it throughout but it was moving very fast and I was like, I was happy there was a huge sync between the two. That was exciting.	4. Found one active clip particularly exciting as the haptics were in sync with it
Yeah, sure. That would be exciting at least to see how it happens [..] **It would be good if we see other emotions also.**	5. Would like to try the experience again 6. Would like to experience other emotions through haptics too

Appendix O

Thematic Analysis: thematic map

THEMATIC MAP