Emotional Responses to Immersive Media

by

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Thesis submitted for the degree of

Doctor of Philosophy

Department of Psychology

Goldsmiths College

University of London

June, 2006

The work presented in this thesis is my own and any information or ideas sourced from the work of others are fully referenced within the text.

Signed: Date: 6/9/07

(Catherine Dillon)

"Life is a tragedy when seen in close-up,
but a comedy in long shot."

Charlie Chaplin (1889-1977)

Acknowledgements

I am grateful to the Independent Television Commission (ITC), especially Dr. Nick Lodge and Dr. David Harrison, who funded my PhD research for the first three years and enabled me to participate in the applied research process to a greater extent than would otherwise have been possible. My appreciation also for the generous support of i2 media research ltd. who took up where the ITC left off, especially Dr. Jonathan Freeman for having faith in my ability to finish the thesis. I would also like to acknowledge The EC FET OmniPres project (2002-2005) who supported the development and dissemination of the theoretical ideas presented in this thesis.

Possibly never before has a PhD been supervised by so many, for so long, for the benefit of one student. My thanks to Prof. Jules Davidoff who was instrumental in bringing the ITC Immersive Television Project to Goldsmiths College, Dr. Ed Keogh for sticking with me as far as was possible and for playing 'Good Cop' on many occasions, Jonathan, my official unofficial supervisor, who isn't a 'Bad Cop' at all and my special gratitude to Prof. Linda Pring who stepped in at the end and saved the day.

The Department of Psychology at Goldsmiths College provided the resources that enabled the research in this thesis to be conducted and accepted the delay in committing it to paper. I would like to express my appreciation to Rob Davis who designed the polygraph equipment used in this thesis, Richard Billingham and Steve Yesson who arranged the smooth running of the visual display technology, and Maurice Douglas and Ian Hannent who dealt with the many other things of a fiddly nature. My special thanks go to Dr Jane Lessiter for coffee, sympathy and wide ranging discussions about presence and emotion.

I would also like to express my gratitude to the presence research community, especially the International Society for Presence Research and presence-research.org, for providing access to the work, experience and ideas of others and also for the opportunity to disseminate my own research and make contact with other researchers tussling with their psychophysiology equipment and the concept of presence.

To my family and friends: Warmest thanks to Katie and Penny for being constants, Mum and Dad for humour and understanding and especially Grandad for making the past present in the best possible way. A wag to the doggies (Bob, Amber, Ollie, Eureka, Daisy, Nala, little Peanut, big Peanut and Coco), who don't watch television and much prefer Wimbledon Common. And lastly, but mostly, my love to Jon.

Abstract

The five experiments presented in this thesis aimed to investigate the relationship between subjective presence (the sense of 'being there' in a mediated environment) and subjective and physiological emotional responses. The investigation served as an initial step in the evaluation of emotion-based corroborative measures of presence.

Two of the determinants of presence (Media Form and Media Content) were experimentally manipulated in order to create varying levels of presence and different types of subjective and physiological emotional responses. Varying levels of presence were created by manipulating Media Form characteristics in the context of a video display – specifically, the absence and presence of stereoscopic cues (Experiments 1 and 2) and small versus large eye-to-screen visual angles (Experiments 3 and 5). Media Content (video clips) with varying types of emotional impact was presented to participants via the video displays (Experiments 1, 2, 3 and 5). The research showed that enhancements in Media Form increased both subjective presence and subjective arousal across all Content types. However, there was little evidence to show that Media Form manipulations affected physiological arousal, indicating limited utility for physiological measures of presence in this context.

Media Content characteristics were investigated in more depth in Experiments 4 and 5. Differences in subjective presence between Media Contents shown to elicit different types of subjective emotion were investigated and correlations between subjective presence and subjective emotion were examined. The research indicated that the quality and intensity of emotional responses elicited by Media Content are potentially important determinants of subjective presence.

The thesis concludes by suggesting that in further investigations of presence and emotion, which aim to identify corroborative measures of presence, it may be useful to analyse the relationship between different dimensions of presence (Physical Space, Naturalness and Engagement) and different components of emotional responses (Subjective, Cognitive, Behavioural and Physiological).

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Chapter 1 Introduction: Presence Theory and Research

1.1 Background to thesis

One of the first motion pictures depicted a steam train in perspective heading towards the camera (Lumière & Lumière, 1895, see Figure 1.1). The audience reputedly ran for cover. We might suppose that their hearts began to race, they broke into a sweat and they felt terrified. Their bodies and minds prepared for action in the face of an apparent threat. After the film, members of the audience may have reflected on their experience and dismissed the idea that they were really in danger, but at the time they reacted and perhaps felt as if they were in the same physical space as the train. Indeed, Maxim Gorky said of his first cinematic experience, "You are forgetting where you are. Strange imaginings invade your mind and your consciousness begins to wane and grow dim." (Gorky, 1896, in Macdonald & Cousins, 1996, pg. 8).

Figure 1.1 Arrivée d'un Train à la Ciotat (Lumière & Lumière, 1895).
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Gorky could be reporting on an experience similar to one promised over fifty years later. The marketing of television and cinema shows us that an enduring promise of entertainment system developers has been to deliver realistic and intense mediated experiences designed to immerse us in alternative worlds and enhance our connection with the characters in them. For example, one DuMont advertisement from the 1950's depicts Alice in Wonderland seated before a television receiver. The text suggests that Alice will see more of the world than a 'member of an elder generation could have seen in a busy lifetime' and that she 'will see it as clearly as though she were there' on the 'big, clear, direct view screen' (see Figure 1.2).

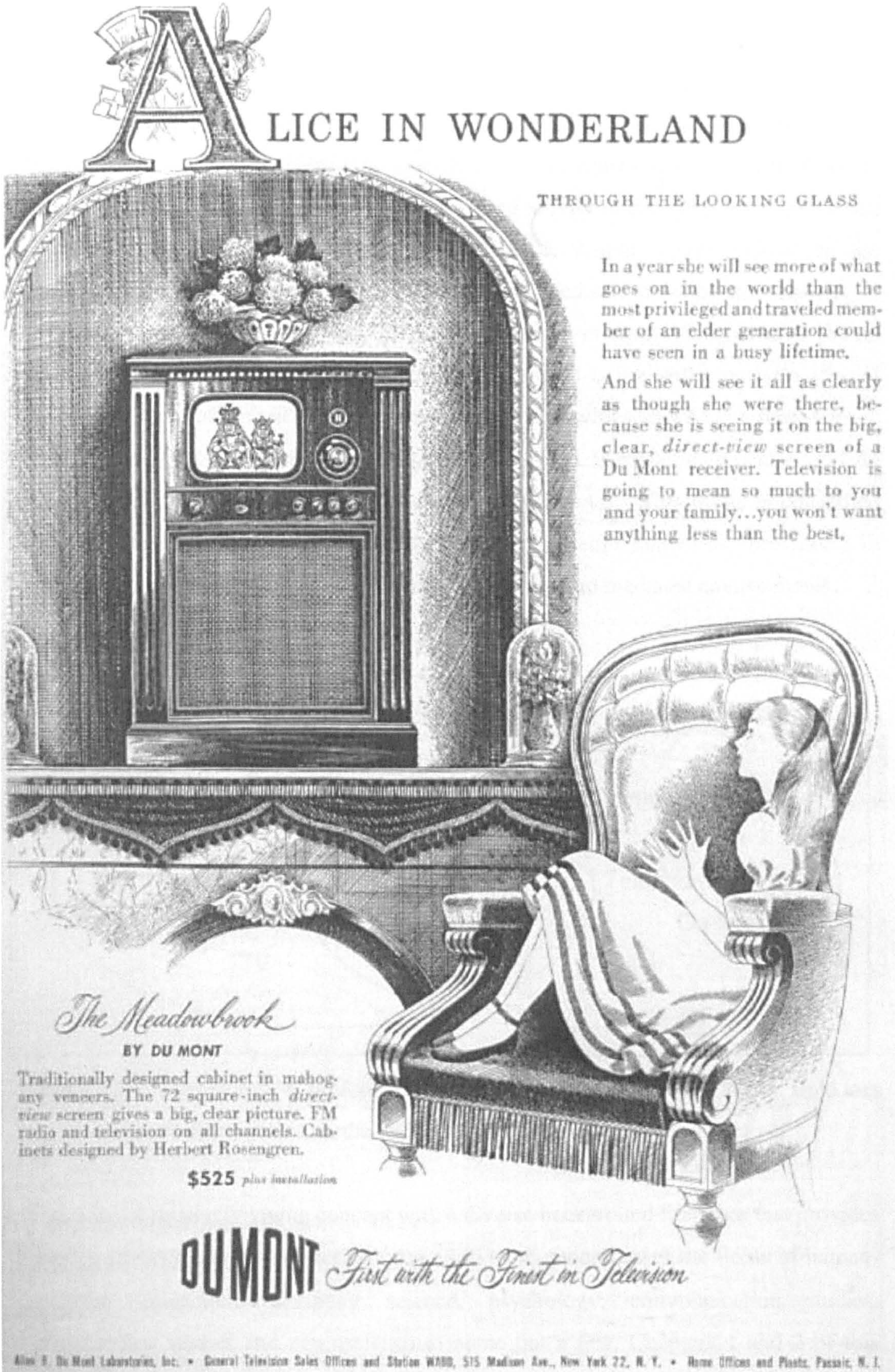

Figure 1.2 Vintage DuMont television-set advertisement, (appeared in National Geographic Magazine c.1949, © Allen B. DuMont Laboratories, Inc.)

Experiencing mediated environments as if we are part of depicted scenes and events has become the subject of much recent research. The experience was first termed 'telepresence' by Minsky (1980) who described a teleoperator's sense of 'being there' at a remote location. The term 'Presence' is now used to refer to the '(psychological) sense of being there' in a virtual environment' (Slater & Wilbur, 1997). However, the concept of presence has been applied across many media to describe the sense of 1) being physically located in a space (Physical Presence: via virtual environments [VEs], books, tele-operating systems, television and film), 2) being with someone (Social Presence: via phone, e-mail or in chatrooms) or 3) being with someone in a shared space (Co-Presence: via a shared virtual environment) – see IJsselsteijn, Freeman and de Ridder (2001) for a typography of presence and Figure 1.3. This thesis is concerned with the relationship between Physical Presence (hereafter known as 'presence') in mediated environments and peoples emotional responses to mediated environments.

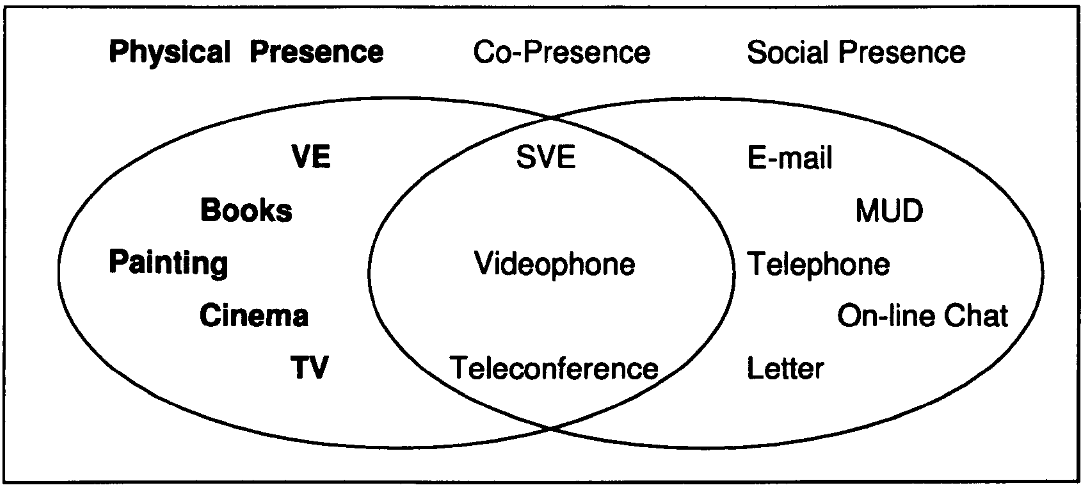

Figure 1.3 A typology of presence. Adapted from IJsselsteijn et al. (2001). Bold text indicates main media relevant to thesis.

Presence is a relatively young concept with a diverse background literature that provides a bridge across many disciplines (Biocca, 2001) and encompasses the fields of human-computer interaction, computer science, psychology, communication studies, consciousness studies and neuroscience to name but a few. Chapters 1 and 2 of this thesis explore recent literature addressing presence primarily from a psychological perspective. The chapters cover some of the key issues in the field noted by IJsselsteijn, et al. (2001): the structure of presence, explanatory models of presence, the determinants of presence, the effects of presence and the measurement of presence.

The literature suggests that when we reflect on and report a sense of presence in a place we are reporting on the psychological processes activated by an environment. Our experience of the environment goes beyond what is given to the senses. In particular, the role of our emotional experience of and response to mediated environments is highlighted in the introductory chapters. Presence theory can help to explain why the first moving images provoked such intense emotional reactions. In addition, it is proposed that such reactions may be among those that lead us to say 'it felt like it was real' or 'I felt like I was there'. Investigations of the relationship between presence and emotion may have applied utility. In addition to aiding the development of technologies built for both presence and emotion (e.g., advanced entertainment systems and therapeutic virtual environments) it may be possible to develop an emotion based measure of presence, which could overcome some of the disadvantages of current presence measurement techniques.

The remainder of the thesis is concerned with an investigation of the relationship between presence and emotion. Current knowledge concerning the structure and determinants of presence is utilised in order to explore novel presence measurement techniques. The investigation involves evaluating subjective and physiological measures of emotion as potential indicators of presence.

1.2 Definitions of Presence

There is no single definition of presence. Generally, over time, technological descriptions of presence have given way to human centred definitions. In particular, the relationship between presence in mediated environments and presence in real environments has become increasingly important as attempts have been made to model human mind and behaviour in relation to advanced media systems. An important distinction for this thesis, which arises from these definitions, is the difference between presence as a type of experience and people's subjective reports of presence.

It has been argued that 'true' presence is the feeling of concrete information being experienced in the here and now (Waterworth & Waterworth, 2003). The feeling enables humans to distinguish between external stimuli 'out there' in the world and internally generated stimuli, such as thoughts and imaginings (Waterworth & Waterworth, 2003, after Damasio, 1999). True presence, or the 'experience of experiencing', occurs most completely when an alert person is not attending to internally generated stimuli. Similarly, Slater (2003) has described presence as the absence of reflection. Such a state of consciousness may or may not be the type of experience we are reflecting on when we report that we have a sense of presence in a mediated environment.

In order to avoid making claims about consciousness it is useful in the context of this thesis to ground a definition of presence to what happens to a human user during a mediated experience. Lombard & Ditton (1997) have extensively reviewed the many situations in which a person may report a sense of presence. They provide a definition of presence that can be applied across many media such as virtual environments, television and film. Presence is defined as the 'perceptual illusion of non-mediation' and occurs when 'a person fails to perceive or acknowledge the existence of a medium in his/her communication environment and responds as he/she would if the medium were not there'. By describing presence as a perceptual illusion, Lombard and Ditton (1997) place the experience of presence as arising from an interaction of the human information processing system with the properties of a medium.

When examining the human information processing system, as the following sections will do, it is apparent that there could be many routes to a perceptual illusion of non-mediation and subsequent reports of presence (see Heeter, 2001). When a user reports on presence, they may be reporting on a wealth of psychological responses to a mediated environment. It is difficult to verify if these responses constitute true presence as described by Waterworth and Waterworth (2003). Therefore, for the purposes of this thesis, presence is not defined as the sum of a collection of psychological processes, but it is suggested that our subjective reports of presence could be based on these processes. Hence, it is useful to view presence as a conclusion that we arrive at or as something that we are asked to reflect on.

The second part of Lombard and Ditton's (1997) definition of presence links the illusion of non-mediation to the expression of naturalistic behaviour. This idea is seen in a number of other definitions of presence (Freeman, Avons, Meddis, Pearson & IJsselsteijn, 2000; Slater, 1999) and has been termed 'Behavioural Realism' by Freeman et al. (2000). It is not necessary to link Behavioural Realism with 'true' presence as defined by Waterworth and Waterworth (the feeling of concrete information experienced in the here and now. Everyday experience varies from person to person and situation to situation. If a person is clumsy and confused in a real environment, and remained clumsy in a similar mediated environment we would have to conclude that they behaved naturalistically in the mediated environment and so were present in that environment (even though they may feel confused and unconnected to their environment). If they became elegant and clearheaded in the mediated environment we would have to conclude that they behaved extraordinarily, had a high degree of connection to their environment and were experiencing 'true' presence. In order to avoid making a claim about whether either of these people is experiencing true presence, and for the purposes of this thesis, it is supposed that the psychological processes that lead to subjective reports of presence in a mediated environment are those which also lead to behaviours, feelings and cognitions that would be observed in a similar real environment (after Heeter, 2001).

The following sections examine some of the psychological constructs that have been linked to reports of presence and Behavioural Realism: perception, attention, mental models and schemata. Hence, the structure of presence is described in terms of the psychological processes underlying reports and behaviours that are taken to indicate a perceptual illusion of non-mediation. The relationship between presence and emotional processes is also evaluated – an under-researched and under-specified area of the presence literature (Huang & Alessi, 1999).

1.3 Perceptual Realism and Presence

1.3.1 Perception

The first psychological process underlying reports of presence in mediated environments to be examined is perception. Perception has been defined as "...the means by which information acquired from the environment via the sense organs is transformed into experiences of objects, events, sounds, tastes etc." (Roth, 1986, p.81). Hence, perceptual processes are a good starting point for examining how information acquired from a mediated environment via the sense organs (e.g., eyes, ears, nose) is transformed into the experience of objects, events, sounds, tastes and so on that appear as if they were real (i.e., non-mediated). Examples of this process may be found in the history of art and cinema.

1.3.2 Perceptual Illusions and Presence

A person can be tricked into believing that an environment depicted in a two-dimensional (2D) flat screen image is a three-dimensional (3D) environment by 1) reproducing sensory cues within the image that we use to infer visual depth in natural scenes and 2) reducing conflicting cues from an image and its surrounding environment (Gregory, 1973; Gombrich, 1960). For example, trompe l'oeil (trick-of-the-eye) painting techniques include reproducing depth cues, such as linear perspective and shading, in order to create a perceptual illusion of depth within an image. To enhance the illusion of depth, the frame of a painting may be removed, the painting may fill a large part of the visual field and some distance between a viewer and a painting may be maintained. A strong perceptual illusion of depth may occur when the discontinuity between the mediated and real environment is hard to detect and the physical structure of the mediated environment is difficult to discern.

Bordwell (1985) notes that artistic techniques such as linear perspective locate the viewer as an observer with a defined viewpoint in relation to the space depicted in a 2D visual image. The viewer may then have the illusion of being an observer or actor within a depicted environment. An artist or film-maker may manipulate such depth cues as a narrative tool. For example, the impact of creating illusions of depth was clearly expressed by cinematic innovators of the 1950s. Marketers promised that stereoscopic films (which provide binocular depth cues) would put the viewer in the picture as if they were there and that this would be more exciting and intense than conventional cinema (Lodge, 2000). Recent experimental work demonstrates that the addition of depth cues to mediated environments (such as virtual environments and immersive television) is indeed associated with increases in reports of 'being there' (e.g., Hendrix & Barfield, 1996; Freeman, et al., 2000). These applied and empirical examples demonstrate the link between the illusion of sensory realism and reports of presence.

1.3.3 Immersive Displays and Presence

The link between sensory realism and presence has been proposed across the presence research literature in particular with respect to immersive displays and presence (Ellis, 1996; Held & Durlach, 1992; Sheridan, 1992; Zeltzer, 1992). Trompe L'Oeil paintings and 3D cinema are historical examples of displays which have attempted to fully engage the senses of the user with information that is designed to mimic naturally occurring information, in order to create an illusion of non-mediation. More recent displays that attempt to do the same have been termed 'immersive' displays, such as immersive virtual environments and 3D television. Like presence, definitions of 'immersion' vary across the literature. For the present purposes immersion can be defined as a Media Form variable relating to the amount and quality of sensory information provided to a user via a display and also the extent to which sensory information from a real environment is restricted. It is widely predicted that enhancing the immersive properties of a display via Media Form variables will be associated with increases in reported presence.

For example, in the context of virtual environment evaluation, Slater and Wilbur (1997) propose that reports of presence, as much as they are determined by immersion, are determined by the extent to which a virtual environment is Inclusive, Extensive, Surrounding and Vivid. Inclusiveness refers to the extent to which information from a real environment (e.g., distracting elements of display such as cables and screen edges) is restricted. Extensiveness refers to the range of sensory modalities provided for by a display (such as visual, auditory and haptic information). The extent to which a display provides a panoramic rather than a narrow visual field-of-view (e.g., a head-mounted display versus a small television screen) is the extent to which it is Surrounding. Vividness refers to the resolution, fidelity and variety of sensory information provided by a display (e.g., pictorial realism).

The type and quality of interactivity provided by a display has also been highlighted as a Media Form variable that may determine the level of presence elicited by a mediated environment (Sheridan, 1992; Slater & Wilbur, 1997; Steuer, 1995). For example, Sheridan (1992) proposed three main Media Form determinants of presence: 1) the extent of sensory information (in terms of actual bits of information transmitted to a user), 2) control of sensors in relation to an environment (e.g., the ability of a user to modify his/her viewpoint) and 3) the ability to modify an environment (e.g., the quality of motor control enabling objects within an environment to be moved). For the present purposes 'interactivity' will be treated as a form of immersion as the types and qualities of interactivity provided by a display are Media Form variables (e.g., number of channels, delay and type of feedback). As such the prediction about the relationship between presence and immersion remains the same: that more channels, better quality information and reduced interference will lead to a higher degree of reports of presence.

There is a great deal of evidence supporting the idea that enhanced immersion will result in increases in reports of presence. For example, Schuemie, Van der Straaten, Krijn and Van der Mast (2001) have reviewed research in which aspects of Vividness were manipulated in order to investigate their effects on levels of reported presence. Sixteen out of twenty-one studies reviewed found some enhancement of reported presence as a result of enhanced Vividness. Means of enhancing Vividness were generally some form of adding sensory breadth and depth to a mediated environment, such as increasing image size and the use of binocular depth cues. For example, increasing eye-to-screen visual angle generally results in higher subjective ratings of presence (Hatada, Sakata & Kusata, 1980; IJsselsteijn, de Ridder, Freeman et al., 2001; Lombard et al., 1997; Prothero & Hoffman, 1995; Reeves, Detenber & Steuer, 1993). Schuemie et al. (2001) also report that, in a majority of studies, a better quality of interactivity leads to increases in reported presence. However, not all studies demonstrate that reported presence varies according to the degree of immersion (Mania & Chalmers, 2001) and, furthermore, there are conceptual problems in equating presence with immersion.

1.3.4 Differences between Immersion and Presence

The link between immersion and presence appears simple. If a display provides enough high fidelity sensory information to a user, then the user is more likely to perceive the information as if it were real (i.e., experience an illusion of non-mediation) and are more likely to report presence in the depicted mediated environment. Indeed, early theories in the field defined presence simply as the variation in the number and fidelity of sensory input and output channels within a display (Zeltzer, 1992). This is an objective technological approach to presence, termed a 'cybernetic' definition of presence by Draper, Kaber and Usher (1998). It suggests that media that provide more sensory channels and a better quality of sensory information will generate a higher degree of presence. It also suggests that presence can be simply measured as a function of the characteristics of these channels (e.g., modality, bandwidth and resolution).

However, the perception of an environment is not simply determined by incoming sensory information but involves the transformation of sensory information into something meaningful. For example, while some theories of visual perception propose that all the information we need to perceive a visual scene is inherent in patterns of light emitted from the visual scene (e.g., Gibson 1979) other theories have argued that perception is a hypothesis testing process in which expectations guide the interpretation of a visual scene (e.g., Gregory, 1973).

Some research in the presence field demonstrates that expectations may guide perceptions of mediated environments in a way that goes beyond information that is given to the senses. For instance, Biocca, Kim & Choi (2001) demonstrated that visual to haptic (touch) cross-modal sensory illusions may occur in virtual environments that provide only visual sensory information. In a physical manipulation task, user's experiences of a virtual hand-held manipulation tool were both visual (the depiction of a spring-mechanism on the tool) and haptic (the feel of the spring snapping into place in the hand) even though haptic information was not provided by the virtual environment. The more likely a user was to experience the illusion, the more likely they were to report a higher level of presence than other participants. Furthermore, in a similar task, the addition of richer visual information was not associated with increases in reports of presence (Biocca, Inoue, Lee, Polinsky & Tang, 2002). In the two experiments, the quality of visual information alone did not appear to be as strongly related to reported presence as the user's ability to interpret and elaborate on the visual scene.

Further evidence that media form properties alone cannot fully account for evoked presence in mediated environments comes from a series of studies on interaction and presence. Interactivity in a mediated environment can engender a high sense of presence and was noted early on in the presence literature as an important determinant of presence (Sheridan, 1992). In support of this, Regenbrecht & Schubert (2002) demonstrated that spatial presence correlated with the number of possible interactions available to users of interactive 3-D computer games: the more interactions that were possible in a game, the higher the sense of presence. A follow-up study, conducted in an immersive VE, showed that spatial presence and realism were higher when users were allowed to move freely through their environment, rather than viewing a pre-recorded walk-through of the environment. However, Regenbrecht and Schubert also demonstrated that not only did possible and actual interactivity determine presence but that the perceived potential to interact also determined presence. When users of the VE were given pre-instructions that they would be able to interact with animated characters in the VE (when no actual interaction was possible) they reported a higher sense of spatial presence than users that were told that they could not interact with the animations. The studies demonstrate the importance of interaction, or immersion, in evoking presence but also imply that less interactive and immersive media, such as film or television, could have the potential to engender presence if users are oriented to the potential to act within the mediated environment and therefore such media could be used to study presence.

Given the evidence presented by Biocca et al. (2001), Biocca et al. (2002) and Regenbrecht and Schubert (2002) it is apparent that simply equating presence with the immersive properties of a display does not adequately describe the psychological processes by which a user may come to report on a sense of presence in a mediated environment. In support of this proposal, Schubert, Friedman and Regenbrecht (2001) have found that ratings of the quality of a display (e.g., image quality) are somewhat independent of ratings of experiences of mediated environments depicted by a display (such as a sense of space). Lessiter and Freeman (2001) have also demonstrated that presence ratings may serve as a global media quality metric, over and above ratings of single display characteristics such as audio volume and clarity. In recognition of the findings which show that immersion does not always lead directly to presence, Schubert et al. (2001) have proposed that there are two further cognitive concepts that may define presence. These concepts are *attention* and *mental models*, which may provide a mediating layer between the sensory information provided by a display and our experiences of the environment depicted by a display. When we report on our sense of presence, it is these underlying processes on which Schubert et al. (2001) propose we are reflecting. The following sections first examine potential relationships between attentional processes and reported presence and then potential relationships between mental models and presence.

1.4 Attention and Presence

1.4.1 Attention

Attention as a psychological process was described by William James (1890, p. 403-404) as "...the taking possession of the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalisation, concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others". Similarly, subsequent theories of attention have highlighted the limited cognitive resources available to deal with incoming sensory information (e.g., Broadbent, 1958), the function of attention in segmenting sensory information (e.g., auditory streams: Cherry, 1953) and in binding sensory information (e.g., feature integration in perceptions of objects: Treisman, 1988) and the close relationship between what we are attending to and what we are aware of (Velmans, 1999). Hence, the term attention is used to refer to the selection of parts of incoming sensory information for further processing but is also used to refer to the intensity of subjective concentration on or involvement with that information (Moray, 1969).

Attention as a selection mechanism and also attention as involvement have been implicated in a number of theories of presence (Bystrom, Barfield & Hendrix, 1999; Draper et al., 1998; Kim & Biocca, 1997; Schubert & Crusius, 2002; Schubert, et al., 2001; Slater, 2002; Waterworth & Waterworth, 2001, 2003; Witmer & Singer, 1998). For example, an examination of attentional processes can provide some insight into the link between immersion and presence and may also indicate how immersion may be a necessary but not a sufficient component of presence. In particular, the way in which we focus cognitive resources on incoming sensory information, select information from available sensory information and the relationship between focus, selection and awareness are relevant to discussions of the way in which mediated environments may come to be perceived as non-mediated.

1.4.2 Focused Attention

The terms 'focused attention' and 'selective attention' are often used synonymously. Both terms are used to refer to the process by which a person selects and rejects certain parts of information presented to the senses. However, for the present discussion, focus and selection will be dealt with separately in order to illustrate how subjective reports of presence may be related to (a) the location on which attentional processing is focused and (b) the process of selecting the focus of attention. Therefore, the focus of attention here refers to stimuli to which an individual directs information processing resources. For example, in the case of auditory information processing a person can attend to one of several people speaking simultaneously (Cherry, 1953) while in the case of visual information processing attention has been likened to a spotlight with a variable beam capable of highlighting more or less visual information in a scene (Eriksen, 1990).

In the Focus, Locus and Sensus model of mediated experiences, Waterworth and Waterworth (2001; 2003) suggest that presence occurs at one extreme of a Focus dimension. Similarly to Eriksen's (1990) conception of focused visual attention, the Focus dimension is likened to a lightbulb swinging between two adjacent rooms. The light can illuminate either room fully or only a mix of parts of both. One room represents the internal world of abstract thoughts and imaginings and the other room represents the external world of concrete information. The portion of each room that is illuminated is the focus of attention. Because attentional processes are said to have limited capacity (i.e., they can only deal with a certain amount of information) it is not possible for both the internal and external worlds to be fully illuminated simultaneously. Waterworth and Waterworth (2000; 2003) claim that as presence increases the more a person focuses on concrete information in the external world rather than the abstract world. This is regardless of whether the Locus of the external world is a real environment or a mediated environment. Further to this they suggest that Locus and Focus may be influenced by Sensus (level of attentional arousal). We may only pay attention to the external world when our attentional systems are activated, and therefore may only experience presence in this state.

One of the implications of the Focus, Locus and Sensus model is that if an alert user is attending exclusively to external stimuli, and if the only available external stimuli originate from a mediated environment, then the user should experience a high degree of presence in that mediated environment. Hence, more immersive displays, which reduce the availability of information from the surrounding real environment, should be associated with a higher degree of presence. However, currently available displays are not yet able to fully reproduce real world sensory information or completely eliminate real world sensory information being transmitted to the user, yet high ratings of presence may be observed in response to such environments (for example stereoscopic video produces higher ratings of presence than monoscopic video but is not highly immersive, . Freeman, et al., 2000). In addition, the model takes a narrow view of presence in that it is defined as a specific quality of experience linked only to the processing of external stimuli. In order to examine how a user may arrive at a report of presence, when presence is alternatively defined as an illusion of non-mediation, a consideration of how a user distinguishes between different Loci, in addition to distinguishing between internally and externally generated information, may be needed.

Drawing on fiction-reading research (Gerrig, 1973), Kim and Biocca (1997) have argued that we may be present in one of three places: the real environment, the virtual environment (including all mediated environments) and the imaginal environment (e.g., day dreams). They have suggested that presence (characterised as transportation to one of the three environments from one of the other environments) is influenced by sensory engagement. Information from the different environments competes for attentional processing in that it competes for accessibility to limited capacity sensory channels (similarly to Waterworth & Waterworth, 2000; 2003). Hence, immersion can support presence in a mediated environment by reducing information available to a user from a real environment. However, it may also be predicted that, if attention can be thought of as a competition between information from different environments, then stimuli which have a high degree of importance to a user (such as those which signal danger) may also be expected to draw attention and support presence (Heeter, 2003). Examples of Media Content variables (events, objects, people and places within mediated environments) that have been proposed to support involvement and presence may be found throughout the presence literature. For example, the narrative of a book or film may demand attention in order to increase comprehension (Schubert & Crusius, 2002) or a particular goal-directed task may engage the user (Bystrom et al., 1999).

In summary, the presence literature suggests that both Media Form (such as immersive display characteristics) and Media Content (such as involvement) variables are related to the degree of attention allocated to mediated stimuli, or the focus of attention. An immersive display may increase the likelihood that a user attends only to a mediated environment by blocking out extraneous real world information. Involving content may ensure that limited capacity attentional processing is directed towards a mediated environment to the exclusion of the real environment. An example of this would be the high degree of involvement experienced when attending to the visual and auditory information provided by a film. In order to attend to the film the user must exclude the rich visual, auditory, olfactory, tactile and proprioceptive information provided by the real environment of a cinema (Barfield, Zeltzer, Sheridan & Slater, 1995).

It has further been proposed that in order to experience presence in a mediated environment, a user must have some way of selecting a subset of mediated stimuli from an array of available sensory information and also some means of suppressing information that conflicts with information in a mediated environment (Schubert et al., 2001; Witmer & Singer, 1998).

1.4.3 Selective Attention

The study of selective attention is the study of the way in which some sensory inputs are selected for attentional processes rather than others and the nature of the selection process. The study of selective attention is important in presence research as it has been proposed that attention is the gateway to conscious experience (Baars, 1988). The focus of our attention, or what becomes selected for attentional processing, may determine the contents of current experience. Hence, the nature of selection processes may to some extent determine whether a person is most aware of a real, mediated or imagined environment. As such, the process of allocating attentional resources to mediated environments may be the first step in determining a perceptual illusion of non-mediation, or a report of presence in a particular environment. Theories of selective attention indicate how attention and presence may be related.

Early theories of attention proposed that, due to limited capacity attentional channels, after early perceptual processing of the sensory qualities of stimuli a subset of relevant incoming sensory information is selected for attention and awareness. Relevant information is retained for further processing and all irrelevant information is rejected (Broadbent, 1958). Hence, it is possible to listen to one person's voice over the melee of a cocktail party (Cherry, 1953). However, later theories suggested that incoming sensory information is partially analysed for meaning, in addition to quality, before being selected or rejected for attention and awareness (Deutsch & Deutsch, 1963). For example, if while in conversation at a cocktail party someone on the other side of the room were to mention your name, the sound of your name might suddenly enter your awareness. In addition, spoken words that have previously been associated with an electric shock produce physiological fear responses in participants, even when the participant is attending to an alternative set of words (Von Wright, Anderson & Stenman, 1975). The theory and evidence suggest a role for the impact of both sensory information and knowledge in the selection process.

Treisman (1988) suggested an efficient way in which relevant parts of a sensory array may come to be selected for attention and awareness (in the case of object recognition). Pre-attentive processes occur which involve the fast and automatic detection of sensory features. This involves the parallel processing of sensory information in channels dedicated to only one type of information (e.g., the shape, size or colour of an object). A large amount of information may therefore be analysed in parallel before awareness. However, detected features must be integrated to form the perception of a whole object. Treisman proposed that this stage of processing requires a slow, flexible, serial search through conjunctions of detected features. The efficiency of the serial limited capacity search can be aided by top-down processes. Top-down processing refers to the role of knowledge and expectation in information processing. As in the discussion of immersion, it is relevant that perceptions are not only formed from available sensory information but also by what makes sense. Hence, both initial data-driven (bottom-up) processes and top-down processes may determine information that is selected for attention and therefore what we are aware of, or perceive, in our environment.

For example, Gregory (1973; 1998) has proposed that the analysis of sensory information is guided by perceptual hypotheses and that perception involves a selection between competing hypotheses (a top-down process). Gregory's idea has been developed by Stark (1995) who proposes that the selection of one particular visual hypothesis will result in a repeated pattern of eye movements over an environment (or scan sensing) as if the observer is using eye-movements, or focal attention, to verify that hypothesis. An example of this process may be seen through the analysis of eye-movements across pictures that can be interpreted in two different ways (see Figure 1.4 for a picture that can be interpreted as both a duck and a rabbit). Research has shown that when a person experiences one of the interpretations (e.g., the rabbit) their eye-movements tend to focus on the parts of the image which define that interpretation (e.g., the tips of the ears).

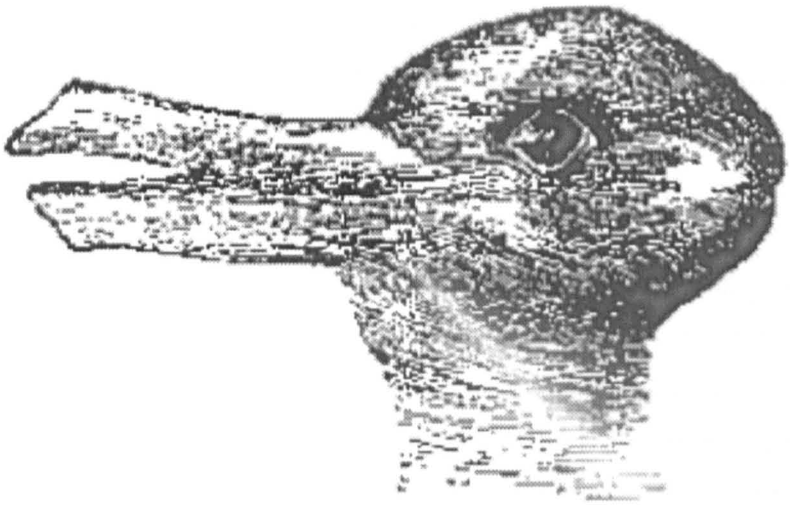

Figure 1.4 The Duck-Rabbit Illusion (Jastrow, 1899)

Using the theories of Gregory and Stark as a starting point, Slater (2002) has suggested that presence may be considered as a perceptual selection mechanism that organises sensory data into a perceptual hypothesis about a current environment. Experiences of virtual environments are good examples of occasions when two clear perceptual hypotheses co-exist (the mediated environment vs. the real environment). The selected hypothesis will determine how a user scan-senses their environment and what information is attended to. Therefore, a hypothesis that leads to scan-sensing of a mediated environment exclusively, as opposed to the surrounding real environment, may support a perceptual illusion of non-mediation and a report of presence in the mediated environment.

Slater (2002) has proposed that an indicator of the success of a mediated environment as the selected hypothesis is the frequency with which a user experiences switches in attention from the mediated to the real environment. Such attentional switches have been termed Breaks in Presence (BIPs: Slater, 1999, 2002). BIPs occur when significant information that is incongruent with a current perceptual hypothesis reaches awareness. For example, distracting information from the real environment (e.g., screen edges, cables or the sound of an experimenter's voice) or internally generated information (such as self-awareness) may interrupt a user's experience of presence. Indeed, the occurrence of BIPs has been shown to negatively correlate with post-test ratings of presence (Slater & Steed, 2000): the fewer BIPs a person reports during their mediated experience the more presence they are likely to report after a mediated experience. However, further considerations of the relationship between selective attention and awareness indicate that attentional processes alone may not fully account for reports of presence.

1.4.4 Attention and Awareness

Velmans (1999) and others have argued that attention is somewhat independent of what we are aware of. We are not aware of attentional processes themselves (e.g., we read automatically without being aware of the analysis of letters and words). In addition, evidence suggests that stimuli are partially analysed for meaning before they are selected for attention (Deutsch & Deutsch, 1963) and that information that is selected for attention is further analysed for meaning before it reaches awareness (Treisman, 1988). When considering the perception of our external environment, Velmans proposes that what we are aware of and what we can report on is a complete analysis of attended to information that has already been integrated and disseminated through the brain. That is, our perceptions follow attentional processing of incoming sensory stimuli, but are not equivalent to attention. In terms of the perception of mediated environments, a user's report of a sense of presence may reflect a focus on an environment that made sense, was coherent and was meaningful and not just the focus itself.

Evidence that attention is only one process associated with reports of presence comes from the analysis of items on presence questionnaires. The subjective feeling of 'Involvement' has been described as a consequence of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities (Witmer & Singer, 1998). Although attentional processes themselves may not reach awareness the feeling of being 'involved' might be a part of the experience of mediated environments and presence. However, it has generally been found that items on presence questionnaires relating to 'involvement' group together more coherently than they do with items relating to – typically – a sense of space or realism (e.g., see the factor analyses of Schubert et al., 2001 and Lessiter, Freeman, Keogh & Davidoff, 2001). The different dimensions of mediated experiences identified through factor analysis are correlated but are not equivalent or regarded as being in the same conceptual class.

Furthermore, although Slater and Steed (2000) present evidence for a relationship between attentional switches away from mediated environments (BIPs) to reports of presence there are problems with such an approach. Although the occurrence of BIPs has been shown to correlate with post-test reports of presence (Slater & Steed, 2000) the methods used to demonstrate this effect may have biased reports of presence by forcing the user to reflect on their mediated experience while it was happening. In addition, when using BIPs as indicators of presence, attention to a coherent set of stimuli could not be distinguished from attention to less meaningful stimuli. It would be possible to conclude that a person doing data entry continuously for twenty-minutes experienced more presence in their database than a person who occasionally became aware of their head-mounted display during a twenty-minute virtual environment experience. Information about selective attention may only give information about where a person was focused, not whether they had a sense of being there. Indeed, measures of BIPs may not adequately indicate the focus of attention: if a person experienced only one BIP during a mediated experience it would not be possible to infer that their attention returned to the mediated environment if no subsequent BIPs were reported.

There is also some evidence to suggest that users' experiences of mediated environments may be more fluid than attentional approaches to presence suggest. Spagnolli and Gamberini (2002) have qualitatively examined the impact of immersion and 'emmersion' (i.e., BIPs) on VE users. From video and audio analysis of VE experiences and subsequent interviews they concluded that emmersion, caused by distracting (i.e., attention grabbing) elements of a real environment, is less frequent than expected. Rather, the user is able to mentally construct hybrid environments from the real and virtual worlds. Elements such as the experimenter's voice and obstruction from cables can become built into a continuous narrative rather than drawing attention away from the virtual environment. In considering how a user comes to report on a sense of presence, the processes by which users come to report on a coherent sense of space, place or event are therefore also important factors. This has been strongly suggested in a number of theories that propose a role for higher-level cognitive processes and knowledge structures, such as mental models and schemata, in the elicitation of presence in mediated environments.

1.5 Mental Models and Presence

1.5.1 Mental Models

To summarise the discussions of the relationship of presence to perception and attention given above a number of key points can be made. Firstly, presence has often been linked with immersion (the number and fidelity of sensory channels provided by a display and the availability of real world sensory information). Immersive displays may be associated with greater reports of presence than less immersive display because they may (a) support perceptual illusions of sensory realism and (b) enable focused attention on a subset of mediated sensory information. However, evidence suggests that perceptions of mediated stimuli are not simply driven by currently available sensory information but may be influenced by top-down processes such as expectation. In addition, an overview of the attention literature suggests that top-down processes may also influence the selection of mediated stimuli over real world stimuli for the focus of attention. Furthermore, the meaning of depicted content to a user has been proposed as an important influence on both attentional processes and presence. In conclusion, the routes by which a user comes to report on a sense of presence may not adequately be described in terms of immersion and attention alone. A user's mental representation of a display and content are also important considerations. For example, perceptual hypotheses may guide attentional focus in a mediated environment and 'sense-making' abilities may influence the way an environment is interpreted. The presence literature contains examples of how we may think about perceptual hypotheses and sense-making abilities. These include the use of the term 'mental models' to explain how sensory information can be constructed in a meaningful way and to demonstrate that existing representations of knowledge can guide current experience.

Conceptions of mental models differ across the literature. Different emphasis has been placed on whether mental models can be described in terms of imagery, schematic information, propositional information or spatial information (Langston, Kramer & Glenberg, 1998). However, it can be said that the term mental model refers to some mental representation of a situation where the structure of the mental model "...corresponds to the structure of the situation it represents" (Johnson-Laird, 1989 pg. 488). A mental model allows relationships between things to be understood, allows predictions to be made and simulations of systems to be run. All this can be done on the basis of limited sensory data, given that currently active mental models are formed from information available in an environment combined with information retrieved from long-term memory. In summary, current knowledge about an environment goes beyond what is given to the senses.

The mental model construct has been applied to a number of psychological processes. For example, it has been proposed that in order to understand text a reader uses a mental representation of what the text is about (e.g., the context and situation) in addition to the structure of the text itself and relationships between concepts in the text (Dijk and Kinston, 1983; Teasedale & Barnard, 1993). In the case of reasoning, it has been proposed that novel inferences and predictions may arise from the construction of mental models based on limited premises (Johnson-Laird, 1983). In the case of ergonomics and human-computer interaction it has been proposed that users have naïve theories (or mental models) about the working of a system or interface which helps guide their behaviour (e.g., where to find things; Norman, 1986). In presence research the term mental model has been used to refer to the way in which a user constructs a working mental representation of the content depicted in a mediated environment in order to guide their behaviour in that environment.

1.5.2 Mental Models of Space

Von der Heyde and Riecke (2002) have developed a theory that links presence to mental models by considering the way in which we move through our environment. They have proposed that one important goal of an organism is to be spatially orientated (being able to find one's way around an environment). In order to achieve spatial orientation an organism's perception of space must be consistent (where all sensory information contributes to one coherent percept) and continuous (in space and time). Von der Heyde and Riecke (2002) claim that to achieve a consistent perception of an environment, sensory information must be constructed within an 'egocentric reference frame' (a mental model of the world from a first-person perspective). When a person interacts with a displayed environment, sensory information comes from a variety of sources (e.g., the real environment and the mediated environment). Therefore, multiple reference frames are possible. The primary reference frame is the one on which most sensory inputs agree (e.g., the real environment vs. the mediated environment). Von der Heyde and Riecke (2002) propose that Spatial Presence ('the consistent feeling of being in a specific spatial context and intuitively knowing where one is with respect to the immediate surround') may only occur if one consistent egocentric reference frame is agreed on.

Therefore, according to Von der Heyde and Riecke's theory, the sense of presence reflects the success of a user in achieving a consistent perception of space, which is necessary for spatial orientation. Further to this, their theory also proposes that the sense of presence reflects a consistency check on the primary egocentric reference frame, in that presence is proposed to be a sufficient but not a necessary pre-requisite for continuous spatial updating (updating self-to-environment references using velocity, acceleration and relative displacement during movement through an environment) and instantaneous spatial updating (landmark based updating during movement). Spatial updating is seen in the theory as a necessary pre-requisite for reflexive and intuitive spatial behaviours. 'Obligatory behaviours' (e.g., automatic reflexes, such as fear) are also proposed to arise from presence (in turn dependent on the consistency check on the egocentric reference frame). Hence, presence may be measured using observations of intuitive spatial behaviours and obligatory behaviours. When observations of behaviours correlate highly with reported presence it is proposed that one consistent egocentric reference frame is in use.

An example of the association between intuitive spatial behaviour and presence may be seen in the work of Slater, Usoh and Chrysanthou (1995). They used a reflexive pointing task as an indicator of presence in virtual environments that varied by the amount of dynamic shadow included. Users were required to point to a virtual radio when they heard the sound of an unseen real radio, which varied in its proximity to the virtual radio. The accuracy of pointing to the virtual radio was taken to indicate the dominance of the virtual environment as the accepted reality in comparison to the real environment. Increased dynamic shadow was associated with increased accuracy of pointing to the virtual radio in those users whose dominant mode of processing information was visual (in neurolinguistic programming terms) and enhanced reported presence across all users. However, a second task in the experiment (manipulating and targeting spears in the virtual environment) was not improved by the addition of dynamic shadows. Similar results are reported by Slater, Steed, McCarthy and Maringelli (1998).

The results support the theory of Von der Heyde and Riecke (2002) in that they demonstrate that enhancing aspects of a display that should aid the construction of a consistent egocentric reference frame may increase both reported presence and performance on a reflexive spatial task. This is in contrast to a spatial task which required planning and may have been dependent on other more reflective processes such as planning and learning. However, it was only in a subset of users that dynamic shadow influenced reflexive behaviour, whereas reported presence increased across all users with the addition of dynamic shadow. According to the theory this would imply that only a subset of the participants could be said to be operating on one consistent egocentric reference frame. Alternatively, it may be the case that some users are better able to construct and act on representations of visual space than others and that reports of presence may simply co-occur with reflexive spatial behaviours.

A demonstration of the latter point is provided by Meehan, Insko, Whitton & Brooks (2002). Meehan et al. (2002) exposed users to a thirty-foot virtual cliff through a head mounted display. For medium to high frame-rates (30-60 frames per second) ratings of presence and the reflexive physiological indicators of fear positively correlated and both increased as frame-rate increased. However, for a very low frame rate (10fps) users exhibited the physiological indicators of fear but did not report a high level of presence. This evidence suggests that obligatory reflexes may be observed in response to mediated environments even when a user does not report presence. The reasons for this result are unclear. Meehan et al. (2002) point out that the appearance of the VE was severely degraded at the very low frame rate. Potentially, features of the environment at a low frame rate may have been sufficient to prompt a spatial reflex but not sufficient to support a consistent model of a place in which one could report a sense of presence.

Von der Heyde and Riecke's (2002) theory is useful in that it explicitly proposes a framework in which the notion that feelings of presence arise from the construction and checking of mental models of space can be tested. In addition, the theory provides an explanation for why reports of presence should be associated with naturalistic reflexive behaviours. However, the theory is complex and not fully described here. It is a theory in development and is currently being tested. Experimental evidence relevant to the theory suggests that though reflexive behaviours and reports of presence may sometimes co-occur, they may also occur independently and their co-occurrence may be influenced by individual differences. As in the discussions of immersion and attention it may be the case that mental models of space are an important process to consider in the elicitation of reports of presence, but cannot be viewed as the only process. In particular, Von der Heyde and Riecke's theory describes the process of eliciting presence as primarily data-driven, spatial and tied to movement, with a limited role for such processes as imagination or expectation in the construction of mental models of an environment. Other applications of the mental model concept to presence have proposed a more important role for such processes.

1.5.3 Mental Models and Memory

Memory can be de defined as 'the retention of experience' (Morton, 1994) and can be described in terms of three processes: encoding of information, storage of information and retrieval of information (Eysenck & Keane, 1995). A number of presence researchers have highlighted the role of memory in the generation of feelings of presence. Prior experience and knowledge may affect how we experience and react to mediated environments. For example a mediated environment and its content may provoke (cue) or demand that a user retrieves explicit (conscious) and implicit (unconscious) memories.

Von der Heyde and Riecke's (2002) theory of presence described above is tied to mental models of space and actual physical movement: accurate movement is possible in an environment when one consistent mental model of space is acted upon and this is reflected in reports of presence. However, not all displays require or allow movement (e.g., books, film and IMAX cinema) and an alternative mental models approach in the literature, which requires a consideration of memory processes, can account for feelings of presence in mediated environments presented via such displays (Schubert et al., 2001).

Schubert et al. (2001) have proposed that one process leading to reports of presence in a mediated environment is the construction of mental models of space surrounding the body. They liken this process to the 'embodied perception' in a real environment. Embodied perception involves mentally combining potential patterns of action that are possible within an environment in order construct a mental model of that environment (after Glenberg, 1997). Therefore, environments can be mentally represented in terms of what you can possibly do in that environment. For example, mental models of a virtual environment are not just spatial models of the 3-D computer model but 'spatial-functional models'. Schubert et al. (2001) propose that it is possible to have a spatial mental model of a virtual environment without being present (e.g., a designer working on shading in the visual image) but not presence without a spatial-functional mental model. Embodied presence only develops when mental representations of potential actions within a mediated environment (e.g., navigation, manipulation and interaction) emerge. An implication of this approach to presence is that it allows presence to be a relevant concept to experiences of displays with poor sensory quality, such as books, as well more immersive displays, such as virtual environments, as spatial-functional models can be constructed from the information presented by both (Schubert & Crusius, 2002).

Information about potential patterns of action for the construction of spatial-functional models is said to come from two sources (Schubert et al., 2001; after Glenberg, 1997 and Gibson, 1979). Properties of a displayed environment will directly afford certain actions (e.g., surfaces for putting things on and containers for putting things in). Properties of a person will also determine the nature of the mental model. A person will have implicit memories about the functions of the content of the displayed environment and the consequences of interacting with this content. Hence, spatial-functional mental models of mediated environments, and therefore reported presence, are not only determined by incoming sensory information (bottom-up information) but also by the user's existing memories and knowledge (top-down information). Evidence for the role of memory in determining reports of presence comes from a number of sources.

When expertise is required to interact with an interface there is some evidence that repeated exposure (or practice) enhances absorption and presence. This is seen in qualitative interviews with users of text-based virtual worlds (Jacobson, 2001) and Heeter's (1992) study of immersive game users. Practice with the interface of a display may allow a user to better interact with the contents of the display. In mental model terms, it may be the case that experience with a mediated environment allows a more accurate model of the actions that can be taken in an environment to be constructed.

However, repeated exposure may also reduce presence. This effect was demonstrated in an experiment in which novice users watched the same footage on an immersive television set over four days (Lessiter & Freeman, 2000c). Presence ratings reduced over the course of this period. However, presentation of novel content and adding stereoscopic information to the display caused a rebound in presence ratings. Meehan et al. (2002) also observed reductions in reported presence in novice users over repeated exposures to the same virtual environment. Potentially, experience with a mediated environment, allowing a rich mental model of that environment to be constructed, may also alert the user to limitations on potential actions in that environment and a reduced sense of presence.

Importantly, it is the mental representation of the potential to act within a mediated environment, rather than objective actual or possible actions, that Schubert et al (2001) propose as a determinant of presence. As described previously (pg. 24), Regenbrecht & Schubert (2001) demonstrated in a series of studies that presence positively correlates with the number of possible interactions in a mediated environment, is higher when users can interact with, rather than view, a mediated environment and is also higher when users believe they can interact with their environment (when interaction is not objectively possible). Prior knowledge or expectation may enable a rich spatial functional model of an environment to be mentally represented and thus lead to relatively higher presence.

Interestingly, the findings described by Regenbrecht and Schubert (2002) were mainly restricted to measures of spatial presence: actual, possible and potential interactions enhanced users' sense of space and realism, but did not affect their sense of involvement in a mediated environment. The evidence suggests that the role of mental models in determining presence is specific to the sense of physical space rather than attentional components of presence.

However, there is also evidence to suggest that experience and knowledge which is not directly related to spatial information can also enrich presence. In particular, phobic users of a VE that displayed phobia inducing stimuli were shown to report a higher sense of presence than non-phobic users (Robillard, Bouchard, Fournier & Renaud, 2003). In another experiment, users that were led to believe they would encounter snakes in a VE depicting a desert (without any actual snakes) gave higher ratings of presence and anxiety than users that were not told they would encounter snakes (Bouchard, St. Jaques and Renaud, 2004). In both experiments a predisposition to attend to danger may have enriched spatial functional mental models and hence presence (as participants were primed, naturally or in an induced way, to believe they would 'interact' with dangerous stimuli). Alternatively, such knowledge or predispositions may not necessarily directly contribute to spatial functional mental models but may be part of more general structures of knowledge which a user brings to a mediated environment (see section 1.6).

1.5.4 Evaluation of the Mental Model Approach in Presence Research

Mental Model approaches in presence theory suggest that feelings or reports of spatial presence are in part based on the successful construction of models of mediated space around a user which may give rise to certain types of intuitive behaviours or at least give the user information about what types of behaviours might be possible in the mediated environment. The mental model approach can be linked to previously described approaches that highlight the role of perception and attention in the elicitation of presence. In particular, mental models are relevant to predictions concerning the effects of Media Form and Media Content variables on reported presence. Immersive displays may support reports of presence by providing realistic sensory information and engaging attentional processes. They may also provide the sensory information required to support a mental model of space in which the user feels the potential to act. Media Content may also draw the attention of the user and may enrich a mental model when aspects of the Media Content match the contents of the user's memory. Further to perceptual and attentional approaches to presence, the mental model approach implies that individual differences, or User Characteristics, will have an impact on feelings and reports of presence, as each user will have different experiences with (and therefore memories of) a particular mediated environment or may be better able than others to construct a mental model out of sensory information. Hence, the mental model approach may be able to account for expertise and novelty effects.

However, some evidence suggests that the types of behaviours and reflexes proposed to arise from mental models of space may not always co-occur with reports of presence. This implies that different types of information in a mediated environment may be used by different types of response systems (e.g., subjective and behavioural). It could further be proposed that subjective reports of presence may in part be based on coherent mental models of space but may also reflect other types of mental representations or associations to an environment. For example, schema theory has been applied in presence research to demonstrate how a user's memory of a mediated environment may be important in determining reports of presence.

1.6 Schema Theory and Presence

1.6.1 Schema Theory

As with the term 'mental model', the term 'schema' has been used for a diverse number of purposes across psychological literature. For the present purposes, an overview of the term schema provided by Mandler (1992) is useful: A schema is a coherent and structured representation of generic knowledge that organises experience and recall. Current experience is influenced by available sensory information and regularities extracted from similar experiences in the past. The regularities relate to events or objects that have previously co-occurred in our experience (e.g., we are normally served food, not garden tools, in a restaurant). Representations of previously experienced regularities, or schemata, may be concrete in nature (e.g., categories of perceptions such as cutlery) or abstract (e.g., romance). Concrete schemata may cue abstract schemata and vice versa. Expectations are elements of an activated abstract schema not supported directly by available sensory information (e.g., we expect that a restaurant serves alcohol, though it is not on display). In terms of what we experience, currently activated schemata automatically make available to us information that we do not directly sense (e.g., 'what a nice atmosphere this restaurant has'). The description of schemata may appear similar to the description of mental models given in previous sections but is distinct in that the term schema is used here to refer to representations of environments which go beyond spatial-functional information.

Schema theories have been used to explain a number of memory, perceptual and attentional processes. For example, an early psychological experiment demonstrated that when recalling a North American Indian folk tale western participants restructured the story to fit western expectations (Bartlett, 1932). Bartlett suggested that recall of events may be structured using schematic knowledge. Similarly, Schank and Abelson (1977) claimed that events may be represented in terms of stereotypical actions, or script-like schemata. Scripts specify sequences of actions that should occur in given situation (e.g., going to a restaurant) and contain slots with default settings for actors and props that might be encountered in that situation (e.g., cutlery and drinks). Nelson (1986; 1993) has stated that scripts are one form of generalised event representations (GERs), which are one form of schemata. GERs encode regularities in familiar events that are repeatedly experienced. For example, Hudson and Nelson (1986) observed that after experiencing an event five or six times (such as a visit to the zoo) pre-school children tend to start recalling the event in general terms (e.g., using the present tense) and confuse 'slot-fillers' (e.g., animals encountered). The use of such schemata may have the advantage of reducing demands on processing capacity. For example, expectations about the contents of a visual scene means that attentional processing resources can be directed to unexpected content (Friedman, 1979) and promotes fast, if at times inaccurate, retrieval of information (Brewer & Treyens, 1981; Mania & Robson, 2002).

There have been many criticisms of schema theory. In particular, the inflexibility of schematic representations of knowledge have been noted and as such it is difficult to conceive of the way in which schemata may be activated, acquired and developed, given the amount of shared information between situations and variations in situations (e.g., visiting a formal restaurant, burger bar or sushi bar). In addition, the characterisation of schemata as rigid structures of knowledge guiding experience and recall cannot explain why in some cases specific details of situations can be recalled, whereas in other situations, generic information will be recalled. Alternative characterisations of the way in which pieces of information are associated with each other have been suggested.

1.6.2 The Connectionist Approach to Schemata

Schemata such as scripts and generalised event GERs described above can account for the way in which invariant knowledge about a given situation can be generalised in memory from experience and then used at recall. Other accounts of memory can account for both the recall of generalised information and specific instances. For example, McClelland and Rummelhart (1985) developed the idea of parallel distributed processing (PDP) to explain the acquisition, storage and retrieval of information about concepts.

In a PDP model a network of highly connected units (representing micro-features) and modules of units (relating to concepts) is posited. Learning in a model occurs with exposure to a stimulus. Exposure activates connections between units or modules. The frequency with which connections are activated determines the strength, or weighting, of connections between units or modules. Hence, the model may capture prototypical structures inherent in a set of exemplars (e.g., features common to all types of dogs). Retrieval of information from a model is equivalent to the re-instatement of prior patterns of activation using priming or cues. Exposure to a cue (partial information from a previously experienced stimulus) will result in spreading activation among units, with connections with stronger weightings having a greater probability of activation than others. Hence, prototypical information (strongly connected information) has a high probability of retrieval (Knapp & Anderson, 1984). Recently activated connections may also have stronger weightings than others may. Hence, recent specific instances may also be retrieved. Specific instances may also be retrieved when cues are comprehensive.

Rummelhart, Smolensky, McClelland and Hinton (1986) proposed that experimental effects attributed to the action of schemata (e.g., script errors) could be explained using PDP models. They describe schemata as patterns of activation that emerge from a connectionist network at a given moment. When highly connected units are activated, schematic processing is observed. However, more loosely connected patterns of activation may occur (e.g., reinstatements of specific instances). In addition, schemata may be formed instantaneously from currently available information, (rather than being thought of as discrete, inflexible structures of information) and may be simply modified (by exposure).

Evidence for the connectionist like properties of human memory and learning comes from a comparison of human performance with artificial network performance. For example, Shanks (1991) compared the performance of a computer neural network and human participants in making common and rare medical diagnoses on the basis of varying symptoms. Both the neural network and the human participants learned to make probability based diagnoses. In addition, both made errors based on the frequency with which symptoms were associated with a certain disease (so that common diagnoses were often over-diagnosed on the basis of a symptom which had equal probability of being associated with a rare diagnosis, but which was naturally presented less frequently in the latter context).

While connectionist approaches to memory can account for many experimental findings the approach has been criticised. In particular, the analogy between connectionist networks and neurological representation is debated as is the adequacy of networks in accounting for higher level cognitive processes (Baddeley, 1990). In addition, there are some phenomena which neither schema theories nor connectionist models can explain.

For example, neither position explains why it is sometimes possible to recall every detail about a person apart from their name (Morton & Bekerian, 1985). However, it may be generally said that 1) exposure to a stimulus may cue previous associations to stimuli of that type, 2) that these previous associations may cue further associations and 3) that this activation of knowledge based on currently available information and prior experience may determine current experience and recall. It is in this sense that the term schema will be used for the remainder of this thesis.

1.6.3 Media Schemata and Presence

Notions of schemata have been applied in presence research to describe how a user may bring structures of knowledge to their experiences of mediated environments. A user may have knowledge concerning the capabilities of a display and also the environment that it depicts. For example, in a qualitative investigation of children's emotional responses to television, Buckingham (1996) noted that, through experience, children acquire knowledge about the television medium. While learning to cope with gory television dramas knowledge concerning special effects may be acquired, channel hopping and cushions may be utilised and the reasoning that 'it's not real' may come to be used. IJsselsteijn (2002) has described such structures of knowledge as 'media schemata'. These are generalised mental representations concerning what media are, what they are capable of and what we should expect from media. Media schemata allow us to watch horror films without running for our lives. IJsselsteijn suggests that presence occurs when media schemata are not activated by a display or its content as there is nothing to suggest that our experiences are not real (see also Reeves & Nass, 1996). It may be further suggested that when media schemata are not activated, content activated schemata may guide experiences and reactions to mediated environments as if they were real (e.g., see Heeter, 2003).

There may be a number of circumstances under which media schemata are not activated in response to a display and the environment it depicts. For example, under conditions of high immersion when media cues (e.g., screen edges and poor visual quality) are not available, or when content is compelling (and demands attention away from media cues) it might be predicted that schemata cued by aspects of content will be the most highly activated schemata. Therefore, some displays will generally produce more reports of presence than others will and some contents will produce reports of presence regardless of the nature of the display. Content may be compelling because it has significance to the user. For example, some types of content will provoke immediate survival based reactions (such as the train heading for the audience in the first cinematographe presentation) or may relate to user's goals, beliefs and desires. In essence, some media and some content will stimulate the activation of associations that go beyond the 'cold' representations of space suggested by Von der Heyde and Riecke (2002) and Schubert et al. (2001).

IJsselsteijn (2002) reasoned that reports of presence occur when media schemata are not activated. Elaborating on IJsselsteijn's idea of media schemata, it can be suggested that the absence of activated media schemata should result in cognitions, feelings and behaviours which are closely tied to currently attended content and that these responses may also form the bases of reports of presence (similarly to Heeter, 2003). In addition, the activation of cognitions, feelings and behaviours that are tied to currently attended content could lead to the suppression of media schemata. This reasoning follows from Heeter's (1992) proposed determinants of presence. Drawing on the way in which we validate our existence in the real world, Heeter (1992) asks what types of evidence a mediated environment should provide in order to convince a participant that they are present in that environment. Examples of validating evidence might include the representation of the body, the observation of physical rules in an environment and the existence of others and their reactions to you. Potentially, content activated cognitions, feelings and behaviours may be used as evidence of presence in an environment by a user. Regardless of the direction of causality, an implication of schema approaches to presence is that reports of presence should co-occur with responses that are closely associated to content. The idea that content associated emotional responses may co-occur with reports of presence is explored in the following sections.

1.7 Emotion and Presence

1.7.1 Emotions

Levenson (1994) has described emotions as "short-lived psychological-physiological phenomena that represent efficient modes of adaptation to changing environmental demands" (pg. 124). In other words, 'emotions' are something that a person experiences mentally and physically as we deal with the survival challenges present in our environment. A body of other researchers have also proposed that emotions serve functions (i.e., guiding goal-directed behaviour), are a distributed phenomenon (e.g., having experiential, physiological, cognitive and behavioural components) and have beneficial consequences (i.e., survival) – (for a review, see Keltner & Gross, 1999).

For example, one person may feel irritated or angry when something (another person standing in the way) obstructs him/her from reaching his/her goal (catching the train in time to attend an early meeting) causing him/her to find the means to overcome the obstruction (scowl, shout or push past the person to get onto the train). The same person could then experience the physiological symptoms of fear (sweating, raised Heart Rate etc.) when their train stops unexpectedly and without information in a tunnel (threatening both personal integrity and the chance of getting to the meeting on time) prompting him/her to call ahead to work. After such minor setbacks and delays the person may have a sense of relief when stepping off the platform at their destination and perhaps happiness that their goal has been achieved.

As the narrative above illustrates, the term 'emotion' can be used to describe a number of subjective sensations, behaviour, thoughts and physiological symptoms. The term 'emotion' is generally used to refer to the short-lived phenomena described above. 'Moods' can be viewed as more long-lived emotional states. These may be orienting states that predispose a person towards experiencing a particular emotion (Frijda, 1993; Smith, 1999) and may include persistent states such as depression (Teasedale & Barnard, 1993). Finally, the term 'affect' can be used to encompass emotions, moods, preferences and attitudes (Eysenck & Keane, 1995). In the present thesis the term 'emotion' is used as a general term throughout to refer to feelings, behaviours and physiological responses such as those described above in a way which also encompasses changes in mood-state. 'Emotion' is used as a general term as a range of emotional processes will be examined in this thesis. In particular, all emotional response can be described as having a 'quality' and 'intensity'. The following sections examine background research relating to the quality and intensity of emotional experience.

1.7.2 Emotional Experience

Subjective emotional experience can be described as having both a 'quality' and 'intensity'. Mandler (1992) suggests that the quality of an emotional experience is determined by the 'cognition of values' (e.g., whether a stimulus is evaluated as positive or negative). The intensity of an emotional experience, Mandler claims, is provided by the strength of visceral arousal, (i.e., activation of components of the autonomic nervous system, such as the heart and electrodermal system [sweat gland activity]). These 'heartfelt' and 'gut' reactions, add 'feeling' to the evaluative cognitions. Intensity may also be determined by the degree to which an event is appraised as relevant to an individual's current concerns (i.e., motives and goals) and the way in which that individual regulates his or her reactions (Sonnemans & Frijda, 1995). Hence, a particular quality of emotion can be experienced to a greater or lesser degree depending on physiological reactions, predispositions and context.

Theories about the determinants of emotional experience are diverse. Each lends a different amount of weight to the role of behavioural, physiological and cognitive processes. It has been variously proposed that we feel a particular quality of emotion because a) we have exhibited specific behavioural or physiological responses to a stimulus (James-Lange theory), b) specialised brain centres stimulate qualitative experience and physiological intensity independently (Cannon-Bard theory) or c) that we interpret physiological and behavioural responses with respect to our interpretations of our environment to produce a qualitative feeling (Schacter & Singer, 1962). There is evidence to support each of these approaches (Izard, 1993).

James's (1884; 1890) proposed that specific behaviours elicit the experience of the relevant emotion (e.g., we are scared because we run away and not vice versa). In support of this view research has shown that when a person is directed to display the typical facial expression for one emotion (e.g., the down-turned mouth of sadness) they also begin to display the subjective and physiological indicators of that particular emotion (Ekman, Levenson & Friesen, 1983; Levenson, Ekman & Friesen, 1990). It has also been shown that snake-phobics (but not non-phobics) are more likely to respond with fear to a snake-like stick when they are physiologically aroused through exercise than at rest (Lang, 1988). Similarly, anxiety may be more readily provoked in trait anxiety-sensitive individuals than others, particularly after physiological challenges such as caffeine consumption (Telch, Silverman & Schmidt, 1996). The evidence suggests some feedback from states of the body (action readiness) to emotional experience. However, the evidence also suggests a role for individual preparedness (e.g., mood like states) and context (e.g., relevance of stimuli to current concerns).

While body-state information can be said to feed into emotional experience, the James-Lange approach does not explain how action tendencies are initially stimulated. Cannon (1932) suggested that environmental stimuli are processed for emotional value before action tendencies and emotional experiences occur. Cannon located the thalamic region of the brain as an emotional processor that deals with incoming stimuli and which then projects independently and in parallel to the cerebral cortex (to produce experience) and the autonomic nervous system (to produce action tendencies). As such, autonomic signals are less differentiated and slower to respond than qualitative emotional experience. More recently, subcortical structures, particularly the limbic system, have been seen as necessary to the production of emotional experience (Le Doux, 1996; Davidson & Irwin, 1999). For example, early sensory processing in the thalamus is said to be sent quickly to the amygdala. The amygdala has been implicated as the main brain area responsible for the production of defensive responses. The neural pathway from the thalamus to amygdala allows fast responses to potential danger (e.g., a snake like stick).

Evidence for the importance of the amygdala in emotional processing comes from a number of sources. Damage to the amygdala has been shown to interfere with the learning of conditioned fear responses (LaBar, LeDoux, Spencer and Phelps, 1995). Importantly, a person can be aware of an association between conditioning stimuli yet not display any fear response. Conversely, stimulation of the amygdala in animals can result in defensive reactions in the absence of stressors (LeDoux, 1987). The amygdala also receives projections from, among other brain areas, the sensory cortex, the hippocampus and the prefrontal cortex. These connections allow slower, potentially inhibitory, responses to fear-related stimuli based on more complex patterns of sensory information, long-term memory, context and cognition.

While complex neurological systems are heavily implicated in the production of emotional responses, there are qualifications to this approach. For example, amygdala related responses have been more closely related to fear than other emotions (see Davidson & Irwin, 1999). In addition, while neurological structures underlie emotional experience a less reductionist consideration of the way in which emotional meaning is identified, evaluated and reported by people may be more appropriate for the current discussion. A neuropsychology of presence has only recently been proposed (Schlögl, Slater and Pfurtscheller (2002). Hence, a higher level account of the way in which different types of information (e.g., quick bodily responses, associations from memory and cognitions) are combined in reported experience is useful when evaluating responses to complex mediated stimuli (Smith, 1999).

For example, Schacter & Singer (1962) demonstrated that emotional experience may be cognitively mediated. In one experiment participants were given an injection of adrenaline and were then presented with pleasant, unpleasant or neutral stimuli. The undifferentiated and unexplained physiological arousal state produced by the adrenaline became labelled by participants according to the quality of stimuli they were presented with. Schacter and Singer's findings were used to demonstrate that physiological arousal is undifferentiated and that emotional experience requires some interpretation or is dependent on the context of arousal. The results have not been consistently replicated (Mezzacappa, Katkin & Palmer, 1999) and the specificity of patterns of arousal to specific emotions is still debated (Scheirer, Fernandez, Klein & Picard, 2002). However, the role of interpretation in the production of conscious emotional feelings is widely accepted. In particular, it is thought that a stimulus must be appraised for its significance before a particular emotion is felt (Arnold, 1960; Frijda, 1993; Lazarus, 1991)

In summary, evidence shows that the quality and intensity of 'feelings', or emotional experiences, are produced via a complex interplay between many response systems. Izard (1993) has usefully summarised the different response systems in the following way:

Physiological: Automatic reactions to stimuli providing energy for behavioural and cognitive responses (e.g., fight-flight responses in the autonomic nervous system).

Behavioural: Automatic and planned responses to stimuli, mobilisation of responses and communication (e.g., facial expression and posture).

Cognitive: Mental representations of emotion which, when activated, generate physiological, behavioural and experiential responses. In turn, influenced by other response systems (e.g., the panic cycle).

Experiential: The experience of emotion has a 'quality', 'intensity' and duration related to the type and intensity of responses in other systems (e.g., anxiety < fear < terror).

There are many theories that integrate the many components of human emotional response systems (Leventhal, 1984; Scherer, 1984; Oately & Johnson-Laird, 1987; LeDoux, 1987; Izard, 1993; Frijda, 1986). Of particular interest for the present thesis is research which has examined the relationship between cognition and emotion. Specifically, there are lines of research which have examined the role of emotional processes in areas previously discussed in this chapter: perception, attention and memory.

1.7.3 Cognition and Emotion

Early work linking emotional and cognitive processes included that which looked at 'perceptual set' and 'perceptual defence'. In theories of 'perceptual set' it was proposed that the existing 'mental set' of a person, including emotions, desires and motivations, can influence perceptions of an environment or stimulus. For example, Bruner and Goodman (1947) showed two groups of children a coin. Less affluent children tended to overestimate the size of the coin in comparison to more affluent children indicating that their 'mental set' influenced the perception of a physical object. 'Perceptual defence' refers to the idea that people can fail to perceive distressing stimuli, as a form of defence. Research in this field yielded findings to suggest that distressing stimuli (such as taboo words) are less easily recognised than neutral words but can interfere with conscious cognitive processing of neutral stimuli when presented below the threshold of consciousness (Hardy & Legge, 1968). Such studies demonstrate a role for emotional responses in perceptual processing. However, it has been suggested that the results may be best explained by examining sub-processes which occur before conscious awareness (Dixon, 1981).

Later research, for example, has examined the influence of emotional traits and states on attention, memory and interpretation. Eysenck (1992) proposed that anxious individuals are more likely to attend to threat in their environment, be distracted from other stimuli by threatening stimuli and interpret ambiguous stimuli in a threatening way. There is also a body of research investigating the effects of mood on memory. Bower (1981) presented research which demonstrated that material congruent with a person's mood state is better recalled than incongruent material and also that recall is better when mood at recall matches mood at learning. Research in the field of cognition and emotion has been applied clinically to explain the characteristics of, and develop treatments for, psychological disorders such as anxiety and depression. One such theory arose out of work in the field of human-computer interaction and can be used to illustrate the relevance of theories of emotion to discussions of presence.

In the Interacting Cognitive Subsystems (ICS) model of human information processing, a relationship between sensory, structural and meaning codes is proposed (Teasedale and Barnard, 1993). Different levels of meaning are created in the following way. Sensory codes (acoustic, visual and body-state codes) are derived from incoming raw sensory data. Structural codes (morphonolexical and object codes) are derived from reoccurring regularities across the sensory codes (visual and acoustic codes respectively). Propositional meaning is a code derived from regularities in combinations of the Structural codes. The Propositional level of meaning relates to semantic information (similar to language, in encoding what things are and how they relate to each other). Another, higher, level of meaning is then proposed. Reoccurring regularities across Propositional and Sensory codes combined are represented as Implicational meaning. Codes at this level of meaning are described as holistic, schematic models of experience.

Each code is dealt with in separate, parallel subsystems. Activity in a subsystem, relating to the copying of incoming information from another subsystem into a memory record, is said to constitute subjective experience. One subsystem can output to another subsystem in a non-automatic, limited capacity, transformation process. The Implicational subsystem receives input from the Sensory and Propositional subsystems and can output to the Propositional and body state subsystems (via somatic and visceral/autonomic activation). Hence, many representations of the same event may be stored in a number of different codes and at different levels of meaning.

As an example of the distinction between Propositional and Implicational meaning, Teasedale and Barnard (1993) consider the interpretation of text. From the Propositional statements "John knocked the glass off the table. Mary went to the kitchen to fetch the broom" a reader may infer that a glass has been broken. Teasedale & Barnard (1993) attribute the inference to the transformation of Propositional code into an Implicational code representing schematic knowledge concerning 'brokenness' (the generic content of the Propositional meanings that have previously co-occurred). The code for 'brokenness' may then be transformed back into Propositional code to produce the semantic meaning 'something is broken' which can be elaborated on by recently stored specific content to provide the inference 'the glass was broken'. The Propositional information may then in turn may be fed back to the Implicational subsystem and stimulate 'guilt' or 'blame' related schemata and so on. The exchange between the two levels of meaning may continue in the absence of the eliciting stimuli (the text). The Implicational level of meaning allows the totality of a situation to be 'felt' in the absence of complete information.

Teasedale and Barnard (1993) go on to propose that emotional experience arises from the activation of schemata at the Implicational level of meaning. Affect-related (emotion related) schemata at the Implicational level are formed from repeating patterns of Propositional and Sensory codes in previous emotion eliciting situations (e.g., the co-occurrence of 'glass' and 'brush'). The partial reinstatement of previously experienced Propositional or Sensory information (e.g., a scream, a sunny day, or a sharp object) may result in the activation of affect-related schemata. The activation of affect-related schemata gives rise to phenomenal experience with Implicational information content. For example, the feeling of apprehension implies that something bad will happen and the feeling of confidence implies that a person will be able to cope. Because affect-related schemata output to the body-state subsystem, the behavioural and autonomic indicators of emotion can accompany the activation of affect-related schemata. For example, the activation of body-state codes may be experienced as physical feelings of being shaky or calm. Affect-related schemata may also feed out to the Propositional system. Hence, cognitions (such as inferences) about an emotion eliciting situation may also be formed. Propositional and sensory information may then feed back into the Implicational subsystem. However, the transformation of information between subsystems is not automatic and therefore emotional material can be experienced in one subsystem (e.g., Propositional) and not another (e.g., body-state).

Teasedale and Barnard (1993) do not claim to provide evidence for the existence of Implicational meaning and its relationship to emotional experience. Rather their approach uses the ICS account of human information processing to elaborate on existing theories of in the field of cognition and emotion (Leventhal 1979, 1984; Oatley

& Johnson-Laird, 1987) and to account for several types of experimental results. For example, it is proposed that 'mood' can be equated to the persistent activation of affect-related schemata at the implicational level leading to a predisposition or orientation to experience emotion and process emotional material in other subsystems, and therefore interpret material with respect to emotion. More specifically, Teasedale & Barnard (1993) use features of the ICS approach to account for a) mood congruous and incongruous recall (e.g., Bower, 1981), b) the maintenance of depressive mood states (e.g., Beck, 1973) and c) the effects of mood on global evaluative judgements (e.g., Johnson & Tversky, 1983). The theory is not used directly in this thesis to investigate the relationship between presence and emotion, but is used below to illustrate how emotion related schemata, or Implicational meanings, are relevant to presence and the 'sense of being' there in a mediated environment that does not accurately represent real physical space.

1.7.4 Emotion and Presence

Film viewing can be used an example of the way in which the ICS description of emotional responses may be applied to mediated experiences. Smith (1999) describes how bursts of simple emotion associated stimuli (e.g., music, lighting and facial expression) are used to maintain mood during films. The cues are often redundant to the plot (e.g., a series of sharp shocks in a horror movie). However, the cues maintain an orientation to experience a particular emotion and a tendency to interpret the film narrative with respect to the 'script' associated with that orientation (i.e., the schematic representation of the mood). In ICS terms, patterns of sensory stimuli associated in the past with emotional responses are used to activate current affect-related implicational schemata. The activation produces the feeling of a mood, stimulates the tendency to experience a particular emotion and promotes emotion-related narrative inferences (e.g., 'he's behaving oddly', 'something bad is going to happen'). We may 'know' things 'instinctively' about a mediated environment directly and without effort. We may form opinions about avatars and actors or have a 'bad' or a 'good' feeling about a mediated environment. We may react emotionally to mediated stimuli as if it was real.

It can be reasoned that reports of presence should co-occur with the activation of affect-related schemata. The more immersive the display is, or the stronger the associations between content cues and emotional responses, the less likely it may be that affect-related schemata will be attenuated by input from Sensory or Propositional systems indicating the presence of the medium (e.g., media schemata cued by the presence of screen edges, or the knowledge the 'it's not really real'). Persistent activation of affect-related schemata by mediated stimuli may also be expected to feed into sensory and knowledge based systems. If we come to perceive our emotional responses as arising directly from depicted content there may be justification for suggesting that content based feelings and responses (arising from implicational representations) may be used as personal evidence of presence (after Heeter, 1992). It may also be expected that experiences that include the activation of implicational schemata would be richer and more 'meaningful' to users. Hence, reports of presence could be underpinned by emotional processing in addition to mental models and attention (after Schubert et al., 2001).

The argument presented above constitutes a speculative account of a two-fold relationship between reports of presence and emotional responses. Immersive mediated environments which increase the likelihood of reports of presence should also increase the likelihood or intensity of content-based emotional responses. In addition, the occurrence of emotional responses to mediated content may lead to reports of presence in a mediated environment. The argument demonstrates in particular how the Behavioural Realism approach in presence research can be extended to include emotional responses: as presence increases in a mediated environment it may be expected that emotional responses will tend towards those that would be expected in a similar real environment.

However, at the outset of this thesis the relationship between emotion and presence was not well researched (Huang & Alessi, 1999)[1] and comprehensive theories concerning the relationship between presence and emotion had not been formulated. Therefore the relationship between presence and emotion will be the focus of the remainder of this thesis, particularly the predictions of Behavioural Realism. A review of evidence relating to the predictions is presented below including some relevant research conducted after the research in thesis was completed. The review will highlight the need to investigate the relationship between presence and subjective and physiological emotional responses.

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[1] Following the completion of the experiments presented in a large scale EU project investigating presence and emotion received funding. See the General Discussion (Chapter 8) for further details.

1.8 Determinants of Presence

1.8.1 Determinants of Presence

The preceding sections in this chapter have outlined psychological structures that potentially underlie reports of presence in mediated environments. The review suggests that immersion supports reports of presence by providing illusions of sensory realism and enabling focused attention on a subset of available sensory information. From available sensory information and information stored in long-term memory a user may build a mental representation of space surrounding the body. Hence, a further factor influencing reported presence is the likelihood of accepting a mental model of a mediated space as an alternative to a real space. The likelihood may be strengthened when retrievals from long-term memory do not include media schemata. Content-driven schemata would then be expected to produce content-congruent emotional responses that co-occur with presence or feed into reports of presence themselves by further focussing attention on meaningful stimuli and providing rich interpretations of environments.

It is therefore apparent that a subjective report of presence could be determined in a number of ways. The determinants of presence can be manipulated, identified or controlled by a researcher investigating the structure of presence. Work on the determinants of presence in mediated environments has been usefully summarised by IJsselsteijn et al., (2001). They categorise four types of presence determinants based on various theoretical analyses. The four categories of presence determinants are:

1) **The extent and fidelity of sensory information** (the amount of useful and salient sensory information presented in a consistent manner to the appropriate sense of the user).
2) **The match between sensors and the display** (referring to sensory-motor contingencies).
3) **Content factors** (objects, actors and events represented by a medium and our ability to interact with the content).
4) **User Characteristics** (such as perceptual, cognitive and motor factors).

The first two categories can be collapsed into one category: Media Form. This leaves three categories of presence determinants: Media Form, Media Content and User Characteristics. The following comprises a brief summary of determinants of presence with particular reference to emotional processes. This serves as a review of research into the relationship between presence and the subjective, behavioural and physiological indicators of emotion.

1.8.2 Media Content

It is well established that mediated content can produce meaningful and intense emotional responses (Gross & Levenson, 1995; Zillman, 1991). Indeed, film stimuli have been shown to be one of the most effective ways of eliciting emotions in experimental situations (Westerman, Spies, Stahl & Hesse, 1996). The idea that different types of Media Content will have specific effects on emotional responses has been utilised by a number of researchers. For example, the relationship between the quality and intensity dimensions of subjective emotion and the physiological indicators of emotion has been investigated in depth using short film clips (Detenber & Reeves, 1996; Detenber, Simons & Bennet, 1998; Detenber, Simons & Reiss, 2000; Reeves, Lang, Kim & Tartar, 1997; Simons, Detenber, Roedema & Reiss, 1999). In more sustained viewing contexts film stimuli have been used to test hypotheses concerning the physiological and subjective characteristics of discrete emotions such as happiness, sadness and fear (e.g., Averill, 1969; Fredrickson & Levenson, 1998; Gross, Fredrickson & Levenson, 1994; Mezzacappa, Katkin & Palmer, 1999; Sternbach, 1963).

The effectiveness of mediated content in eliciting emotions has been used to great effect in Virtual Environment (VE) psychological therapy applications. A key assumption of the use of VEs in therapy is that a mediated environment will provoke thoughts, feelings and behaviours which are comparable in quality and intensity to real environments. Glantz, Durlach, Barnett and Aviles (1997) reviewed the way in which VEs can be best used in psychological therapy for emotional disorders. For example, in the use of VEs to treat phobias the success of such environments (and consequently the outcome of therapy) centres around 1) the extent to which fearful responses are elicited by the VE, 2) the decrease in fearful responses over repeated exposures and 3) the degree to which the habituation is transferred to real environments.

Schuemie et al. (2001) have provided an overview of research into VE therapy, reporting that immersive VEs are effective in provoking intended emotional responses. For example, the subjective and physiological characteristics of phobic responses to virtual heights and flights, and subsequent desensitisation, have been observed over repeated exposures to VEs (North, North, and Coble, 1997; Wiederhold and Wiederhold, 2000). Furthermore, Emmelkamp, Hulsboch, Krijn et al. (2000) demonstrated that in vivo and VE treatment of fear of heights were equally effective in reducing anxiety and avoidance, and remained so after six months. Overall, research using therapeutic VEs indicates that participants can experience intense content specific emotions during mediated experiences. However, while it might also be expected that participants in therapeutic VEs will feel a high degree of presence this effect had rarely been tested at the outset of this thesis. Some literature indicates that this may be a worthy research avenue.

Slater and colleagues have examined a number of VEs designed for the treatment of social anxieties, such as fear of public speaking. Slater, Pertaub and Steed (1999) reported that participants who faced a virtual audience and reported a high level of presence tended to give more positive responses to a positive audience and more negative responses to a negative audience. The finding indicates a content-specific relationship between presence and emotional intensity: as presence increased so did the intensity of emotional responses, while the quality of the emotion remained relevant to the content of the VE. However, Pertaub, Slater and Barker (2002) do not report the same findings in a similar experiment, finding instead that emotional responses varied with respect to aspects of Media Form. Furthermore, while presence and the physiological and behavioural indicators of fear have been shown to correlate in response to simulated fear inducing stimuli (Meehan et al., 2002; Insko, 2003; Ravaja, Laarni, Kallinen et al., 2004, Wiederhold, Jang, Kaneda, Cabral, Lurie, May, Kim & Wiederhold, 2001), this is not a consistent finding (Meehan, et al., 2002).

Research conducted after the research presented in this thesis was completed provides more information about the effects of Media Content on presence and emotion. Banos, Botelli, Alcaniz et al (2004) exposed users to two versions of a virtual park: one version elicited a sad emotional state and the second elicited a neutral emotional state. Users viewed the virtual parks on a head mounted display, a large video wall and a PC monitor. The results showed that the sad park was rated higher in presence than the neutral park and that the difference in presence ratings between the parks was widest when they were presented on a PC monitor.

Previous research in this area has tended to use anxiety inducing content. The study by Banos et al. (2004) suggests that widening the range of content used to investigate the relationship between presence and emotion may be useful. For example, in the wider literature, Kaplan and Kaplan (1989) have noted the potential of some types of scenes, (e.g., natural scenes) to evoke involuntary attention. These types of scenes are described as 'fascinating' because they are understandable but sufficiently complex to hold attention. Such scenes may have a positive effect on viewers if they also evoke a feeling of 'being away'. Given the proposed relationship between attention and presence, it is possible that further investigations of Media Content could contribute to an understanding of the relationship between presence and emotion.

In sum, it may be said that there is potential evidence for a relationship between presence and content-congruent emotional responses in mediated environments. However, the results indicate some inconsistencies and a restricted set of stimuli (mainly fear inducing stimuli) has been investigated in previous research, suggesting a need for further research into Media Content effects. In addition, the results of previous research suggest that Media Form may be an important factor when considering the relationship between presence and emotion in addition to Media Content.

1.8.3 Media Form

Media Form variables that may determine presence include aspects of immersion such as the extent and fidelity of sensory information in a mediated environment. Variations in these factors may be linked to user experience via psychological constructs such as perception and attention. In addition enhanced immersion, as much as it enhances presence, would be expected to impact on thoughts, feelings and behaviours, which may be reflected in emotional responses (in line with the Behavioural Realism approach in presence research). Research which has examined the impact of such Media Form variables in entertainment media, VE therapy and presence research is presented below.

For example, it has been shown that aspects of video presentations (such as motion, image size, colour, and structural events) that affect subjective presence have independently been shown to impact on emotional responses. One set of experiments in particular employed a particular paradigm to investigate the impact of Media Form variables on emotional responses (Detenber & Reeves, 1996; Detenber et al., 1998; Detenber et al., 2000; Reeves et al., 1997; Simons, et al., 1999). In these experiments, participants were exposed to a series of six-second video excerpts while physiological indicators of emotional arousal were recorded. Participants also rated the stimuli in terms of valence (a measure of emotional quality ranging from positive to negative) and arousal (a measure of emotional intensity ranging from high to low). The ratings were used to group the stimuli into high, low and medium arousal categories and pleasant, unpleasant and neutral valence categories respectively. The impact of Media Form manipulations on overall physiological responses and also the relationship between categories in each of the valence and arousal groupings were then analysed.

Detenber et al., (1998) and Simons et al., (1999) investigated the impact of image motion on emotion ratings and physiological arousal. They found that moving, versus still, versions of the video stimuli where rated higher in arousal and pleasantness and generally produced larger Electrodermal Responses (EDRs), facial electromyography (EMG) responses and Heart Rate (HR) responses indicative of emotional arousal. Motion also accentuated the differences between categories in both the arousal and valence categories (Detenber et al., 1998) and in one experiment the valence category only (Simons et al., 1999). Arousing stimuli became more arousing when motion was added to the clips, and positive and negative clips became more widely differentiated.

Similar results were found in investigations of image size. Large image sizes were rated higher in subjective arousal than small image sizes in a study conducted by Detenber and Reeves (1996). In addition, Reeves et al., (1997) have shown that larger image sizes also produce larger EDRs and HR decelerations than medium and small screen sizes. Simons et al. (1999) argued that image motion and size (as Media Form variables) impact primarily on the arousal dimension of emotion, not valence. Therefore, enhancements of Media Form have an intensifying effect on emotional responses that can account for polarising effects on both arousal and valence categories. More consistent findings associated with EDRs and subjective arousal, in comparison to valence related HR and EMG, were taken as evidence for this.

Overall, the set of studies described above suggest that enhancements of Media Form related to immersion (such as motion and image size), intensify emotional responses.

An association between presence and the intensity of emotional responses could therefore be predicted. In fact, Lombard, Reich, Grabe, Bracken and Ditton (1998) have demonstrated in one study that increased screen size enhanced reports of presence, increased subjective arousal and produced larger EDRs in response to video stimuli. Qualitative focus-group data also indicates that adding stereoscopic cues to video presentations is associated with increases in reports of 'being there' and more intense emotional responses (Freeman & Avons, 2000).

Alternatively, it may be suggested that the physiological measures used to indicated emotional arousal in the experiments described above are simply indicating a relationship between stimulus intensity (in terms of extent and dynamics of sensory information) rather than emotional processes[2]. For example, the insertion of graphics into video lectures, scene changes and edits are associated with Heart Rate responses indicative of attention (Lang, 1990; & Thorson & Lang, 1992). Such findings demonstrate that features of mediated environments that would be expected to reduce presence (by reducing inclusiveness and providing distractions) produce identical responses to those associated with increased presence (such as increased vividness and surrounding-ness). Support for the idea that physiological and subjective measures of emotion may be independently affected by Media Form variables comes from Detenber, Simons and Reiss, (2000). Using the previously described paradigm they found that colour images were rated as more pleasant and arousing than identical monochrome images. However, colour and monochrome images did not differ in terms of physiological arousal. The finding is interesting in that the addition of colour to an image may not affect the range or dynamics of sensory information presented to participants, in contrast to manipulations of image size and motion.

Unfortunately, much applied presence research has not fully accounted for the multiple determinants of emotion and emotion-related responses (e.g., Jang, Kim, Sang, Wiederhold, Wiederhold & Kim, 2002; Salnass, 1999). For example, Calvert and Tan (1996) compared three groups of teenagers who either participated in a VE game, observed the game, or simply performed the actions that would take place in the game (the control group). Heart Rate increased significantly from pre- to post-game in the first group only. Calvert and Tan (1996) argued that the increase in Heart Rate indicated

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[2] See Chapter 2 for further discussions relating to physiological indicators of emotion.

that participation results in stronger arousal than mere observation. However, the observation group did not perform any movements, weakening this argument. A fourth condition requiring participants to both observe and perform actions without direct interaction would be needed to confirm Calvert and Tan's hypothesis. The finding does however demonstrate an intense effect of immersive, interactive environments on Heart Rate.

A similar impact is clearly seen in a series of experiments investigating the potential of emotional responses as measures of presence (Meehan et al., 2002). As described in earlier sections of this chapter, participants were exposed to a 30ft virtual pit through a Head Mounted Display (HMD). Changes in physiological measures from a training room to the pit room were compared with behavioural and post-exposure subjective presence measures. The measures were taken over repeated exposures to the VE and across versions of the VE that differed in terms of frame rate and over versions of the VE which differed in terms of passive-haptics. Changes in Heart Rate, and to a lesser extent Electrodermal Activity, correlated with subjective presence and also distinguished between VEs which differed in terms of frame-rates and passive haptics. There was some evidence for a similar pattern of findings for behavioural indicators of fear (Insko, 2003). However, a condition that generated very low presence (a very low frame-rate condition) also provoked relatively intense physiological responses.

Meehan argued that the physiological response to the pit reflected fear responses: participants who experienced a greater sense of presence than others also felt more afraid of the pit. However, the anomalous result concerning the low-frame rate pit indicates that physiological reactions could potentially reflect more than one construct within one experimental context. The relatively large physiological response in the low frame-rate condition may have been associated with fear, for example if the display could be described as equivalent to confronting a deep drop in the dark. The response may also have reflected some type of strain, (such as negative side-effects), or perceptual and attentional processing, due to degraded stimulus information.

The idea that physiological measures of autonomic activity such as Heart Rate and Electrodermal Activity may indicate physical negative-effects rather than emotional responses has some experimental support in presence research. Cobb, Nichols, Ramsey and Wilson (1999) reviewed a body of research that investigated determinants and measurement of simulator sickness. They report that varying levels of immersion (comparing a VE with a TV display) produces differences in cardiovascular changes between conditions that reflect the subjective report of negative side-effects rather than subjective reports of presence.

One further study completed before the outset of this thesis investigated the impact of varying levels of immersion on presence and emotional responses. Wiederhold, Davis & Wiederhold (1998) found that electrodermal responses and presence ratings, but not Heart Rate response, were more intense for a Head Mounted Display, in comparison to a computer-screen presentation of a virtual flight. This effect was most apparent for a flight phobic participant. However, only five participants were tested in this experiment. This limits the reliability of the physiological evidence, given the large amount of variability that may be observed in such data. In addition, and in common with Meehan's studies, given the use of a single content it is difficult to equate physiological response differences between displays to content specific emotional responses indicative of presence. However, the combination of the individual difference finding and the Media Form finding in Wiederhold et al.'s (1998) study is suggestive that physiological arousal indicated fear in this case.

Research completed since the outset of this thesis provides further information about Media Form, presence and emotion. As described previously Banos et al., (2004) found that a sad virtual park was rated higher in presence than a neutral virtual park and that the difference in ratings was widest when users viewed the park on PC monitor (compared with a head mounted display and a big screen). The results suggest that emotive content may elicit higher levels of presence than neutral content and also suggests that this may be most effective at low levels of immersion. However, the results of the Banos et al. (2004) study were restricted to ratings of realness and engagement rather than spatial presence. In terms of presence theory it could be suggested that emotive content demands more attention or effortful processing than neutral content and hence promotes involvement. At higher levels of immersion the nature of the content may be less important to a user's experience of a novel mediated environment than spatial features.

Other recent research does not support the above findings. Freeman, Lessiter, Pugh & Keogh (2005) found that increasing screen size and also adding interaction to a virtual 'relaxation island' environment increased ratings of physical space and engagement respectively but did not affect mood ratings. Conversely, Sponselee, de Kort, and Meijnders (2004) found that participants displayed a faster physiological recovery from a stressor when watching natural scenes on a large screen compared to a small screen but that there was no difference in presence ratings between the large and small screen presentations.

In sum, it may be suggested that manipulations of Media Form characteristics can impact on both reports of presence and emotional responses. Generally, factors which are usually associated with enhanced reported presence are also associated with more intense emotional responding. However, the relationship between Media Form variables, reported presence and emotional responses may vary from one context to the next. In particular, some research does not show that Media Form affects emotional responses and other research shows that presence and components of emotional responses (subjective, behavioural and autonomic) appear to be affected differently by different types of Media Form and Media Content variables.

1.8.4 User Characteristics

Many User Characteristics have been proposed as potential determinants of presence such as representational style (Slater and Usoh, 1993; Slater, et al., 1994), reality monitoring abilities (Banos, Botella, Garcia-Palacios et al., 2000), gender (Heeter, 1992) expertise (Jacobson, 1999) and age (Baugmartner, Valko, Esslen, & Jancke,, 2006). Emotion related User Characteristics will be dealt with briefly, given that these are not the main focus of this thesis.

For example, it has been shown that prior emotional state may impact on subsequent emotional responses to film and television stimuli (Fredrickson and Levenson, 1998; Zillman, 1991). In addition, prior levels of physiological arousal may affect subsequent subjective emotional responses to film stimuli (Mezzacappa et al., 1999). Given the previously described co-occurrence of reports of presence and emotional responses, it could be suggested that those pre-disposed to experience emotion in response to certain content are also more likely to report presence. In support of this notion recent research has shown that phobics report a higher level of presence in response to a VE depicting phobia inducing stimuli in comparison to non-phobics (Robillard et al. 2003). Conversely, some individual characteristics may dampen some reactions to film stimuli, as in the case of the repressive coping style (Sparks, Pellechia & Irvine, 1999), and hence may be expected to reduce presence.

There is indirect evidence for the impact of emotion related User Characteristics on presence. As mentioned previously, VE based psychological therapies depend on the elicitation of naturalistic human responses. As such, individual differences apparent in real environments are expected to be apparent in mediated environments. For example, spider-phobics, not non-phobics, should be afraid of a simulated tarantula. This may be one indication that a mediated environment approximates a real environment. For example, Pertaub, et al. (2001) found that prior self-ratings of fear of public speaking correlated with post-exposure ratings of fear in response to positive and neutral virtual audiences. For a negative audience, fear ratings were higher than for the other two audiences and uncorrelated with the pre-ratings. The finding perhaps shows the individual impact of objectively non-threatening audiences on social phobics and the wide-ranging impact of a negative audience on public speakers in general. Pertaub et al. (2001) also report that social phobics exhibit more fearful responses when speaking to a virtual audience than to an empty room, and that this response is greater in phobics than more confident participants. Hence, individual differences that occur in real environments operate on experiences of mediated environments. The findings are similar to differences found between phobic and non-phobic subjective and physiological responses to virtual flights (Wiederhold, et al., 1998; Wiederhold, Jang, Kim & Wiederhold, 2002). However, not all results supports this view, such as Garau's (2003) finding that pre-rated social anxiety did not impact on physiological responses to avatars in a simulated library.

In sum, individual differences may impact on emotional responses to mediated stimuli. Given that emotional responses have been shown to correlate with reports of presence and that individual differences determine the type of naturalistic response exhibited in a mediated environment, user characteristics may be a significant factor when considering the relationship between presence and emotion. For example, evidence that predispositions, such as phobias, can affect reported presence suggests that emotions may possibly determine presence in some circumstances. However, little research has investigated the relationship between emotion-related user characteristics and presence, and some results may be inconsistent. User Characteristics are not the focus of this thesis, however, the influence of User Characteristics on reported presence may be an important factor to consider when evaluating research presented in this thesis.

1.9 Summary and Conclusions

This Chapter has explored the structure and determinants of reported presence in mediated environments by reviewing research into underlying psychological variables: perception, attention, memory and emotion. In particular, research which has directly or indirectly addressed the relationship between determinants of presence and emotional responses suggests the following. (1) Content-congruent emotional responses can co-occur with reports of presence, or occur in situations that would be expected to elicit presence. (2) Enhancements in Media Form variables which are usually associated with enhanced reports of presence can also intensify emotional responses. (3) Emotion related User Characteristics may influence emotional responses to content and may be expected to influence reports of presence. The research and theory presented in this chapter suggests that emotional processes may be an important consequence or determinant of reported presence.

However, there has been little research in the area of presence and emotion and existing research tends to have examined a limited range of Media Content and Media Form variables. In particular, research which has claimed to demonstrate a link between presence and emotional responses tends to have used content designed to provoke fear or anxiety or has confounded the impact of Media Content and Media Form variables on physiological measures of emotion. A more controlled investigation of the relationship between presence and different qualities of emotion may be useful.

In addition, inconsistencies in findings have been noted. In particular, although physiological indicators have been widely used to investigate emotional responses to media and have been proposed as objective indicators of presence (Meehan et al., 2002; Barfield & Weghorst, 1993; Sheridan, 1992; Held & Durlach, 1992; IJsselsteijn et al., 2002) results from such studies indicates potentially varying relationships between physiological measures and both presence and subjective emotional experience. The following chapter explores different measures of presence with a particular focus on emotion based and physiological measures of presence. While research presented in this chapter demonstrates theoretical justification for investigating the link between presence and emotion, the following chapter demonstrates how such research could be implemented and applied.

1.10 Plan of Thesis

The remainder of this thesis is focussed on applying the background literature presented in Chapter 1 to a novel investigation of the relationship between presence and emotion involving the exploration of new presence measurement techniques and new methods for investigating presence and emotion.

Chapter 2 Presents a review of presence measurement techniques, with a focus on psychophysiological measures. The theoretical, methodological and applied aims of the thesis are then described.

Chapter 3 Experiment 1 introduces a methodology for exploring the relationship between presence and emotion by investigating the effects of both Media Form and Media Content on measures of presence, emotion and physiological arousal. Specifically, the effects of stereoscopic video presentation, and screen enhancements, for two types of video content are explored.

Chapter 4 Experiment 2 re-investigates some of the key findings from Experiment 1 using modifications of the original experimental design. Specifically, the effects of stereoscopic video presentation on presence and physiological arousal for two types of content are investigated.

Chapter 5 Experiment 3 begins to address some of the limitations of Experiment 1 and 2. In particular, in order to widen the range of video contents investigated in this thesis, the effects of increasing eye-to-screen visual angle on presence, emotion and physiological arousal are investigated.

Chapter 6 Experiment 4 is a ratings study which compares the video content used in previous experiments in the thesis with a wide range of emotive and neutral video content. The results are used to develop sets of amusing, sad and neutral content to be used in future experiments. The sets of stimuli are also used to investigate the effects of emotive and neutral Media Content on presence.

Chapter 7 Experiment 5 uses the methodology and stimuli developed in Experiments 3 and 4 to further investigate the effects of Media Form and Media Content on presence and emotion. Specifically, the experiment investigates the effects of eye-to-screen visual angle on presence, emotion and physiological arousal for both emotive and neutral video content.

Chapter 8 In the general discussion, the results of Experiments 1 to 5 are evaluated with respect to the theoretical, methodological and applied aims of the thesis. Future directions for investigations of presence and emotions are proposed, including a scaffolding for mapping the relationship between components of emotional responses and different dimensions of presence.

Chapter 2 Introduction: Measuring Presence

2.1 Measuring Presence[3]

Measures of presence have generally been developed hand in hand with theories of presence. Some measures are intended to reflect the underlying psychological structure of presence (perceptual realism, attention and mental models) and others tackle proposed psychological and behavioural correlates of presence (cognition, task performance, movement and emotion). This chapter gives a brief descriptive overview of approaches to the measurement of presence. Examples of direct subjective measures of presence are given along with subjective and objective indicators that may corroborate reported presence. Particular attention is paid to potential psychophysiological indicators of presence. Two psychophysiological measures are described in detail (electrodermal and cardiovascular activity) as these measures appear in subsequent experimental chapters.

Examples of each approach to presence measurement are given and each approach is evaluated with reference to respective advantages and disadvantages. Bases for the evaluation of each measurement approach have been suggested in a number of sources. For example, Hendrix and Barfield (1996) suggest that a presence measure should be (1) relevant - have a direct connection with presence and it's components, (2) sensitive – have sensitivity to variations in variables affecting presence, (3) convenient – easy to learn and administer, portable and low cost, (4) non-intrusive – so as not to interrupt the sense of presence, and (5) reliable – have proven test-retest reliability. The need for validity, multi-dimensionality, sensitivity, usability and reliability in measurement has been noted elsewhere (Ellis, 1996; Lessiter et al., 2001; Meehan et al., 2002; Witmer & Singer, 1998). In addition, the extent to which a measure generalises across Media Forms, Media Content and Users is an important issue (Lessiter et al., 2001). Finally, the extent to which a measure is useful may depend on its applicability in the development of media systems and in furthering the understanding of the presence construct.

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[3] This chapter was submitted to the OmniPres project (EC Future and Emerging Technologies 1st Presence Initiative) as a contribution to a presence measurement compendium (van Baren & IJsselsteijn, 2004). The compendium is a comprehensive guide to available presence measures and a summary can be found at: www.presence-research.org/compendium.html.

2.2 Subjective Measures of Presence

Sheridan (1992) proposed that given presence is primarily thought of as a mental manifestation, its primary mode of measurement should be subjective. Subjective measures of presence are those which generally require some reflection, evaluation and self-report on behalf of participants. Four direct subjective measures of presence are included here: Qualitative methods, psychophysical methods, questionnaire measures and continuous self-report.

2.2.1 Qualitative methods

2.2.1.1 Examples

Qualitative methods yield non-quantitative data that require contextual interpretation on behalf of a researcher. Data may include text, speech and behaviour yielded from various forms of interviewing and observation techniques. Data may be analysed with respect to content, discourse and narrative. Such methods have been seen as particularly useful in the field of human-computer interaction, where the possible permutations of users, interfaces and tasks often exceeds a practical limit for experimental evaluation. Hence techniques such as verbal protocols (where a user is asked to think out loud) and participant observation are widely used in this field (Wright & Monk, 1989).

There are various examples of qualitative methods being used in presence research: (1) the use of ethnographic methodology to investigate user explorations of VEs (McGreevy, 1993), (2) qualitative interviewing to investigate components of presence in text based virtual worlds (Jacobson, 2001), (3) video observations of behaviour in VEs (Spagnolli & Gamberini, 2002) and (4) focus-group interviewing to examine the impact of monoscopic and stereoscopic video footage (Freeman & Avons, 2000).

2.2.1.2 Advantages

Qualitative methods have the advantage of providing in-depth information about user experience, in the users own words. For example, Freeman and Avon's (2000) focus group study confirmed that users spontaneously describe mediated experiences in terms of 'being there'. The study also revealed a multi-dimensionality in experience relating to evaluations of media quality alongside reports of feelings and behaviours. In addition, sensitivity to variations in presence determinants (Media Form and Media Content) was apparent in the data. Qualitative research may also challenge assumptions of presence theory. For example, Spagnolli & Gamberini (2002) recently demonstrated that user experience may be more fluid than attentional approaches to presence suggest (e.g., Slater, 2002). Such findings may inform presence theory and research, such as in the case of questionnaire development (Lessiter et al., 2001).

2.2.1.3 Disadvantages

Qualitative methods are limited in a number of ways. Large amounts of data tend to be generated which require in-depth analysis. The objectivity and reliability of findings is limited by the fact that the researcher's interpretation is often central to analysis. In addition, when cross-media and cross content comparisons are needed, qualitative methods limit sensitivity and generalisability.

2.2.2 Psychophysical Methods

2.2.2.1 Examples

Psychophysical methods address the extent to which participants can discriminate between stimuli that vary along controlled parameters (e.g., display configurations). For example, participants may be asked to assign values to stimuli according to the strength of their sense of presence, anchoring all values in relation to their rating of the first stimulus experienced (Snow and Williges, 1998). Such methods may tap into sensations not easily reported verbally by asking participants to express their sensation in one modality through the intensity of another modality, such as the amplitude of a tone (Welch, 1997).

The extent to which participants can discriminate between different display configurations has been examined by Welch, Blackmon, Lui, Mellers and Stark (1996). Participants rated pairs of stimuli (simulated driving tasks differing by one or more Media Form variables) in terms of the degree of difference in presence between each pair. Ratings of 100 indicated strong differences in presence and ratings of 1 indicated similar levels of presence.

2.2.2.2 Advantages

Psychophysical methods have several advantages. They provide quick, intuitive and sensitive methods of comparing between variations in Media Form and also Media Content. Such comparisons allow experimental control and should yield reliable, generalisable data. For example, Welch et al.'s (1997) results indicated that their psychophysical presence measure was sensitive to variations in pictorial realism, degree of interactivity and delay of interactivity. The finding is in line with the presence literature.

2.2.2.3 Disadvantages

It is debatable how closely psychophysical ratings are related to presence. In the Welch et al., (1997) study it is unclear how the scale may be interpreted by users. In addition, the use of anchoring (i.e., exaggerated comparisons in practice trials) may lead to evaluations based on the physical properties of a display rather than sensations of presence.

2.2.3 Questionnaire Measures

2.2.3.1 Examples

Post-test questionnaires are the most common subjective measure of presence. A number of presence questionnaires have been developed and these vary widely. Often, assumptions about the nature of presence guide item choice. For example, Slater (1999) states that his conception of presence is based both on an accepted definition of presence (that the experience involves a sense of 'being there' in a mediated environment) and observations of participant's behaviour in and discussions of VEs (relating to the extent to which a mediated environment becomes the dominant reality for a participant and the extent to which they view the environment as somewhere visited or just seen). The three factors ('being there', 'reality' and 'visited') have been widely used to quantitatively evaluate presence (UCL Presence Questionnaire: Slater & Usoh, 1993 and Slater, Usoh & Steed, 1994).

A variety of other presence questionnaires have been developed: (1) Witmer and Singer's (1998) Presence Questionnaire; based around the theory that involvement and psychological immersion should determine presence, (2) Kim & Biocca's (1997) questionnaire; based on presence as transportation, (3) Lombard, Ditton, Crane, et al.'s, (2000) presence questionnaire; drawing widely from the presence and communication studies literature, (4) The Reality Judgement and Presence Questionnaire (Banos, Botella, Garcia-Palacios, Villa, Pernina, & Alcaniz, 2000); based on the idea that reality judgements and affective judgements are central to presence, (5) The I-Group Presence Questionnaire (Schubert et al., 2001); based on the idea that attention and mental models underlie reports of presence and (6) The ITC-Sense of Presence Inventory (Lessiter et al., 2001); drawing widely from the presence literature.

2.2.3.2 Advantages

Questionnaire measures of presence vary in quality. However, some questionnaires have been shown to be sensitive to the determinants of presence in many situations (Lessiter et al., 2001, Schubert et al., 2001; Slater et al., 1994). Such measures provide simple data that allow comparisons between many Media Forms and Media Contents. In addition, the design of presence questionnaires has furthered the understanding of the presence concept. For example, using factor analyses Schubert et al. (2001) demonstrated that ratings of the quality of a technology are somewhat independent of ratings of experiences with technology. Furthermore, some factors or clusters appear to be common to more than one questionnaire. These are typically a sense of space, a sense of realism and a sense of involvement (Lessiter et al. 2001 and Schubert et al., 2001 in particular). The latter questionnaires drew most widely from the presence literature, were tested on the widest range of media and were piloted on the largest samples. These factors may indicate some validity for the 'physical space', 'realism' and 'involvement' concepts as important components of presence measurement.

2.2.3.3 Disadvantages

Some disadvantages of presence questionnaires are specific to the particular metric. For example, some questionnaires confound technological and experiential evaluations. In other cases, scaling issues indicate either that concepts may be confounded with each other or that the questionnaire will not be easily understood. Also, some questionnaires have not been well tested and may be appropriate to only some types of media or content.

One disadvantage that applies to all post-test questionnaires is that they are typically administered after mediated experiences. As such, a questionnaire does not address experience as it happens. Hence, questionnaire measures of presence are potentially prone to biases of recall. This can also apply to psychophysical and qualitative methods. In general, subjective measures of user experience are prone to a number of biases, such as experimenter effects, and depend on cognitive mediation between an experience and the report of an experience (Wilson & Sasse, 2000).

Although presence questionnaires have many documented disadvantages their advantages suggests they are one of the most accessible ways of measuring presence. Because questionnaires directly address subjective experience, are easy to use and can address many dimensions of presence, they are used throughout this thesis as the primary means of measuring presence and as a benchmark against which other presence measures must compare. However, some of the limitations of presence measures are acknowledged. For example, the ITC-SOPI provides a lot of detail about users' mediated experiences and so provides a good measure for exploratory research or when specific predictions about different dimensions of presence are made. However, due to its length, the ITC-SOPI may not always be the best questionnaire to use over multiple exposures, when time is limited or when demands on participants are high. For short manipulation checks and pilot work the UCL-PQ may be a preferable questionnaire due to its length and widespread use throughout the literature.

2.2.4 Continuous Self-Report

2.2.4.1 Examples

To overcome the recall biases of questionnaire measures, attempts have been made to collect presence ratings in real time (throughout a mediated experience). Continuous self-report measures typically require users to register fluctuations in their evaluations of an experience on a sliding scale or dial, which automatically registers data. The method has been applied in emotions research (Fredrickson & Kahneman, 1993) and is also recommended for the formal assessment of television picture quality by the International Telecommunications Union (ITU-R BT.500). IJsselsteijn, De Ridder, Hamberg, Bouwhuis and Freeman (1998) modified the ITU method for presence ratings. They asked participants to rate a sequence of video footage varying at different points in time in terms of combinations of camera angles, depth cues and stereoscopic parameters.

2.2.4.2 Advantages

IJsselsteijn et al.'s (1998) results indicated temporal variations in continuous self-reports that were in line with the presence literature, in that realism enhanced presence ratings. The method could provide an accurate method of tapping experience on-line that allows easy identification of temporal factors affecting user judgements. In addition, the method is intuitive to the user. Finally, the simple data collected should allow easy cross Media Form and Media Content comparisons.

2.2.4.3 Disadvantages

Continuous measures of presence allow only one construct to be measured at a time. Hence, the measures lack the detail of other self-report measures. In addition, because users are requested to assess their experience on-line, the measures have the potential to interrupt sensations of presence. Importantly, (Freeman, Avons, Pearson & IJsselsteijn, 1999) have demonstrated that continuous self-report measures of presence may be prone to biases. In one experiment, users who had prior experience of depth ratings appeared to be sensitised to depth information when rating presence for subsequent presentations. The finding is of relevance to all self-report measures of presence, given that experience and expectation may be a feature of all subjective evaluations.

2.3 Subjective Corroborative Indicators of Presence

Using corroborative indicators of presence may overcome some of the problems with self-reports of presence and contribute to the validity and generalisability of findings. Corroborative measures of presence generally arise from theories about presence. For example, it is thought that reports of presence arise from underlying psychological processes (such as attention and mental models) and should be accompanied by naturalistic thoughts, feelings and behaviours (Freeman et al., 2000; Lombard & Ditton, 1997; Slater et al., 1994; Schubert et al., 2001). Corroborative indicators can provide information about the predicted concomitants of reported presence. Three examples are given below: two cognitive measures (memory and attention) which require subjective mediation and also self-reports of emotional responses.

2.3.1 Attention

2.3.1.1 Examples

It has been proposed that attentional processes are an important component of presence. IJsselsteijn et al. (2001) have suggested that attentional tasks, such as secondary reaction time tasks, may be utilised in the measurement of presence. It is predicted that as the sense of presence increases more attention will be directed towards a mediated environment than a real environment. Slater (2002) suggests that the measurement of BIPs (attentional shifts away from mediated environments) could serve as a measure of presence. Measures of BIPs may include subjective reports and studies of brain activity.

2.3.1.2 *Advantages*

Attentional measures of presence would tap into a psychological construct that is heavily implicated in generating reports of presence. Indeed, Slater & Steed's (2000) results indicated that a user's awareness of BIPs correlated with post-test reports of presence and distinguished between levels of presence for one type of VE (a chess game). Such measures could tap into on-line experience and may require intuitive, reflexive responses rather than bias prone reflective responses.

2.3.1.3 *Disadvantages*

Though attention is proposed as a key component of presence, predictions about the relationship between the two could vary. For example, increased involvement could potentially lead to increased reactivity or reduced reactivity to secondary tasks. Such measures also only indicate one dimension of presence. In addition, the instruction to report awareness of attention may potentially bias subsequent reports of presence in this direction. Attentional indicators may also interrupt experience and disrupt the experience of presence. Attentional measures may address the 'quantity' of an experience not the quality, hence limiting generalisability across Media Forms and Media Content.

2.3.2 Memory

2.3.2.1 *Examples*

It has been suggested that features of recall may be associated with levels of reported presence. For example, Mania and Robson (2002) applied schema theory to the recall of objects in Virtual Environments, such as simulated offices (following Brewer & Treyens, 1981). Virtual offices which varied in terms of visual quality were compared in terms of reported presence and script-based recall.

2.3.2.2 *Advantages*

Memory indicators of presence may aid the identification of psychological processes underlying reports of presence. For example, Mania and Robson (2002) looked for evidence of content relevant schema activation in Virtual Environments. Such methods indirectly address knowledge and experience, and hence may tap into unbiased indicators of presence. This provides simple, quantitative data with which to evaluate mediated environments

2.3.2.3 Disadvantages

Rather than serving as indicators of presence, research into memory measures is at an exploratory stage. For example, though Mania and Robson's (2002) study indicated that Virtual Environments activated content relevant schemata, no differences between levels of image quality were observed for either reports of presence or script based errors. In addition, other research has demonstrated a varying relationship between recall and Media Form manipulations (Biocca, Li & Daugherty, 2001; Kim & Biocca, 1997; Larsson, Vastfjall & Kleiner, 2001; Rose, Attree, Brooks & Andrews, 2001). The diversity in findings may in part be due to the type of memory addressed and type of information recalled varying across studies. Finally, a general memory measure of presence is unlikely to emerge given the content-specificity required.

2.3.3 Emotional responses

2.3.3.1 Examples

Self-report measures of emotion tap into the experiential component of emotional processes. Some measures address primarily the valence and arousal components of an emotional response (Self-Assessment Manikin, Lang, 1980; The Positive and Negative Affect Schedule, Watson, Clark, & Tellegen, 1988). Other measures require ratings of emotional states such as happiness and sadness (Fredrickson & Kahneman, 1993; Gross & Levenson, 1995; Izard, Dougherty, Bloxom & Kotsch, 1974). Changes in mood states may be also rated using self-report measures (Profile of Mood States - Bi-polar, McNair & Douglas, 1984). Self-report measures of emotion have been implemented in a number of experiments alongside self-report measures of presence (Pertaub et al., 2002; Schuemie et al., 2001; Slater et al., 1999)

2.3.3.2 Advantages

Self-report measures of emotional responses can provide a quick and easily understood method of evaluating user experience. In addition, many measures of emotion have been extensively tested and have high reliability (e.g., PANAS and POMS). Such measures may tap into underlying psychological constructs related to presence or provide evidence that presence is associated with the production of naturalistic feelings. Indeed, content relevant reports of emotion in mediated environments have often been shown to either correlate with presence or vary according to the determinants of presence (Schuemie et al., 2001; Slater et al., 1999).

2.3.3.3 Disadvantages

Though some research indicates a relationship between emotional responses and presence the results may be inconsistent (Pertaub et al., 2002). Further research is required to verify that emotional responses may be used as indicators of presence. In addition, self-reported emotional responses may be prone to the same biases as self-report measures of presence.

2.4 Objective Corroborative Indicators of Presence

It is an advantage to have a corroborative indicator of presence that does not require some type of self-report (e.g., related to presence, emotion, recall or attentional state). Objective corroborative measures allow subjective biases in the evaluation of presence to be reduced. In addition, means of tapping into online experience without interrupting experience, by requesting subjective evaluations, are desirable. Various objective corroborative indicators of presence have therefore also been suggested in the presence literature: task performance, reflexive behaviour and psychophysiological methods. In addition to providing objective means of evaluating presence, the measures may further the understanding of the presence concept.

2.4.1 Task Performance

2.4.1.1 Examples

It has been proposed that presence may have some relation to task performance. For example, Held and Durlach (1992) have suggested that presence should enhance task performance in VEs designed for training purposes (e.g., pilot training) and entertainment (where the goal is to have fun). For Schloerb (1995), presence is primarily described in terms of task performance. Objective telepresence is the ability to successfully perform remote tasks while subjective telepresence is seen as a measure of achieving a sense of presence when that is the task required during teleoperation. Various measures of task performance have been proposed as objective indicators of presence, such as appropriateness of actions, speed and accuracy (Barfield and Weghorst, 1993).

2.4.1.2 Advantages

Task performance indicators of presence can be collected on-line, or overall task outcomes should at least relate to performance over time. In addition, such measures should have a direct relationship with the intended application of a medium. Finally, the data should be objective and comparable between media for similar tasks.

2.4.1.3 Disadvantages

Ellis (1996) points out that enhanced presence may not necessarily lead to enhanced task performance. A reduction in the realism of a display (and hence presence) may lead to enhanced task performance (e.g., in the case of air traffic control displays). In addition, 'tasks', in the sense that they represent explicit goals to participants, may be prone to similar sources of bias as subjective measures of presence. Therefore, the extent to which a task engages a user is also important (Bystrom, Barfield & Hendrix, 1999), as is the ability and motivation of the user (Heeter, 1992; 2003). Importantly, only certain types of behaviours may be easily related to presence. For example, it has been shown that a reflexive pointing task in a VE was more closely related to presence than a planned targeting task (Slater, et al., 1995; Slater et al., 1998). In general, the relationship between presence and task performance may be complex, and the task-based indicators of presence may be highly content specific.

2.4.2 Reflexive Behaviour

2.4.2.1 Examples

It has been widely suggested that measures of reflexive behaviour could serve as objective corroborative indicators of presence (Freeman et al., 2000; Insko, 2001; Lombard & Ditton, 1997; Slater et al., 1994; Von der Heyde & Riecke, 2002). The proposal generally stems from the idea that presence involves both the subjective experience of 'being there' and naturalistic behaviour (Lombard & Ditton, 1997). Specifically, Freeman et al., (2000) have promoted a Behavioural Realism approach in presence evaluation. Behavioural Realism predicts that the better an environment approximates a real environment, the more behaviours will tend to those that would be observed in a similar real environment.

Various reflexive behaviours have been proposed as indicators of presence, for example: (1) startle reflexes to looming objects (Held & Durlach, 1992; Sheridan, 1996) (2) social reflexes (Barfield & Weghorst, 1993), (3) automatic emotional responses (Insko, 2001; Meehan et al., 2002; Pertaub et al., 2002) and (4) intuitive spatial behaviours (Freeman et al., 2000; Slater et al., 1995; Von der Heyde & Riecke, 2002). Large studies have included the measurement of postural sway in response to videos varying in depth cues, motion and image size (Freeman et al., 2000; IJsselsteijn, de Ridder, Freeman, Avons & Bouwhuis, 2001) and observations of fear responses over repeated exposure to a virtual pit environment varying along frame-rate and passive-haptics parameters (Insko, 2001; Meehan et al., 2002).

2.4.2.2 Advantages

There are many advantages to proposed reflexive indicators of presence. Some indicators are sensitive to variations in the determinants of presence and have reliability in some circumstances (Freeman et al., 2000; IJsselsteijn et al., 2001; Insko, 2001; Meehan et al., 2002). In addition, behavioural reflexes are not normally under conscious control and so may be less prone to the biases of subjective measures of presence. Such reflexes may be measured in real-time, without disrupting experience, and so may serve as continuous measures of presence. Furthermore, the implementation of behavioural indicators of presence may provide evidence relating to the behavioural realism theory. Finally, the efficacy of a medium or content in producing a reflexive behaviour has a direct connection to intended applications in some cases (e.g., therapy for phobias).

2.4.2.3 Disadvantages

Research investigating the utility of behavioural indicators of presence has yielded mixed results. For example, measures of postural sway in response to video content are sensitive to some Media Form variables, but not others (IJsselsteijn et al., 2001). In addition, objective reflexive measures are not always shown to correlate with reported presence (IJsselsteijn et al., 2001; Meehan et al., 2002). The latter finding may indicate some independence between reflexive and reflective response systems, so may not necessarily be a disadvantage in terms of investigating the presence construct. However, reflexive measures also tend to be highly content specific and may only relate to one aspect of an experience. Hence, general behavioural indicators of presence are unlikely to emerge and they may be used best in conjunction with other measures. Furthermore, behavioural measures tend to require overt observable responses on behalf of participants. Hence, some Media Forms or Contents may limit their applicability. Finally, behavioural indicators tend to generate large amounts of data and require complex analysis.

2.4.3 Psychophysiological Measures

2.4.3.1 Examples

Psychophysiology is "...the process of inferring psychological significance from physiological signals", (Cacioppo and Tassinary, 1990, pg. 16). This process ideally involves examining the specificity of a physiological signal to a psychological construct across a range of contexts. Physiological signals may then come to be used as either outcome measures, markers, concomitants or invariant measures of psychological constructs. Pugnetti, Meehan and Mendozzi (2001) have reviewed the use of physiological measures in applied contexts relevant to presence research. They looked at psychophysiological applications in Virtual Environments (VEs) and have identified seven key uses for psychophysiological measures in this context. (1) testing VEs for safety, (2) developing more effective VEs, (3) studying specific aspects of cognition in VEs, (4) understanding more about desensitisation in VE therapy, (5) using physiological channels to control VEs, (6) studying the effects of system parameters on physiology, and (7) addressing important ethical issues (such as the emotional impact of entertainment media).

Several of the areas listed above have been suggested or implemented in presence research. Applications include, (1) using electroencephalogram (EEG) or Magnetic Resonance Imaging (MRI) techniques to study brain activity related to BIPs (Slater, 2002), (2) studying startle reflexes using autonomic indicators of arousal (Barfield & Weghorst, 1998; Sheridan, 1996), (3) using autonomic measures to investigate individual differences and desensitisation in therapeutic contexts (Wiederhold et al., 1998; Wiederhold et al., 2002), (4) investigating reflexive social responses with autonomic measures (Garau, 2003), (5) evaluating the impact of presence determinants, such as Form, Content and Interactivity, using autonomic measures (Calvert & Tan, 1996; ; Jang et al., 2002; Lombard et al., 1998; Meehan et al., 2002) (6) evaluating autonomic measures of fear as corroborative measures of presence (Meehan et al., 2002; Wiederhold et al., 1998) and (7) using measures of heart rate and brain activity to indicate BIPs during mediated experiences (e.g., Guiger, Edlinger, Leeb et al., 2004).

2.4.3.2 Advantages

Kramer and Weber (2000) have described the utility of psychophysiological methods in human factors research and state they have a particular advantage when three conditions are fulfilled. They must:

1) prove to be more valid or reliable indices of relevant psychological constructs than traditional behavioural or subjective measures or,
2) enable the measurement of constructs that are difficult or impossible to measure with traditional measures; or
3) enable the measurement of relevant constructs in situations where other types of measures are unavailable.

For example, psychophysiological measures are reliable and valid indices of vigilance and mental workload (Kramer and Weber, 2000). They may also reflect variations in media quality which are not apparent from self-report data (Wilson and Sasse, 2000). Scheirer et al. (2002) have also demonstrated the utility of psychophysiological methods in situations that are difficult to evaluate using self-report. They used pattern recognition techniques to identify likely moments of frustration and non-frustration during a computer game.

The examples above highlight advantages of psychophysiological methods in human factors research that may also apply to presence research. Psychophysiological methods could provide continuous measures which do not interrupt user experience. They are generally not under conscious control and so may highlight effects not apparent from bias prone self-report measures. The measures also have an advantage over objective behavioural measures as they do not require overt, observable responses. In addition, presence research utilising psychophysiological methods may further the understanding of psychological constructs underlying reports of presence (e.g., attention and emotion). The methods also have direct applied utility, particularly in the field of virtual therapy.

2.4.3.3 Disadvantages

A review of the relationship between the determinants of presence and measures of emotion (Chapter 1) revealed that further research was required to verify that physiological measures of emotional arousal could be used as indicators of presence. In particular, the use of restricted Content (i.e., mainly fear inducing stimuli) and the presence of potential confounds in research of this type limits the generalisability of findings at this time. Further concerns about the use of psychophysiological measures in applied presence research should include (1) proneness of physiological measures to artefacts from movement and electrical interference, (2) the extent to which a measure restricts movement, (2) the large amounts of data generated and the complex analyses required and (4) the multiple determination of many psychophysiological measures.

2.5 Summary of Presence Measurement Techniques

All approaches to the measurement of presence have certain disadvantages and advantages. Subjective measures tap directly into the experience of presence and can reflect underlying psychological constructs associated with reports of presence. However, subjective measures of presence may be prone to biases of recall and expectation. Many subjective measures also do not tap online experience, and those that do may be intrusive. Therefore, other types of subjective and objective measures may be used to corroborate subjective reports of presence. Corroborative measures of presence generally arise from the idea that reports of presence should be associated with naturalistic thoughts, feelings and behaviours. However, research indicates that many corroborative measures of presence require further investigation, as findings are often either scarce or inconsistent.

Chapter 1 suggested that emotions should be considered, alongside perception, attention mental models and schemata, as one of the psychological constructs underlying reports of presence. Theoretical and experimental evidence was presented that demonstrated the tendency of emotional responses to co-occur with reports of presence, intensify as presence increased and potentially determine reports of presence. Hence, there is justification for suggesting that measures of emotion could be used as corroborative measures of presence. However, the scarcity and inconsistency of findings in this area illustrates the need for an initial in-depth investigation of the relationship between presence and emotion. In particular, it would be of interest whether emotional responses varied with respect to the determinants of presence in the same way as self-reported presence and also whether emotional responses correlated with presence.

Of further interest is the reliability of physiological measures (especially autonomic measures) as indicators of emotional arousal and presence. Physiological indicators of emotional arousal could provide an objective, continuous and non-intrusive corroborative measure of presence. Indeed, autonomic measures of arousal have been the most widely proposed and implemented psychophysiological indicator of presence. Hence, this thesis will aim to look at the relationship between reports of presence, reports of emotion and autonomic responses over a wider range of Media Forms and

Media Contents than has previously been evaluated. The two autonomic measures which are used throughout this thesis (electrodermal activity and cardiovascular activity) are introduced below.

2.6 Electrodermal Activity

Electrodermal activity (EDA) is the generic term for measures of tonic and phasic electrical activity of the skin (including skin conductance, skin resistance and skin potential). Andreassi (1989), Boucsein, (1993), Dawson, Schell and Filion (2000), Fowles, Christie, Edelberg, Grings and Venables (1981), Venables & Christie (1980) and Turpin (1989) have extensively described work relating to the physiological basis, measurement and uses of EDA measures. The reviews provide general methodological and interpretative guidelines, which are summarised below.

2.6.1 Physiological Basis of Electrodermal Activity

Feré (1888) noted changes in skin resistance between two electrodes, placed on the surface of a human's skin, between which a small electrical current was passed. Specifically, after the presentation of external stimuli (e.g., visual, auditory, olfactory) the skin becomes a better conductor of electricity. This variation in skin conductance is known as electrodermal activity (EDA), where greater conductivity indicates an increase in EDA. Important physiological mechanisms involved in EDA variability involve the skin, eccrine sweat glands, sympathetic nervous system (SNS) and central nervous system (CNS). In particular, the activity of eccrine sweat glands is implicated in the generation of EDA variability (see Figure 2.1).

The skin can be divided into three layers: the epidermis (outer layer), the dermis (mid-layer) and hypodermis (containing blood and lymph vessels, sensory nerves, and hair follicles). The secretory portion of the eccrine sweat gland is a coiled compact body within the hypodermis. A single excretory duct travels through the dermis from the gland and opens in the outer part of the epidermis as a pore. It is generally proposed that variations in EDA relate to the level of sweat within eccrine ducts and the number of active ducts (Venables & Christie, 1980). The ducts act as variable resistors in parallel. As sweat rises in a greater number of ducts, a more conductive path forms across the surface of the epidermis.

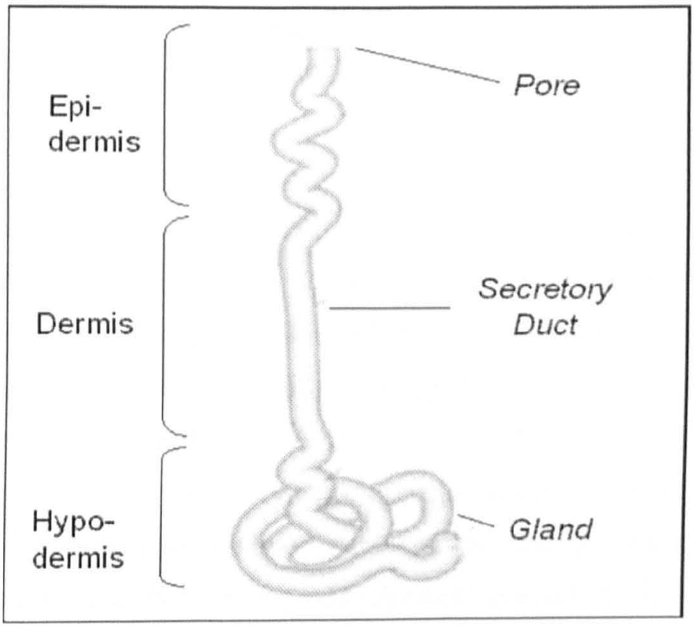

Figure 2.1 The eccrine sweat gland.

The secretory portion of the eccrine sweat glands is innervated by cholinergic fibres of the SNS. Variations in EDA are generally thought to be directly proportional to SNS activity (though this is debated by some authors, e.g., Bradley, 2000). The SNS is one of two branches of the autonomic nervous system, which is part of the peripheral nervous system and responsible for automatic control of the organs of the body. The second branch is the parasympathetic nervous system (PNS). The SNS is implicated in fight-or-flight responses, in contrast to the rest-and-digest functions of the PNS. Though the SNS is generally associated with noradrenaline, the neurotransmitter most associated with variations in EDA is acetylcholine. This reflects the relationship between EDA and sensory stimulation. The adaptive function of the SNS is reflected in the differential responsiveness of eccrine sweat glands across the body.

Eccrine sweat glands are found across most of the surface of the human body. The greatest density is found on the soles of the feet and the palms of the hands (Andreassi, 1989). Eccrine sweat glands are thought to be involved in thermoregulation. However, though glands that appear on parts of the body other than the soles and palms are mainly responsive to thermal stimuli, those that appear on the soles and palms are also responsive to psychological and sensory stimuli. This fits with the notion that the greater density of eccrine glands in these areas reflects emergency survival functions such as grasping behaviours and protection from lesions (Hughdahl, 1995). Hence, EDA measurements are generally taken from the palms of the hands (Andreassi, 1989; Boucsein, 1993; Dawson et al., 2000; Fowles et al., 1981; Venables & Christie, 1980).

There are several central nervous system (CNS) mechanisms involved in the control of EDA via the SNS (Andreassi, 1989; Dawson et al., 2000; Raine & Lencz, 1993; Sequiera & Roy, 1993). Each mechanism, or brain area, has different functional roles that may be reflected in EDA variations. The hypothalamus, amygdala, and premotor cortex have excitatory control of EDA associated with thermoregulatory sweating, emotional processing and fine motor control respectively. The hippocampus has inhibitory control of EDA associated with emotional processing. The frontal cortex and reticular formation have both excitatory and inhibitory control of EDA associated with attentional processes and gross motor control respectively. The behavioural and psychological correlates of EDA are therefore complex and diverse.

2.6.2 Measurement of Electrodermal Activity

There are three types of EDA data: skin resistance (SR), skin conductance (SC) and skin potential (SP). SC and SR are the most reliable indicators of EDA (Andreassi, 1989; Venables & Christie, 1980). This thesis is primarily concerned with measures of SC and SR. Hence, SP measures are excluded from further discussions. Important issues surrounding the measurement of SC and SR include recording techniques, units of measurement, data management and reduction and sources of error variance.

The measurement of EDA exosomaticaly depends on the measurement of the ease with which a current travels over the skin between two electrodes. There are two main methods of obtaining this measure via a polygraph: the measurement of SC or SR. A polygraph is the generic term for equipment that collects, amplifies, shapes, displays and stores electrical signals from the body. Two polygraphs are used in this thesis and are described in Chapter 3 and Appendix A1. Both polygraphs measure EDA in similar ways.

A constant DC current source from the polygraph amplifier connects to the participant via bi-polar electrode placement on the palm of the hands (completing a circuit between the eccrine sweat glands and the polygraph). The voltage across the electrodes is measured by a computer linked to the amplifier. SR measures are derived from the voltage measures using Ohms law. SR, voltage and current are related by Ohms law: V = IR, where V is volts of potential, I is amperes of current and R is ohms of resistance. Skin resistance may be calculated from a re-arrangement of Ohms law: R = V/I, where V is measured across the two electrodes and I is the constant applied current.

The recommended unit of measurement of EDA is SC (mhos). SC is the reciprocal of SR (Conductance = 1/R) and is preferred for several reasons (Andreassi, 1989; Fowles et al., 1981; Venables & Christie, 1980). Firstly, SC data is more likely to be normally distributed than SR and is therefore more suitable for parametric statistical analysis. Secondly, SC is more linearly related to the number of active sweat glands at a recording site. In addition, SC levels (SCLs) and SC responses (SCRs) tend to be uncorrelated, unlike SR levels (SRLs) and SR responses (SRRs). SC is therefore less prone to the Law of Initial Values (LIV) than SR, in which the size of a response is proportional to its baseline value (Myrtek & Foester, 1986). Finally, SC is the more intuitively appealing unit of measurement given that as EDA (and SNS activity) rises so does SC. SR is measured directly in this thesis and converted to SC in all experiments.

Three types of dependent variables may be derived from EDA. Measures relating to event-related responses are derived from skin conductance or resistance responses (SCRs or SRRs). These will be termed electrodermal responses (EDRs). EDRs generally occur within 1-4secs of stimulus onset and are described in terms of amplitude, latency, rise-time, recovery time and habituation (Venables & Christie, 1980). Frequency of non-specific EDRs may also be used as a general measure of EDA. EDRs may be termed phasic measures of EDA. Tonic measures of EDA refer to overall skin conductance or resistance levels (SCLs or SRLs). These may be termed electrodermal levels (EDLs). This thesis is primarily concerned with gradual changes in EDLs from one time period to another. Changes in EDLs may be influenced by changes in the tonic level of SNS activity and the frequency and characteristics of EDRs.

Individual differences are one source of error variation in experimental situations. These may include psychopathological characteristics, gender, ethnicity, age and drug use (Fowles et al., 1980; Turpin, 1989). Other extraneous experimental variables may also affect measures of EDA. These include electrical noise, room temperature, movement and psychological/physical events not linked to experimental stimuli (Fowles et al., 1981; Venables & Christie, 1980).

2.6.3 Main Uses of Electrodermal Measures

The main uses of EDA measures are reviewed by Andreassi (1989) and Dawson et al. (2000). In general, as the intensity of a stimulus increases so does EDA (Bernstein, 1969). Stimulus variables may include sensory information, emotionality, stress, task variables, novelty, expectation, meaning, complexity, incongruity and conflict. Variations in EDA due to such stimulus variables are linked to arousal, attention and emotion processes (Greenwald, Cook & Lang, 1989; Yaremko, Blair & Leckhart, 1970). Important individual difference influences on EDA have also been noted (Turpin, 1989).

Arousal is a non-specific term that describes the intensity but not quality of activation within a system. For example, autonomic arousal refers to the variability of activation within the autonomic nervous system (Andreassi, 1989). Subjective arousal refers to the intensity dimension of emotion (Lang, 1980). Arousal is also used to refer to central nervous system (CNS) activation linked to attention and alertness (Duffy, 1962). EDA may be used as a broad indicator of SNS arousal (Bradley, 2000), which may be indicative of other arousal processes involved in energy mobilisation, pre-attentive processes, effortful attention allocation and the effects of stress. For example, EDRs are used in the study of deception and implicit memory to investigate the recognition of stimuli that a participant wishes to conceal or is unable to consciously recall (Dawson et al., 2000; Revelle & Loftus, 1992).

EDA has also been an important component of investigations of the Orienting Response (OR) – (Turpin, Schaeffer and Boucsein, 1999). ORs are said to reflect the immediate allocation of attentional resources to significant, non-aversive stimuli (Graham, 1992). ORs generally occur after a sudden change in a stimulus. EDRs are a component of this response. Different types of attention-related EDA responses are further discussed by Turpin et al. (1999), in terms of profile, habituation and psychological significance. For example some ORs reflect defensive responses (e.g., ORs to unpredictable loud noises) and do not habituate, whereas others habituate quickly (e.g., ORs to predictable, lower volume noises).

Measures of EDA have also been linked to operational discriminations between emotions (Scheirer et al., 2002). Working within a two-dimensional (valence and arousal) framework of emotion it has been shown that EDA is most closely related to the arousal dimension of emotion (Greenwald, Cook & Lang, 1989; Lang, Greenwald, Bradley & Hamm, 1993; Simons, et al., 1999). For brief, novel stimuli, EDA discriminates between neutral and emotive stimuli, but not pleasant and unpleasant stimuli, and positively correlates with subjective arousal (Bradley, 2000). However, in more sustained emotive contexts, EDA, as one component of a pattern of autonomic responses, has been shown to discriminate between emotions which vary in terms of quality (e.g., Anger, Happiness, Surprise, Sadness, Disgust, Fear) in addition to intensity, (e.g., Collet, Vernet-Maury, Delhomme and Dittmar, 1997). For example, recent evidence indicates that Sadness may be associated with decreases in EDA, in contrast with increases in EDA associated with other negative emotions (Bradley, 2000).

The idea that patterns of autonomic activation are specific to discrete emotional qualities is widely debated (James, 1884; LeDoux, 1996; Schacter & Singer, 1962; Scheirer, et al., 2002). However, it can generally be said that more emotive or arousing stimuli, particularly negative aversive stimuli, are associated with increased EDA. Hence, EDA is used widely to study negative 'stress'. The use of EDA in this context is useful in that it may objectively indicate stressful situations which have a potential long-term negative impact on health (Kramer & Weber, 2000; Wilson and Sasse, 2000).

Finally, measures of EDA have been used to study individual differences. Individual differences related to EDA include psychopathological characteristics, gender, ethnicity, age, and drug use (Turpin, 1989). One individual difference in particular illustrates that EDA responsivity may not always have expected behavioural and subjective concomitants. 'Repressors' typically display EDA responses to anxiety provoking stimuli but do not report subjective anxiety (Sparks, et al., 1999).

2.7 Cardiovascular Activity

Cardiovascular activity is a generic term for measures of tonic, phasic and frequency measures of the circulatory system. This review is particularly concerned with measures of Heart Rate (HR) derived from the electrocardiogram (ECG). Work relating to the physiological basis, measurement and uses of HR has been extensively described by Andreassi (1989), Brownley, Hurwitz and Schneiderman (2000), Bernston, Bigger, Eckberg et al. (1997) and Jennings, Berg, Hutcheson, Obrist & Turpin (1981). Their work is summarised below.

2.7.1 Physiological basis of HR measures

Important physiological mechanisms involved in HR generation involve the heart muscle and circulatory system, internal and external controls of the cardiac cycle, and the autonomic and central nervous systems. The heart muscle acts as a rhythmic double pump supplying blood to the tissues of the body. Each pump consists of two chambers, an atrium and ventricle, on the left and right sides. When the left ventricle contracts, blood delivering oxygen and nutrients, and removing metabolic by-products, is sent to body tissues. The deoxygenated blood returns to the right atrium. This passes to the right ventricle which, when it contracts, sends the blood to the lungs where carbon dioxide is removed and oxygen is added. The re-oxygenated blood returns to the heart via the left atrium and then passes to the left ventricle for re-distribution.

The efficiency with which this process continues depends on the rhythmic and sequential contraction (systole) and relaxation (diastole) of the atria and ventricles due to cellular de-polarisation passing rapidly though the heart. During atrial de-polarisation (contraction), the ventricles are relaxed. The ventricles then de-polarise as the atria re-polarise. A full sequence of atrium and ventricle systole and diastole (i.e., both depolarise and repolarise) represents one cardiac cycle, or heart beat. The rate at which cardiac cycles occur (i.e., Heart Rate) is under the control of several internal and external mechanisms (Bernston et al., 1997; Brownley, et al., 2000).

The main internal mechanism involves the sinoatrial node (SA node), which consists of a small bundle of cells in the right atrium. Cardiac tissue depolarisation originates in the SA node. This impulse for contraction is then slightly delayed by the atrioventricular node (AV node) before passing into the ventricles via the AV bundle. Purkinje fibres then pass the impulse to all parts of the ventricles.

The SA node acts as the internal pacemaker of the heart and depolarises and repolarises at a frequency which would give a Heart Rate of 120 beats-per-minute (bpm). The action of the SA node is modulated by innervations from both branches of the autonomic nervous system. For example, the vagus nerve (of the PNS) inhibits the SA node to give an average tonic Heart Rate of 70-80 bpm. However, the effects of SNS and PNS activity on cardiac control are complex (Bernston et al., 1997). Generally, PNS activity is associated with slowing of HR whereas SNS activity is associated with an increase in HR and cardiac output (reflecting the role of the SNS in emergency responses). However, HR increases may also be seen in response to reduced PNS activity, or both a reduction in PNS activity combined with an increase in SNS activity.

Other influences on cardiac control include blood born hormonal influences associated with norepinephrine and epinephrine receptors in cardiac tissue, other hormonal and chemical influences, the integration of autonomic responses across all internal organs (such as baroreceptor and respiratory influences) and the relationship between tonic HR and circadian rhythms. Essentially, the cardiovascular system supports the normal functioning of the entire body and the heart is therefore responsive to a complex array and integration of bodily influences.

CNS influences on cardiac control include the medulla, hypothalamus, cerebral cortex, cerebellum and amygdala (Andreassi, 1989; Bernston, et al., 1997, Brownley, et al., 2000). The medulla mediates tonic and phasic changes in HR by responding to baroreceptor reflexes (which provide information about blood pressure in the carotid sinus) in order to ensure an adequate supply of blood to the brain. The hypothalamus controls the release of vasopressin into the blood stream and is implicated in blood volume regulation and autonomic influences on the heart. The cerebral cortex is said to exert an influence on the cardiovascular system in response to psychogenic challenges, reflecting its role in the integration of sensory, perceptual and emotional stimuli. The amygdala plays a role in linking sensory stimuli to emotional responses and, in combination with the hypothalamus and periaqueductal gray, regulates cardiac components of defence and vigilance responses. The behavioural and psychological correlates of HR are therefore complex and diverse.

2.7.2 Measurement of HR

There are many methods of monitoring HR. Common methods in psychophysiological settings include the photoplethysmyograph, pulse detection, impedance cardiography and the electrocardiogram (ECG) - (Andreassi, 1989; Brownley, et al., 2000; Jennings et al., 1981). This review concentrates on the use of the ECG for monitoring the electrical activity of the heart. The ECG generally allows more accurate resolution of

HR than the photoplethysmyograph or pulse detection (Bernston et al., 1997) and can be less obtrusive than impedance cardiography, which is generally used for identification of cardiac events other than rythmicity. Important issues surrounding the measurement of HR using the ECG include recording techniques, units of measurement, data management and reduction, and sources of error variance.

Two simple ECG recording systems operating on similar principles are used in this thesis. Essentially three electrodes are placed on the surface of the skin at strategic points (such as the ribcage or limbs). Two electrodes constitute positive and negative terminals on the skin connected to a biopotential amplifier. This acts as a circuit between the amplifier and the heart, as electrical activity from the heart passes over the skin. The third electrode constitutes a ground electrode connected to a body part outside the main circuit. As the heart beats, voltage between the positive and negative electrodes changes and is measured and displayed as the ECG signal.

The graphical display of voltage change between the electrodes is termed the ECG (see figure 2.2). A single, simple ECG cycle consists of the three main waves and two intervals corresponding to one cardiac cycle. Events in the ECG cycle are labelled PQRST. The P wave coincides with atrial contraction. The QRS complex co-occurs with ventricular depolarisation and so contraction. The T wave co-occurs with re-polarisation of the ventricles.

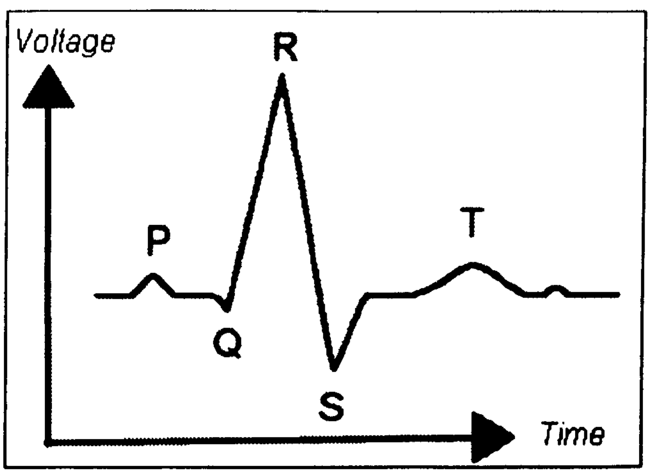

Figure 2.2 Schematic representation of an electrocardiogram QRS complex.

There are three main measures of HR derived from the ECG, which may be used as dependent variables: sustained changes in HR, HR variability (HRV) and event-related responses. Sustained changes in HR from tonic or resting levels would be expected to last more than thirty-seconds. Estimates of sustained HR may be influenced by sources of HR variability and event-related responses. Event related responses generally have a 10-second profile and are measured after the presentation of specific stimuli. Measures of HRV, including variance and spectral analysis, are generally taken over periods lasting more than 100 seconds and give information about external and internal physiological influences on Heart Rate.

Measures of HR in bpm may be derived from the ECG by analysing the length of time between successive QRS peaks. The distance (in seconds) between successive peaks is known as the inter-beat interval (IBI). A beat-by-beat IBI series may be derived from ECG voltage data in a number of ways using peak-finding algorithms, slope detection algorithms and template matching (Jennings et al., 1981; Bernston et al., 1997; Brownley et al., 2000). Sustained Heart Rate may be simply derived from a beat-by-beat series by averaging successive IBIs over a given period of time. To derive event-related HR responses over short periods of time and also for spectral analysis of HRV, IBIs per second (derived from the IBI series using linear interpolation) are analysed, rather than seconds per IBI. This ensures comparability across subjects who may produce varying numbers of beats across similar periods of time. For intuitive data interpretation, mean IBIs over a given period of time can be converted to HR in bpm (HR = 60/IBI) so that as cardiac cycles become more frequent, HR increases. Individual IBIs should not be converted to HR before this mean is derived, as this may result in biased estimates of HR (Bernston et al., 1997).

Artefacts in ECG data unrelated to experimental conditions can influence estimates of HR. Artefacts may arise from such sources as electrical interference, muscle tremor, poor electrode contact, cardiac arythmias, inadequate sampling rates and movement (Mulder, 1992). Such factors may result either in spurious peaks or absent peaks in the ECG data. Hence some form of artefact correction is usually required when deriving HR from the ECG. Various individual differences may also influence estimates of HR in experimental situations. Similarly to EDA, these include age, the menstrual cycle, drug use, medical history and food/drink consumption (Turpin, 1989). For example, attention must be paid to participants using medication that specifically inhibits cardiac responsiveness (e.g., some anti-depressants, beta-blockers and anti-epileptics)

2.7.3 Main Uses of Cardiovascular Measures

The main uses of measures of HR in psychological research are reviewed by Andreassi (1989) and Brownley et al. (2000). The cardiovascular system has a central role in normal physiological functioning. Therefore, cardiac responses linked to metabolic requirements, for example to power motor movement, are expected. The focus here is on cardiac responses linked to psychological rather than physiological demands, though these in turn may be linked to metabolic requirements. In general, variations in HR have been associated with perceptual, attentional and emotional processes and the psychophysiological study of the heart has been applied in health settings (Brownley, 2000; Graham, 1992; Lang, Greenwald, Bradley & Hamm, 1993).

HR responses, in the absence of motor movement, have been widely observed in response to internally and externally generated stimuli (Andreassi, 1989). Sustained changes in HR may be observed during the performance of some mental tasks and short-term changes in HR are observed in response to briefly presented stimuli (Graham, 1992; Turpin et al., 1999). The meaning and intensity of the task or stimuli may determine the direction and profile of HR change.

For example, HR generally decreases before an expected event or after a significant or unexpected event. This response is a component of the OR, which has been described previously. Turpin et al., (1999) further describes different types of HR responses, including ORs, defence and startle responses, to different types of stimuli. It is generally thought that these HR responses indicate the beginning and end of attentional states and bear some relationship with metabolic states allowing the intake of information and the mobilisation of resources (Graham, 1992).

Measures of HR, like EDA, have been linked to operational discriminations between emotions (Scheirer et al., 2002). It has been shown that HR is most closely related to the valence dimension of emotion (Greenwald, Cook & Lang, 1989; Lang, Greenwald, Bradley & Hamm, 1993; Simons, et al., 1999). For brief, novel, stimuli, the response profile of HR generally discriminates between neutral, pleasant and unpleasant stimuli (Bradley, 2002). However, different emotion eliciting tasks have been shown to produce different results (e.g., HR is associated with arousal in imagery tasks). In more sustained emotive contexts, HR, as one component of a pattern of autonomic responses, has been shown to discriminate between emotions which vary in terms of quality (e.g., Anger, Happiness, Surprise, Sadness, Disgust, Fear) in addition to intensity, (Levenson, 1992). Inconsistent findings may in part be due to the relationship between task variables and metabolic demands.

One important feature of the relationship between HR and emotion is the impact of emotion related changes in HR on physical health (Brownley et al., 2000). Negative affect associated with stressful situations is generally associated with elevated levels of HR and general cardiac output. This can lead to increased strain on the cardiovascular system. Variations in stress responsivity (due to context and individual variables) have been linked to the incidence of heart-disease. The psychophysiological study of the cardiovascular system is, therefore, widely used to study psychosocial variables, which may negatively or positively impact on health (Brownley et al., 2000).

2.8 Summary of Electrodermal and Cardiovascular Measures

The above description of EDA and HR suggests the following about their origins, measurement and uses. Firstly, both measures are directly related to activity in the autonomic nervous system. This indicates their utility for indicating the functioning of the autonomic nervous system, which is associated with emotional processes. However, both measures are potentially affected by varying components of the central nervous system. Secondly, both measures may be simply measured in a laboratory environment. However, attention must be paid to data management and sources of error such as environmental and individual variables. Finally, both measures have been linked to emotional responses in research. However, both measures have multiple determinants and have been linked to perceptual and attentional processes in addition to emotion. The features of HR and EDA measures given above indicate that they appropriate measures for an investigation of emotional responses to mediated environments. However, such an investigation must take into account the multiple influences on these measures.

2.9 Aims and Plan of Thesis

The overarching aims of the research presented in the following chapters can be usefully divided into three areas: theoretical, methodological and applied. Firstly the review of presence theory and research presented in Chapter 1 indicates theoretical justification for conducting experiments into the relationship between presence and emotion. In particular it was reasoned that the predictions of the Behavioural Realism approach in presence research could be extended to include emotional responses. Because it was argued that reports of presence are likely to intensify when media schemata are suppressed (e.g., under conditions of high immersion) and when mediated content directly stimulates emotional responses in a user (providing evidence of personal presence) it could be predicted that as presence in a mediated environment increases then emotional responses will tend towards those that would be expected in a similar real environment.

However, in previous research investigating the relationship between presence and emotion limited contents and few displays have been evaluated. Furthermore, some research has employed autonomic measures of arousal as indicators of emotional arousal without fully controlling multiple influences on autonomic measures or using subjective measures of emotion to corroborate findings. Thus, the experiments presented in the following chapters in this thesis are conducted with the aim of extending the range of situations over which emotional responses and reports of presence are collected. This is with the aim of investigating associations between presence and both subjective and physiological emotional responses.

The investigation will be implemented using the following methodology. Knowledge concerning the determinants of presence will be used to create varying levels of reported presence. This will involve manipulating aspects of a video display, particularly the absence and presence of stereoscopic cues (Chapters 3 and 4) and viewing angle (Chapters 5 and 7) which are known to affect reported presence. Content with varying types of emotional impact will be presented via these displays (Chapters 3, 4, 5, 6 and 7). If an association between reports of presence and emotional responses exists then self-reported presence, self-reported emotion and autonomic activation will vary in the same way. Specifically, presentations associated with higher reports of presence will be associated with more intense ratings of content-relevant emotional responses and more intense changes in autonomic activity.

Potentially, an investigation of the relationship between presence and emotion, such as that described above, may aid the development of new emotion-based measures of presence. An association between presence and emotion would imply that measures of emotion could be used as corroborative indicators of presence. In particular, physiological indicators of emotion, such as autonomic measures of Heart Rate and electrodermal activity, would be valuable as corroborative measures of presence because they are objective, continuous and versatile. Therefore, the final, applied, aim of this thesis was to implement exploratory evaluations of subjective and objective emotion-based corroborative measures of presence by first investigating potential relationships between presence and emotion.

Chapter 3 EXPERIMENT 1:

Exploring Media Form and Media Content Effects on Presence and Emotion

3.1 Introduction

The Behavioural Realism approach to presence research predicts that increases in subjective reports of presence (the sensation of 'being there' in a mediated environment) should be accompanied by an increased tendency to display naturalistic behaviours in response to a mediated environment (Freeman, Avons, Meddis et al., 2000). One implication of the Behavioural Realism approach is that naturalistic responses to mediated environments may serve as objective and corroborative indicators of presence. The research presented in this thesis aims to investigate whether the predictions of the Behavioural Realism approach can be extended to include subjective and physiological indicators of emotional responses to mediated environments. In particular, Experiment 1 aims to provide an initial investigation of the relationship between presence and emotion. The research serves as a first step in assessing the utility of measures of emotion as objective and corroborative indicators of presence.

Variables that have been shown to determine levels of reported presence (Media Form, Media Content and User Characteristics) also influence emotional responses, yet the relationship between presence and emotion is an under-researched area. Some research suggests that enhancements of Media Form increase subjective presence, subjective arousal and autonomic arousal (Lombard et al., 1997; Meehan et al., 2002). However, research in this area has been limited in a number of ways. Single Media Form manipulations tend to have been implemented, limiting generalisations of findings across categories of Media Form. In addition, single Content types (highly arousing or fear inducing stimuli) have been investigated, limiting generalisations of findings across categories of emotion. Furthermore, there has been an inconsistent use of subjective measures of emotion to corroborate measures of physiological arousal across research to date. Therefore, Experiment 1 will aim to examine the relationship between presence and emotion across a greater range of Media Form and Media Content variables than has previously been investigated[4] using a battery of presence and emotion measures (see Chapter 2 for a discussion of presence measures).

In order to further investigate the relationship between presence and emotion a methodology proposed in the conclusion to Chapter 2 is implemented in Experiment 1. The methodology involves the use of Media Form manipulations to generate varying

[4] Presence and emotion research conducted after the thesis research was completed is noted in Chapter 8.

levels of rated presence. The intensity and direction of subjective and physiological emotional responses can then be examined at each level of presence for different types of content. The Behavioural Realism approach would predict that emotional responses will be more intense at higher levels of presence, and therefore differences between contents in terms of emotion measures will be enhanced at higher levels of presence. Hence, Experiment 1 aims to provide an exploratory investigation of the relationship between presence and emotion by examining ratings of presence, ratings of mood change, and changes in Skin Conductance Levels and Heart Rate (used as physiological indicators of emotional arousal) in response to a number of Media Form and Media Content variations.

Two Media Form variables will be used to produce varying levels of reported presence in response to two types of content. The first Media Form variable of interest is perceived 'Depth' in a video image, varied through the presentation of monoscopic and stereoscopic video. The addition of binocular depth cues to monoscopic presentations has consistently been found to enhance reported presence (Hendrix & Barfield, 1996; Freeman et al., 2000). Therefore, stereoscopic video presentation is expected to generate higher ratings of presence than monoscopic presentation.

The second Media Form variable is the presence or absence of a Moiré fringe screen-surround ('Surround') designed to enhance perceived depth in flat-screen monoscopic images by disturbing the perception of the picture plane. User-testing indicates that the screen-surround affects ratings of presence (Lessiter & Freeman, 2000b). The screen-surround could increase reported presence in number of ways, for example by reducing media cues associated with the plane and frame of an image. Conversely, the screen-surround could introduce conflicting depth cues into the perception of an image and also draw attention to the edges of an image and hence reduce presence.

Previous research investigating the impact of presence enhancing Media Form variables on emotional responses tends to have presented participants with highly arousing content. Therefore, it is unclear whether the effect of Media Form variables on presence and emotion should generalise across contents which vary in emotional tone or should be specific to content types (in line with the Behavioural Realism approach). Hence, Experiment 1 presents participants with two, similarly produced types of 'Content': a leisurely boat-ride video sequence thought to be relaxing and calming in nature and a fast-paced rally-driving video sequence thought to be exciting and arousing. It is expected that the two contents will have differential effects on changes in mood, Skin Conductance Levels and Heart Rate. The effects of 'Depth' and 'Surround' could have a number of effects on changes in mood, Skin Conductance Levels and Heart Rate. In line with previous research it may be expected that higher presence presentations (e.g., stereoscopic presentations) will be more subjectively and physiologically arousing than lower presence presentations (e.g., monoscopic presentations). However, the Behavioural Realism approach would predict that enhancements in presence will accentuate differences between Contents (e.g., a relaxing content should be more relaxing at higher levels of presence).

In summary, Experiment 1 aims to provide an initial exploration of the relationship between presence and emotion by (1) generating varying levels of subjective presence ratings through the use of two media form variables (Depth and Surround) and (2) examining the effects of the Media Form variables on emotional responses to two types of Content. The study required individual participants to view both monoscopic and stereoscopic versions of either the boat or rally video with a screen-surround either present or absent. Participant's physiological responses were monitored before, during and after viewing and they also gave pre-and post-viewing ratings of mood and post-viewing ratings of presence. By looking at the patterns of reported presence generated across conditions and comparing these with emotional responses it is hoped that potential connections between the two, worthy of further investigation, will emerge. The exploration of the effects of Media Form and Media Content on reported presence and emotional responses is expected to inform subsequent experiments and also the assessment of emotional responses as objective and corroborative measures of presence.

3.2 Method

3.2.1 Design

A mixed-subjects 2 x 2 x 2 factorial design was used. 'Depth' was a within-groups factor with two levels (monoscopic presentation [MONO] vs. stereoscopic presentation [STEREO]). 'Surround', referring to the Moiré fringe screen-surround, was a between-groups factor with two levels (screen surround absent [SURROUND-OFF] vs. screen surround present [SURROUND-ON]). 'Content' was a between-groups factor with two levels (boat video sequence [BOAT] vs. rally video sequence [RALLY])[5].

Participants were assigned to one of four Experimental Groups ($BOAT^{OFF}$, $BOAT^{ON}$, $RALLY^{OFF}$ and $RALLY^{ON}$). All participants viewed both MONO and STEREO presentations of either the BOAT or RALLY video sequences with either the SURROUND-ON or SURROUND-OFF presentation method. Table 3.1 summarises the independent variables implemented for each of the four viewing conditions. Half the participants saw the MONO presentation first and half saw the STEREO presentation first.

Table 3.1 Summary of Independent Variables and Experimental Groups in Experiment 1.

		Depth (within)	
Content (between)	**Surround (between)**	**MONO**	**STEREO**
BOAT	**SURROUND-OFF**	$BOAT^{OFF}$ $_{N=30}$	
	SURROUND-ON	$BOAT^{ON}$ $_{N=30}$	
RALLY	**SURROUND-OFF**	$RALLY^{OFF}$ $_{N=30}$	
	SURROUND-ON	$RALLY^{ON}$ $_{N=30}$	

The dependent variables were subjective ratings of presence, changes in subjective mood ratings from pre-viewing to post-viewing, and changes in Skin Conductance

[5] Though the BOAT and RALLY video sequences were chosen to represent 'relaxing' and 'exciting' Content, BOAT and RALLY are used as variable labels as the video sequences were not pre-rated for emotional impact, and also to ensure continuity throughout the remainder of the thesis.

Levels and sustained Heart Rate from pre-viewing to viewing. Additional data concerning adverse consequences of viewing and participant characteristics were also collected. The order of post-viewing questionnaire measures was counterbalanced across participants.

3.2.2 Participants

One hundred and forty-nine participants were recruited from Goldsmiths College, University of London and through advertisements in local newspapers. In return for their participation, thirty-one first-year psychology students received course credits towards their degree mark. The remaining participants were paid £3. Of the one hundred and forty-nine participants, twenty-nine were excluded: seventeen due to failure to reach the inclusion level for stereo-acuity[6], nine due to technical difficulties during physiological recording, two due to extraneous noise outside of the experimental setting and one due to excessive movement during testing[7]. The final data set consisted of one hundred and twenty participants (60 male, 60 female, average age 24.03 years, SD = 6.90). All participants had normal or corrected to normal vision and a stereo-acuity of thirty seconds-arc or better (as tested on the RANDOT® random-dot stereo-test [Stereo Optical Company]). Participants also indicated consent for their participations, and that they had never previously participated in a similar experiment in the Goldsmiths College Independent Television Commission (ITC) laboratory.

3.2.3 Video Presentation Apparatus and Materials

3.2.3.1 Viewing Platform

The Platform for Immersive Television (P*i*T - see Figure 3.1a) is a viewing platform comprising of a soundproofed booth containing a Phillips 100-hertz (Hz), 71 centimetre (cm), cathode-ray tube television display that receives input from two Sony Beta SP

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[6] Zaroff, Knutelska & Frumkes (2003) showed that 88% of a sample of 106 15-60 yr-olds had a stereoacuity threshold within 2sds of a mean of 37 arcsec. 3% of the sample had elevated thresholds and 9% had low thresholds or were stereoblind. Taking into account variations in age range and testing conditions these data indicate that the number of participants excluded from Experiment 1 due to low stereoacuity (11% of the sample) was comparable to normative data. Participants were not excluded prior to testing in order to avoid demand characteristics prompted by the stereo-test.

[7] Technical difficulties during physiological recording, extraneous noise outside of the experimental setting and excessive movement during testing resulted in large segments of missing data or physiological responses well in excess of 3.29sds of the mean.

video players. The television screen is fitted with a Central Research Laboratories (CRL) Vistral screen-surround. The P*i*T also contains an adjustable, comfortable seat and physiological data acquisition pre-amplifiers. Participants were seated in the P*i*T with eye-level at the centre of the screen and at a viewing distance of 1metre (m) between the eye and screen, rendering a 34.45-degree eye-to-screen horizontal visual angle (see Figure 3.2b). Temperature in the P*i*T was maintained at around 21-degrees Celsius in order to minimise temperature related biases in the physiological measures.

3.2.3.2 Visual Display

Stereoscopic images were presented to participants using a 'field sequential system'. In a field-sequential system, each field on a visual display is a left-eye or right-eye view which when combined form a stereo-pair. However, the right-eye view is only presented to the right-eye and is blocked from the left-eye and vice versa. When the right- and left-eye views are presented alternately (and quickly), the viewer perceives a stereo image. The specific method used in this experiment can be termed 'page-swapped' and is described below.

Two synchronised SONY BETA SP video players provided the separate left-eye and right-eye video inputs for the display. Outputs from the video players fed into a YUV to RGB (plus horizontal and vertical synch) Shootview converter, which converted both video streams to RGB in parallel. Outputs from the converter fed into a custom-built 100Hz (vertical update) RGB framestore (AEA Technology). Outputs from the framestore fed directly to the 100Hz Philips display, presenting left-eye and right- eye views alternately. For ordinary CRT television displays images are displayed at 25 frames-per-second. Each frame is constructed from two sets of interlacing vertical scan-lines, which are updated at a rate of 50Hz. The display used in this experiment presented 50 frames per second (left-eye and right-eye views were alternate frames) at 100Hz, therefore presenting each eye with 25-frames per second.

Participants viewed the stimulus videos on the television display while wearing Crystal-Eyes shutter spectacles (see Figure 3.1c). The spectacles allow viewers to perceive stereoscopic images constructed from disparate left and right-eye images presented on the television screen. Receiving an infra-red signal from a box connected to the video players, the left and right-eye shutters flickered on and off alternately at a rate of 50Hz, in synchrony with the video output (switching the visible image between the left and right eye). Because the Crystal Eyes shutters flickered on and off in synchrony with the video output, frames displaying the right-eye view were only visible to the right-eye and frames displaying the left-eye view were only visible to the left-eye. Hence, the system displayed STEREO video to a viewer wearing the Crystal Eyes spectacles.

When two left eye view videotapes were placed in the video players, the system displayed MONO video to a viewer wearing the Crystal Eyes spectacles. This method of video presentation ensured that STEREO pictures appeared without apparent degradation in the television image, as the 100Hz video output was equivalent to normal 50Hz presentation for each eye. The method also ensured that MONO images contained the same amount of sensory information and were presented at the same speed as STEREO images. Video output was synchronised and controlled by custom-made software via a PC.

3.2.3.3 CRL Vistral Screen Surround

The Phillips television display was fitted with a CRL Vistral Screen Surround (see Figure 3.1e). The screen-surround comprised of a clear plastic sheet placed over the front of the display with a fifteen centimetre deep frame appearing around the edge of the television screen. The frame has a pattern of black dots on the front of the plastic sheet and white dots on the back of the sheet. When the frame is back-lit (SURROUND-ON conditions), a Moiré fringe interference pattern appears within the space of the frame. The interference pattern makes the frame difficult to focus on and it appears to float around the edges of the television screen. CRL claim that the screen-surround enhances depth information in monoscopic images placed within the back-lit frame because the interference pattern disturbs the perceived plane of the image by producing an apparent discontinuity between the screen and its frame. Removing the consistency of depth information between the screen and its frame should make depth information within the image more difficult to spatially locate with respect to the viewing environment.

3.2.3.4 Video Sequences

Two 100-second (sec) sequences of STEREO video footage were used as stimuli. For each sequence, a synchronised left-eye and right-eye view videotape was prepared with 100-secs of blank screen at the beginning and end of each sequence. The BOAT video sequence was a 100-sec excerpt from the ACTS MIRAGE project feature *'An Afternoon on the River'* (ACTS MIRAGE, 1999). The stimulus was a continuous piece of footage (without edits) shot by a small stereoscopic camera positioned on the stern of a boat travelling at a leisurely pace along a stretch of the Norfolk Broads (see Figure 3.1c). The RALLY video sequence was a 100-sec excerpt from rushes filmed for the ACTS MIRAGE stereoscopic documentary *'Eye to Eye'* (ACTS MIRAGE, 1997). The stimulus was a continuous piece of footage (without edits) shot by a small stereoscopic camera positioned on the hood of a rally car travelling at speed around an off-road rally track (see Figure 3.1d). Both sequences were prepared without an accompanying audio track.

The BOAT and RALLY sequences were chosen for a number of reasons. In order to examine differences between monoscopic and stereoscopic video it was necessary to find stereoscopic video compatible with the visual display equipment installed in the P*i*T. The range of available video was restricted. However, because the BOAT and RALLY sequences were produced in a similar way (using a point-of-view camera position), and displayed structurally similar scenes (a moving view along a route in an unpopulated area as seen from the front of a vehicle) and were both available in stereoscopic video, they were thought suitable for comparison. In addition, feedback in a piloting phase revealed that viewers had different reactions to the BOAT and RALLY sequences. Viewers reported the fast-paced RALLY sequence to be more exhilarating than the slow-paced relaxing BOAT sequence. The sequences therefore provided the potential for exploring the effect of Media Form manipulations on Contents that differed in emotional tone.

The duration of the video sequences was set at 100-secs because this was comparable in length to video content used in emotion research where physiological differences between different types of content had been observed (i.e. 100-secs was thought long enough for differences in HR and SC to emerge but not too long for differences to return to baseline) – Gross et al (1994), Gross and Levenson (1995). The 100-sec duration also allowed the best match between the BOAT and RALLY sequences in terms of clean, continuous point-of-view shots appearing in the source material

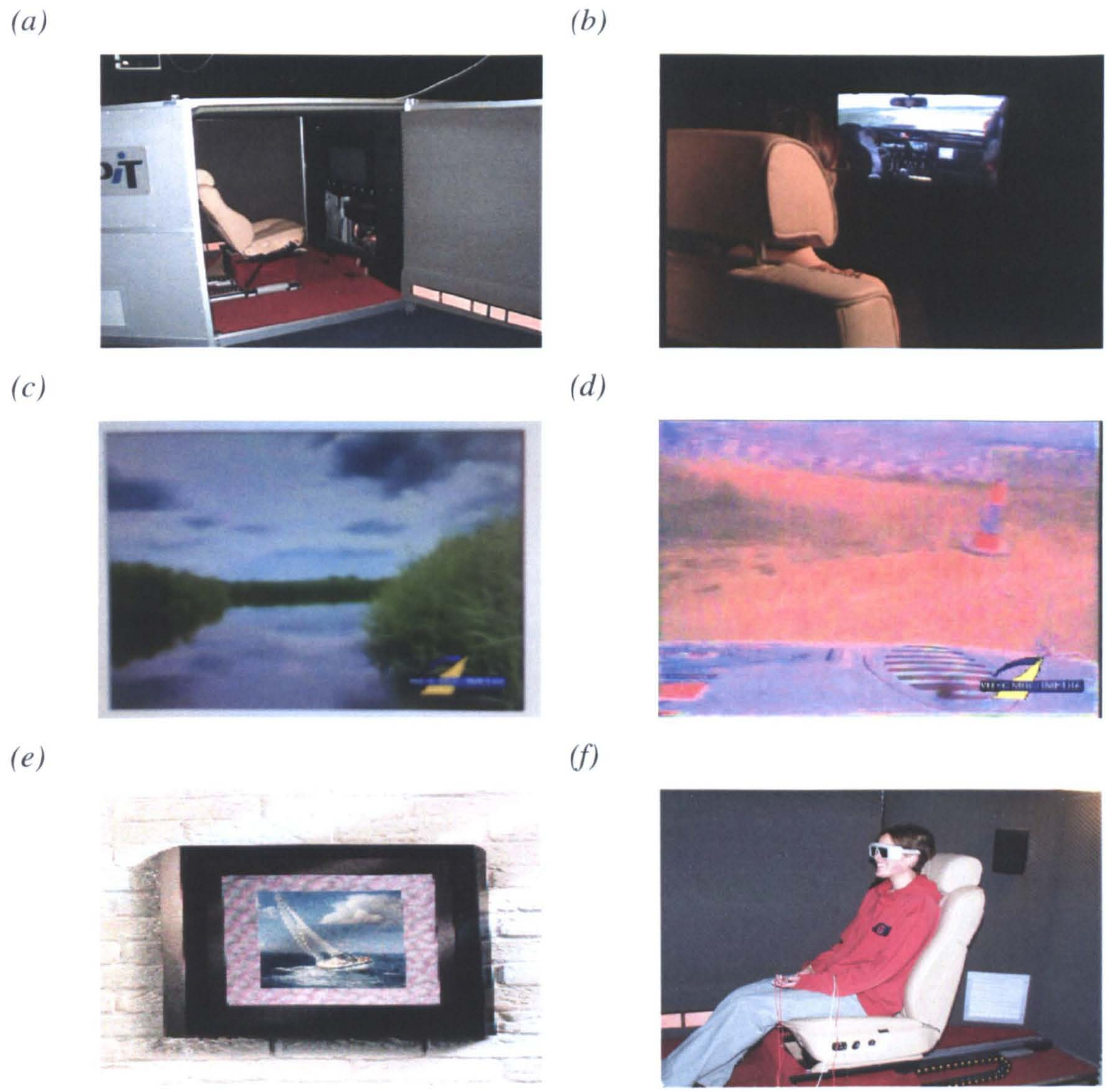

Figure 3.1a-f (a) The Platform for Immersive Television (P*i*T); (b) participant's view from the seat to the screen in the P*i*T; (c) a screen-shot from the BOAT video; (d) a screen-shot from the RALLY video; (e) manufacturer's marketing photograph of the Vistral screen-surround (patterned area immediately surrounding the picture of a yacht); (f) a participant seated in the P*i*T wearing the Crystal-Eyes spectacles and attached to the polygraph equipment.

3.2.4 Questionnaire Measures

3.2.4.1 ITC–Sense of Presence Inventory[8]

The ITC–Sense of Presence Inventory (ITC-SOPI: Lessiter et al., 2001) is a forty-three item post-viewing questionnaire measure of presence. The questionnaire yields scores on four subscales relating to different elements of mediated experiences. Three subscales relate to elements of reported presence that have been identified in the presence literature: **Physical Space** (a sense of being physically located in the space depicted in a displayed environment; 19 items), **Engagement** (a sense of involvement with the narrative/content of a displayed environment; 13 items) and **Ecological Validity** (a sense of naturalness and believability of the depiction of an environment and events within an environment; 5 items). The final subscale (**Negative Effects**; 6 items) addresses adverse physical consequences of mediated experiences such as eye-strain, headaches and sickness. Each item is rated on a one-to-five point scale where one equals 'strongly disagree' and five equals 'strongly agree'. Each subscale is scored by calculating the mean ratings of items on each subscale (so that subscale scores may range between one and five).

To ensure comparability with other presence research and subsequent experiments presented in this thesis one question from the **Physical Space** subscale ('I had a sense of being in the scenes displayed') was examined in isolation (**'being there'**). This question closely addresses the traditional definition of presence as the 'sense of being there' in a mediated environment.

The ITC-SOPI also includes a background information sheet that requests participant details in two main groupings: **Media Use and Knowledge** and **Demographics**. In terms of **Media Use and Knowledge**, ratings are required concerning participant's computer expertise, average weekly television viewing, size of television usually watched, previous experience of viewing 3D films or television, knowledge of 3D production, frequency of computer game playing, knowledge of television production, previous experience of virtual reality and knowledge of virtual reality production. Higher ratings for these items indicate greater usage or knowledge. **Demographic** information concerning age, nationality, occupation and level of education is also

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[8] The ITC-SOPI is copyrighted and may be obtained from Dr Jane Lessiter, Department of Psychology, Goldsmiths College, New Cross, London, SE14 6NW (Email: j.lessiter@gold.ac.uk).

requested. Free self-labelling of nationality and occupation is required and level of education information is collected as categorical data. The background information sheet was not administered until the end of the experiment in order to avoid demand characteristics prompted by questions regarding advanced media systems.

The ITC-SOPI was chosen as the measures of presence for Experiment 1 as it provides an easy to use and detailed measure of reported presence. In addition, research indicates that the ITC-SOPI is sensitive to variations in the determinants of presence (Lessiter et al., 2001). Furthermore, the ITC-SOPI scales are similar to those which have emerged on other presence questionnaire measures (Schubert et al., 2001; Lombard et al., 2001) indicating their validity. The ITC-SOPI also includes approximations to Slater et al.'s (1994) widely used presence questions, ensuring comparability of findings with other research (i.e., the '**being there**' item). Finally, the **Negative Effects** scale and background information data may be useful in the interpretation of findings, such as findings for physiological measures that may have multiple determinants (Cobbs et al., 1999). For the reasons above it was thought the ITC-SOPI had sufficient sensitivity, reliability and validity, in combination with usability and detail, to serve as a measure of presence for exploratory research of the type described here. Further information about the ITC-SOPI and its relative value as a subjective presence measure may be found in Chapter 2 (pg. 73-75).

3.2.4.2 Profile of Mood States Bipolar Form

The Profile of Mood States Bipolar Form (POMS-BI: McNair & Douglas, 1984) is a seventy-two item mood-adjective checklist. The items are divided into six twelve-item bipolar scales: **Agreeable-Hostile**, **Clearheaded-Confused**, **Composed-Anxious**, **Confident-Unsure**, **Elated-Depressed** and **Energetic-Tired**. For each item participants are required to choose the statement which best describes how they feel in relation to that word: 'much unlike this', 'slightly unlike this', 'slightly like this' or 'much like this'. The instructions can be varied according to the period of time for which a mood rating is required. Participants completed the POMS-BI before each presentation with the instructions to fill it out for 'how you feel right now'. Participants also completed the POMS-BI after each presentation with instructions to fill it out for 'how you felt during the presentation'. Mood change scores were calculated by subtracting the pre-viewing scores from post-viewing scores for each subscale. A positive score indicated a change towards a positive mood state. A negative score indicated a change towards a negative mood state. Scores could range between thirty-six and minus thirty-six.

The POMS-BI was chosen because it provides an easy to use, reliable, valid and detailed indication of mood change (McNair & Douglas, 1984). The questionnaire also assesses several types of mood states, including both positive and negative states of high and low subjective arousal, in line with many approaches to the definition and measurement of mood (Lang, 1980; Mandler, 1992; Russell, 1980). Chapter 2 (pg. 78) contains further information about the POMS-BI and other measures of subjective emotion.

3.2.5 Physiological Measures, Apparatus and Data Management

Physiological data collection and management were in accordance with the publication guidelines set out by the International Society of Psychophysiology described in Fowles et al. (1981) and Jennings et al. (1981). The measures extracted, the apparatus used and the methods of data management are described below.

3.2.5.1 Physiological Measures

The physiological measures of interest in Experiment 1 were changes in Skin Conductance Levels (SCLs) and sustained changes in Heart Rate (HR) pre-viewing levels to the video viewing periods. These measures were chosen because they provide broad physiological indicators of changes in autonomic activity, which is linked to changes in emotional arousal (see Chapter 2, pgs. 79-91 for an in depth description of the nature and use of measures of SCLs and HR).

3.2.5.2 Physiological Recording Apparatus

Skin Resistance and Electrocardiogram data were collected in order to obtain estimates of changes in SCLs and HR respectively (a description of the relationship between Skin Resistance and Electrocardiogram data and measures of SCLs and HR may be found in Chapter 2, pgs. 79-91). Skin Resistance data were collected using a constant current method via two electrodes placed on the distal phalanges (fingertips) of the non-dominant hand. Electrocardiogram data were collected using lead position RI, via bi-polar placement of electrodes on the inner wrists. Due to equipment availability two polygraphs were used to collect Skin Resistance and Electrocardiogram data. A custom-made polygraph was used in SURROUND-OFF conditions and a Datalab 2000™ system was used in SURROUND-ON conditions. The custom made system was developed throughout the course of the early experiments in this thesis and was intended to overcome some of the disadvantages of the Datalab 2000™ system. The custom-made system later became the system of choice in this thesis (see Experiment 3, pg 156). However, the methods of obtaining Skin Resistance and Electrocardiogram data were technically identical (see Chapter 2, pg. 85-96 for a description of data collection methods and Appendix A1 for a full description of the polygraphs).

3.2.5.3 Physiological Data Management

The methods of extracting **SCL** and **HR** information from the Skin Resistance and Electrocardiogram data were broadly identical across the two polygraphs. However, there were two differences between data collected from each polygraph, which have been accounted for in terms of data management (see Appendix A2 and below) and data analysis (see the Results section): 1) the range of Skin Resistance recordings differed between the two polygraphs and 2) sampling rates differed between the two polygraphs.

Data Management: Skin Conductance Levels

For ease, intuitiveness and reliability of analysis each individual's Skin Resistance data was converted to Skin Conductance prior to averaging of **SCLs** (Andreassi, 1989; Fowles et al, 1981; Venables & Christie, 1980). A within subjects range correction transformation was applied to the Skin Conductance data. Each individual's Skin Conductance data for each individual presentation was standardised across the entire recording period ([sample value – standard deviation]/mean).

For further analyses mean standardised **SCLs** were calculated by averaging standardised Skin Conductance data over the BASELINE and VIEWING periods respectively. In order to account for potential time-varying changes in **SCLs** a second method of presenting **SCL** data was also used. The last 20-secs of the pre-viewing period were used as an alternative baseline period (BASELINE 2). Individual mean standardised **SCL** values for BASELINE 2 were calculated as were mean standardised **SCL** values for five consecutive 20-sec segments (TIME 1-5) occurring during VIEWING.

Data Management: Heart Rate

HR information was extracted from the Electrocardiogram data using a method proposed to be adequate for estimating sustained changes in **HR** (Bernston et al., 1997; Jennings et al., 1981). The Electrocardiogram data were converted to a beat-by-beat series from which interbeat-intervals (IBIs) were calculated. The Electrocardiogram series were visually inspected for artefacts when the IBI series indicated recorded beats of less than the equivalent of 50 beats-per-minute (bpm) and more than 100bpm (using guidance notes and diagrams for the detection of noise in Electrocardiogram series, e.g., Mulder, 1992). The IBI series was manually corrected when the Electrocardiogram series indicated an undetected or spurious beat. IBI data was deleted when the Electrocardiogram was unreadable (less than five-percent of the entire data set or any individual data set). For further analyses mean IBIs for the BASELINE and VIEWING periods respectively were converted to mean **HR** (bpm).

Date Management: Dependent Variables

Skin Resistance and Electrocardiogram recordings were taken for 100secs before viewing a video presentation (pre-viewing), 100-secs during viewing (VIEWING) and 100-secs after viewing (post-viewing). To determine the overall effects of video presentations on **SCLs** and **HR**, the last 60-secs of the pre-viewing period was used as the baseline period (BASELINE). Individual mean **HR** and standardised **SCL** BASELINE values were subtracted from the mean **HR** and **SCL** VIEWING values (V-B) in order to obtain measures of change in **SCLs** and **HR**. This method of data management has been used widely to investigate the emotional impact of film stimuli (Fredrickson & Levenson, 1998; Gross, 1998; Gross, Fredrickson & Levenson, 1994). Such baseline-to-stimulus difference scores have been proposed as one of the most appropriate psychophysiological indexes for use with parametric statistics (Jennings & Stine, 2000) and the comparison of difference scores between different types of stimuli has been proposed as the appropriate means of assessing emotion-related physiological responses (Davidson & Irwin, 1999).

In addition to the range correction applied to the Skin Conductance data, and in order to account for potential reactivity differences between polygraphs used in this experiment, a method of examining time-varying changes in **SCLs** was also used in this experiment. Mean **SCLs** in the last 20-secs of the pre-viewing period were used as a baseline period. Individual mean SCL values for the 20-sec baseline period (BASELINE 2) were subtracted from the means of five consecutive 20-sec segments occurring during VIEWING (TIME 1-5).

3.2.6 Procedure

Participants were informed that they would be taking part in a study assessing new television systems, which would include some monitoring of their Heart Rate and skin conductance (see Appendix A3 for instructions). On arrival at the laboratory, participants were asked to confirm that they did not did not have any eye problems that were not corrected, were not claustrophobic and had not previously taken part in any similar experiment in the P*i*T. In order to avoid demand characteristics participants were not informed that they would be viewing stereoscopic images or about the nature of the content.

Participants were then seated in the P*i*T at a distance of 1m from the screen, with eye-level at the centre of the screen. The physiological data acquisition apparatus was attached, calibrated and tested and participants were given further instructions. They were told that they would be seated in the P*i*T for approximately 5-minutes, during which time they would see 100 seconds of blank screen, followed by 100 seconds of video, followed by 100 seconds of blank screen (the pre-viewing, VIEWING and post-viewing periods). Participants were then requested to complete the POMS-BI for 'how you feel right now'.

Participants were asked to wear the Crystal-Eyes spectacles throughout the entire presentation and were instructed to remain still and look straight ahead at the screen for the duration of the presentation, including the periods of blank screen. Participants who normally wore spectacles or contact lenses for watching television were requested to do so for the duration of the experiment and the Crystal-Eyes spectacles were worn over these. Participants were also given safety instructions for the P*i*T. On closing the P*i*T door, lighting in the P*i*T was switched off and physiological data acquisition and video output were activated simultaneously (both could be monitored by the experimenter on screens outside the P*i*T). Participants then watched either a 100sec MONO or STEREO version of either the RALLY or BOAT video with either SURROUND-OFF or SURROUND-ON presentation. The Vistral screen-surround remained illuminated during the 100-sec pre- and post-viewing periods in the SURROUND-ON condition and was not illuminated during the pre- and post-viewing periods in the SURROUND-OFF condition.

Skin Resistance and Electrocardiogram recordings were taken for the 100-secs pre-viewing period, the 100-secs viewing period and the 100-secs post-viewing period. Questionnaire completion occurred immediately after the 300-sec presentation. The ITC-SOPI was completed after each presentation. The POMS-BI was also completed after each presentation for 'how you felt during the presentation'. After a five-minute break, participants viewed the version of the stimulus (MONO or STEREO) which they had previously not seen, under the conditions described above.

After both presentations were completed, the RANDOT™ stereo-test and the background information sheet from the ITC-SOPI were administered. On completion of the experiment, participants were de-briefed and received payment or course-credits. The procedure lasted approximately one hour. Table 3.2 summarises the procedure of the experiment.

The procedure for Experiment 1 was piloted in a number of ways. The experimenter worked extensively with laboratory technicians to ensure the smooth running of the visual display equipment and feedback was collected from colleagues and ITC team members who agreed to view the BOAT and RALLY sequences in the P*i*T before data collection commenced. For example, the piloting stage led to the decision to present videos without audio information because of wide differences in the audio tracks which could potentially confound physiological data interpretation. In addition, the procedure for collecting and managing synchronised physiological data was practiced and this piloting lead to the development of a custom-made polygraph (see Appendix 1 and Experiment 3, pg. 161). Furthermore, questionnaire measures used in this experiment were chosen on the basis that they had been used in previous research of this type (such as the ITC-SOPI which had been used experiments in the P*i*T) and were therefore suitable for use. The timing of the experiment was then calculated in practice runs before data collection commenced.

However, the research conducted in this thesis was of an exploratory nature and the general procedure was refined over the course of several experiments. Piloting was therefore an evolving process, particularly with respect to physiological recording and questionnaire administration. Further information may be found in subsequent experimental chapters.

Table 3.2 Summary of procedure for Experiment 1.

Stage		*Procedure*
(1)	**Arrival**	• Information about experiment given • Some inclusion criteria confirmed
(2)	**Preparation**	• Vistral switched on or off • Polygraph calibrated and tested • Instructions given
(3)	**Pre-viewing questionnaire**	• POMS-BI completed with instructions for 'how you feel right now'
(5)	**100-sec Pre-viewing period**	• Video-players and polygraph activated simultaneously • Data acquisition begins • Participant views blank screen
4)	**100sec Viewing Period**	• Video onset • MONO or STEREO version of the BOAT- or RALLY seen by participant • Physiological data acquisition continues
(6)	**100-sec Post viewing period**	• Blank screen seen by participant • Physiological data acquisition continues • Video off-set
(7)	**Post-viewing questionnaires**	• POMS-BI completed with instructions for 'how did you feel during the video' • ITC-SOPI completed
(8)	**Five-minute break**	• Participant rests
(9)	**Second presentation**	• Repeat stages 2-7 • MONO version of the stimulus seen if STEREO version seen previously and vice versa • Content and Surround conditions remain the same
(10)	**Final assessments**	• RANDOT™ STEREO-test completed • Background information sheet from the ITC-SOPI completed
(11)	**End**	• Debriefing and reward

3.3 Results

The results of Experiment 1 are reported in four sections corresponding to (1) participant characteristics, (2) presence ratings and negative effects ratings on the ITC-SOPI, (3) changes in mood ratings on the POMS-BI scales and (4) changes in physiological measures. Significance levels are set at $p<.05$ (two-tailed) for all statistical tests, with Bonferroni corrections where appropriate. Non-significant results are not reported. The analyses were repeated with outliers (+/-3.29sds) excluded, (further to those excluded on the basis of stereo-acuity and physiological recording anomalies). The results of the outlier analysis are noted when findings diverged from the pattern of results obtained when no outliers were removed.

3.3.1 Results: Participant Characteristics

Data concerning **Media Use and Knowledge** and **Demographics** were collected, using the background information sheet of the ITC-SOPI, as a mixed-groups design was implemented in this experiment. The data were used to check whether there were any differences between independent Experimental Groups ($BOAT^{ON}$, $BOAT^{OFF}$, $RALLY^{ON}$ and $RALLY^{OFF}$; see Table 3.1) that could potentially affect the dependent variables of interest (measures of presence, mood, and physiological arousal).

3.3.1.1 Analysis: Media Use and Knowledge

Table 3.3 presents the group mean ratings for each item concerning **Media Use and Knowledge** on the ITC-SOPI background information sheet[9]. A series of 2 x 2 Analysis of Variance (ANOVAs), with Content (BOAT vs. RALLY) and Surround (SURROUND-ON vs. SURROUND-OFF) serving as between-groups factors, were conducted for each item (computer expertise, average weekly television viewing, size of television usually watched, pervious experience of viewing 3D films or television, knowledge of 3D production, frequency of computer game playing, knowledge of television production, previous experience of virtual reality and knowledge of virtual reality production). No significant effects were observed.

Table 3.3 Summary of Media Use and Knowledge information requested on the ITC-SOPI background information sheet.

Experimental Group		***BOAT^{ON}***	***BOAT^{OFF}***	***RALLY^{ON}***	***RALLY^{OFF}***
Media Use and Knowledge					
Computer Expertise	*Mean*	2.77	2.52	2.86	2.86
	SD	*(0.57)*	*(0.83)*	*(0.74)*	*(0.69)*
Weekly TV Viewing	*Mean*	1.77	2.31	2.00	1.90
	SD	*(0.77)*	*(1.39)*	*(1.28)*	*(1.05)*
TV Size	*Mean*	1.83	2.00	1.96	1.72
	SD	*(0.65)*	*(0.65)*	*(0.69)*	*(0.59)*
Viewed 3D	*Mean*	1.37	1.55	1.48	1.38
	SD	*(0.49)*	*(0.51)*	*(0.51)*	*(0.49)*
Knowledge of 3D	*Mean*	1.90	1.69	1.66	1.62
	SD	*(0.66)*	*(0.71)*	*(0.77)*	*(0.78)*
Computer game use	*Mean*	1.90	2.17	1.97	1.90
	SD	*(0.88)*	*(1.10)*	*(0.87)*	*(0.77)*
Knowledge of TV	*Mean*	2.20	2.28	2.38	2.03
	SD	*(0.66)*	*(0.88)*	*(0.82)*	*(0.87)*
Used VR	*Mean*	1.73	1.86	1.90	1.75
	SD	*(0.45)*	*(0.35)*	*(0.31)*	*(0.44)*
Knowledge of VR	*Mean*	1.53	1.62	1.48	1.48
	SD	*(0.57)*	*(0.78)*	*(0.74)*	*(0.74)*

[9] Data were not collected for two participants in the *BOAT^{ON}* condition and two participants in the *RALLY^{ON}* condition due to experimenter error.

3.3.1.2 Analysis: Demographics

Table 3.4 presents a summary of **Demographic** data collected using the ITC-SOPI background information sheet. The group mean ratings for age and a summary of frequency data concerning nationality, occupation and level of education are presented[10]. A 2 x 2 Analysis of Variance (ANOVA) was calculated for the age of participants, with Content (BOAT vs. RALLY) and Surround (SURROUND-ON vs. SURROUND-OFF) serving as between-groups factors. No significant group differences were found for age. Frequency data were not analysed. However the data indicated that, overall, experimental conditions appeared to be well balanced with respect to nationality, occupation and education.

Table 3.4 Summary of Demographic information requested on the ITC-SOPI background information sheet.

	Experimental Group	$BOAT^{ON}$	$BOAT^{OFF}$	$RALLY^{ON}$	$RALLY^{OFF}$
Demographics					
Age	*Mean*	22.93	26.25	22.76	24.27
	SD	*(4.50)*	*(10.88)*	*(5.39)*	*(4.94)*
Nationality	British	22	24	20	28
	Non-British	8	4	8	2
Occupation	Student	29	21	24	27
	Non-Student	1	7	4	3
Education	A-Level +	29	26	26	29
	Below A-Level	1	2	2	1

3.3.1.3 Summary of Results: Participant Characteristics

Overall the data collected using the ITC-SOPI background information sheet indicated that differences between the four Experimental Groups ($BOAT^{ON}$, $BOAT^{OFF}$, $RALLY^{ON}$ and $RALLY^{OFF}$) were limited in terms of **Media Use and Knowledge** and **Demographics**. As such, **Media Use and Knowledge** and **Demographics** were not expected to be a significant source of error in between-groups comparisons made in subsequent analyses of the dependent variables of interest (see below).

[10] Data were not collected for two participants in the $BOAT^{ON}$ condition and two participants in the $RALLY^{ON}$ condition due to experimenter error.

3.3.2 Results: Subjective Presence Ratings

In order to assess the effects of Depth, Surround and Content on subjective ratings of presence post-viewing data from the **'being there'** item and the three presence related scales (**Physical Space**, **Engagement** and **Ecological Validity**) of the ITC-SOPI were analysed. In addition, the ITC-SOPI **Negative Effects** scale was analysed in order to account for adverse consequences of video presentations that may act as potential confounds of the dependent variables of interest (presence ratings, mood ratings and physiological changes).

3.3.2.1 Analysis: ITC-Sense of Presence Inventory

Table 3.5 presents the group mean ratings for the **'being there'** item and the four scales of the ITC-SOPI: **Physical Space**, **Engagement**, **Ecological Validity** and **Negative Effects**. A 2 x 2 x 2 Analysis of Variance (ANOVA) was calculated for each scale, with Depth (MONO vs. STEREO) serving as a within-groups factor and Surround (SURROUND-ON vs. SURROUND-OFF) and Content (BOAT vs. RALLY) serving as between-groups factors.

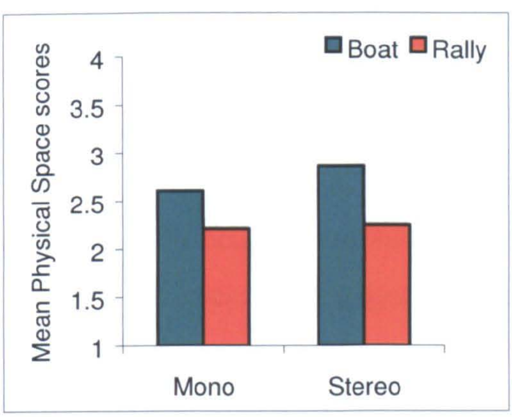
As predicted, significant main effects of Depth were observed for presence ratings: '**Being there**' (MONO = 2.99, STEREO = 3.34; $F_{(1,116)} = 13.29$, $p < .001$), **Physical Space** (MONO = 2.41, STEREO = 2.56; $F_{(1,116)} = 14.27$, $p < .001$), **Engagement** (MONO = 3.08, STEREO = 3.31; $F_{(1,116)} = 21.17$, $p < .001$) and **Ecological Validity** (MONO = 3.43, STEREO = 3.57; $F_{(1,116)} = 8.09$, $p < .01$). The data indicate that STEREO video presentations generated significantly higher ratings of presence than MONO presentations.

In addition, main effects of Content were found for the **'being there'** item and on all four ITC-SOPI subscales. BOAT presentations received significantly higher ratings than RALLY presentations in terms of **'Being there'** (BOAT = 3.44, RALLY = 2.89; $F_{(1,116)} = 10.43$, $p < .01$), **Physical Space** (BOAT = 2.74, RALLY = 2.24; $F_{(1,116)} = 15.55$, $p < .001$), **Engagement** (BOAT = 3.40, RALLY = 2.98 ; $F_{(1,116)} = 15.33$, $p < .001$), and **Ecological Validity** (BOAT = 3.79, RALLY = 3.21; $F_{(1,116)} = 17.34$, $p < .001$). RALLY presentations received significantly higher ratings of **Negative Effects** (BOAT = 2.01, RALLY = 2.31; $F_{(1,116)} = 4.23$, $p < .05$) than BOAT presentations. The data indicate that BOAT presentations generated higher levels of reported presence and fewer adverse consequences of viewing than RALLY presentations.

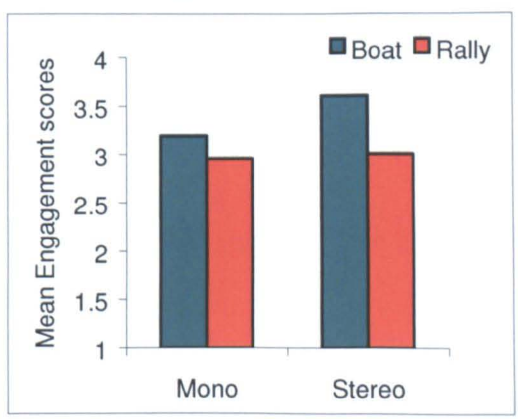
Table 3.5 Effects of Depth, Content and Surround on the group mean scores of the ITC-SOPI subscales and 'being there' item.

Condition		BOAT				RALLY			
		SURROUND-OFF		SURROUND-ON		SURROUND-OFF		SURROUND-ON	
ITC-SOPI Item/subscale		**MONO**	**STEREO**	**MONO**	**STEREO**	**MONO**	**STEREO**	**MONO**	**STEREO**
'Being There'	Mean	3.00	3.37	3.40	4.00	2.71	2.93	2.83	3.07
	SD	*(1.11)*	*(0.93)*	*(1.25)*	*(0.98)*	*(0.87)*	*(1.17)*	*(1.09)*	*(1.20)*
Physical Space	Mean	2.43	2.64	2.79	3.10	2.24	2.31	2.19	2.20
	SD	*(0.61*	*(0.63)*	*(0.86)*	*(0.84)*	*(0.63)*	*(0.60)*	*(0.79)*	*(0.82)*
Engagement	Mean	3.11	3.44	3.28	3.78	3.06	3.15	2.85	2.86
	SD	*(0.59*	*(0.57)*	*(0.80)*	*(0.58)*	*(0.65)*	*(0.63)*	*(0.62)*	*(0.73)*
Ecological Validity	Mean	3.63	3.83	3.74	3.95	3.13	3.31	3.22	3.19
	SD	*(0.66*	*(0.64)*	*(1.05)*	*(0.77)*	*(0.70)*	*(0.79)*	*(0.81)*	*(0.88)*
Negative Effects	Mean	2.24	2.04	1.93	1.83	2.14	2.16	2.47	2.48
	SD	*(0.79*	*(0.74)*	*(0.84)*	*(0.69)*	*(0.85)*	*(0.78)*	*(0.98)*	*(1.13)*

No significant main effect of Surround was observed. However, significant two-way interactions between Depth and Content were found for the **Physical Space** ($F_{(1,116)} = 7.65$, $p < .01$) and **Engagement** ($F_{(1,116)} = 13.36$, $p < .001$) scales (see Figures 3.2a and 3.2b). Follow-up t-tests, with a Bonferroni correction, indicated that for **Physical Space**, the BOAT video received significantly higher ratings than the RALLY video for both MONO (t = 2.95, df = 118, p< .001) and STEREO (t = 4.50, df = 118, p< .001) presentations. However, STEREO presentations were rated higher in **Physical Space** than MONO presentation for the BOAT video only (t = 3.77, df = 59, p< .001). For **Engagement** ratings, the BOAT video received higher ratings than the RALLY video for STEREO presentations only (t = 5.11, df = 118, p< .001). In addition, STEREO presentations were rated higher in **Engagement** (t = 5.57, df = 59, p< .001) than MONO presentations for the BOAT video only. These findings indicate an effect of the Depth manipulation on ratings of **Physical Space** and **Engagement** that was specific to the Content viewed. Overall, the data indicate that the BOAT video benefited more than the RALLY video, in terms of **Physical Space** and **Engagement**, from the addition of binocular depth cues to the display. The absence of these effects for **'Being there'** and on the **Ecological Validity** scale indicates that Depth and Content differentially affected the different subjective dimensions of presence.



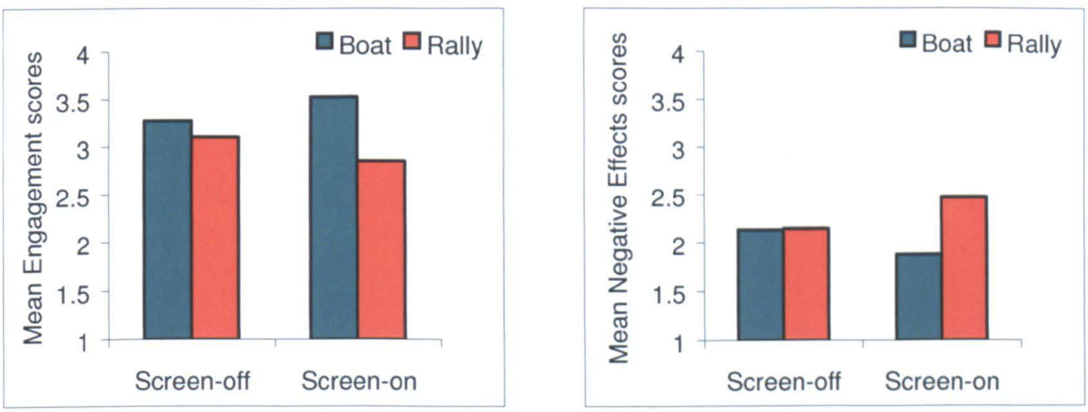
(a) Physical Space



(b) Engagement

Figure 3.2a-b Effects of Depth and Content on group mean scores of two ITC-SOPI scales: (a) Physical Space and (b) Engagement.

Finally, significant two-way interactions were found between Surround and Content on the **Engagement** ($F_{(1,116)} = 5.51$, $p < .05$) and **Negative Effects** ($F_{(1,116)} = 3.96$, $p < .05$) scales (see Figures 3.3a and 3.3b). Follow-up t-tests, with a Bonferroni correction, indicated that during SURROUND-ON presentations, the RALLY video received lower ratings of **Engagement** ($t = 4.08$, $df = 58$, $p < .001$) and higher ratings of **Negative Effects** ($t = 2.64$, $df = 59$, $p < .0125$) than the BOAT video. Therefore, the data indicate an effect of the Screen Surround on ratings of **Engagement** (the attentional component of reported presence) and adverse consequences of viewing that was specific to the content viewed. In addition, the absence of interactions for **'being there'** and on the **Physical Space** and **Ecological Validity** scales indicates a differential effect of the Surround and Content manipulations on different subjective dimensions presence. No other significant effects were observed.



(a) Engagement *(b) Negative Effects*

Figure 3.3a-b Effects of Surround and Content on group mean scores of two ITC-SOPI scales: (a) Engagement and (b) Negative Effects.

With reference to Cohen's (1977, 1988) conventions for mixed-design ANOVA F-tests, it was noted that effect sizes were of moderate to large magnitude for all tests of Depth, the effect of Content on the **'being there'** item and the **Engagement** and **Ecological Validity** subscales, and the interaction of Content and Depth on the **Engagement** scale (0.1 < eta-squared < 0.16). The moderate to large magnitude of the effect-sizes indicates that the significant results are reliable and can be safely accepted. Effects-sizes were small to moderate for all other significant tests (0.001 < eta-squared < 0.06) indicating that some significant findings were less reliable than others.

3.3.2.2 Summary of Results: ITC-Sense of Presence Inventory

In line with the presence literature, and as predicted, ratings of presence were sensitive to the Depth manipulation, with STEREO video presentations rated significantly higher on all measures of presence than MONO presentations. Unexpectedly, ratings of presence were also sensitive to Content, with BOAT video presentations receiving significantly higher ratings of presence than RALLY presentations. In addition, both the Depth and Surround manipulations interacted with Content, indicating effects of Depth and Surround on some dimensions of reported presence that were specific to Content type. In summary, the Depth, Content and Surround experimental manipulations produced a set of viewing conditions that varied in terms of the level of rated presence that were elicited. The conditions were therefore created against which to compare the impact of Media Form variables on emotional responses to different types of Media Content. Results for the **Negative Effects** subscale indicated that Content and Surround variables also affected the incidence of adverse consequence of video viewing and such effects may be considered in the interpretation of the results.

3.3.3 Results: Subjective Mood Ratings

In order to determine the effects of Depth, Surround and Content on subjective emotional experiences, analysis was conducted on the six POMS-BI subscales: **Agreeable-Hostile**, **Clearheaded-Confused**, **Confident-Unsure**, **Composed-Anxious**, **Elated-Depressed**, and **Energetic-Tired**. Change scores were calculated by subtracting pre-viewing scores from post-viewing scores for each scale, with a positive value indicating a change towards the positive pole of a scale and a negative score indicating a change towards the negative pole of the scale.

3.3.3.1 Analysis: Profile of Mood States – Bi-Polar

Table 3.6 presents the group mean change on the POMS-BI ratings over the course of each presentation for the six scales. A 2 x 2 x 2 ANOVA was conducted for each scale, with Depth (MONO vs. STEREO) serving as the within-groups factor and Surround (SURROUND-ON vs. SURROUND-OFF) and Content (BOAT vs. RALLY) serving as between-groups factors.

Looking first at the effects of Depth, a significant main effect of Depth was found on two scales: **Energetic-Tired** (MONO = -1.83, STEREO = 0.17; $F_{(1,116)} = 10.59$, $p < .01$) and **Elated-Depressed** (MONO = -1.02, STEREO = 0.20; $F_{(1,116)} = 5.70$, $p < .05$). The data indicate that STEREO presentations maintained levels of 'energy' and 'elation' relative to increased 'tiredness' and 'depression' for MONO presentations.

In addition, and in line with predictions, significant main effects of Content were found on the **Energetic-Tired** (BOAT = -1.82, RALLY = 0.18; $F_{(1,116)} = 5.59$, $p < .05$), **Agreeable-Hostile** (BOAT = -0.22, RALLY = -2.29; $F_{(1,116)} = 10.92$, $p < .01$) and **Composed-Anxious** (BOAT = 2.17, RALLY = -1.63; $F_{(1,116)} = 22.52$, $p < .001$) scales. Overall, BOAT presentations produced changes towards 'tiredness' and 'composure' relative to maintained 'energy' and increased 'anxiety' for RALLY presentations. In addition, BOAT presentations maintained levels of 'agreeableness' relative to a change towards 'hostility' for RALLY presentations.

No significant main effect of Surround was observed.

Table 3.6 Effects of Depth, Surround and Content on group mean changes on the POMS-BI subscales.

Condition		BOAT				RALLY			
		SURROUND-OFF		SURROUND-ON		SURROUND-OFF		SURROUND-ON	
POMS-BI Subscale		MONO	STEREO	MONO	STEREO	MONO	STEREO	MONO	STEREO
Agreeable-Hostile	Mean	-1.30	0.27	-0.27	0.43	-2.07	-1.23	-2.07	-3.80
	SD	*(2.96)*	*(2.55)*	*(4.34)*	*(5.23)*	*(4.46)*	*(5.39)*	*(5.26)*	*(4.51)*
Clearheaded-Confused	Mean	-0.60	-0.37	-1.07	1.43	-0.43	-0.07	-0.80	-2.43
	SD	*(3.52)*	*(4.27)*	*(3.62)*	*(4.67)*	*(3.37)*	*(4.35)*	*(6.30)*	*(5.99)*
Composed-Anxious	Mean	1.07	2.10	2.00	3.50	-0.70	-0.87	-0.43	-4.53
	SD	*(5.51)*	*(3.86)*	*(5.64)*	*(6.24)*	*(5.31)*	*(5.89)*	*(7.04)*	*(6.82)*
Confident-Unsure	Mean	-1.13	0.13	-0.10	1.30	0.93	2.33	1.53	-1.13
	SD	*(4.18)*	*(4.10)*	*(4.67)*	*(3.98)*	*(4.22)*	*(5.50)*	*(5.12)*	*(5.17)*
Elated-Depressed	Mean	-1.50	0.40	-1.63	0.77	-0.03	1.13	-0.90	-1.70
	SD	*(3.43)*	*(4.68)*	*(5.47)*	*(4.63)*	*(4.03)*	*(4.64)*	*(3.64)*	*(4.18)*
Energetic-Tired	Mean	-3.37	-1.30	-2.00	-0.67	0.17	2.33	-2.10	0.30
	SD	*(5.93)*	*(5.38)*	*(4.87)*	*(4.56)*	*(5.55)*	*(5.88)*	*(6.69)*	*(6.67)*

A significant two-way interaction between Content and Depth was found on the **Composed-Anxious** scale ($F_{(1,116)} = 5.73$, $p < .05$ – see Figure 3.4a). Follow-up comparisons, with a Bonferroni correction, were performed. For STEREO presentation the BOAT video produced an increase in 'composure', relative to an increase in 'anxiety' for the RALLY sequence ($t = 5.08$, $df = 118$, $p < .001$). Given the overall effect of Content on the **Composed-Anxious** scale, this result indicates that STEREO presentation accentuated differences between Contents on the **Composed-Anxious** scale.

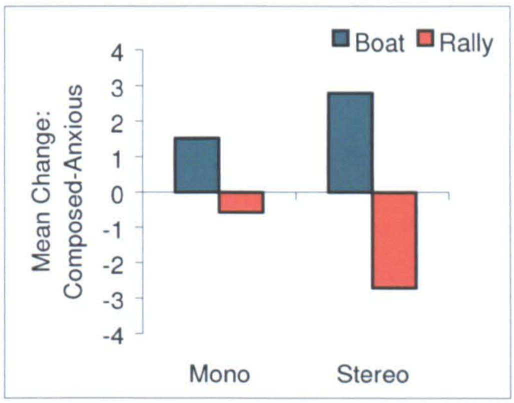


Figure 3.4 Effects of Depth and Content on group mean changes on the POMS-BI 'Composed-Anxious' scale.

Finally, a significant three-way interaction was found between Depth, Surround and Content on the **Clearheaded-Confused** scale ($F_{(1,116)} = 4.13$, $p < .05$– see Figure 3.5). Follow-up comparisons, with a Bonferroni correction, were performed. Overall, the data indicated that under SURROUND-OFF conditions no significant changes in mood occurred. However, under SURROUND-ON conditions, STEREO presentation increased 'clear-headedness' for the BOAT video ($t = 3.38$, $df = 29$, $p < .004$), whereas it increased 'confusion' for the RALLY video ($t = 3.38$, $df = 29$, $p = .007$ [approached significance]).

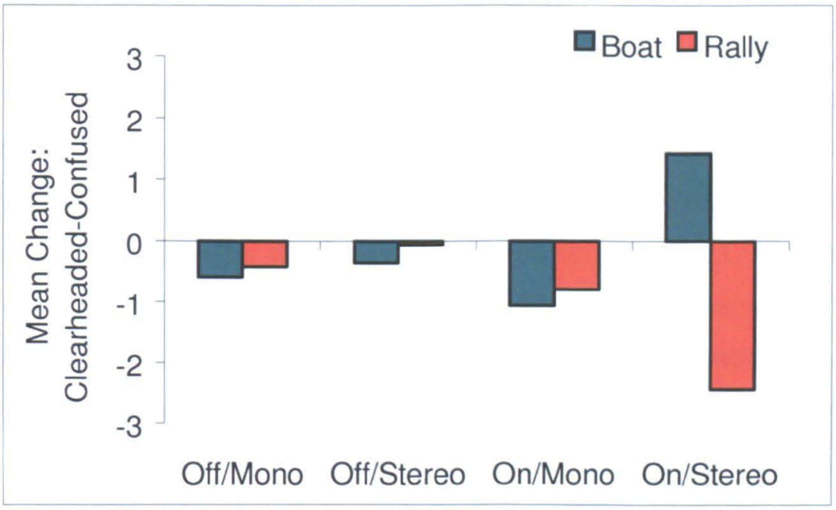


Figure 3.5 Effects of Depth, Surround and Content on the group mean changes on the POMS-BI 'Clearheaded-Confused' scale.

Effect sizes for all significant main effects of Content and Depth were moderate to large (0.05 < eta-squared < 0.16) and were small to moderate for all other significant and non-significant tests (0.001 < eta-squared < .05). These findings indicate that the significant main effects of Content and Depth can be safely accepted but that significant interactions may be less reliable. No other significant results were found[11].

3.3.3.2 Summary of Results: Profile of Mood States – Bi-Polar

As expected, the BOAT and RALLY video Content differed in terms of mood rating changes. The BOAT video (the higher presence Content), maintained or enhanced positive mood ('agreeableness' and 'composure') and generated changes towards low subjective arousal ('composure' and 'tiredness'), relative to the RALLY video. In addition, STEREO video presentations, (which generated relatively high presence ratings), were a more subjectively positive and arousing experience than MONO presentations, with levels of 'energy' and 'elation' maintained overall for STEREO presentations and falling in MONO presentations. The results provide evidence for an effect of the Depth manipulation on subjective emotion that generalised across contents, and also a potential association between presence and positive mood. Evidence in

[11] When the analysis of the POMS-BI was repeated with outliers excluded a significant interaction of Surround and Content was observed for the **Energetic-Tired** scale ($F_{(1,99)} = 4.18$, $p < .05$). The means indicated that levels of energy decreased in all conditions except *RALLY*^{OFF} presentations.

support of the Behavioural Realism prediction that increases in presence will accentuate emotion related differences between Contents was observed for ratings of **Composure-Anxiety**. An overall difference between Contents in terms of **Composure-Anxiety** was complimented by the finding that the BOAT and RALLY videos differed most widely on this scale when STEREO, as opposed to MONO, presentation was used. The finding indicates that the higher presence STEREO presentations accentuated difference between Contents in terms of **Composure-Anxiety**. Finally, a three way interaction between Depth, Surround and Content was observed on the **Clearheaded-Confused** scale, indicating a complex relationship between Media Form and Media Content variables in terms of the **Clearheaded-Confused** dimension.

3.3.4 Results: Physiological Measures

In order to assess the effects of Depth, Surround and Content on physiological measures, changes in standardised **SCLs** and **HR** from baseline levels to video viewing levels were analysed.

3.3.4.1 Analysis: Skin Conductance Levels

Prior to analysis of the effects of interest a 2 x 2 x 2 ANOVA was calculated in order to check for resting BASELINE differences in standardised **SCLs** between presentations. $Depth^{BASELINE}$ (MONO vs. STEREO) served as the within-groups factor and $Surround^{BASELINE}$ (SURROUND-ON vs. SURROUND-OFF) and $Content^{BASELINE}$ (RALLY vs. BOAT) served as between-groups factors. No significant effects were observed, indicating a limited probability of the Law of Initial Values (LIV) affecting results (Myrtek & Foester, 1986; Jennings & Stine, 2000)[12]. Mean resting **SCLs** were 0.06 standard deviations above the total mean (sd = 0.63). The analysis of baseline-to-stimulus changes in **SCLs** then proceeded. Table 3.7 presents (1) total group mean changes in **SCLs** (standardised) from the 60-second BASELINE over the entire VIEWING period (V-B) and (2) changes in **SCLs** (standardised) from a 20-sec baseline over five consecutive 20-sec segments (**TIME 1-5**) during VIEWING (V-B2).

To determine the effects of presentations on total changes in **SCLs** over the 100-sec video viewing period a 2 x 2 x 2 ANOVA was conducted. $Depth^{V-B}$ (MONO vs.

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[12] The Law of Initial Values refers to tendency of some physiological responses to correlate with resting baseline levels. In cases where resting baseline levels differ between conditions it is possible that calculations of change in physiological measures will be biased in favour of the Law of Initial Values.

STEREO) served as the within-groups factor and Surround$^{V\text{-}B}$ (SURROUND-ON vs. SURROUND-OFF) and Content$^{V\text{-}B}$ (RALLY vs. BOAT) served as between-groups factors. No significant effects were observed[13].

To determine the effects of presentations on <u>SCLs</u> over time, a 2 x 2 x 2 x 5 ANOVA was calculated, with Depth$^{V\text{-}B2}$ (MONO vs. STEREO) serving as a within-groups factors, Content$^{V\text{-}B2}$ (RALLY vs. BOAT) and Surround$^{V\text{-}B2}$ (SURROUND-ON vs. SURROUND-OFF) serving as between-groups factors, and Time$^{V\text{-}B2}$ (TIME 1-5) serving as a within-groups factor. The assumption of sphericity was violated and a corrected test with adjusted degrees of freedom was used which has been recommended for use with psychophysiological measures (Greenhouse-Geisser correction: Jennings, 1987; Jennings & Stine, 2000; Kesselman, 1998).

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[13] When the analysis was repeated with outliers deleted a significant interaction between Content and Surround was observed ($F_{(1,99)} = 4.23$, $p < .05$). The data indicate that the independent Experimental Groups were graded in terms of SCLs during viewing (in ascending order $BOAT^{OFF}$, $BOAT^{ON}$, $RALLY^{OFF}$ and $RALLY^{ON}$)

Table 3.7 Effects of Content, Surround and Depth on group mean changes in Skin Conductance Levels (standardised) from baseline levels to viewing levels.

Condition		**BOAT**				**RALLY**			
		SURROUND-OFF		**SURROUND-ON**		**SURROUND-OFF**		**SURROUND-ON**	
SCL Measure		**MONO**	**STEREO**	**MONO**	**STEREO**	**MONO**	**STEREO**	**MONO**	**STEREO**
Total SCL Change During Viewing (V-B)	Mean	-0.67	-0.70	-0.52	-0.67	-0.63	-0.46	-0.53	-0.37
	SD	*(0.79)*	*(0.92)*	*(1.17)*	*(1.19)*	*(0.83)*	*(0.88)*	*(1.11)*	*(1.26)*
TIME 1	Mean	0.00	0.00	0.13	0.12	0.23	0.41	0.12	0.04
	SD	*(0.39)*	*(0.49)*	*(0.58)*	*(0.47)*	*(0.81)*	*(0.93)*	*(0.62)*	*(0.53)*
TIME 2	Mean	-0.20	-0.18	-0.01	-0.09	0.13	0.23	-0.01	-0.01
	SD	*(0.59)*	*(0.72)*	*(0.73)*	*(0.82)*	*(1.03)*	*(1.02)*	*(0.86)*	*(0.79)*
TIME 3	Mean	-0.38	-0.30	-0.24	-0.25	-0.21	-0.07	-0.23	-0.05
	SD	*(0.72)*	*(0.94)*	*(0.90)*	*(1.14)*	*(1.03)*	*(0.97)*	*(0.91)*	*(1.10)*
TIME 4	Mean	-0.51	-0.44	-0.45	-0.53	-0.43	-0.29	-0.44	-0.14
	SD	*(0.81)*	*(0.92)*	*(0.96)*	*(1.14)*	*(1.01)*	*(0.90)*	*(1.01)*	*(1.12)*
TIME 5	Mean	-0.62	-0.58	-0.63	-0.71	-0.51	-0.54	-0.52	-0.14
	SD	*(0.97)*	*(0.98)*	*(1.09)*	*(1.25)*	*(0.87)*	*(0.91)*	*(1.15)*	*(1.27)*

Using a Greenhouse-Geisser epsilon correction a significant main effect of Time$^{V\text{-}B2}$ ($F_{(4,113)} = 82.07$, $p < .001$, $\varepsilon = .54$) was found, indicating that **SCLs** declined over the course of presentations from **TIME 1** onwards. No significant main effects of Depth, Content or Surround were observed. However, a significant three-way interaction between Content$^{V\text{-}B2}$, Surround$^{V\text{-}B2}$ and Time$^{V\text{-}B2}$ was found ($F_{(4,113)} = 4.94 < .05$, $\varepsilon = .42$ – see Figure 3.6). Follow-up t-tests, using a Bonferroni correction, were performed. Given the large number of comparisons involved in the Simple Effects analysis of this interaction, an overview of this analysis is presented here. The analysis revealed that **SCLs** declined significantly in all conditions from **TIME 1** except for presentations of the RALLY with the screen-surround on, in which **SCLs** were maintained relative to other conditions. No other significant effects were observed. It is noted that the use of a Bonferroni correction to perform the simple effects analysis resulted in a very stringent test for significance ($p < .0008$). The data strongly suggests that **SCLs** at **TIME 1** were relatively high for SURROUND-OFF presentations of the RALLY, particularly when compared to SURROUND-OFF presentations of the BOAT ($t = 3.38$, $df = 29$, $p = .012$). In sum, the interaction suggests that there was some evidence for greater **SCLs** during RALLY in comparison to BOAT presentations, though this was affected by the Surround manipulations.

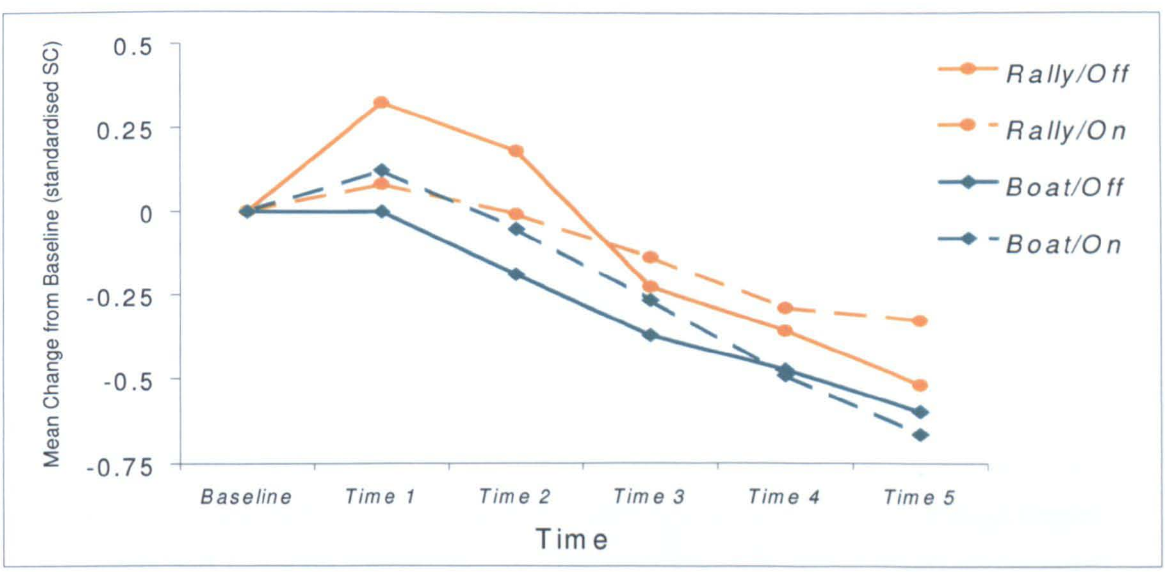

Figure 3.6 Effects of Content, Surround and Time on the group mean changes in Skin Conductance Levels (standardised) over Time.

Effect sizes were small for all tests (eta-squared < 0.02). This was with the exception of the main effect of Time, where the effects size was very large (eta–squared = 0.44) and the interaction of Surround, Content, and Time, which had a small to moderate effect size (eta–squared = 0.05). The effects of Time accounted for the largest proportion of the population variance.

3.3.4.2 Analysis: Heart Rate

Prior to analysis of the effects of interest a 2 x 2 x 2 ANOVA was calculated in order to check for resting BASELINE differences in standardised **SCLs** between presentations. Depth^{BASELINE} (MONO vs. STEREO) served as the within-groups factor and Surround^{BASELINE} (SURROUND-ON vs. SURROUND-OFF) and Content^{BASELINE} (RALLY vs. BOAT) served as between-groups factors. No significant effects were observed, indicating a limited probability of the LIV affecting results (Myrtek & Foester, 1986; Jennings & Stine, 2000). Mean resting **HR** levels were 75.06bpm (SD = 11.5). The analysis of baseline-to-stimulus changes in **HR** then proceeded. Table 3.8 presents total group mean changes in **HR** from a 60-second BASELINE over the entire VIEWING period (V-B).

In order to determine the effects of presentations on changes in **HR** from BASELINE to VIEWING a 2 x 2 x 2 ANOVA was calculated. Depth^{V-B} (MONO vs. STEREO) served as the within-groups factor and Surround^{V-B} (SURROUND-ON vs. SURROUND-OFF) and Content^{V-B} (RALLY vs. BOAT) served as between-groups factors. A main effect of Content $^{V-B}$ was found (BOAT = -1.23, RALLY = -0.33; $F_{(1,116)} = 5.62$, $p < .05$), indicating that **HR** reduced to a greater extent during BOAT presentations than for RALLY presentations. A main effect of Surround was also found (SURROUND-OFF = -1.20, SURROUND-ON = -0.37; $F_{(1,116)} = 5.62$, $p < .05$), indicating that **HR** was reduced to a greater extent in the SURROUND-OFF condition than the SURROUND-ON condition. No significant effect of Depth was observed.

Small to moderate effects sizes were observed for the significant tests of Content (eta-squared = .02) and Surround (eta-squared = .04) indicating that the significant results for Content and Surround have limited reliability. Effects sizes were small (eta-squared < 0.01) for all other tests.

Table 3.8 Effects of Depth, Surround and Content on the group mean changes in Heart Rate (bpm) from baseline levels to video viewing levels.

	Condition	BOAT				RALLY			
		SURROUND-OFF		SURROUND-ON		SURROUND-OFF		SURROUND-ON	
HR Measure		MONO	STEREO	MONO	STEREO	MONO	STEREO	MONO	STEREO
Total HR Change	Mean	-1.52	-1.91	-1.22	-0.29	-1.30	-0.06	-0.32	0.09
During Viewing (V-B)	*SD*	*(1.91)*	*(2.28)*	*(2.19)*	*(2.41)*	*(3.51)*	*(2.48)*	*(2.87)*	*(2.76)*

3.3.4.3 Summary of Results: Physiological Measures

It was predicted that, if measures of SCL and HR were good indicators of subjective emotional arousal, changes in SCLs and HR would reflect the effects of Depth, Content, and Surround on mood ratings. The results of the analysis of the physiological measures partially supported the finding that Contents differed in terms of subjective arousal in that the BOAT and RALLY videos differed in terms of HR and potentially in terms of SCLs (given potential confounding effects of the equipment change between SURROUND-ON and SURROUND-OFF conditions). However, in contrast to findings for mood ratings, there was no evidence for an effect of the presence enhancing Depth manipulation on physiological measures that was either generalised across Contents or specific to each type of Content. In addition an effect of the Surround on changes in HR was observed. The possibility that measures of SCLs and HR were affected by factors other than those of interest (such as Negative Effects, attentional demands and the equipment change) may be useful in the interpretation of findings.

3.4 Discussion

To summarise the pattern of results found in Experiment 1, it can be said that: (1) presence ratings were sensitive to Depth, Content and interactions between Depth and Content and also Surround and Content, (2) mood ratings were sensitive to Depth, Content, interactions between Depth and Content and also interactions between Depth, Surround and Content; (3) Skin Conductance Levels were not sensitive to overall effects of Depth, Surround or Content, but a differential effect of the Surround on the Contents over Time was indicated and (4) Heart Rate was sensitive to Content and Surround, but not Depth. In sum, measures of presence and emotion were sensitive to variations in Media Form and Media Content but in different ways.

Experiment 1 aimed to provide an initial exploration of the relationship between presence and emotion by generating varying levels of presence and examining the intensity and direction of subjective and physiological responses at each level of presence. The experiment succeeded in its first aim of generating varying levels of presence. As predicted, and in line with the presence literature, stereoscopic video presentations received higher ratings of presence than monoscopic presentations. The advantage of stereoscopic video images over monoscopic images in terms of presence ratings may be expected given that stereoscopic video presentations provide binocular depth cues, which are absent in monoscopic presentations, and therefore more closely resemble natural visual scenes. Stereoscopic video presentations also enhance spatial cues within an image, may reduce the impact of the screen and its frame as media cues, and may focus attention on an image due to novelty. In line with this reasoning, effects of Depth were observed for all types of presence ratings (the **'being there'** item, **Physical Space**, **Engagement** and **Ecological Validity**).

Effects of the second display manipulations of interest (Surround) on presence ratings were also observed. However, the manufacturer's claim that the screen-surround would affect perceived depth within monoscopic images was not reflected in presence ratings. Indeed, the effects of the Surround on ITC-SOPI ratings were shown to be specific to each type of content and limited to ratings of **Engagement** (i.e., subjective aspects of attention and involvement) and the occurrence of **Negative Effects** (adverse physical and mental consequences of viewing). It is possible that aspects of content which differed between the BOAT and RALLY videos (such as pace, motion parallax cues and degree of first-person movement), affect the perception of the plane and frame of an image, and hence the impact of the screen-surround on attention and adverse consequences of viewing. The lack of evidence for an effect of the Surround on the **'being there'** item, **Physical Space**, and **Ecological Validity** suggest that the Surround manipulation was not as effective as the Depth manipulation in generating varying levels of presence.

Though not directly predicted, a further variable, Content, also had a large and clear impact on all types of presence ratings with the leisurely paced BOAT video receiving higher ratings than the fast-paced RALLY video. In addition, the effect of the Depth manipulation on reported presence differed for each type of content. The results indicated that the BOAT video benefited more from stereoscopic presentation than the RALLY video in terms of **Physical Space** and **Engagement** ratings. A factor that may have influenced effects of Content on presence ratings may be production style (e.g., representations of spatial information within each video). The occurrence of **Negative Effects** and emotional responses to each video may also be related to the findings for presence ratings and are discussed below.

The second aim of Experiment 1 was to examine the intensity and direction of subjective and physiological emotional responses across the different levels of presence generated. Given that the clearest effects on ratings of presence were seen in response to the Depth and Content manipulations it is emotional responses to these manipulations which are of primary interest. Regardless of Content type, the higher presence stereoscopic presentations were associated with maintained positive mood and maintained subjective arousal relative to the lower presence monoscopic presentations. This finding is somewhat in line with previous research, which shows that higher levels of presence are associated with increased levels of subjective arousal. However, the higher presence BOAT content was associated with increased or maintained positive mood, decreased subjective arousal, decreased **HR**, some indication of decreased **SCLs** and fewer **Negative Effects** relative to the lower presence RALLY content. Therefore, the common feature of higher presence conditions was maintained and increased positive mood relative to increased negative mood in lower presence presentations. This feature of the present results may be worthy of investigation in future experiments.

In addition to the effects of Depth on mood measures that generalised across contents, there was also evidence for an effect of the Depth manipulation on mood change that was more content specific. Relative to one another, the BOAT video tended to generate changes towards a 'composed' mood state and the RALLY video tended to generate changes towards an 'anxious' mood state. The effect was most pronounced for stereoscopic presentations. The finding is in line with the Behavioural Realism approach to presence research, which predicts that responses to mediated content should become more naturalistic as presence increases (and therefore differences between contents in terms of emotional responses may be enhanced). In combination with the evidence that showed that the BOAT sequence generated higher ratings of presence than the RALLY sequence, the finding is also in line with theory in the wider literature which suggests that natural scenes have the potential to draw involuntary attention and may restore viewers to a positive mood when the scene provokes a sense of 'being away' (Kaplan & Kaplan, 1989).

Further investigations of the differential effect of Depth on different types of Content may need to consider (a) why other overall differences between contents were unaffected by Depth, (b) whether the changes in mood ratings can be considered meaningful changes in emotional state and (c) whether similar effects on the physiological measures should also be expected, in support of the findings for mood. In addition, it is of interest whether the effect of Depth on the **Composure-Anxiety** scale is best interpreted with respect to the overall effect of Depth on the **Naturalness** presence scale and **'being there'** or in terms of the Depth by Content interactions on the **Physical Space** and **Engagement** scales.

Before a further investigation of the relationship between presence and emotional responses may proceed a number of features of the present experiment must be considered. Firstly, although some links between presence and mood ratings worthy of further investigation have been identified, the effects of Media Form and Media Content manipulations on mood ratings were diverse and more complex than the effects on reported presence, including an interaction between all three experimental variables. The findings indicate that future experiments should consider multiple sources of influence on emotional responses, which may be unrelated to factors that influence reported presence.

Furthermore, though potential links between reported presence and mood change have been identified, the results are less clear for the physiological measures. Measures of changes in Skin Conductance Levels and Heart Rate were sensitive to factors that had weak effects on presence ratings and were not sensitive to all factors that had strong effects on presence ratings. In addition, there was some indication that the Skin Conductance data were unreliable due to a confound of equipment change with between-groups comparisons involving the screen-surround. This confound may also potentially have affected estimates of Heart Rate. Indeed, across all measures it could be said that between-groups comparisons yielded the least reliable results calling into question the validity of some findings. Factors such as age and occupation which varied between Surround and Content groups may have contributed to this finding as may the smaller sample size for between-groups in comparison to within-groups comparisons. Given the problems with equipment change and between-groups comparisons, the impact of Media Form and Media Content variables on physiological measures is an area that requires clarification. Further investigation in this area should indicate whether some effects observed in the present experiment may be accepted and will allow further examinations of the relationship between presence and emotion to proceed with greater confidence.

To summarise, Experiment 1 successfully implemented the methodology proposed in Chapter 2 for the investigation of presence and emotion. The results suggest that the addition of binocular depth cues to ordinary video presentations (i.e., during stereoscopic viewing conditions) is an adequate means of enhancing ratings of presence. Furthermore, the addition of binocular depth cues to video presentations appeared to impact on subjective measures of emotion in a way that was both generalised across types of content and specific to types of content. The results provide justification for further investigations into the relationship between presence and emotional responses. However, the potential unreliability of the physiological data and some statistical tests was highlighted and is proposed as the first area for exploration.

Chapter 4 EXPERIMENT 2:

Depth and Content effects on Presence and Physiological Responses

4.1 Introduction

The Behavioural Realism approach to presence research predicts that subjective and physiological emotional responses will be more intense, and perhaps more specific to content type, as reported presence increases. The methodology proposed in Chapter 2 for investigating this prediction involves the use of reliable presence enhancing Media Form manipulations to generate varying levels of reported presence. The intensity and direction of subjective and physiological emotional responses can then be examined at each level of presence for different types of content.

The above methodology was applied in Experiment 1 (Chp. 3) in which participants viewed both monoscopic (MONO) and stereoscopic (STEREO) versions of either a boat-ride (BOAT) or a rally-driving (RALLY) video sequence. The results suggested that the addition of binocular depth cues to ordinary video presentations (i.e., during stereoscopic viewing conditions) is an adequate means of enhancing ratings of presence. This is in line with the presence literature in which it is proposed that aspects of Media Form which enhance the fidelity of sensory information will engender heightened experiences of presence in response to a mediated environment (see Chapter 1). Furthermore, the addition of binocular depth cues to video presentations appeared to impact on subjective measures of emotion in a way that was both generalised across types of content and specific to types of content. The results provide justification for further investigations into the relationship between presence and emotional responses.

However, several features of the design and analysis of Experiment 1 introduced some ambiguity into the interpretation of findings. A second Media Form variable (the Screen Surround) was shown to impact on ratings of presence, ratings of mood and changes in physiological indicators of autonomic activity (Skin Conductance and Heart Rate). The effects of the Screen-Surround were difficult to interpret given that the manipulation was confounded with a change in polygraph equipment, which may have resulted in biased estimations of Skin Conductance and Heart Rate responses across the Screen Surround conditions. Furthermore, reasons for effects of the Screen Surround on presence ratings and emotional responses were difficult to interpret as the effects of the Screen Surround on the perception of video content have not been researched in detail previously. Therefore, it was concluded that (1) the Screen Surround manipulation was not an adequate method of producing variations in presence ratings in this thesis and (2) polygraph equipment should be kept constant across conditions.

These concerns are addressed in the design of Experiment 2 which aims to re-investigate the efficacy of the Depth manipulation (i.e., monoscopic vs. stereoscopic viewing conditions) in producing varying levels of presence, without the potential Screen Surround and polygraph confounds.

In Experiment 1 it was also noted that the use of a mixed-subjects design may have limited the reliability and interpretation of some findings. Between-groups comparisons (those involving the Screen Surround and Content) were generally associated with smaller effect-sizes than within-groups comparisons (Depth). This observation is of particular concern for the interpretation of the physiological data. The results indicated that the Depth manipulation affected measures of presence and mood but not Skin Conductance or Heart Rate whereas Content affected all measures. Therefore, the autonomic data did not clearly support the subjective mood data and may have been prone to between-groups error (due to the highly individual nature of physiological responses). Jennings and Stine (2000) propose that a simple way to address ambiguity in physiological data is the use of fully within-subjects designs. This ensures that physiological responses used as dependent variables are scaled in accordance with an individual's responsivity, thus protecting against between-groups error. The proposal is implemented in Experiment 2 with the aim of re-investigating the impact of the presence-enhancing Depth manipulation on SC and HR across different types of Content.

In summary, the primary aim of Experiment 2 is to re-examine some of the findings of Experiment 1 using a modified design. Of particular interest is whether the Depth manipulation is a reliable method of creating varying levels of presence and whether measures of SC and HR may be shown to be responsive to the Depth and Content manipulations using a fully within-subjects design. The experiment is intended as a brief re-investigation of Experiment 1, enabling the predictions of the Behavioural Realism approach to be examined with a stronger design and fewer confounding variables. Experiment 2 also provides the opportunity to follow-up one unexpected finding from Experiment 1, which indicated that the two content types differed in terms of presence ratings.

To achieve the aims of Experiment 2 participants will view both monoscopic and stereoscopic versions of both the boat-ride and rally-driving video sequences in a fully within-subjects design. Simple ratings of presence will be taken after each presentation and, using only one polygraph, changes in SC and HR levels during viewing will be recorded. It is predicted that in line with Experiment 1 and previous research (Freeman et al., 1999; Freeman et al., 2000; IJsselsteijn et al., 1998; IJsselsteijn et al., 2001) that stereoscopic video presentations will be rated higher in presence than monoscopic presentations. The impact of the Media Form manipulation on changes in SC and HR during viewing of the two types of content will be examined. The Behavioural Realism approach would predict that, if these autonomic measures indicate emotional arousal, then SC and HR responses will become more intense and content-specific at higher levels of presence. Finally, if the findings of Experiment 1 are reliable then it may be predicted that the boat-ride video sequence will be rated higher in presence than the rally-driving sequence.

4.2 Method

4.2.1 Design

The design of the procedure of Experiment 2 was informed by the procedure and results of Experiment 1. Therefore, Experiment 1 provided piloting information for Experiment 2. In particular, Experiment 1 suggested that Experiment 2 should be a fully repeated measures design using one polygraph for all participants. The extra time demand on participants that the repeated measures design introduced led to the adoption of a shorter presence questionnaire for the current experiment (see section 4.2.4) and the elimination of mood measures (as the aim of the experiment was focussed on the efficacy of the Media Form manipulation on presence and physiology). The first participants in the experiment acted as pilot participants but were included as experimental participants due to the success of the procedure.

A within-subjects 2 x 2 factorial design was used. 'Depth' was a within-groups factor with two levels (monoscopic video presentation [MONO] vs. stereoscopic video presentation [STEREO]) 'Content' was a within-groups factor with two levels (boat video sequence [BOAT] vs. rally video sequence [RALLY]). The order of video presentations was fully counterbalanced across participants so that all twenty-four combinations of the Content and Depth conditions were used. The dependent variables were post-viewing ratings of presence and changes in two physiological measures (Skin Conductance Levels [SCLs] and sustained Heart Rate [HR]) from baseline to viewing.

4.2.2 Participants

Twenty-eight students from Goldsmiths College were paid £3 for participation. Inclusion criteria were as for Experiment 1. Four participants were excluded (one for failure to reach inclusion criteria for stereo-acuity and three due to technical difficulties resulting in changes in Skin Conductance Levels which were greater than +/-3.29 SDs from the mean). The final data-set consisted of twenty-four participants (12 female, 12 male, Average age = 27.00, SD = 6.78). The sample size was similar to or larger than sample sizes used in previous research comparing monoscopic and stereoscopic presentations of segments from the rally video (Freeman et al., 1999; Freeman et al., 2000; IJsselsteijn et al., 1998; IJsselsteijn et al., 2001)[14]. Participant characteristics were recorded but not analysed in this experiment as between-groups comparisons were not made.

4.2.3 Video Presentation Apparatus and Materials

Experiment 2 was intended as a short reinvestigation of the key results in Experiment 1. Therefore, the viewing platform (P*i*T), video stimuli (BOAT and RALLY), visual display and video presentation method were as for Experiment 1 (Chp. 3, pg. 104). For reasons detailed in the introduction to this chapter, the screen-surround was not used.

4.2.4 UCL Presence Questionnaire

The present experiment was designed to provide a brief re-investigation of the results of Experiment 1 in a within-subjects design. Therefore, in order to run the experiment within a reasonable amount of time and with a minimal demand on the participants a shorter measure of presence was thought to be more desirable than the Independent Television Commission - Sense of Presence Inventory (ITC-SOPI: Lessiter et al., 2001) used in Experiment 1. The UCL-Presence Questionnaire (UCL-PQ: Slater et al., 1994) was chosen for its brevity and relative reliability.[15]

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[14] In these experiments stereoscopic presentations of the rally video were consistently shown to be rated higher on measures of presence than monoscopic presentations. Hence, the sample size for this experiment was judged to be adequate. The choice of sample size takes into account the applied nature of the research questions and the pragmatic demands of user-testing (Cohen, 1977, 1988).

[15] A short form of the ITC-SOPI has recently been developed and was distributed to projects within the EC Future and Emerging Technologies first Presence Initiative by the OmniPres project and is referred to in Experiment 5 and Appendix D2. However, at the time the current experiment was designed and implemented there was insufficient justification for isolating individual items from the ITC-SOPI. In addition, the UCL-PQ was the most widely used short presence measure at the time.

The UCL-PQ is a three-item presence questionnaire that has been shown to have sensitivity to Media Form variables across a range of experiments (Youngblut & Perrin, 2002). Participants are required to rate each of the following statements on a seven-point scale.

Q1-'being there'

Please rate your sense of *being there* in the displayed environment on the following scale from 1 to 7 (*In the displayed environment I had a sense of 'being there' - not at all [1] - very much [7]).*

Q2-'reality'

To what extent were there times during the experience when the displayed environment became the 'reality' for you, and you almost forgot about the 'real world' outside? Please answer on the following 1 to 7 scale. *(There were times during the experience when the displayed environment became more real or present for me compared to the 'real world' - at no time [1]) - almost all of the time [7]).*

Q3-'visited'

When you think back about your experience, do you think of the displayed environment more as *something that you saw,* or more as *somewhere that you visited?* Please answer on the following 1 to 7 scale. (*The displayed environment seems to me to be more like...something that I saw [1] - somewhere that I visited [7])*).

Each of the three questions on the UCL Presence Questionnaire was treated as separate presence scores with a higher score on each indicating a greater sense of presence (**Q1-'being there'**, **Q2-'reality'**, **Q3-'visited'**). In addition, a composite presence score was obtained by calculating the frequency of **High Scores** across all the questions for each person (the frequency with which each participant gave a rating of six or seven: maximum score = 3, minimum score = 0). The first scoring method indicates variations in different components of a mediated experience. The latter scoring method indicates the intensity of the sense of presence as a whole, assuming that 'presence' has occurred when all questions are rated highly (Slater et al., 1994).

The questionnaire, and variants of the questionnaire and each item, has been widely used within the presence research community. In a synthesis of presence theory and measurement, Freeman (2004) proposed that each of the three items qualitatively correspond to the three dimensions of presence measured by three scales on the ITC-SOPI: The first item (**Q1-'being there'**) corresponds to Physical Space, the second item (**Q2-'reality'**) corresponds to Engagement and the final item (**Q3-'visited'**) corresponds to Ecological Validity. Exploratory research also indicates that the UCL-PQ items correlate with the ITC-SOPI scale totals (Lessiter & Freeman, 2000b). In sum, although the psychometric properties of the UCL-PQ have not been systematically investigated, there is evidence to suggest that the questionnaire has a sufficient degree of sensitivity, validity and reliability in order to serve as an indicator of subjective presence. In particular **Q1-'being there'** ensures comparability of findings across experiments presented in this thesis and a body of relevant research (Freeman et al., 1999; Freeman et al., 2000; Hendrix & Barfield, 1996; IJsselsteijn et al., 1998; IJsselsteijn et al., 2001). Hence, the UCL-PQ was chosen as the subjective measure of presence for the current experiment. Chapter 2 (pg. 73-75) contains further information about the UCL-PQ and its relative value as a subjective measure of presence.

4.2.5 Physiological Recording Apparatus and Data Management

Two physiological indicators of changes in autonomic activity over the course of viewing were utilised in this experiment: (1) Changes in Skin Conductance Levels (**SCLs**) and (2) changes in sustained Heart Rate (**HR**). Physiological data acquisition equipment was identical to that used for the SURROUND-ON conditions in Experiment 1 (see Appendix A1 for a description of the Datalab 2000™ system). Recording procedures and data management were the same as for Experiment 1 with the exceptions that (1) raw Skin Conductance (SC) data series were averaged and retained for analysis rather than standardised SC series and (2) time-varying changes in SC were not extracted. These exceptions were implemented as the polygraph equipment was kept constant across experimental conditions and because between-groups comparisons were not made in this experiment.

4.2.6 Procedure

The procedure was as for Experiment 1 (Chp 3, pg. 114) with the following exceptions: (1) participants viewed four video presentations in total: both MONO and STEREO presentations of both the BOAT and RALLY videos and (2) The UCL-PQ was administered after each presentation and (3) no other questionnaires were administered. The experiment took approximately one hour to complete.

4.3 Results

The results are reported in two sections corresponding to (1) presence ratings on the UCL-PQ and (2) physiological responses in terms of changes in Skin Conductance Levels (SCLs) and sustained Heart Rate (HR). Only significant results are reported and significance levels are set at $p<.05$ (two-tailed) for all statistical tests. The analyses were repeated with outliers (+/-3.29sds) on all measures deleted. These outliers were further to those excluded on the basis of stereo-acuity and technical difficulties. The deletion of outliers did not affect the pattern of results and therefore the results of this analysis are not reported.

4.3.1 Results: Presence Ratings

In order to assess the effects of Depth and Content on subjective ratings of presence, post viewing scores for the three items (**Q1-'being there'**, **Q2-'reality'**, **Q3-'visited'**) and **High Scores** on the UCL-PQ were subjected to analysis.

4.3.1.1 Analysis: UCL Presence Questionnaire

The group mean ratings for each of the three questions and high scores on the UCL-PQ are shown in Table 4.1. A 2 x 2 Analysis of Variance (ANOVA) was conducted on each of the four scores, with Depth (MONO vs. STEREO) and Content (BOAT vs. RALLY) serving as within-groups factors.

Table 4.1 Group mean scores for questions and high-scores on the UCL Presence Questionnaire.

	Condition	BOAT		RALLY	
UCL-PQ		MONO	STEREO	MONO	STEREO
Q1-'being there'	*Mean*	4.20	4.71	3.58	4.13
	SD	*(1.62)*	*(1.55)*	*(1.86)*	*(1.54)*
Q2-'reality'	*Mean*	4.00	4.00	3.29	3.88
	SD	*(1.96)*	*(2.00)*	*(1.94)*	*(1.99)*
Q3-'visited'	*Mean*	3.50	3.79	2.79	3.13
	SD	*(2.02)*	*(1.89)*	*(1.69)*	*(1.85)*
High-Scores	*Mean*	0.67	0.88	0.33	0.54
	SD	*(1.09)*	*(1.19)*	*(0.70)*	*(1.02)*

Looking first at the effect of the Depth manipulation on presence ratings it was shown that a main effect of Depth was obtained for **Q1-'being there'** ($F_{(1,23)} = 4.29$, p = .05; MONO = 3.89, STEREO = 4.42). Given the large effect size (eta-squared = 0.16) it can be said that STEREO presentations generated a significantly greater sense of 'being there' than MONO presentations and that the effect was reliable. Although no significant main effects of Depth were observed for **Q2-'reality'**, **Q3-'visited'**and the **High-Scores**, moderate effect sizes (.05 < eta-squared < 0.08) were observed for all tests of Depth on these items indicating a possible effect of Depth on **Q2-'reality'**, **Q3-'visited'**and the **High-Scores**.

Main effects of Content were found on **Q1-'being there'** ($F_{(1,23)} = 5.44$, $p < .05$; BOAT = 4.46, RALLY = 3.86) and **Q2-'reality'** ($F_{(1,23)} = 5.28$, $p < .05$; BOAT = 4.00, RALLY = 3.59). BOAT presentations received higher ratings on **Q1-'being there'** and **Q2-'reality'** than RALLY presentations indicating that BOAT presentations generated a greater sense of being there and felt 'more like a place visited than a place seen' than RALLY presentations. Although no significant main effects of Content were observed for **Q3-'visited'** and the **High-Scores**, all effect sizes for tests of Content were high or high to moderate (0.12 < eta-squared < 0.19) indicating that the significant effects of Content were reliable and that there was a possible effect of Content on **Q3-'visited'** and the **High-Scores**. No other significant effects were observed.

4.3.1.2 Summary of Results: UCL Presence Questionnaire

The analysis of the UCL-PQ provided evidence to suggest that ratings of presence were sensitive to both Depth and Content manipulations. The prediction that STEREO presentations would receive significantly higher ratings of presence than MONO presentations was supported. The results also supported the results of Experiment 1 in that BOAT presentations received significantly higher ratings of presence than RALLY presentations. However, in contrast to Experiment 1 no interactions between Content and Depth were observed in terms of presence ratings. In addition, it may be noted that, unlike Experiment 1, significant effects were not found on all presence scales. Furthermore, the low incidence of **High-Scores** may indicate that a high degree of presence was not elicited across all conditions.

4.3.2 Results: Physiological Measures

In order to assess the effects of Depth and Content on changes in SCLs and HR from BASELINE levels to VIEWING levels the difference between BASELINE and VIEWING (V-B) levels for both SCLs and HR were analysed.

4.3.2.1 Analysis: Skin Conductance Levels

Prior to analysis of the effects of interest a 2 x 2 ANOVA was calculated in order to check for baseline differences in SCLs between presentations. $Depth^{BASELINE}$ (MONO vs. STEREO) and $Content^{BASELINE}$ (BOAT vs. RALLY) served as the within-groups factors. No significant effects were observed, indicating a limited probability of the LIV affecting SCLs (Myrtek & Foester, 1986; Jennings & Stine, 2000). The analysis of baseline-to-viewing changes in SCLs then proceeded. Table 4.2 presents total group mean changes in SCLs (micromhos) from the resting baseline period to the entire 100sec viewing period.

Table 4.2 Effects of Depth and Content on group mean changes in Skin Conductance Levels (micromhos) from the resting baseline to the 100-sec viewing period.

		BOAT		RALLY	
		MONO	**STEREO**	**MONO**	**STEREO**
Change in SCLs	*Mean*	-0.27	-0.34	-0.17	-0.16
	SD	*(0.34)*	*(0.44)*	*(0.31)*	*(0.30)*

A 2 x 2 ANOVA was calculated with $Depth^{V-B}$ (MONO vs. STEREO) and $Content^{V-B}$ (BOAT vs. RALLY) serving as within-groups factors. A significant main effect of $Content^{V-B}$ was found ($F_{(1,23)} = 9.73$, $p < .01$; BOAT = -.30, RALLY = -.16) and there was no significant main effect of Depth. The means indicated that, overall, there was a significantly larger decrease in SCLs for BOAT presentations in comparison to RALLY presentations and therefore BOAT presentations were associated with lower SCLs than RALLY presentations[16]. The effect size was large (eta-squared = 0.30) indicating that the significant effect can be safely accepted. No other significant effects were observed.

[16] Due to polarisation of the skin during constant current application SC recordings, it is usual for a downward drift to appear over time in continuous SC data (Venables & Christie, 1980). The gradient of the drift can be deleted from continuous SC data in order to identify short-term SC responses above resting baseline levels. The gradient was not deleted here and for the remainder of the thesis as the

4.3.2.2 Analysis: Heart Rate

Prior to analysis of the effects of interest a 2 x 2 ANOVA was calculated in order to check for baseline differences in HR between presentations. Depth^{BASELINE} (MONO vs. STEREO) and Content^{BASELINE} (BOAT vs. RALLY) served as the within-groups factors. No significant effects were observed, indicating a limited probability of the LIV affecting changes in HR. The analysis of baseline-to-stimulus changes in HR then proceeded. Table 4.3 presents total group mean changes in HR (bpm) from the resting baseline period over the entire 100sec viewing period.

Table 4.3 Effects of Content and Depth on group mean changes in HR (bpm) from the resting baseline to the 100-sec viewing period.

		BOAT		RALLY	
		MONO	**STEREO**	**MONO**	**STEREO**
Change in HR	Mean	-1.66	-1.50	-0.42	-0.09
	SD	*(3.63)*	*(2.95)*	*(3.62)*	*(3.43)*

A 2 x 2 ANOVA was calculated with Depth^{V-B} (MONO vs. STEREO) and Content^{V-B} (BOAT vs. RALLY) serving as within-groups factors. No significant effects were observed. Effect sizes were very low for all tests with the exception of the test of Content^{V-B} ($F_{(1,23)} = 3.01$, $p = .10$, eta-squared = 0.12) where the effect size was moderate to large. This finding may indicate a potential effect of Content on changes in HR that did not emerge due to low power.

4.3.2.3 Summary of Results: Physiological Measures

The analysis of changes in SCLs and HR described above provided evidence to suggest that physiological measures of autonomic arousal were sensitive to Content manipulations. In comparison to RALLY presentations, BOAT presentations produced a greater reduction in HR and significantly lower SCLs. The findings are similar to those found in Experiment 1, in which evidence for an effect of Content on both SCLs and HR was also observed. However, this interpretation is based in part on an overview of effect-sizes rather than significance levels. The prediction that measures of

gradient of the drift in comparison to longer-term stimulus related changes was not known. Therefore, interpretation of the SC data is based on relative changes in SCLs between conditions rather than baseline to viewing changes.

autonomic arousal would be sensitive to the Depth manipulations was not supported. Interactions between Depth and Content were also not observed.

4.4 Discussion

To summarise the results of Experiment 2, evidence was found for (1) significant effects of Depth and Content on ratings of presence and (2) an effect of Content on changes in SCLs and HR, which was statistically significant for SCLs.

The primary aim of Experiment 2 was to re-examine some of the findings of Experiment 1 using a modified design. Of particular interest was whether the Depth manipulation is a reliable method of creating varying levels of presence. It was predicted that stereoscopic video presentations would generate higher ratings of presence than monoscopic presentations. The results of Experiment 2 partially supported this prediction in that stereoscopic presentations generated significantly higher ratings of 'being there' than monoscopic presentations. However, the difference between stereoscopic presentations and monoscopic presentations in terms of presence ratings was significant for only one out of three questions on the UCL-PQ. In addition mean high-scores on the UCL-PQ were low. The results suggest that the Depth manipulation had a weak effect on presence ratings and that levels of presence may have been low across all presentations.

The ambiguous evidence for an effect of Depth on reported presence could be due to a number of factors including the sample size and the adequacy of the presence rating scale. However, the sample size was comparable to that used in previous research and the UCL-PQ:Q1 ('being there') is similar to the 'being there' item on the ITC-SOPI and other presence questionnaires. Therefore, the significant finding for Depth with a large effect size on the UCL-PQ Q1-'being there' in the current experiment has some validity in comparability with the effects of Depth found in Experiment 1 and previous research (Freeman et al., 1999; Freeman et al., 2000; Hendrix & Barfield, 1996; IJsselsteijn et al., 1998; IJsselsteijn et al., 2001). Nevertheless, potential instability in the ratings of presence highlights the need for objective or corroborative measures of presence, and therefore further research of the type described here.

In addition to re-examining the impact of the Depth manipulation on presence ratings, Experiment 2 aimed to re-examine whether measures of SC and HR were sensitive to

Depth and Content manipulations using a fully within-subjects design. The Behavioural Realism approach would predict that the presence enhancing Depth manipulations should intensify emotion-related physiological responses to Content, perhaps in a way which would amplify differences between Contents. In Experiment 1 there was some evidence for this proposal in terms of measures of mood but not SC or HR. Experiment 2 also did not reveal any impact of the Depth manipulation on either SC or HR. Given the lack of a clear effect of the Depth manipulation on presence ratings in the current experiment, no effects of the Depth manipulation on measures of SC and HR may have been expected. However, there may be alternative reasons for the findings.

Measures of SC and HR are often used to objectively indicate or corroborate subjective emotional arousal (e.g., Meehan et al., 2002). Hence, measures of SC and HR were chosen for use in the thesis as they may potentially serve as objective measures of presence (if the predictions of the Behavioural Realism approach were supported in terms of subjective emotional responses). However, the results of Experiments 1 and 2 suggest that potentially either (1) measures of SC and HR have not been a good indicator of subjective emotional responses in this research context or that (2) the evidence for Content and Depth effects on measures of mood in Experiment 1 were weak or unreliable. For example, effects on the 'energetic-tired' and 'composed-anxious' scales of the Profile of Mood States in Experiment 1 were not fully reflected in measures of SC and HR. This might be expected if changes in mood state were within a range that would not be expected to be reflected in physiological measures (Bradley, 2000) or if another factor (such as video quality, production style or the occurrence of physical side-effects) influenced the physiological measures. A further explanation for the findings could be that Media Form variables affect emotional responses at a subjective level but not at a physiological level. However, further research would be required to investigate this claim.

The discussion above is linked to the following evaluation of one further set of findings from Experiments 1 and 2. In addition to the re-examination of the Depth manipulation and physiological measures, Experiment 2 also provided the opportunity to follow-up one unexpected finding from Experiment 1, which indicated that the boat-ride and rally-driving video sequences differed in terms of presence ratings. This effect was also observed in Experiment 2. Indeed, the effects of Content on ratings of presence are as strong, and in some cases stronger, than those of Depth. Given that Media Content effects are an under-researched area in the presence field, and given that the two video sequences appear to differ in terms of measures of mood, SC and HR, it is apparent that content issues may be an important consideration in an investigation of the relationship between presence and emotion.

Unfortunately, the contents and displays that have been tested to date in Experiments 1 and 2 are restricted in terms of future experimental use in a number of ways. The video stimuli were chosen primarily because they were similarly produced in both monoscopic and stereoscopic views. At the time this experiment was conducted there was a limited amount of stereoscopic video Content suitable for display on the viewing platform used in the study. In addition, the boat and rally videos have been shown to differ on measures other than mood, SC and HR, such as Negative Effects. As the Contents were not well balanced, firm conclusions concerning the effects of display manipulations on different types of content would be restricted in future experiments using the boat and rally video sequences. For a more complete exploration of Media Form and Media Content effects on ratings of presence and emotional responses a Media Form manipulation may have to be used for which there are more balanced sets of contents available.

In summary, Experiment 2 has generally supported the results of Experiment 1 in demonstrating that a Media Form manipulation may affect reported presence but not physiological responses and that Media Content can affect both reported presence and physiological responses. The results appear to show that a presence enhancing Media Form manipulation (Depth) does not intensify autonomic responses to different types of Content. Therefore the predictions of the Behavioural Realism approach were not supported, and measures of SC and HR do not appear to be good candidate objective measures of presence. However, doubts over the efficacy of the Depth manipulation have been raised. Furthermore, features of the Contents used may require further investigation. As such the extent to which a presence enhancing Media Form manipulation may affect subjective and physiological emotional responses to different type of content remains unclear. It can be suggested that these issues justify an extension of the investigation of the relationship between presence and emotion to include a wider range of Media Form and Media Content variables. Experiment 3 will pursue this line of reasoning.

Chapter 5 EXPERIMENT 3:

Visual Angle and Content Effects on Presence and Emotional Responses

5.1 Introduction

In Experiment 1 (Chp. 3) and Experiment 2 (Chp. 4), two of the theoretical determinants of presence (Media Form and Media Content) were manipulated in order to explore their effects on several measures. In Experiment 1 participants viewed both monoscopic (MONO) and stereoscopic (STEREO) presentations of either a boat-ride video sequence (BOAT) or a rally-driving video sequence (RALLY) either with or without the presence of a Moiré fringe screen-surround. In Experiment 2 participants viewed both MONO and STEREO presentations of both the BOAT and RALLY videos. Post-viewing subjective ratings of presence were compared to changes in subjective mood ratings and changes in physiological indicators of autonomic activity (Skin Conductance Levels and sustained Heart Rate) as part of an initial investigation into the relationship between presence and affective responses. In line with the Behavioural Realism approach to presence research it was predicted that video presentations which yielded higher ratings of subjective presence would also produce more intense subjective and physiological emotional reactions. Evidence of such an effect would indicate that emotional responses, particularly physiological responses, could serve as objective and corroborative measures of presence.

The findings suggested that measures of subjective presence, measure of subjective emotion and physiological indicators of autonomic activity are sensitive to variations in Media Form and Media Content in different ways. The main Media Form manipulation of interest (Depth: MONO vs. STEREO video presentation) affected reported presence and subjective emotion but not physiological responses. In contrast, Media Content (Content: BOAT vs. RALLY) affected presence ratings, emotion ratings and physiological responses. The results appear to show that a presence enhancing Media Form manipulation (Depth) does not intensify physiological responses to different types of Content. Therefore the predictions of the Behavioural Realism approach were not supported, and measures of Skin Conductance and Heart Rate do not appear to be good candidate objective measures of presence.

However, Experiment 1 demonstrated some evidence for an effect of the Depth manipulation on subjective emotion measures that was both generalised across Content types and specific to Content types. Furthermore, unexpected effects of Content on presence ratings and negative effects were observed in Experiment 1 and Experiment 2. As such the predictions of the Behavioural Realism approach to presence research require further investigation. In particular, it can be argued that in order to progress the investigation of presence and emotion it is necessary to identify an alternative to the Depth Media Form manipulation in order to extend the range of Contents that could be used in future experiments. Experiment 3 aims to pursue this line of reasoning by investigating the impact of a new Media Form variable (variations in eye-to-screen Visual Angle) on presence ratings, emotion ratings and physiological responses for different types of Content (BOAT vs. RALLY).

The primary aim of Experiment 3 is to establish the efficacy of the Visual Angle manipulation in producing variations in reported presence. It is expected that, in line with the presence literature, larger eye-to screen Visual Angles will generate higher ratings of presence than smaller Visual Angles (Hatada, Sakata & Kusata, 1980; IJsselsteijn et al., 2001; Lombard et al. 1997; Prothero & Hoffman, 1995; Reeves et al., 1993). Larger eye-to-screen visual angles should be associated with enhanced sensations of presence given that the video image will occupy a greater part of the viewer's visual field and therefore appear more immersive, inclusive and surrounding (Slater & Wilbur, 1997). However, when presenting an infomercial to participants on Cathode Ray Tube (CRT) television screens, Kim & Biocca (1997) did not find differences between visual angles in the range of 9.8-degrees to 33.7-degrees in terms of presence ratings. The equipment available for Experiment 3 was the CRT screen in the Platform for Immersive Television (P*i*T), which allowed visual angle variations in the range of 21-degrees to 42-degrees. Therefore, given Kim and Biocca's (1997) anomalous finding under similar conditions to those available in the P*i*T, it is necessary to confirm that the Visual Angle manipulation is an appropriate means of producing variations in presence ratings.

The secondary aim of Experiment 3 is to conduct a preliminary examination of the effects of Visual Angle on Content prior to the planned widening of the range of Contents in further experiments. Previous research suggests that, for very short duration video stimuli (6 seconds), increases in visual angle may increase subjective and autonomic arousal and may accentuate valence related differences between contents (Reeves et al., 1998; Simons et al., 1999). Therefore, there is some evidence to suggest that Visual Angle manipulations affect emotional responses. However, research which has investigated the impact of Visual Angle on both presence and emotion has tended to use single content types (Kim & Biocca, 1997, Lombard et al., 1997). In addition, the impact of Visual Angle on emotional responses for longer duration video stimuli is not well researched and the results are less clear (Reeves et al., 1993; Kim & Biocca, 1997). Hence, the effect of the Visual Angle manipulation will be evaluated for the two relatively long duration Contents used in Experiment 1 and 2 (BOAT and RALLY). The above design will allow an initial investigation of the impact of Visual Angle variations on presence and subjective and physiological emotional responses that can be easily compared with the results of previous experiments in this thesis.

The final aim of Experiment 3 is to examine Media Form and Media Content characteristics in more detail than in Experiment 1 and Experiment 2, in order to understand further the factors that may influence sensations of presence and subjective and physiological emotional responses during video presentations. Hence, new measures will be introduced in Experiment 3. Firstly, subjective post-viewing measures of short-term emotional responses elicited during viewing will compliment measures of mood change. The additional emotion measure will be used to investigate findings that suggest an association between presence and positively valanced emotion and the observation that contents used so far in this thesis may not be particularly emotive. In addition, subjective post-viewing measures of visual image quality will be used in order to examine potential trade-offs between immersion and image degradation. This is a particularly important factor to consider when using manipulations of Visual Angle as perceived image quality may degrade as visual angle (and therefore immersion) increases.

In summary, Experiment 3 aims to (1) investigate the efficacy of increasing eye-to-screen Visual Angle as a means of enhancing subjective ratings of presence, (2) provide a preliminary investigation of the effects of Visual Angle on different types of Content and (3) investigate Media Form and Media Content effects in more depth than in previous experiments.

5.2 Method

5.2.1 Design

A fully within-subjects 2 x 2 factorial design was used. 'Angle' was a within-groups factor with two levels (21-degree [SMALL] vs. 42-degree [LARGE]) and 'Content' was a within-groups factor with two levels (boat-sequence [BOAT] vs. rally-sequence

[RALLY]). Participants viewed both SMALL and LARGE visual angle presentations of both the BOAT and RALLY video sequences. The order of video presentations was fully counterbalanced across participants so that all twenty-four combinations of the Angle and Content conditions were used twice. The dependent variables were post-viewing ratings of presence, post-viewing ratings of elicited emotions, changes in mood ratings from pre-viewing to post-viewing and changes in Skin Conductance Levels and sustained Heart Rate from pre-viewing to viewing. Data concerning negative effects and visual image quality were also collected. The order of post-viewing questionnaire completion was counterbalanced so that half the participants always completed the presence ratings before the other ratings scales and half the participants did the reverse.

5.2.2 Participants

Forty-eight students from Goldsmiths College, University of London were paid £3 or received course credits for their participation (24 male, 24 females, average age = 23.73 years, SD = 6.81). Inclusion criteria were the same as outlined in Experiment 1 (Chp 3, pg. 104) with the exception that a test for stereo-acuity was not needed.

5.2.3 Video Presentation Apparatus and Materials

The viewing platform (P*i*T), video stimuli (BOAT and RALLY), visual display and video presentation method were as reported in Experiment 1 (Chp. 3, pg. 104), apart from the following differences: the screen-surround was not used, only the monoscopic presentation method was used and the Crystal Eyes spectacles were not worn by participants. In the SMALL Angle condition participants were seated in the P*i*T at a viewing distance of 175cm between the eye and screen, rendering a 21-degree horizontal visual angle video display[17]. In the LARGE Angle condition participants were seated in the P*i*T at a viewing distance of 80cm between the eye and screen, rendering a larger 42-degree horizontal visual angle video display. The 21-degree and 42-degree viewing distance were chosen as they rendered a difference in horizontal eye-to-screen visual angles between conditions that was equivalent to that used in an experiment by IJsselsteijn et al., (2001). In IJsselsteijn's experiment, the larger visual

[17] A number of methods of varying eye-to-screen visual angle were piloted including attempts to display the video via an overhead projector and digitising the content in order to vary image size. However, varying eye-to-screen distance in the P*i*T was found to be the method which allowed the largest differences in visual angle between conditions whilst also preserving video quality.

angle was rated higher in presence than the smaller visual angle for rally-driving footage from the documentary *'Eye to Eye'* (ACTS-MIRAGE, 1999) also used in the current experiment.

5.2.4 Questionnaires measures

5.2.4.1 ITC-Sense of Presence Inventory

The ITC–SOPI (Lessiter et al., 2001), as described in Experiment 1 (Chp 3, pg.109), was used as the post-viewing measure of reported presence. The '**being there**' item and the **Physical Space**, **Engagement** and **Ecological Validity** scales were used as measures of reported presence and the **Negative Effects** scale was used to check the impact of the visual angle manipulation on adverse consequences of viewing. Data from the background information sheet was not analysed as a fully within subjects design was used. The ITC-SOPI was chosen for the present experiment as it provides a detailed measure of presence with advantages in scaling and reliability over other shorter measures of presence, such as that used in Experiment 2 (the UCL-PQ). It was thought desirable to use the detailed, longer ITC-SOPI as this was the first experiment in the thesis to examine the effects of visual angle on presence. In addition, the '**being there**' item on the ITC-SOPI ensures comparability amongst findings across this thesis and wider research.

5.2.4.2 Profile of Mood States – Short Form

The Bi-polar version of the Profile of Mood States (POMS BI-POLAR: McNair & Douglas, 1984, described in Experiment 1, Chp.3, pg. 110) was modified for the purposes of this experiment as it was thought that the original questionnaire was too lengthy for the present experiment and could contribute to participant fatigue. In addition, the reliability and validity of the mood-change ratings in Experiment 1 had been questioned and it was thought desirable to include a second type of emotion rating (described in section 5.2.4.3 below). Therefore, the POMS-BI was modified in order to reduce participant demand and increase the scope of subjective emotion measurement.

The POMS-BI questionnaire contains six subscales relating to mood states with positive and negative poles. Each subscale is labelled with a positive and negative subscale item as follows: **Agreeable-Hostile**, **Clearheaded-Confused**, **Composed-Anxious**, **Confident-Unsure**, **Elated-Depressed** and **Energetic-Tired**. Based on data collected in Experiment 1 these subscale items were found to correlate highly with their respective subscale totals (after deletion of the item from the scale total) across a range of viewing conditions ($p < .001$). One item ('Depressed') did not appear on the original questionnaire. However, this descriptor was thought to be more representative of the overall mood of the negative pole of the **Elated-Depressed** scale than any of the constituent items on the scale.

In order to create a short version of the POMS BI-POLAR (the POMS-SF), the descriptors for each pole of each subscale were presented to participants as opposing ends of six visual analogue scales corresponding to the six subscales of the original questionnaire (see Appendix B1). The POMS-SF asks participants to mark the 100-millimetre long visual analogue scale to indicate which pole best describes how they feel. The instructions can be varied according to the period of time for which a mood rating is required. Participants completed the POMS-SF before each presentation with the instructions to fill it out for 'how you feel right now'. Participants also completed the POMS-SF after each presentation with instructions to fill it out for 'how you felt during the presentation'. The mark on each scale indicates a score on a continuous scale between 0 and 100 where 100 is the positive pole of each mood state and 0 is the negative pole. Mood change scores were calculated by subtracting the pre-viewing scores from post-viewing scores for each of the six scales. A positive score indicated a change towards a positive mood state. A negative score indicated a change towards a negative mood state. Scores could range between 100 and –100.

5.2.4.3 Elicited Emotion Scales

The Elicited Emotion Scales (EES) were taken from Gross and Levenson's (1995) method for evaluating the emotional impact of film clips. Participants were required to rate sixteen items which comprise of words referring to aspects of positive and negative emotion and non-specific subjective arousal (**Amusement**, **Anger**, **Arousal**, **Confusion**, **Contentment**, **Contempt**, **Disgust**, **Embarrassment**, **Fear**, **Happiness**, **Interest**, **Pain**, **Relief**, **Sadness**, **Surprise**, and **Tension**) on a nine-point scale. For each item, '0' indicates that the participant did not feel the slightest bit of that emotion during the clip while '8' indicates that they felt that emotion the most they had ever done in their life (see Appendix B2).

The EES was chosen because it has been used widely to assess the emotional impact of film stimuli (Fredrickson & Levenson, 1998; Gross, Fredrickson & Levenson, 1994).

In particular, a large-scale film ratings study reported by Gross and Levenson (1995) includes detailed ratings on the EES for a range of film stimuli thought to have high emotional impact or neutral impact. This information will provide some gauge of the emotional impact of the BOAT and RALLY presentations. In addition, rather than providing an estimate of persistent changes in mood over time, as the POMS-SF does, the measure can provide an indication of extremes of emotion felt at any moment during viewing. In conjunction with the POMS-SF, the EES will allow the BOAT and RALLY sequences to be characterised in terms of subjective valence (i.e., positive or negative emotional tone) and subjective arousal.

5.2.4.4 Visual Image Evaluation Scales

When a viewer sits closer to a television screen, aspects of the image such as pixelation and scan-line patterns may become more visible. Therefore, although the television image takes up a greater part of the viewer's visual field (and so may appear more immersive) degradations in perceived visual quality may adversely affect the viewing experience. Because viewing distance was used to manipulate Visual Angle in the present experiment, and because the visual quality of the BOAT and RALLY videos was not assessed in previous experiments, three visual analogue scales were used to assess **Image Quality**, **Image Adequacy** and **Image Brightness** (see Appendix B3 for the Visual Image Evaluation Scales [VIES]). Participants mark a 100-millimetre long un-labelled scale between a positive and negative pole. The mark for each subscale indicates a score on a continuous scale between 0 and 100 where a higher score indicates that the image was better quality, more adequate or brighter. The scales were based on recommendations from two sources: (1) The International Telecommunications Union (ITU) recommendation for the evaluation of single stimuli (ITU-R BT.500-10: International Telecommunications Union[18], 2000) and (2) Modifications of ITU-R BT.500 methods recommended by Mullin, Smallwood, Watson and Wilson (2001) and Bouche, Watson and Sasse (1998).

5.2.5 Physiological Recording Apparatus and Data Management

As in Experiment 1 and Experiment 2 the physiological measures of interest in Experiment 3 were changes in Skin Conductance Levels (**SCLs**) and sustained changes in Heart Rate (**HR**) from a 60-sec baseline (BASELINE) period immediately prior to

[18] ITU-R BT.500-11 is now in force and has superseded previous versions.

video viewing (VIEWING). The change in **SCLs** and **HR** were calculated by subtracting VIEWING levels from mean BASELINE levels (V-B).

Physiological data acquisition equipment was as for the SURROUND-OFF conditions described in Experiment 1 (the custom made system described in Appendix A1). The custom-made polygraph was chosen over the Datalab 2000™ system for a number of reasons. An evaluation of Experiments1 and 2 from a practical perspective indicated that a poor signal was often acquired using the Datalab system and this was thought to be related to the length of the recording leads in combination with the transmission of an analogue signal from the amplifiers to the PC. These factors possibly meant that biopotential signals were not well protected from mains and other electrical interference (using guidance notes and diagrams for the detection of types of noise in ECG series - Mulder 1992). In addition, a general decline in Skin Conductance (SC) data was observed in Experiments 1 and 2 when the Datalab system was used. This could indicate that stimuli provoked little SC response but may also indicate a downwards drift in the SC data due to polarisation of the skin or poor contact of the electrodes (Venables & Christie, 1980; Fowles et al., 1981). Finally, the Datalab system could not be automatically synched with video output, allowed only short segments of data at a time to be exported into an analysis package and produced text laden data files. Therefore, data management time was lengthy when the Datalab system was used. Consequently, the custom made polygraph was chosen for this, and subsequent experiments, as it used short recording leads, a digital converter in the amplifier and Ag/AgCl electrodes, which protect against drift (Venables & Christie, 1980; Fowles et al., 1981) and which have better contact with the skin. In addition, the polygraph could be automatically synched with video-output and produced a simple, time-coded and continuous dataset ready for analysis. Choice of the custom-made polygraph system was intended to be reflected in a reduction in data management time (by approximately thirty-minutes per subject), reduced subject attrition and clarification of the impact of video stimuli on SC.

Recording methods were the same as for the SURROUND-OFF conditions in Experiment 1 (Appendix A1) with one modification. Electrocardiogram (ECG) recordings were taken from a bi-polar placement of the recording electrodes on the lower rib cage rather than the left and right wrists. This modification was implemented as electrode placement over the bone of the ribcage produces a cleaner ECG signal that is less prone to participant movement and muscle tension artefacts (Campbell, personal communication, 2001; Meehan, personal communication, 2001). The modification was intended to reduce subject attrition due to poor signal acquisition, increase the ease of Heart Rate extraction from ECG signals and increase participant comfort. Participants were requested to attach their own ECG recording electrodes and leads under directions from the experimenter.

The use of the custom-made polygraph system and the new ECG recording method was not expected to radically impact on estimates of changes in SCLs and sustained HR or statistical analyses. As such, data management was the same as for the SURROUND-OFF conditions detailed in Experiment 1 (Chp 3, pg. 112) with the exceptions that (1) raw SC data was averaged and retained for analysis rather than standardised SC and (2) time-varying changes in SC were not extracted. These exceptions were implemented as no confounding effects of equipment change or between-groups comparisons were possible in the present experiment and because time-varying changes in SC were not analysed.

5.2.6 Procedure

The procedure was essentially the same as for Experiment 1 (Chp. 3, pg. 114) with the following exceptions: (1) participants viewed four video presentations in total: both SMALL and LARGE presentations of both the BOAT and RALLY video sequences, (2) the POMS-SF and not the POMS-BI was completed before and after each presentation and (3) The EES and VIES were completed in addition to the ITC-SOPI after each presentation. The procedure took approximately one hour and thirty minutes to complete. Table 5.1 summarises the procedure of Experiment 3.

The design and results of Experiments 1 and 2 informed the design of the procedure in Experiment 3, particularly with respect to physiological data collection and the design of questionnaires. However, it was recognised that there was an increase in the demands on participants. Hence the procedure was piloted by collecting oral feedback from the first participants in the experiment. Feedback indicated that the experimental procedure was suitable.

Table 5.2 Summary of procedure for Experiment 3

Stage		*Procedure*
(1)	**Arrival**	• Information about experiment given • Inclusion criteria confirmed
(2)	**Preparation**	• Participant seated in the P*i*T for either SMALL or LARGE presentation • Polygraph calibrated and tested • Instructions given
(3)	**Pre-viewing questionnaire**	• POMS-SF completed with instructions for 'how you feel right now'
(5)	**100-sec Pre-viewing period**	• Video-players and polygraph activated simultaneously • Data acquisition begins • Participant views blank screen
4)	**100sec Viewing Period**	• Video onset • BOAT or RALLY seen by participant • Physiological data acquisition continues
(6)	**100-sec Post viewing period**	• Blank screen seen by participant • Physiological data acquisition continues • Video off-set
(7)	**Post-viewing questionnaires**	• POMS-SF completed with instructions for 'how did you feel during the video' • ITC-SOPI, EES and VIES also completed
(8)	**Five-minute break**	• Participant rests
(9)	**Second presentation**	• Repeat stages 2-7 three times so that both Contents are viewed at both Angles
(11)	**End**	• Debriefing and reward

5.3 Results

The results of Experiment 3 are reported in four sections corresponding to (1) ratings of presence on the Physical Space, Engagement and Ecological Validity subscales of the ITC-SOPI and the ITC-SOPI 'being there' item, (2) ratings of emotional response on the POMS-SF and EES, (3) changes in Skin Conductance Levels (SCLs) and HR and (4) ratings of other factors which may affect viewing experience and physiological response (Negative Effects and perceived visual quality on the VIES). Significance levels are set at $p<.05$ (two-tailed) for all statistical tests, with Bonferroni corrections for Simple Effects analyses where appropriate. Non-significant results are not reported. Analyses for all dependent variables were repeated with outliers (+/-3.29 SDs of the mean) excluded. Results for the latter analysis are reported where the pattern of results obtained with outliers excluded diverged from that obtained with the total sample.

5.3.1 Results: Presence Ratings

5.3.1.1 Analysis: ITC-SOPI

Table 5.2 presents the group mean ratings for the 'being there' item and the three presence related scales of the ITC-SOPI: Physical Space, Engagement, and Ecological Validity. A 2 x 2 ANOVA was calculated for each scale, with Angle (SMALL vs. LARGE) and Content (BOAT vs. RALLY) serving as within-groups factors.

Table 5.2 Effects of Angle and Content on the group mean scores of the ITC-SOPI subscales and 'being there' item.

	Content	**BOAT**		**RALLY**	
ITC-SOPI	***Angle***	**SMALL**	**LARGE**	**SMALL**	**LARGE**
'Being There'	***Mean***	2.69	2.79	2.56	3.10
	SD	*(1.09)*	*(1.13)*	*(1.10)*	*(1.12)*
Physical Space	***Mean***	2.13	2.23	2.09	2.26
	SD	*(0.68)*	*(0.66)*	*(0.65)*	*(0.65)*
Engagement	***Mean***	2.68	2.83	2.67	2.86
	SD	*(0.68)*	*(0.65)*	*(0.64)*	*(0.66)*
Ecological Validity	***Mean***	3.51	3.47	3.20	3.34
	SD	*(0.69)*	*(0.75)*	*(0.66)*	*(0.60)*

Looking first at the effects of Angle, significant main effects of Angle were found for the 'being there' item and on the Physical Space and Engagement subscales. The LARGE presentations received higher ratings on these scales than SMALL presentations: '**Being there**' ($F_{(1,47)} = 8.33$, $p < .01$; SMALL mean = 2.63, LARGE= 2.95), **Physical Space** ($F_{(1,47)} = 8.08$, $p<.01$; SMALL mean = 2.67, LARGE = 2.85) and **Engagement** ($F_{(1,47)} = 7.97$, $p<.01$; SMALL mean = 2.11, LARGE = 2.25) subscales. The results indicate that the LARGE angle presentations generated a greater 'sense of being there', gave an enhanced sensation of physical space and were more engaging than SMALL angle presentations. A significant main effect of Angle was not observed for the **Ecological Validity** subscale.

Significant main effects of Content were also found on one ITC-SOPI presence related subscale: **Ecological Validity** ($F_{(1,47)} = 7.04$, $p<.05$; BOAT = 3.50, RALLY = 3.27). The means indicate that BOAT presentations generated higher ratings of **Ecological Validity**, and perhaps appeared more naturalistic, than RALLY presentations. Significant main effects of Content were not observed for the '**being there**' item and on the **Physical Space** and **Engagement** subscales.

Effects size were moderate to large or large (0.13 < eta-squared < 0.16) for all significant tests indicating that the results can be safely accepted. Effect sizes were low for all other tests (eta-squared < .02) with the exception of tests for an interaction of Content by Angle on the '**being there**' item (eta-squared = .06) and the **Ecological Validity** subscale (eta-squared = .08) in which case effect sizes were moderate. In addition, Content by Angle interactions approached significance for the '**being there**' item (p=.08) and the **Ecological Validity** subscale (p=.06). No other significant results were observed[19].

5.3.1.2 Summary of Results: ITC-SOPI

The analysis of the ITC-SOPI provided evidence to suggest that ratings of presence were sensitive to both Angle and Content manipulations. The prediction that LARGE Angle presentations would receive higher ratings of presence than SMALL Angle presentations was supported. The results also supported the results of Experiment 1 and Experiment 2 in that BOAT presentations received significantly higher ratings of presence than RALLY presentations.

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[19] When the analysis was repeated with outliers excluded a significant Content by Angle interaction for the '**being there**' item emerged ($F_{(1,45)} = 4.42$, $p < .05$).

However, the findings were somewhat inconsistent with Experiments 1 and 2. A main effect of the display manipulation on ratings of **Ecological Validity** was not observed in the present experiment. In addition, main effects of Content on **Physical Space**, **Engagement** and the '**being there**' item were also absent in the present experiment. Furthermore, significant Content by Angle interactions for **Physical Space** and **Engagement** were not observed in the present experiment. However, there was some evidence for Content by Angle interactions for ratings of **Ecological Validity** and '**being there**', which were not observed in Experiment 1 and Experiment 2.

5.3.2 Results: Emotion Ratings

Table 5.3 presents the group mean change in mood ratings from pre-viewing to post-viewing on the six visual analogue scales of the POMS-SF: **Agreeable-Hostile**, **Clearheaded-Confused**, **Confident-Unsure**, **Composed-Anxious**, **Elated-Depressed**, and **Energetic-Tired**. Table 5.3 also presents the group mean ratings for the sixteen items of the EES: **Amusement**, **Anger**, **Arousal**, **Confusion**, **Contentment**, **Contempt**, **Disgust**, **Embarrassment**, **Fear**, **Happiness**, **Interest**, **Pain**, **Relief**, **Sadness**, **Surprise**, and **Tension**. A 2 x 2 ANOVA was calculated for each scale of the POMS-SF and each item of the EES, with Angle (SMALL vs. LARGE) and Content (BOAT vs. RALLY) serving as within-groups factors.

Table 5.3 Effects of Angle and Content on the group mean changes in scores on the POMS-SF visual analogue scales and group mean scores on EES items.

Questionnaire	Content / Angle	BOAT SMALL	BOAT LARGE	RALLY SMALL	RALLY LARGE
Profile of Mood Sates – Short Form					
Agreeable-Hostile	*Mean*	0.50	-1.21	-8.25	-6.66
	SD	*(13.46)*	*(13.03)*	*(12.87)*	*(15.23)*
Clearheaded-Confused	*Mean*	-4.21	0.22	-2.35	-3.58
	SD	*(15.84)*	*(15.83)*	*(20.02)*	*(15.37)*
Composed-Anxious	*Mean*	3.38	2.34	-5.96	-9.78
	SD	*(21.55)*	*(18.29)*	*(20.48)*	*(24.21)*
Confident-Unsure	*Mean*	-0.21	4.67	-3.17	-2.23
	SD	*(18.79)*	*(17.22)*	*(12.69)*	*(17.49)*
Elated-Depressed	*Mean*	-1.27	4.35	-3.13	2.84
	SD	*(11.95)*	*(11.36)*	*(18.76)*	*(14.15)*
Elicited Emotion Scales					
Amusement	*Mean*	1.62	2.08	2.26	2.52
	SD	*(1.67)*	*(1.97)*	*(1.74)*	*(2.13)*
Anger	*Mean*	0.40	0.13	0.26	0.40
	SD	*(1.11)*	*(0.33)*	*(0.84)*	*(1.12)*
Arousal	*Mean*	1.28	1.48	1.81	2.15
	SD	*(1.70)*	*(1.07)*	*(1.76)*	*(2.08)*
Confusion	*Mean*	0.63	0.75	0.81	1.15
	SD	*(1.00)*	*(1.35)*	*(1.36)*	*(1.65)*
Contentment	*Mean*	3.31	3.38	2.10	2.18
	SD	*(1.96)*	*(2.08)*	*(1.62)*	*(1.81)*
Contempt	*Mean*	0.67	0.47	0.53	0.47
	SD	*(1.48)*	*(1.16)*	*(1.01)*	*(1.01)*
Disgust	*Mean*	0.25	0.04	0.27	0.34
	SD	*(1.10)*	*(0.29)*	*(1.00)*	*(0.86)*
Embarrassment	*Mean*	0.30	0.19	0.17	0.29
	SD	*(1.07)*	*(0.61)*	*(0.66)*	*(0.87)*
Fear	*Mean*	0.09	0.24	0.60	0.90
	SD	*(0.40)*	*(0.80)*	*(1.00)*	*(1.43)*
Happiness	*Mean*	2.74	3.06	2.12	2.20
	SD	*(1.72)*	*(1.83)*	*(1.65)*	*(1.92)*
Interest	*Mean*	2.75	3.03	2.91	3.08
	SD	*(2.12)*	*(2.11)*	*(1.80)*	*(1.89)*
Pain	*Mean*	0.13	0.06	0.04	0.04
	SD	*(0.61)*	*(0.24)*	*(0.29)*	*(0.20)*
Relief	*Mean*	1.54	1.41	0.55	0.51
	SD	*(2.01)*	*(2.02)*	*(1.03)*	*(1.25)*
Sadness	*Mean*	0.79	0.51	0.30	0.19
	SD	*(1.40)*	*(0.94)*	*(0.99)*	*(0.67)*
Surprise	*Mean*	0.76	0.94	0.96	1.36
	SD	*(1.32)*	*(1.37)*	*(1.27)*	*(1.48)*
Tension	*Mean*	0.89	0.92	1.59	2.05
	SD	*(1.36)*	*(1.54)*	*(1.82)*	*(1.84)*

5.3.2.1 Analysis: Profile of Mood States – Short Form

Significant main effects of Angle were observed on two POMS-SF visual analogue scales: **Elated-Depressed** ($F_{(1,47)} = 6.71$, $p<.05$; SMALL = -2.20, LARGE = 3.59) and **Energetic-Tired** ($F_{(1,47)} = 4.15$, $p<.05$; SMALL = -3.68, LARGE = 0.49). The means indicate that SMALL angle presentations generated increases in depressed mood and tiredness, relative to an increase in elation and maintained energy for LARGE angle presentations. No other main effects of Angle were observed.

Significant main effects of Content were found on three POMS-SF visual analogue scales: **Agreeable-Hostile**, ($F_{(1,47)} = 9.07$, $p<.01$; BOAT = -0.36 , RALLY = -7.46), **Composed-Anxious** ($F_{(1,47)} = 7.77$, $p<.01$; BOAT = 2.86 , RALLY = -7.87) and **Energetic-Tired** ($F_{(1,47)} = 4.85$, $p<.05$; BOAT = -5.47 , RALLY = 2.29) scales. In addition, a main effect of Content on the **Confident-Unsure** scale approached significance ($F_{(1,47)} = 4.01$, $p = .051$; BOAT = 2.23, RALLY = -2.70). The means indicate that BOAT presentations maintained agreeableness and increased composure, tiredness and confidence, relative to an increase in hostility, anxiety, energy and feeling unsure for the rally-sequence. No other significant main effects of Content were observed and no significant interactions between Angle and Content were observed.

Effect sizes were moderate to large or large (0.13 < eta-squared < 0.16) for all significant tests. This was with the exception of the significant tests of Content (eta-squared = 0.09) and Angle (eta-squared = 0.08) on the **Energetic-Tired** Scale and the test of Content on the **Confident-Unsure** scale (eta-squared = 0.08). Effects sizes were low or low to moderate for all other tests (eta-squared < .03). These finding indicate that most significant results may be safely accepted but that those tests involving the **Energetic-Tired** and **Confident-Unsure** scales may have low replicability.

5.3.2.2 Analysis: Elicited Emotion Scales

Significant main effects of Angle were found for three EES items. In each case LARGE angle presentations received significantly higher ratings than SMALL angle presentations: **Amusement** ($F_{(1,47)} = 6.30$, $p<.05$; SMALL = 1.94, LARGE= 2.30), **Arousal** ($F_{(1,47)} = 4.59$, $p<.05$; SMALL = 1.54, LARGE = 1.81) and **Fear** ($F_{(1,47)} = 4.25$, $p<.05$; SMALL = 0.34, LARGE = 0.57). The data indicate that LARGE angle presentations were more arousing and emotive than SMALL angle presentations, but could not be described as either positive or negative in comparison to SMALL angle presentations. No other significant main effects of Angle were observed.

A significant main effect of Content was observed for eight of the EES items. In four cases BOAT presentations received significantly higher ratings than RALLY presentations: **Contentment** ($F_{(1,47)}$ = 22.09, p<.001; BOAT = 3.34, RALLY = 2.14), **Happiness** ($F_{(1,47)}$ = 13.46, p<.01; BOAT = 2.90, RALLY = 2.16), **Relief** ($F_{(1,47)}$ = 18.12, p<.001; BOAT = 1.48, RALLY = 0.53) and **Sadness** ($F_{(1,47)}$ = 8.46, p<.01; BOAT = 0.65, RALLY = 0.25). In a further four cases RALLY presentations received significantly higher ratings than BOAT presentations: **Amusement** ($F_{(1,47)}$ = 7.65, p<.01; BOAT = 1.85, RALLY = 2.39), **Arousal** ($F_{(1,47)}$ = 8.62, p<.01; BOAT = 1.38, RALLY = 1.98), **Fear** ($F_{(1,47)}$ = 22.38, p<.001; BOAT = 0.16, RALLY = 0.75) and **Tension** ($F_{(1,47)}$ = 16.56, p<.001; BOAT = 0.91, RALLY = 1.82). No other significant main effects of Content were observed. The data indicate that neither sequence can be described as comparatively positive or negative given that the each sequence received relatively higher or lower ratings on a mix of both positive and negative emotion terms. However, it appeared that RALLY presentations were more subjectively arousing than BOAT presentations. No other significant effects were observed.

Effect sizes were large for all significant tests of Content (0.14 < eta-squared < 0.32) indicating that these results may be safely accepted. Significant tests of Angle were associated with moderate to large effect sizes (0.08 < eta-squared < 0.12) indicating relatively lower replicability for tests of Angle. Effect sizes were low or moderate for all other tests (eta-squared < 0.70). However, although some large and moderate to large effect sizes were observed for tests of Content and Angle, scores were generally low on the EES. Indeed, in comparison to Gross and Levenson's (1995) ratings study, ratings for any emotion term for BOAT and RALLY presentations were very low.[20]

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[20] Gross and Levenson (1995) developed a set of rated video clips, each of which elicited one target emotion (Amusement, Sadness, Contentment, Anger, Fear or Surprise). Ratings of the target emotion for a video clip (e.g., ratings of Amusement for an amusing clip) were significantly higher than for other clips (e.g., ratings of Amusement for a surprising clip) and were significantly higher than ratings of all other emotion terms for that clip (e.g. Amusement ratings were higher than ratings of Surprise for the amusing clip). Mean ratings of the target emotion for each clip ranged between 3.46 and 6.05). See Experiment 4 (Chapter 6) for a more detailed discussion of the Gross and Levenson (1995) study.

Furthermore, scores were often close to zero on an eight-point scale with some very low scores yielding smaller standard deviations than higher scores. These details indicate that 1) floor-effects may have produced spurious significant results, 2) the BOAT and RALLY presentations may not have elicited strong emotions and 3) the BOAT and RALLY presentations may not have elicited any specific emotion type.

5.3.2.3 Summary of Results: Emotion Ratings

The analysis of the emotion ratings questionnaires (the POMS-SF and EES) provided evidence to suggest that, in line with predictions, ratings of emotion were sensitive to both Angle and Content manipulations.

Results for mood ratings on the POMS-SF were broadly in line with those reported in Experiment 1. LARGE angle presentations produced increases in positive mood and subjective arousal relative to SMALL angle presentations. In addition, BOAT presentations were generally associated with maintained or increased positive mood and decreased subjective arousal in comparison to increases in negative mood and subjective arousal for RALLY presentations. Therefore, in line with Experiment 1, the common feature of the higher presence Angle condition (LARGE) and the higher presence Content condition (BOAT) was a change towards a more positive mood state over the course of viewing.

The results of the EES analysis pose a challenge to the finding that higher presence conditions were positively valanced. In terms of extremes of specific emotion types experienced during viewing, neither Angle condition and neither Content condition could be described as more positively or negatively valanced than the other. In addition, inspection of the data indicated that EES ratings of all presentations were very low in comparison to ratings of video stimuli appearing in published research (Gross & Levenson, 1995). As such, the suggestion that experimental manipulations implemented so far in this thesis have a small impact on subjective emotion is partially supported. It is possible that significant findings for emotion ratings reported in Experiment 1 and in the present experiment represent reliable but very small differences between experimental conditions.

Finally, no evidence for an interaction between Angle and Content was apparent for ratings on either the POMS-SF or EES. The result is inconsistent with the results presented in Experiment 1 in which evidence for a Depth by Content interaction on the POMS-BI Composed-Anxious scale was observed. The finding suggests that there was no content-specific effect of a presence enhancing display property on subjective emotion in the current experiment. It may be useful to interpret this result in the context of subjective arousal ratings on the POMS-SF and EES, which both indicated a disassociation between ratings of presence and rating of subjective arousal. LARGE angle presentations increased subjective arousal and presence in comparison to SMALL angle presentations, whereas BOAT presentations decreased subjective arousal and increased presence in comparison to RALLY presentations. The implications of this observation for the predictions of the Behavioural Realism approach and also for interpretation of the physiological data will be explored further in the Discussion section.

5.3.3 Results: Physiological Measures

5.3.3.1 Analysis: Physiological Measures

Prior to analysis of the effects of interest a 2 x 2 ANOVA was calculated for both resting SCLs and HR in order to check for resting baseline differences in SCLs and HR between presentations. Angle^{BASELINE} (SMALL vs. LARGE) and Content^{BASELINE} (BOAT vs. RALLY) served as the within-groups factors. No significant effects were observed, indicating a limited probability of the LIV affecting SCL and HR data. The analysis of baseline-to-stimulus changes in SCLs and HR then proceeded. Table 5.4 presents total group mean changes in SCLs (micromhos) and HR (bpm) from the resting baseline period over the entire 100sec viewing period.

Table 5.4 Effects of Content and Angle on group mean changes in SCLs (micromhos) and HR (bpm) from the resting baseline to the 100-sec viewing period.

	Content	**BOAT**		**RALLY**	
Physiological Measure	**Angle**	**SMALL**	**LARGE**	**SMALL**	**LARGE**
Change in SCLs	***Mean***	-2.92	-3.12	-1.99	-1.79
	SD	*(3.15)*	*(4.28)*	*(3.98)*	*(3.58)*
Change in HR	***Mean***	-1.33	-1.80	-0.34	-0.14
	SD	*(3.08)*	*(2.36)*	*(2.84)*	*(2.42)*

In order to assess the effects of Angle and Content on SCLs and HR from BASELINE levels to video VIEWING levels (V-B) a 2 x 2 ANOVA was calculated for both SCLs and HR with Angle$^{V\text{-}B}$ (LARGE vs. SMALL) and Content$^{V\text{-}B}$ (BOAT vs. RALLY) serving as within-groups factors. A significant main effect of Content$^{V\text{-}B}$ was found for SCLs ($F_{(1,47)} = 4.47$, $p < .05$; BOAT = -3.02, RALLY = -1.89) and HR ($F_{(1,47)} = 11.18$, $p < .01$; BOAT = -1.56, RALLY = -0.24). The means indicate that there was a larger decrease in SCLs and HR for BOAT presentations relative to RALLY presentations. No significant main effect of Depth was observed and no other significant effects were observed.

The effect size for the test of Content$^{V\text{-}B}$ on SCLs was moderate (eta-squared = 0.09) and large for the tests of Content$^{V\text{-}B}$ on HR (eta-squared = 0.19). Effect sizes were low for all other tests (eta-squared < 0.02). These findings indicate that the effects of Content^{VIEWING} on HR were reliable while the effects of Content on SCLs^{VIEWING} were less so.

5.3.3.2 Summary of Results: Physiological Measures

The analysis of changes in physiological indicators of autonomic activity during viewing indicated an effect of Content on changes in SCLs and HR. The results supported the findings of Experiment 1 and Experiment 2 in which BOAT presentations produced greater decreases in SCLs and HR than the rally-sequence. The SCL and HR findings support the finding that BOAT presentations are subjectively less arousing than RALLY presentations. However, similar results are not apparent for the Angle manipulation, which also produced effects on subjective arousal. In addition, and in line with Experiments 1 and 2, no interaction between Angle and Content was apparent, providing little evidence for a content-specific effect of a presence enhancing display manipulation on SCLs and HR. Finally, steps were taken to protect against downwards drift in the SC data. Given that overall declines in SC were again apparent for both types of Content it is possible that the Contents were not arousing in autonomic terms.

5.3.4 Results: Negative Effects scale and Visual Image Evaluation Scales

5.3.4.1 Analysis: Negative Effects and Visual Image Evaluation Scales

Table 5.5 presents the group mean ratings on the ITC-SOPI **Negative Effects** scale and the three VIES visual analogue scales: **Image Quality**, **Image Adequacy** and **Image**

Brightness. A 2 x 2 ANOVA was calculated for each scale, with Angle (SMALL vs. LARGE) and Content (BOAT vs. RALLY) serving as within-groups factors.

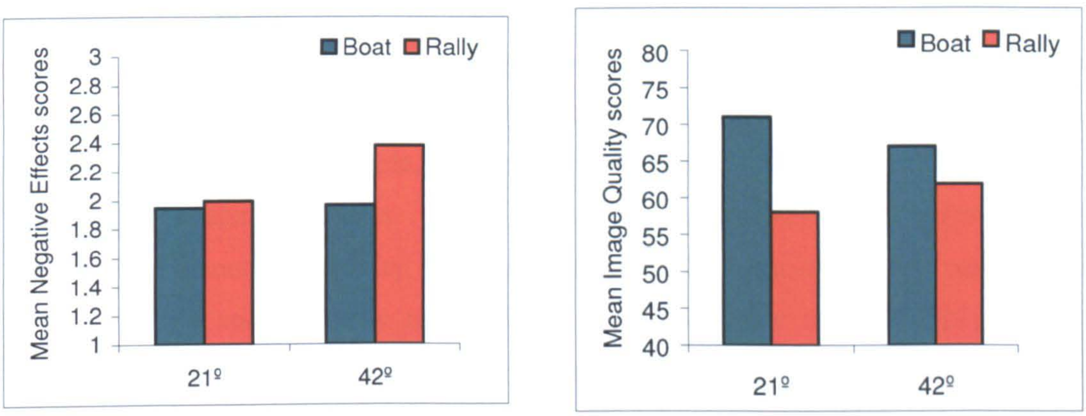
Table 5.5 Effects of Content and Angle on the group mean scores on the ITC-SOPI Negative Effects scale and the VIES.

Questionnaire	Content / Angle	BOAT SMALL	BOAT LARGE	RALLY SMALL	RALLY LARGE
ITC-SOPI Negative Effects					
Negative Effects	***Mean***	1.95	1.97	2.00	2.38
	SD	*(0.46)*	*(0.61)*	*(0.63)*	*(0.91)*
Visual Image Evaluation Scales					
Image Quality	***Mean***	71.04	67.06	58.08	61.90
	SD	*(19.11)*	*(23.54)*	*(19.02)*	*(20.83)*
Image Adequacy	***Mean***	69.58	67.77	63.27	63.98
	SD	*(20.80)*	*(22.85)*	*(20.15)*	*(22.28)*
Image Brightness	***Mean***	66.88	66.02	70.50	71.75
	SD	*(18.18)*	*(20.04)*	*(16.20)*	*(17.10)*

Looking first at effects of Angle, a significant main effect of Angle was found on the **Negative Effects** subscale ($F_{(1,47)}$ = 5.00, p<.05; SMALL = 1.98, LARGE= 2.18) indicating that LARGE angle presentations generated more adverse consequences of viewing than SMALL angle presentations. In addition, significant main effects of Content were found on the **Negative Effects** ($F_{(1,47)}$ = 8.85, p<.01; BOAT = 2.74, RALLY = 2.24), **Image Quality** ($F_{(1,47)}$ = 9.03, p<.01; BOAT = 69.05, RALLY = 59.99;) and **Image Brightness** ($F_{(1,47)}$ = 5.07, p<.05; BOAT = 66.45, RALLY = 71.13) scales. The data indicate that RALLY presentations generated more adverse consequences of viewing and were perceived to be lower in quality and brighter than BOAT presentations. No significant main effect of Angle was observed for the **Image Adequacy** item and no significant main effect of Content was found on any of the scales.

Significant interactions of Content and Angle were found on the **Negative Effects** ($F_{(1,47)}$ = 6.84, p<.05) and **Image Quality** ($F_{(1,47)}$ = 6.14, p<.05) scales – see Figure 5.1. Follow up comparisons with a Bonferroni correction revealed three significant comparisons. On the **Negative Effects** scale RALLY presentations received higher ratings than BOAT presentations for LARGE angle viewing conditions (t = -3.42, df = 47, p<.01). In addition, LARGE angle presentations received higher ratings than the

SMALL angle presentations for the RALLY video clip (t = 2.96, df = 47, p<.01). The data indicate that LARGE angle presentations of the RALLY video clip generated more adverse consequences of viewing (such as eye-strain, headache and nausea) than other conditions. On the **Image Quality** scale RALLY presentations received lower ratings than BOAT presentation for SMALL angle viewing conditions (t = 2.63, df = 47, p<.0125). The data indicate that the perceived **Image Quality** of the RALLY video was degraded in comparison to the BOAT video for SMALL angle presentation, but that for LARGE angle presentations (closer to the screen) perceived image quality of BOAT presentations was degraded to an equivalent degree.



(a)Negative Effects *(b)Image Quality*

Figure 5.1 Effects of Angle and Content on group mean scores for (a) the ITC-SOPI Negative Effects Scale and (b) Image Quality ratings on the VIES.

Effects sizes were moderate to large or large for all significant tests (0.10 < eta-squared < 0.16). Effect sizes were low for all other tests (eta-squared < 0.02). These findings indicate that the significant results may be safely accepted.

5.3.4.2 Summary of Results: Negative Effects and Visual Image Evaluation Scales

Ratings of Negative Effects and visual quality were included in the current experiment in order to check for potential confounds of the Angle manipulation with viewing distance/image resolution. When a viewer sits closer to a television screen aspects of the image such as pixelation and scan-line patterns may become more visible to participants. In addition, because the image fills a greater part of the viewer's visual field aspects of Content (such as movement and brightness) may have a greater impact on the viewer. Hence, aspects of visual quality and negative effects are potentially affected by viewing distance to a television display and in turn may be associated with presence ratings and emotional responses, particularly subjective and physiological stress-related responses.

Given that LARGE angle presentations (closer to the screen) were rated higher in presence than SMALL angle presentations it can be argued that in the present experiment the immersive properties of the LARGE visual angles presentations were not degraded by the effects of viewing distance on negative effects and visual quality. However, findings for the **Negative Effects** scale and the VIES suggest that presence ratings and emotional responses may have been affected by confounding factors in the present experiment. For example, Contents differed in terms of Negative Effects, Image Quality and Image Brightness. These factors may potentially affect physiological indicators of autonomic activity. As such, observed differences between contents in terms of **SCLs** and **HR** may be attributed to factors other than elicited emotion. Furthermore, the relatively high incidence of **Negative Effects** for LARGE angle RALLY presentations and the overall degradation in **Image Quality** at the LARGE angle presentations, particularly for the BOAT video, may in part explain the absence of strong Content by Angle interactions for presence ratings (assuming a trade-off between image quality, negative effects and sensations of presence) and the absence of Content by Angle interactions for emotional responses (given that factors other than presence may have affected subjective and physiological emotional responses).

5.4 Discussion

To summarise the results of Experiment 3 it may be said that (1) variations in eye-to-screen Visual Angle affected subjective ratings of presence and subjective ratings of emotion (2) variations in Content affected subjective ratings of presence, subjective ratings of emotion and physiological responses and (3) the effects of Visual Angle and Content were independent in terms of ratings of presence, ratings of emotion and physiological responses. In addition, effects of Visual Angle and Content and interactions between Visual Angle and Content were seen for measures of negative effects and visual quality.

The primary aim of the current experiment was to evaluate whether increasing eye-to-screen Visual Angle was an adequate means of increasing subjective ratings of presence. This was found to be the case given that LARGE angle presentations produced significantly higher ratings of the sense of **'being there'**, **Physical Space** and **Engagement** in comparison to the smaller angle presentations. The finding is in line with previous research (Hatada et al., 1980; IJsselsteijn et al., 2001; Lombard et al., 1997; Prothero & Hoffman, 1995; Reeves et al., 1993) and may be expected given that video displays viewed at larger Visual Angles should appear to be more 'inclusive' and 'surrounding' (Slater & Wilbur, 1997). The findings suggest that the Visual Angle manipulation can be used in further experiments investigating the effects of Media Form variations on different types of content.

However, there were some discrepancies between results of the current experiment and those reported in Experiment 1 and Experiment 2 in terms of subjective ratings of presence. Specifically, presence-related scales that were affected by Media Content and Media Form variations in previous experiments were not affected in the current experiment. For example, Angle did not affect **Ecological Validity** in the present experiment, whereas Depth affected **Ecological Validity** in Experiment 1. More strikingly, differences between contents were restricted to **Ecological Validity** ratings in the current experiment. Furthermore, evidence for Content by Angle interactions, in terms of presence ratings, was not as strong as in Experiment 1. The observed discrepancies between current and previous findings may indicate instability in presence measures or perhaps specific effects of different display types on different elements of presence. It is also possible that factors such as **Negative Effects** and **Image Quality** may affect Visual Angle effects on presence ratings and this will be considered in the discussion of further findings and the thesis as a whole (see Chapter 8: General Discussion).

The secondary aim of Experiment 3 was to conduct a preliminary examination of the effects of Visual Angle on Content prior to the planned widening of the range of Contents in further experiments. Previous research suggests that, in line with the Behavioural Realism approach to presence research, increases in Visual Angle may increase subjective and autonomic arousal and may accentuate valence-related differences between contents (Reeves et al., 1998; Simons et al., 1999). The present experiment demonstrated that Visual Angle enhanced ratings of presence and increased some indicators of subjective arousal on the POMS-SF and EES across Content types. However, there was no evidence for effects of Visual Angle on emotion ratings that was specific to Contents, such as accentuating valence-related differences between Contents. The latter finding is in contrast to Experiment 1. In addition, while Contents were shown to differ in terms of changes in physiological measures (SCLs and HR), Visual Angle did not affect physiological measures in a way that was either generalised across Contents or specific to Content types. Furthermore the observation in Experiment 1 that higher presence presentations may be associated with positively valanced emotional responses was challenged by the results of Experiment 3.

By using Gross and Levenson's (1995) Elicited Emotion Scales (EES) it was possible to examine the emotional impact of Visual Angle and Content in more depth than previous experiments in the thesis. The EES measures the strength of short-term emotional responses experienced during video viewing. The results of the EES supported results for the POMS-SF in terms of subjective arousal indicating that LARGE angle and RALLY presentations were more subjectively arousing than SMALL angle and BOAT presentations respectively. However, the EES indicated that (1) the BOAT and RALLY video sequences and the LARGE and SMALL angle presentations could not be described as comparatively positively or negatively valanced, (2) the emotional impact of the BOAT and RALLY video sequences may have been weak and diffuse (in contrast to the previous assumption that the BOAT sequence was calming and the RALLY sequence was exciting).

The above observations, in conjunction with observed Content effects on measures of negative effects and visual quality, have a number of consequences for the interpretation of findings and also future testing of Behavioural Realism predictions. The Behavioural Realism approach to presence research would predict that subjective and physiological emotional responses to mediated content should increase as presence increases. However, if the method of enhancing presence is subjectively and physiologically arousing in itself (e.g., by increasing negative effects or stimulus intensity) then one may expect that some Content effects will not follow the predictions of the Behavioural Realism approach (e.g., calming stimuli may be more relaxing at higher levels of presence, but not if the means of enhancing presence is exciting to the viewer). Similarly Content with little emotional impact (i.e., neutral content) may not be expected to be affected by presence enhancing display manipulations, as the

Behavioural Realism approach would predict that neutral content should remain neutral at higher levels of presence.

If the arguments above were to be rejected the results of Experiments 1, 2, and 3 would suggest little evidence for an association between presence and emotion, and therefore little justification for using subjective and physiological measures of emotion as objective and corroborative measures of presence. However, it is possible that the arguments presented above apply to the design and results of research presented in Experiments 1, 2 and 3. As such, Experiments 1, 2 and 3 have not adequately tested the predictions of the Behavioural Realism approach. Therefore, the observation that manipulations of Media Form and Media Content may have effects on measures other than presence, emotion and physiological arousal (such as negative effects and visual quality), which may serve as confounding variables, will be considered in the design of further experiments and the interpretation of findings. More importantly the focus of further experiments will follow the reasoning that Contents tested so far in this thesis may be relatively neutral in emotional tone, and hence unsuitable for testing the predictions of the Behavioural Realism approach.

In summary, Experiment 3 has fulfilled its primary aim of confirming that increasing eye-to-screen Visual Angle is an adequate means of enhancing ratings of presence. Furthermore, the preliminary investigation of the effects of Visual Angle on different types of Content, in terms of emotional responses, revealed little evidence in support of the Behavioural Realism approach (i.e., an effect of variations in presence on emotional responses that is dependent on the emotional tone of the content). However, a close examination of the Visual Angle and Content manipulations revealed the presence of multiple and potentially conflicting influences on dependent variables, such as increases in negative effects and visual image degradation in conjunction with increased immersion. In addition, there is evidence to suggest that the BOAT and RALLY Contents used in this experiment are relatively neutral in tone and therefore unsuitable for testing the predictions of the Behavioural Realism approach in the current experimental context. This latter observation in particular provides further justification for broadening the range of contents to be used in future experiments, specifically a re-examination of the proposal that presence enhancing eye-to-screen Visual Angle variations will enhance subjective and physiological emotional reactions to different types of content. This argument will be pursued in Experiment 4.

Chapter 6 EXPERIMENT 4:

Effects of Film Clips on Subjective Ratings of Presence and Emotion

6.1 Introduction

In preceding experiments in this thesis the effects of Media Form and Media Content variables on subjective ratings of presence, subjective ratings of emotion and physiological responses were investigated. It was predicted that Media Form manipulations that enhanced ratings of presence would also intensify subjective and physiological emotional responses. Of particular interest was a prediction arising from the Behavioural Realism approach to presence research which suggested that differences between contents, in terms of emotional response, would be enhanced as presence increased. Such a finding would indicate that measures of emotion could be utilised as objective and corroborative indicators of presence.

The findings of previous experiments indicated that measures of presence, subjective emotion and physiological response were sensitive to variations in Media Form and Media Content, but in different ways. Increasing the immersive properties of a display, by adding binocular depth cues (Experiment 1, Chp. 3) and increasing eye-to-screen visual angle (Experiment 3, Chp. 5), resulted in increases in both ratings of presence and subjective emotional intensity across content types. In addition, there was evidence to suggest that differences between types of content, in terms of mood change, were enhanced as presence increased (Experiment 1). However, the findings for subjective emotion were not reflected in physiological indicators of autonomic arousal (changes in Skin Conductance Levels and changes in Heart Rate) and were not consistent across experiments. In particular, increased eye-to-screen visual angle did not enhance differences between contents in terms of emotional responses (Experiment 3).

Two possible reasons for the latter finding were suggested: (1) the contents used were neutral in emotional tone and as such a presence enhancing display property would not be expected to intensify emotion related differences between the contents or (2) increased visual angle (and hence presence) does not enhance differences between contents in terms of emotional response. Before examining proposal (2), it was argued that proposal (1) required further investigation as there was evidence to suggest that the contents used in previous experiments (the boat-ride [BOAT] and rally-driving [RALLY] video sequences) were limited in their capacity to elicit strong emotions.

Therefore, the first aim of Experiment 4 is to determine whether the BOAT and RALLY video sequences may be best categorised as *Emotive* or *Neutral* in subjective emotional tone. The categorisation of the BOAT and RALLY sequences will be achieved using a ratings study analysed in two steps (see Results: Part One) involving the development of a set of video clips that elicit a variety of specific emotions (*Amusement, Anger, Contentment, Disgust, Fear, Sadness, Surprise* and *Neutral*) and then the comparison of the BOAT and RALLY sequences with the video clips. The correct categorisation of the BOAT and RALLY sequences will aid the interpretation of previous findings in this thesis.

The second aim of Experiment 4 is to develop sets of video stimuli that could be used to examine proposal (2) – the effects of eye-to-screen visual angle on emotional responses. In order to achieve this secondary aim, sets of *Emotive* and *Neutral* video clips will be developed from the video clips assessed in Part One, (see Results: Part Two). The sets will be developed according to the following criteria. Categories of both positively and negatively valanced *Emotive* clips should be developed along with *Neutral* clips in order to increase the generalisability of future findings. In addition, categories of positive and negative *Emotive* clips should contain clips that are similar in the quality of emotion they elicit in order to avoid confounds between valance and arousal. For example, '*Amusement*' and '*Contentment*' are examples of positive emotions yet are associated with different levels of physiological and subjective arousal and as such should not be grouped together. Additionally, it is thought desirable to maximise the number of clips in each category in order to further increase the generalisability of future findings.

The video clips to be assessed in Experiment 4 are drawn from a number of sources and the majority are segments of narrative film. In addition to descriptions of emotional impact, video clips such as these may be described along numerous dimensions, such as production values, plot, character types and so on. Therefore, in addition to being rated for emotional impact the video clips will also be rated for presence, arousal, interest, identification, empathy and familiarity. These types of ratings were chosen because they broaden the way in which video clips may be described, may be useful for increasing experimental control in future research and, importantly, have been identified as factors which may be associated with emotional responses to narrative film (both in this thesis and in the wider film theory literature: e.g., Plantinga & Smith, 1999).

The third aim of Experiment 4 is to examine the categories of video clips retained after the initial stages of analysis in more detail and using the ratings described above. In particular, the ratings will be used to examine statistical associations between subjective emotional responses and subjective ratings of presence in response to video clips which elicit different types of emotions (see Results: Part Three). This method of examining the relationship between presence and emotion is an alternative and complimentary method to the one implemented so far in this thesis. The Behavioural Realism approach implies that emotional responses will become more intense as presence increases. Therefore, it can be predicted that category emotions (e.g., ratings of amusement in the *Amusement* category of video clips) will positively correlate with ratings of presence.

In order to fulfil the three aims of Experiment 4 a ratings experiment will be conducted based on Gross and Levenson's (1995) study of the emotional impact of video stimuli. Gross and Levenson (1995) developed a collection of sixteen video-clips that can be described as either *Emotive* or *Neutral*. The *Emotive* clips elicit *Anger*, *Amusement*, *Contentment*, *Disgust*, *Fear*, *Sadness* or *Surprise* to a greater degree than any other emotion and the *Neutral* clips elicit no emotion. The present study rates Gross and Levenson's (1995) clips, the BOAT and RALLY clips and additional clips in terms of subjective emotion in order to perform three stages of analysis. The initial stage of analysis aims to assess whether each clip had been correctly categorised as eliciting a specific emotion and also whether the BOAT and RALLY clips can be described as *Emotive* or *Neutral* (Results: Part One). The second stage of analysis aims to assess correctly classified clips for their suitability for use in future experiments and in the development of *Emotive* and *Neutral* sets of video clips (Results: Part Two). The third stage of analysis aims to examine statistical associations between subjective ratings of emotion and presence among those clips that have been correctly classified and chosen for future experimental use (Results: Part Three). The results of Experiment 4 will be used in the interpretation of previous experiments in this thesis and will contribute to a further understanding of the relationship between presence and emotion.

6.2 Method

6.2.1 Participants

Thirty-six students from Goldsmiths College, University of London (18 males and 18 females; average age = 23.03yrs, SD = 6.36) received course credits for their participation. All participants had normal or corrected-to-normal vision.

6.2.2 Visual Display Apparatus

Participants viewed video stimuli on a 14" SONY portable television. A Panasonic NV-HD660 VHS video player provided the video input for the display. Participants were seated on average 160cm from the centre of the screen.

6.2.3 Video Stimuli

Gross and Levenson (1995) developed eight pairs of video-clips in eight categories (*Amusement, Anger, Contentment, Disgust, Fear, Sadness, Surprise* and *Neutral).* Each pair can be described as containing *Emotive* or *Neutral* clips. Each individual clip elicits one Target Emotion, or a *Neutral* state, as rated on nine-point ratings scales (see section *6.2.4.1*): **amusement, anger, contentment, disgust, fear, sadness,** and **surprise**. Ratings of the Target Emotion for a video clip (e.g., ratings of **amusement** for an *Amusing* clip) were significantly higher than for other clips (e.g., ratings of **amusement** for a *Surprising* clip) and were significantly higher than ratings of all other Emotion Terms for that clip (e.g., **amusement** ratings were higher than ratings of **surprise** for the *Amusing* clip). *Neutral* clips have mean ratings of < 2 for all seven Target Emotions on nine-point ratings scales (see section *6.2.4.1*). Mean ratings of the Target Emotion for each clip ranged between 3.46 and 6.05.

In Gross and Levenson's (1995) set there are two clips per the seven *Emotive* categories plus two clips which elicit *Neutral* states. To provide comparability with previously published ratings the set of clips was used as a starting point for building a new set of clips in the current experiment. James Gross, (Gross, personal communication, 2001), provided the sourcing and editing instructions to re-create his set of video-clips. Because Gross and Levenson's (1995) clips were tested on an American student population in the late 1980s and early 1990s[21] it was possible that the set of clips would

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[21] The collection of video stimuli for the Gross and Levenson (1995) study commenced in 1988.

not have the intended impact on a contemporary UK sample. In addition, a copy of one *Disgust* clip and good copies of the *Contentment* and *Neutral* clips could not be obtained. Therefore, three clips were added to the *Disgust* category and two more clips were added to all other categories.

The BOAT and RALLY video sequences used in previous experiments in this thesis were included in the *Contentment* and *Fear* categories respectively, as the sequences were shown to differ on ratings of **contentment** and **fear** in Experiment 3 with greater significance and effect sizes than other Emotion Terms. This difference between the clips was consistent with findings in Experiments 1 and 3 that showed the BOAT and RALLY video sequences to differ on a **composed-anxious** dimension. Additional video-clips came from a variety of sources: The Observer's Top 100 Film Moments, FilmFour's 100 Greatest Films nominees, TV Guide's 50 Greatest Movie Moments, The British Film Institutes 100 Greatest British films, The American Film Institute's 100 Greatest Films, the makers of 'The Making of the Human Body' (Discovery/BBC), previous unpublished undergraduate research and personal recommendation. A list of 85 *Emotive* films was generated. Clips were then chosen on the basis that they had been described in various sources as eliciting strong emotions, were comparable in length to Gross and Levenson's (1995) clips and had a self-contained narrative which could be understood without reference to other parts of the source film or programme. All the additional *Emotive* clips portrayed fictional events with the exception of one *Disgust* clip, which depicted a medical procedure. The additional *Neutral* clips portrayed simple scenes filmed on Digital Video in London. Details of the thirty-two clips appear in Table 6.1 (Abbreviations in parentheses after each film title will be used for the remainder of this Chapter).

The video clips were recorded onto two VHS tapes with 2-minutes of blue screen at the beginning of each tape and 10-seconds of blue screen between each clip. Four presentation orders were used in the experiment (see Appendix C1). In each order, no two clips from the same category appeared next to each other and no positive, negative or neutral clips appeared next to each other (where '*Surprise*' is considered neither positively or negatively valanced). The video clips were viewed by colleagues and members of the ITC team before data collection commenced in order to collect feedback regarding image quality and emotional impact. No changes were made the videos.

Table 6.1 Categorised video-clips used in Experiment 4.

Emotion Category:	Film Name and Abbreviation	Description of Scene:	Length (secs):
Amusement	When Harry Met Sally (HARRY) *	Discussion of orgasm in cafe	149
	Robin Williams Live (ROBIN) *	Comedy routine	204
	Play it Again Sam (SAM)	Nervous man on first date	210
	Pretty Woman (PRETTY)	Woman goes shopping	252
Anger	Cry Freedom (CRY) *	Police abuse protesters	153
	My Bodyguard (BODY) *	Bully scene	240
	Boys from the Blackstuff (BOYS)	Police beat-up man	218
	One Flew Over the Cuckoos Nest (ONE)	Nurse reprimands patient	232
Contentment	Waves (WAVES) *†	Waves on a beach	58
	Beach Scene (BEACH) *†	Seagulls on a beach	23
	The Big Blue [Le Grand Bleu] (BLUE)	Dolphins swimming	101
	Boat-sequence (BOAT)	Boat travels down Norfolk Broads	100
Disgust	Pink Flamingos (PINK) *	Person eats dog faeces	30
	Toe Operation (TOE) ‡	Removal of in-growing toenail	119
	Un Chien Andalou (CHIEN)	Man slices open eye	32
	Trainspotting (TRAIN)	Man goes to toilet	63

* Clips derived from Gross and Levenson's (1995) set. † Available from http://www-psych.stanford.edu/~psyphy/resources.htm. ‡ Courtesy of Prof. Philip Corr.

Table 6.1 continued

Emotion Category:	Film Name and Abbreviation	Description of Scene:	Length (secs):
Fear	The Shining (SHINE) *	Boy playing in hallway	80
	Silence of the Lambs (LAMBS) *	Basement chase scene	204
	Halloween (HALL)	Woman chased	222
	Rally-sequence (RALLY)	Car drives round rally track	100
Sadness	The Champ (CHAMP) *	Boy cries at fathers death	196
	Bambi (BAMBI) *	Mother deer dies	129
	Four Weddings and a Funeral (FOUR)	Speech at funeral	256
	Truly, Madly, Deeply (TRULY)	Woman in counselling	198
Surprise	Capricorn One (CAP) *	Agents burst through door	52
	Sea of Love (SEA) *	Man startled by pigeons	11
	LA Confidential (LA)	Man shot unexpectedly	53
	The Human Body (HUMAN)	Car stops suddenly	77
Neutral	Abstract Shapes (SHAPES) *†	Coloured moving lines	204
	Colour bars (COLOUR) *†	Test-signal pattern	90
	Street-scene (STREET)‡	Quiet residential street	81
	House-scene (HOUSE)‡	House interior	54

* Clips derived from Gross and Levenson's (1995) set. † Available from http://www-psych.stanford.edu/~psyphy/resources.htm. ‡Courtesy of Prof. Philip Corr.

6.2.4 Questionnaire measures

6.2.4.1 Elicited Emotion Scales

Gross and Levenson's (1995) sixteen item Elicited Emotion Scales (EES) were chosen as a measure of subjective emotion in order to provide consistency with their ratings study and to allow comparability with results described in Experiment 3. Ratings of the seven emotions for which categories of films existed (**amusement**, **anger**, **contentment**, **disgust**, **fear**, **sadness** and **surprise**) were used as indicators of the intensity of specific qualities of subjective emotion and were called the Emotion Terms. The **arousal** and **interest** items served as indicators of non-specific subjective arousal and the remaining seven items served as distracter items. On the nine-point scales of the EES, '0' indicates that the participant did not feel the slightest bit of that emotion during the clip while '8' indicates that they felt that emotion the most they had ever done in their life. Very low ratings (e.g., mean ratings of less than or equal to two and modal ratings of zero) across all Emotion Terms were taken to indicate an absence of subjective emotional response (i.e., a *Neutral* state). Group mean ratings and group modal ratings of each Emotion Term for each clip were used in the classification of each video clip. Group mean ratings of the **arousal** and **interest** items were analysed separately and used in the development of sets of video clips.

6.2.4.2 UCL Presence Questionnaire

The UCL-Presence Questionnaire (UCL-PQ: Slater et al., 1994) was as described in Experiment 2 (Chp. 4, pg. 144). The three items (Q1 -'being there', Q2-'reality' and Q3-'visited') were used as quick and simple indicators of reported presence suitable for repeated use over the ratings of the thirty-two video clips. The UCL-PQ was chosen for the current experiment as the main focus of the experiment was the development of sets of clips for experimental use and not presence measurement; hence a short presence measure was thought desirable in order to reduce demands on participants.

Q1-'being there' addresses the traditional definition of presence as the 'sense of being there' in a displayed environment and as such provides consistency in presence rating methods between this and previous experiments in the thesis. Q2-'reality' and Q3-'visited' provide additional information about proposed elements of presence (i.e., whether a displayed environment becomes more real than the surrounding environment and whether the depicted scenes seemed more like a place visited or a place seen). It had been proposed that Q1 is related to the physical space element of reported presence, Q2 is related to naturalness and Q3 is related to naturalness/engagement (Freeman, 2003). Each item is scored on a seven-point likert-type scale, where a higher score indicates a higher degree of reported presence. Given the infrequent occurrence of high scores on these scales observed in Experiment 2, each question was analysed separately and an average presence score was calculated by taking the mean of the three scores.

6.2.4.3 Response to Characters

A number of additional questions were addressed to participants. Participants were asked to rate how much they 'identified with the concerns of one or more of the characters' in the displayed environment and how much they 'empathised with one or more of the characters' in the displayed environment. The items were included as additional items on the UCL-PQ and were rated on the same seven point scale, where a higher score indicated greater **identification** or greater **empathy** with the characters. The items were included as cognitive film theorists have proposed that identification and empathy are two major determinants of emotional response to narrative film (Plantinga & Smith 1999).

6.2.4.4 Familiarity

Participants were also asked to indicate whether they had seen each clip before and were given three response options ('never', 'once' or 'more than once'). Responses were scored on a 0-2 scale, where a lower score indicated less familiarity with the content.

6.2.4.5 Questionnaire Administration

The EES and UCL-PQ with additional 'character' and 'familiarity' items were presented as three sections on one questionnaire (one copy per clip), in a booklet. The EES constituted one section, the UCL-PQ plus 'character' items constituted a second section and the 'familiarity' item was the final section. The order of the first two sections was counterbalanced across participants. The familiarity rating always appeared after the EES and UCL-PQ sections and the three sections on each page were labelled A, B and C (see Appendix C2).

6.2.5 Procedure

Participants were tested on their own or in groups of two to five people in the Goldsmiths College ITC Laboratory (a blacked out room with comfortable seating and the visual display). Group viewing can produce different media responses to lone viewing, such as differences in allocation of attention (LaRose, Heeter & Lee, 2005) and in the intensity of emotional responses (Austin, Roberts & Nass, 1990). However, it was thought that a mixture of group and lone viewing was appropriate for the presence experiment due to time demands and because the primary objective was to gather pooled data in order to describe the overall tone of video sequences. It was not expected that overall emotional tone would differ between group and lone viewing, although it was possible that emotional intensity would differ.

Participants were informed that they would be rating a collection of thirty-two video-clips that would be used in future research and that the video-clips had either been used in previous psychological research or were widely available on VHS. They were also informed that (1) some of the clips dealt with issues such as sex, violence, drug-use and grief and had an '18' video classification, (2) they were under no obligation to look at any clip and were free to leave the experimental situation at any time, (3) they should feel free to ask the experimenter questions during the experiment but (4) they should try as far as possible not to disturb other participants while a clip was showing. All participants signed a consent form to indicate that they understood the nature of the experiment and were willing to participate (see Appendix C3).

The format of the questionnaire booklet was explained to participants and some terminology was explained. Participants were instructed that the term **'arousal'** did not refer to any particular emotion but should be rated in terms of how tense, excited, alert or physiologically active they felt- in line with Lang's (1980) definition of subjective arousal. Participants were also asked to treat the **identification** and **empathy** questions differently. They were instructed that the 'identification' item referred to whether or not a clip addressed issues that were personally relevant and that the 'empathy' question referred to whether they had felt the same emotions portrayed by one or more of the characters, regardless of whether the issues portrayed were personally relevant.

One participant was nominated to control the video player via a remote control and the control of the video player was demonstrated. The nominated participant was instructed that each video clip was separated from the next clip by a blue screen and that on seeing a blue screen after a clip they should 'pause' the video. When the video was paused all participants were instructed that they should fill out one set of questionnaires (sections A, B and C) with reference to the clip they had just seen. When all participants in a group had completed sections A, B and C the next clip would be played.

After checking that the correct procedure was followed for the first clip, participants were left to complete ratings of the first sixteen clips on the tape. When participants had viewed the first sixteen clips, they were offered a short break. After the break the procedure was followed as before until all thirty-two clips had been viewed. Tea and biscuits were served on request. On completion of the experiment participants were debriefed, awarded course credits and thanked for their co-operation. A space was left at the end of the questionnaire booklet for participants to leave comments and suggest other films for each emotion category. The entire procedure lasted approximately 2hrs and 15mins.

6.3 Results: Introduction

The results section is divided into three parts relating to the three aims of the experiment. Part One details analyses used to (1) determine whether each of the thirty-two clips described above were classified correctly in terms of subjective emotion and (2) determine whether the BOAT and RALLY clips may be described as *Emotive* or *Neutral.* Part Two details analyses used to determine which categories of clips could be retained for future experimental and to explore characteristics of categories retained for experimental use. Part Three provides an exploration of the relationship between ratings of presence and subjective emotion amongst the clips retained for experimental use. Significance levels are set at $p<.05$ for all statistical tests, with Bonferroni corrections where appropriate. Non-significant results are reported where appropriate. The analysis was repeated with outliers (+/- 3.29sds) excluded. A note is made when the pattern of results obtained with outliers excluded diverged from that obtained with outliers included.

6.4 Results: Part One – Video Clip Classification

6.4.1 Part One: Introduction

In Experiment 3 it was observed that increasing eye-to-screen visual angle enhanced presence and increased subjective arousal but did not enhance differences between contents in terms of emotional tone. The latter finding is contrary to the predictions of the Behavioural Realism approach to presence research. It was suggested that a content-specific effect of increased visual angle on emotional responses was not observed because the contents used (the BOAT and RALLY clips) were neutral in emotional tone. Part One of the analysis aims to examine this proposal by (1) determining whether each of the thirty-two clips described above are classified 'correctly' in terms of subjective emotion and (2) determine whether the BOAT and RALLY clips may be described as *Emotive* or *Neutral* in comparison to correctly classified clips. The results are therefore reported in two steps (Part 1a and Part 1b).

6.4.2 Part 1a - Classification of Clips by Emotion Term

The aim of Part 1a of the analysis was to confirm that each video-clip was correctly classified and to eliminate clips that were not well classified. Table 6.2a-h displays a summary of subjective ratings on the EES collected for each clip and the statistics used to evaluate the classification of each clip in Part One of the results section.

6.4.2.1 Plan of Analysis

Gross and Levenson's (1995) method of video-clip classification was used to complete the first step of the analysis. Following ANOVAs to check for overall effects of Emotion Term on the EES, the Target Emotion for each *Emotive* clip was compared to ratings of all other Emotion Terms for that clip (e.g., the 'Target Emotion' for clips in the '*Amusement*' category is '**amusement**'). A clip was said to be classified correctly if ratings of the Target Emotion were significantly higher than all other Emotion Terms (e.g., if ratings of '**amusement**', for an *Amusement* category clip, were significantly higher than ratings of '**anger**', '**contentment**', '**disgust**', **fear**', '**sadness**' and '**surprise**'). A clip was considered *Neutral* if no differences between Emotion Terms were observed and low mean ratings and modal responses for all Emotion Terms were also observed. Clips that were not classified correctly and could not be re-classified, were excluded from further analyses. A summary of the analysis is shown in Tables 6.2a-h.

Tables 6.2a-h Summary of EES ratings of clips within the (a) *Amusement*, (b) *Anger*, (c) *Contentment*, (d) *Disgust*, (e) *Fear*, (f) *Sadness*, (g) *Surprise* and (h) *Neutral* categories and a summary of Part One of the results section.

Guide to Tables:

Mean Target Emotion ratings are shown in the shaded block; When multiple modes were observed the lowest modal value is shown in italics; ANOVA statistics for effects of each clip on Emotion Term are shown - df = 6,30 for all tests with epsilon and corrected values given when appropriate (summary of effect sizes shown below table); In order to summarise statistical comparisons of Target Emotions with other Emotion Terms, ratings marked with an asterix were not significantly different to the Target Emotion shown in the shaded block (Neutral category excluded); The decision concerning whether a clip was retained for further analysis is indicated with a tick (retained) or a cross (rejected).

(a) Amusement

CLIP	Emotion Term / Statistic	amusement	anger	contentment	disgust	fear	sadness	surprise	F-value	*p*	Epsilon	*Retain?*
HARRY	Mean	**4.97**	**0.00**	**1.39**	**0.14**	**0.00**	**0.11**	**0.86**	**38.55**	**<.001**	**na**	✓
	SD	*(2.25)*	*(0.00)*	*(1.74)*	*(0.42)*	*(0.00)*	*(0.46)*	*(1.38)*				
	Mode	6	0	0	0	0	0	0				
ROBIN	Mean	**4.89**	**0.14**	**1.58**	**0.31**	**0.00**	**0.08**	**0.75**	**76.95**	**<.001**	**.52**	✓
	SD	*(2.08)*	*(0.49)*	*(1.89)*	*(0.89)*	*(0.00)*	*(0.50)*	*(1.40)*				
	Mode	4	0	0	0	0	0	0				
SAM	Mean	**4.72**	**0.33**	**1.39**	**0.25**	**0.11**	**0.25**	**1. 58**	**58.65**	**<.001**	**.59**	✓
	SD	*(1.81)*	*(1.07)*	*(1.93)*	*(0.84)*	*(0.52)*	*(0.65)*	*(2.02)*				
	Mode	5	0	0	0	0	0	0				
PRETTY	Mean	**4.25**	**0.36**	**1.92**	**0.28**	**0.03**	**0.47**	**0.53**	**55.64**	**<.001**	**.55**	✓
	SD	*(1.99)*	*(0.99)*	*(2.01)*	*(0.88)*	*(0.17)*	*(1.32)*	*(1.11)*				
	Mode	5	0	0	0	0	0	0				

0.61< eta-squared < 0.86

(b) Anger

CLIP	Emotion Term / Statistic	amusement	anger	contentment	disgust	fear	sadness	surprise	F-value	*p*	Epsilon	*Retain?*
CRY	Mean	**0.44**	**5.28**	**0.31**	**4.94***	**2.58**	**5.33***	**1.92**	**53.88**	**<.001**	**.55**	✗
	SD	*(1.11)*	*(2.13)*	*(0.79)*	*(2.63)*	*(2.45)*	*(2.01)*	*(2.02)*				
	Mode	0	5	0	8	0	7	0				
BODY	Mean	**0.72**	**3.94**	**0.31**	**2.94**	**1.31**	**3.38***	**0.83**	**28.30**	**<.001**	**.63**	✗
	SD	*(1.21)*	*(2.45)*	*(0.75)*	*(2.65)*	*(2.14)*	*(2.36)*	*(1.59)*				
	Mode	0	4	0	0	0	0	0				
BOYS	Mean	**0.78**	**3.31**	**0.44**	**2.94***	**1.39**	**3.25***	**1.28**	**20.92**	**<.001**	**.59**	✗
	SD	*(1.29)*	*(2.53)*	*(1.11)*	*(2.38)*	*(1.76)*	*(2.33)*	*(1.73)*				
	Mode	0	0	0	0	0	4	0				
ONE	Mean	**1.33**	**3.39**	**0.50**	**2.31**	**0.78**	**3.42***	**0.69**	**20.27**	**<.001**	**.58**	✗
	SD	*(1.55)*	*(2.61)*	*(1.23)*	*(2.35)*	*(1.44)*	*(2.20)*	*(1.04)*				
	Mode	0	3	0	0	0	3	0				

0.37 < eta-squared < 0.61

(c) Contentment

CLIP	Emotion Term / Statistic	amusement	anger	contentment	disgust	fear	sadness	surprise	F-value	*p*	Epsilon	*Retain?*
WAVES	**Mean**	**0.47**	**0.03**	**2.17**	**0.03**	**0.11**	**0.28**	**0.11**	**6.67**	**<.01**	**na**	✓
	SD	*(0.88)*	*(0.17)*	*(2.24)*	*(0.17)*	*(0.67)*	*(0.88)*	*(0.40)*				
	Mode	0	0	0	0	0	0	0				
BEACH	**Mean**	**0.42***	**0.03**	**0.58**	**0.00**	**0.03**	**0.25***	**0.33***	**2.86**	**<.05**	**na**	✓
	SD	*(1.05)*	*(0.17)*	*(1.13)*	*(0.00)*	*(0.17)*	*(0.87)*	*(0.93)*				
	Mode	0	0	0	0	0	0	0				
BLUE	**Mean**	**1.81***	**0.11**	**2.72**	**0.19**	**0.25**	**0.14**	**0.36**	**25.47**	**<.001**	**.41**	×
	SD	*(2.32)*	*(0.40)*	*(2.21)*	*(1.01)*	*(1.02)*	*(0.68)*	*(1.22)*				
	Mode	0	0	0	0	0	0	0				
BOAT	**Mean**	**0.47**	**0.00**	**1.28**	**0.03**	**0.03**	**0.31**	**0.11**	**10.55**	**<.001**	**.33**	×
	SD	*(1.03)*	*(0.00)*	*(1.86)*	*(0.17)*	*(0.17)*	*(0.95)*	*(0.40)*				
	Mode	0	0	0	0	0	0	0				

0.23 < eta-squared < 0.51

(d) Disgust

CLIP	Emotion Term / Statistic	amusement	anger	contentment	disgust	fear	sadness	surprise	F-value	*p*	Epsilon	*Retain?*
PINK	**Mean**	**2.75**	**0.72**	**0.44**	**5.78**	**0.22**	**0.17**	**3.47**	**46.72**	**<.001**	**.61**	✓
	SD	*(2.39)*	*(1.95)*	*(1.11)*	*(2.32)*	*(0.68)*	*(0.85)*	*(2.94)*				
	Mode	0	0	0	8	0	0	0				
TOE	**Mean**	**0.69**	**0.06**	**0.33**	**3.28**	**0.92**	**0.36**	**0.58**	**25.36**	**<.001**	**na**	✓
	SD	*(1.12)*	*(0.23)*	*(0.89)*	*(2.63)*	*(1.50)*	*(1.10)*	*(1.05)*				
	Mode	0	0	0	2	0	0	0				
CHIEN	**Mean**	**1.61**	**0.69**	**0.33**	**5.25**	**1.31**	**0.78**	**4.22***	**36.09**	**<.001**	**.56**	×
	SD	*(1.96)*	*(1.85)*	*(0.79)*	*(2.72)*	*(2.28)*	*(1.77)*	*(2.68)*				
	Mode	0	0	0	8	0	0	*0*				
TRAIN	**Mean**	**3.36**	**0.14**	**0.47**	**4.69**	**0.22**	**0.28**	**0.83**	**49.25**	**<.001**	**.54**	✓
	SD	*(2.26)*	*(0.54)*	*(1.23)*	*(2.63)*	*(0.76)*	*(0.88)*	*(1.59)*				
	Mode	*0*	0	0	4	0	0	0				

0.43 < eta-squared < 0.57

(e) Fear

CLIP	Statistic	amusement	anger	contentment	disgust	fear	sadness	surprise	F-value	p	Epsilon	*Retain?*
SHINE	**Mean**	**0.69**	**0.17**	**0.44**	**0.22**	**3.22**	**0.67**	**1.25**	**32.52**	**<.001**	**.57**	✓
	SD	*(1.33)*	*(0.38)*	*(0.94)*	*(0.59)*	*(1.97)*	*(1.20)*	*(1.59)*				
	Mode	0	0	0	0	3	0	0				
LAMBS	**Mean**	**0.89**	**0.64**	**0.39**	**1.94**	**3.11**	**0.56**	**2.22**	**12.58**	**<.001**	**.40**	✓
	SD	*(1.86)*	*(1.10)*	*(1.29)*	*(2.44)*	*(2.40)*	*(1.18)*	*(2.32)*				
	Mode	0	0	0	0	0	0	0				
HALL	**Mean**	**1.00**	**0.69**	**0.33**	**0.86**	**3.69**	**0.33**	**1.78**	**25.27**	**<.001**	**.59**	✓
	SD	*(1.37)*	*(1.37)*	*(0.86)*	*(1.57)*	*(2.24)*	*(0.83)*	*(1.99)*				
	Mode	0	0	0	0	5	0	0				
RALLY	**Mean**	**0.56**	**0.08***	**0.58**	**0.08***	**0.11**	**0.17***	**0.22***	**4.85**	**<.01**	**.55**	✗
	SD	*(0.94)*	*(0.37)*	*(1.16)*	*(0.28)*	*(0.32)*	*(0.70)*	*(0.59)*				
	Mode	0	0	0	0	0	0	0				

0.12 < eta-squared < 0.48

(f) Sadness

CLIP	Statistic	amusement	anger	contentment	disgust	fear	sadness	surprise	F-value	p	Epsilon	*Retain?*
CHAMP	**Mean**	**0.58**	**0.92**	**0.42**	**0.69**	**0.83**	**5.50**	**0.47**	**58.55**	**<.001**	**.70**	✓
	SD	*(1.08)*	*(1.59)*	*(1.02)*	*(1.83)*	*(1.66)*	*(2.06)*	*(0.94)*				
	Mode	0	0	0	0	0	5	0				
BAMBI	**Mean**	**1.17**	**1.75**	**0.69**	**1.00**	**0.94**	**4.58**	**0.69**	**22.41**	**<.001**	**.57**	✓
	SD	*(1.84)*	*(2.37)*	*(1.45)*	*(1.67)*	*(1.72)*	*(2.52)*	*(1.43)*				
	Mode	0	0	0	0	0	6	0				
FOUR	**Mean**	**0.71**	**0.50**	**0.32**	**0.26**	**0.21**	**4.68**	**0.12**	**54.80**	**<.001**	**.39**	✓
	SD	*(1.29)*	*(0.99)*	*(0.98)*	*(1.21)*	*(0.64)*	*(2.50)*	*(0.54)*				
	Mode	0	0	0	0	0	7	0				
TRULY	**Mean**	**0.31**	**0.64**	**0.36**	**0.44**	**0.25**	**4.25**	**0.39**	**51.03**	**<.001**	**.38**	✓
	SD	*(0.86)*	*(1.17)*	*(0.68)*	*(1.23)*	*(0.73)*	*(2.39)*	*(0.77)*				
	Mode	0	0	0	0	0	3	0				

0.39 < eta-squared < 0.63

(g) Surprise

CLIP	Emotion Term / Statistic	amusement	anger	contentment	disgust	fear	sadness	surprise	F-value	p	Epsilon	Retain?
CAP	**Mean**	**1.03**	**0.47**	**0.33**	**0.25**	**1.03**	**0.19**	**4.56**	**44.09**	**<.001**	**.57**	✓
	SD	*(1.84)*	*(1.58)*	*(0.89)*	*(0.91)*	*(1.81)*	*(0.71)*	*(2.08)*				
	Mode	0	0	0	0	0	0	5				
SEA	**Mean**	**0.86**	**0.08**	**0.56**	**0.11**	**2.03**	**0.11**	**3.56**	**38.91**	**<.001**	**.41**	✓
	SD	*(1.27)*	*(0.37)*	*(1.08)*	*(0.40)*	*(1.90)*	*(0.32)*	*(2.31)*				
	Mode	0	0	0	0	0	0	6				
LA	**Mean**	**0.83**	**0.81**	**0.61**	**1.28**	**0.78**	**1.17**	**5.25**	**41.07**	**<.001**	**.61**	✓
	SD	*(1.50)*	*(1.45)*	*(1.78)*	*(1.65)*	*(1.40)*	*(1.54)*	*(2.23)*				
	Mode	0	0	0	0	0	0	5				
HUMAN	**Mean**	**1.36***	**0.06**	**0.67***	**0.17**	**1.11***	**0.19**	**1.14**	**6.89**	**<.001**	**.60**	×
	SD	*(1.73)*	*(0.23)*	*(1.26)*	*(0.56)*	*(1.77)*	*(0.62)*	*(1.96)*				
	Mode	0	0	0	0	0	0	0				

0.18 < eta-squared < 0.56

(h) Neutral

CLIP	Emotion Term / Statistic	amusement	anger	contentment	disgust	fear	sadness	surprise	F-value	p	Epsilon	Retain?
SHAPES	**Mean**	**0.50**	**0.19**	**0.56**	**0.19**	**0.11**	**0.08**	**0.19**	**1.68**	**0.18**	**.44**	✓
	SD	*(1.13)*	*(0.62)*	*(1.00)*	*(1.01)*	*(0.67)*	*(0.37)*	*(1.01)*				
	Mode	0	0	0	0	0	0	0				
COLOUR	**Mean**	**0.26**	**0.00**	**0.43**	**0.09**	**0.00**	**0.17**	**0.08**	**2.05**	**0.11**	**na**	✓
	SD	*(1.04)*	*(0.00)*	*(1.31)*	*(0.51)*	*(0.00)*	*(0.61)*	*(0.50)*				
	Mode	0	0	0	0	0	0	0				
STREET	**Mean**	**0.50**	**0.00**	**1.00**	**0.22**	**0.17**	**0.28**	**0.44**	**4.08**	**<.05**	**.36**	✓
	SD	*(1.13)*	*(0.00)*	*(1.62)*	*(1.33)*	*(0.70)*	*(1.37)*	*(1.48)*				
	Mode	0	0	0	0	0	0	0				
HOUSE	**Mean**	**0.50**	**0.14**	**0.44**	**0.22**	**0.14**	**0.44**	**0.19**	**1.28**	**.30**	**.51**	✓
	SD	*(1.18)*	*(0.59)*	*(1.11)*	*(0.68)*	*(0.68)*	*(1.40)*	*(0.62)*				
	Mode	0	0	0	0	0	0	0				

0.04 < eta-squared < 0.21

6.4.2.2 Within Clip Analysis

A one-way within-groups ANOVA was performed for each clip, with Emotion Term (**amusement**, **anger**, **contentment**, **disgust**, **fear**, **sadness** and **surprise**) serving as the within-groups factor. For twenty-seven of the thirty-two clips the assumption of sphericity was violated and a Greenhouse-Geisser correction with adjusted degrees of freedom was used. Table 6.2 summarises the results of the ANOVAs by displaying F-values, p, epsilon and effect sizes for tests of Emotion Term for each clip.

Significant main effects of Emotion Term were found for all clips in the seven *Emotive* categories and for one *Neutral* clip (STREET), indicating that these clips may have elicited some emotions more than others. No significant effects were found for all other clips in the *Neutral* category (SHAPES, COLOUR, and HOUSE). These clips could be said to elicit no emotion more than any other emotion. Effect sizes were very high across all clips with the exception of *Neutral* clips (where large effect sizes would not be expected). Therefore, the effects of clips on Emotion Terms may be said to be large and reliable and effect sizes will not be reported for the remainder of Part One of the analysis.

Further analysis was required to examine which specific emotion each clip in the *Emotive* categories elicited, and to verify the classification of the *Neutral* clips. Therefore, for *Emotive* clips, for which overall effects of Emotion Term had been observed, a series of planned comparisons between Emotion Terms were used to determine whether the Target Emotion was the correct classification (the Target Emotion is indicated by a shaded block in Tables 6.2a-h). In addition, the mean and modal scores for each Emotion Term were also examined for clips in the *Emotive* and *Neutral* categories when verification of classification was required. In addition to establishing correct classification the results of the comparison tests were intended to indicate which clips in each category could be retained for further use. As such, a summary and interpretation of the results for clips within in each of the eight categories is detailed below. Tables 6.2a-h also summarise the results of the analysis by indicating which Emotion Terms did not significantly differ from the Target Emotion for each clip in the *Emotive* categories (indicated with an asterix) and therefore which *Emotive* clips were unsuitable for further use (indicated by a tick or a cross). Details of the comparison tests may be found in Appendix C4.

6.4.2.3 Summary of Amusement Clips

Ratings of <u>**amusement**</u> for each clip in the *Amusement* category (HARRY, ROBIN, SAM, PRETTY) were significantly higher than all other <u>Emotion Terms</u> ($p<.001$). Therefore, all the clips in the *Amusement* category were considered to be classified correctly and were retained for further analysis.

6.4.2.4 Summary of Anger Clips

For clips in the *Anger* category it may be said that <u>**anger**</u> ratings were well differentiated from most other <u>Emotion Terms</u> ($p<.05$). However, <u>**anger**</u> ratings were best differentiated from positive <u>Emotion Terms</u> and were not well differentiated from <u>**sadness**</u> and <u>**disgust**</u>. Therefore, the results indicate that clips in the *Anger* category were generally negative in tone and did not produce one specific emotion. Given the strict inclusion criteria, all clips in this category were excluded from further analysis.

6.4.2.5 Summary of Contentment Clips

For two of the *Contentment* clips (WAVES and BOAT) <u>**contentment**</u> ratings were well differentiated from all other emotions ($p<.01$) suggesting that the clips were classified correctly. One further clip, (BLUE) had generally positive ratings in comparison to ratings of negative <u>Emotion Terms</u> ($p<.001$) but cannot be said to produce the discrete emotion of *Contentment* as <u>**contentment**</u> rating were not significantly different to <u>**amusement**</u> ratings. As such, the BLUE clip was excluded from further analysis. For the remaining clip (BEACH) <u>**contentment**</u> ratings were higher than some <u>Emotion Terms</u> ($p<.01$) but were not well differentiated from others. In addition, all ratings for the BEACH clip were less than one and modal ratings were 0 (75% of participants 'did not feel the slightest bit' of any emotion during the clip). The BEACH clip was therefore re-classified as a *Neutral* clip. It was noted that modal ratings of all <u>Emotion Terms</u> for all *Contentment* clips were 0. In particular, the BOAT clip, which had been used in previous experiments, received low mean ratings (<1.28) of all <u>Emotion Terms</u> in addition to modal ratings of 0 (55% of participants) for <u>**contentment**</u>. Therefore, the classification of the BOAT sequence in the *Contentment* category was doubtful and was re-examined in Part 1b of the analysis. In summary, the WAVE clip was considered to be correctly classified, the BLUE clip was excluded from further analysis, the BEACH clip was reclassified as a *Neutral* clip and the BOAT clip was re-examined in Part 1b of the analysis.

6.4.2.6 Summary of Disgust Clips

For three clips in the *Disgust* category (PINK, TOE, TRAIN) **disgust** ratings were well differentiated from all other Emotions Terms (p<.05) and as such were considered to be classified correctly. However, **disgust** ratings were not well differentiated from **surprise** ratings for the CHIEN clip. Therefore the CHIEN clip was excluded from further analysis.

6.4.2.7 Summary of Fear Clips

For three clips in the *Fear* category (SHINE, LAMB and HALL) **fear** ratings were well differentiated from other Emotion Terms (p<.001). Therefore, these three clips were considered to be correctly classified and were retained for further analysis. However, it was noted that one of the three retained clips (LAMB) had a modal rating of 0 for **fear** (25% of participants) indicating that the Target Emotion was not elicited by this clip in a sizeable minority of participants. For the remaining clip (RALLY) ratings of **fear** were not well differentiated from other negative terms and were significantly lower than positive Emotion Terms (p<.05). As such, the RALLY clip was not classified correctly as a *Fear* film. In addition, mean ratings were less than 2 and modal ratings were 0 for all Emotion Term ratings of the RALLY clip. This suggests that the RALLY clip may have been *Neutral* in tone and further analysis in Part 1b was required to verify the classification of this clip.

6.4.2.8 Summary of Sadness Clips

Ratings of **sadness** for each clip in the *Sadness* category (CHAMP, BAMBI, FOUR, TRULY) were significantly higher than all other Emotion Terms (p<.001). Therefore, all clips in the *Sadness* category were considered to be classified correctly and were retained for further analysis.

6.4.2.9 Summary of Surprise Clips

For three clips in the *Surprise* category (CAP, SEA and LA) ratings of **surprise** were significantly higher than all other Emotion Terms (p<.001). Therefore, these three clips were considered to be classified correctly and were retained for further analysis. The remaining clip (HUMAN) did not fit well into the *Surprise* category as **surprise** ratings were low and not well differentiated from other positive and negative terms. As such, the HUMAN clip was excluded from further analysis.

6.4.2.10 Summary of Neutral Clips

In order to verify the classification of the four clips in the *Neutral* categories, an examination of mean and modal ratings was conducted. For three of the *Neutral* clips (SHAPES, COLOUR, and HOUSE) no significant overall effects of Emotion Term had been observed. In addition, each of these clips received mean ratings of less than or equal to 1 and modal ratings of 0 for all Emotion Terms (indicating that most participants 'did not feel the slightest bit' of any emotion during the clips). An overall effect of Emotion Term had been observed for one *Neutral* clip (STREET). This clip also received mean ratings of less than or equal to 2 and modal ratings of 0 for all Emotion Terms. In addition, a series of unplanned paired t-tests, with a Bonferroni correction, to compare ratings of each of the seven Emotion Terms revealed one significant comparison. Ratings of **contentment** were significantly higher than ratings of **anger** ($t = 3.70$, $df = 35$, $p < .001$). Though a significant difference between **anger** and **contentment** ratings was found, it was observed that 36 (100%) and 23 (64%) participants gave ratings of zero for the **anger** and **contentment** terms respectively.

The results of the analysis of the *Neutral* clips indicated that three clips (SHAPES, COLOUR, and HOUSE) were clearly classified correctly as no differences between Emotion Terms and low ratings of all Emotion Terms were observed. The remaining clip (STREET) was also classified as *Neutral* given that very low ratings of all Emotion Terms were observed, even though there were slight differences between two Emotion Terms.

6.4.2.11 Summary of Part 1a

The aim of Part 1a of the analysis was to determine the correct classification of the twenty-eight clips in the seven *Emotive* categories and the four clips in the *Neutral* category. Of the thirty-two clips, twenty-two clips were found to be classified correctly (including 12 out of 15 clips from Gross and Levenson's original set). Eighteen *Emotive* clips were classified correctly as the Target Emotion was significantly higher than all other Emotion Terms (HARRY, ROBIN, SAM, PRETTY, WAVES, PINK, TOE, TRAIN, SHINE, HALL, LAMB, CHAMP, BAMBI, FOUR, TRULY, CAP, SEA, LA). In addition, all four *Neutral* clips (SHAPES, COLOUR, STREET, and HOUSE) were classified correctly as they received low ratings of all Emotion Terms. Eight *Emotive* clips were excluded from further analysis as they were *Emotive* but did not elicit one specific emotion (CRY, BODY, BOYS, ONE, BLUE, CHIEN, HUMAN).

One further clip (BEACH) was re-classified from the *Contentment* to *Neutral* category as it did not elicit a specific emotion and elicited low ratings for all Emotion Terms.

Finally, the classification of two clips (BOAT and RALLY) was shown to require further analysis, as the extent to which they were *Emotive* or *Neutral* was unclear.

6.4.3 Part 1b - Classification of the BOAT and RALLY Video Sequences

The aim of Part 1b of the analysis was to determine the correct classification of the BOAT and RALLY clips, which had been used as stimuli in previous experiments. Of primary interest was whether the clips could be described as *Emotive* or *Neutral* as this classification had implications for the interpretation of previous results and the direction of future research.

6.4.3.1 Plan of Analysis

A number of criteria were used to guide the classification of the BOAT and RALLY clips. The clips would be classified correctly if they fulfilled the criteria for *Emotive* clips described in Part 1a. However, in the event that ratings of the clips suggested neutrality (i.e., low mean or modal ratings of all Emotion Terms) then additional criteria would need to be fulfilled. Specifically, ratings of the Target Emotion for each of the clips would need to be comparable to or higher than ratings of the Target Emotion for other clips in each of the BOAT and RALLY clip's respective category or be significantly higher than ratings of neutral clips (e.g., the BOAT clip should be comparable to or higher in '**contentment**' than other *Contentment* clips and also significantly higher in '**contentment**' than *Neutral* clips). If these criteria were not fulfilled then the BOAT and RALLY clips could be re-classified as *Neutral* clips.

6.4.3.2 Classification of the BOAT clip

The BOAT clip was included in the *Contentment* category as it had been shown to generate significantly higher ratings of **contentment** than the RALLY clip in Experiment 3. The analysis in Part 1a suggested that the BOAT clip may have been correctly classified as a *Contentment* clip as it generated higher ratings of **contentment** than all other Emotion Terms. However, it was noted that **contentment** ratings for the BOAT clip were very low (<2) even though they were significantly higher than other terms. Therefore, planned comparisons were conducted between the BOAT clip and all other *Contentment* and *Neutral* clips in terms of **contentment** ratings in order to determine the emotional intensity of the BOAT clip (details in Appendix C4).

The BOAT clip was significantly lower in **contentment** than the correctly classified *Contentment* clip (WAVES; $p < .01$) and the excluded *Contentment* clip which was shown to elicit generally positive emotions (BLUE; $p < .001$). In addition, the BOAT clip was significantly higher in **contentment** than three of the *Neutral* clips, (SHAPE, COLOUR and HOUSE; $p < .01$), and not significantly different to two *Neutral* clips (STREET and BEACH).

The results of the analysis suggest that though the BOAT clip produced relatively higher ratings of **contentment** in comparison to most other Emotion Terms it was not as intense on this dimension than other similar clips. In fact, the BOAT clip was not well differentiated from all *Neutral* stimuli. As such, the BOAT clip was re-classified as a *Neutral* clip, given the low ratings for all Emotion Terms and the general consensus of low ratings amongst participants.

6.4.3.3 Classification of the RALLY clip

The RALLY clip was included in the *Fear* category as it had been shown to generate significantly higher ratings of **fear** than the BOAT clip in Experiment 3. However, the analysis in Part 1a suggested that the RALLY clip may have been incorrectly classified as a *Fear* film as ratings of **fear** were not well differentiated from other negative Emotion Terms and were lower than positive Emotion Terms. In addition, the RALLY clip received low mean and modal ratings for all Emotion Terms. In sum, the evidence suggested that the clip was *Neutral* in tone. However, to check that the RALLY clip did not belong in another *Emotive* category ratings for the highest rated Emotion Term ('**amusement**') were compared to ratings of **amusement** given to *Amusement* and *Neutral* clips (see Appendix C4).

A series of planned comparisons revealed that the RALLY clip received significantly lower ratings of **amusement** than all the correctly classified *Amusement* clips (HARRY, ROBIN, SAM and PRETTY; $p < .001$). In addition, the RALLY clip was significantly higher in **amusement** than one *Neutral* clip (SHAPES, $p<.05$) and was not significantly different in **amusement** to all other *Neutral* clips (COLOURS, STREET, HOUSE and BEACH).

The results of the analysis suggest that the RALLY clip can be re-classified as a *Neutral* clip as ratings of the Target Emotion were not well differentiated from other Emotion Terms, low mean and modal ratings of all Emotion Terms were observed and ratings for the highest rated Emotion Term were significantly lower than other *Emotive* clips and comparable to the majority of *Neutral* clips.

6.4.3.4 Summary of Part 1b

The aim of the Part 1b analyses was to determine the correct classification of the BOAT and RALLY clips. The evidence suggests that the BOAT and RALLY were relatively neutral in emotional tone and therefore should be classified as *Neutral* clips.

6.4.4 Part One: Discussion

The first aim of Experiment 4 was to establish either the *Emotive* or *Neutral* quality of the BOAT and RALLY clips used in previous experiments in this thesis. In order to achieve this aim a set of thirty-two video clips were rated in terms of subjective emotion and were then either classified as having a specific emotional tone (*Amusement, Anger, Contentment, Anger, Disgust, Fear, Anger, Sadness, Surprise* and *Neutral*) or excluded from analysis. By comparing the BOAT and RALLY clips with similarly classified clips, the neutrality of the BOAT and RALLY clips was confirmed.

The finding has implications for the interpretation of previous experiments in this thesis. Specifically, in Experiment 3 it was shown that increased eye-to-screen visual angle enhanced ratings of presence and subjective arousal but did not increase differences between the BOAT and RALLY video clips in terms of emotional tone. In contrast, the Behavioural Realism approach to presence research would predict that differences between *Emotive* contents should be enhanced as presence increases. However, the prediction implies that *Neutral* content may be expected to remain *Neutral* as presence increases. As such, the use of the *Neutral* BOAT and RALLY clips may not have been the best content to use in isolation for testing the Behavioural Realism predictions. Therefore, future investigations of the relationship between reported presence and emotional responses using the paradigms implemented in Experiments 1-3 could test both *Emotive* and *Neutral* stimuli in order to clarify the impact of Media Form variables on different types of content. Part Two of the results section, below, details analyses used to establish sets of clips for future experimental use.

6.5 Results: Part-Two – Selection of Experimental Stimuli

6.5.1 Introduction

In Part One of the results section the correct classification of thirty-two clips in seven *Emotive* and one *Neutral* category of clips was established and those clips that were not well classified were identified and excluded. It was established that video clips used in prior experiments in this thesis were *Neutral* in emotional tone and that future experiments examining the impact presence enhancing Media Form variables on emotional responses to different types of content may benefit from the inclusion of both *Emotive* and *Neutral* sets of stimuli. Part Two of the results sections details analyses used to select and validate *Emotive* and *Neutral* experimental stimuli from the video clips remaining after Part One of the analysis.

6.5.2 Plan of Analysis

In order to achieve the aims of Part Two the remaining clips were first reviewed and sets of stimuli for validation were chosen. The following criteria were used: (1) categories of positively, negatively and neutrally valanced clips should be represented in order to improve experimental control and generalisability and (2) several clips should be included in each category in order to increase generalisability. Remaining categories of clips were then further assessed by ensuring that clips within each category were suitable for averaging. Averaged category data were then assessed for the extent to which each category elicited its target emotion and the extent to which each category was distinct from other categories in terms of the emotion it elicited.

6.5.3 Review of Remaining Clips

Of the original set of thirty-two clips, twenty-five clips were retained. Eighteen of the retained clips were *Emotive* and seven were *Neutral*. A summary of clips remaining in each category appears below in Table 6. 3.

Table 6.3 Summary of video-clips remaining in each category following the analyses in Part One of the Results.

Category	Clips	Number of clips
Amusement*	HARRY, ROBIN, SAM, PRETTY	4
Anger	No clips remaining	0
Contentment	WAVES	1
Disgust	PINK, TOE, TRAIN	3
Fear	SHINE, HALL, LAMB	3
Sadness*	CHAMP, BAMBI, FOUR, TRULY	4
Surprise	CAP, SEA, LA	3
Neutral*	SHAPES**, COLOUR**, STREET, HOUSE, BEACH**, BOAT, RALLY	7
Total		25

** Categories retained for future experimental use*

*** Clips excluded from retained categories*

A review of the clips remaining in each category indicated that the *Amusement*, *Sadness* and *Neutral* categories contained the largest number of clips (four, four and seven clips respectively). A further four sets (*Contentment*, *Fear*, *Disgust* and *Surprise*), also had a number of clips remaining. However, the running time for clips in two of these sets (*Surprise* and *Disgust*) were thought to be too short for experimental use (see Table 6.1). In addition, the *Fear* and *Contentment* categories were thought to contain too few clips, and there was some doubt over the classification of the LAMB clip in the *Fear* category. Retaining the *Amusement*, *Sadness* and *Neutral* categories was thought useful in a number of ways. In particular, the representation of positively, negatively and neutrally valanced stimuli in the three categories would allow further experiments to control for both emotionality and valence and would also increase the generalisability of findings across emotion types. Hence, the *Amusement*, *Sadness* and *Neutral* categories of clips fulfilled the criteria for categories retained for experimental use and were examined in more detail.

It was noted, however, that the *Amusement* and *Sadness* categories contained four clips each whereas the *Neutral* category contained seven clips. In addition, two of the *Neutral* clips portrayed abstract shapes and colours (SHAPES and COLOUR) rather than the types of scenes or events portrayed in the *Emotive* categories. Therefore the SHAPES and COLOURS clips were discarded to leave five clips (HOUSE, STREET, BEACH, BOAT and RALLY) in the *Neutral* category, which were more comparable in terms of visual realism to the *Emotive* categories. Of these five clips the BEACH clip was much shorter and of much poorer quality than other clips, and so was discarded. This left a *Neutral* category comparable in size and style to the *Amusement* and *Sadness* categories.

6.5.4 Creating Category Data

To ensure that the four clips within each category were well balanced on Emotion Terms and therefore suitable for averaging into category data, within category comparisons of each Emotion Term were performed. A series of within groups ANOVAs were performed for each of the seven Emotion Terms, with the four Clips within each category serving as the within groups factor. Details of the analysis may be found in Appendix C4, and mean ratings of each Emotion Term for each clip found in Table 6.2. Though some significant effects of Emotion Term were observed ($p<.05$) Clips within each category were well balanced on most Emotion Terms. In addition, it was noted that across all clips mean ratings were low and modal ratings were zero for all Emotion Terms apart from the Target Emotion. This indicated that no *Emotive* clip elicited an emotion other than the Target Emotion and that all *Neutral* clips produced neutral states.

The analysis above indicated that clips within each of the *Amusement*, *Sadness* and *Neutral* categories were adequately balanced on ratings of most Emotion Terms. In addition, when clips were not balanced on an Emotion Term, average ratings of that term were very low. Given the number of parameters that could vary between video stimuli that elicit one dominant emotion state it was thought that observed statistical differences were minimal and the best match between films from the original thirty-two film set had been found. Therefore, it was concluded that clips within each category were similar in terms of subjective emotion and were suitable for averaging. Table 6.4 and Figure 6.1 display the mean category ratings of Emotion Terms on the EES for the *Amusement*, *Sadness* and *Neutral* Categories.

Table 6.4 Mean ratings of EES Emotion Terms for the *Amusement*, *Sadness* and *Neutral* categories of clips.

Category	AMUSEMENT	SADNESS	NEUTRAL
	Mean *SD*	**Mean** *SD*	**Mean** *SD*
Emotion Term			
Amusement	**4.71*** *(1.39)*	**0.69** *(0.90)*	**0.51** *(0.72)*
Anger	**0.21** *(0.42)*	**0.96** *(1.05)*	**0.06** *(0.21)*
Contentment	**1.57** *(1.48)*	**0.47** *(0.85)*	**0.83** *(0.97)*
Disgust	**0.24** *(0.60)*	**0.62** *(1.08)*	**0.14** *(0.52)*
Fear	**0.03** *(0.15)*	**0.56** *(0.92)*	**0.11** *(0.33)*
Sadness	**0.23** *(0.56)*	**4.75*** *(1.83)*	**0.30** *(1.01)*
Surprise	**0.93** *(0.94)*	**0.42** *(0.69)*	**0.24** *(0.50)*

**Target Emotion*

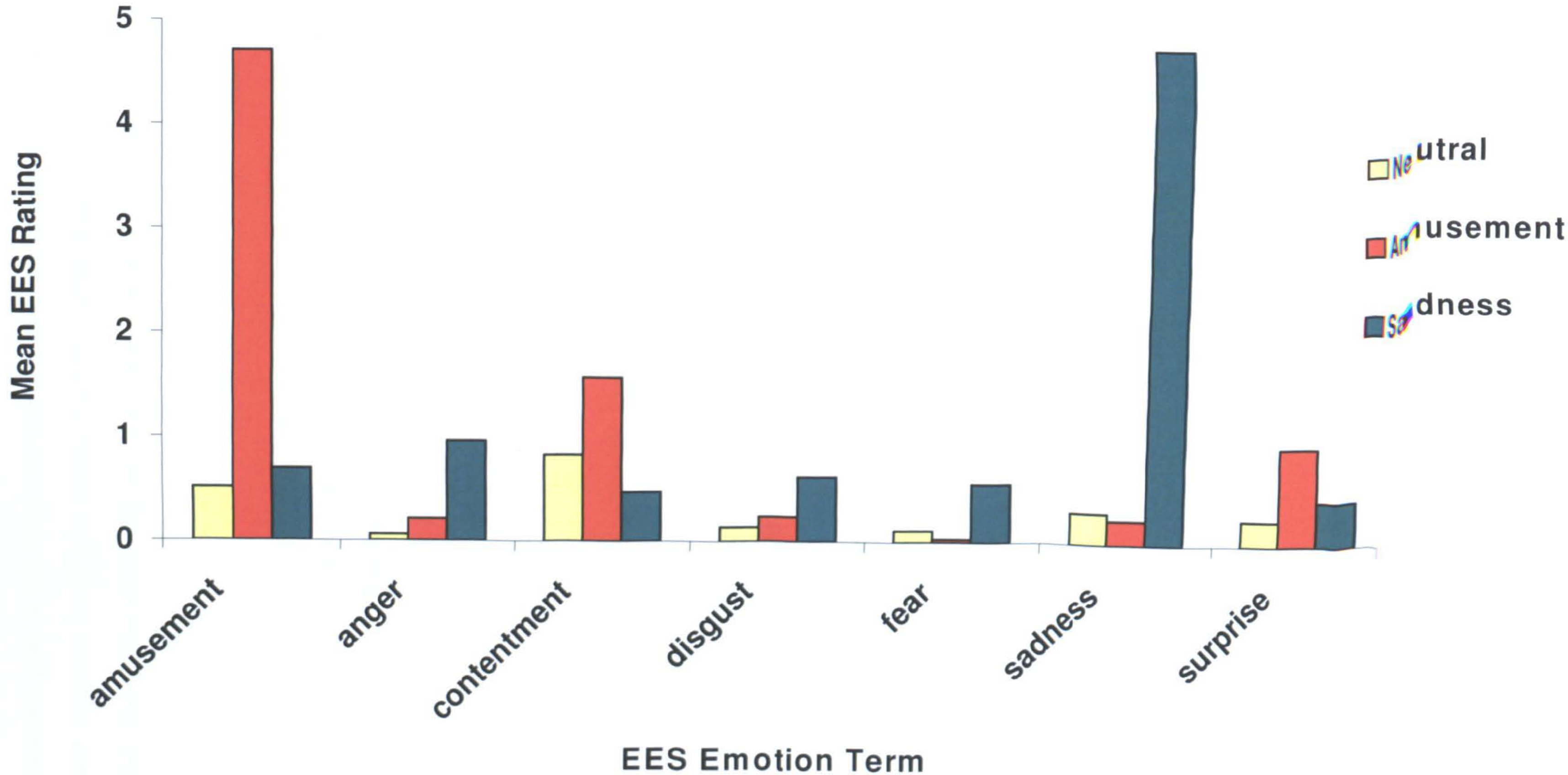


Figure 6.1 Mean ratings of EES Emotion Terms for the *Amusement*, *Sadness* and *Neutral* categories of clips.

6.5.5 Validation of the Categories

The aim of the analysis described in this sections was to confirm that each category was correctly classified according to the criteria set out in Part One of the results section and that each category was distinct in the type of emotion it elicited. Table 6.4 displays a summary of mean category emotion ratings on the EES used to validate the classification of each category.

As the *Neutral* category received mean ratings of less than one for all Emotion Terms the *Neutral* category was said to elicit a neutral state. A one-way within-groups ANOVA, with Emotion Term (**amusement**, **anger**, **contentment**, **disgust**, **fear**, **sadness**, and **surprise**) serving as the within-groups factor, was conducted for the *Amusement* and *Sadness* categories to investigate overall effects of Emotion Term. Details of the analysis may be found in Appendix C4. The results indicated that there were effects of Emotion Term for both the *Amusement* and *Sadness* categories ($p<.001$). Follow up comparisons revealed that in both categories the Target Emotion was rated significantly higher than all other emotion terms ($p<.001$).

To confirm that the categories differed from each other in terms of the Target Emotions and were therefore distinct from each other in terms of emotional tone, one-way within-groups ANOVAs were used to compare ratings of the Target Emotions (**amusement** and **sadness** respectively); Category (Category: *Amusement*, *Sadness* and *Neutral*) served as the within-groups factor. The results of the analysis (Appendix C4) indicated that the three Categories differed from each other in terms of both **amusement** and **sadness** ($p<.001$). Follow up comparisons indicated that the *Sadness* category was rated higher in **sadness** than the *Amusement* and *Neutral* categories and that the *Amusement* category was rated higher in **amusement** than the *Sadness* and *Neutral* categories ($p<.001$). Furthermore, the *Amusement* and *Neutral* categories did not differ in terms of **sadness** and the *Sadness* and *Neutral* categories did not differ in terms of **amusement**.

The above analyses indicate that each of the three categories elicits their Target Emotion state and that each category elicits a distinct emotion state. The *Neutral* category elicits no specific emotion and the *Amusement* and *Sadness* categories elicit **amusement** and **sadness** respectively to a greater degree than other emotions and categories.

6.5.6 Summary and Discussion of Part Two

In Part Two of the results section the largest categories of clips thought suitable for future experimental use remaining after the analysis conducted in Part One were selected and validated (*Amusement*, *Sadness* and *Neutral*). In each category, mean ratings of all Emotion Terms other than the Target Emotion were very low. Therefore, the Emotion Term data for clips within each chosen category were thought suitable for averaging. After averaging, each category was shown to elicit its Target Emotion state and was distinct in emotional tone from other categories. Though clips within each category did not share identical profiles in terms of subjective emotion this may not be expected with complex ecological stimuli such as narrative film. Therefore, the largest possible sets of positive, negative and neutral stimuli with known emotional qualities were created successfully and the second aim of the experiment was fulfilled.

6.6 Results: Part Three – Associations between Presence and Emotion

6.6.1 Introduction and Plan of Analysis

The final aim of this experiment was to capitalise on the data collected in the process of validating sets of experimental stimuli in order to explore potential associations between subjective ratings of presence and emotion. This was achieved in two main stages. Initially, the validated sets of *Amusement*, *Sadness* and *Neutral* clips were examined in order to investigate how ratings of presence varied between contents that differed broadly in emotional tone. Data concerning arousal, interest, identification, empathy and familiarity were also examined in order to investigate how other factors associated with emotional responses to media varied between the types of content. A correlational analysis was then used to investigate associations between Target Emotion ratings and reported presence within the *Emotive* categories.

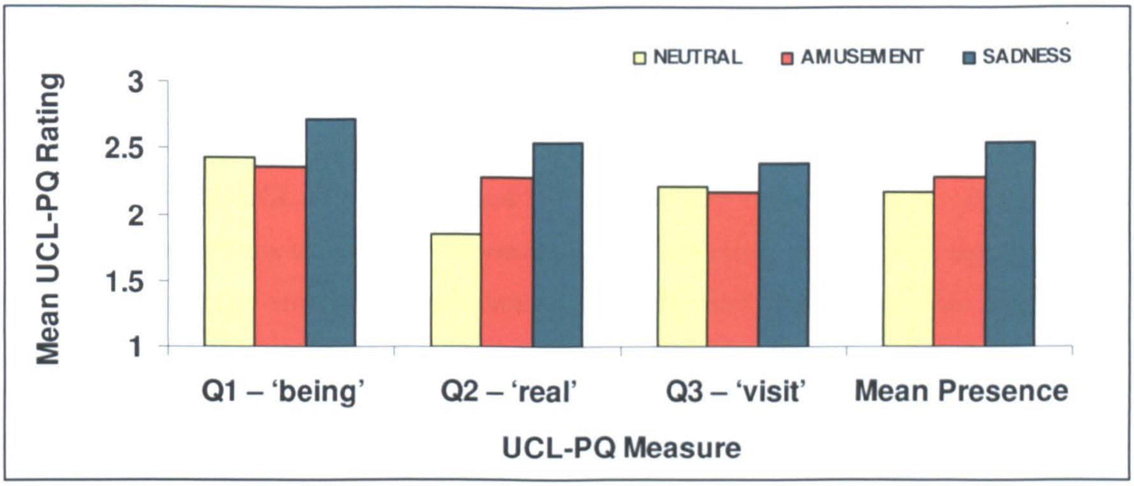
6.6.2 Between Categories Analysis

In order to explore differences in responses to the *Amusement*, *Sadness* and *Neutral* categories of clips, ratings of presence, arousal, interest, identification, empathy and familiarity data were first averaged within the four clips in each category respectively. A series of one-way, repeated measures ANOVAs with Category (*Amusement* vs. *Sadness* vs. *Neutral*) serving as the within-groups factor were then performed. Table 6.5 and Figure 6.2 display the mean ratings for each of the averaged media responses and summarises the results of the ANOVA procedures. F-values, epsilon and significance levels for each test are given in Table 6.5 (effect sizes are given below the table)

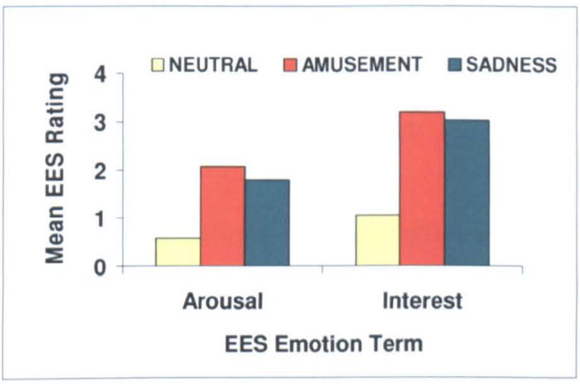
Table 6.5 Mean ratings of presence and other media responses for the *Amusement*, *Sadness* and *Neutral* categories of clips.

Category	AMUSEMENT		SADNESS		NEUTRAL		ANOVA SUMMARY		
	Mean	*SD*	Mean	*SD*	Mean	*SD*	F	ε	*p*
UCL-PQ Presence Ratings									
Q1 – 'being'	**2.37**	*(1.26)*	**2.72**	*(1.20)*	**2.44**	*(1.09)*	**1.55**	**.61**	*.22*
Q2 – 'real'*	**2.28**	*(1.28)*	**2.54**	*(1.28)*	**1.86**	*(0.93)*	**6.71**	**.67**	*<.01*
Q3 – 'visit'	**2.17**	*(1.16)*	**2.39**	*(1.13)*	**2.22**	*(1.15)*	**0.72**	**.67**	*.49*
Mean Presence	**2.28**	*(1.13)*	**2.55**	*(0.85)*	**2.17**	*(0.75)*	**2.52**	**.64**	*.09*
EES Arousal Ratings									
Arousal*	**2.07**	*(1.92)*	**1.80**	*(1.77)*	**0.58**	*(0.75)*	**14.56**	**na**	*<.001*
Interest*	**3.19**	*(1.55)*	**3.03**	*(1.54)*	**1.06**	*(0.89)*	**46.67**	**.81**	*<.001*
Response to Characters									
Identification*	**2.58**	*(1.42)*	**3.64**	*(1.51)*	**1.28**	*(0.69)*	**50.34**	**na**	*<.001*
Empathy*	**2.81**	*(1.51)*	**4.53**	*(1.34)*	**1.23**	*(0.70)*	**116.5**	**na**	*<.001*
Familiarity*	**1.76**	*(0.37)*	**1.64**	*(0.41)*	**1.22**	*(0.17)*	**21.59**	**.81**	*<.001*

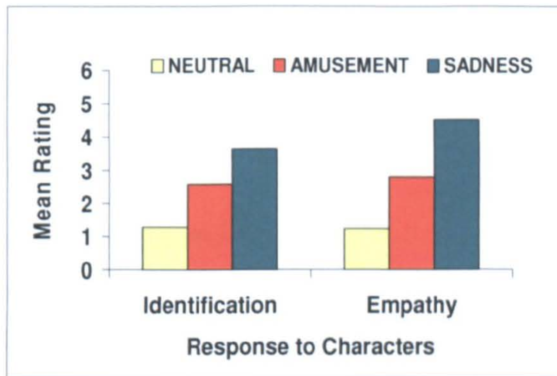
**Significant Main Effect of Category (df (2,34), n=36 for all tests, .16 < eta-square < .87 for significant results; eta-squared < .04 for non-significant results).*



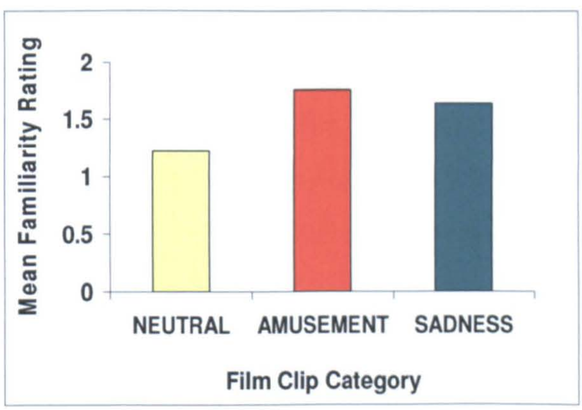
(a)Presence



(b) Arousal and Interest



(c) Identification and Empathy



(d) Familiarity

Figures 6.2a-d Mean Neutral, Amusement and Sadness Category ratings of (a) Presence, (b) Arousal and Interest, (c) Identification and Empathy and (d) Familiarity.

A full description of the results may be found in Appendix C4. Significant main effects of Category were observed for all types of ratings with the exception of questions on the UCL-PQ (Q1, Q3 and the mean score) – see Table 6.5. A series of planned comparisons using t-tests, revealed that the *Neutral* category was significantly lower on arousal, interest, identification, empathy and familiarity than both the *Amusement* category ($p < .001$) and the *Sadness* category ($p < .01$). In addition the *Neutral* category was significantly lower on the UCL-PQ Q2-'real' than the *Sadness* category ($p < .01$). Similarly, the Amusement category received higher ratings on Q2-'real' than the Neutral category ($p = .06$). In addition the *Sadness* category was significantly higher on the UCL-PQ Q2-'real', identification and empathy than the *Amusement* category ($p < .01$). T-tests also revealed that the *Amusement* and *Sadness* categories did not differ in terms of arousal, interest, and familiarity and were therefore well balanced on these variables.

6.6.3 Associations between Subjective Ratings of Presence and Emotion

Pearson correlations were used to explore associations between ratings of presence and emotion. Correlations were run between the three items on the UCL-PQ and the target emotion for the *Amusement* and *Sadness* categories of clips (see Tables 6.6a-b). The *Neutral* category was excluded from the analysis given the very low mean and modal ratings for all emotion terms. Non-target emotions in the *Emotive* categories were not analysed for the same reason. Of primary interest was whether the ratings of the Target Emotion in each *Emotive* category correlated with reported presence. This was supported for the *Amusement* and *Sadness* categories. Ratings of **amusement** in the *Amusement* category were positively correlated with Q1-'being' ($r = .53$, $p < .01$), Q2-'real' ($r = .53$, $p < .01$) and Q3-'visit'($r = .50$, $p < .01$). Ratings of **sadness** in the *Sadness* category were positively correlated with Q1-'being' ($r = .38$, $p < .05$), Q2-'real' ($r = .39$, $p < .05$) and Q3-'visit'($r = .51$ $p < .05$) – Table 6.6.

Table 6.6a-b Correlations between reported presence and target emotion ratings for (a) *Amusement* and (b) *Sadness* categories of clips

(a)Amusement Clips

	Q1-'being'	Q2-'real'	Q3-'visit'
Amusement ratings	**0.53****	**0.53****	**0.50****

(b)Sadness Clips

	Q1-'being'	Q2-'real'	Q3-'visit'
Sadness ratings	**0.38***	**0.39***	**0.51****

* Correlation is significant at the .01 level
** Correlations is significant at the .05 level

6.6.4 Summary and Discussion of Part Three

The aim of Part Three of the analysis was to explore potential associations between reported presence and subjective emotion ratings. The aim arose out of predictions noted in the introductory chapters that more intense emotional responses to mediated environments may be associated with higher levels of presence. The results described in Part Three partially supported the prediction.

As predicted, within *Emotive* categories ratings of the Target Emotion were positively correlated with presence ratings across all items on the UCL-PQ. Ratings of **amusement** for *Amusement* clips, and also ratings of **sadness** for *Sadness* clips correlated positively with participants' sense of being there, realness and sense of having visited a place. In addition, *Emotive* clips were rated higher in presence (the extent to which the displayed environment became more real or present to the participant than the 'real world') than *Neutral* clips, and the *Sadness* category was rated significantly higher in presence than the *Amusement* category. Therefore, reported presence varied between categories according to both the emotive quality of the categories and also the emotional intensity of the categories.

It was also noted that the *Amusement*, *Sadness* and *Neutral* categories of clips differed from each other in terms of arousal, interest, identification and empathy. An interesting avenue for future research would be an examination of the relationship between presence, emotion types and those factors which may influence the elicitation of different types of emotion, such as empathy and identification[22]. However, the immediate question for the current research programme is a re-investigation of the proposal that Media Form variables may have an effect on both reported presence and emotional responses. An appropriate direction for this re-investigation is to follow-up the finding that ratings of presence correlated with Target Emotion states for *Emotive* video clips (i.e., ratings of **amusement** and **sadness** for *Amusement* and *Sadness* clips respectively). Given this finding, it may be expected that a Media Form variable that enhances reported presence (such as increased eye-to-screen visual angle) may also be expected to enhance Target Emotion states for *Emotive* video clips.

6.7 General Discussion

The first aim of Experiment 4 was to establish whether the BOAT and RALLY clips used in previous experiments could be described as *Emotive* or *Neutral*. In order to achieve this aim, video clips classified by the type of emotion each elicited were first collected and rated. By comparing the BOAT and RALLY clips with correctly classified clips, the emotional neutrality of the BOAT and RALLY clips was established. Three sets of experimental stimuli were then extracted from the classified set (*Amusement*, *Sadness* and *Neutral*). In line with the secondary aims of the experiment the new categories of experimental stimuli represented the largest possible groups from the original clips and included positively and negatively valanced clips in addition to neutral clips. Rating data were used to explore potential associations between reported presence and emotion across and within the new sets of experimental stimuli. The results indicated that one UCL Presence Questionnaire item varied across the sets and that ratings of the Target Emotion state (e.g., ratings of **amusement** for the *Amusement* category of clips) were positively correlated with all items on the presence questionnaire.

Video stimuli, such as those used in this experiment, are complex stimuli that vary along many parameters. These include not only elicited emotions but also media responses such as identification, empathy and familiarity. Production values also vary as do plot, actors, location, theme and a variety of other factors. Additionally, viewing may take place in a variety of contexts and each viewer brings their own knowledge and

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[22] See Chapter 8 for a more in-depth discussion of the way these findings could be explored in future research.

state of mind to their interpretation of the stimuli. Comparing one video-clip to another in terms of emotional impact may, therefore, be complex given the number of relevant factors that could vary between clips. However, the present experiment has demonstrated that with a relatively small sample, a good replication of a previous large-scale film ratings study may be achieved.

Twelve out of fifteen clips from Gross and Levenson's (1995) original set were shown to elicit their Target Emotion to a greater extent than other Emotion Terms. The quality of emotion elicited by Gross and Levenson's clips could be viewed as a reliable effect and statistical analysis suggested that new clips added in this ratings study were equally reliable. As such the validated set of video clips provided a good comparison for the BOAT and RALLY sequences. This enabled further evaluation of results presented in Experiments 1, 2 and 3.

In previous experiments it was predicted that increases in reported presence would be associated with increases in the intensity of the specific emotional qualities of different types of content (BOAT and RALLY). Whilst manipulations of Media Form had some general effects on subjective arousal ratings, few effects of the Media Form manipulations that were specific to contents were observed. Given that the BOAT and RALLY sequences have been shown to be neutral in emotional tone the latter effects may not have been expected (as neutral stimuli cannot become more intensely neutral at higher levels of presence). Further investigations of the relationship between reported presence and emotional responses using the paradigm implemented in Experiments 1-3 could utilise the sets of *Amusement*, *Sadness* and *Neutral* experimental stimuli developed in the present experiment. Though the categories, and clips within the categories, vary somewhat on ratings other than their respective target emotions, it is the validated distinctiveness of the emotional state elicited by each category that is of most importance for the paradigm.

Analysing emotional responses to different types of content at different levels of Media Form is only one way of investigating the relationship between reported presence and emotional responses. The present study utilised two further methods: examining differences between *Emotive* and *Neutral* clips, and examining correlations between presence and emotion within categories of *Emotive* clips. *Emotive* clips elicited higher levels of reported presence than *Neutral* clips, and the highest rating was received by the Sadness set of clips. In addition, within each of the *Emotive* categories reported presence and the Target Emotion ratings were positively correlated.

Further research could address the above findings. Potential avenues for research would include examining why differences between categories of contents were found for only one type of presence rating and whether this was related to other observed differences between contents (e.g., on the empathy and identification scales). For example, it has been proposed that Q2-'real' is a measure of naturalness (Freeman, 2003). Research could examine film-reception processes that may explain why a set of *Sadness* clips is associated with higher ratings of naturalness than other sets.

Alternatively, Q2 could reflect the 'Engagement' dimension of presence in this context. The question asks:

"To what extent were there times during the experience when the displayed environment became the 'reality' for you, and you almost forgot about the 'real world' outside"?

The *Emotive* categories may have been both more emotionally engaging and more demanding of attentional capacity than *Neutral* clips. Stimuli which demand more attention (e.g., because they require more processing of movement, speech and events, and so may be more 'engaging') may be expected to reduce focus on the external 'real' environment and so engender a greater sense of presence.

However, the research programme in this thesis is focused on investigating the relationship between presence, subjective emotion and physiological responses. As such the second finding is of more interest, (that reported presence correlated with Target Emotion states for *Emotive* contents). Given this finding, the question to be explored in Experiment 5 is whether Media Form manipulations that enhance reported presence may also be expected to enhance Target Emotion responses to *Emotive* contents.

In summary, the three aims of the experiment have been fulfilled. The emotional quality of experimental stimuli used in prior experiments in this thesis (BOAT and RALLY) has been confirmed, sets of experimental stimuli for future use have been developed and associations between presence and emotion have been explored. The limitations of rating and validating complex video stimuli are acknowledged. However, these limitations are offset by the usefulness of the reported results in aiding the interpretation of previous findings and opening up avenues for further research.

Chapter 7 EXPERIMENT 5:

Effects of Visual Angle on Presence and Emotion for Emotive and Neutral Content

7.1 Introduction

The Behavioural Realism approach to presence research proposes that increases in subjective sensations of presence should be associated with increased naturalistic responses to Media Content. A prediction arising from the Behavioural Realism approach links the five experimental chapters in this thesis. The prediction is that increases in reported presence, due to enhancements of the immersive properties of a medium, should be associated with increased emotional responding to Media Content. For example, it may be expected that increased presence would make a horror movie more frightening or a pleasant scene more relaxing. The aim of Experiment 5 is to further investigate this prediction in a way which extends and improves on previous experiments presented in this thesis.

Previous research investigating the relationship between presence and emotion tends to have used highly arousing Media Content such as fear inducing (e.g., depictions of heights) or fast paced stimuli. For example, presence and the physiological and behavioural indicators of fear have been shown to correlate in response to simulated fear inducing stimuli (Meehan et al., 2002; Insko, 2003, Wiederhold, Jang, Kaneda, Cabral, Lurie, May, Kim & Wiederhold, 2001). However, this is not a consistent finding (Meehan, et al., 2002) and there have been few studies examining presence and emotion via other routes, such as by comparing different types of emotive content in terms of presence ratings. One study by Banos et al, (2004) demonstrated that sad content was rated higher in presence than neutral content, suggesting that the findings of the correlational studies may extend beyond fear inducing stimuli.

Little research has compared emotional responses to different types of Media Content across variations in Media Form and studies have yielded mixed findings. For fear inducing stimuli there is some evidence that enhanced immersion increases both presence and emotional responding (Meehan et al., 2003; Wiederhold et al., 1998). However, research using other types of content reveals a more complex pattern of findings. In the Banos et al., (2004) study, a sad virtual park was rated higher in presence than a neutral virtual park and this effect was most apparent at low levels of immersion, specifically for ratings of engagement and ecological validity. Furthermore, Freeman et al. (2004) found that Media Form variables affected presence but not emotion for users of a relaxing virtual environment. Further research examining both the effects of Media Form and different types of Media Content would be beneficial to the field of presence and emotion.

In Experiments 1, 2 and 3 (Chps. 3, 4, and 5 respectively) two of the theoretical determinants of presence (Media Form and Media Content) were varied in order to determine their effects on several measures. Post-viewing subjective ratings of presence were compared to changes in Skin Conductance and Heart Rate, and self-reported emotion and mood. Whilst enhancements of Media Form were shown to increase subjective ratings of presence and general subjective arousal, few consistent and reliable effects of Media Form manipulations on the subjective and physiological indicators of specific emotions were observed.

The results of Experiment 4 (Chp. 6) indicated that the video content used in preceding experiments (BOAT and RALLY) was relatively neutral in emotional tone when compared to other types of video content, such as sequences from popular films. Given that neutral video content may not be expected to elicit stronger emotional responses at higher levels of presence, it was proposed that the effects of Media Form manipulations on emotional responses to different types of Media Content required further testing, using both emotive and neutral content. The results of previous experiments are utilised to this end in the current experiment.

In particular, Experiment 3 demonstrated that increasing the horizontal eye-to-screen visual angle of a video display from 21- to 42-degrees enhanced subjective ratings of presence. Therefore, the present experiment will utilise the visual angle (Angle) variable as the means of manipulating subjective presence ratings. Participants will view both 21-degree (SMALL) and 42-degree (LARGE) presentations of three types of video content (Content). It is predicted, in line with Experiment 3 and other research (Hatada, Sakata & Kusata, 1980; IJsselsteijn et al., 2001; Lombard et al., 1997; Prothero & Hoffman, 1995; Reeves et al., 1993) that LARGE angle presentations will generate higher levels of subjective presence than SMALL angle presentations.

The video content to be presented to participants in Experiment 5 was developed in Experiment 4 and comprises of three categories of four video clips. In Experiment 4, each category was shown to elicit a subjective Target Emotion state that was distinct from each of the other categories. The NEUTRAL category of video clips elicited no strong emotions, whereas the AMUSEMENT and SADNESS categories elicited high ratings of 'amusement' and 'sadness' respectively (to a greater degree than other emotions and to a greater degree than the other categories). It is expected that these results will be replicated in the present experiment. Furthermore, it is expected that the effects of the Angle manipulation on subjective and physiological emotional responses will be dependent on the type of Content presented.

In terms of subjective emotion ratings it is expected that LARGE angle presentations will be more generally arousing than SMALL angle presentations. However, it is expected that Angle manipulation will have a greater impact on the emotive AMUSEMENT and SADNESS categories of video clips in comparison to the NEUTRAL category. In particular, it is expected that ratings of 'sadness' will increase for the SADNESS category of video clips and not the AMUSEMENT and NEUTRAL categories. Similarly, it is expected that ratings of 'amusement' will increase for the AMUSEMENT category of video clips and not the SADNESS and NEUTRAL categories.

In terms of emotion related physiological responses the predictions must be more speculative. The three categories of content are expected to differ in terms of the changes they elicit in Skin Conductance Levels and Heart Rate. The effects of Angle on Skin Conductance and Heart Rate may be dependent on Content type. However, the exact pattern of physiological responses to be expected is a matter of debate in the wider research literature.

Skin Conductance Levels and Heart Rate are determined by the two branches of the autonomic nervous system (the sympathetic nervous system and the parasympathetic nervous system)[23]. Skin Conductance is thought to be determined by activity in the sympathetic nervous system, with levels of emotional arousal positively correlated with Skin Conductance Levels. Therefore, the more emotive AMUSEMENT and SADNESS categories of video clips may be expected to be associated with higher Skin Conductance Levels than the NEUTRAL category. However, recent research indicates

[23] See Chapter 2 for an in depth review of the biological basis and psychological correlates of Skin Conductance and Heart Rate measures.

that there may be an inhibitory action of the parasympathetic nervous system on Skin Conductance that may be present during 'sadness' (Bradley, 2000).

Short-term changes in Heart Rate are associated with both the sympathetic and parasympathetic branches of the autonomic nervous system. The two systems have a complex relationship with gross measures of Heart Rate. It may generally be said that increased activity in the sympathetic nervous system raises Heart Rate, such as during intense emotional arousal or stress, and that the parasympathetic nervous system can reduce Heart Rate, such as during sustained attention or relaxation. Therefore, the emotive AMUSEMENT and SADNESS categories may be expected to differ from the NEUTRAL categories in terms of changes in Heart Rate because of their capacity to arouse the viewer and sustain attention. Research conducted by Fredrickson and Levenson (1998), who examined subjective and physiological responses to video content, suggests that emotive content (within the range of arousal elicited by the Content used in this experiment) will be associated with lower Heart Rate than neutral content.

In line with predictions for subjective emotion ratings, the Angle manipulation is expected to have a greater impact on physiological responses to the emotive AMUSEMENT and SADNESS categories of video clips, in comparison to the NEUTRAL category. One possibility is that physiological responses observed under SMALL angle conditions will be exaggerated under the higher presence LARGE angle conditions. However, given that there are multiple psychological and physiological influences on measures of Skin Conductance and Heart Rate, steps will be taken in this experiment to protect against and identify confounding variables. For example, participants will view LARGE and SMALL angle presentations on separate occasions in order to protect against the effects of repeated exposure on physiological measures. In addition, measures of visual quality and negative effects will be taken in order to identify features of the video content and viewing conditions which may impact on emotional and physiological responses.

In summary, in Experiment 5 participants will view both SMALL and LARGE version of three types of video content (NEUTRAL, AMUSEMENT and SADNESS categories of clips). It is expected that LARGE angle viewing conditions will generate higher ratings of presence than SMALL angle presentations. Because LARGE angle presentations are expected to elicit higher levels of presence, it is expected that LARGE angle presentations will have a greater impact on subjective and physiological emotional responses to the AMUSEMENT and SADNESS categories of clips, in comparison to the NEUTRAL category. Specifically, amusing clips are expected to become more amusing, and sad clips more sad.

7.2 Method

7.2.1 Design

A within-subjects 3 x 2 factorial design was used. 'Angle' was a within-groups factor with two levels (horizontal eye-to-screen visual angle = 21-degree [SMALL] vs. horizontal eye-to-screen visual angle = 42-degree [LARGE]) and 'Content' was a within-groups factor with three levels (Video clip category: NEUTRAL video clips [NEUTRAL] vs. AMUSEMENT video clips [AMUSEMENT] vs. SADNESS video clips [SADNESS]).

SMALL and LARGE Angle presentations of the video clips took place in separate 2-hour testing sessions approximately one-week apart. Half the participants viewed the SMALL angle presentations in the first week, followed by LARGE angle presentations in the second week. The remaining participants viewed LARGE angle presentations followed by SMALL angle presentations. In each testing session the order of video clip presentation was counterbalanced so that no two clips from the same category appeared next to each other (see Appendix D1 for counterbalancing details).

The dependent variables were post-viewing subjective ratings of presence and emotion, and also changes in Skin Conductance Levels and sustained Heart Rate from pre-viewing baseline levels to viewing levels and post-viewing levels Subjective ratings of engagement, negative side-effects and visual quality were also collected. Questionnaire order was counterbalanced across participants (see Appendix D1).

7.2.2 Participants

Twenty-six participants were recruited from Goldsmiths College, University of London (14 males, 12 female, average age 25.04 years, sd = 6.26), and received £15 in return for their participation. All participants were over 18-years old. Two male participants who failed to complete the experiment were excluded from all analyses. All participants signed a consent form. The consent form asked participants to confirm that they understood that some of video clips they would see dealt with emotive subjects such as sex, drug-use and bereavement and had received an '18' certificate. Participants were also asked to confirm on the consent form that they had normal, or corrected to normal vision, were not claustrophobic, were not taking medication which affected Heart Rate and had not taken part in any other experiment in the ITC laboratory. The consent form and experimental instructions may be found in Appendix D4.

7.2.3 Video Presentation Apparatus and Materials

7.2.3.1 Viewing Platform and Visual Display

The viewing platform and visual display apparatus were as described in Experiment 3 (Chp. 3, pg. 104), with participants seated 175cm from the screen in the SMALL angle condition and 80cm from the screen in the LARGE angle condition. A number of alternative methods of varying eye-to-screen visual angle were piloted (using feedback from colleagues, ITC team members and technicians) including displaying the video content via an overhead projector and digitising the content in order to vary image size. However, varying eye-to-screen distance in the P*i*T was found to be the method which allowed the largest difference in visual angle between conditions whilst also preserving video quality.

7.2.3.2 Auditory Display

Audio information, particularly audio quality and spatial depth, has been shown to affect both ratings of presence and emotion (Vastfjall, 2003; Vastfjall, Larsson & Kleiner, 2002). Therefore, in order to minimise artefacts arising from the changed listening position between Angle conditions, audio information accompanying the video stimuli was presented in mono through a Yamaha DSP-5982 amplifier and headphones. The use of headphones ensured that audio amplitude and quality was balanced across the Angle conditions.

7.2.3.3 Video Stimuli

Table 7.1 contains details of the twelve video-clips used in this study. Each clip was assigned to one of three categories (AMUSEMENT, SADNESS and NEUTRAL) on the basis of the ratings study described in Experiment 4. Mean presence, Emotion Term, arousal, interest, identification, empathy and familiarity ratings for each category of clips may be found in the results section of Experiment 4 (Chp. 6, pg. 205-216). The critical difference between the three categories of clips is that the clips in each category elicit a Target Emotion state that is distinct from clips in other categories. Clips in the AMUSEMENT and SADNESS categories elicit higher ratings of **amusement** and **sadness**, respectively, to a greater extent than ratings of other Emotion Terms (Chp. 6, pg. 208). Clips in the NEUTRAL category elicit low ratings for all Emotion Terms (modal rating = 0, or ratings of all Emotion Terms < 2).

To ensure that the group mean length of the video clips was approximately balanced between categories, the NEUTRAL clips were looped so that *STREET* was cut to 80-secs and seen 2.5 times per presentation, *HOUSE* was cut to 50-secs and seen four times per presentation, and *BOAT* and *RALLY* were seen twice per presentation.

Table 7.1 Description of video clip stimuli in each of the NEUTRAL, AMUSEMENT, and SADNESS categories.

Target Emotion Category	Film Name and Abbreviation	Description of Scene	Length (secs)
NEUTRAL	Boat Sequence (*BOAT*)	Boat travels down Norfolk broads	200
	Street-scene (*STREET*)	Quiet residential street	200
	House-scene (*HOUSE*)	House interior	200
	Rally-sequence (*RALLY*)	Car drives round rally track	200
AMUSEMENT	When Harry Met Sally (*HARRY*) *	Discussion of orgasm in cafe	149
	Robin Williams Live (*ROBIN*) *	Comedy routine	204
	Play it Again Sam (*SAM*)	Nervous man on first date	210
	Pretty Woman (*PRETTY*)	Woman goes shopping	252
SADNESS	The Champ (*CHAMP*) *	Boy cries at fathers death	196
	Bambi (*BAMBI*) *	Mother deer dies	129
	Four Weddings and a Funeral (*FOUR*)	Speech at funeral	256
	Truly, Madly, Deeply (*TRULY*)	Woman in counselling	198

* Films appear in Gross and Levenson's (1995) set.

The clips were recorded onto one Beta SP video with120-seconds of blue screen at the beginning and end of the whole sequence of clips and 120-seconds of blue screen separating each clip. The video activation and presentation order were controlled via a PC using software described in Experiment 1 and Appendix A1. Clips were presented in a semi-random order so that no two clips from the same category appeared next to each other and so that no participant saw two clips in the same order at both presentation times. The presentation orders are detailed in Appendix D1.

7.2.4 Questionnaire Measures

Participants completed four short questionnaires after each video-clip (described below). For each questionnaire measure, scores were averaged across the four clips in each category of film clips (NEUTRAL, AMUSEMENT and SADNESS) in the SMALL and LARGE angle conditions respectively.

7.2.4.1 UCL Presence Questionnaire

The UCL-Presence Questionnaire (UCL-PQ: Slater et al., 1994) was as described in Experiments 2 and 4 (see Chp. 4, pg. 144 for the questionnaire items). Each of the three items (**Q1-'being'**, **Q2-'real'** and **Q3-'visit'**) were analysed separately and a composite score (**Mean Presence**) was created by taking the mean of the three items. Each item was scored on a 0-7 scale where a higher score indicated a higher level of reported presence.

The UCL-PQ was used in this experiment as it provides a quick and simple means of measuring presence. The length of questionnaires was a particular concern in the current experiment due to the increased time and effort demands placed on participants in comparison to previous experiments. The measure was determined to be adequate for use in the current experiment as it may be useful for verifying the effects of Media Form variations on experiences of presence (see Chp. 4, Experiment 2). For example, the results of Experiment 3 indicated that a 42-degree visual angle generated higher ratings of Physical Space, Engagement and 'being there' on the ITC-SOPI than a 21-degree angle. Given that the UCL-PQ includes items similar to those on the ITC-SOPI (e.g., rating the sense of 'being there' [**Q1-'being'**]), it provides the means for indicating whether the effects of Angle on reported presence, seen in Experiment 3, are replicated in the present experiment.

7.2.4.2 ITC-Sense of Presence Inventory Items

Although the UCL-PQ may provide a simple Angle manipulation check, the measure may not fully address the Engagement dimension of reported presence. In addition, the UCL-PQ does not address Negative Effects, which are an important potential confound when examining the effects of varying visual angles (see Chp. 5, Experiment 3). Therefore, short adaptations of the 'Engagement' and 'Negative Effects' ITC-SOPI (Lessiter et al., 2001) scales were utilised in this experiment. A full description of the ITC-SOPI can be found in the method section of Experiments 1 (Chp. 3, pg. 109).

Engagement-Short Form:

Items on the ITC-SOPI 'Engagement' scale were examined for their suitability for inclusion on a three-item short form of the 'Engagement' scale (Engagement-SF). Items that referred to emotional responses were rejected. This ensured that the remaining items did not address constructs appearing elsewhere in the self-report data and were not biased towards any particular film category. The three items with the highest loadings onto the ITC-SOPI 'Engagement' factor were selected from the remaining items and are detailed below (see Appendix D2 for factor loadings)[24]. Item B2 also loaded onto the ITC-SOPI Physical Space factor[25].

B1: I felt myself being drawn in.
B2: I felt involved (in the displayed environment).
B3: I lost track of time.

Negative Effects-Short Form:

Six items appear on the ITC-SOPI 'Negative Effects' subscale, each referring to a distinct, negative, mental or physical side-effect of mediated experiences. These items were combined to create one question addressing the occurrence of negative side-effects (Negative Effects-SF):

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[24] Factor loadings were taken from Lessiter & Freeman (2000a), an internal technical report detailing the development of the ITC-SOPI. Questionnaire items were labelled with the prefix 'B' in the original report. The factor loadings may be found in Appendix 4.

[25] The scale was later refined and a revised version was submitted to the EC-FET Presence Initiative OmniPres project. The latter version is also included in Appendix D2 for comparison.

'I experienced sensations such as dizziness, disorientation, nausea, a headache, eyestrain or tiredness'.

Participants were instructed that the Engagement-SF and Negative Effects-SF questionnaire items referred to their thoughts or feelings while they were experiencing the displayed environment and were asked to rate how much they agreed with each statement on a five point scale (1 = Strongly disagree, 2 = Disagree, 3 = Neither agree or disagree, 4 = Agree, 5 = Strongly agree) – see Appendix D3. The one item Negative Effects-SF scale provided a simple measure of the occurrence of negative side effects (**Negative Effects-SF**). The mean score was calculated for the three items on the Engagement scale (**Engagement-SF**).

7.2.4.3 Elicited Emotion Scales – Short Form

The Elicited Emotion Scales - Short Form (EES-SF) questionnaire was a modified version of Gross and Levenson's (1995) measure for evaluating the emotional impact of film clips (described in Experiments 3 and 4). Participants are usually required to rate sixteen Emotion Terms on eight-point scales. In the present study, only ratings of particular emotions (Emotion Terms: **amusement** and **sadness**) and ratings of non-specific emotional intensity (Arousal Terms: **arousal** and **interest**) were of interest in terms of the experimental hypotheses in the present study and these were retained on the EES-SF. Items referring to other primary emotions (**anger**, **contentment**, **disgust**, **fear**, **happiness**, and **surprise**) served as filler words and were also used to verify the emotional specificity of the Content categories. The EES-SF thus contained eight Emotion Terms and two Arousal Terms (see Appendix D3). Participants were asked to rate the greatest amount of each Emotion Term that they had felt whilst watching each clip on nine-point scale. A rating of '0' indicated that the participant did not feel the slightest bit of that emotion during a clip while '8' indicated that they felt that emotion the most they had ever done in their life. Mean ratings of less than or equal to 2, or a modal score of 0, were taken to indicate an absence of emotional intensity (i.e., a neutral state).

7.2.4.4 Visual Image Evaluation Scales

The Visual Image Evaluations Scales (VIES) were described in Experiment 3 (Chp.5, pg. 161), in which effects of Angle and interactions between Content and Angle were observed on these scales. The visual quality issues addressed on the three 100-point visual analogue scales of the VIES are **Image Quality**, **Image Adequacy** and **Image**

Brightness. These variables are potentially associated with variations in physiological measures, the occurrence of negative side-effects and subjective emotions. In addition visual quality issues were not addressed in the ratings study described in Experiment 4. Therefore, the VIEs were included in the present study in order to account for any potential confounding effects of visual quality factors (see Appendix B3 for a copy of the VIES).

7.2.4.5 Questionnaire Administration

The questionnaire measures described above were presented to participants after each video-clip in four sections corresponding to the UCL-PQ, ITC-SOPI questions (Engagement-SF and Negative Effects-SF), the EES-SF and the VIES. Presence ratings can be influenced by prior experience with ratings scales addressing other qualities of a visual image (Freeman et al., 1999). Therefore, the order of questionnaire completion was counterbalanced so that half of the participants completed the VIES before completing presence related questions and half completed the VIES after the presence questions. It is also possible that ratings of emotions may affect ratings of presence and vice versa. In order to avoid this possible confound half of the participants who completed the VIES first completed the presence related questions before the EES-SF and half completed the EES-SF before the presence related questions. The same was true for participants who completed the VIES last. The components of the post-viewing questionnaire booklet are presented in Appendix D3. Counterbalancing details are presented in Appendix D1.

7.2.5 Physiological Recording Equipment

Heart Rate (HR) and Skin Resistance recordings were obtained using the custom-made data acquisition system and software package described in Experiments 1 and 3 (Appendix A1). HR data was obtained from electrocardiogram (ECG) readings, using a bipolar placement of Biotrace Ag/AgCl electrodes over the bone on the left and right hand side lower ribcage. To obtain Skin Resistance data, Biotrace Ag/AgCl disposable electrodes were attached to the distal phalanges of the first and third fingers of the left hand after the skin had been cleaned with distilled water.

7.2.6 Physiological Data Management

ECG and Skin Resistance recordings were taken for 100-secs before (pre-viewing), during (viewing), and 100-secs after each presentation (post-viewing). HR information was extracted from the ECG data using the method described in Experiment 1 (Chp. 3 and Appendix A1). For ease and intuitiveness of analysis the Skin Resistance data was converted to Skin Conductance. Each individual's Skin Conductance data for each individual presentation was then standardised as recording sessions occurred over two days. Though the recording sessions were counterbalanced, standardisation protected against confounds such as the LIV (where the size of Skin Conductance responses is related to baseline Skin Conductance Levels [SCLs]) and small variations in recording methods (such as electrode placement). The reported patterns of findings for standardised SCLs were identical to un-standardised SCL findings (except where indicated in the Results section).

In order to explore the effects of varying visual angle on each category of films three modes of data reduction were used:

Method 1: Change During Viewing

In the first method the last 60-secs of the pre-viewing period were used as the baseline period. Individuals mean SCL and HR values for the baseline period were then subtracted from the mean HR and SCL values for each entire clip (**SCL-TOT** and **HR-TOT**) and the first (**SCL-1** and **HR-1**), second (**SCL-2** and **HR-2**) and last sixty-seconds (**SCL-3** and **HR-3**) of each clip. The change from baseline for each of these segments was then averaged across the four films in each category. Method 1 allows overall changes during viewing from the pre-viewing baseline in each category to be examined, while taking into account that all clips in each category were not of the same length.

Method 2: Range of Change

The maximum (**SCL-Max** and **HR-Max**) and minimum (**SCL-Min** and **HR-Min**) values of change, from the pre-viewing baseline, in HR and SC during the first two minutes of each film period were also calculated and averaged across the four films in each category. Method 2 allowed differences in ranges of activation to be compared whilst taking into account that the timing of significant (change inducing) events may differ between films.

Method 3: Post-Viewing Change

Because all clips in each category were not of the same length, and because Fredrickson and Levenson (1998) have shown that physiological recovery from film-induced emotions may vary between emotion categories, a further mode of data reduction was employed. Mean HR and SCLs during the last sixty seconds of each clip were used as a second baseline period and subtracted from mean HR and SCLs during the sixty-seconds immediately following video off-set (recovery period: **SCL-Rec** and **HR-Rec**). The change from the second baseline during the recovery period was then averaged across the four films in each category.

7.2.7 Procedure

The experiment was conducted over two two-hour sessions, one week apart. In the first session, participants were told that they would be taking part in a study assessing the physiological effects of new television systems, and were asked to read instructions relating to the experiment (see Appendix D4). Participants were also asked to complete the consent form described in section 7.2.2 and presented in Appendix D4.

In one of the two sessions, participants viewed all twelve film clips under SMALL angle viewing conditions. In the other session participants saw all twelve film clips under LARGE angle viewing conditions. The remainder of the procedure was identical across both sessions. Participants were seated in the Platform for Immersive Television (P*i*T) at a distance of either 80cm (LARGE conditions) or 175cm (SMALL conditions) from the visual display. A detailed description of the experimental environment is given in Experiment 1 (Chp. 3, pg. 104) and Experiment 3 (Chp 5, pg. 158). The appropriate areas of skin (physiological recording sites) were cleaned with distilled water. Participants were asked to sit in a comfortable position with their hands on their lap, palms facing upwards, and the Skin Resistance and ECG electrodes were then attached.

After the physiological recording equipment had been calibrated and tested the participants were given further instructions. They were told that they would be required to sit still, looking straight ahead at the screen, and that they would see 100-seconds of blank screen, followed by a video clip, followed by 100-seconds of blank screen. Participants were informed that if they did not want to watch a particular clip they were under no obligation to do so and were able to stop the experiment either by alerting the attention of the experimenter or by pressing a button which stopped the video equipment. Once the P*i*T door had been closed the video player was activated simultaneously with the physiological recording equipment and one video clip was viewed. After the video presentation, participants were required to complete the UCL-PQ, the ITC-SOPI questions, the EES-SF and the VIES. This procedure was conducted twelve times in each session so that participants saw all video clips at both viewing distances.

The design of the procedure of Experiment 5 was informed by the design and results of previous experiments in this thesis (particularly Experiments 1-3). For example, the time and effort demands placed on participants led to the use of short presence and emotion measures in this experiment and partly led to the division of the experiment into two testing sessions. The first participants in the experiment acted as pilot participants but were included as experimental participants due to the success of the procedure.

7.3 Results

The results of the experiment are reported in four sections corresponding to: (1) Presence-related subjective ratings on the UCL-PQ and the Engagement-SF scale (2) subjective ratings of Emotion and Arousal Terms on the EES-SF, (3) changes in physiological indicators of HR and SCLs and (4) subjective ratings on the VIES and Negative Effects-SF scale, which may indicate potential confounds. Significance levels are set at $p<.05$ (two-tailed) for all statistical tests, with Bonferroni corrections for Simple Effects analyses and follow-up comparisons where appropriate. Given the large number of comparison tests needed for the investigation of significant interactions in this 3 x 2 design, Simple Effects analyses and follow-up comparisons are summarised in the results section and presented in full in Appendix D5. Where the assumption of sphericity has been violated a Greenhouse-Geisser correction has been used with adjusted degrees of freedom. In general, only significant results are reported, with reference to effect sizes where appropriate.

7.3.1 Results: Presence Ratings

Subjective ratings of presence on the UCL-PQ and ratings of Engagement-SF were taken after each video clip and averaged across the four clips in each Content category (NEUTRAL, AMUSEMENT and SADNESS) for SMALL and LARGE angle viewing conditions respectively. Table 7.2 shows the group mean ratings for UCL-PQ and Engagement-SF ratings. The analyses of UCL-PQ and Engagement-SF ratings was conducted with aim of investigating the hypothesis that LARGE angle viewing conditions would generate higher ratings of presence than SMALL angle viewing conditions.

Table 7.2 Effects of Angle and Content on Subjective Ratings of Presence and Engagement.

Measure	*Content* / *Angle*	NEUTRAL SMALL	NEUTRAL LARGE	AMUSEMENT SMALL	AMUSEMENT LARGE	SADNESS SMALL	SADNESS LARGE
UCL-PQ							
Q1-'being'	*Mean*	**2.85**	**3.26**	**3.07**	**3.24**	**3.21**	**3.43**
	SD	*(0.93)*	*(1.22)*	*(1.23)*	*(1.28)*	*(1.04)*	*(1.41)*
Q2-'real'	*Mean*	**2.33**	**2.75**	**2.97**	**3.19**	**2.93**	**3.38**
	SD	*(1.15)*	*(1.38)*	*(1.40)*	*(1.32)*	*(1.24)*	*(1.47)*
Q3-'visit'	*Mean*	**2.75**	**2.95**	**2.51**	**2.44**	**2.51**	**2.88**
	SD	*(1.15)*	*(1.25)*	*(1.23)*	*(1.03)*	*(1.15)*	*(1.25)*
Mean Presence	*Mean*	**2.65**	**2.99**	**2.85**	**2.95**	**2.88**	**3.23**
	SD	*(1.00)*	*(1.25)*	*(1.19)*	*(1.07)*	*(1.02)*	*(1.23)*
ITC-SOPI Engagement Questions							
Engagement-SF	*Mean*	**2.17**	**2.33**	**2.96**	**2.91**	**2.85**	**3.09**
	SD	*(0.77)*	*(0.85)*	*(0.72)*	*(0.91)*	*(0.76)*	*(0.98)*

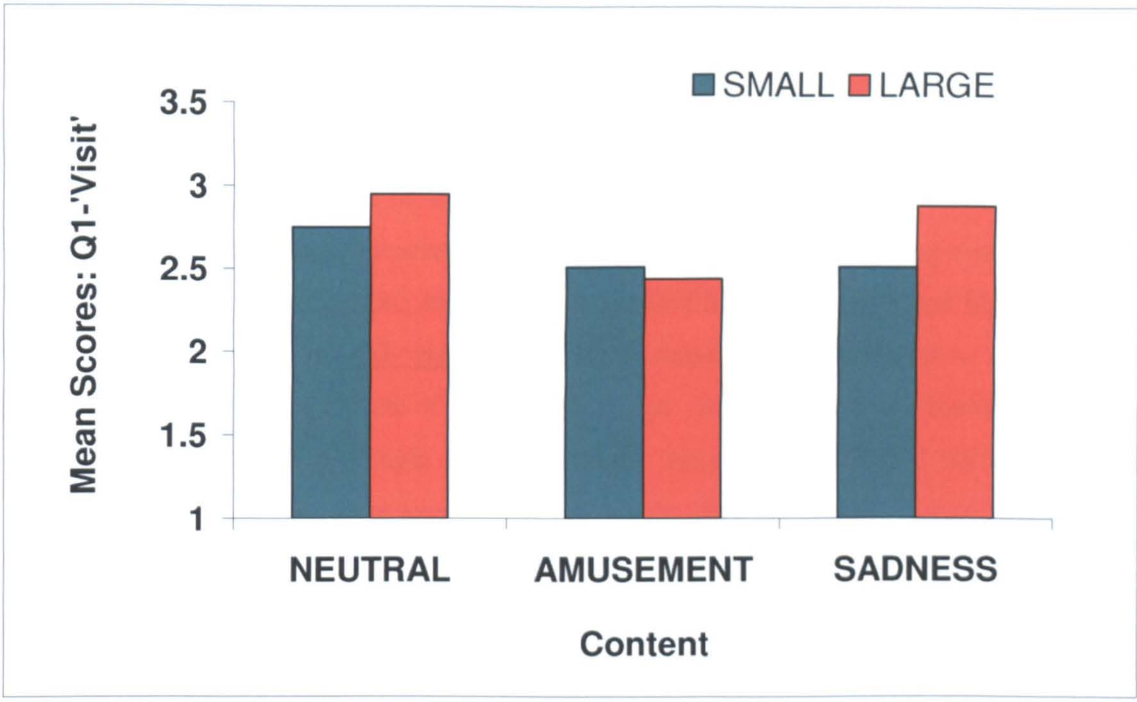
7.3.1.1 Analysis: Presence Ratings

A 3 x 2 within-groups ANOVA was conducted for each of the three individual UCL-PQ presence questions (**Q1-'being'**, **Q2-'real'** and **Q3-'visit'**), the **Mean Presence** score on the UCL-PQ and the mean **Engagement-SF** score, with Angle (SMALL vs. LARGE) and Content (NEUTRAL vs. AMUSEMENT vs. SADNESS) serving as the within groups factors (see Table 7.2 for means).

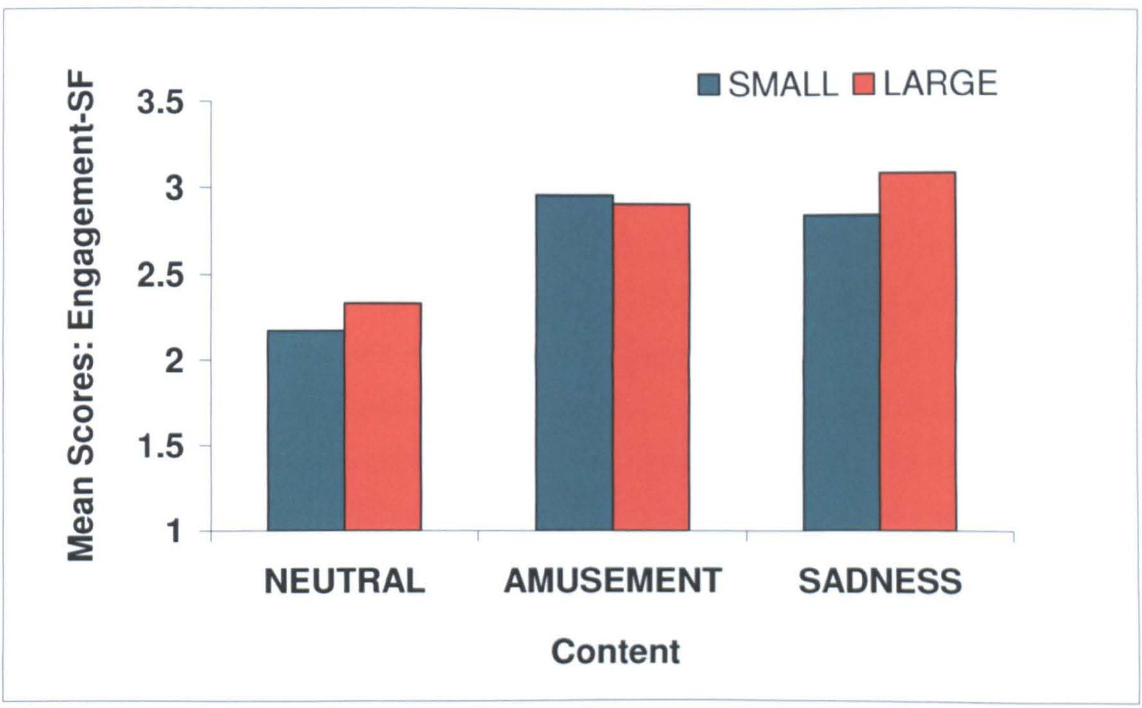
Looking first at Angle, a significant main effect of Angle was observed for **Q2-'real'** ($F_{(1,23)} = 5.22$, $p<.05$, SMALL = 2.74, LARGE = 3.10), indicating that, in line with predictions, LARGE angle presentations received higher ratings of presence that SMALL angle presentations on one item of the UCL-PQ. No other significant main effects of Angle were observed on either the UCL-PQ or Engagement-SF scales.

However, a significant main effect of Content was observed for **Q2-'real'** ($F_{(2,22)} = 5.05$, $p<.05$, $\epsilon = .73$: NEUTRAL = 2.52, AMUSEMENT = 3.08, SADNESS = 3.15) and **Engagement-SF** ($F_{(2,22)} = 10.60$, $p<.01$, $\epsilon = .86$: NEUTRAL = 2.25, AMUSEMENT = 2.96, SADNESS = 2.97). Follow up comparisons using a Bonferroni correction revealed that the SADNESS category of clips received higher ratings than the NEUTRAL category on **Q2-'real'** ($p < .05$). In addition, the SADNESS and AMUSEMENT clips received higher ratings of **Engagement-SF** than the NEUTRAL category ($p < .001$). A summary of the comparison tests may be found in Appendix D5. No other significant main effects of Content were observed.

Finally, a significant interaction between Angle and Content was found for both **Q3-'visit'** ($F_{(2,22)} = 3.44$, $p = .05$ – see figure 7.1a) and **Engagement-SF** ($F_{(2,22)} = 3.40$, $p = .05$ – see Figure 7.1b).



(a)UCL-PQ Q1-'visit'



(b)Engagement-SF

Figure 7.1 Effects of Angle and Content on (a) mean scores on the UCL-PQ: Q1-' Visit' and (b) mean Engagement-SF.

The Angle by Content interactions were first examined using Simple Effects Analyses with a Bonferroni correction. In the case of **Q3-'Visit'** no significant simple main effects were obtained. However, the application of a less stringent criterion for significance (no adjustment of significance levels) revealed a simple main effect of Content for LARGE angle presentations ($F_{(2,22)} = 4.30$, $p = .03$). Follow up comparisons (with a Bonferroni correction) indicated that SADNESS clips were rated higher than AMUSEMENT clips on **Q3-'visit'** for LARGE angle presentations ($p = .02$). No significant simple main effects of Angle were found. In order to further investigate the significant interaction of Angle by Content, the magnitudes of effect sizes for the Simple Effects analyses were examined. The results showed that the test of Angle for SADNESS clips yielded a moderate effect size ($F_{(1,23)} = 2.90$, $p = .10$, eta-squared = .11) in comparison to very small effects sizes for tests of Angle for NEUTRAL and AMUSEMENT clips. The data indicated that, for the SADNESS category of clips, LARGE angle presentations received higher ratings of **Q3-'visit'** than SMALL angle presentations.

Simple Effects analyses of the Angle by Content interaction for **Engagement-SF** ratings indicated, in line with the overall main effect of Content described above, significant simple main effects of Content for both SMALL ($F_{(2,22)} = 9.82$, $p = .05$) and LARGE ($F_{(2,22)} = 9.39$, $p = < .001$) Angle presentations. Follow up comparisons showed that, in line with results for the overall main effect of Content, AMUSEMENT and SADNESS clips received higher ratings of **Engagement-SF** than NEUTRAL clips ($p <.001$). However, no significant simple main effects of Angle were found. In order to further investigate the significant Angle by Content interaction the magnitudes of effect sizes for the Simple Effects analyses were examined. The results showed that the test of Angle for SADNESS clips yielded a moderate effect size ($F_{(1,23)} = 2.97$, $p = .10$, eta-squared = .12) in comparison to very small effects sizes for tests of Angle for NEUTRAL and AMUSEMENT clips. The data indicated that, for the SADNESS category of clips, LARGE angle presentations received higher ratings of **Engagement-SF** than SMALL angle presentations.

For the overall 3 x 2 ANOVA analysis, effect sizes for significant main effects and interactions were moderate to large (.18 < eta-squared <.49). Moderate effects sizes were obtained from tests of Angle and Content on **Q1-'being'** (eta-squared = .09) and tests of Angle and Angle by Content on **Mean Presence** scores (eta-squared = .10 and

.13). For all other non-significant results, small effect sizes were observed (eta-squared < .06). These observations indicate that significant results were reliable, but that effects of Angle and Content on ratings of presence may not have been apparent in the present experiment due to low power.

7.3.1.2 Summary of Results: Presence Ratings

The aim of Experiment 5 was to examine the effects of a presence enhancing Media Form manipulation on subjective and physiological emotional responses to contents that differ in terms of emotional tone. In order to fulfil the aims of the Experiment it was therefore necessary that the Media Form variable of interest (Angle: horizontal eye-to-screen visual angle) had a statistically significant effect on presence ratings. As such, and in line with the results of Experiment 3, it was predicted that LARGE visual angle viewing conditions would generate higher ratings of presence than SMALL visual angle viewing conditions. The results of the present experiment supported the prediction in that LARGE angle conditions received significantly higher ratings of presence than SMALL angle conditions for one question on the UCL-PQ. The results indicated that during LARGE angle presentations the mediated environment became "more real or present for participants compared to the 'real world' to a greater extent than for SMALL angle presentations. An interpretation of effect-sizes for tests of Angle suggested further support for the prediction that LARGE angle viewing conditions would be associated with higher ratings of presence that SMALL angle viewing conditions.

A number of further significant effects of interest were obtained. In line with previous experiments, effects of Content on ratings of presence were observed. As expected the emotive AMUSEMENT and SADNESS categories of film clips were rated as more engaging than the non-emotive NEUTRAL category. They were also rated as more real to participants than the Neutral category. In addition, two Angle by Content interactions indicated that the effects of Angle on presence ratings was in part dependent on the type of Content presented to participants: increased visual angle was associated with increased engagement, and a feeling of having visited rather seen the mediated environments, for the SADNESS category of clips in particular.

7.3.2 Results: Emotion Ratings

Subjective ratings of emotional intensity on the EES-SF were taken after each video clip and averaged across the four clips in each Content category (NEUTRAL, AMUSEMENT and SADNESS) for the SMALL and LARGE Angle presentations respectively. Ratings of eight specific Emotion Terms (**amusement**, **anger**, **contentment**, **disgust**, **fear**, **happiness**, **sadness** and **surprise**) and two non-specific Arousal Terms (**arousal** and **interest**) comprised the EES-SF.

Ratings of the eight Emotion Terms were used to verify the emotional tone of each Content category. Using the criteria set out in Experiment 4 a preliminary analysis confirmed that 1) the NEUTRAL category produced no specific emotion, receiving modal ratings of 0 and mean ratings < 2 for all Emotion Terms 2) the AMUSEMENT category elicited **amusement** to a greater degree than any other emotion and 3) the SADNESS category elicited **sadness** to a greater degree than any other emotion (see Appendix D5).

Ratings of **amusement** and **sadness** were then used to investigate the effects of increased visual Angle on each type of Content. It was first predicted that the Contents would differ from each other in terms of elicited emotion and that the NEUTRAL category of clips would be associated with lower ratings of subjective arousal than the AMUSEMENT and SADNESS categories of clips. It was then predicted that LARGE angle presentations would be more subjectively arousing than SMALL angle presentations. In particular, LARGE angle presentations would enhance ratings of the Target Emotion for each type of emotive Content (i.e., ratings of **amusement** for the AMUSEMENT category and ratings of **sadness** for the SADNESS category) in comparison to SMALL angle presentations, as evidenced by an Angle by Content interaction for ratings of **amusement** and **sadness**. Table 7.2 shows the group mean ratings for Emotion Term and Arousal Term items on the EES-SF.

Table 7.3: Effects of Angle and Content on Subjective Ratings of Emotion and Arousal.

	Content	NEUTRAL		AMUSEMENT		SADNESS	
Measure	*Angle*	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE
Emotion Term							
Amusement	*Mean*	**0.72**	**0.79**	**4.04**	**4.07**	**0.73**	**0.84**
	SD	*(0.84)*	*(0.91)*	*(1.94)*	*(1.72)*	*(0.73)*	*(1.00)*
Sadness	*Mean*	**0.35**	**0.44**	**0.21**	**0.28**	**3.65**	**4.06**
	SD	*(0.65)*	*(0.70)*	*(0.34)*	*(0.46)*	*(1.60)*	*(1.75)*
Arousal Term							
Arousal	*Mean*	**0.89**	**1.25**	**2.34**	**2.91**	**1.96**	**2.63**
	SD	*(0.90)*	*(1.36)*	*(1.92)*	*(2.05)*	*(1.82)*	*(2.09)*
Interest	*Mean*	**1.17**	**1.45**	**3.75**	**3.82**	**2.81**	**3.17**
	SD	*(1.18)*	*(1.08)*	*(1.89)*	*(1.63)*	*(1.61)*	*(1.56)*

7.3.2.1 Analysis: Emotion Ratings

In order to investigate the effect of Angle and Content on ratings of emotion and arousal a 3 x 2 within-groups ANOVA was conducted on ratings of **amusement**, **sadness**, **arousal** and **interest**, respectively, with both Content (NEUTRAL vs. AMUSEMENT vs. SADNESS) and Angle (SMALL vs. LARGE) serving as within groups factors (see Table 7.2 for means).

A significant main effect of Content was obtained for all four types of rating: **amusement** ($F_{(2,22)} = 79.05$, $p<.001$, $\epsilon = .73$: NEUTRAL = .76, AMUSEMENT = 4.06, SADNESS = .79), **sadness** ($F_{(2,22)} = 117.50$, $p<.001$, $\epsilon = .57$: NEUTRAL = .40, AMUSEMENT = .25, SADNESS = 3.90), **arousal** ($F_{(2,22)} = 11.80$, $p<.001$: NEUTRAL = 1.07, AMUSEMENT = 2.63, SADNESS = 2.29) and **interest** ($F_{(2,22)} = 31.31$, $p<.001$: NEUTRAL = 1.31, AMUSEMENT = 3.79, SADNESS = 2.99). As expected, follow-up comparisons with Bonferroni corrections showed that the AMUSEMENT category was rated higher in **amusement** than the NEUTRAL and SADNESS categories, whereas the SADNESS categories was rated higher in **sadness** than the NEUTRAL and AMUSEMENT categories ($p <.05$). In addition, the NEUTRAL category was rated lower in **arousal** and **interest** than the SADNESS and AMUSEMENT categories ($p <.05$). Appendix D5 details the follow-up analyses.

It was predicted that LARGE angle presentations would enhance ratings of the Target Emotion for each of the emotive categories of Content, in comparison to SMALL angle presentations. This effect would be evidenced by an Angle by Content interaction. No significant Angle x Content interaction was obtained. However, for ratings of **sadness** a main effect of Angle was found ($F_{(1,23)} = 4.48$, $p<.05$, SMALL = 1.40, LARGE = 1.59) with LARGE angle presentations receiving higher ratings of **sadness** than SMALL angle presentations. In addition, a main effect of Angle on ratings of **arousal** approached significance ($F_{(1,23)} = 3.87$, $p = .06$, SMALL = 1.72, LARGE = 2.26), indicating that LARGE angle presentations were somewhat more subjectively arousing than SMALL angle presentations. No other significant main effects of Angle were observed.

Effect sizes were large for all significant effects of Content (.52 < eta-squared <.84) indicating reliable findings for these tests. Moderate effect sizes were observed for the significant effect of Angle on **sadness** ratings (eta-squared = .16) and the near significant effect of Angle on **arousal** ratings (eta-squared = .14). For all non-significant results, effect-sizes were small (eta-squared < .06).

Inspection of the data indicated that ratings of **amusement** and **sadness** were at floor levels in non-target conditions (e.g., ratings of **sadness** in response to AMUSEMENT clips). The violation of normality in the data, given the small sample size, warranted an investigation of the effects of Angle and Content on ratings of **amusement** and **sadness** using non-parametric statistics. SMALL angle **amusement** and **sadness** ratings were subtracted from LARGE angle **amusement** and **sadness** ratings respectively in order to obtain difference scores for each of the three Contents ($Angle^{DIF}$ = LARGE – SMALL). For ratings of **amusement** and **sadness** respectively, a Friedman test was conducted to assess the effect of Content (NEUTRAL, AMUSEMENT and SADNESS) on $Angle^{DIF}$. A significant effect of Content was obtained for ratings of **sadness** (chi-square = 7.71, df = 2, p = .02; NEUTRAL = .08, AMUSEMENT = .07, SADNESS = .41). Follow-up comparisons using the Friedman test indicated that the increase in **sadness** ratings from SMALL to LARGE angle presentations was significantly greater for SADNESS clips in comparison to both NEUTRAL (chi-square = 4.55, df = 1, p = .03) and AMUSEMENT (chi-square = 4.55, df = 1, p = .03) clips. No other significant effects were found. Figure 7.2 illustrates the effects of Angle and Content on ratings of **sadness**.

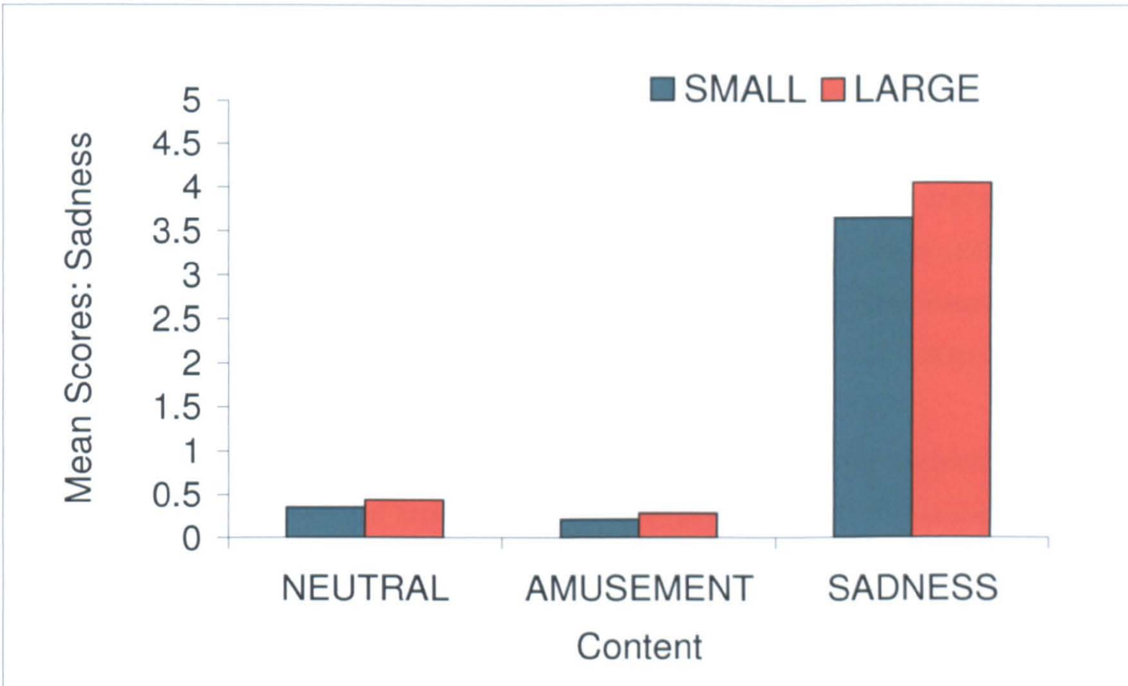


Figure 7.2 Effects of Angle and Content on EES-SF Sadness ratings

7.3.2.2 Summary of results: Emotion Ratings

In line with the criteria prescribed in Experiment 4 (Chp. 6), the analysis of Emotion Terms and Arousal Terms from the EES-SF first confirmed that each Content category (NEUTRAL, AMUSEMENT and SADNESS) elicited its Target Emotion state. In addition, the categories differed from each other in terms of the Target Emotion and the emotive AMUSEMENT and SADNESS categories were shown to elicit higher ratings of arousal and interest than the NEUTRAL category. Therefore, the three categories of video clips were shown to fulfil the criteria required for testing the hypothesis that the effects Angle on subjective ratings of emotion would be dependent on Content type.

The aim of Experiment 5 was to investigate the effects of a presence enhancing Media Form variable on emotive and neutral content. It was predicted that, if increased eye-to-screen visual angle increased rating of presence, LARGE angle presentations (in comparison to SMALL angle presentations) would be associated with increased ratings of the Target Emotion for emotive contents (e.g., **sadness** ratings for SADNESS content) whereas there would be no difference between Angle conditions for NEUTRAL content. There was evidence to support this prediction. For the SADNESS category of clips, there was a significantly greater increase in **sadness** from SMALL to LARGE angle presentations than for NEUTRAL and AMUSEMENT categories of clips. However, this effect was not replicated for **amusement** ratings of AMUSEMENT clips. In addition, there was evidence to suggest that ratings of subjective **arousal** were greater for LARGE angle in comparison to SMALL angle presentations, regardless of the Content type.

7.3.3 Results: Visual Image Evaluation and Negative Effects

Increasing eye-to-screen visual angle by reducing eye-to-screen viewing distance may potentially result in a perceived degradation in image quality and an increase in perceived image brightness. Such cues to the mediated nature of an experience may be detrimental to the experience of presence. In addition, such effects may serve to increase the occurrence of negative physical side-effects of viewing. Because visual image variables and the occurrence of negative effects are potentially associated with presence, emotion and physiological responses, participants were required to complete visual image evaluation and negative effects scales after presentations of each film clip. The analysis of the scales was intended to highlight any potential confounds in the present experiment which could impact on the effects of interest (effects of a presence-enhancing display manipulation on emotive and neutral content in terms of subjective and physiological indicators of emotion). The scales were also implemented in the present experiment as the ratings study described in Experiment 4 had not taken visual image variables and negative effects into consideration during the development of the experimental stimuli. See Tables 7.4 and 7.5 for mean ratings on the VIES and Negative Effects-SF respectively.

7.3.3.1 Analysis: Visual Image Evaluation Scales

A 3 x 2 within-groups ANOVA was conducted on ratings of **Image Quality**, **Image Adequacy** and **Image Brightness**, with Angle (SMALL vs. LARGE) and Content (NEUTRAL vs. AMUSEMENT vs. SADNESS) serving as the within-groups factors (see Table 7.4 for means). Main effects of Content were found for the first two questions: **Image Quality** ($F_{(2,22)}$ = 20.96, $p<.001$, ϵ =.66: NEUTRAL = 52.67, AMUSEMENT = 61.08, SADNESS = 61.28) and **Image Adequacy** ($F_{(2,22)}$ = 17.17, $p<.001$, ϵ =.66: NEUTRAL = 55.49, AMUSEMENT = 67.09, SADNESS = 68.69). Follow-up comparisons revealed that the NEUTRAL category was rated lower in **Image Quality** and **Image Adequacy** than the SADNESS and AMUSEMENT categories (p. <.05) – see Appendix D5. No significant main effects of Angle were observed and no other significant effects were found. Effects sizes for significant effects of Content were large (.43 < eta-squared < .47) and were small for all non-significant tests (.01 < eta-squared < .05).

7.3.3.2 Analysis: Negative Effects-SF

A 3 x 2 within-groups ANOVA was conducted on the **Negative Effects-SF** scale with both Angle (SMALL vs. LARGE) and Content (NEUTRAL vs. AMUSEMENT vs. SADNESS) serving as the within groups factors (see Table 7.5 for means). A significant main effect of Content ($F_{(2,22)}$ = 12.76, $p<.001$, ϵ =.66: NEUTRAL = 2.13, AMUSEMENT = 1.60, SADNESS = 1.61) was found. Follow up comparisons showed that the SADNESS and AMUSEMENT categories received lower ratings of **Negative Effects-SF** than the NEUTRAL category (p <.05) – see Appendix D5. No significant main effects of Angle were observed and no other significant effects were found. The effect size for the significant effect of Content was large (eta-squared = .35) and small to moderate for the non-significant effects (.01 < eta-squared <.07).

Table 7.4 Effects of Angle and Content on the Visual Image Evaluation Scales (VIES)

Measure	*Content* / *Angle*	NEUTRAL SMALL	NEUTRAL LARGE	AMUSEMENT SMALL	AMUSEMENT LARGE	SADNESS SMALL	SADNESS LARGE
Visual Image Evaluation Scales							
Image Quality	*Mean*	**53.84**	**51.51**	**62.59**	**61.00**	**62.09**	**60.46**
	SD	*(15.38)*	*(17.15)*	*(14.80)*	*(17.20)*	*(15.22)*	*(15.53)*
Image Adequacy	*Mean*	**55.90**	**55.08**	**67.93**	**66.25**	**69.65**	**67.73**
	SD	*(20.79)*	*(21.30)*	*(17.26)*	*(18.82)*	*(15.30)*	*(17.92)*
Image Brightness	*Mean*	**61.31**	**60.95**	**66.43**	**63.48**	**61.96**	**59.39**
	SD	*(16.46)*	*(17.42)*	*(12.63)*	*(14.90)*	*(13.92)*	*(16.78)*

Table 7.5 Effects of Angle and Content on Negative Effects-SF ratings.

Measure	*Content* / *Angle*	NEUTRAL SMALL	NEUTRAL LARGE	AMUSEMENT SMALL	AMUSEMENT LARGE	SADNESS SMALL	SADNESS LARGE
Negative Effects	*Mean*	**2.10**	**2.16**	**1.67**	**1.53**	**1.57**	**1.66**
	SD	*(0.77)*	*(0.97)*	*(0.79)*	*(0.74)*	*(0.68)*	*(0.69)*

7.3.3.3 Summary of Results: Visual Image Evaluation and Negative Effects

Increasing eye-to-screen visual angle via decreased viewing distance may potentially result in perceived degradation in image quality and an increase in the occurrence of negative effects. However, contrary to expectations, LARGE angle viewing conditions (in comparison to SMALL angle viewing conditions) were not associated with either perceived image degradation or increased negative effects in the present experiment. Consequently, effects of Angle on subjective presence ratings, subjective emotion ratings and physiological responses are unlikely to have been influenced by confounding visual image and negative effects variables.

However, the NEUTRAL category of video clips was shown to be rated lower in image quality and image adequacy, and higher in negative effects, than the AMUSEMENT and SADNESS clips. Therefore, visual image and negative effects variables must be considered as potential confounds when evaluating the impact of Content on presence ratings, emotion ratings and physiological responses. Finally, there was no evidence to suggest that visual image and negative effects variables should be considered as potential confounds when evaluating the Content x Angle interactions.

7.3.4 Results: Physiological Measures

Physiological recordings were taken before (pre-viewing), during (viewing) and after (post-viewing) each video presentation. Changes in Skin Conductance Levels (SCLs) and Heart Rate (HR) were calculated for (1) changes from a sixty-second pre-viewing baseline to the whole viewing period (**Total**) and the first (**1st**), second (**2nd**) and last (**Last**) sixty seconds of the viewing period, (2) minimum (**Min**) and maximum (**Max**) deviations from the pre-viewing baseline period and (3) changes from a sixty-second viewing baseline to a sixty-second post-viewing recovery period (**Rec**). The aim of the analysis of SCLs and HR was to investigate the effects of increased eye-to-screen visual angle (Angle) on different types of Content. It was expected that the three types of Content (NEUTRAL, AMUSEMENT and SADNESS) would differ from each other in terms of changes in SCLs and HR. It was then of interest whether increased visual Angle would enhance physiological differences between each of the contents.

7.3.4.1 Analysis: Skin Conductance Levels

A 3 x 2 within-groups ANOVA was conducted on changes in standardised SCLs from the pre-viewing baseline to the entire viewing period (**SCL-Total**), the first (**SCL-1st**), second (**SCL-2nd**), and last sixty-seconds (**SCL-Last**) of viewing, the minimum (**SCL-Min**) and maximum (**SCL-Max**) Skin Conductance values occurring during viewing and the sixty-second recovery period (**SCL-Rec**). Content (NEUTRAL vs. AMUSEMENT vs. SADNESS) and Angle (LARGE vs. SMALL) served as the within-groups factors (see Table 7.6 for means).[26]

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[26] Skin Conductance Levels appear to decrease over time in all conditions (see Table 7.5). However, it is likely that the apparent decrease is due in part to drift in the skin conductance data (due to factors such as polarisation of the skin) rather than general decreases in arousal. Therefore, in the description of the results, comparisons between conditions are relative rather than absolute (e.g., 'the AMUSEMENT category has higher SCLs than the SADNESS and NEUTRAL categories' rather than 'there was a greater decrease in SCLs in the SADNESS and NEUTRAL categories').

Table 7.6 Effects of Content and Angle on Skin Conductance Levels (standardised).

	Content	NEUTRAL		AMUSEMENT		SADNESS	
Measures	*Angle*	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE
SCLs (stan): Change from Pre-Viewing Baseline to Viewing period							
SCL-Total	*Mean*	**-1.06**	**-1.25**	**-0.47**	**-0.60**	**-0.86**	**-0.98**
	SD	*(0.63)*	*(0.53)*	*(0.89)*	*(1.06)*	*(0.78)*	*(0.77)*
SCL-1st	*Mean*	**-0.67**	**-0.78**	**-0.37**	**-0.38**	**-0.58**	**-0.61**
	SD	*(0.50)*	*(0.51)*	*(0.72)*	*(0.80)*	*(0.72)*	*(0.65)*
SCL-2nd	*Mean*	**-1.06**	**-1.38**	**-0.49**	**-0.62**	**-0.88**	**-1.08**
	SD	*(0.74)*	*(0.57)*	*(1.01)*	*(1.21)*	*(0.83)*	*(0.81)*
SCL-Last	*Mean*	**-1.44**	**-1.49**	**-0.55**	**-0.72**	**-1.13**	**-1.22**
	SD	*(0.79)*	*(0.74)*	*(1.09)*	*(1.28)*	*(0.88)*	*(1.06)*
SCLs (stan): Minimum and Maximum Deviations from Pre-Viewing Baseline during Viewing							
SCL-Min	*Mean*	**-1.87**	**-2.10**	**-1.50**	**-1.62**	**-1.74**	**-1.78**
	SD	*(0.42)*	*(0.64)*	*(0.55)*	*(0.64)*	*(0.48)*	*(0.49)*
SCL-Max	*Mean*	**0.55**	**0.42**	**0.95**	**0.87**	**0.61**	**0.43**
	SD	*(0.99)*	*(1.01)*	*(1.10)*	*(1.25)*	*(1.00)*	*(0.87)*
SCLs (stan): Change from Viewing Baseline to Post-Viewing period							
SCL-Rec	*Mean*	**0.24**	**0.22**	**0.32**	**0.17**	**0.34**	**0.23**
	SD	*(0.58)*	*(0.48)*	*(0.70)*	*(0.54)*	*(0.70)*	*(0.60)*

In line with predictions, significant main effects of Content were found for most SCL measures (with the exception of **SCL-Max** and **SCL-Rec**): **SCL-Total** ($F_{(2,22)}$ = 8.83, p<.01, ϵ =.66: NEUTRAL = -1.16, AMUSEMENT = -.54, SADNESS = -.92), **SCL-1st** ($F_{(2,22)}$ = 5.67, p<.05, ϵ =.77: NEUTRAL = -.72, AMUSEMENT = -.37, SADNESS = -.59), **SCL-2nd** ($F_{(2,22)}$ = 7.38, p<.01, ϵ =.73: NEUTRAL = .-1.22, AMUSEMENT = -.55, SADNESS = -.98), **SCL-Last** ($F_{(2,22)}$ = 9.37, p<.01, ϵ = .70: NEUTRAL = -1.46, AMUSEMENT = -.64, SADNESS = -1.17), **SCL-Min** ($F_{(2,22)}$ = 7.28, p<.01, ϵ =.68: NEUTRAL = -1.99, AMUSEMENT = -1.56, SADNESS = -1.76). Follow-up comparisons with a Bonferroni correction revealed that, for all significant main effects of Content, the AMUSEMENT category of clips elicited higher SCLs during viewing than the SADNESS and NEUTRAL clips (p < .05)[27] – see Appendix 4 for a full description of the comparison tests. No other significant main effects of Angle were observed.

A main effect of Angle was also observed for one SCL measure: **SCL-Min** ($F_{(1,23)}$ = 4.60, p<.05, SMALL = -1.70, LARGE = -1.83). The minimum Skin Conductance value was lower in LARGE Angle presentations in comparison to SMALL angle presentations[28]. No other significant effects were found and no other significant main effects of Angle were observed.

Effects sizes for significant effects of Content were large (.20 < eta-squared < .29) and moderate for the significant effect of Angle (eta-squared = .17). Moderate effects sizes were observed for non-significant tests of Content (eta-squared = .12) and for one non-significant test of Angle (**SCL-2nd**: eta-squared = .11). The results indicate reliable significant effects and also effects of Content and Angle which may not have emerged in the current experiment due to low power. Effects sizes for all other tests were small to moderate (.01 < eta-squared < .06).

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[27] An identical pattern of Main Effects of Content was observed for un-standardised SCLs. However, follow-up comparisons revealed that, for un-standardised SCLs, AMUSEMENT clips did not differ from NEUTRAL clips, but SADNESS clips had lower SCLs than AMUSEMENT clips (see Appendix 4).

[28] No significant main effects of Angle were observed when the analysis was repeated using the un-standardised Skin Conductance data.

7.3.4.2 Analysis: Heart Rate

A 3 x 2 within-groups ANOVA was conducted on changes in HR (bpm) from the pre-viewing baseline period to the entire viewing period (**HR-Total**), the first (**HR-1st**), second (**HR-2nd**), and last sixty-seconds (**HR-Last**) of viewing, the minimum (**HR-Min**) and maximum (**HR-Max**) Skin Conductance values occurring during viewing and the sixty-second recovery period (**HR-Rec**). Content (NEUTRAL vs. AMUSEMENT vs. SADNESS) and Angle (LARGE vs. SMALL) served as the within-groups factors (see Table 7.7 for means).

Table 7.7 Effects of Content and Angle on Heart Rate (bpm).

	Content	NEUTRAL		AMUSEMENT		SADNESS	
Measure	*Angle*	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE
HR (bpm): Change from Pre-Viewing Baseline to Viewing period							
HR-Total	*Mean*	**-1.36**	**-1.09**	**-3.23**	**-3.62**	**-3.65**	**-3.46**
	SD	*(1.45)*	*(1.88)*	*(2.72)*	*(2.59)*	*(2.49)*	*(2.21)*
HR-1st	*Mean*	**-1.66**	**-1.81**	**-3.29**	**-3.27**	**-3.51**	**-3.34**
	SD	*(1.56)*	*(2.41)*	*(2.67)*	*(2.24)*	*(2.56)*	*(1.83)*
HR-2nd	*Mean*	**-1.27**	**-1.18**	**-3.42**	**-4.09**	**-3.98**	**-4.10**
	SD	*(1.63)*	*(1.99)*	*(3.03)*	*(2.73)*	*(2.56)*	*(2.23)*
HR-Last	*Mean*	**-1.26**	**-0.51**	**-3.26**	**-3.64**	**-3.66**	**-3.41**
	SD	*(1.89)*	*(1.90)*	*(3.19)*	*(3.27)*	*(2.75)*	*(3.19)*
HR (bpm): Minimum and Maximum Values from Pre-Viewing Baseline during Viewing							
HR-Min	*Mean*	**-12.32**	**-11.36**	**-13.67**	**-12.86**	**-14.15**	**-12.81**
	SD	*(3.97)*	*(4.21)*	*(5.55)*	*(5.03)*	*(5.56)*	*(4.21)*
HR-Max	*Mean*	**12.70**	**12.15**	**10.12**	**9.69**	**10.27**	**9.12**
	SD	*(3.81)*	*(4.49)*	*(3.52)*	*(3.29)*	*(4.39)*	*(3.86)*
HR (bpm): Change from Viewing Baseline to Post-Viewing period							
HR-Rec	*Mean*	**0.92**	**1.11**	**3.16**	**2.80**	**4.24**	**3.58**
	SD	*(1.34)*	*(2.14)*	*(2.83)*	*(2.68)*	*(2.08)*	*(3.79)*

In line with predictions, a significant main effect of Content was obtained for each HR measure: **HR-Total** ($F_{(2,22)}$ = 30.13, p<.001, ϵ = .74: NEUTRAL = -1.22, AMUSEMENT = -3.56, SADNESS = -3..43), **HR-1st** ($F_{(2,22)}$ = 13.07, p<.001: NEUTRAL = -1.73, AMUSEMENT = -3.28, SADNESS = -3.42), **HR-2nd** ($F_{(2,22)}$ = 36.13, p<.001, ϵ = .78: NEUTRAL = .-1.22, AMUSEMENT = -4.04, SADNESS = -3.75), **HR-Last** ($F_{(2,22)}$ = 20.14, p<.001, ϵ = .74: NEUTRAL = -.88, AMUSEMENT = -3.45, SADNESS = -3.54)), **HR-Min** ($F_{(2,22)}$ = 23.84, p<.001: NEUTRAL = -11.84, AMUSEMENT = -13.27, SADNESS = -13.49), **HR-Max** ($F_{(2,22)}$ = 4.62, p<.01,: NEUTRAL = 12.42, AMUSEMENT = -9.91, SADNESS = 9.69) and **HR-Rec** ($F_{(2,22)}$ = 15.06, p<.001, ϵ = .74: NEUTRAL = -1.02, AMUSEMENT = 2.98, SADNESS = 3.91). No significant main effects of Angle were observed.

Follow-up comparisons of the main effects of Content revealed that HR was reduced to a greater extent for the AMUSEMENT and SADNESS categories in comparison to the NEUTRAL category during the whole clip and the 1st, 2nd and last sixty-second viewing periods (p<.05). Following viewing, (during the recovery period), HR rose to a greater extent for the AMUSEMENT and SADNESS categories in comparison to the NEUTRAL category (p<.05). In addition, during the recovery period, HR rose to a greater extent for the SADNESS category in comparison to the AMUSEMENT category (p<.05). Finally, the maximum and minimum values of HR during viewing were greater for the NEUTRAL category in comparison to the SADNESS and AMUSEMENT categories (p<.05). The results suggest a similar range of HR reactivity during viewing amongst the three categories of clips, but a greater overall reduction in HR during viewing for the emotive categories in comparison to the NEUTRAL category. No other significant effects were found.

Effects sizes for significant effects of Content were large (.30 < eta-squared < .69). Moderate effects sizes were observed for non-significant tests of the Content x Angle interaction for the whole recording period (eta-squared = .09) and the last sixty seconds of viewing (eta-squared < .12). The data indicated that Heart Rate was higher during LARGE angle presentations of NEUTRAL and SADNESS clips, in comparison to SMALL angle presentations. The opposite effect was observed for AMUSEMENT clips. Effects sizes for all other tests were small to moderate (.001 < eta-squared < .07)

7.3.4.3 Summary of Results: Physiological Measures

In line with predictions, the three types of Content significantly differed from each other in terms of changes in physiological activity. Changes in SCLs are thought to reflect activity in the sympathetic nervous system. In line with a body of emotion research (e.g., Collet, et al., 1997, Fredrickson & Levenson, 1998), the AMUSEMENT clips were associated with higher SCLs (and perhaps sympathetic activation) than the NEUTRAL and SADNESS categories. The emotive AMUSEMENT and SADNESS categories were also associated with greater decreases in HR than the NEUTRAL category. The Content effects on HR potentially reflect activation in the parasympathetic nervous system (which when dominant may reduce HR levels), that may in turn indicate a greater allocation of attentional resources to the emotive content (Fredrickson & Levenson, 1998).

Contrary to predictions, significant effects of Angle on physiological changes were restricted to one indicator of Skin Conductance and were not dependent on Content type. However, the finding that the minimum Skin Conductance value during viewing was lower during LARGE angle presentations in comparison to SMALL angle presentations is consistent with the finding that LARGE angle presentations were associated with higher levels of 'sadness' than SMALL angle presentations. Recent emotion research indicates that the emotion of 'sadness' may be associated with a reduction in SCLs, via an inhibitory effect of the parasympathetic nervous system (Bradley, 2000).

An examination of effect sizes indicated that with increased statistical power some effects involving Angle may have reached significance. However, in comparison to tests of Angle, effect-sizes for tests of Content were large and reliable. Overall, the findings for the physiological measures implemented in this experiment, when considered in terms of underlying activity in the autonomic nervous system and psychological correlates, indicate a potentially complex action of Angle and Content variables on changes in SCLs and HR.

7.4 Discussion

The aim of Experiment 5 was to examine the prediction that increased presence in a mediated environment should be associated with increased emotional responding to emotive Media Content. The method of testing this hypothesis was to use a Media

Form variable to create varying levels of subjective presence and then to examine subjective and physiological emotional responses to emotive and neutral content at each level of presence. Therefore, participants viewed both small and large visual angle video presentations of neutral, amusing and sad video clips. In order to fulfil the aim of the experiment it was necessary to demonstrate that 1) increasing horizontal eye-to-screen visual angle increased subjective ratings of presence, 2) the three categories of video clips differed reliably in terms of elicited emotion and physiological response and 3) increases in visual angle affected emotional responses to emotive categories of video clips to a greater degree than a neutral category of clips (i.e., Sad clips became more sad, and Amusing clips more amusing).

The results of Experiment 5 indicated support for predictions 1 and 2. Large visual angle video presentations generated significantly higher ratings of presence than small angle presentations, particularly for the sadness category of clips. Furthermore, the three categories of video clips were shown to elicit their subjective target emotion state (neutral, amusement or sadness respectively) and differed in terms of physiological response. The results also indicated that the visual angle manipulation has some overall effects on emotional and physiological responses.

In sum, experimental conditions were successfully created in order to test the hypothesis that increases in presence would be associated with increases in emotional responses to emotive content. However, the results indicated mixed support for the hypothesis. While there was evidence to suggest that sad clips became more 'sad' at higher levels of presence, amusing clips did not become more amusing. In addition, increasing visual angle, and hence presence, was not associated with clear-cut effects on physiological responses. The findings are counter-intuitive to lay beliefs concerning the effects of Media Form on emotional responses (i.e., the bigger the better). The findings also do not fully support theories that propose increases in presence should be associated with increased naturalistic responses to Media Content (e.g., the Behavioural Realism approach). However, a critical examination of Experiment 5 reveals interesting avenues for further research into the relationship between presence and emotion.

Firstly, although large angle presentations generated significantly higher ratings of presence than small angle presentations, the effect was restricted to one item on the UCL-PQ. The results indicated that, overall, large angle video presentations were 'more real' to participants than small angle presentations. The findings are in contrast to the results of Experiment 3 in which large angle presentations generated higher ratings of Physical Space, Naturalness and Engagement on the ITC-SOPI than small angle presentations. In comparison to Experiment 3 the effects of Angle in the present experiment appear much weaker. Potentially, the smaller sample size in the present experiment may account for this finding. Indeed an evaluation of effect sizes indicated that with increased statistical power the effects of Angle on presence ratings may have reached significance for more types of presence rating. Alternatively, the UCL-PQ may be a less sensitive, or qualitatively different, measure of presence than the ITC-SOPI. Furthermore, the use of separate testing sessions for small and large angle presentations may have reduced participant's expectations about 'correct' responses. Doubt over the efficacy of the Angle manipulation in the present experiment has consequences for the overall interpretation of the results. As such the following evaluation of the results must be treated with caution.

Non-parametric analysis of 'sadness' and 'amusement' ratings indicated that the sadness category of clips became subjectively more sad at larger angles, whereas the amusement and neutral category of clips were unaffected by the angle manipulation. Therefore, in line with predictions, sad video clips became subjectively sadder. There are a number of possible explanations for this finding. Firstly, there was an increase in engagement and the sense of having visited a place from small to large angles for the sadness category specifically, suggesting that a wide visual angle was more natural and engaging to participants for these types of clips. There may be a relationship between the increased visual angle and the nature of sadness that is stronger than the relationship between increased visual angle and amusement. For example, being closer to or more surrounded by a mediated scene may be more effective in eliciting sadness because the viewer feels closer to a distressing event (in which they can neither intervene nor leave). Being closer to an amusing event may not be expected to change the meaning of that event in the same way.

One interpretation of these findings would be that the engagement and naturalness dimensions of presence are related to emotional responses to a greater degree than other dimensions of presence. Hence, if increasing visual angle increased engagement and naturalness for sadness clips only, then an increase in emotional responding may be expected to be restricted to sadness clips. Alternatively, increased engagement and naturalness (feeling involved, being drawn in, loosing track of time and a sense of journey or 'place') may be a greater part of the sadness response than the amusement response, and perhaps reflective of the high personal relevance of the sadness clips. An increase in sadness may have contributed to evaluations of presence. Alternatively, increases in both sadness and engagement may have been supported by the overall increased naturalness of large angle presentations and vice versa. In conclusion, it is possible that there is a more complex relationship between the visual angle manipulation, emotion type and dimensions of reported presence than was accounted for in initial predictions.

Of further note are the characteristics of the categories of clips. Clips within the sadness category dealt with a single theme: death, loss and grief. Although the setting of each clip varied, each sadness clip depicted the reaction of a bereaved person (or animal, in the case of 'Bambi') and used clear signals of distress (often in close-up), such as crying. Such events and signals may be expected to have almost universal significance to adult viewers or participants. In contrast the amusement clips dealt with varied themes designed to elicit emotion (embarrassment, slap-stick, drug-taking etc.) in a variety of settings (stand-up, dating, shopping etc.). The varied themes perhaps reflect individual preferences in humour. Indeed the results of Experiment 4 indicated that the sadness category clips were rated higher in identification and empathy with depicted characters than the amusement category. Not only would the homogeneity of individual relevance within categories be expected to affect mean emotion ratings in the present experiment, but the results of the present experiment may indicate a role for User Characteristics in the relationship between presence and emotion.

The above evaluation of the subjective data presented in this experiment is tentative, given the difficulty in generalising from the small number of clips and small sample size. However, such observations could be pursued in further research and may be useful when considering the design of affective media, both in terms of Media Form and Media Content. Potentially, different types of emotions may be associated with some dimensions of presence and not others and the route to variation in either an emotion or a dimension of presence can be examined in terms of both Media Form and Media Content and vice versa. Hence, if the aim is to induce Behavioural or Emotional Realism in users then different combinations of Media Form and Content variables may need to be considered for different types of emotional response.

A desirable feature of an investigation of the relationship between presence and emotion would be the use of objective measures to corroborate or qualify subjective data. To this end, physiological measures have been utilised throughout this thesis in order to begin to assess the utility of measures of autonomic activity (Skin Conductance and Heart Rate) as useful measures of presence. In the present experiment, categories of video clips that were shown to differ in terms of elicited subjective emotion were also shown to differ in terms of physiological responses. The results were broadly in agreement with the emotion research literature, indicating that the emotive categories of clips were associated with greater changes in autonomic arousal than the neutral category of clips. However, little evidence was observed for an effect of Angle on physiological measures. There was some evidence to suggest that Skin Conductance responses covered a greater range of activity during large angle presentations and this was consistent with subjective ratings of sadness. However, the measure used (minimum Skin Conductance value) is not a customary measure of Skin Conductance and the lack of corroboratory evidence in the alternative derivations of Skin Conductance (such as the mean change from baseline) indicate that the finding must be treated with caution.

The above discussion highlights limitations of the physiological measurement and analyses implemented throughout this thesis. Broad measures of change in Skin Conductance and Heart Rate have been utilised throughout the thesis. Broad measures of Skin Conductance Levels and Heart Rate may be expected to reflect not only emotional responses to meaning within a video image but also the effects of increased sensory stimulation when image size is increased, the effects of image degradation and negative physical side-effects. Although the results of the present experiment indicated that image quality and negative-effects variables were not affected by the Angle manipulation, it is possible that the physiological effects of increased image size were in opposition to the effects of emotions elicited by the content. For instance, reductions in Heart Rate associated with greater attentional focus to a large angle display may be attenuated by increases in Heart Rate associated with a stronger emotional reaction to a large angle display.

There are alternative derivations of autonomic measures, such as event-related Skin Conductance responses and Heart Rate variability, which may be more easily related to complex psychological responses to media. For instance, the analyses of event-related responses can isolate a short-term emotion related physiological response from the overall response during a mediated experience. The spectral analysis of Heart Rate series allows sympathetic and parasympathetic influences on Heart Rate variability to be isolated and quantified. However, these types of analyses were not suitable for the data collected in the present experiment (due to the low number of predictable responses and the suitability of the Heart Rate data for spectral analysis).

The interpretation of the physiological results in the present experiment becomes further muddied when it is considered that autonomic responses may feedback into emotional experiences. For example, increased Heart Rate may be interpreted as a symptom of fear (Telch et al., 1996). Research presented in this thesis has not fully considered the direction of causality between measure of presence, emotion and autonomic activity. As stated previously, initial predictions about the relationship between presence and emotion may not have taken into account the complex interplay of human-media interactions that may occur in an experiment of the type conducted in this thesis.

In the context of previous research in the field, the results of Experiment 5 and other experiments in this thesis both support and challenge previous findings. Overall, the results do not support findings which have suggested a direct relationship between presence and emotional intensity. For example, for single fear inducing contents (such as a virtual cliff and a virtual aeroplane flight) it has been shown that presence correlates with emotion related physiological responses and that emotional responses may increase as immersion and presence increase (Meehan et al., 2003; Wiederhold et al., 1998). Results presented in this thesis suggest that such findings may be specific to the contents or displays which were used in these experiments as similar results are not found across a range of contents and displays in this thesis.

The results in this thesis are more similar to research which has moved away from the use of fear inducing stimuli in presence and emotion research. In particular, the results of Experiment 5 support Banos et al.'s (2004) finding that sad content is rated higher in presence than neutral content (at least in terms of ecological validity and engagement). In addition, the results support Freeman et al., (2004) who did not observe an effect of presence enhancing display manipulations on mood ratings for a positively valanced relaxing virtual island. Similarly, in this thesis it has emerged that some types of content may be affected by media form manipulations and not others. Importantly, the effects of Media Form and Media Content on presence and emotion demonstrated in this thesis have been observed at relatively low levels of immersion (similarly to Banos et al., 2004). The findings suggest a role for emotion in determining the extent to which a person may feel presence in non-immersive media such as film and television, while other processes may be more important for more immersive and interactive media.

From the above discussion of the results of Experiment 5 it emerges that there are two-levels of evaluation and criticism that could be addressed in future research. The first level relates to aspects of the experimental design that could be improved such as choice of sample size, stimuli, measures and analyses. The second level of evaluation addresses the more fundamental assumptions about an investigation of the relationship between presence and emotion. In the General Discussion (Chapter 8) of the thesis this deeper level of evaluation will be addressed. Specifically, potential causal links between conceptually distinct dimensions of presence and components of emotional responses (such as subjective physiological, behavioural and cognitive) will be analysed, with reference to Media Form and Media Content variables.

To summarise, the aim of Experiment 5 was to examine the prediction that increased presence in a mediated environment should be associated with increased emotional responding to emotive Media Content. The conditions for testing this hypothesis were successfully created and sad films were shown to become more sad in higher presence conditions, in line with Behavioural Realism. However the results indicated that mediated environments which generated higher ratings of presence than others did not necessarily increase emotional responding. Rather, the results indicated that there was a more complex relationship between dimensions of reported presence and emotional responses. In particular it was reasoned that Media Form variables, Media Content variables, dimensions of presence and components of emotional responses should be discussed in more depth before generating further predictions about the relationship between presence and emotion.

Chapter 8 General Discussion

8.1 Introduction: Aims of the Thesis

The purpose of Chapter 8 is to evaluate and interpret the results of experiments presented in this thesis, with respect to the theoretical, methodological and applied aims of the thesis that were set out in the introductory chapters. A summary of these aims follows.

8.1.1 Background Theory

Presence has been described as the "subjective sensation of being there in a mediated environment" (Slater et al., 1994) and also the "perceptual illusion of non-mediation" (Lombard and Ditton, 1997). The Introductory chapters to this thesis (Chapters 1 and 2) described some of the psychological processes implicated in theories of presence. These were perception, attention, mental models and schemata. The review asked: what psychological processes could lead to variations in subjective reports of presence? A role for each of the processes was suggested. In particular, the view that reports of presence occurred when media schemata were suppressed was highlighted (IJsselsteijn, 2003). Media schemata are structures of knowledge which allow us to distinguish between real-world and technologically mediated stimuli (such as between actual events and television images). Media schemata may be less likely to be activated, for example, when mediated information is high in sensory realism or when media cues, such as screen edges, wires and so on, are less available to attention.

8.1.2 Theoretical Aims of the Thesis

When media schemata are not activated, and hence presence is high, then emotional responses may be expected to be driven by mediated content as if it was real (e.g., a film of a roller-coaster ride is more exciting on a wide-screen than a small screen). The prediction is consistent with a number of theories of presence, where presence has been equated with increased naturalness of behaviour in response to mediated stimuli. For example, the Behavioural Realism approach to presence research predicts that as presence in a mediated environment increases, behavioural responses will tend to those that would be observed in a similar real environment (Freeman et al., 2000). The present thesis aimed to explore the potential relationship between presence and emotion by extending the predictions of the Behavioural Realism approach to include emotional responses.

8.1.3 Methodological Aims of the Thesis

One method of investigating the relationship between presence and emotion is to examine the impact of variations in the theoretical determinants of presence (Media Form and Media Content) on measures of presence and emotion. A similar methodology has been implemented in previous research (e.g., Meehan et al., 2002). However, previous research was limited in the type and range of Media Form and Media Content variables utilised. For example, highly arousing Media Content tended to be used, such as Content designed to scare or shock. Therefore, the second aim of this thesis was to examine the relationship between presence and emotion using better controlled experiments designed to find means of manipulating levels of presence through the use of Media Form variations and then examine the impact of the manipulation across a range of Media Content.

8.1.4 Applied aims of the Thesis

A continuing problem in presence research is the effective measurement of presence (IJsselsteijn et al., 2001). One solution to the problem involves including subjective and objective corroborative measures in the presence measurement battery. For example, Freeman et al. (2000) investigated the utility of measures of postural sway in response to video stimuli as an objective measure of presence. Potentially, an investigation of the relationship between presence and emotion may result in the development of new measures of presence, such as measures of subjective emotion and objective measures of physiological arousal. Physiological indicators of emotional arousal, such as Skin Conductance and Heart Rate, would be particularly valuable as corroborative measures of presence as they are not only objective, but also continuous, versatile and not normally under conscious control. Therefore, the final aim of this thesis was to implement exploratory investigations of subjective and objective measures of emotion as corroborative measures of presence, by first investigating potential relationships between presence and emotion.

8.1.5 Summary

The presence research literature predicts a potential relationship between presence and emotional responses and this thesis primarily aimed to investigate this prediction. The methodological aim of this thesis was to implement an experimental design which examined the impact of determinants of presence (Media Form and Media Content) on measures of subjective presence, subjective emotion and objective measures of physiological arousal in order to examine potential links between presence and emotion. The final, applied, aim of this thesis was to use the results of experiments presented in the thesis as an exploratory stage in the evaluation of measures of emotion based corroborative measures of presence.

8.2 Summary of Results

8.2.1 Introduction

The following sections give a general overview of results gathered in the five experiments described in this thesis. The experiments were designed to test predictions about the relationship between presence and emotion. Knowledge concerning the determinants of presence was used to create varying levels of subjective presence. Varying levels of presence were created by manipulating aspects of Media Form in the context of a video display – particularly, the absence and presence of stereoscopic cues (Experiments 1 and 2) and large versus small eye-to-screen visual angle (Experiments 3 and 5). Media Content with varying types of emotional impact was presented via the video displays (Experiments 1, 2, 3, and 5). It was of interest whether increases in reported presence due to Media Form manipulations would be associated with more intense subjective and physiological (Skin Conductance and Heart Rate) emotional responding. For example, it was suggested that higher presence video presentations could be more arousing than lower presence presentations, in line with previous research, or that, in line with Behavioural Realism, increased presence could intensify content-specific responses (e.g., a relaxing stimulus may become more relaxing under high presence conditions).

In the process of developing video content for the above experiments the opportunity also arose to investigate presence and Media Content (Experiments 4 and 5). It was possible to examine differences in subjective presence between Media Contents shown to reliably elicit different types of subjective emotion and also to examine correlations between subjective presence and subjective emotion.

8.2.2 Effects of Media Form on Presence and Emotional Responses

A key feature of the investigation of presence and emotion in this thesis was the use of Media Form manipulations that would produce variations in subjective reports of presence. In all experiments (excluding Experiment 4 in which no Media Form manipulation was used) effects of Media Form on subjective measures of presence were observed. In Experiment 1, in line with the presence literature (Hendrix & Barfield, 1996; Freeman et al., 2000), stereoscopic video presentations were rated significantly higher in Physical Space, Engagement, Naturalness and 'Being there' on the ITC-Sense of Presence Questionnaire (ITC-SOPI) than monoscopic presentations. The finding was somewhat supported by Experiment 2, in which ratings on the UCL-Presence Questionnaire (UCL-PQ) Q1-'being there' item were significantly higher for stereoscopic in comparison to monoscopic presentations. In Experiment 4, 42-degree visual angle display presentations were rated higher in Physical Space and Engagement than 21-degree visual angle display presentations, in line with the presence literature (Hatada et al., 1980; IJsselsteijn et al., 2001; Lombard et al., 1997; Prothero & Hoffman, 1995; Reeves et al., 1993). The finding was somewhat supported in Experiment 5 in which 42-degree presentations were rated higher on the UCL-PQ Q1-'real' item than 21-degree presentations.

Furthermore, the addition of stereoscopic depth cues to video presentations, and also increased visual angle, was associated with increases in subjective emotional arousal (on the Profile of Mood States 'Energetic-Tired' scale in Experiments 1 and 3, and on the Elicited Emotions Scales 'Amusement', 'Fear' and 'Arousal' items in Experiment 3) and increases in positive mood (on the Profile of Mood States 'Elated-Depressed' scale in Experiments 1 and 3). This finding can be explained in lay-terms as a 'fair-ground effect' as it is the finding one might expect when visiting a simulator or 3D cinema for entertainment: large screen and stereoscopic video presentations were subjectively more energising and exciting.

However, in Experiment 5 larger visual angles generated higher overall ratings of 'sadness' in addition to 'arousal' on the Elicited Emotions Scales. Moreover, although higher presence displays were rated higher in subjective arousal, there was only one piece of evidence to suggest that they were also more physiologically arousing (Experiment 5). In this case Skin Conductance appeared to span a greater range of activation in higher presence presentations, (which may corroborate the finding for 'sadness' and 'arousal' ratings). However, the range of activation is not a widely used

Skin Conductance measure, and it may be concluded that there was little evidence for an effect of Media Form on Skin Conductance and Heart Rate[29].

In summary, Media Form enhancements that are widely predicted to increase sensations of presence (Ellis, 1996; Held & Durlach, 1992; Sheridan, 1992; Zeltzer, 1992) were found to do so in this thesis. As such, an essential aim of the methodological component of this thesis was fulfilled: varying levels of presence were successfully created through the use of Media Form manipulations. In addition, the presence enhanced video presentations also increased subjective arousal, such as feelings of energy, but did not reliably increase changes in physiological arousal, in comparison to lower presence presentations. However, some findings (Experiments 2 and 5) suggest that the effects of Media Form manipulations on subjective ratings of presence were not as strong as expected. In addition, the effects of Media Form manipulations were not always observed on every, or the same scale, of the ITC-SOPI and UCL-PQ presence measures, and also subjective emotion measures. A number of explanations for these latter two observations are explored below and in Section 8.4.

8.2.3 Effects of Media Content on Presence and Emotional Responses

Previous research has demonstrated that increasing presence through the use of Media Form manipulations also increases emotion related physiological arousal. However, in previous research, the Media Content used to demonstrate this effect was highly arousing in nature and only one type of content was used in each experiment. For example, Meehan et al. (2002) exposed participants to a 30-foot virtual cliff at different frame-rates and with or without enhanced haptic information. Wiederhold, Davis & Wiederhold (1998) exposed flying-phobics to a virtual aeroplane flight on a head-mounted display or computer screen. Consequently, it is unclear from previous research whether increases in physiological responses were associated with increases in presence, or whether they were more closely related to the other elements of the Media Form manipulations (such as changes in frame-rate, motion and so on).

In contrast to previous research, experiments in the present thesis used a wider range of Media Content to examine the relationship between presence and emotion. In

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[29] In Experiment 1 there was an effect of a further Media Form manipulation (a screen-surround) on Heart Rate. This finding is discussed in section 8.2.4 (Other Findings).

particular, it was of interest whether the findings of previous research could be verified across a wider range of contents. Furthermore, predictions arising from the Behavioural Realism approach to presence research were taken into account – if increased presence is associated with an increase in emotional responding, then the type of emotional response observed will be dependent on the emotional tone of the content. Finally, it is widely proposed that, in addition to Media Form, Media Content is a determinant of presence (Heeter, 2003) and there is some evidence to suggest that emotive content will be rated higher in presence than neutral content (Banos, et al., 2004). The experiments conducted in this experiment provided the opportunity to examine in more detail whether subjective emotional tone, as a Media Content variable, was associated with variations in subjective presence.

As described in Section 8.2.2 above, the first three experiments described in this thesis did not verify the results of previous research. Across a range of Contents, presence enhancing Media Form manipulations did not increase emotion related physiological responding. For example, in Experiments 1, 2 and 3 participants viewed monoscopic and stereoscopic versions of a fast-paced rally-driving video sequence and a slow-paced boat-ride video sequence. Although, overall, the two content types were shown to differ in terms of subjective emotion and physiological arousal, and although increasing presence was shown to generally increase subjective arousal, there was little evidence to show that increased presence was associated with increased emotion related physiological responses either across both contents or in a way which was dependent on the type of content.

Although experiments in this thesis did not support previous research into the relationship between presence and emotion-related physiological arousal there are a number of potential reasons for these findings, some of which are noted above in Section 8.2.2, and others which will be discussed in Section 8.4. In addition, the research presented in this thesis was able to provide evidence concerning a previously under-researched area in the presence field.

Two findings in particular suggested that further experiments were needed in order to investigate Media Content variables in more depth. In Experiment 1, there was evidence to suggest that the boat-ride video, which was more subjectively 'relaxing' than the rally-driving video, became more relaxing when presence was higher (in line with the Behavioural Realism predictions). However, because mood and emotion ratings in response to the boat and rally videos were low (near to floor-levels), it was also possible that the videos were relatively neutral in emotional tone. If the latter proposal were to be true, then in Experiments 1, 2 and 3, enhanced presence would be expected to have little effect on emotional responses (as a neutral content may remain un-arousing at a higher level of presence).

The latter proposal was supported by evidence presented in Experiment 4. When compared to a range of video clips drawn mainly from popular film and television, the boat and rally videos were shown to be relatively neutral in emotional tone (e.g., when compared to footage from horror movies, love stories and comedies). From the range of video content used in Experiment 4, three sets of video clip were developed: clips that elicited Amusement, Sadness or a Neutral emotional state. The impact of a presence enhancing Media Form manipulation was then examined for the three sets of clips (Experiment 5).

Experiment 5 yielded interesting results in terms of the aims of this thesis. The results were broadly in line with Experiments 1, 2 and 3 in that a Media Form manipulation enhanced presence and increased subjective arousal across all three types of content. In addition, there was limited evidence to show that increased presence was associated with increased changes in physiological arousal. However, increases in certain types of presence rating (engagement and the sense of having visited a place) were restricted to the sadness category of clips, and a specific increase in subjective ratings of sadness was seen in this category (i.e., sad films became sadder at higher levels of presence). Although this effect was not seen for amusing clips, and was not corroborated by the physiological data) the finding suggests some support for the Behavioural Realism hypothesis. It was argued that the relationship between presence and Media Form may not be constant across different types of emotive Media Content.

Media Content is widely proposed as a determinant of subjective presence (Heeter, 2003; IJsselsteijn et al., 2001), and yet little research has directly investigated the characteristics of content that may impact on a persons sense of presence (such as plot, task relevance, personal interest and so on). The present research indicates that the emotional impact of a mediated environment may be an important Media Content characteristic. In Experiments 4 and 5, for example, it was shown that, for validated sets of video clips, emotive video clips generated higher ratings of presence that neutral video clips, in line with Banos et al.'s (2004) finding that sad content was rated higher in presence than neutral content. The results also showed that content-congruent emotion ratings positively correlated with subjective presence ratings (e.g., ratings of amusement correlated with ratings of presence for the Amusement set of video clips). Indeed, throughout all experiments presented in this thesis the results indicated that Media Content had a greater impact on subjective presence ratings than Media Form.

Experiments 4 and 5 included measures designed to probe media responses associated with the emotional impact of video content. The results indicated that, in addition to varying in levels of presence, different types of Media Content also varied on measures of identification, empathy and personal relevance. As may be expected, emotive content was judged more personally relevant and prompted more feelings of empathy and identification than neutral content. In particular, the Sadness set of clips, which received the highest ratings of presence, was associated with greater empathy and identification than Amusement or Neutral clips. The finding links the present research to the wider fields of audience research and film theory, which have been concerned with audience reception processes to a greater extent than the presence field. In addition, the finding suggests further routes for investigating the underlying processes which may link presence and emotion.

In summary, a core component of the methodology used to investigate the relationship between presence and emotion in this thesis was the examination of emotional responses to different types of Media Content, when Media Form (and hence presence) was varied. The results of the research showed enhancements in Media Form (and hence presence) increased subjective arousal across all content types. However, there was little evidence to show that those enhancements affected physiological arousal or that the emotional response was dependent on the content type. Instead, the research revealed that Media Content is a potentially important determinant of subjective presence, and that the emotional impact of video content is a potentially important Media Content characteristic.

8.2.4 Other Findings

In addition to the findings described above, other results were observed throughout the course of the experiments conducted in this thesis that are relevant to the evaluation of the aims of the thesis. In particular, a number of supplementary measures were used in order to identify confounding variables and add explanatory power. Furthermore, unexpected findings suggested alternative lines of research which could not be addressed in this thesis.

In the course of developing and evaluating advanced visual media, such as immersive television, video-conferencing and virtual reality, it is usual to assess the physical impact of the mediated visual image on the user or viewer. For example, slow frame-rates, poor image resolution and delayed image updating can be associated with negative side-effects such as headaches, eye-strain and nausea. Because features of the visual image and interactions with the mediated environment can lead to negative effects, and also because the quality of the visual image can impact on viewers' enjoyment and satisfaction, measures of image quality are also used in product development and evaluation. Hence, subjective measures of Negative Effects (Experiment 1, 3 and 5) and Image Quality (Experiments 3 and 5) were used in this thesis. It was of interest whether variations in Media Form and Media Content were associated with Negative Effects and Image Quality, and whether these variations were important to the evaluation of the effects of Media Form and Media Content on subjective presence, subjective emotion and physiological responses.

In Experiment 3, the larger visual angle generated more Negative Effects than the smaller visual angle. In Experiments 1, 3 and 5 it emerged that there were differences between Media Content types in terms of Image Quality. In Experiments 1 and 3 it was shown that the experience of Negative Effects and the evaluation of Image quality were dependent on interactions between Media Form and Media Content.

Such findings are important to the overall interpretation of the results of the thesis, as it is apparent that experimental conditions designed to investigate presence and emotion may have been confounded by other factors which may be associated with presence and emotion. For example, increasing eye-to-screen visual angle may create a more immersive mediated environment for a viewer, but associated increases in presence could be attenuated by apparent image degradation and consequent negative side-effects and negative emotions. Aspects of a viewing experience that cause physical or emotional stress may detract from the intended emotional impact of content or produce physiological reactions that are associated with the look rather than the meaning of the mediated environment. In some cases, different factors could cancel each other out – for example when a stimulus is relaxing but the physical environment is novel, stressful or exciting.

Given the observations above, conclusions regarding the impact of Media Form and Media Content on presence and emotion observed in this thesis must be treated with caution. In spite of this, the pattern of results observed provides information about how best to implement such experiments and the utility and psychological validity of the measures used. As an example, the results of Experiment 1 can be considered. In this experiment a Vistral screen-surround was used. The screen-surround is back-lit and appears to float around the edges of a television screen. Heart Rate was shown to be lower when viewing video footage when the screen-surround was absent, in comparison to when the screen-surround was present. A relatively greater reduction in Heart Rate during viewing could be due to decreases in alertness, or potentially increases in attentional focus. Regardless of the interpretation, the result was not corroborated by any subjective measures. The physiological data revealed an effect during viewing that was not revealed by post-test subjective questionnaire measures, and was therefore of added value in the measurement battery.

8.3 Evaluation of the Results

8.3.1 Introduction

The overarching aim of this thesis was to investigate the relationship between presence and emotion. This thesis therefore implemented a methodology for examining the relationship between presence and emotion and it was further suggested that such a methodology could serve as an exploratory stage in the development of emotion based corroborative measures of presence. The following sections evaluate the findings of experiments presented in this thesis in terms of the theoretical, methodological and applied aims set out in Section 8.1 above.

8.3.2 Evaluation of the theoretical aims of the thesis.

The overarching theoretical aim of this thesis was to examine predictions arising from theories of presence concerning the relationship between presence and emotion. In particular, the Behavioural Realism approach to presence research would predict that as presence increases then emotional responses to Media Content should become more natural. Other research has shown that high-presence mediated environments are more arousing than mediated environments that elicit lower levels of presence.

The research presented in this thesis provided some support for extending the predictions of Behavioural Realism to include emotional responses. It was shown that Media Form manipulations that enhance presence may also increase subjective arousal, and that the emotional quality of Media Content is associated with variations in subjective presence. Hence, the thesis has shown that there is support for the notion that there is a relationship between a persons 'sense of being there' in a mediated environment and their emotional responses to a mediated environment.

Therefore, this thesis supports the idea that emotional processes can be included as a psychological factor relevant to presence research - in addition to the psychological processes underlying reports of presence that were highlighted in Chapter 1 (perception, attention, mental models and schemata). In particular, the impact of Media Content, in addition to Media Form, on a person's experience of a mediated environment has been highlighted as an important determinant of both presence and emotional responses. Such conclusions are relevant in diverse applied fields, particular in the development of clinical, educational and entertainment technologies where design may aim for both presence and emotional impact in varying degrees.

However, although support for theories of presence, such as Behavioural Realism, was evidenced in this thesis, conclusions must be qualified given the diverse pattern of results obtained, suggesting a complex interplay between media variables and psychological processes. The results taken in the context of the methodology employed in the thesis suggest that further research is needed in this area. The following section briefly considers the methodological aims of the thesis.

8.3.3 Evaluation of the methodological aims of the thesis

The methodological aim of this thesis was to examine the relationship between presence and emotion by examining the impact of determinants of presence (Media Form and Media Content) on subjective reports of presence and subjective and objective indicators of emotion. The methodology was similar to that employed in previous research, but aimed for a more rigorous approach by extending the range of Media

Contents used as experimental stimuli and by including a broad range of measures of user experience.

Aspects of Media Form which increased 'immersion' (the addition of stereoscopic depth cues and increases in eye-to-screen visual angle) were shown to enhance presence. In addition, the experiments in this thesis highlighted the importance of Media Content as a determinant of presence (an under-researched area in the presence field). However, there were features of the methodology which suggested alternative methodological approaches and also factors which require consideration in future experimental design.

For example, the effects of Media Form manipulations were not consistent across the experiments in this thesis. Two different measures of presence were used (the ITC-SOPI and the UCL-PQ) and effects were seen on some scales in some experiments and not others. Questions arising from this finding encompass whether the measures were valid and reliable and whether experiments were designed to maximise their impact on presence measures.

The question of validity and reliability of subjective measures of presence is much debated in the presence field. For example, Lessiter et al. (2001) argue that presence measures should be multi-dimensional in order to capture the range of factors which are thought to contribute to a person's sense of presence. Given this argument, it is possible that the three-item UCL-PQ may have been an inadequate measure of presence in this thesis. However, the UCL-PQ is a widely used measure of presence and the results of experiments may reflect other factors.

For example, different types of Media Form manipulations may affect some dimensions of presence and not others. Furthermore, in order to use Media Form and Media Content manipulations to examine subjective and physiological emotional reactions it may be preferable to implement more widely differentiated experimental conditions which do not require large numbers of participants in order to demonstrate significant effects. Indeed it could be argued that the displays and content used in this thesis were not true presence technologies, in comparison to fully immersive technologies such as virtual environments and highly interactive technologies such as remote tele-operating techniques.

Given that the effects of manipulations of presence were inconsistent in this thesis and given the low immersive properties of the displays utilised, it is possible that the predictions of the Behavioural Realism approach were not fully tested in this thesis. Therefore, the experiments in this thesis have value in indicating presence related effects of Media Form and Media Content on subjective and physiological emotional responses, but future research could consider using alternative displays and contents[30], perhaps in ecological settings, with a greater focus on the validity and reliability of measurement techniques.

However, one over-riding problem in presence research is that subjective measures of presence may be inherently unstable (Lessiter et al., 2001). Indeed the applied aim of this thesis was to explore emotion-based corroborative measures of presence given that presence questionnaires may be prone to subjective biases. The following section explores the applied aims of this thesis.

8.3.4 Evaluation of the applied aims of the thesis

The applied aim of this thesis was to explore the use of emotion based corroborative measures of presence. In particular, Chapter 2 highlighted physiological measures of autonomic arousal (which are often used to indicate emotional arousal) as valuable potential measures of presence given that they can provide objective and continuous data. Subjective measures of emotion could also be used as corroborative measures of subjective presence. The use of measures of emotion as measures of presence depends upon their validity (as an indicator of presence), reliability, sensitivity, usability and non-intrusiveness (see Chapter 2). In addition, the validity and reliability of the emotion measures themselves in mediated environments is a matter for consideration.

The experiments in this thesis demonstrated that measures of subjective emotion and physiological measures of arousal do not respond in the same way as measures of presence to Media Form and Media Content manipulations (or may do so only in specific circumstances). Emotion measures were sensitive to the determinants of presence, but could not be said to be good indicators of presence in the experimental

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[30] For example, the recently completed EU EMMA project (Alcaniz-Raya et al., 2002) used mediated content (such as a virtual park designed for use in psychological therapy) which differed only in terms of emotive details (such as colouring, weather and brightness) on immersive and non-immersive display platforms.

contexts used in this thesis. Rather the experiments revealed a potentially complex relationship between presence and emotion and pointers towards further research into emotional indicators of presence.

It was apparent that there were a range of factors in the experiments, in addition to emotion cues, that could affect subjective and physiological responses. For example, Negative Effects, Image Quality and other factors such as novelty were identified as potential confounding variables. In particular, although physiological measures of Skin Conductance and Heart Rate are often used to indicate emotional arousal, these measures may have been subject to multiple influences and may be better employed in either case-studies or in primary research in highly controlled experiments (e.g., when examining event-related responses in mediated environments)[31].

Despite the findings of experiments in this thesis, emotion measures remain good candidates for corroborative measures of presence due to a number of factors. Subjective measures of emotion are high in usability: generally, they are easy to obtain, administer and understand (by both participants and experimenters). There are also a range of objective measures of emotion such as behaviour analysis, eye gaze and pupil dilation (which can be used continuously and non-intrusively) that may have value in mediated environments. Alternatively, qualitative research could provide more information about people's emotional responses to mediated environments and lead to the development of tailor-made emotion measures for specific contexts. Indeed it can be argued that emotion measures could have value in the evaluation of user experience which goes beyond presence measurement, particularly when mediated environments are designed with emotional responses in mind.

However, it is likely that any emotional indicator of presence will be highly context or individual specific, and also that it will be corroborative rather than definitive. This is because emotions elicited in a mediated environment are likely to be highly dependent on content and the individual and because it is probable that the relationship between presence and emotion may also be dependent on a range of factors within a mediated environment. Further research is needed to build on the research presented in this thesis

[31] For example, Scheirer et al. (2002) have developed methods of identifying moments of frustration during computer games using measures of autonomic arousal.

and elsewhere in the presence literature in order to establish the nature of the relationship between presence and emotion before emotional indicators of presence are developed. The following sections constitute a speculative scaffolding of the factors which may need to be considered when developing research questions and identifying potential presence measures in this field.

8.4 Future Directions

8.4.1 Introduction

Following the outset of this thesis there have been wide-ranging developments in the field of presence research. Amongst these developments has been the growth of European research into presence. Under the European Union Information Society Technologies sixth framework for research (Future and Emerging Technologies), twelve international projects received funding for presence related research and development projects. One contribution from these projects has been the development of psychological models of presence and the cross-project synthesis of research.

For example, in the MEC (Measurement, Effects Conditions) project, Wirth, Vorderman, Hartmann et al. (2003) introduced a model which examined presence at several levels of explanation: cognitive, behavioural, experiential and biological. Under the OmniPres banner, Freeman (2004) introduced a synthesis of current presence theory and research, noting that most theoretical approaches can be said to describe presence in term of three psychological dimensions: a sense of physical space, engagement and naturalness. In the EMMA (Engaging Media for Mental Health Applications) project, which collected data concerning the relationship between presence and emotion, the degree of causality and the direction of causality between presence and emotion became a focus of interest (EMMA, 2004). Importantly, using virtual environments, the EMMA project was able to evaluate the effects of Media Form and Media Content variations on reported presence and emotion using a similar methodology to that employed in this thesis, but in a highly controlled manner (e.g., the structural visual features of environments could be kept constant across a number of media platforms while emotion cues in the content could be varied).

The conclusion to this thesis is a proposed scaffolding for future investigations of presence and emotion. The research in this thesis showed that the relationship between presence and emotion is worthy of further investigation. However, it was noted that results varied in terms of the measure of presence and measure of emotion examined. Therefore, it may be a useful exercise to specify the problem space in more detail and attempt to map components of emotional responses onto the theoretical dimensions of presence.

The exercise is similar to that proposed in the EMMA project in that varying types of relationships between presence and emotion can be considered (see Figure 8.1). However the scaffolding described here further proposes that a detailed examination of the presence concept and also emotional processing is required (similarly to the approach taken by MECC and OmniPres). Furthermore, it is specifically proposed that such an exercise could be used to 1) **identify potential emotional indicators of presence**, when underlying psychological processes associated with each dimension of presence may be seen as causes of emotional responses, **2) identify emotional determinants of presence,** when reports of presence may be seen as a consequence of emotional processing and **3) identify occasions when emotional responses and reports of presence may not be associated.**

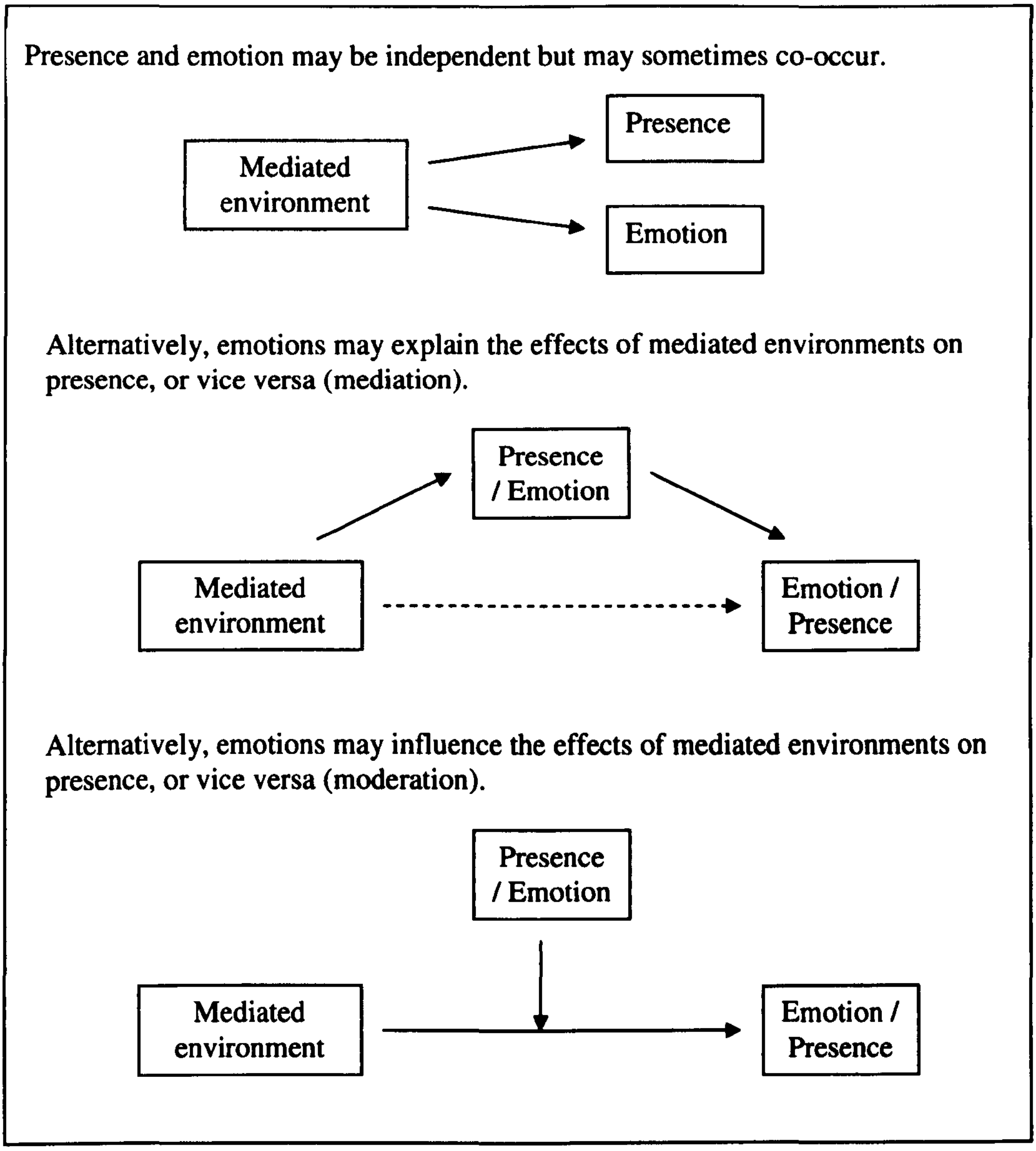

Figure 8.1 Examples of potential causal relationships between presence and emotion adapted from Dillon, Freeman & Keogh (2003).

8.4.2 Dimensions of presence

The first stage in the speculative development of a presence-emotion scaffolding is to specify in more detail what is meant by 'presence'. Converging lines of evidence from diverse perspectives and methodologies suggest that subjective reports of Physical Presence (reports of 'being there' in a displayed environment) can be divided into three dimensions: A '*sense of physical space*', '*engagement*' and '*naturalness*' (Freeman, 2004). The three dimensions are similar to the three dimensions of the ITC-SOPI (Lessiter et al., 2001), but are more specific in terms of the psychological processes implicated in each dimension and their relationship to the determinants of presence.

For example, in qualitative research participants describe their experience in terms of a sense of space, involvement and naturalness (Freeman & Avons, 1999). In addition, three similar dimensions emerge in questionnaire development and analysis: physical space, engagement, naturalness (Lessiter et al., 2001; Schubert, Friedman & Regenbrecht, 2001; Banos, et al., 2000). Finally, many theories of presence suggest a role for perception, attention and higher-level cognitive processes underlying reports of presence (see Chapter 1).

In synthesis (after Freeman, 2004) the following characteristics of the proposed three dimensions of presence could be postulated (see Table 8.1). A sense of '*physical space*' may be achieved by providing good spatial cues and physical interactions (Media Form characteristics) that promote accurate perception-action coupling. Such a display combined with meaningful Media Content will promote '*engagement*' in the user by blocking out extraneous information and focusing the user on important stimuli. The '*naturalness*' of the experience may then be determined by the extent to which Media Form and Media Content can be mentally combined by the user (User Characteristics) to produce experiences and behaviours that appear as if they were 'real'. Alternative speculations about the characteristics of the three dimensions of presence are possible.

Table 8.1 Three Dimensions of Presence.

Dimension of Presence	***Defining Characteristics***		
	Determined by...	***Underlying Process***	***Experience***
Physical Space	Media Form	Perception-action coupling	Sense of space
Engagement	Media Form Media Content	Focused attention	Interest Involvement
Naturalness	Media Form Media Content User Characteristics	Selective Attention Mental Models Schematic Processing	Believability Realism Control

8.4.3 Components of emotional responses

The second stage in the development of the presence-emotion research scaffolding is to describe in more detail what is meant by an 'emotional response'. In this thesis a number of measures of emotion were implemented. At the subjective level, changes in mood over time were monitored as were short term changes in emotion. In addition, levels of subjective arousal (variations in energy) were evaluated. At the physiological level, changes in Skin Conductance and Heart Rate over time (often used to indicate stress and subjective arousal) were measured. In relation to emotion theory it can be noted that each of these measures relates to a different component of an emotional response, and perhaps different elements of emotional response systems. For example, Izard (1993) described four emotional responses systems:

Physiological: Automatic reactions to stimuli providing energy for behavioural and cognitive responses (e.g., fight-flight responses in the autonomic nervous system).

Behavioural: Automatic and planned responses to stimuli, mobilisation of responses and communication (e.g., facial expression and posture)

Cognitive: Mental representations of emotion which, when activated, generate physiological, behavioural and experiential responses. In turn, influenced by other response systems (e.g., the panic cycle).

Experiential: The experience of emotion has a 'quality', 'intensity' and duration related to the type and intensity of responses in other systems (e.g., anxiety < fear < terror).

8.4.4 Dimensions of Presence and Components of Emotion

Potentially, in a given context, one dimension of presence may be associated with one component of an emotional response and not another. Therefore, an attempt to map components of emotional responses onto dimensions of presence may be useful. Some of the potential associations between dimension of presence and components of emotional responses are shown in Figure 8.2 – the diagram is not definitive or predictive as many more associations than those shown are possible and most have not been the subject of research or theory.

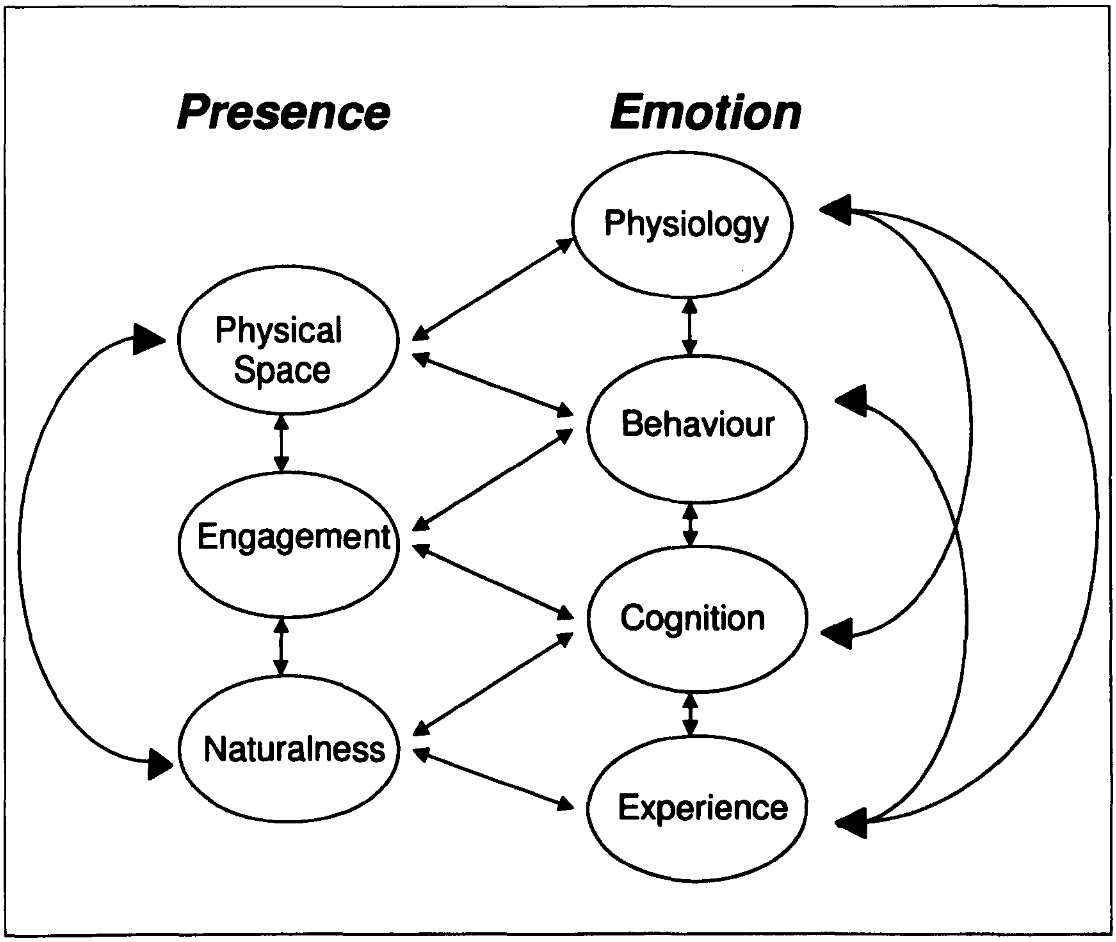

Figure 8.2 Potential associations between dimensions of presence and components of emotions, (Dillon et al., 2004)

8.4.5 Identifying paths for research

Given the multi-dimensionality of the problem space illustrated in Figure 8.2 (in contrast to a simple consideration of 'presence' and 'emotion') and the large number of associations possible between the concepts, speculations concerning the relationship of components of emotional responses to separate dimensions of presence can be informed by previous research and theory.

For example, a variety of presence and emotion measures have been used in this thesis and in previous research. Observed associations and dissociations between presence and emotion may be dependent on the emotional response system cued by a mediated environment and measured (i.e., physiological, behavioural, cognitive and experiential components of emotion do not always match up, or respond to the same cues) and the dimension of presence measured (physical space, engagement and naturalness, which may be determined by different elements of the mediated environment such as Form, Content and the User). Table 8.2 illustrates types of emotional responses that may be associated with each dimension of presence, taking inspiration from the literature and wider speculation.

The aim of mapping dimensions of presence onto components of emotional responses (as shown in Table 8.2) is to simplify, clarify and increase specificity in the presence-emotion problem space. The exercise could be used for generating research questions or explaining experimental results. Such a research scaffolding could be used to isolate, or at least narrow down, the range of important variables in a research problem. For example, using the information presented in Table 8.2, Table 8.3 demonstrates how the division of the presence-emotion problem space into its constituent components could lead to the identification of emotional indicators of presence, emotional determinants of presence and cases were emotion and presence may not be expected to be associated. The information presented in Tables 8.2 and 8.3 is speculative.

Table 8.2 Potential matches between dimensions of presence and components of emotional responses.

Dimension of Presence	*Component of Emotion* *Physiology*	*Behaviour*	*Cognition*	*Experience*
Physical Space	-spatial reflexes (e.g., to heights, looming objects) -energy mobilisation	-reflexive approach / avoid behaviour	-reflexes feed into emotional and spatial processing - 'perceptual set'	- transient emotions in response to spatial content (e.g., fear in response to a looming object) - feelings of interest in novel environments - negative effects
Engagement	- fight-flight responses - attention related responses - intensity and duration of responses (e.g., to phobic stimuli)	-reflexive social behaviour (e.g., social reflexes) - responsivity to emotive stimuli outside the mediated environment	- content-driven emotion activation -cognitive biases of attention	-content driven mood -intensity of experience (i.e., subjective arousal) - interest, energy and involvement
Naturalness	-responses closely tied to content (i.e., physiological indicators of specific emotions)	-expressive behaviour, planned behaviour (e.g., the natural response for the user, as if the stimuli were real)	-emotions attributed to content -content-driven appraisals -cognitive biases of memory - empathy	-emotions consistent with activated mood - the quality of the emotion -emotions closely tied to currently available content

Table 8.3 Selected examples of predictions that can be made about presence and emotion.

Dimension of Presence	***Emotional Responses could be:***		
	Indicators of Presence	**Determinants of Presence**	**Independent of Presence**
Physical Space	-Reflexes to spatial content increase	- Spatial reflexes may provide evidence to a user that they are 'present' (and therefore promote engagement and naturalness) - Negative Effects could reduce presence	-Reflexes can occur to stimuli which may not continue to be engaging or natural (e.g., early roller coaster simulators)
Engagement	- Reflexes to real world reduced as presence increases - Reflexes to content increase as presence increases - Fight-flight responses - The intensity and duration of emotions	- Emotive and interesting content may focus attention and reduces attention to the real word (therefore increasing the likelihood of a sense physical space and naturalness)	- Engaging stimuli may continue to be processed as 'mediated stimuli' (e.g., horror films)
Naturalness	- The 'natural' response of the individual user given the content - The quality of the emotion - Higher-level cognitive processes such as empathy - Memory for the environment - Behavioural analysis	- Activated mental representations of emotion allow an environment to be interpreted and events to be predicted – this may promote Engagement and Physical Space -'Natural' emotional responses may not promote engagement with or presence in an environment (e.g., excessive worry and rumination)	- If a user experiences a high degree of 'naturalness' then emotional responses should not be independent of presence.

8.4.6 Applying a Research Scaffolding to Results Presented in this Thesis

The scaffolding described above can be applied to the research presented in this thesis. In order to demonstrate the application it is useful to concentrate on two key findings: (1) at the low levels of immersion provided by the displays in this thesis, the emotive quality of Media Content was shown to be a stronger determinant of the naturalness and engagement dimensions of presence than Media Form and (2) enhancing immersion was consistently associated with relatively greater changes in subjective arousal but did not always affect all components of presence.

In example (1) the author would suggest a mediating role of emotional responses in generating specific components of presence. Emotion is an integral feature of experience and users respond to film and television with emotion. Indeed, it can be argued that these types of media are emotion generators rather than presence generators. Viewing involving, emotive content would be expected to enhance feelings of engagement and perhaps provoke natural feelings akin to 'real' responses to depicted content. Hence, emotional responses could determine the non-spatial components of subjective presence. This proposal could explain why variations in presence are sometimes found across contents presented under conditions of low immersion.

In contrast the spatial component of presence (Physical Space) appeared to act independently of subjective emotional quality and intensity in the experiments presented in this thesis. In particular, enhanced immersion consistently affected subjective arousal but did not always enhance the sense of space or 'being there' (i.e. in Experiment 5). However, because there was no effect of immersion on the sense of space in Experiment 5 the results in this thesis cannot definitively propose that there is no relationship between spatial presence and emotion. This is because earlier experiments in the thesis exposed users to neutral content only, while Experiment 5 used both emotive and neutral content. It therefore remains a question for further research whether enhancements in spatial presence across a range of contents would reveal a relationship between presence and emotion. The author believes that there may be moderating role of spatial presence on emotional responses given that theory and research has suggested inter-relationships between the three components of presence.

8.5 Applications of Presence and Emotion Research

The speculative scaffolding above is presented as the conclusion to this thesis and is intended to show how research in this thesis and in the wider presence field has led to a personal development in the consideration of research questions tackling presence and emotion. The application of this analytical development is the better identification of research routes in future research in this field (as presented in Table 8.3). However, there are more concrete examples of how presence-emotion research can be applied in the 'real-world'. It is also important to acknowledge the application of emotion research in more diverse fields than presence research.

Since the outset of this thesis 'emotions' have risen higher on the agenda in design, human factors and the research and development of new media. For example, the Design and Emotion Society (http://www.designandemotion.org/) was formed in order to promote an understanding of emotions in the design process. Norman (2004), in "Emotional Design: Why we Love (or Hate) Everyday Things", proposed that emotions have been an overlooked area in human factors research and should be a core consideration in the design process. In the field of 'affective-computing' ('computing that relates to, arises from, or deliberately influences emotion', Picard, 1997, pg. 3), Picard (2002) proposed that interactive system developers should address a person's emotional needs, in addition to the needs for transparency and efficiency in a system. The aim of including emotional considerations in the design process is, according to Picard (2002), to ease people's interactions with systems and to promote opportunities for emotional skill learning (for both the human and the computer).

The Picard (2002) paper was part of collection of papers presented in a special issue of the journal Interacting with Computers (Vol. 14) to which the present author responded as part of a collection of commentaries (Dillon, Freeman & Keogh, 2004 in Interacting with Computers, Vol. 16). The commentary proposed that presence research is relevant to affective-computing and design for emotional needs, particularly when considering the proliferation of immersive and interactive technologies in the home and in clinical settings.

Examples in the home where presence and emotion research may be relevant in design include methods of navigating digital and interactive television, methods of collecting feedback through interactive television, the delivery of immersive experiences via television and computer games, the use of video conferencing and the development of virtual human interfaces (e.g., Freeman et al., 2003). There is also an established body of research into the use of advanced technologies in clinical settings such as virtual environments for the treatment of phobias (e.g., North et al., 1996). Presence and emotion research has been applied in the development of new therapeutic applications, such as in the EMMA project, and similar research continues to be funded under the European Commission's second Presence Initiative.

8.6 Conclusion

The aims of this thesis were theoretical, methodological and applied. The overarching theoretical aim of the thesis was to investigate the relationship between presence and emotion. The method chosen to investigate the relationship between presence and emotion was to examine the impact of variations in determinants of presence on measures of subjective emotion and physiological arousal. The investigation served as an exploratory stage in the development of novel, emotion-based, corroborative measures of presence.

This thesis has fulfilled its aims by providing evidence for a relationship between presence and emotion, by successfully implementing a methodology for the investigation of presence and emotion which improved on previous research in the field and by identifying factors important for the development of emotion-based corroborative measures of presence.

Furthermore, the thesis can claim some innovation in the field of presence research in a number of ways. The thesis has highlighted the importance of Media Content factors as a determinant of presence in addition to the much researched Media Form factors. In particular, the evidence presented in the thesis indicates that emotional processes are a Media Content characteristic that could potentially influence subjective presence. Hence, it can be proposed that emotional processes are a psychological variable that may be considered in theories and models of presence, in addition to perception, attention, mental models and schemata. Finally, the results of the experiments in this thesis suggested to the author a way of analysing and further specifying the presence and emotion problem space. It is hoped that the research presented in this thesis will contribute to the burgeoning body of literature concerning presence and emotion and as such inform primary research in the field and contribute to the realisation of new technological applications.

Appendix A

A1 Experiment 1: Physiological recording equipment

SURROUND-OFF Conditions Polygraph

Physiological recordings were taken using a custom-made polygraph (software and hardware designed by Rob Davis, Department of Psychology, Goldsmiths College). This comprised of data acquisition and amplification modules that were attached to participants via leads and electrodes and which contained an analogue to digital converter for transmission of collected biopotential signals to a PC. Custom-made PC software was used to collect, store and display the physiological signals. This was integrated with software controlling video output so that videotape time-codes and physiological recordings were synchronised and stored simultaneously.

For the acquisition of Skin Resistance (SR) data, Biotrace disposable AG/AgCl electrodes with snap connectors were attached to the distal phalanges (fingertips) of the first and third fingers of the left hand, after the skin had been cleaned with de-ionised water. The electrodes were then connected, via leads, to the data acquisition amplifier, which also supplied a constant current of 14 micrcoamps to the skin. The amplifier was calibrated via the PC. Voltage change across the skin was measured then converted into kilohms (kΩ). SR could be measured and was accurately calibrated within the range of 0-300kΩ. SR levels were not expected to be outside of this range.

Cardiovascular information was acquired using ECG lead position RI (the inner-wrists and inner-right ankle). Biotrace disposable AG/AgCl electrodes with snap connectors were attached to the given areas of skin (pre-cleaned with de-ionised water) and then connected to the data acquisition amplifier via leads. The measured output was voltage change across the skin, between the electrodes, associated with electrical activity in the heart.

The data acquisition amplifier was placed inside the P*i*T next to the testing seat. This allowed the recording leads to be kept as short as possible and to be isolated from electrical equipment, thus reducing noise in the data. In addition, the amplifier converted the data to a digital signal using 12-bit resolution thus further reducing noise, in the data due to transmission of the signal between the amplifier and PC. Both SR and ECG recordings were sampled at 100Hz.

SURROUND-ON Conditions Polygraph

Lafayette Instruments supplied a Datalab 2000™ polygraph for physiological recordings. This included Biopotential Amplifiers (Model 70702) for connection to specific recording leads, modules and electrodes and which supplied power, amplification and isolation for SR and ECG recordings. The amplifiers sent collected analogue biopotential signals to the General Purpose Interface Bed (GPI, Model 70701). The GPI connected the amplifiers to a PC, which used a National Instruments Data Acquisition Card (NI-DAQ card: Model 70760), NI-DAQ software and BioBench software to collect, store and display physiological signals. Data acquisition was controlled via the BioBench software, which was manually synched with software controlling video output.

A Galvanic Skin Resistance Preamplifier (GSR: Model 70708) was used to monitor SR changes. Stainless steel electrodes were attached to the distal phalanges of the first and third fingers of the left hand after both the skin and electrodes had been cleaned with de-ionised water. A constant current of 6 micrcoamps was applied to the skin from a preamplifier built into the GSR cable between the electrodes and a DC coupled biopotential amplifier. Both the amplifier and preamplifier were calibrated simultaneously using BioBench. Voltage change across the skin was measured then converted into kΩ. SR could be measured within the range of 0-1040kΩ and could be accurately calibrated for 10–1000kΩ. SR levels were not expected to be outside of this range.

Cardiovascular information was acquired using ECG lead position RI. Vermed disposable foam electrodes with snap connectors were attached to the given areas of skin, (pre-cleaned with de-ionised water), and then connected to an ECG Electrode Lead Selector Module (Model 70736) using a Safety 5-lead Wiring Harness (Model 76656SC-5). The selector module was connected to a biopotential amplifier, which was calibrated using BioBench. The measured output was voltage change across the skin, between the electrodes, associated with electrical activity in the heart.

The PC, GPI and amplifiers were placed in close proximity to the P*i*T. The recording leads and pre-amplifier were isolated as well as possible from electrical equipment and mains connections and fed into the P*i*T through one of the rear air vents. This allowed the leads to be easily connected to a participant while avoiding interference in the signal. Both SR and ECG recording were collected at 200Hz, which allowed BioBench to filter out mains interference online.

A2 Experiment 1: Physiological data management methods

Given the differences in sampling rate between the SURROUND-OFF and SURROUND-ON conditions, the screen-on data was subsampled so that every other sample was retained. This meant that 100 samples-per-second were retained in the data for all conditions. This was intended to ensure similar rates of resolution for estimates of SCLs and HR across conditions and was high enough for accurate resolution of estimates of HR (Bernston et al., 1997).

For ease, intuitiveness and reliability of analysis each individual's SR data was converted to SC prior to averaging (Andreassi, 1989; Fowles et al., 1981; Venables & Christie, 1980). Because the range of SR recording was not balanced across the Screen conditions a within subjects range correction transformation was applied to the SC data. Each individual's SC data for each individual presentation was standardised across the entire recording period ((sample value – standard deviation)/mean). This method of range correction is similar to that recommended by Ben-Shakar (1986, 1987) for the standardisation of SC responses.

HR information was extracted from the ECG data using a method proposed to be adequate for estimating sustained changes in HR (Bernston et al., 1997; Jennings et al., 1981). QRS peaks, and the time at which they occurred, were filtered out of the raw ECG voltage data using a simple maxima-based peak finding algorithm. The first time and voltage samples on the peak were then filtered from the resulting series using a minimum time-difference based algorithm, so that one sample per peak was retained. This produced a beat-by-beat series from which interbeat-intervals (IBIs) were calculated. The ECG series were visually inspected for artefacts when the IBI series indicated recorded beats of less than the equivalent of 50bpm and more than 100bpm (using guidance notes and diagrams for the detection of noise in ECG series, Mulder 1992). The IBI series was manually corrected when the ECG series indicated an undetected or spurious QRS peak. IBI data was deleted when the ECG was unreadable (less than five-percent of the entire data set or any individual data set). For further analyses mean IBIs were converted to mean bpm.

SC and ECG recordings were taken for 100-secs before (pre-viewing), 100-secs during (viewing), and 100-secs after (post-viewing) each presentation. To determine the overall effects of presentation on SC and HR, the last 60-secs of the pre-viewing period was used as the resting baseline period. Individual mean HR and SC values for the baseline period were subtracted from the mean HR and SC values for the 100sec viewing period. This method of data management has been used widely to investigate the emotional impact of film stimuli (Fredrickson & Levenson, 1998; Gross, 1998; Gross, Fredrickson & Levenson, 1994). Such baseline-to-stimulus difference scores have been proposed as one of the most appropriate psychophysiological indexes for use with parametric statistics (Jennings & Stine, 2000) and the comparison of difference scores between different types of stimuli has been proposed as the appropriate means of assessing emotion-related physiological responses (Davidson & Irwin, 1999).

Estimated SC levels can be affected by SC reactivity, estimates of which may in turn be affected by factors such as electrode size and contact and sensitivity of a polygraph (Venables & Christie, 1980). As the applied range correction cannot account for potential reactivity differences between the polygraphs used in this experiment a check for potential time-varying changes in SC was also used. The last 20-secs of the pre-viewing period were used as the pre- stimulus-onset baseline period. Individual mean SC values for the baseline period were subtracted from the means of five consecutive 20-sec segments occurring during the viewing period.

A3 Experiment 1: Additional materials

General Instructions

You are going to take part in an experiment that aims to look at the physical and psychological effects of different television systems. I am going to show you some video clips in the PIT and while you are watching the clips we will measure your Heart Rate and galvanic skin response. The video clips will be of *rally driving track/a boat ride*. There will also be a few questionnaires to fill out at various points during the procedure. All the equipment and measuring techniques are safe and you are free to terminate the procedure at any time. If you suffer from epilepsy, are taking medication that affects your Heart Rate, have impaired eyesight or believe that watching these video clips could affect you adversely in any other way, you must tell me now. You are free to stop this experiment at any time you wish.

Psychophysiology Instructions

While you are watching each video clips I will be recording your Heart Rate and skin conductance. In order to do this I will need to attach various electrodes to your body

To measure your Heart Rate I'm going to use electrocardiogram recordings or ECG. The ECG records electrical impulses from your heart. I'll need to attach electrodes to your wrists and to your right ankle. Please could you roll up your sleeves and your right sock. I'm going to wash these areas with a bit of water to make sure there are no substances on your skin that could affect the readings. The white pads are the electrodes please do not touch them until the procedure is finished. I'll now attach the electrodes to your wrist and ankles and they will send information about your Heart Rate to the computer.

I also need to wash the first and third fingers on your left hand and attach these leads to your fingertips. These will measure your skin conductance. Skin conductance is related to the amount you sweat – the more you sweat, the easier it is for an electrical current to pass over your skin and the more electrical activity the computer will record. A very small current is passed between the two electrodes. This is completely harmless.

Procedural Instructions

After I close the door to the Pit, please look straight ahead at the screen. You will see a blank screen for 100 seconds while I take a baseline recording of your Heart Rate and skin conductance. A video-clip will then play for 100 seconds after which you will see a blank screen for 100 seconds. It is very important that you do not move while physiological recordings take place – that means once the door has been closed until I open it again. It is also important that you look straight ahead at the screen at all times with your eyes open. You can stop the experiment at any time by pressing the red button to your left.

Do you have any questions?"

De-briefing

Thank you for taking part in this study. The aim of the study is to investigate ways of assessing new media. We are interested in a viewer's sense of 'Presence'. Presence is the viewer's sensation of 'being there' in a displayed environment, such as the video clips you have just seen. We showed you two types of clip – one was in 3D and one was in 2D. You may have felt more present when the presentation was in 3D. One of the questionnaires you filled out after each clip is a new questionnaire designed to assess your sense of presence. One problem with questionnaires like this is that they rely on subjective reports after an event. I am investigating objective ways of measuring presence during an event, such as television viewing, using Heart Rate and skin conductance. With the results collected in this experiment I will be comparing the way you rated your experience using a questionnaire with the continuous measurements of Heart Rate and skin conductance.

Do you have any questions about the experiment?

Appendix B

B1 Experiment 3: Profile Of Mood States-Short Form (POMS-SF)

(Size of text reduced for thesis)

Below are six boxes containing words that describe feelings and moods people have. Each box contains two words that describe opposite feelings and moods. Please indicate **HOW YOU FEEL RIGHT NOW AT THIS MOMENT** by putting a cross on the line between each pair of words. If you feel more like one word than the other put your mark towards that word. The more you feel like that word the further towards that word you should put your mark.

For example if you feel slightly hungry right now, but not as hungry as you could feel, you might put a cross on the line in the box below as shown.

Hungry ______________________________ Full

Please complete the following six boxes

1.
Composed ______________________________ Anxious

2.
Agreeable ______________________________ Hostile

3.
Elated ______________________________ Depressed

4.
Confident ______________________________ Unsure

5.
Energetic ______________________________ Tired

6.
Clearheaded ______________________________ Confused

B2 Experiment 3 and 5: Elicited Emotion Scales (EES)

Next to every emotion word below, please circle the number on the scale that best describes the *greatest amount* of that emotion you felt at anytime <u>during the video clip you have just seen</u>. On these scales 0 means you did *not feel even the slightest bit* of the emotion and 8 is the *most you have ever felt in your life.*

Amusement	0 1 2 3 4 5 6 7 8	Fear	0 1 2 3 4 5 6 7 8
Anger	0 1 2 3 4 5 6 7 8	Happiness	0 1 2 3 4 5 6 7 8
Arousal	0 1 2 3 4 5 6 7 8	Interest	0 1 2 3 4 5 6 7 8
Confusion	0 1 2 3 4 5 6 7 8	Pain	0 1 2 3 4 5 6 7 8
Contentment	0 1 2 3 4 5 6 7 8	Relief	0 1 2 3 4 5 6 7 8
Contempt	0 1 2 3 4 5 6 7 8	Sadness	0 1 2 3 4 5 6 7 8
Disgust	0 1 2 3 4 5 6 7 8	Surprise	0 1 2 3 4 5 6 7 8
Embarrassment	0 1 2 3 4 5 6 7 8	Tension	0 1 2 3 4 5 6 7 8

THANKYOU

B3 Experiment 3 and 5: Visual Image Evaluation Scales (VIES)

Please rate the visuals of the presentation that **you have just experienced** (*the image you saw on the screen*) on the scales below by putting a mark through each of the lines between the negative and positive poles.

Image Quality	*Image Adequacy*	*Brightness*
+	+	+
-	-	-

THANKYOU

B4 Experiment 3: Instructions and Consent Form

Thank you for agreeing to take part in this study, investigating the physiological effects of television systems. You will watch four simple videos, which will consist of a rally-car sequence and a river-boat sequence. Before each video you will fill out a simple questionnaire. While you watch each video your Heart Rate and galvanic skin responses will be measured.

Your Heart Rate will be measured using an electrocardiogram monitor. This measures electrical activity across your skin associated with electrical activity in the heart. Electrodes will be placed on your lower ribs and collar-bone in order to do this. Galvanic skin response is a measure of electrical activity across your skin associated with activity in your sweat glands. Electrodes will be placed on your fingertips to measure this. Both these procedures are completely harmless.

After watching each video there will be four short questionnaires to fill out. These questionnaires should be completed with reference to the video **you have just seen**, not any of the other videos you have seen.

Please try not to move while you are watching each video. Each viewing will last only 300 seconds and you will have a break between each video. Please also look straight ahead at the screen for the duration of each video.

If you have any questions, please do not hesitate to ask the experimenter.

CONSENT FORM

Please sign below to confirm the following:

1. I do not have any problems with my eyesight that have not been corrected (e.g., by glasses or contact lenses).
2. I have not previously taken part in any study in the ITC lab.
3. I do not have a medical condition that affects my heart.
4. I am not taking any medication that affects my heart (e.g., beta-blockers; anti-epileptics; anti-depressants).
5. I agree to participate in the experiment described above.
6. I consent to my responses being used for analysis by the experimenter and understand that my responses will be treated confidentially.

NAME **(block capitals):**

____

SIGNED:____________________________________

DATE:________________

Age: ________ **Gender** M / F **E-mail/Tel no.:**

Appendix C

C1 Experiment 4: Video clip presentation orders

Order 1	*Order2*	*Order 3*	*Order 4*
STREET	FOUR	SEA	BOYS
LA	HUMAN	BLUE	PINK
WAVES	PRETTY	SHINE	COLOUR
CRY	HOUSE	ONE	TRAIN
BAMBI	TRULY	ROBIN	SAM
RALLY	TOE	CHAMP	CAP
HARRY	BEACH	BOAT	LAMBS
CHIEN	BODY	HALL	SHAPES
SHAPES	HALL	BODY	CHIEN
LAMBS	BOAT	BEACH	HARRY
CAP	CHAMP	TOE	RALLY
SAM	ROBIN	TRULY	BAMBI
TRAIN	ONE	HOUSE	CRY
COLOUR	SHINE	PRETTY	WAVES
PINK	BLUE	HUMAN	LA
BOYS	SEA	FOUR	STREET
SEA	BOYS	STREET	FOUR
BLUE	PINK	LA	HUMAN
SHINE	COLOUR	WAVES	PRETTY
ONE	TRAIN	CRY	HOUSE
ROBIN	SAM	BAMBI	TRULY
CHAMP	CAP	RALLY	TOE
BOAT	LAMBS	HARRY	BEACH
HALL	SHAPES	CHIEN	BODY
BODY	CHIEN	SHAPES	HALL
BEACH	HARRY	LAMBS	BOAT
TOE	RALLY	CAP	CHAMP
TRULY	BAMBI	SAM	ROBIN
HOUSE	CRY	TRAIN	ONE
PRETTY	WAVES	COLOUR	SHINE
HUMAN	LA	PINK	BLUE
FOUR	STREET	BOYS	SEA

C2 Experiment 4: Questionnaire measures[32]

(Size reduced for thesis presentation)

A) Circle the number on the scale next to every word that best describes the *greatest amount* of that emotion you felt at anytime <u>during the video clip you have just seen</u>. On these scales 0 means you did *not feel even the slightest bit* of the emotion and 8 is the *most you have ever felt in your life.*

Amusement	0 1 2 3 4 5 6 7 8	Fear	0 1 2 3 4 5 6 7 8
Anger	0 1 2 3 4 5 6 7 8	Happiness	0 1 2 3 4 5 6 7 8
Arousal	0 1 2 3 4 5 6 7 8	Interest	0 1 2 3 4 5 6 7 8
Confusion	0 1 2 3 4 5 6 7 8	Pain	0 1 2 3 4 5 6 7 8
Contentment	0 1 2 3 4 5 6 7 8	Relief	0 1 2 3 4 5 6 7 8
Contempt	0 1 2 3 4 5 6 7 8	Sadness	0 1 2 3 4 5 6 7 8
Disgust	0 1 2 3 4 5 6 7 8	Surprise	0 1 2 3 4 5 6 7 8
Embarrassment	0 1 2 3 4 5 6 7 8	Tension	0 1 2 3 4 5 6 7 8

B) Below are six questions about the experience that you have just had. The term 'displayed environment refers to the place depicted by the media system that you have just experienced. Please circle just ONE number for each question on the

(i) Please rate your sense of *being there* in the displayed environment on the following scale from 1 to 7.
In the displayed environment I had a sense of 'being there'

1 2 3 4 5 6 7

not at all ... very much

(ii) To what extent were there times during the experience when the displayed environment became the "reality" for you, and you almost forgot about the "real world" outside? Please answer on the following 1 to 7 scale.
There were times during the experience when the displayed environment became more real or present for me compared to the 'real world' –

1 2 3 4 5 6 7

not at all ... almost all the time

(iii) When you think back about your experience, do you think of the displayed environment more as *something that you saw*, or more as *somewhere that you visited?* Please answer on the following 1 to 7 scale.
The displayed environment seems to me to be more like...

1 2 3 4 5 6 7

something that I saw ... somewhere that I visited

[32] Visual Image Evaluation Scales were also used in Experiment 3 and can be found in Appendix B3.

(iv)	I identified with the concerns of one or more of the characters in the displayed environment.... **1 2 3 4 5 6 7** not at all very much
(v)	I empathised with the feelings of one or more of the characters in the displayed environment........ **1 2 3 4 5 6 7** not at all very much
C)	**Have you seen this video clip before (apart from today)?** ***(Please circle one of the responses below)*** ***Never*** ***Once*** ***More than once***

C3 Experiment 4: Instructions and consent form

Thank you for agreeing to participate in this study. The aim of this study is to obtain ratings for a set of video clips that will be used in future research.

You will be watching 32 short video clips. After each clip you will be required to complete a short questionnaire. The questionnaires are contained in this booklet. There are 32 questionnaires in the booklet, one per page - for each video clip. Please make sure that you complete sections A, B and C for each video clip. Answer the questions as quickly as possible, your first response is usually the best response.

The video clips that you will see have either been used in previous psychological research or are feature films widely available on VHS. You may find some, of the clips distressing. Please feel free to look away during these clips. You are also free to discontinue the experiment should you prefer to. Ask the experimenter if you have any questions now or during the experiment. However, please try not to disturb other participants while video clips are playing.

Please indicate that you consent to participate in this experiment by signing below.

....

I consent to participate in the experiment described above and to my responses being used for analysis by the experimenter. I understand that my responses will treated confidentially.

Name:

Signed:

Date

Age: **Gender:** **m / f**

C4 Experiment 4: Additional Analyses

Results: Part 1a Within Clips Analysis

Summary of Amusement Clips

HARRY: Amusement ratings were significantly higher than anger ($t = 13.26$, $df = 35$, $p < .001$), contentment ($t = 8.30$, $df = 35$, $p < .001$), disgust ($t = 12.35$, $df = 35$, $p < .001$, fear ($t = 13.27$, $df = 35$, $p < .001$), sadness ($t = 12.07$, $df = 35$, $p < .001$) and surprise ($t = 9.59$, $df = 35$, $p < .001$).

ROBIN: Amusement ratings were significantly higher than anger ($t = 13.30$, $df = 35$, $p < .001$), contentment ($t = 8.80$, $df = 35$, $p < .001$), disgust ($t = 13.25$, $df = 35$, $p < .001$), fear ($t = 14.10$, $df = 35$, $p < .001$), sadness ($t = 13.76$, $df = 35$, $p < .001$) and surprise ($t = 10.94$, $df = 35$, $p < .001$).

SAM: Amusement ratings were significantly higher than anger ($t = 10.69$, $df = 35$, $p < .001$), contentment ($t = 9.47$, $df = 35$, $p < .001$), disgust ($t = 13.47$, $df = 35$, $p < .001$), fear ($t = 14.21$, $df = 35$, $p < .001$), sadness ($t = 9.09$, $df = 35$, $p < .001$) and surprise ($t = 14.43$, $df = 35$, $p < .001$).

PRETTY: Amusement ratings were significantly higher than anger ($t = 10.03$, $df = 35$, $p < .001$), contentment ($t = 6.04$, $df = 35$, $p < .001$), disgust ($t = 11.55$, $df = 35$, $p < .001$), fear ($t = 12.84$, $df = 35$, $p < .001$), sadness ($t = 11.17$, $df = 35$, $p < .001$) and surprise ($t = 11.45$, $df = 35$, $p < .001$).

Summary of Anger Clips

CRY: Anger ratings were significantly higher than amusement ($t = 11.93$, $df = 35$, $p < .001$), contentment ($t = 12.64$, $df = 35$, $p < .001$), fear ($t = 5.87$, $df = 35$, $p < .001$) and surprise ($t = 6.48$, $df = 35$, $p < .001$). Anger ratings were not significantly different to disgust and sadness ratings.

BODY: Anger ratings were significantly higher than amusement ($t = 6.65$, $df = 35$, $p < .001$), contentment ($t = 8.51$, $df = 35$, $p < .001$), disgust ($t = 2.25$, $df = 35$, $p < .05$), fear ($t = 6.79$, $df = 35$, $p < .001$), and surprise ($t = 6.99$, $df = 35$, $p < .001$). Anger ratings were not significantly different to sadness ratings.

BOYS: Anger ratings were significantly higher than amusement ($t = 5.96$, $df = 35$, $p < .001$), contentment ($t = 6.58$, $df = 35$, $p < .001$), fear ($t = 4.86$, $df = 35$, $p < .001$), and surprise ($t = 4.68$, $df = 35$, $p < .001$). Anger ratings were not significantly different to disgust and sadness ratings.

ONE: Anger ratings were significantly higher than amusement ($t = 3.71$, $df = 35$, $p < .01$), contentment ($t = 6.22$, $df = 35$, $p < .001$), disgust ($t = 2.67$, $df = 35$, $p < .05$), fear ($t = 5.90$, $df = 35$, $p < .001$) and surprise ($t = 6.05$, $df = 35$, $p < .001$). Anger ratings were not significantly different to sadness ratings.

Summary of Contentment Clips

WAVES: Contentment ratings were significantly higher than amusement ($t = 4.67$, $df = 35$, $p < .001$), anger ($t = 5.75$, $df = 35$, $p < .001$), disgust ($t = 5.75$, $df = 35$, $p < .001$), fear ($t = 5.50$, $df = 35$, $p < .001$), sadness ($t = 5.48$, $df = 35$, $p < .001$) and surprise ($t = 5.60$, $df = 35$, $p < .001$).

BEACH: Contentment ratings were significantly higher than anger ($t = 3.01$, $df = 35$, $p < .01$), disgust ($t = 3.10$, $df = 35$, $p < .01$) and fear ($t = 3.01$, $df = 35$, $p < .01$). Contentment ratings were not significantly different to amusement, sadness and surprise ratings.

BLUE: Contentment ratings were significantly higher than anger ($t = 6.82$, $df = 35$, $p < .001$), disgust ($t = 5.75$, $df = 35$, $p < .001$), fear ($t = 5.50$, $df = 35$, $p < .001$), sadness ($t = 5.48$, $df = 35$, $p < .001$) and surprise ($t = 5.60$, $df = 35$, $p < .001$). Contentment ratings were not significantly different to amusement ratings.

BOAT: Contentment ratings were significantly higher than amusement ($t = 4.01$, $df = 35$, $p < .05$), anger ($t = 4.12$, $df = 35$, $p < .001$), disgust ($t = 3.97$, $df = 35$, $p < .001$), fear ($t = 4.01$, $df = 35$, $p < .001$), sadness ($t = 3.06$, $df = 35$, $p < .01$) and surprise ($t = 3.73$, $df = 35$, $p < .01$).

Summary of Disgust Clips

PINK: Disgust ratings were significantly higher than amusement ($t = 5.01$, $df = 35$, $p < .001$), anger ($t = 9.82$, $df = 35$, $p < .001$), contentment ($t = 11.44$, $df = 35$, $p < .001$), fear ($t = 14.27$, $df = 35$, $p < .001$), sadness ($t = 14.35$, $df = 35$, $p < .001$) and surprise ($t = 4.06$, $df = 35$, $p < .001$).

TOE: Disgust ratings were significantly higher than amusement ($t = 5.14$, $df = 35$, $p < .001$), anger ($t = 7.54$, $df = 35$, $p < .001$), contentment ($t = 6.64$, $df = 35$, $p < .001$), fear ($t = 5.18$, $df = 35$, $p < .001$), sadness ($t = 6.94$, $df = 35$, $p < .001$) and surprise ($t = 5.56$, $df = 35$, $p < .001$).

CHIEN: Disgust ratings were significantly higher than amusement ($t = 6.06$, $df = 35$, $p < .001$), anger ($t = 9.51$, $df = 35$, $p < .001$), contentment ($t = 10.85$, $df = 35$, $p < .001$), fear (t = 9.00, df = 35, p < .001) and sadness (t = 10.10, df = 35, p < .001). Disgust ratings were not significantly different to surprise ratings.

TRAIN: Disgust ratings were significantly higher than amusement (t = 2.43, df = 35, p < .05), anger (t = 10.69, df = 35, p < .001), contentment (t = 8.10, df = 35, p < .001), fear (t = 9.98, df = 35, p < .001), sadness (t = 9.49, df = 35, p < .001) and surprise (t = 8.15, df = 35, p < .001).

Summary of Fear Clips

SHINE: Fear ratings were significantly higher than amusement (t = 6.60, df = 35, p < .001), anger (t = 9.24, df = 35, p < .001), contentment (t = 7.84, df = 35, p < .001), disgust (t = 9.07, df = 35, p < .001), sadness (t = 7.43, df = 35, p < .001) and surprise (t = 5.55, df = 35, p < .001).

LAMBS: Fear ratings were significantly higher than amusement (t = -3.91, df = 35, p < .001), anger (t = 6.63, df = 35, p < .001), contentment (t = 5.33, df = 35, p < .001), disgust (t = 3.00, df = 35, p < .01), sadness (t = 6.13, df = 35, p < .001) and surprise (t = 2.20, df = 35, p < .05).

HALL: Fear ratings were significantly higher than amusement (t = 5.62, df = 35, p < .001), anger (t = 7.49, df = 35, p < .001), contentment (t = 8.11, df = 35, p < .001), disgust (t = 7.13, df = 35, p < .001), sadness (t = 8.11, df = 35, p < .001) and surprise (t = 4.95, df = 35, p < .001).

RALLY: Fear ratings were significantly lower than amusement (t = 2.67, df = 35, p < .05) and contentment (t = 2.76, df = 35, p < .01). Fear ratings were not significantly different to anger, disgust, sadness and surprise.

Summary of Sadness Clips

CHAMP: Sadness ratings were significantly higher than amusement (t = 11.80, df = 35, p < .001), anger (t = 10.90, df = 35, p < .001), contentment (t = 13.57, df = 35, p < .001), disgust (t = 10.84, df = 35, p < .001), fear (t = 11.83, df = 35, p < .001) and surprise (t = 13.12, df = 35, p < .001).

BAMBI: Sadness ratings were significantly higher than amusement (t = 6.33, df = 35, p < .001), anger (t = 6.89, df = 35, p < .001), contentment (t = 7.51, df = 35, p < .001), disgust (t = 7.08, df = 35, p < .001), fear (t = 8.63, df = 35, p < .001) and surprise (t = 8.14, df = 35, p < .001).

FOUR: Sadness ratings were significantly higher than amusement (t = 8.95, df = 35, p < .001), anger (t = 8.38, df = 35, p < .001), contentment (t = 9.26, df = 35, p < .001), disgust (t = 8.21, df = 35, p < .001), fear (t = 10.63, df = 35, p < .001) and surprise (t = 10.63, df = 35, p < .001.

TRULY: Sadness ratings were significantly higher than amusement (t = 8.55, df = 35, p < .001), anger (t = 9.65, df = 35, p < .001), contentment (t = 9.03, df = 35, p < .001), disgust (t = 7.68, df = 35, p < .001), fear (t = 9.99, df = 35, p < .001) and surprise (t = 8.92, df = 35, p < .001)

Summary of Surprise Clips

CAP: Surprise ratings were significantly higher than amusement (t = 8.58, df = 35, p < .001), anger (t = 9.01, df = 35, p < .001), contentment (t = 10.65, df = 35, p < .001), disgust (t = 11.40, df = 35, p < .001), fear (t = 9.81, df = 35, p < .001) and sadness (t = 11.40, df = 35, p < .001).

SEA: Surprise ratings were significantly higher than amusement (t = 6.28, df = 35, p < .001), anger (t = 9.16, df = 35, p < .001), contentment (t = 6.76, df = 35, p < .001), disgust (t = 8.80, df = 35, p < .001), fear (t = 4.97, df = 35, p < .001) and sadness (t = 8.80, df = 35, p < .001).

LA: Surprise ratings were significantly higher than amusement (t = 9.90, df = 35, p < .001), anger (t = 10.08, df = 35, p < .001), contentment (t = 9.38, df = 35, p < .001), disgust (t = 9.57, df = 35, p < .001), fear (t = 11.87, df = 35, p < .001) and sadness (t = 10.23, df = 35, p < .001).

HUMAN: Surprise ratings were significantly higher than anger (t = 9.65, df = 35, p < .001), disgust (t = 7.68, df = 35, p < .001) and sadness (t = 8.92, df = 35, p < .001). Surprise ratings were not significantly different to amusement, contentment and fear ratings.

Results: Part 1b – Classification of the BOAT and RALLY Clips

Classification of the BOAT Clip

The BOAT clip was significantly lower in contentment than the correctly classified Contentment clip (WAVES t = 2.94, df = 35, p < .01) and the excluded Contentment clip which was shown to elicit generally positive emotions (BLUE - t = 4.23, df = 35, p < .001). In addition, the BOAT clip was significantly higher in contentment than three of the Neutral clips, (SHAPE - t = 3.04, df = 35, p < .01; COLOUR - t = 2.97, df = 35, p < .01 and HOUSE - t = 2.94, df = 35, p < .01), and not significantly different to two Neutral clips (STREET and BEACH).

Classification of the RALLY Clip

A series of planned comparisons revealed that the RALLY clip received significantly lower ratings of amusement than all the correctly classified Amusement clips (HARRY, ROBIN - t = 12.04, df = 35, p < .001, SAM - t = 12.56, df = 35, p < .001 and PRETTY t = 10.51, df = 35, p < .001). In addition, the RALLY clip was significantly higher in amusement than one Neutral clips (SHAPES - t = -.238, df = 35, p < .05) and not significantly different in amusement to all other Neutral clips (COLOURS, STREET, HOUSE and BEACH).

Results: Part 2 – Selection and Validation of Experimental Stimuli

Creating Category Data

A series of four–level, within groups ANOVAs were performed for each of the seven Emotion Terms, with the four Clips within each of the Categories serving as the within groups factor. The assumption of sphericity was violated for some tests and a Greenhouse-Geisser correction was applied in these cases (adjusted values are given where appropriate). Clips within each category were well balanced on all Emotion Terms (as evidenced by the absence of main effects of Clips) with the exception of contentment ratings within the Neutral category ($F(3,33) = 3.23$, $p<.05$, $\varepsilon = .82$), sadness, anger, fear ratings and surprise ratings within the Sadness category ($F(3,33) = 3.59$, $p<.05$; $F(3,33) = 4.41$, $p<.05$, $\varepsilon = .69$; $F(3,33) = 4.71$, $p<.05$, $\varepsilon = .67$; $F(3,33) = 3.36$, $p<.05$, $\varepsilon = .66$) and surprise ratings within the Amusement ($F(3,33) = 3.92$, $p<.05$) – see Table 7.2 for means (Chp. 7). A series of t-tests, with Bonferroni corrections were used to compare clips within each category on Emotion Terms for which main effects of Clip had been found. One significant comparison was found. Surprise ratings of PLAY were greater than surprise ratings of PRETTY (t = 3.48, df = 35, p = .001).

Validation of the Categories

A seven-level one-way within-groups ANOVA, with Emotion Term (amusement, anger, contentment, disgust, fear, sadness, and surprise) serving as the within-groups factor, was conducted for the Amusement and Sadness categories to investigate overall effects of Emotion Term. Significant main effects of Emotion Term were found for both categories: Amusement ($F(6,30) = 146.01$, $p<.001$, $\varepsilon = .53$) and Sadness ($F(6,30) = 87.93$, $p<.001$, $\varepsilon = .43$). T-tests were used to perform planned comparisons between ratings of target and non-target emotions for the Sadness and Amusement categories. The Amusement category had significantly higher ratings of amusement than all the other Emotion Terms: anger ($t = 18.49$, $df = 35$, $p < .001$), contentment ($t = 10.98$, $df = 35$, $p < .001$), disgust ($t = 18.08$, $df = 35$, $p < .001$), fear ($t = 19.92$, $df = 35$, $p < .001$), sadness ($t = 18.86$, $df = 35$, $p < .001$) and surprise ($t = 16.07$, $df = 35$, $p < .001$). In addition, the Sadness category had significantly higher ratings of sadness than all the other Emotion Terms: amusement ($t = 11.45$, $df = 35$, $p < .001$), anger ($t = 13.46$, $df = 35$, $p < .001$), contentment ($t = 11.84$, $df = 35$, $p < .001$), disgust ($t = 11.02$, $df = 35$, $p < .001$), fear ($t = 14.71$, $df = 35$, $p < .001$) and surprise ($t = 13.18$, $df = 35$, $p < .001$). This confirms that the Amusement and Sadness categories elicit their respective target emotions to a greater degree than all other emotions.

A series of three-level, one-way repeated-measures ANOVAs were used to compare ratings of the target emotions (amusement and sadness) between categories (Category: Amusement, Sadness and Neutral). Significant main effects of Category were observed for both target emotions: amusement ($F(1,35) = 149.47$, $p<.001$, $\varepsilon = .72$) and sadness ($F(1,35) = 159.74$, $p<.001$, $\varepsilon = .54$). T-tests were used to confirm that the Amusement category was rated significantly higher in amusement than the other categories: Sadness ($t = 15.96$, $df = 35$, $p < .001$) and Neutral ($t = 17.42$, $df = 35$, $p < .001$). T-tests were also used to confirm that the Sadness category was rated significantly higher in sadness than the other categories: Amusement ($t = 13.87$, $df = 35$, $p < .001$) and Neutral ($t = 12.03$, $df = 35$, $p < .001$). The Amusement and Neutral categories did not differ in terms of sadness ratings and the Sadness and Neutral categories did not differ in terms of amusement ratings.

Results: Part 3 – Associations between Reported Presence and Emotion Ratings

A series of three-level, one-way within-groups ANOVAs, with Category (Amusement, Sadness and Neutral) serving as the within-groups factor, were used to compare ratings of arousal, interest, identification, empathy, familiarity and the UCL-PQ presence ratings between categories. When the assumption of sphericity was violated a Greenhouse-Geisser correction was used (corrected values and epsilon are given). Significant main effects of Category were observed for all types of ratings with the exception of two of the presence ratings (Q1-'being' and Q3-'visit'): arousal ($F(2,34) = 14.55$, $p<.001$) interest ($F(2,34) = 47.66$, $p<.001$, $\varepsilon = .81$) identification ($F(2,34) =$

50.34, $p<.001$), empathy ($F(2,34) = 116.35$, $p<.001$) and familiarity ($F(2,34) = 21.59$, $p<.001$, $\varepsilon = .81$), UCL-PQ Q2-'real' ($F(2,34) = 6.71$, $p<.001$; $\varepsilon = .67$).

As series of comparisons using t-tests with a Bonferroni correction, revealed that, as expected, the Neutral category was significantly lower in arousal, interest, identification, empathy and familiarity than both the Amusement category ($t = 5.41$, $df = 35$, $p < .001$; $t = 8.09$, $df = 35$; $p < .001$;m $t = 4.57$, $df = 35$; $p < .001$; $t = 6.35$, $df = 35$, $p < .01$, $p < .001$; $t = 7.50$, $df = 35$, $p < .001$ and $t = 5.62$, $df = 35$, $p < .001$ respectively) and the Sadness category ($t = 4.57$, $df = 35$, $p < .001$; $t = 7.09$, $df = 35$, $p < .01$; $t = 10.17$, $df = 35$, $p < .001$; $t = 15.47$, $df = 35$, $p < .001$ and $t = 4.35$, $df = 35$, $p < .001$) respectively. The Sadness category was, significantly higher in identification ($t = 5.77$, $df = 35$, $p < .001$) and empathy ($t = 7.62$, $df = 35$, $p < .001$) than the Amusement category. In addition, both the Sadness and Amusement categories received higher ratings of presence on one UCL-PQ item (Q2-'real') than the Neutral Category (Amusement - $t = 3.69$, $df = 35$, $p = .06$; Sadness - $t = 10.23$, $df = 35$, $p < .01$). Finally the Sadness category received higher ratings on Q2-'real' than the Amusement category ($t = 5.88$, $df = 35$, $p < .05$).

T-tests also revealed that the Amusement and Sadness categories did not differ in terms of arousal, interest, and familiarity and two of the UCL-PQ presence questions and were therefore well balanced on these variables.

Appendix D

D1 Experiment 5: Presentation orders and counterbalancing

Twenty-four participants viewed both 21-degree (SMALL) and 42-degree (LARGE) visual angle presentations of 12 video-clips in two sittings respectively. Half the participants viewed the SMALL presentations in the first sitting and the LARGE presentations in the second sitting and half viewed the LARGE presentations followed by the SMALL presentations. Participants completed three types of questionnaires after each video clip (VIES, EES-SF and Presence questionnaires). Half the participants completed the VIES first (Order 1) and half completed the VIES last (Order 2). The order of the Presence and EES-SF questionnaires was also counterbalanced, with half completing the Presence questions before the EES-SF (Order 1) and half completing the Presence questions after the EES-SF (Order 2). Three video-clip presentations orders were used (see table below):

Order 1	Order 2	Order 3
RALLY	STREET	HOUSE
ROBIN	FOUR	BAMBI
CHAMP	SAM	BOAT
HARRY	RALLY	PRETTY
HOUSE	ROBIN	TRULY
PRETTY	BAMBI	SAM
TRULY	HARRY	STREET
BOAT	CHAMP	FOUR
BAMBI	HOUSE	HARRY
SAM	TRULY	CHAMP
FOUR	PRETTY	ROBIN
STREET	BOAT	RALLY

The counterbalancing of Angle, questionnaire completion and presentation orders is shown in the table on the next page:

Participant	Angle Week 1	Video Order Week 1	Video Order Week 2	VIES Order	Presence /EES-SF Order
1	Small	1	2	1	1
2	Small	2	1	1	1
3	Small	1	3	1	1
4	Small	3	1	1	2
5	Small	2	3	1	2
6	Small	3	2	1	2
7	Small	1	2	2	1
8	Small	2	1	2	1
9	Small	1	3	2	1
10	Small	3	1	2	2
11	Small	2	3	2	2
12	Small	3	2	2	2
13	Large	1	2	1	1
14	Large	2	1	1	1
15	Large	1	3	1	1
16	Large	3	1	1	2
17	Large	2	3	1	2
18	Large	3	2	1	2
19	Large	1	2	2	1
20	Large	2	1	2	1
21	Large	1	3	2	1
22	Large	3	1	2	2
23	Large	2	3	2	2
24	Large	3	2	2	2

D2 Experiment 5: Development of an Engagement Short-Form

Items on the ITC-SOPI 'Engagement' scale were examined for their suitability for inclusion on a three-item short form of the 'Engagement' scale (Engagement-SF). Items that referred to emotional responses were rejected. This ensured that the remaining items did not address constructs appearing elsewhere in the self-report data and were not biased towards any particular film category. The three items with the highest loadings onto the ITC-SOPI 'Engagement' factor (Lessiter & Freeman, 2000a) were selected from the remaining items. Item B2 also loaded onto the ITC-SOPI Physical Space factor. The items and their factor loadings on all four scales of the ITC-SOPI are shown in the table below.

	ITC-SOPI Factor Loadings			
Engagement Item	**Physical Space**	**Engagement**	**Naturalness**	**Negative Effects**
B1: I felt myself being drawn in	.14	**.63**	.24	.00
B2: I felt involved (in the displayed environment)	**.31**	**.58**	.29	.12
B3: I lost track of time	.13	**.52**	.27	-.08

The items above were later revised during the development of short ITC-SOPI scales for OmniPres, a European Commission Future and Emerging Technologies project (2002-5). An additional criterion dictated that there should be no cross-loadings for items appearing on short versions of the ITC-SOPI scales. Thus, the following items were submitted to the OmniPres project.

	ITC-SOPI Factor Loadings			
Engagement Item	**Physical Space**	**Engagement**	**Naturalness**	**Negative Effects**
B1: I felt myself being drawn in	.14	**.63**	.24	.00
B3: I lost track of time	.13	**.52**	.27	-.08
B26: I paid more attention to the displayed environment than I did to my own thoughts (e.g., personal preoccupations, daydreams etc.)	.06	**.49**	.19	-.11

D3 Experiment 5: Questionnaire measures[33]

Instructions:

We are interested in finding out what you feel about the experience you have just had in the 'DISPLAYED ENVIRONMENT'. We use the term 'displayed environment' here, and throughout this questionnaire, to refer to the film clips you will encounter. The displayed environment and its content (including the story, scenes or events, whatever you could see, hear, or sense happening within the displayed environment and representations of people, animals, or cartoons) are different from the 'REAL WORLD': the world you live in from day-to-day. Some questions refer to feelings that you may experience during your experience of a displayed environment. Please note that that the term 'Arousal' is a non-specific word: high arousal refers to being alert/tense/excited/ready for action and low arousal refers to being tired/calm/bored/inactive. Please refer back to this page if you are unsure about the meaning of any question.

There are three parts to each questionnaire in the booklet, parts A, B and C[34]. Fill out one questionnaire after each film clip that you see. Please answer all the questions in all three sections. Do not spend too much time on any one question. Your first response is usually the best. For each question, choose the answer CLOSEST to your own.

Please remember that there are no right or wrong answers – we are simply interested in YOUR thoughts and feelings about the displayed environment.

(The text size of the questionnaires has been reduced for presentation in the thesis).

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[33] The Visual Image Evaluation Scales (VIES) were also administered in Experiment 4 and can be found in Appendix B.

[34] Counterbalancing details can be found in Section 1 of this Appendix.

A) **Below are three questions about the experience that you have just had. Please circle just ONE number for each question.**

(1) Please rate your sense of *being there* in the displayed environment on the following scale from 1 to 7: *In the displayed environment I had a sense of 'being there'*

1 2 3 4 5 6 7

not at all **very much**

(2) To what extent were there times during the experience when the displayed environment became the "reality" for you, and you almost forgot about the "real world" outside? *There were times during the experience when the displayed environment became more real or present for me compared to the 'real world'* –

1 2 3 4 5 6 7

not at all **almost all the time**

(3) When you think back about your experience, do you think of the displayed environment more as *something that you saw,* or more as *somewhere that you visited?* Please answer on the following 1 to 7 scale*: The displayed environment seems to me to be more like...*

1 2 3 4 5 6 7

something that I saw **somewhere that I visited**

B) Please indicate HOW MUCH YOU AGREE OR DISAGREE with each of the following statements by circling just ONE of the numbers using the 5-point scale below.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	2	3	4	5

DURING MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT...

1. I felt myself being 'drawn in'.	1	2	3	4	5
2. I felt involved (in the displayed environment)	1	2	3	4	5
3. I lost track of time	1	2	3	4	5
4. I experienced sensations such as dizziness, disorientation, nausea, a headache, eyestrain or tiredness	1	2	3	4	5

C) Next to every word below, circle the number on the scale that best describes the *greatest amount* of that emotion you felt at anytime DURING YOUR EXPERIENCE OF THE DISPLAYED ENVIRONMENT. On these scales '0' means you did *not feel even the slightest bit* of the emotion and '8' is the *most you have ever felt in your life.*

Surprise	0 1 2 3 4 5 6 7 8	Sadness	0 1 2 3 4 5 6 7 8
Disgust	0 1 2 3 4 5 6 7 8	Happiness	0 1 2 3 4 5 6 7 8
Amusement	0 1 2 3 4 5 6 7 8	Anger	0 1 2 3 4 5 6 7 8
Interest	0 1 2 3 4 5 6 7 8	Arousal	0 1 2 3 4 5 6 7 8
Contentment	0 1 2 3 4 5 6 7 8	Fear	0 1 2 3 4 5 6 7 8

D4 Experiment 5: Instructions and Consent Form

Thank you for agreeing to participate in this study. The study is part of a larger investigation of new television systems. I will be examining your responses to different types of video clips.

Please inform the experimenter **now** if:

- you are claustrophobic
- you take medication which could affect your Heart Rate
- you have a visual or auditory impairment
- you need to wear glasses, contact lenses or a hearing-aid for watching TV
- you have previously taken part in any experiment in the ITC laboratory.

You will watch 12 video clips this week and 12 video clips at the same time next week. You will watch the clips one at a time in the Platform for Immersive Television (P*i*T). I will be monitoring your Heart Rate and skin conductance while you watch the clips and for 100-seconds before and after each clip (during which time you will see a blank screen). **Please remain as still as possible and look straight ahead at the screen for the entire recording period**, which will start once I have closed the P*i*T door (this includes the periods of blank screen).

After each of the 12 recording sessions you will fill out a short questionnaire. You will find twelve identical questionnaires in your booklet, one for each clip. **After a clip, complete one of the questionnaires**, making sure that you **read the instructions and answer all the questions in sections A, B and C**. Work through the booklet in the same order that you see the clips.

The video clips that you will see have either been used in psychological research or are taken from feature films widely available on VHS. The classifications awarded to the films the clips have been taken from range between 'U' and '18'. Some of the scenes you will see deal with issues such as sex, drugs and bereavement. However, none of the scenes portray graphic sexual or violent content. If you would prefer not to see these clips, please inform the experimenter. Please also feel free to look away from the screen or discontinue the experiment, if you find any scene too distressing. However, if possible, please remain still and look straight ahead, during recording sessions. **Ask the experimenter if you have any questions now or during the experiment.**

Please indicate that you agree with the following statements by signing below.

- I am not claustrophobic
- I do not have a visual or auditory impairment which is not corrected
- I d not take medication which could affect my Heart Rate
- I have not previously taken part in any experiment in the ITC laboratory
- I understand the information detailed above
- I consent to participate in this experiment
- I understand that my responses will be treated confidentially

Signed: **Date:**

Print Name:

Age: **Gender: M / F**

D5 Experiment 5: Additional analyses

Results: Presence

(i) Follow-up analysis of main effects of Content for Q1-'real' and Engagement-SF

Pairwise Comparisons – Q1 'real'

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
					Lower Bound	Upper Bound
Neutral	Amusement	-.536	.250	.129	-1.183	.110
	Sadness	-.609(*)	.225	.038	-1.190	-2.840E-02
Amusement	Neutral	.536	.250	.129	-.110	1.183
	Sadness	-7.292E-02	.135	1.000	-.422	.276
Sadness	Neutral	.609(*)	.225	.038	2.840E-02	1.190
	Amusement	7.292E-02	.135	1.000	-.276	.422

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – Engagement-SF

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
					Lower Bound	Upper Bound
Neutral	Amusement	-.688(*)	.177	.002	-1.144	-.231
	Sadness	-.722(*)	.155	.000	-1.122	-.322
Amusement	Neutral	.688(*)	.177	.002	.231	1.144
	Sadness	-.035	.122	1.000	-.349	.279
Sadness	Neutral	.722(*)	.155	.000	.322	1.122
	Amusement	.035	.122	1.000	-.279	.349

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

(ii) Simple Effects Analyses of Q3-'visit'

Pairwise Comparisons of Content for each level of Angle

ANGLE	(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
						Lower Bound	Upper Bound
Small	Neutral	Amusement	.240	.280	1.000	-.484	.963
		Sadness	.240	.274	1.000	-.467	.946
	Amusement	Neutral	-.240	.280	1.000	-.963	.484
		Sadness	.000	.189	1.000	-.487	.487
	Sadness	Neutral	-.240	.274	1.000	-.946	.467
		Amusement	.000	.189	1.000	-.487	.487
Large	Neutral	Amusement	.510	.313	.348	-.297	1.318
		Sadness	.073	.286	1.000	-.666	.812
	Amusement	Neutral	-.510	.313	.348	-1.318	.297
		Sadness	-.438(*)	.148	.021	-.819	-.056
	Sadness	Neutral	-.073	.286	1.000	-.812	.666
		Amusement	.438(*)	.148	.021	.056	.819

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons of Angle for each level of Content

CONTENT	(I) ANGLE	(J) ANGLE	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
						Lower Bound	Upper Bound
Neutral	Small	Large	-.198	.203	.340	-.618	.222
	Large	Small	.198	.203	.340	-.222	.618
Amusement	Small	Large	.073	.244	.768	-.431	.577
	Large	Small	-.073	.244	.768	-.577	.431
Sadness	Small	Large	-.365	.214	.103	-.808	.079
	Large	Small	.365	.214	.103	-.079	.808

Based on estimated marginal means

a Adjustment for multiple comparisons: Bonferroni.

(iii) Simple Effects Analyses of Engagement-SF

Pairwise Comparisons of Content for each level of Angle

ANGLE	(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
						Lower Bound	Upper Bound
Small	Neutral	Amusement	-.792(*)	.190	.001	-1.282	-.302
		Sadness	-.681(*)	.163	.001	-1.102	-.259
	Amusement	Neutral	.792(*)	.190	.001	.302	1.282
		Sadness	.111	.140	1.000	-.251	.474
	Sadness	Neutral	.681(*)	.163	.001	.259	1.102
		Amusement	-.111	.140	1.000	-.474	.251
Large	Neutral	Amusement	-.583(*)	.197	.021	-1.091	-.075
		Sadness	-.764(*)	.175	.001	-1.215	-.313
	Amusement	Neutral	.583(*)	.197	.021	.075	1.091
		Sadness	-.181	.126	.495	-.506	.144
	Sadness	Neutral	.764(*)	.175	.001	.313	1.215
		Amusement	.181	.126	.495	-.144	.506

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons of Angle at each level of Content

CONTENT	(I) ANGLE	(J) ANGLE	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
						Lower Bound	Upper Bound
Neutral	Small	Large	-.156	.123	.215	-.410	.097
	Large	Small	.156	.123	.215	-.097	.410
Amusement	Small	Large	.052	.158	.744	-.274	.378
	Large	Small	-.052	.158	.744	-.378	.274
Sadness	Small	Large	-.240	.139	.098	-.527	.048
	Large	Small	.240	.139	.098	-.048	.527

Based on estimated marginal means

a Adjustment for multiple comparisons: Bonferroni.

Results: Emotion Ratings (EES-SF)

Follow-up analysis of main effects of Content for ratings of amusement, sadness, arousal and interest.

Pairwise Comparisons – Amusement Ratings

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	-3.302(*)	.334	.000	-4.163	-2.441
	Sadness	-3.125E-02	.191	1.000	-.526	.463
Amusement	Neutral	3.302(*)	.334	.000	2.441	4.163
	Sadness	3.271(*)	.354	.000	2.357	4.185
Sadness	Neutral	3.125E-02	.191	1.000	-.463	.526
	Amusement	-3.271(*)	.354	.000	-4.185	-2.357

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – Sadness Ratings

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	.151	.097	.402	-1.000E-01	.402
	Sadness	-3.458(*)	.324	.000	-4.295	-2.622
Amusement	Neutral	-.151	.097	.402	-.402	1.000E-01
	Sadness	-3.609(*)	.314	.000	-4.419	-2.799
Sadness	Neutral	3.458(*)	.324	.000	2.622	4.295
	Amusement	3.609(*)	.314	.000	2.799	4.419

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – Arousal Ratings

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	-1.557(*)	.320	.000	-2.384	-.731
	Sadness	-1.224(*)	.285	.001	-1.960	-.488
Amusement	Neutral	1.557(*)	.320	.000	.731	2.384
	Sadness	.333	.215	.403	-.221	.888
Sadness	Neutral	1.224(*)	.285	.001	.488	1.960
	Amusement	-.333	.215	.403	-.888	.221

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – Interest Ratings

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	-2.479(*)	.335	.000	-3.344	-1.615
	Sadness	-1.682(*)	.275	.000	-2.392	-.973
Amusement	Neutral	2.479(*)	.335	.000	1.615	3.344
	Sadness	.797	.330	.072	-5.435E-02	1.648
Sadness	Neutral	1.682(*)	.275	.000	.973	2.392
	Amusement	-.797	.330	.072	-1.648	5.435E-02

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Results: Visual Image Evaluation Scales (VIES)

Follow-up analysis of a main effect of Content on two VIES ratings (Image Quality and Image Adequacy).

Pairwise Comparisons – Image Quality

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	-9.122(*)	1.912	.000	-14.058	-4.185
	Sadness	-8.602(*)	1.802	.000	-13.254	-3.950
Amusement	Neutral	9.122(*)	1.912	.000	4.185	14.058
	Sadness	.519	.781	1.000	-1.499	2.537
Sadness	Neutral	8.602(*)	1.802	.000	3.950	13.254
	Amusement	-.519	.781	1.000	-2.537	1.499

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – Image Adequacy

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	-11.599(*)	2.806	.001	-18.844	-4.354
	Sadness	-13.198(*)	2.992	.001	-20.923	-5.473
Amusement	Neutral	11.599(*)	2.806	.001	4.354	18.844
	Sadness	-1.599	1.143	.525	-4.550	1.352
Sadness	Neutral	13.198(*)	2.992	.001	5.473	20.923
	Amusement	1.599	1.143	.525	-1.352	4.550

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Results: Negative Effects

Follow-up analysis of a main effect of Content on Negative Effects ratings.

Pairwise Comparisons – Negative Effects

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	.531(*)	.152	.006	.140	.923
	Sadness	.516(*)	.121	.001	.203	.828
Amusement	Neutral	-.531(*)	.152	.006	-.923	-.140
	Sadness	-1.563E-02	.073	1.000	-.203	.172
Sadness	Neutral	-.516(*)	.121	.001	-.828	-.203
	Amusement	1.563E-02	.073	1.000	-.172	.203

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Results: Skin Conductance

Follow-up analyses of main effects of Content on five measures of Skin Conductance

Pairwise Comparisons – SCL Total

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	.384(*)	.093	.001	.142	.625
	Sadness	.622(*)	.191	.011	.127	1.116
Amusement	Neutral	-.384(*)	.093	.001	-.625	-.142
	Sadness	.238	.146	.354	-.140	.616
Sadness	Neutral	-.622(*)	.191	.011	-1.116	-.127
	Amusement	-.238	.146	.354	-.616	.140

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – SCL-1st

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	95% Confidence Interval for Difference(a) Upper Bound
Neutral	Amusement	.219(*)	.078	.031	1.637E-02	.421
	Sadness	.354(*)	.130	.037	1.803E-02	.689
Amusement	Neutral	-.219(*)	.078	.031	-.421	-1.637E-02
	Sadness	.135	.104	.626	-.134	.404
Sadness	Neutral	-.354(*)	.130	.037	-.689	-1.803E-02
	Amusement	-.135	.104	.626	-.404	.134

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – SCL-2nd

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	95% Confidence Interval for Difference(a) Upper Bound
Neutral	Amusement	.429(*)	.133	.011	8.701E-02	.772
	Sadness	.668(*)	.222	.018	9.625E-02	1.241
Amusement	Neutral	-.429(*)	.133	.011	-.772	-8.701E-02
	Sadness	.239	.163	.468	-.182	.660
Sadness	Neutral	-.668(*)	.222	.018	-1.241	-9.625E-02
	Amusement	-.239	.163	.468	-.660	.182

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – SCL-Last

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	95% Confidence Interval for Difference(a) Upper Bound
Neutral	Amusement	.539(*)	.124	.001	.219	.858
	Sadness	.826(*)	.241	.007	.204	1.449
Amusement	Neutral	-.539(*)	.124	.001	-.858	-.219
	Sadness	.288	.200	.488	-.227	.803
Sadness	Neutral	-.826(*)	.241	.007	-1.449	-.204
	Amusement	-.288	.200	.488	-.803	.227

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – SCL-Min

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	.202(*)	.065	.016	3.287E-02	.370
	Sadness	.428(*)	.138	.015	7.140E-02	.784
Amusement	Neutral	-.202(*)	.065	.016	-.370	-3.287E-02
	Sadness	.226	.120	.218	-8.404E-02	.536
Sadness	Neutral	-.428(*)	.138	.015	-.784	-7.140E-02
	Amusement	-.226	.120	.218	-.536	8.404E-02

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Results: Heart Rate

Follow-up analyses of main effects of Content on measures of Heart Rate

Pairwise Comparisons – HR-Total

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	.132	.263	1.000	-.548	.812
	Sadness	-2.206(*)	.425	.000	-3.302	-1.109
Amusement	Neutral	-.132	.263	1.000	-.812	.548
	Sadness	-2.338(*)	.306	.000	-3.129	-1.548
Sadness	Neutral	2.206(*)	.425	.000	1.109	3.302
	Amusement	2.338(*)	.306	.000	1.548	3.129

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – HR-1st

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	.143	.283	1.000	-.587	.873
	Sadness	-1.546(*)	.375	.001	-2.513	-.579
Amusement	Neutral	-.143	.283	1.000	-.873	.587
	Sadness	-1.689(*)	.327	.000	-2.533	-.844
Sadness	Neutral	1.546(*)	.375	.001	.579	2.513
	Amusement	1.689(*)	.327	.000	.844	2.533

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – HR-2nd

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	.288	.282	.952	-.440	1.017
	Sadness	-2.530(*)	.447	.000	-3.684	-1.377
Amusement	Neutral	-.288	.282	.952	-1.017	.440
	Sadness	-2.819(*)	.347	.000	-3.714	-1.923
Sadness	Neutral	2.530(*)	.447	.000	1.377	3.684
	Amusement	2.819(*)	.347	.000	1.923	3.714

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – HR-Last

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	9.128E-02	.358	1.000	-.834	1.017
	Sadness	-2.564(*)	.595	.001	-4.101	-1.027
Amusement	Neutral	-9.128E-02	.358	1.000	-1.017	.834
	Sadness	-2.656(*)	.441	.000	-3.794	-1.517
Sadness	Neutral	2.564(*)	.595	.001	1.027	4.101
	Amusement	2.656(*)	.441	.000	1.517	3.794

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – HR-Rec

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	-.930(*)	.347	.040	-1.826	-3.382E-02
	Sadness	1.965(*)	.509	.002	.651	3.279
Amusement	Neutral	.930(*)	.347	.040	3.382E-02	1.826
	Sadness	2.895(*)	.520	.000	1.552	4.237
Sadness	Neutral	-1.965(*)	.509	.002	-3.279	-.651
	Amusement	-2.895(*)	.520	.000	-4.237	-1.552

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – HR-Min

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	.217	.536	1.000	-1.167	1.601
	Sadness	-1.425	.575	.063	-2.908	5.866E-02
Amusement	Neutral	-.217	.536	1.000	-1.601	1.167
	Sadness	-1.642(*)	.559	.022	-3.086	-.197
Sadness	Neutral	1.425	.575	.063	-5.866E-02	2.908
	Amusement	1.642(*)	.559	.022	.197	3.086

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

Pairwise Comparisons – HR-Max

(I) CONTENT	(J) CONTENT	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a) Lower Bound	Upper Bound
Neutral	Amusement	.212	.517	1.000	-1.123	1.546
	Sadness	-2.516(*)	.402	.000	-3.555	-1.477
Amusement	Neutral	-.212	.517	1.000	-1.546	1.123
	Sadness	-2.728(*)	.507	.000	-4.038	-1.418
Sadness	Neutral	2.516(*)	.402	.000	1.477	3.555
	Amusement	2.728(*)	.507	.000	1.418	4.038

Based on estimated marginal means

* The mean difference is significant at the .05 level.

a Adjustment for multiple comparisons: Bonferroni.

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