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2 Introduction

Films have been enjoyed for over a hundred years now and though much have changed in how films are made and mediated to an audience; some things remain the same and have become conventions. Recent development has introduced TV's that are bigger in width and much smaller in depth, and development in storage facility has allowed for better image and sound quality. This means that it is now possible to have a 50" inch screen with a high resolution while maintaining a good relationship with the spouse. We are still seeing even thinner screens being introduced, but little has changed when it comes to the basic form of the screen. In a way it can be said that if a new TV is to be a commercial success it has to have higher resolution, a bigger screen and it has to have a high "wife acceptance factor". It seems that by convention a television is a squared frame containing the image! But, Phillips have with the Ambilight technology literally thought "outside the frame" in an attempt to part with the conventional screens. The first Ambilight LCD Television was introduced by Phillips in 2004 [1]. These innovative TV sets distinguish themselves by being equipped with chains of RGB LEDs capable of projecting a wide range of colors onto the back wall. The result of having colored light shed from the back of the screen is that an aura seems to surround the TV when it is viewed from the front (see Figure 1).

Figure 1 Ambilight on Phillip's "Cinema" 21:9 format LCD HD TV [2]

The color and the intensity of the backlights are often controlled by a pixel process algorithm build into the TV, which ensures that the light has a tight color relation to the displayed content. The direct result of this setup is that the viewer is presented with a soft colored light (in coherence with the displayed image) in the peripheral parts of the field of view. The Ambilight system was originally designed to enhance the atmosphere and emotional responses to movies viewed upon their systems [3], but research conducted regarding the effects of TV backlight during cinematic experience is (to our knowledge) very limited. The limited selection of prior work will be described briefly in the next paragraph, and serve as a motivation for this project.

2.1 Prior work and motivation

John Bullough and colleagues [4] did an experiment in 2006 testing the effects of a static white TV backlight on comfort and fatigue of nine participants, while they were viewing 60 minutes of an action movie. Reaction times, subjective ratings, eye blinks and ERP responses were collected during two viewing sessions (one with backlight and one without) all indicating that participants during the backlight condition were less likely to experience fatigue or eyestrains. However the effect was modest in magnitude. It is worth noting that Phillips sponsored the applied equipment and that they had a delegate coordinating the experiment.

Pieter Seuntiens, Ingrid Vogels and Arnold van Keersop, from Phillips Research Laboratories presented in 2007 [5] an experiment testing the effects of a pixilated Ambilight system (meaning that the backlight was controlled by a pixel process algorithm) on subjective reports of viewing experience, perceived depth, naturalness, perceived ambilight, perceived image quality and *presence*. Presence was in this context defined as *the perceived degree of becoming part of the displayed space*. Twenty test subjects participated in a with-in subject evaluation of 36 conditions including among others two movie clips and three conditions of Ambilight at respectively 0%, 50% and 100% intensity. The results indicated that perceived ambilight, viewing experience and presence was positively affected by the increase in intensity of the TV backlight. Again it is worth noting that this study has been conducted by Phillips' own research labs.

Lastly Mulder, I. and Vliet, H. made a small-scale test [6] involving eight participants, which each brought a partner. Each participant was to bring a personal video clip, which they were asked to watch with their partner. In two sessions (with and without TV backlight) of five minutes the video clip was displayed to the particular participants. The results indicated that participants in the backlight condition rated the duration of the viewing session shorter than in the no-backlight condition. Yet again it is worth noting that the article featuring these findings was published under the Phillips Research Book Series.

From the few studies on TV backlight it can be observed that the experiments tend to apply a low amount of test subjects (max. twenty participants). At the same time it seems like all of the current studies were done in collaboration with Phillips in one way or another. It is our observation that the significance of the study on TV backlight could be enhanced by increasing the amount of test participants in the investigation and that a study in this field could gain more credibility if it was done independently from Phillips. Another observation is that none of the studies include emotional responses as the dependent variable. This is particularly curious since the concept of Ambilight, according to a publication by Phillips Research Laboratories [3], was developed with an emphasis on the creation of an appropriate atmosphere or mood in connection with film viewing. The article describes how Ambilight implementations can "catch" the mood created by light and colors in the film and extend it by manipulating the ambient light in the room. We feel that a study is missing, which examines whether TV backlight actually manifests in emotional responses. Therefore this study will attempt, not only to investigate emotional responses of a TV backlight solution but also, to do so independently from Phillips to avoid any bias.

3 Method

In this chapter we describe how the report is structured and why. The report is divided into three parts (1) *Preanalysis,* (2) *Analysis* (3) *Test.* The Preanalysis will focus on analyzing the system we are evaluating, by describing what it is the Ambilight system does during playback of a movie. The Analysis will be used to analyze how the addition of Ambilight is likely to be perceived by the viewer. We therefore describe the cognitive processes involved when watching film, and speculate what will happen when ambilight are used. As a result the overall structure of the report is that in the first part we define how the system works and in the second part we describe how it is perceived.

3.1 Part 1 - Preanalysis

Emotions & mood

The research Phillips have conducted in the development of the Ambilight system, mentions emotions and moods as features that are influenced by the system. However they fail to give a thorough description of what they consider to be emotions. It is obviously important to understand what it is a system influences, and in order to communicate your results it is equally obvious that you have to define what you consider to be the area where your product has an effect. To get a clear definition of what emotions and mood are, we turn to the field of psychology to get a description of the concepts. The purpose of this is to create a description of mood and emotions that enjoys scientific endorsement and are in general considered to be valid

Analyzing Ambilight

In this chapter we analyze the Ambilight system; we do this by investigating how it has been implemented in different products over the years. We also look into if there are other products that resemble the Ambilight system. We purchase Ambilight hardware that we use to analyze how the hardware is responding when used with movies. Our analysis will consist of two parts, one is basic observations and the other is measurements where we develop a program that can analyze a video stream for light intensity. The combination of the two methods enables us to understand that the Ambilight system is mainly responding to colors in the image, light intensity, and editing.

Analyzing film

With a description of how the Ambilight works, we analyze how colors, light intensity and editing are used in films to induce mood (in the definition we establish in "Emotions & mood). For our analysis we turn to the research field of film theory. We initiate the chapter by giving a general description of what film are, and we establish a framework for distinguishing between film form and hardware form. We also evaluate if there are other aspects of film that has a substantial influence on emotion, and conclude that sound is highly used for the purpose of creating moods and emotions in movies.

Sound in film

We have concluded that sound is a powerful tool used to set/create the mood and emotions in film; we therefore turn to film sound analytics to get a description of how sound is used in film. We conclude that cinema sound consists of speech, ambience and music. We also conclude that film sound in cinema exploit the concept of attention in terms of listening modes. Also, we find that film is highly dependent of cross modal perception between sound and image and that there is reason to believe that sound and Ambilight might influence each other.

Initial problem formulation

The Preanalysis will be concluded with an initial problem formulation that forms the basis of the analysis.

3.2 Part 2 - Analysis

Human vision

In this chapter we analyze how the stimuli produced by the Ambilight are perceived. We investigate how the human sight is constructed, and conclude that the vision can be segmented into central field of view, para fovea- and peripheral field of view. Here it is found that the para fovea- and the peripheral field of view is guiding attention (eye fixation) and that Ambilight stimulus in these eye-areas has potential of being distracting. We also conclude that if information is received in the para fovea- or peripheral field of view it will influence the cognitive processes unconsciously.

Unconscious processes

We turn to the field of psychology to find a description of the processes that are taking place unconsciously, and investigate how they are linked to emotions and mood. We focus on how emotional content (when presented in the para fovea field of view and peripheral field of view) influences the process which leads to emotions.

Presence

In this chapter we analyze the processes that are taking place during movie watching, and use the concept of presence to describe them. We define the aspects of presence that are relevant to movie watching and conclude that presence can be used as a measure for evaluating a system for mediation and to detect distractions.

Final problem formulation hypotheses

In this chapter we discuss our findings up until now, and use this discussion to form hypotheses, that can be tested and measured.

3.3 Part 3 - Test

Design and Implementation

In this chapter we describe a method for testing if the hypotheses are false or true. We conclude that a test with two scenarios is needed, with ambilight as the independent variable and emotional response and presence as dependant variables. We describe the test setup and the procedure. We also describe how the test was implemented.

Results

Here we present the results from the test in form of plots and statistics accompanied by descriptive text.

Discussion conclusion

The report is concluded with a discussion and a conclusion where we discuss the results of the test and draw a conclusion

4 Preanalysis

4.1 Towards a definition of emotion

One of the first attempts to define emotions was performed by the famous Charles Darwin. The definition was made by applying his evolutionary theory to the mind and emotions as well. Darwin was cued by the observation that animals and humans independently of race and cultural background expressed the same emotions through the same movements. In his book "The expression of the emotions in man and animals" [7] Darwin gave a number of examples of how characteristics in animals have evolved to become emotional expressions in humans. For instance the baring of the fangs of a wolf could have turned into the sneer of the human when feeling contempt or disgust. Some monkeys also turn red in the face during a battle with a rival just like a man would in an angry moment. According to Darwin an emotional outburst is a reaction to emergency events in the environment, which increases our chances of survival. The tradition of using (facial) expressions as a mean to distinguish discrete emotions has later been elaborated by researchers such as Izard [8].

Later William James [9] and Carl Lange [10] independently introduced another theory and definition of emotion. As expressed by the words of William himself their definition is: *The bodily changes follow directly the PERCEPTION of the exciting fact and that our feeling of the same changes as they occur IS the emotion*. The essence of their theory is that physiological changes are started by the perception of an event in the environment. The sensation of these internal changes (e.g. butterflies in the stomach) is what James and Lange define as an emotion. This also explains why the term "feelings" is often used as a synonym to "emotion".

Stanly Schachter and Jerome Singer [11] extended the theory of James and Lange by arguing that various emotions (and non-emotions) could be the result of the same bodily state. Therefore they proposed that a cognition-parameter should be considered together with physiological changes (such as arousal) when defining emotions. To support their theory an experiment was conducted in which a set of participants were given a shot of adrenaline and at the same time given either correct-, incorrect- or no information on what the effects of the injection would be. The misguided participants were here told that the injection would result in mild side-effects such as numb feet, itching and a headache, which is not the case when adrenaline is injected. The participants were then placed in a context that was either positive or negative, which was assumed to give the misguided and ignorant participants a reason of why they were feeling the effects of the adrenaline (arousal). The correctly informed participants were instead expected already to have an eligible reason for the physiological changes. The results of the experiments displayed as expected that the misinformed and ignorant participants rated their emotional states as being more intense in relation to the correctly informed group. According to Schachter and Singers theory, this is because they experienced the effects of the adrenaline, and as they have no explanation, as to why they feel that way, attributed the feelings to being either happy or angry. In other words, the physiological reaction was similar in both groups, and the emotions the two groups experienced were different.

Several models have been conceptualized due to one or several of the above theories [12,13]. One which is particularly well-known [14] is the Circumplex model by James Russell [12]. The model consists of two axes one indicating the amount of arousal and the other is an indication of pleasantness, which combined makes up the 2D bipolar space (Figure 2 Circumplex model).
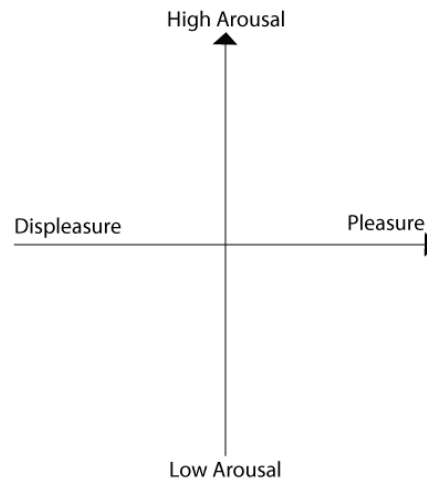
Figure 2 Circumplex model

Russell asked undergraduates to group 28 words of distinct emotional states into categories. The relationships between each pair of words were recorded. When the data was analyzed into a 2D space (see [12] for details), Russell found out that the positions of the emotional words made up a circle-shaped pattern and that his model could be placed into the space, such that the data points representing each emotion was related to the axes in a meaningful way. He later performed the same experiment across cultures and reached the same result [15]. The Circumplex model is supportive and an informative illustration of the Schachter and Singers theory, which claims that emotions are dependant of two factors, namely cognition and arousal.

By now we should have gained enough knowledge to give a satisfying definition of emotion. We use Schachter and Singers approach to define emotion. Thus our definition of emotion is:

- An emotion is a subjective interpretation of a bodily reaction to a given stimuli.

Note that other contributions have been made to the field of emotional research as well. For instance Sigmund Freud developed a theory on suppressed emotions [16], which adds a new complex dimension to the concept of emotion. However for the sake of this thesis, we find that the above definition is sufficient. Returning to our discussion regarding the descriptive words given by Phillips in describing the capabilities of the Ambilight system, "emotions" seem to be a fitting label.

The quote *they can feel that the alien is near again. Goosebumps!* is clearly an emotion when considering the James-Lange theory which states that emotion is the feeling of a bodily reaction (goose bumps). *…a green pulsating light from beneath the couch startles them* is describing a high arousal state due to a sudden unexpected event, which according to Darwin initiate emotions such as surprise and fear inherited from the fight-or-flight mechanisms found in animals. Phillips also uses the term "spooky atmospheres" which cannot be linked directly to emotions. The word "spooky" implies that some object, event or phenomenon has the potential of putting one in a state of startle or fear (spooked). However "atmosphere" is a curious word, it can probably not be defined as an emotion, but seeing it in the wording

a spooky atmosphere gives the understanding that it is a phenomenon capable of eliciting some sort of an emotion state. But what exactly is an atmosphere?

4.1.1   Towards a definition of atmosphere

We were not able to find any academic literature which attempts to define "atmosphere" even though the word itself was widely used in various publications. As such we turned to look in a dictionary to get some sort of definition or maybe even synonyms which academic literature has investigated more in depth. The results from [17] yielded a large range of definitions as "atmosphere" has multiple meanings: from the gasses surrounding planets, to conventional units of pressure. However among the definitions some useful information was obtained. The following three definitions were assumed to be in line with the intended use of "atmosphere" from the Phillips quotes (1) *a surrounding or pervading mood, environment, or influence: an atmosphere of impending war; a very tense atmosphere.*" (2) *The dominant mood or emotional tone of a work of art, as of a play or novel: the chilly atmosphere of a ghost story.* And (3) *a distinctive quality, as of a place; character: The old part of town has lots of atmosphere.* A couple of observations can be made upon these definitions. It seems that atmosphere is **something** which can be attached to either an object (e.g. "[atmosphere]...*of a play"*, "[atmosphere]..*of a ghost story"*, "[atmosphere]..*of a work of art"* etc.), an environment (e.g. "[atmosphere]..*of a place"*, "*a surrounding .. environment"*, "*The old part of town has lots of atmosphere."* etc.) or be understood in terms of itself (e.g. "*a very tense atmosphere"*, "*an atmosphere of impending war"*). The **something** is in the ambilight context defined as: "a .. *pervading mood .. or influence"*, "*the dominant mood or emotional tone.."*, "*a distinctive quality.."*. The word "influence" seems to be in line with the argument presented in the above paragraph stating that an atmosphere is capable of eliciting emotional states in a subject (influence the subject). Our considerations regarding the concept of "quality" is that it refers to an objects which is explicitly "well" at inducing an emotional state. For instance consider the sentence "The house has atmosphere". This could very well be a statement given by a real estate agent to a potential buyer. The agent attempts to emphasize a <u>quality</u> of the house, since he probably has an assumption that the house is likely to elicit a certain emotional state or mood in the buyer by the very sight, smell or touch of it. The reason of why some objects are perceived as potentially "better" at inducing emotions or a mood could be many things but in this case it would probably be a culturally related reference. From the words "influence" and "quality" from the definitions we would define atmosphere in the following way:

- An atmosphere is a quality attached to an object or an environment, which entails that it has the capability to elicit a dominant mood or an emotional tone

Atmosphere is as such a concept similar to an intermediary. The words emotional tone is used here as we do not consider emotion to be a fitting description. An atmosphere does not elicit as intense an emotional response as an event or object. For instance encountering a dog with rabies would probably not be surrounded by a negative atmosphere, which brings the individual in a bad mood. Instead the event itself would induce a strong need to flee, manifested in an emotion of fear or terror. That is why we think emotional tone is more fitting for the definition of atmosphere.

However, our definition does not cover the scenario where atmosphere can be seen independently from an object or an environment (e.g. "*a very tense atmosphere*", "*an atmosphere of impending war"*). This is because we simply believe that atmosphere in these situations is used as a synonym of a mood or an emotional tone. To avoid confusion we will keep our definition of atmosphere and instead strive to apply the word mood in these situations.

From this discussion it is obvious that it would be wise to consult the literature regarding the distinction between emotion and mood.

4.1.2 Towards an understanding of the distinction between mood and emotion

It seems like the literature regarding emotions indeed has had the same problems in discriminating terms such as mood and emotion [18,19,20]. From the studies we have found, determined to distinct mood and emotion [21], the study of Christopher Beedie and colleagues are by far the most extensive In this study two approaches were taken to investigate the meaning of the term mood and emotion. The first approach was to ask 106 people about their interpretation of how the two concepts differ in meaning. The findings where then compared with the results from the second approach in which 65 contributions to the academic literature were treated by extracting defined distinctions between the two concepts. The outcome was divided into a set of fourteen criterions under which emotion and mood were distinctive, but in our opinion some of them can be grouped. As such we will describe their findings in these groupings and if more detail is needed the reader is directed to [21].The most appearing distinction of mood and emotion was said to be in the duration of the two concepts. Apparently, mood is understood as having a longer duration compared to emotions. While emotions are volatile and can appear and disappear instantaneous, moods evolve slowly and can last for hours, maybe even days. Another frequently appearing distinction was the difference in cause. Emotions were here understood as always caused by a specific event or object which the emotion is directed towards (e.g. hating or loving a person), while the individual "holding" the mood often is unaware of the cause of the mood and thereby the mood is not directed towards anything in particular. Lastly, emotions are understood as being intense uncontrolled feelings calling for behavior and displayed through expression, while mood is mild controlled thoughts which are largely cognitive and not displayed. The findings of Christopher Beedie and colleagues are useful in the understanding of emotion and mood as separated concepts.

We return to the claims by Phillips with renewed knowledge. When Phillips states: *When he fires up the Home Cinema system a dark purple glow amplifies the spooky atmosphere of the first scenes*, we note that the dark purple glow from the Ambilight system *amplifies* the *spooky atmosphere* of the first scenes. Likewise when Phillips later in their article states: *First of all, the specific light settings can be derived from the "mood" of each scene, as expressed with color and light in the film, because these elements are important ambience creation tools.* we note that the word "*mood*" might be interchanged with the word atmosphere as these can be understood as synonyms. The conclusion is that Phillips attempt to communicate that the Ambilight system is capable of derive and amplify the atmosphere of a scene in terms of light. As a research question we reply: is this even possible?

4.2 What is the Ambilight system?

Ambilight TV's has been marketed in different versions where the early versions only had light projected on the left and right side of the TV and the newest versions have light on all sides of the screen (Figure 1). Thusly when one wants to investigate ambilight one must remember that ambilight is not A product, it is A concept. In this report when we refer to the Ambilight TV we use a capital "A" and when referring to ambilight as a technology we use lower case "a". We describe the ambilight technology, by choosing Phillips' own wording from the abstract of the below described patent: *Extracting video content encoded in a rendered color space for broadcast by an ambient light source, using perceptual rules in concert with user preferences* [22].

In 2001 Phillips started the "User-centric experience research" which according to Phillips is a research program that studies human and technology interaction as well as novel concepts for ambient intelligence [23]. One of the results of this program is the ambilight. A review of material regarding ambilight from Phillips gave little information on how the system actually functions. However a sketchy description of the concept behind the ambilight system can be found by looking at the patent application relevant to the ambilight technology [22].

In (Figure 3) we find that ambilight manipulates light shed onto the back wall by dividing the screen into segments (L1 – L6). Each section is analyzed and an appropriate color is then projected upon the wall behind- the frame of the screen (L1-L6). ("D" is the central area of the screen, "A8" is the back wall light and "Df" is the frame area). We can see that back wall light in the "L6" area (left part of the figure) will reflect the "R6" area of the screen "L1" reflects "R1" and so on and so forth. Several patents are being implemented in the current version of the Ambilight TV and the patent we refer to here might not describe all technologies that are used in the latest generation of Ambilight TVs (e.g. Figure 1).
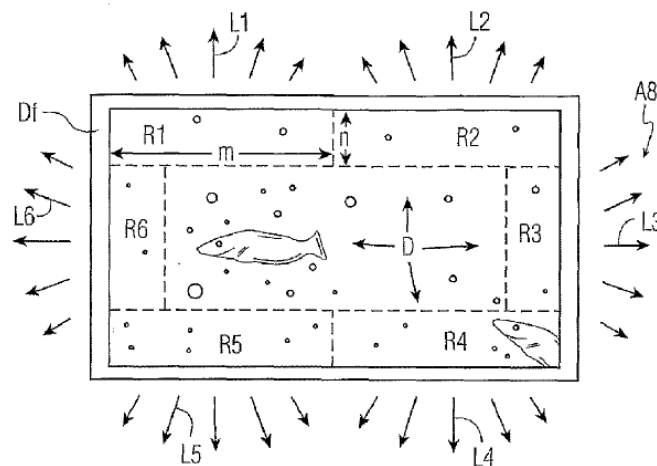

Figure 3 ambilight patent figure [22]

We wanted to investigate the ambilight system further by making our own observations on the system, however the high--end implementation is beyond our financial reach (current prices for the top model is approximately 30.000kr. or 4000 Euros). However Phillips has implemented ambilight in a solution for

computer games which is within our financial capabilities (approximately 800 kr or 106 Euros). The system is called "amBX" [24] (Figure 4) and is an ambilight implementation and will be investigated as such.

Figure 4 Picture of the "amBX"

4.3 Evaluating the amBX system

The amBX was developed with focus on computer games. The version of the system, which was available to us, featured one subwoofer two speakers three lamps two fans and a rumbling pad for haptic feedback that can be controlled by the computer game. The System also featured a stereo speaker set with a subwoofer (the stereo speakers are build into two of the lamps). There are two types of lamps a left/right lamp that has to be placed to the left and right of the screen, and a center lamp that has to be placed behind the screen. Although we cannot be sure that the technology that the amBX features is the same as the one applied in the TV's, we know from the description on the amBX webpage [25] that it is designed to be used with movies, computer games, or as mood lighting. With the amBX connected to a computer we watched several DVD's and we could observe that the lamps reflected the material on the screen, much as described in the patent. We also observed that each of the left/right lamps has one independent light source, where the center lamp has three independent light sources (Figure 5)

Figure 5 Close-up of amBX ambilight

During playback of the DVD we were observing what aspects of the movie that would activate the amBX ambilight. As expected the color of the screen were reflected in the color the amBX shed on the hind wall, thusly if the color in the left side of the screen were mostly green the color in the left lamp would be mostly green to. The color in the top of the screen was reflected in the center lamp. The intensity of the light on the screen were also determining for the light intensity of the lamp. These findings were not surprising and confirmed our assumptions that the amBX is an ambilight implementation.

4.4 Analyzing film

4.4.1 Form and content - our Definition

At this point it is useful with a definition of "Form and content" since this is a term we will be using to distinguish between the TV setup and the movie. Form and content are typically used in describing art, and the terms are often "Form" and "substance". Form describes everything related to how the idea behind the art piece is presented. In painting it could be painting technique, high/low contrast, style (expressionistic, modernistic ect.) there are even examples of artists using faeces and tin cans as form. Form is whatever means that an artist may choose to use to mediate his idea. The "idea" or the content/essence is much

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more abstract since it is what the art piece is intended to communicate. The reason for this consideration is that we must understand what it exactly is that ambilight is changing and on what this change have an effect. The movie itself consists of form and content, however the filmmaker does not have control over how the movie is presented to the audience, since he does not know the final hardware it is presented on. He does however know that it is likely to be a square screen, with some sort of audio producing capability. The consequence is that when a movie is watched in the viewer's home it is Film form and content + added hardware form. There are consequently two levels of form, the one the film maker controls and the one the TV maker controls. When we claim that using ambilight is a change in form we mean that it is a change in the form that the TV maker controls, not the film form.

This research is focused on how the change in hardware form influences film form and in the subsequent chapter we found that Color and color intensity are linked between film and hardware (ambilight) form. We have conceptualized this in [Figure 6] to illustrate the relations between ambilight and form.
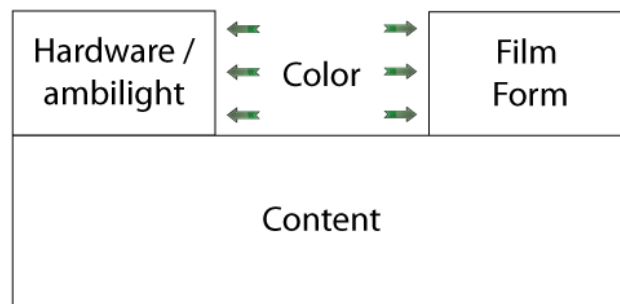

Figure 6 Relation between form and content in movies

4.5 *What is the purpose of a film?*

In the following chapter we investigate how emotions are created in film, with focus on color, and consider lighting to be the change of color intensity. To get an overall idea of how the viewer responds to movies we find that *… Artwork cues us to perform a specific* (mental) *activity [26].* This mental activity is the process of recognizing and predicting events. *The mind is never at rest. It is constantly seeking order and significance, testing the world for breaks in the habitual pattern.*

This quote suggests that movies are not something that can be viewed as an independent entity, if a movie fails to trigger a mental activity in the viewer the movie is not a movie, it is just rays of photons and changes in air pressure. But what is the purpose of a movie beyond triggering mental activity?

In modern cinema the main purpose of a movie is to tell a story, there are examples of movies that stray from this convention but often to tell a story is the main purpose of a movie. Thus the movie (and hardware) as such is a container for a story. To be able to understand the story the viewer must be able to understand the emotions the characters in the narrative are experiencing. As mentioned the human mind seeks order and significance, but humans are also very good at understanding intentions of other humans. The most dominant story telling technique [26 p. 89] is based upon the concept of someone wanting

something and to understand why they want it, the viewer has to be able to understand the emotional state of the character in the movie.

5 Colors and atmosphere in film

We have established that the ambilight functions manly by capturing color in the image and projecting them onto the wall behind the screen and we will now describe how color can have an effect on the mood in film. To our knowledge color use in film has not been studied extensively, as it is the case with e.g. film sound. Where film sound enjoys specific attention from researchers, color is researched as a smaller part of a greater whole. E.g. The question of, why does color have an effect in film, is often answered with examples of how they have been used. Because of this we investigate how colors are linked to emotions in a non film context; we also describe how colors are used in paintings, and finally we investigate how it is used in film by studding some examples. Firstly we need to expand our vocabulary for describing "color"

5.1 Colors and the HLS scale

Colors are typically quantified by the Hue Saturation and lightness (HSL) scale where "hue" refers to the perceived wavelength of the light received by the retina, and are typically denominated as, "red", "green", "blue", "purple", black", "white" and so on. Saturation refers how "strong" the color is perceived to be, this means that a color e.g. red can be more or less red dependant on intensity. Most colors are a mix of the primary colors (red, green and blue) and the lightness describes how much of each color are present. A TV produces three colors Red, Green and Blue (RGB) and the HSL scale is typically used to describe how the RGB is mixed. In computers it is normal to apply a scale of 0 to 255 when describing the RGB and we use the same scale to describe the relationship between the RGB here. Thusly if pure red is showed on the TV the RGB combination would be: R=255, G=0 and B=0. By mixing the values any HLS value can be achieved, thusly a yellow color with middle light intensity could have the values somewhere around R=150, G=150 and Blue= 0. A color on a TV is the combination of RGB and the mixture of the three results in the color.

5.2 Color linked to emotions

Several studies has shown that colors are connected to emotions, [27, 28, 29, 30, 31, 32] Although the opinions on how to map colors to emotions differs, there seem to be a general acceptance that colors are in fact linked to emotions somehow. The study [27] links specific emotions to specific colors. In the study the researchers asked 72 test subjects grouped in three, differentiated by age with both sexed equally represented in each group to link specific emotions to specific colors,(group one were in average 7,3 years old range 6,7 - 7,8. Group two were 11,2 years old range 10,5 - 12,0. Group three was in average 30 years old, range 20 - 56). The test consisted of two parts, one where only colors were evaluated, and one where only emotions were evaluated. Initially the participants were individually asked to evaluate colors and emotions pair wise by judging which of two colors were the most *beautiful* and which of two emotions

were more likable. Secondly the participants were asked to associate an emotion to a color. The colors used in the experiment were White, black, red, green, yellow and blue. For color preferences the adults rated the colors as follows: blue, red, yellow, green, white and black. The emotions were: Happiness, surprise, anger, sadness, aversion and fear and was rated in that order.

	Blue	Yellow	Red	White	Green	Black
Happiness	3	9	0	1	11	0
Surprise	6	1	4	10	3	0
Anger	0	10	2	0	2	10
Sadness	3	1	6	6	6	10
Aversion	1	5	4	1	4	10
Fear	2	1	1	1	1	15

Figure 7 test results from [27] First row = colors, first Colum = emotions. The numbers represent how many test participants associated the respective color to the emotion.

For the sake of simplicity we do not list all the results here. The conclusion of the test that is of interest is that *at all ages, colors and emotions are consistently related to each other* [*27* page 14]*.* In the study the focus were to investigate if color emotion linking is influenced by age; however the exact link between color and emotions are a little fuzzy in the test. E.g. happiness is related to both yellow and green, and sadness cannot be linked specifically to on or even more colors,. It is however interesting to see that anger sadness aversion and fear, are all associated to black, the observation is interesting since these emotions (and thereby black) could be related to unpleasantness on the Circumplex model (4.1).

Colors have been associated more specifically to emotions, in [33] the anxiety state of 40 test subjects was measured while subjecting them to four different colors: red, yellow, blue and green. In the study it was concluded that red arouses more anxiety than blue and green. It was also concluded that the fact that red and yellow were found to be associated with high anxiety, and green were associated with low anxiety, were consistent with previous findings made by [34] and [35]

There are however studies that links colors and emotions differently. In the paper [36] the author claims that the previous studies in general has neglected the importance of hue, saturation and brightness the result of the research were that emotions were greatly and consistently influenced by hue, saturation and brightness. We have summarized the findings in (Figure 8) where we can see that colors related to blue were regarded as more pleasant, where greenish colors were more arousing and caused a stronger emotional response (more dominance). This is indeed conflicting with the findings that red should be arousing and blue non-arousing.

	Pleasant	Arousing	Dominant
More	Blue, blue-green, green, red-purple, purple, and purple-blue	Green-yellow, blue-green, and green	Green-yellow
Less	yellow and green-yellow	purple-blue and yellow-red	red—purple

Figure 8 Results from [36] Scale is divided into "Pleasant", "Arousing" and "Dominant"

The three studies we have reviewed here all suggest that a color can be linked to an emotion quite specifically, in the following chapter we investigate an example of how this can be implemented in paintings.

5.3 Color in art

It is interesting to investigate how colors are used in painting because of the simple fact that an image begins its existence as a blank canvas and separate colors in a tube (we are fully aware that images can be constructed in many other ways, eg. Colors do not have to come from a tube, and they do not have to be applied on a canvas). The image is created by mixing colors, and combining them on the canvas. This means that an extensive knowledge of colors is essential when creating paintings. In painting colors are typically describe by their location on a "color wheel" (Figure 9)
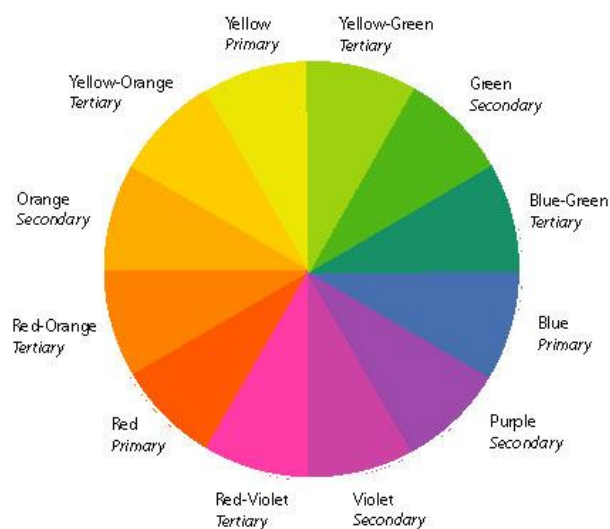

Figure 9 Color wheel [37]

A method for describing the overall hue in a painting is to describe it in terms of color scheme. When creating an image the painter has to choose what colors he will use and he can do so by choosing a color scheme. According to [38] there are five basic types of color schemes: monochromatic, Analogous, Triadic, Complementary, Split Complementary. We will explain two of the schemes here to get an understanding of how the scheme influences the mood of the picture. In monochromatic Scheme, only one color is used and mixed with white black and gray (hence the name "Monochrome") In the figure (Figure 10) the painter has chosen a green – yellowish color and added black and white. In the analogous color scheme the painter chooses one primary color on the color wheel (Figure 9) and three adjacent colors, in the figure (Figure 11) the painter has used Blue as the primary color and the three adjacent colors towards red.

Figure 10 Monochromatic Color scheme

Figure 11 Analogous color scheme

The choice of color scheme has a great influence on the atmosphere of the picture, by changing the choice of color and their individual placement on the color wheel it is possible to get two completely different moods in the images. The images are not very different in what they are depicting, but the choice of color determines the atmosphere. The example illustrates that by choosing and combining colors in a specific way, very different expressions can be achieved. If the ambilight are capable of capturing the hue and saturation of the image it is reasonable to assume that the atmosphere the image is trying to establish can be expressed in the light surrounding the TV by mimicking the color scheme.

5.4 Color in films examples.

We have described the connection between colors and emotions and in the following we will look at an example of how this can be implemented in a movie, and what it looks like with the ambilight.

The movie "Traffic" [39] uses colors very vividly as a storytelling tool, the film takes place in Mexico and America and deals with the problems of drug trafficking between Mexico and America. In the film the color schemes of a warm yellow reddish versus a cold blue is used, we do not wish to give a thorough analysis of why the director has chosen to use these exact colors, but we will use the example to demonstrate that the method used in this film is clearly resembling the examples described in (5.3)

When the picture is blurred (Figure 12 vs. Figure 13) it is easier to see the color scheme without being disturbed by the acting, where the face of the girl in the blue picture is not as happy as the self confident woman in the yellow.

Figure 12 Two different scenes from the movie "Traffic"

Figure 13 Color scheme of two different scenes from the movie "Traffic"

The degree to which a movie uses color schemes varies, and one of the reasons that it is evident that Traffic uses it, is that in Traffic very different color schemes are used in the same movie. Typically a movie will only use one color scheme with smaller variations. The movie "Quarantine" [40] also uses a bluish color scheme (Figure 14) and this is done throughout the movie.

Figure 14 Color scheme from the movie "quarantine"

We are reluctant to give an evaluation of exactly what emotion the bluish color scheme from Traffic and Quarantine are expressing for two reasons. Firstly we claimed in the introduction to this chapter, that movies are nothing but light waves and changes in air pressure if it is not interpreted. And our interpretation might differ from that of the reader. Secondly according to [36] the bluish scene should be pleasant and not arousing. And the yellowish scene should be less pleasant less arousing. In other words the bluish scene should be more pleasant than the yellowish. According to [33] the bluish scene should be non-arousing and the reddish scene should be arousing. When watching Traffic one quickly realizes that the scene with the girl is very unpleasant, since she has just prostituted herself for drugs. The mood in Quarantine is also unpleasant since it is a horror film. The yellowish scene shows a happy woman who are on her way to meet her boyfriend. The use of colors in movies seems to be consistent with the assumption that red is arousing and blue is non–arousing; however this might not be the case in all movies.

When we attach the ambilight to the film (Figure 15 Figure 16) there is very little doubt that it does indeed mimic the color of the scene and project it onto the wall, there is also little doubt that colors are used to set the atmosphere in Traffic. The question is: by adding more blue light does the atmosphere of the scene become less arousing. And in the specific case of the blue scene in Traffic, is the atmosphere more unpleasant with the ambilight on or off? And is the red/yellow scene more arousing? In other words does the ambilight enhance the atmosphere of the film?

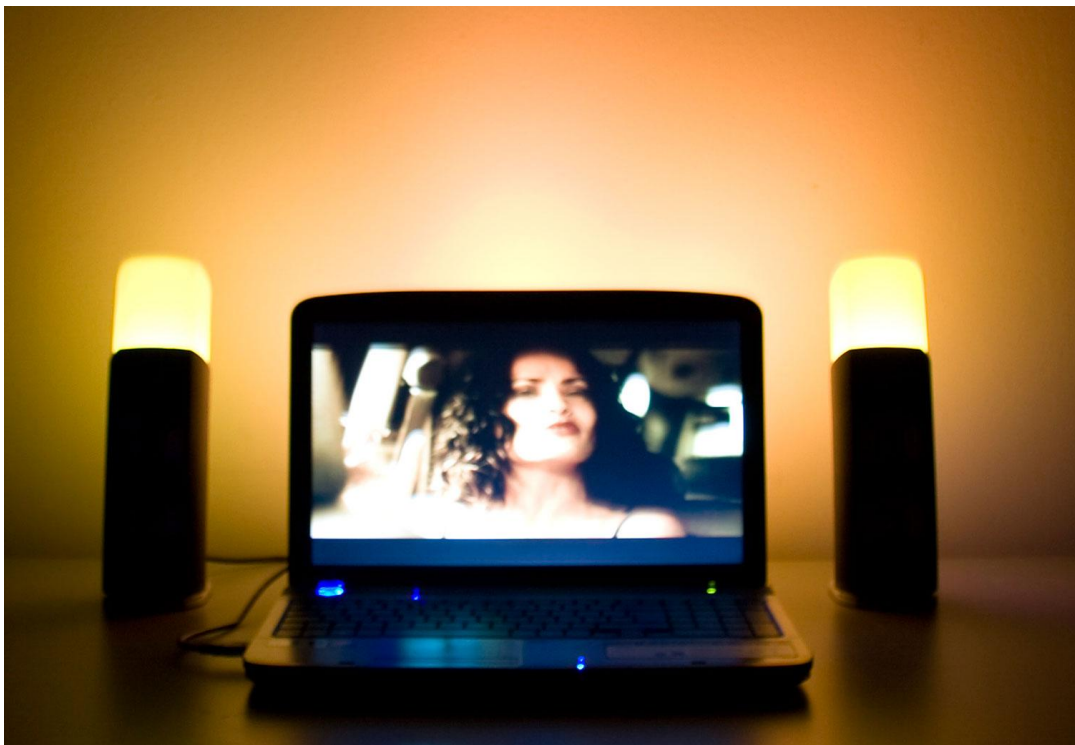**Figure 15 A girl has just prostituted herself for drugs in the movie "Traffic"**

Figure 16 A woman on the way to visit her lover in the movie "Traffic"

5.4.1 Movies are more than colors.

There are many different ways a film director can choose to express the content of his art piece. The choice of form is a choice of tools, where colors are one very important tool. In the example of Traffic, colors are used very extensively as a tool to establish atmosphere. Obviously we have chosen the Traffic example to exaggerate how colors are used to make our point clearer. We must therefore be aware that not all films use colors as vividly, but they do use them to some extent. In traffic the difference in atmosphere is an important element of the story and this is shown with color. Consequently if a movie does not use colors very much the ambilight will not be activated very much. We assume that the effect of the ambilight will vary on this basis.

5.4.2 Sum up.

In the previous chapter we have described what emotions are. We have also analyzed how the ambilight functions. We found that the ambilight mimics the color used in a movie. We have then asked if the use of colors have an effect on emotions. We have found that colors can be linked to emotions as we have described them in (4.1). We have also found that colors are used in painting and the combination of colors is referred to as color schemes. We have argued that color schemes are used in film as well. And we have described an example of how colors are used to set the atmosphere in a film. In the next chapter we raise the question, what other aspects of film form influences the atmosphere?

6 Sound in film

A movie provides two types of stimuli: light and sound. Traditionally the visual aspect of movies has had the most focus in research, and sound has been thought of as an added feature of. However several studies [41, 42] has suggested that there is a close link between sound and vision in cinema and that sound and vision is used in a multimodal fashion. The study [43] found that the perceived quality of an image is influenced by the quality of the sound. This would suggest that in some form or another image and sound is undergoing an interaction (Appendix A). This underline that when investigating light and image in cinema it is necessary to understand sound as well, since sound has a great influence on the perception of the image. In cinema the task of understanding the multimodal perception of sound and image is complicated even further since the combination of the two types of stimuli is used as an art form that are heavily reliant on things that are not defined by physical laws, such as trends and tendencies in society. Music are used in films and there is a clear link between music and emotions, the fact that music can provoke emotions is such a common observation, that is not necessary to argue if this is true or not. However for the sake of the argument, the simple fact that music is used to stress prisoners, to lovemaking underlines that music creates a strong emotional response (we acknowledge that the music in the two examples are properly of different genres). Therefore in this chapter we describe what sound is used for in movies, with focus on how it influences the emotional response in the viewer and how it is combined with the image.

6.1 Combining image and sound in movies

On the very basic level sound and image has to be combined such that the mind perceives that sound and image is indeed caused by the same event, thereby avoiding segregation of stimuli [Appendix A].

There are no natural cause between the sound and image in a movie, the viewer has to accept that the sound he perceives from the speakers are indeed coming from the screen, and even more so, the viewer has to accept that the sound from the speakers are coming from a certain element on the screen. The concept of combining mentally the audio track of a movie with the image track is referred to as "the audiovisual contract" by Chion [44] the viewer has to be able to combine image and sound, Chion claims that *synchresis* [44 p. 63] is a key element to achieve the combination. Synchresis is a combination of the words "synchronism" and "synthesis". In other words *synchresis* is the mental process of synchronizing image and sound and synthesizing a meaning/story from the two percepts.

In movies sound produces an "added Value" [44] p. 6, 26] to the image, in the way that the story the image portrays is perceived differently when sound is present. This suggests that the "meaning" of the movie is formed by sound and image together, and sound does not "tell" the same story as the image. It is important to note that the viewer typically does not notice that sound is changing the way image is perceived, the narrative of the movies is perceived to be coming from the image thusly image is perceived as being primary and sound secondary.

6.2 Where does sound come from in film?

When discussing sound in film one must distinguish between from where the sound originates. A typical method of spatial segregation in film is the distinguishing between diegetic and non diegetic space. Diegetic space is the narrative space or the narrative world. A way of understanding the distinction is to consider perspective. The diegetic space is everything that the inhabitants of the narrative space, has a possibility to perceive. Non diegetic space is everything present in a movie that the inhabitants of the narrative cannot perceive. Diegetic space is the narrative space and is on short considered to be every object that has a plausible existence in the story world, depicted or not.

6.3 What is sound in movies

Sound in cinema can be divided into three categories speech effects and music [44], 26 p. 347]

Speech is fairly simple to describe in movies since speech are the spoken word of the characters (also including narrators that stems from the non-diegetic space). Speech is the type of sound that is given the most attention. Chion claims that …*Cinema is vococentric or, more precisely, a verbocentric phenomenon.* With this statement Chion claims that the spoken word is the most important part of the soundtrack. Chion claims that this is due to the fact that humans are verbocentric in their habitual behavior as well. Chion continues: So *if these voices speak in an accessible language, you will first seek the meaning of the words, moving on to interpret the other sounds only when your interests in meaning has been satisfied.* This suggests that there is an importance hierarchy between the different categories of sound, with speech as the most important.

Sound effects are used in cinema as the sound of objects in the scene, e.g. closing of doors, footsteps etc. While watching a movie one is likely not noticing how few events in the scene that actually produces audible sounds. In the natural environment there are several sounds present at all times, this can be subtle background such as noise from traffic or the turbulent noise of wind in the window. Sound effects are added after shooting the scene, and the director has to decide what events are to have a sound. This choice is a powerful cinematic tool that can be used for creating an emotional response, and are often used to give e sonic description of the emotional state of the characters on the screen. This is achieved by changing the fidelity of the sound (not by changing the quality but the semantic relation between the sound and the visual source). An example of this can be found in the blockbuster movie "Saving private Ryan" [45] the viewer follows the landing on the beaches in Normandy on D-day during world war II. The scene is filled with sounds of gunfire, exploding grenades and shouting men. At some point the scene is shot in manner as to simulate that the audience is watching the scene through the eyes of a soldier (point of view) landing on the beach. During the shot the soldier is immersed in water. The sound is muffled to simulate the sound that one would hear when immersed in liquid. Manipulating the fidelity of the sound effects is a powerful filmic tool that guides the audiences understanding of the emotions in the scene. Fidelity can also be changed on speech, and it can be argued that when this is done, speech becomes a sound effect. An example of this can be found in "The Game" [46] where the protagonist of the film is poisoned, the speech of the other characters are changed so it is out of synch with the lip movements, and again the sound is muffled, this is to help the audience understand the emotional / physical state of the protagonist.

By actively choosing what events on the screen should have a sound event the filmmaker creates a form of cocktail effect, since he is directing the attention of the audience, by shutting out sounds that he does not want the viewer to pay attention to. The change in fidelity is often perceived unconsciously unless it is used vividly as in the "Saving private Ryan" example.

Music
There are two different types of music for film that one must consider Music score and music in film [47]. Music score is the music present when showing the films score, and are not directly used as a story telling tool, it is more of a marketing tool then it is used to guide scene specific emotions. It can be argued that the music score sets the overall emotional frame of the movie where film music is used to set the mood in a specific part/scene of the film. Music can be used as diegetic and non diegetic sound, where speech and effects are bound to objects in the image (speech can be used non diegetic, as the voice of a narrator, it will however have a source in the form of the narrator), non diegetic music does not need a source as such in the image. We focus on music as a story telling tool.

In 1993 Cohen [48] conducted an experiment that had the purpose of investigating how the perceived emotional value of a video clip and a music clip would influence each other. In the experiment participants was asked to judge happiness and sadness of either a video clip of a bouncing ball or a music clip. The experiments show that the music clips with higher tempo and pitch, and the video clips with the highest bouncing ball were judged to contain more happiness. The experiment also showed that when a video clip, previously judged to be of high happiness, were combined with music of low pitch and slow tempo, the video clip would be judged to have less happiness. In other words the mood of the sound clip and the mood of the video clip would be joined into one evaluation.

Because film content provides the object of emotion generated by music, the film helps to control the definition of the object of the emotion experienced during the presence of music[49]. The quote underlines the importance of music as an instrument of creating emotions. It also underlines the relationship between music and film, image shows the object of the emotions the viewer is experiencing caused by music. In other words the functionality is that music is used to create an emotion in the viewer, and then image provides an object that the emotion can be connected to. In this way the sound becomes primary, (if emotions are evaluated separately) and vision is secondary, therefore sound provides the primary information of the emotion, and image provides the secondary information of where it is coming from. This makes perfect sense when considering the statement from [50] where it's stated that music can *express* and *arouse* emotions, but it cannot *represent* emotions. Image provides a representation that the emotion provided by the music can be connected to.

Music can incite many emotions in a listener, and even though different persons react differently to the same piece of music there are general aspects that describe the mood of a piece of music. Describing how music incite emotions when listened to outside a film context, is a vast study on its own, thusly trying to describe what exact features of music would cause different emotions is beyond the scope of this report since there are variables such as basic music theory, inter textual context, cultural context, and so on and so forth. The important distinction is that music is used actively to express emotions in film [49] [26 p. 356].

6.4 Why is surround implemented?

Movies are designed to support surround sound, why is this? One must ask why more sound channels are being added to movie theaters as well as to home theaters. And why is more content not being shifted into the surround channels? And we must also ask does the surround channel have an influence on emotions?

Surround sound is becoming synonymous with a loudspeaker setup consisting of five or six speakers, three in front (left, center and right) and two behind the viewer (surround left and surround right) and a subwoofer. However "surround" does in its basic form mean that sound is intended to "surround" the viewer. Since the beginning of cinema there has been a one wall approach to how the narrative space and thus the sound were implemented in the cinema. This approach has meant that the narrative space is in front of the viewer, the viewer is looking into the narrative trough a frame which is the screen. With the introduction of surround sound the film designer had the opportunity to stretch the narrative space beyond the screen by providing film sound content in the surround speakers. This meant that the "one wall" convention was broken. This lead to a disturbing effect that caused the audience to direct their attention away from the screen towards the location of the speakers [47p. 83] Today surround speakers are used very carefully, even though it is technically possible to reproduce sound behind the viewer, it is only done in a very limited manner, as not to brake with the one wall convention. The surround channels are mainly used for sound effects and for music. Typically when the surround channel is used for music, the front speakers are playing the music much louder than hind speakers. This means that the rear speakers are used very carefully and are designed to not draw attention away from the screen. In a way sound in the rear speakers are not to be noticed and therefore be unconsciously perceived. Sound in the surround channels are used to create a mood, but more precisely to enhance the mood from the front speakers. Chion describes this as the *super field*. With the *superfield* description Chion conceptualizes what extending the narrative space behind the viewer can be used for. In the movie "The village"[51] the surround speakers are

used to present very subtle sounds effects in the rear speakers, not loud enough to draw attention away from the narrative space in front of the viewer, but loud enough to create an eerie mood. Thusly the introduction of the surround channels behind the viewer has caused a new breed of effects, or a change in how the narrative space is presented, but it can be used to extend the sound content. In other words when a sound designer designs a sound he can use the rear speakers as an effect that can create a mood. It has been shown that when a person is presented to a sound, the sound is more uncanny / eerie when the source cannot be located. Therefore rear channels might better suited for audio content that has the purpose of eliciting unpleasant emotions.

6.4.1 Listening modes:

One aspect of sound is how it is designed, but another aspect is how the sound is listened to by the viewer. On a cognitive level the viewer can more or less consciously choose what he wants to focus on. The process of guiding attention is described as listening modes

Gaver [52] gives a description of two different types of listening modes that describes listening in general, namely *musical listening* and everyday *listening*. The difference lies in how the perceived sound is described, thus categorized by the receiver, the main distinction lies in either describing the source of the sound or the sound itself. Most of the time humans do not describe the sound, but the event that are creating the sound, e.g. the sound of a slamming door (everyday listening) and not a sound with a hard attack, short decay, and little sustain and release (musical listening). Gaver describes the process of describing listening as a mapping between the sound-producing world to the sound-perceiving experience. *The goal of all research on auditory perception is to understand the mappings between relevant physical attributes of sound and a listener's experience, but where most traditional research on audition concerns itself with musical listening, without reference to sound sources, everyday listening concerns itself with the entire continuum linking sonic events to conscious experience* [52 p. 3] In the context of this report this mapping would be between the narrative movie world and the sound-perceiving experience, with focus on emotional response. Gaver gives a general description of perception and the concept of listening, which is not directly related to cinema. Chion however describes listening modes in a cinematic context. Chion segments listening modes while watching a movie into three groups: *Casual listening, Semantic listening,* and *reduced listening. Casual listening* resembles everyday listening, which is focused on gathering information about the event causing the sound. This information can then be grouped into different categories dependant of how specific the sound is linked to an event. A sound can be linked directly to one object e.g. this is the sound of MY cell phone or more generally to; this is the sound of A cell phone. In cinematic context the level to which degree the sound is linked to an object is dependent on the visual stimuli. If the object creating the sound is depicted on the screen the sound will be linked to that specific object. If the sound is coming from an object that belongs to the story world (diegetic space) the sound will be linked more generally to a sound in that world. Even when there are no apparent source and the sound cannot be recognized the sound can still be linked to a more elusive phenomenon such as atmosphere e.g. a sound can be robot like. This linking of sound to an atmosphere is dependent on movie conventions. An example of this is the humming sound of a neon lamp, which has become synonymous with the sound of institutions. Often non specific inter textual references are made using sound, that resembles sounds from other movies. This indicates that the combination of sound and image is influencing what listening mode

the viewer uses during the clip and the response of the viewer can become emotional if the image sound combination manages to trigger the right thought process.

Semantic listening mode is typically used when decoding speech in film. It does not necessarily have to be decoding of speech alone, an example of this is the use of machinery sounds by the Character of "R2D2" in "Star Wars 1-6" [53] where R2D2 (a robot) has the capability of communicating its emotional states trough beeping sounds, which has no words. It is possible to listen to speech with both semantically and casually. Semantic listening is to determine what words are being used and casually listening is to determine the mood of the speaker.

Reduced listening is used to describe the process of listening to the sound itself without evaluating what causes it. To listen without the purpose of identifying the source is the opposite of what the auditory system is designed to do and it is an ability that needs to be learned. It is also in contradiction with the way image and sound is working together in cinema. The audiovisual contract encourages the viewer to combine what is seen and heard even when the two are different in nature. Thusly *reduced listening* is a process that rarely takes place in a normal listening situation in the cinema; however the listening mode is quite useful when it comes to understanding the sound as a single entity. It is evident that the purpose of the cinema is not to create an audio only experience, and as a result of this it would take quite some concentration to avoid a cross modal experience in the cinema. Therefore pure *reduced listening* is reserved for the audio connoisseur. Sound in cinema consists of Speech, ambience and music. The soundtrack of a film often contains all three types of sound at the same time. As Chion mentions attention is focused on speech and secondly on music and ambience. Listening modes are related to how the viewers attention is directed and a mix of listening modes are combined at almost all time, dependant of how the soundtrack is composed and its relation to the image. E.g. if there is only speech (and a visual source, e.g. an actor in the image) semantic listening will be used where, casual and reduced listening is sparsely applied. Also *reduced listening* is seldom used as the primary listening mode on a conscious level. Therefore when attention is focused on speech, and there is music present, the viewer is unwarily applying reduced listening mode to interpret the music. Chion concludes that due to the fact that the ears cannot be "turned off" it is possible to saturate and "shortcut" our perception and as a result: *sound, much more than the image, can become means of affective and semantic manipulation* [44p. 34].

Sound has a very strong impact on emotions, since it is used as a tool to set the mood of the story. Through synchresis sound is interplaying with the image thusly the story, and atmosphere is created based on sound and image. When watching a movie the process of listening is a complex interplay of how the image sound is combined, but also on how the user is listening, how attention is directed. This means that when an emotion occurs during a movie watching session, it is dependent on the stimuli present from the movie, but also the interpretation from the viewer. There are thusly two variables that have to be evaluated when asking: Is there an emotion during this movie watching session? Does the film produce the atmosphere? And did the viewer feel the emotion?

6.4.2 Partial conclusion

In the previous chapter we have described the aspects of film that we believe are relevant when investigating ambilight. We have given a formal description of what we consider to be emotions and argued why it can be used to describe the claims by Phillips. We have analyzed art and film form with the purpose of understanding how emotions are created by color. We have observed that, the ambilight will mimic how colors are used in film. We consider sound since there is very strong evidence that sound influences the perception of the image on all levels ranging from sensation to perception and cognition and that sound is a very strong tool for creating the atmosphere in a film.

The findings of the Preanalysis can be summarized as follows: Emotions can be described in a scientific manner. Ambilight mimics the color use in a film. Colors can elicit emotions. Colors are used to set the atmosphere in paintings. To a various degree colors are used to set atmosphere in film. Sound is a strong tool for setting the atmosphere in film.

These findings leads to an interesting conclusion: there is ample evidence that the ambilight to some degree might enhance the atmosphere of the film. Since the ambilight projects the films atmospheric information the question remains: is the viewer capable of perceiving this atmosphere? This leads us to our initial problem statement.

7 Initial Problem statement

To what extend does the ambilight transfer atmospheric information to the cognitive level?

8 Analysis

The Preanalysis concluded that the ambilight might be capable of enhancing the atmosphere a film produces. In the following chapter we will analyze why it might do so.

At this point observations have shown that the Ambilight system responds to color in the image, light and. It is also known that all of these elements probably carry some kind of information about the atmosphere of a scene in the film. In this analysis we will consider whether the stimuli from the Ambilight system could be manifested in an amplified mood or emotion in the viewer of the film and if so, how it could be measured. The findings will be used in the forming of a set of testable hypotheses.

When stimulus from the Ambilight system reaches the eyes of the viewer it goes through a process and might result in an emotion or mood. A common model for describing this process is the sensation/perception and cognition model [54]. The model is simply a method for describing how stimuli are pickup by our senses (sensation), categorized (perception) and then used in the cognitive domain (see Figure 17).
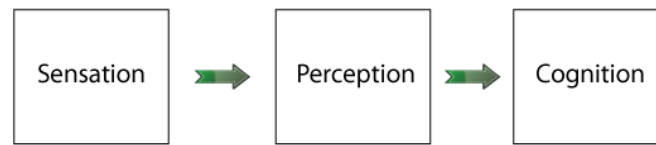
Figure 17 Atmospheric information has to travel from the sensation level to the cognitive level

As already defined, emotions are part bodily and part cognitive, whereas mood is mostly cognitive (4.1). As an atmosphere is the potential of inducing emotion or mood, the atmospheric information has to reach the cognitive level to have full effect. Therefore if the atmosphere of a film is to be communicated efficiently through ambilight the stimulus has to pass through the sensation and perception stages in this model, without the loss of the atmospheric information. It is therefore necessary to delve into each stage of the model to get an impression of whether this is possible. We noticed during the observation of the Ambilight system that the product was intended to work "passively" in the outer most areas of the field of view, while the viewer was experiencing the film. This led us to further investigate sensation and perception of light in peripheral areas of the field of view.

8.1 *Visual sensation*

To understand the properties of visual sensation in detail one has to take a closer look at the anatomy of the human eye. When the light passes through the pupil of the eye it hits the light sensitive "wall" at the rear of the eye, named *retina* [54 p. 52]. The retina is a layer of light receptors, which absorbs the light rays and sends them to the brain for interpretation. The retina has been reported capable of providing human beings with a maximum horizontal field of view (FOV) of around 200° [55], a 100° to the left and right of the viewing direction. However human beings are not uniformly sensitive to light along the retina. The amount of receptors is greatest at the region of the eye called *fovea* located in the back of the eye directly opposite the pupil. The density of receptors then decreases in a radius from this region and out towards the edge of the retina. Furthermore these receptors can be divided into two types: Cones (color-sensitive) and rods (illumination sensitive). The fovea and the area around have a high population of cones, while the peripheral areas of the retina have a high density of rods [54 p. 61]

This distribution of receptors result in the highest resolution and color sensitivity in the image processed from the light hitting fovea, while the resolution resulting from light on the remaining part of the retina will gradually decrease. As such the FOV can be divided into three, namely the central FOV (CFOV), the para fovea FOV (PFFOV) and the peripheral FOV (PFOV). Most distinctions between CFOV, PFFOV and PFOV places the CFOV to be around 2° of the FOV (1° on each side of the fixation point) [56,57], PFFOV to be the region between 1° and 5° on each side of the fixation point [58], while the PFOV is the remaining 95° on each side of the fixation point (see Figure 18).
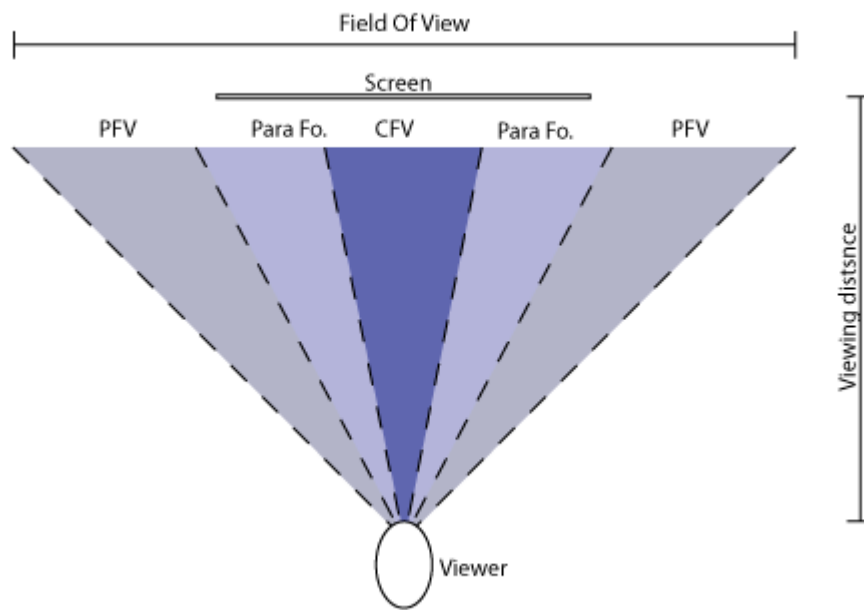
Figure 18 the segmentation of field of view

A main feature of the PFFOV and the PFOV is that it enables human beings to "plan" where to look next by providing the human brain with a lower resolution sensation of the environment. If something (e.g. an object) in the PFFOV-PFOV gist becomes of interest, "attention" is shifted. The eyes are then moved (saccadic movements) in a way that the light from the object of interest is hitting the fovea resulting in refined details [54 p. 118]. This is in line with another attribute of the PFOV (18° from fixation in the referenced study), namely that it is more sensitive to movement than the CFOV [59]. This is practical since objects of interest are likely to be seen as moving elements on a static background.

8.1.1 Distribution of FOV between screen and wall

For starters it seems reasonable to examine how much of the CFOV which is actually covered by the screen (and how much which is not?). Here it is interesting to learn that guidelines from THX recommend that the screen should occlude between 26° and 35° (degrees assumed horizontal) of the FOV [60]. However this does probably only hold true in the case of large theaters. Arnold Lund did a thorough study [61] comparing the preferred viewing distance, in relation to screen height, of fifty participants (experts and non-experts) across four experiments. His findings suggest that the ratio between viewing distance and image size decreases as the size of the image increases. Some of the specific results from the experiments are:

11" screen preferred viewed at a mean distance of 132,3 cm. – covering approx. 9.3° of horizontal FOV and approx. 7.7° of vertical FOV.

20" screen preferred viewed at a mean distance of 187 cm. – covering approx. 12.4° of horizontal FOV and approx. 9.3° of vertical FOV.

32" screen preferred viewed at a mean distance of 239,24 cm. – covering approx. 15.6° of horizontal FOV and approx. 11.5° of vertical FOV.

60" projected image preferred viewed at a mean distance of 380 cm. – covering approx. 17.9° of horizontal FOV and approx. 14.1° of vertical FOV.

From the gathered results Lund was able to derive a mathematical formula, taking screen height in return for the approximated preferred viewing distance (Figure 19):

$$20.739 + 4.647 * -0.025 * (x^2)$$

Figure 19 viewing distance formula

As it can be seen from these results, the peripheral parts of the FOV seem to become more important as the viewer is presented to larger displays. In the case where the guidelines from THX is applied (which according to Lucas Film should provide the best conditions for film viewing) including the peripheral sight into the visual experience seems even more important than in the home-cinema setup, as the CFOV only takes up a 2° of the recommended approximated 30°. Still only 15% of the FOV or below is exposed to the visuals of the movie, which leaves the majority of the PFOV to perceive nothing but the "bare walls".

8.2 Is atmospheric information lost in the sensation step?

We have enough information now to be able to discuss the consequences of the sensation step. From Arnold Lund's experiments it can be seen that as the screen grows larger more and more of the PFOV is covered by it. However this also implies that when the screen becomes bigger, the ambilight will be move further out in the PFOV. As the ambilight stimulus is pushed toward the edge of the FOV, one will first lose the ability to perceive color (due to the distribution of cones) and ultimately lose sight of the ambilight (since the rods will eventually disappear as well). But, the viewer will probably not constantly keep his or her eyes fixated at the center of the screen. Instead their fixation point will be moving around the screen to points of interest. As such it is hard exactly to know how much, and where in the FOV, ambilight will be perceived, but it is reasonable to believe that ambilight will be perceived mostly through either the PFOV or

the PFFOV as long as the viewer's attention is directed towards the content on the screen. When ambilight is perceived in this way, there is potential danger for the loss of atmospheric information. As already mentioned, the sensation of color could disappear for a while (when ambilight is perceived too far out in the PFOV). The low resolution of the outer areas of the PFOV is not considered a problem as the ambilight does not contain any textural or detailed information. The sensation of light intensity should actually be more accurate in the PFFOV and the PFOV as more rods are located in these areas of the retina. Another potential danger for the loss of atmospheric information is of another character, but linked to this type of sensation. As ambilight is changing according to the displayed content on the screen, it will probably appear as movement in the PFFOV or the PFOV. As stated these areas are more sensitive to motion and as such this movement might become of interest to the perceptual system resulting in a relocation of the fixation point to the ambilight (which is rather uninteresting compared to the film content).

8.2.1 Non-CFV perception

In the search for more information on the perception process of light arriving in the PFOV and PFFOV, we started to browse through reviews of the ambilight system or the amBX. Here it seemed that the amount of distraction induced by the system is often debated. *Sometimes ambilight succeeds at this, but more often I found it simply distracting* [62] and *The amBX gaming peripherals are an unconventional concept, but for gaming purposes, the lighting seems superfluous and distracting to me* [63] were some of the examples of comments from reviewers which found the ambilight distracting. The most positive reviews were given by writers, which got used to the system or were able to somehow cope with the distractions of the ambilight: *It works, but only when you stop checking out the effects themselves and focus on the game. All the amBX devices tempt you to focus on the devices themselves, but once you get over that the real benefits come to the fore* [64]. Even though the majority of reviews speak positively about the ambilight systems it seems that distraction is an issue which has to be taken into consideration. However, based upon the reviewer comments, some find ambilight to be a benefit in a media experience if it is perceived without putting direct attention towards it. But, if attention should be elsewhere (e.g. on the mediated content) then how can the ambilight then be perceived? Is attention somehow divided between screen image and ambilight or is the ambilight somehow unattended perceived and processed?

When diving into research regarding unattended perception one quickly realize that there is a blend between this line of research and studies investigating unconscious perception. Most studies on unconscious perception [65] tend to make their participants unaware about a presented stimulus by preventing "full" perception of the stimulus. For instance visual stimulus can be displayed/primed very quickly (during a couple of milliseconds), which leaves the participants unaware that the stimulus has been presented to them. Studies investigating perception without attention [66] on the other hand, usually direct participants' attention to a primary task, while examining the perception of a secondary stimulus. Light received at the PFFOV and the PFOV will probably not render the participants unaware of the light, but instead the participants might perceive the light while their attention will be focused elsewhere. However even though perception without awareness and perception without attention is two different conditions for perception, empirical work comparing the two conditions has found that they elicit some of

the same effects [67], which might imply that both conditions addresses a similar underlying concept of awareness. Also placing stimulus in the PFFOV-PFOV is used in both lines of studies [66,68,69]. The link between perception without attention and without awareness has also been found by John Kihlstrom and colleagues, which has gathered both condition and coined them as "implicit perception" [70 p. 33]. As such an insight into both research fields might give more information on the effects of perception of ambilight on cognitive emotions.

8.3 The effects of implicit perception in the emotional domain

One of the most important findings within implicit perception research in relation to this study is the discovery of how attended stimulus is likely to be associated with a certain emotion when stimulus showing the same emotion is perceived implicitly. This association is displayed in the choices an individual makes following the exposure (so called affective reactions) [65]. For instance an experiment [71] by Murphy and Zajonc showed that displaying emotional faces rapidly (4 milliseconds) to participants produced increased liking of Chinese ideographs primed with a happy face and decreased preference of ideographs primed with an unhappy face. No significant effect was found for aware exposure (1000 milliseconds) of the emotional faces. Even though this study applies primed (rapid prior exposure of) stimuli to make the participants unaware of the exposure there is the possibility that the same association effect might apply to stimulus exposed in the PFFOV or the PFOV. If this is the case unattended exposure to a color, which has been shown to carry emotional value (5.2), might make the participant associate this emotion with the attended stimulus (e.g. the content of the movie). This would indeed be a strong argument speaking for the assumption that ambilight can amplify the atmosphere of a film. However none of the studies, we were able to find within the field of implicit perception, used color as a stimulus for implicit perception in the PFOV and the PFFOV. However images and words have been used, which semantically are more complicated to decode for emotional value.

In a study [57] by Calvo and colleagues, participants were primed for 150 milliseconds to two images (one emotional and one neutral) in the PFOV (5.2° from fixation point) and then asked to verify whether a subsequent probe image was identical to one of the presented peripheral images or not. The results revealed that the recognition rate was not above chance level and that there was no advantage for emotional- over neutral images. This suggests that specific content is not semantically processed of either emotional or neutral scenes when presented in the PFOV. However a significant increase was found in incorrect "yes" responses to probe pictures that had not been presented as primes, but that were related in general content and emotional valence to the presented primes. This lead to the conclusion that stimulus in the PFOV is only perceived as a gist impression, but that emotional signals from the content can be derived to a degree at which an image with a similar emotional signal can be identified. In a subsequent experiment Calvo and colleagues found that this gist can be perceived as expressing an emotion, since it improved the chances of a subsequent fixation on the emotional rather than the neutral images [57]. This implies that the PFOV to a certain degree is sensitive to emotional stimulus. A similar experiment done by Calvo and Lang [72] used the same experimental setup as in the above PFOV experiment, but here the images were instead presented to the unattended PFFOV (2.1° or 2.5° from fixation point). The yield of this

experiment was, opposite to those from the examination of the PFOV, referring to semantic processing of emotional content rather than just a "gist"-processing. This make sense the sensation probably provides a higher resolution in the PFFOV than in the PFOV.

In studies where emotional words were the primed stimulus in the PFFOV, the main tendency has been that especially unpleasant or threat-related words tend to have a significant impact on participant responses [69,73] (see [74] for null results). For instance in the study by Calvo and Castillo [74] the purpose was to investigate the effect of showing words in PFFOV in either a pleasant or unpleasant context. After either being shown a pleasant or unpleasant image or no images at all the participants were told to remember details in the picture and were then put through a series of trails. In each trail the participants were primed for 150 milliseconds with two words: One at fixation and one in the PFFOV (2.2° from fixation), which was then followed by a foveally presented probe word. The participants were informed to state whether this last probe word was a word or a non-word (letters which do not give a semantic meaning). Previous prime studies of this type have shown that being primed with a word which has the same emotional valance as the subsequent probe word will result in shorter respond times, in oppose to cases where the words were unrelated in valance. Calvo and Castillo wanted to test whether the introduced context would elicit an increase or decrease in the respond time. Their results showed that the respond times only were significantly decreased in scenarios where an unpleasant probe word followed an identical parafoveal prime word. Moreover, this effect was enhanced for unpleasant words in the unpleasant context condition, in comparison with the no-context condition, whereas a pleasant context did not affect the respond times of positive prime-probe words. It seems that the implicitly perceived stimulus has a greater effect (at least for negative scenarios) if it is in line with the individuals existing emotional state build by the context. If this holds true for colors as well this is a good argument talking for the assumption that ambilight can enhance the atmosphere build by a movie. As this congruity often is build into the ambilight. In most Ambilight implementations the resulting ambilight "follow" the image on the screen by portraying the same colors. As such an "enhancement" might take place when an individual is exposed implicitly to ambilight while being in an emotional context build by the film content.

8.3.1 The effects of "long" implicit perception in the emotional domain

For now it seems, according to most reviewers of Ambilight systems, that ambilight has the greatest effect if it is perceived implicitly and unattended and apparently implicit perception has an effect on the emotional domain, namely that the emotional valence of a stimulus implicitly perceived can be associated with the attended stimulus. This discovery is also used widely in another area, namely business. Research [75], in how physical surroundings can influence customer impressions towards an offered service or an object of interest, addresses the phenomenon that when customers visit a store or a hotel they usually have attention directed towards the task at hand and as such tend to gain impressions of the detailed environment through implicit perception. The attributes of the implicitly perceived environment is then associated with the service or product. For instance in a study by Barry Barin and colleagues [76] it has been shown that consumers thought they would be more likely to purchase products in a store with blue interior in oppose to a store with orange interior. With the addition of bright lights in combination with the

orange interior the consumers indicated a reduced shopping intention. The consumers also reported that this combination produce expectations of very low prices. However the changing of condition to the use of orange interior with soft lighting appeared to have the opposite effect.

When viewing a film with Ambilight, the viewer is continuously exposed to ambilight, which might result in additional long-term effects in the emotional domain. Therefore findings such as the above concerned with longer unattended exposure to color or light, is important to consider as most implicit perception studies deal with the consequences of exposure during a couple of milliseconds. It now seems reasonable to believe that sensation of unattended color and light is implicitly processed and can have an effect on the attended element(s). However in addition to Barin's store experiment, studies in the field of environmental psychology have found that effects of environmental lighting can differ between gender and age.

Igor Knez and collogues have done a series of studies [77,78,79] in which it is concluded that lighting and colors in a physical location has different effects across gender and age on people staying that space. In [80] 108 participants were in turn placed in a room painted in off-white. The room was lit by three types of light serving as the independent variable on a within-subjects basis. The types of light applied were a "warm" reddish-white lighting, a "cool" bluish-white lighting and an artificial white daylight lighting. The participants were after spending about 100 minutes in the room asked about their perception of the light. The results showed that females perceived the light in all conditions as being more expressive than did males. In a similar study [] involving 96 participants a significance effect was found in mood between genders during the exposure to reddish-white and bluish-white light conditions. Females reported their negative mood to decrease during reddish-lighting and increase in bluish-lighting, while males rated their negative mood opposite. Both of these studies demonstrate that light conditions have effects across gender. The age parameter was investigated in a study by Knez and Christina Kers [81]. 80 participants were her placed in an office-like room with naturally colored walls. The room was either illuminated by reddish-white- or bluish-white lighting. The participants were of two age groups (mean age 23.3 and 65.2) and of both genders. In groups of 2 or 4 they were each placed in the office space with one of the lighting condition for around 120 minutes while performing a task. Self-reported mood showed that the young age-group preserved a negative mood in the "warm"-lighting condition where the old age-group preserved a negative mood in the "cold"-lighting. In addition younger females were in general better at preserving a positive and negative mood than younger males.

To summarize, Barry Barin's experiment makes it reasonable to assume that color and light perceived implicitly can be attached to objects (products). To elaborate on this effect studies form environmental psychology on lighting conditions displayed a significant difference in how light and its color-attribute is perceived and how it affects a person's mood across gender and age. If these findings from other fields of research are valid in relation to the perception of ambilight during film viewing, this implies that the ambilight might have an effect on the viewer's mood, but that this effect could be different across genders and age. These variables have to be considered in a forthcoming experiment, testing the capabilities of ambilight.

8.4 Is atmospheric information lost in the perception step?

The fact that film music is already perceived unaware or implicitly (6.4.1) encourages us to believe that other stimulus perceived in this manner could have a similar effect on mood or emotions. The bundle of studies dealing with implicit perception show evidence that stimulus, understood to have emotional meaning when perceived normally, can be perceived implicitly and then attach this emotional meaning to the attended stimulus. This view on implicit perception also explains why elements such as interior, in store environment can increase the liking of products located in the store. However it also seems that color and light can be perceived differently across gender and age groups. With all of this in mind we ask: Is atmospheric information lost in the perception step?

8.5 Presence

So how is it that he viewer are capable of accepting that what is happening on the screen is a plausible story, why is it that an Ogre in "Lord of the rings" [82] are considered to be a natural element in that particular story. In the following chapter we describe the complex process that are taking place when viewing a movie (or at least are intended to take place)

A movie triggers a series of mental processes that are required for the viewer to combine the image he sees and the sound that he hears into one percept. This process is relatively simple, compared to the process that is taking place on the cognitive level. From the starting point the human mind is designed to interpret stimuli in order to estimate what events are taking place in his surroundings, so that he can adapt accordingly. This means that in terms of cinema the viewer should have one look at the screen, and initially be shocked by what he sees (e.g. A big dangerous dinosaur in Jurrasic Park [83]) he would then after a few milliseconds discover that the dinosaur on the screen is flat and it cannot be real even though it does look a little real, after touching the screen and establishing that it is in fact just an image, and the sound of the beast, resembles that of an big engine rather than that of a mighty beast. The example is a thought experiment as of what would happened if we did not have the capability to interpret the stimuli with a different strategy then the more autonomous one. The processes that are taking place during the consumption of a movie are also happening in many other situations such as reading a text, playing a computer game, talking on the phone and many other processes. The process has been described by many different research fields, with different purposes, but a general term has, over the recent years, become a convention, namely the concept of presence. In its broadest term the research in presence is trying to understand the processes taking place when humans interact with remediated things.

In the following we will focus on presence in relation to movies.

In [84] they try to create an overview over the different types of presence that exists across disciplines. According to Lombard there are 6 types of presence; the types relevant for this report are *presence as realism, Presence as transportation* and *Presence as immersion*. P*resence as realism* is typically used when a mediums form is evaluated. "Realism" is a problematic term when researching hardware for movie

mediation. Movies are usually never realistic in the sense that they are true to the real physical world (compared to virtual reality systems). The question one could raise, does the use of peripheral light make a screen better at mediating realism? It might make the screen more realistic in the sense that the screen becomes better at mediating the story that the movie is telling. It is therefore important to distinguish between realism in relation to the real world and in relation to the narrative world.

8.5.1   Presence as transportation

The wording of this conceptualization of presence is related to the mental process that appears namely the concept of mental transportation. During the watching of a film the viewer has to mentally transport himself to the imaginary narrative world of the film. If/When the viewer is fully transported into the movie world his senses are no longer focused on the actual world but on the movie world thus all percepts he receives are treated as if they are coming from the screen, however if the percepts are clearly from outside the movie world, presence will be broken. It is easier to understand presence as transportation in terms of virtual reality systems where the viewer can choose himself what he wants to see by moving his head around. In virtual reality the viewer is subjected to a 3D world that has boundaries, intrinsic relation and distance between the virtual objects making it easier to feel that he is in a different physical reality.

During the transportation into the movie world the user accepts that the relationship between objects in the narrative environment are not related by physical boundaries but by phenomenon's that can be very abstract in nature Eg in the movie "The Matrix" a greenish coloration of the image suggests that the action is taking place within a computer program. Thus "green" becomes "they are now in the computer".

Presence as transportation is, by [84] divided into three different types of transportation "You are there" "It is here" and "We are together" (shared space) The three term discusses the method in which the viewer is transported, either the viewer is transported into the narrative or the narrative is transported to the viewer (the "We are together" are concerning conference systems and are as such not interesting in relation to narrative movies.) The different terms describe how researchers have approached the task of describing what the viewer experienced during their presence experience. Lombard claims that "You are there" is likely to be the oldest type of presence since it is the type of presence taking place during story telling. Since most modern film are following this tradition of storytelling it is very likely to assume that the "You are there" type of presence is taking place during the viewing of a film, and if a medium is more or less effective of giving this experience it should be possible to measure this effect. "you are there" is however often used to evaluate virtual systems, and it can be argued that with the introduction of virtual environments (VE) it is necessary to distinguish between the types of presence felt between film and VE. Since transportation in VE is more directly linked to the concept of transport, connected to the illusion of movement where there are none.

Another aspect of presence is "Presence as immersion" and is related to how many of the senses are covered and how much a person is feeling he is immersed into the media he is consuming. The assumption is that the more senses are covered by a virtual environment the more the subject will be perceptually immersed, and the more perceptually immersed a person is the more present he will feel. The perceptual properties of a system are typically evaluated when VE are described and not as much with home cinema

But recent development in home cinema with larger screens and surround sound, clearly suggests that the development is going towards covering more of the senses. This is also the case with peripheral light, where the use of peripheral light is trying to cover more of the vision by providing more stimuli and thus covering more of the visual sense. Immersive presence are also described as a physical process Lombard uses the words *When users feel immersive presence they are involved, absorbed engaged, engrossed.*

It is clear that presence can be used in different ways, when one claims that presence as transportation is the oldest type of presence one is neglecting the fact thee the meaning of presence has changed with the introduction of virtual reality. When comparing the feeling of "you are there" between a narrative and virtual reality it becomes clear that the feeling of being there in virtual reality does not require as much imagination as being there in a narrative does. This is due to the fact that with the introduction of virtual reality it is becoming possible to reproduce a virtual world on a stimuli level rather than on a cognitive imaginary level. Therefore presence as transportation is more appropriate when describing virtual reality and presence as immersion are more appropriate when describing the concept of feeling presence in a narrative.

8.5.2 Suspension of disbelief

Lombard describes that the level of presence a person is able to achieve is not only dependant of a given mediums ability to immerse. It is highly dependent of the person's willingness to be immersed; Lombard describes this as *the willingness to suspend his disbelief* [84]. Consequently before the viewer can feel present or immersed into a film he has to be in a state of mind where he stops evaluating if the percepts he is given are physically real or not, he has to suspend his disbelief. When a viewer has suspended his disbelief he is accepting that the media he is presented to are indeed real. It can be compared to when a person ask another person to imagine something. Humans have an ability to imagine situations that are not taking place at the moment expressions such as "try to imagine if you were in that situation; what would you have done". This capability is heavily relied upon in cinema since the director is asking the viewer to imagine things that are quite often abstract.

8.5.3 Presence as immersion the concept of transportation into a narrative

The process of suspending ones disbelief so as to be able to transport oneself into a narrative requires that the narrative has certain features. Marie-Laure Ryan, has written a book [85] that amongst other things discusses the concept of immersion into a narrative. In her work she constructs a figure [Figure 20] that describes what a narrative must possess for a user to be immersed into it.
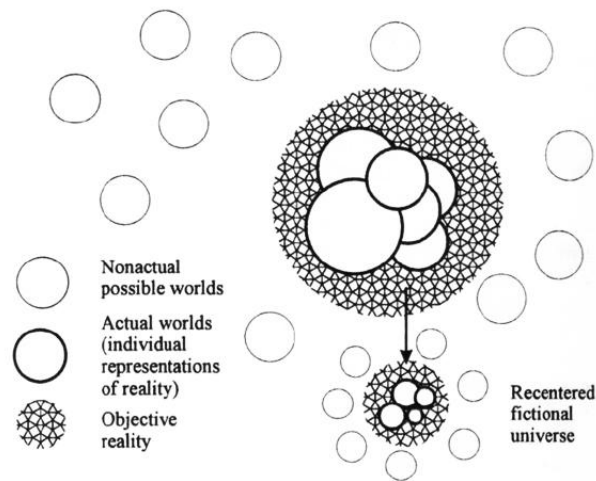
Figure 20 a recenterable possible-worlds model [85 p. 102]

Ryan claims that every person's world consists of three elements: The nonfactual possible worlds, Actual worlds and the objective reality. In other words, what a person holds to be real, what a person holds to be possible and that which is real independently of the persons. For a person to transport his mind into a narrative world it must be constructed in the same way as the person's reality. Our description here is far from being exhaustive, and the treatment and a discussion of the concepts in the figure is indeed very philosophical. However this helps us to understand that a complex process is taking place when a person is immersed into a narrative, and the question is how the addition of ambilight influences this process. Obviously the ambilight can influence the process negatively, positively or not at all. If the ambilight is influencing the process negatively it could be because it is drawing attention away from the narrative, if the viewer are not capable of abstracting from the ambilight (as the reviews from (8.2.1) suggests) . Phillips claims in [5] that presence is improved and they define presence as the perceived degree of becoming part of the displayed space, this sounds like presence as transportation, which can be interpreted in both the virtual reality context and the narrative context. Due to the description by Ryan, we believe that if the ambilight are to improve presence it should improve presence as immersion, in terms of how *involved, absorbed, engaged and engrossed* the viewer is feeling.

8.6 Analysis summery

We found in (8.4) that is should be possible to perceive the atmosphere of a film trough the ambilight stimuli. We also described that during the watching of a film the viewer is experiencing a complex process that could potentially be interrupted by the ambilight. If the ambilight can reproduce the atmosphere of a film, and the viewer are capable of perceiving it there is reason to believe that the added stimuli the ambilight produces could create an emotional response in the viewer. Based on the assumption we pose a final problem statement that we test in part three of the report.

9 Final Problem statement

- To what degree does the atmospheric information in the ambilight manifest in an enhanced emotional response related to the content of the viewed film?

9.1 Hypotheses

In order to give an answer to the final problem statement, precise and testable hypotheses must be defined. The essential part of the problem statement is not only whether the ambilight enhances emotional response, but also that the emotional response in correlated with the atmosphere of the content. Furthermore it should be noted that "emotional response" is used to cover both emotions and mood. As mood is rather difficult to define as distinct emotional tones (4.1.2), the two dimensions of the circumplex model are used to formulate the following hypotheses:

H_{A1}: The addition of ambilight increases pleasant emotions or moods during exposure to films with a pleasant content.

H_{A2}: The addition of ambilight increases unpleasant emotions or moods during exposure to unpleasant content.

H_{A3}: The addition of ambilight increases arousal during exposure to arousing content.

H_{A4}: The addition of ambilight decreases arousal during exposure to non-arousal content.

To be able to elaborate on the answer to the problem statement, two additional hypotheses are posted. These hypotheses are concerned with the possibility that ambilight might be distracting to the viewer and thereby ruin one of the essential cognitive corner stones of film viewing, namely presence. The hypotheses are defined as follows:

H_{B1}: The addition of ambilight is not significantly distracting.

H_{B2}: The addition of ambilight does not decrease presence.

10 Test

The description of the experiment will be in two parts. The first part is entitled *Design and implementation* will treat the considerations and design choices made in the forming of the experiment. The second part, *Results*, will list the obtained results after they have gone through a statistical analysis.

10.1 Design and implementation

This section will seek to describe the considerations leading to a set design choices made in the forming of an experiment able to test the presented hypothesis.

10.1.1 Measurements

As both the problem formulation and the hypotheses state, emotional responses are the main dependent variable to be measured. A secondary dependent variable is presence. A range of measuring methods [86,87] has been proposed for determining the occurrences of these variables. In general both concepts tend to be very sensitive to intrusions, as the feeling of presence can be broken and emotions can change due to disturbances. Therefore an important criterion in the choice of measurement tool was the intrusiveness. Secondly, reliability was equally important and therefore it was the attitude that if an existing well-tested measurement method could be applied within the frames of the experimental setting, the method would be preferable compared to a customized or tailored method. A more practical issue such as ease of use and ease of data treatment was also important aspects in the choice of a suiting measuring tool for both emotions and presence. A more detailed description of the considerations regarding the choice of measuring methods is included below, where emotions and presence is treated separately.

Emotional measurements

Measuring methods for quantifying emotions range from subjective self-report to observation of facial expressions and psycho physiological measurements. A detailed overview of existing methods can be found in the review by Randy Larsen and Barbara Fredrickson [86]. We quickly realized that we did not have the experience to do a facial expression analysis and that it was unreasonable to expect every test participant to bring a person close to them to the experiment, which could observe and analyze the facial expression for us. At the same time psycho physiological measurements often require electrical equipment with wires to be attached to the body, which would compromise the demand of non-intrusiveness. In addition psycho physiological measurements such as heart rates and skin conductance would only give an indication of some part of the emotional spectrum, more specifically "arousal". Instead we felt that subjective self-reports would be able to give a more "complete" indication of the emotional processes taking place in test participants. Questionnaires are easy to work with and there are existing procedures of how to analyze the data obtained with them. Therefore it was reasoned that questionnaires would be the best tool for collecting the emotional data even though the data is collect retrospectively.

As the situation, in which emotions had to be measured, cannot be categorized as being novel, and thereby probably will not require the tailoring of a specialized questionnaire, the pool of existing questionnaires were reviewed to find the most "complete" measurement of emotions available. Researchers have always debated whether emotions ought to be measured in terms of 2-3 general scales or by a range of scales for each distinct emotion. To avoid this lengthy discussion and to be able to measure the emotional response as "complete" as possible we decided to include both approaches in the experiment.

The DES described in [76] represents the measuring approach where distinct emotions are being rated on separately scales. As this questionnaire consists of a reasonable low amount of score compared to alternatives, this multi-item questionnaire was chosen.

The Affect Grid [76] was chosen as it is an illustrative way to measure emotions in terms of two scales (arousal and pleasantness). This questionnaire item was also thought to give a little diversion after having answered all the DES scales.

The items of both of these self-report measuring methods were gathered in the first part of the questionnaire (see Appendix B) as the measure of emotional response to the conditions in the experiment.

Presence measurements

The issue of measuring presence has lead to a range of methods attempting to quantify the concept. An overview of current measurement methods can be obtained in [87]. Much of the considerations regarding the emotional measurements are valid to presence measurements as well. As such it was also decided to investigate the mainly questionnaires for measuring presence. One of the great problems with presence questionnaires according to our setup is that most of the questionnaires often address Virtual Reality experimental setups. As a cinematic experience often excludes any direct interaction with the media, a great deal of questionnaire items tends to become irrelevant in for instance the PQ questionnaire [87]. A widely used presence questionnaire is the ITC-SOPI [88], which has been developed directly with the intention of being applicable across media types. We found that most items in this questionnaire were relevant in relation to the purpose of the experiment.

The ITC-SOPI is divided into four parts entitled "Sense of Physical Space", "Engagement", "Ecological Validity" and "Negative Effects" containing respectively 19, 13, 5 and 6 items for participants to rate. By including these questionnaire items in addition to the included emotional items, the total count of items would reach 56 in the experimental questionnaire. Considering that the participants probably had to fill out this questionnaire repetitively depending on the film material, the inclusion of this amount of items were assessed to be too overwhelming for participants, which probably would result in large artifacts in the collected results of the late items due to fatigue. Since the four parts of the ITC-SOPI are designed to measure different dimensions of presence, we evaluated each of the parts with the intention of finding the dimension which best suited our definition of presence during a cinematic experience. In general we

thought that the "Engagement" items were more descriptive than those of the "Sense of Physical Space" (seen in the light of the Presence as Transportation discussion in (8.5.1)), and the "Ecological Validity" parts. The "Negative Effects" items seemed not to measure presence directly, but instead measure special cases were exposure to a media (especially VR exposure) can lead to physical effects such as nauseous and dizziness. As these effects were expected less likely to appear during film viewing, it was reasoned that the "Engagement" part of the ITC-SOPI in itself would be efficient as a measure of presence in this experimental setting.

Additional measurements

Besides the emotion- and presence measurements, we found relevance in asking some additional questions in the questionnaire. Presence was included in the experiment as a measure to determine whether the viewer is distracted or not. However if the experiment should yield low presence ratings, one would have to infer about the possible reasons of this. Since we suspect the Ambilight of being distracting during film viewing we therefore decided to include an additional item in the questionnaire asking about the distraction-factor of the system. In this way it could be documented whether low presence scores was caused by distraction. Finally questions checking up on other factors, which we felt could have an impact on the dependent variables, were added to the questionnaire. These factors where things such as whether the participants had seen the particular film clip before or if they were accustomed to film viewing with Ambilight. The final questionnaire can be seen in Appendix B.

10.1.2 Equipment and setup

To start with the setup had to simulate a usual viewing experience. For doing so a corner of a 8mx8m room was shielded with partitions (made of Rockwool) to make a 3m x 3m box to test in. The test area was opened in one end for participants to enter the setup (as displayed in Figur 21). An observation station was placed next to the partitions from which the experiment was controlled and monitored. The sealing of windows in doors and walls made the entire room dark to a degree where a Sekonic Flashmate L-308S could not make a reading.
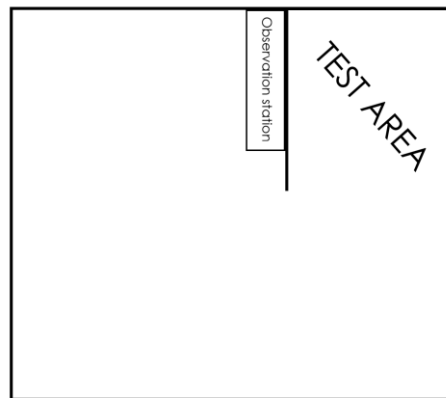
Figur 21 the corner of a room was used as test area while the observation station was placed next to it. The area was open in one end for the participants to be able to enter the setup.

A Samsung PPM50H3Q 50" plasma screen was now put up at a small table at the back of the test area. In this position the center of the screen was located 114 cm above the ground. A coach (with dimensions 300 cmx70cmx60cm) was placed centered in front of the screen by a distance of 220 cm. The distance was calculated from the equation given by Lund, A. in [61], which was created from his analysis of preferred viewing distances in a variety of setups. Between the screen and the couch a table (with dimensions 220 x 50 cm x 65cm) was placed for the participants to have a place to fill out questionnaires and to simulate the coffee table often found in living room environments.

An Acer Aspire 5738ZG laptop, supporting 5.1 HD Surround Sound, was put up in the observer station. The soundcard of the laptop was connected to a NAD T761 Surround Sound Receiver from which cables were pulled to 5 speakers and a subwoofer. The speakers were placed according to the guidelines provided by Dolby [89], with three front speakers (left, center, right) and two rear speakers (rear left, rear right) placed on each side of the couch. However, later the rear speakers were moved further back in an attempt to improve the listening experience for several listeners. A series of small listening test showed that having the rear speakers placed directly next to the participants' heads lead to a significant amount of sound blocking from the first participants head, resulting in a decreased listening experience for the second participant. An overview of the setup is shown from a top-down perspective in (Figure 22).
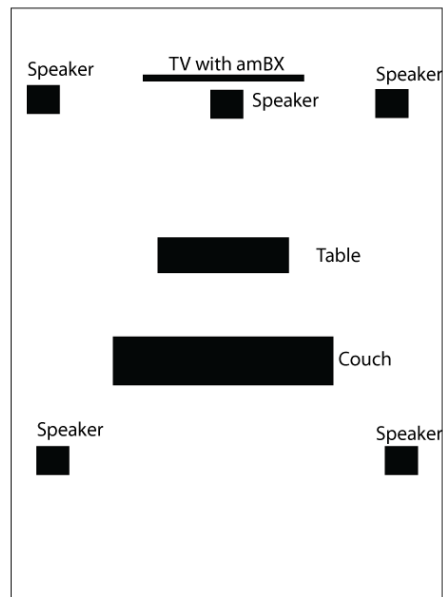
Figure 22 Overview of test setup

As the observant reader might have noticed the screen placed in the setup is not a Phillips Ambilight television. The solution used was the cheaper amBX system (4.3), originally intended for use in a PC gaming setup and attach it with wires to the back of 50" Samsung screen. The central unit was placed horizontally centered in a height of 140 cm above the ground. Each of the light towers was placed on each horizontal side and at the around the center of the screen as seen in (Figure 23).

Figure 23 50 " LCD TV with amBX mounted on the back

10.1.3 Participants

Normally a through screening process is preferred before accepting participants in an experiment like this, but with the thoughts on the lengthy questionnaire given several times to each participant during the experiment it was decided not to include an extensive screening. Instead we hoped that a reasonable sample size would minimize the variance in participant-variables such as mood prior to the experiment and presence tendencies.

Both males and females were to be invited to participate in the experiment. We hoped that it would be possible to get an equal amount of female and male test participants. However if this was not the case adjustments or a selection of the measurements would be needed as the work done in the analysis (what section?) has already pointed out that emotional responses can vary due to gender. As the same is the case with a parameter such as age, we also decided only to include participants with an age of around 20-30 years as it was expect that the majority of the available participants (university students) would be around this age.

10.1.4 Test material

To get an impression of how unattended light "in general" impacts emotional processes in the viewers, the material had to vary widely in context and emotional intention. As with the hypotheses the arousal-pleasantness emotional paradigm provides a simple framework to categorize emotions, which was also used in the selection of test material. The main criteria for the inclusion of a movie clip in the test were that it could be expected to elicit a clearly defined emotion in terms of arousal and pleasant feelings and that this emotion was distinct from the remaining test material. As a secondary parameter, it is also known that it can have an impact on the feeling of presence, whether the movie clip has been seen before or not [84] as such we sought to chose movie clips which we had reason to believe that the participants might not be familiar with beforehand. As a result four movie clips were selected (all of them are included at the appended DVD). In the following the considerations leading to the choice of the particular movie clip will be discussed.

Step up – Nicknamed "Dance" [90] (Assumed to be pleasant and arousing)

Figure 24 Step up

This clip starts by portraying an excited audience waiting for a show to begin. When the curtain came up it reveals a modern dance performance with two characters, a man and a woman, in the front. The dance sequence has both slow and fast paced sequences and a variation of styles; however modern dance styles such as street- and break dance are the most dominant. When the show ends the performers receive a great applause from the audience. The clip ends when the curtain comes down.

The clip was assumed to be perceived as being pleasant and arousing by most of the participants due to several factors. Dance is an activity which is often related to sex [91]. This is emphasized in the music accompanying the dance scene, which contains background elements of a panting woman. As sexual stimuli can result in a state of high arousal [92] we expected that this would be the case for dancing as well. In addition we hoped that the participants would share the pleasant feelings displayed in the clip (e.g. the audience's excitement and the dancers' feeling of success).

Ichi the Killer – Nicknamed "Tongue" [93] (Assumed to be unpleasant and arousing)

Figur 25 Ichi the Killer

The clip takes place in an apartment where three Japanese men are setting around a table surrounded by bodyguards. Even though the clip is in Japanese one can tell by body language (finger pointing) and voice level (shouting) that one of the men is angry. Shortly after one of the other men stands up, walks over to a cabinet and pulls out a knife. He then sits down on his knees in front of the other men, binds a scarf around his neck and the cuts off his tongue and hands it to the angry man, which now seems terrified by the event. The clip ends when the tongue-less man receives a phone call and walks out the door.

We assumed that this clip would elicit unpleasant emotions as it contained elements such as blood, injury and surgery normally used as stimuli in investigations of unpleasant emotional responses [94]. Also a red carpet takes up most of the background in the sequence, where the tongue is cut off. As red becomes the dominant color associated with the incident and prior studies have shown that red can elicit a state of high arousal [5.2], an unpleasant-high arousal emotional response was expected during this clip.

Band of Brothers – Nicknamed "BOB" [95] (Assumed to be unpleasant and not arousing)
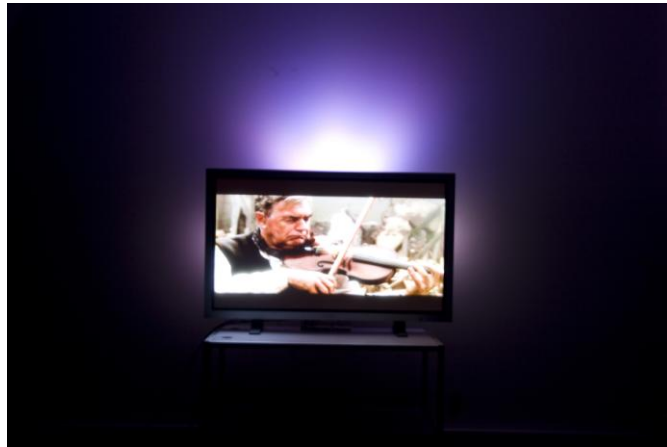

Figure 26 Band of brothers

Band of Brothers is a series in ten parts portraying the lives of several soldier companies during the Second World War. The chosen clip is taken from the beginning of part nine and initializes with a period of silence, where a violin is being put to the shoulder. In the second where the bow strikes the strings the music starts, making it clear to the viewer that the music is coming from the actual violin (is diegetic). The camera then turns around the violinist showing that he is playing in a village in ruins. All the people in the village - young and old - are all cleaning up. Near the end of the clip the camera moves towards the first floor in one of the ruined buildings standing around. Here a couple of soldiers are gathered while watching the villagers cleaning up. The clip ends when one of the soldiers mistakes the played music as being of Mozart, thereafter another soldier coming from a doorway corrects him by saying this it is composed by Beethoven.

It was mainly the music in this clip, which made us assume that the clip would be perceived as being unpleasant while not being arousing. With its slow pace and consisting of only string instruments it brought a rather sad mood to the clip. We thought this would be emphasized by the low moaning and cries heard from some of the villagers.

March of the Penguins – Nicknamed "Pingo" [96] (Assumed to be pleasant and not arousing)

Figure 27 March of the Penguins

This clip displays a parent penguin feeding its child and couple of young penguins taking their first steps. The viewer here follows how the young penguin ventures out from the safety of the parent penguin to frisk in the fields of snow while trying to keep the balance and avoid tumbling. The clip ends when the young penguin decides to return and seek cover at its parent. The whole incident is accompanied by atmospheric music.

Due to the low amount of action in this clip it was assumed that it would not be arousing to the participants. The music was another factor, which we would categorize as being calm, yet optimistic and pleasant. It is also known that exposure to nature related stimuli can be stress reducing and relaxing [97]. Lastly, the snow-covered landscapes gave the clip a bluish glow. As the color blue is known to elicit low arousal states (5.4) we assumed this would be the case for the clip as well.

10.2 Procedure

The participants would, before volunteering for the experiment, be informed that some of the presented clips contained valiant material. Hereafter they were randomly divided into groups of three and then assigned to either the Ambilight- or without Ambilight condition. The groups were in turn escorted into the room and asked to sit in the coach. The participants decided themselves who were to sit where in the coach. After the participants were seated they were instructed about the course of the experiment and told not to communicate until it was over. A small bowl of candy was placed on the tabletop in front of the participants and they were given promising to supply themselves with candy from the bowl throughout the experiment. Before actually starting the viewing sessions, a written flash application was used to get a random order in which the clips were to be shown to each particular group. Now, the three movie clips was shown to the participants one at a time, with Ambilight either being turned on or off. After each clip a small lamp was placed at the tabletop and a questionnaire was given to each of the participants for them to fill out. When the participants were done with the questionnaires, it was noted at the questionnaires whether

it was completed by a participant sitting in either the center, the right- or left side of the coach. The questionnaires were then collected and the lamp was put away before a new movie clip was started. After all questionnaire sets had been filled the participants were shown out of the room, where after a new group of three participants were seated.

10.2.1 Pilot test

A couple of pilot tests were made just before starting the actual experiment. The described procedure was followed during these tests with the addition of a conversation with the participants after the test. By asking these few participants about their answers given in the questionnaire a couple of issues were found.

One issue which came as a surprise was a high arousal rating of the Band of Brothers clip, which was assumed to be emotional depressing (low arousal/unpleasant) to the participants. When asking the participants about why they felt more aroused during this clip, they replied that they had all seen the series and as such mistakenly rated the experience from their memories of the atmosphere in the series in general. From this we inferred that the references of war (e.g. soldiers, weapons, ruins etc.) found in this clip and the eager to get the answer to the obvious question, "What happened here?", must have elicit more arousal feelings into the participants. As a result this clip would elicit about the same arousal and pleasure as the Ichi the Killer clip and because there were no point in displaying two similar stimuli and that all the participants in the pilot test had already seen the Band of Brothers series, we decided to cut the Band of Brothers clip from the experiment.

Another issue was regarding the first part of the questionnaires. Here it first became clear to some of the participants that the scales only was one-way, meaning that putting a mark in 1, in oppose to 3, meant that the participant had neutral emotional response. As a result we put a capital "NOTE" in the describing text on the questionnaire to make the participants aware of this difference.

10.3 Results

As the *Design* section above it mostly concerned with the planning and other pre-experimental considerations, this section will instead describe and list the results obtained after the experiment had been conducted.

During the test, measurements were taken from 52 persons. Five of these where females and unfortunately four of them were assigned to the Ambilight condition. It was therefore decided to remove all females them from the result analysis as the skew gender ratio across conditions might result in unintended variance. Furthermore a single participant had reported being accustomed with Ambilight and therefore this participant was removed from the analysis as well. As he was assigned to the Ambilight condition too, the final participant count in both Ambilight conditions was: 20 with Ambilight and 26 without Ambilight. 4 participants had seen the "Tongue"-clip before, while 3 had seen the "Dance"-clip and 7 had seen the "Pingo"-clip before hand. But, since these participants were relative equally divided between the Ambilight

conditions no adjustments were made. The mean age of the remaining 46 males were 23,02 years with a standard deviation of 3,54 years.

To avoid an overwhelming amount of comparisons, which will decrease readability and also lower the statistical power [98], a three-way ANOVA will be used to treat the measurements. The independent variables "film clip" and "Ambilight" makes up two of the dimensions, but since we toke in three participants at a time the position (Left, Right or Center in the coach) will also be included as the last independent variable. This is to make sure that their position in the coach will not be the cause of any significant effects. To specify details of significant findings, TukeyHSD comparisons will be used whenever it is appropriate. The responses to each part of the questionnaire will be listed in turn starting with the responses to the DES items. Each item will be introduced by the exact question-formulation used in the questionnaire. The results of the item is then listed by a bar diagram displaying means of the dependent variable. Standard deviations are marked with a line on each bar in the plot. On the right side of the diagram the statistics of the ANOVA test will be available. All main effects are listed here and interactions are only listed if they are significant.

"To what extend did you feel ENRAGED/ANGRY/MAD during the movie?"
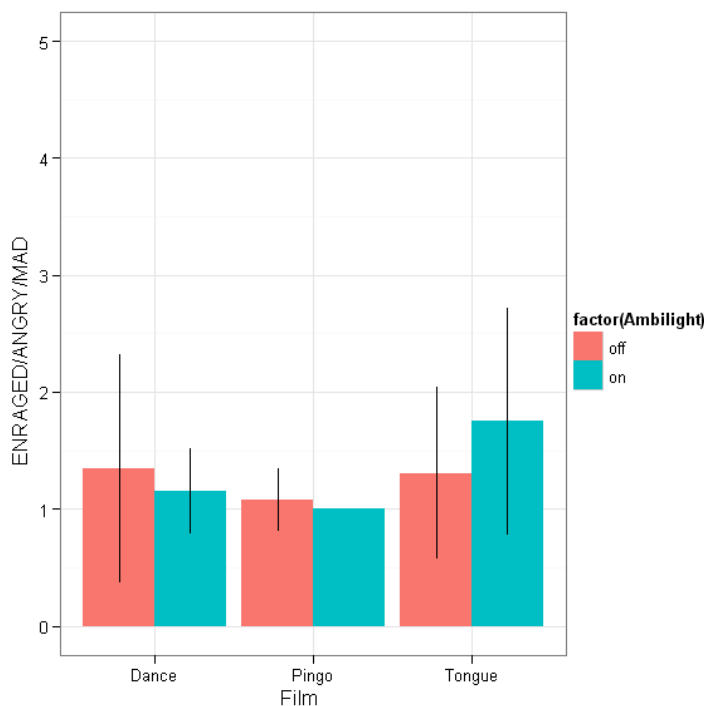
Ambilight

$F(1,40) = 0.1638,$

$p < 0.6878$

Position

$F(2,40) = 0.9163,$

$p < 0.5048$

Film

$F(2,80) = 7.0974,$

$p < \mathbf{0.001454}$

Ambilight:Film

$F(2,80) = 3.8548,$

$p < \mathbf{0.025218}$

The ANOVA showed that there were no main effects between Ambilight conditions and between coach positions. A main effect was found between film clips, among which a TukeyHSD test found a significant

effect between the Pingo and the Tongue clips (p < 0.0040358). An interaction between Ambilight and Films were also found. The addition of Ambilight to the Tongue clip apparently significantly increases enragement, anger, and madness above the ratings given to the Pingo clip with (p < 0.0069945) and without Ambilight (p < 0.0117977). These interactions could imply that Ambilight has an effect on anger when applied to a film with features such as the Tongue clip.

"To what extend did you feel SURPRISED/ASTONISHED/AMAZED during the movie?"
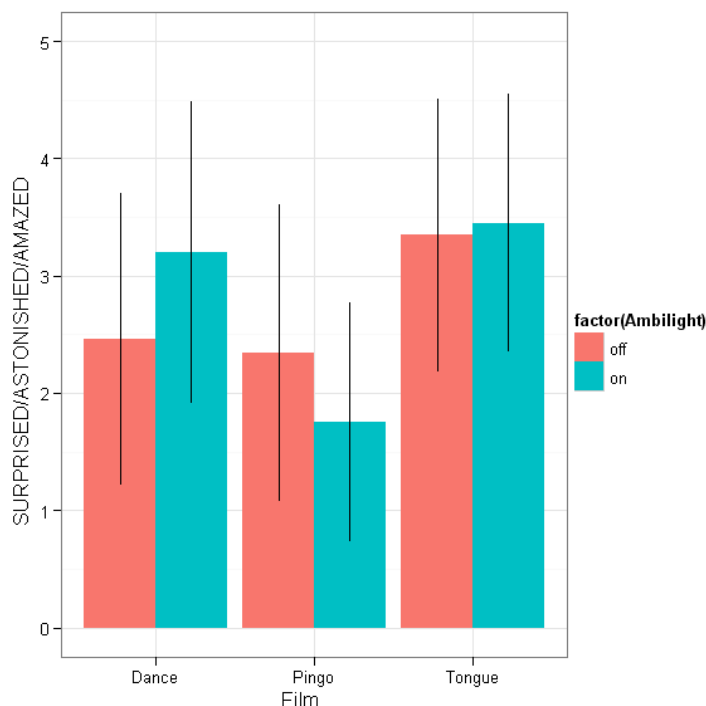
Ambilight

$F(1,40) = 0.1304$,

$p < 0.7199$

Position

$F(2,40) = 0.0305$,

$p < 0.9699$

Film

$F(2,80) = 14.8875$,

$p <$ **3.188e-06**

Ambilight:Film

$F(2,80) = 3.8277$,

$p <$ **0.02585**

The ANOVA displayed no effect between Ambilight conditions and coach positions, but instead a significant difference between film-clips was found. A TukeyHSD gave a significant effect between the Pingo and the Tongue clips (p < 0.0000016). The TukeyHSD was also used to investigate the interactions between Ambilight conditions and film clips resulting in the following list of significant interactions:

- Dance clip with Ambilight - Pingo clip with Ambilight (p < 0.0023818)

- Tongue clip without Ambilight - Pingo clip without Ambilight (p < 0.0395300)
- Tongue clip with Ambilight - Pingo clip without Ambilight (p < 0.0309450)
- Tongue clip without Ambilight - Pingo clip with Ambilight (p < 0.0002860)

- Tongue clip with Ambilight - Pingo clip with Ambilight (p < 0.0002775)

Basically, Ambilight made the Dance clip more surprising, astonishing and amazing, while decreasing this feeling when applied to the Pingo clip to a degree where it became statistically significant. However Ambilight did not have any effect on the Tongue clip, but it was none the less significantly more surprising, astonishing and amazing in relation to the Pingo clip due to content alone.

"To what extend did you feel CONCENTRATED/ATTENTIVE/ALERTED during the movie?"
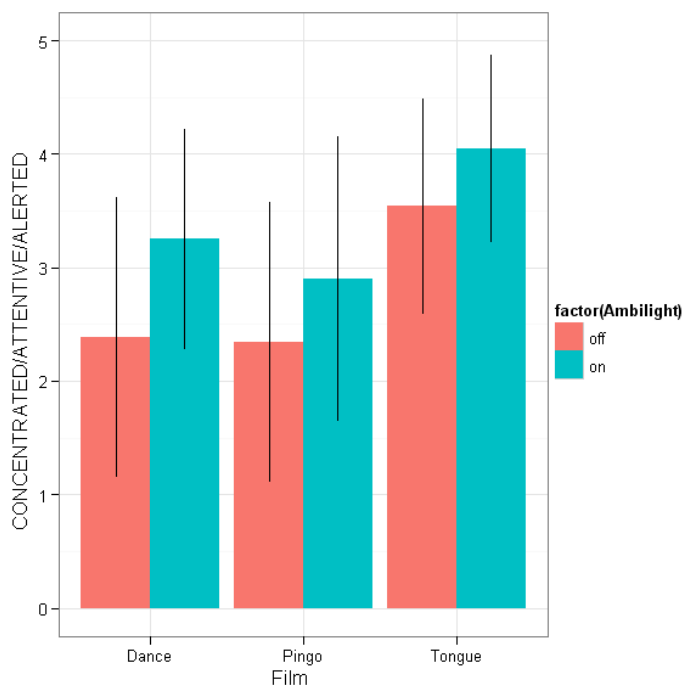
<u>Ambilight</u>

$F(1,40) = 9.2736$,

p < **0.004101**

<u>Position</u>

$F(2,40) = 2.4307$,

p < 0.100870

<u>Film</u>

$F(2,80) = 17.7039$,

p < **4.307e-07**

A main effect was found with the ANOVA in this category due to Ambilight (p < 0004101), but no effects were found across coach positions. A TukeyHSD test was used to investigate the significant effects between clips and displayed a significant increase in concentration, attention and alertness in the Tongue clip seen in relation to the Dance- (p < 0.0000761) and Pingo clip (p < 0.0000032)

"To what extend did you feel DISDAINFUL/CONTEMPTUOUS/SCORNFUL during the movie?"
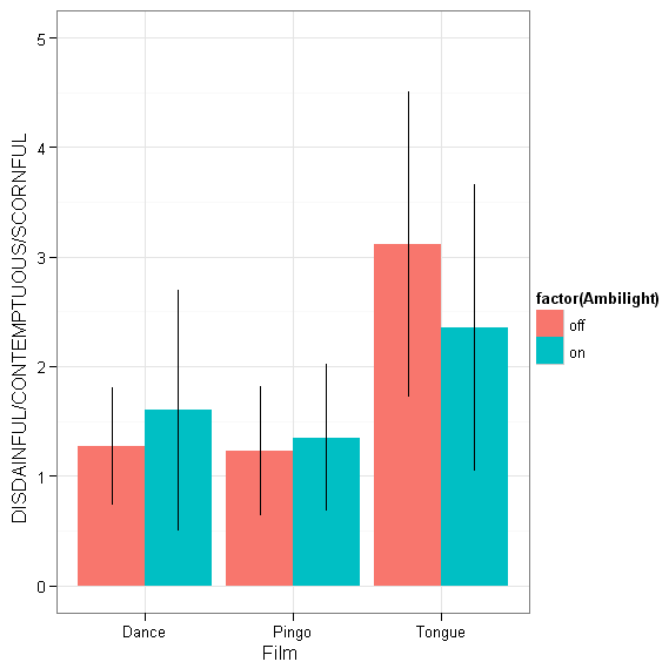
Ambilight

$F(1,40) = 0.2408$,

$p < 0.6263$

Position

$F(2,40) = 0.0561$

$p < 0.9455$

Film

$F(2,80) = 41.6881$,

$p < $ **3.945e-13**

Ambilight:Film

$F(2,80) = 5.0172$,

$p < $ **0.008856**

In this item the ANOVA returned mean effects for neither Ambilight nor coach positions. However as in most cases the film clips had a significant effect. The TukeyHSD test confirmed what the plot is showing, namely that the Tongue clip was significantly more disdainful, contemptuous and scornful than the Dance- ($p < 0.0000001$) and Pingo clip ($p < 0.0000001$). The ANOVA also showed significant effects between Ambilight conditions and the film clips. The TukeyHSD test displayed the following significant interactions:

- Tongue clip without Ambilight - Dance clip without Ambilight ($p < 0.0000001$)
- Tongue clip with Ambilight - Dance clip without Ambilight ($p < 0.0063279$)
- Tongue clip without Ambilight - Dance clip with Ambilight ($p < 0.0000256$)
- Tongue clip without Ambilight - Pingo clip without Ambilight ($p < 0.0000001$)
- Tongue clip with Ambilight - Pingo clip without Ambilight ($p < 0.0041240$)
- Tongue clip without Ambilight - Pingo clip with Ambilight ($p < 0.0000006$)
- Tongue clip with Ambilight - Pingo clip with Ambilight ($p < 0.0267812$)

Apparently, the addition of Ambilight to the Tongue clip resulted in a decrease in the dependent variable large enough to hinter a significant effect between the clip with Ambilight and the Dance clip with Ambilight ($p < 0.1862074$).

"To what extend did you feel SCARED/FEARFUL/AFRAID during the movie?"
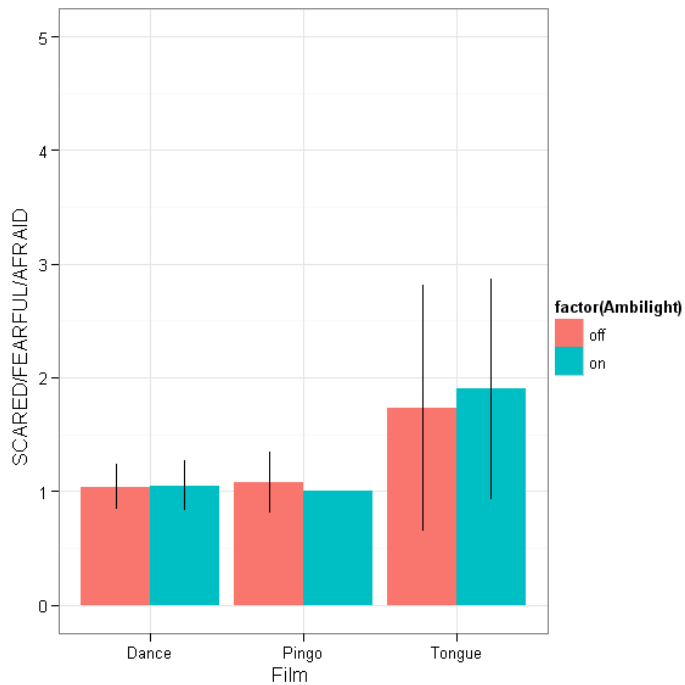
Ambilight

$F(1,40) = 0.1023,$

$p < 0.7507$

Position

$F(2,40) = 0.3013,$

$p < 0.7415$

Film

$F(2,80) = 23.5486,$

$p < \mathbf{9.082e\text{-}09}$

The ANOVA did not show any effect of Ambilight or between coach positions but, returned a significant main effect due to the film clips. The TukeyHSD revealed that the Tongue clip, as expected, more frequently induced a feeling of being scared/fearful/afraid than did the Dance- ($p < 1e\text{-}07$) and the Pingo clip ($p < 1e\text{-}07$).

"To what extend did you feel REPENTANT/GUILTY/BLAMEWORTHY during the movie?"
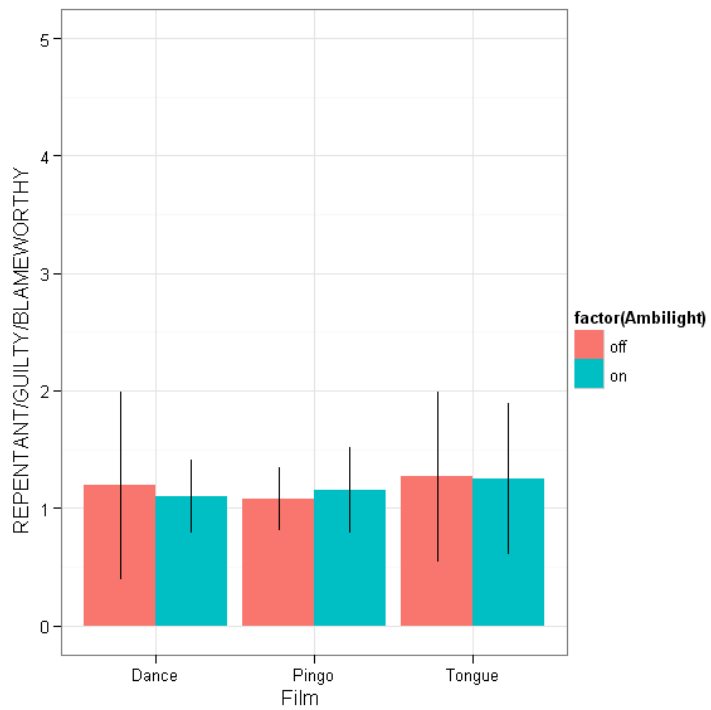
Ambilight

$F(1,40) = 0.0121,$

$p < 0.9131$

Position

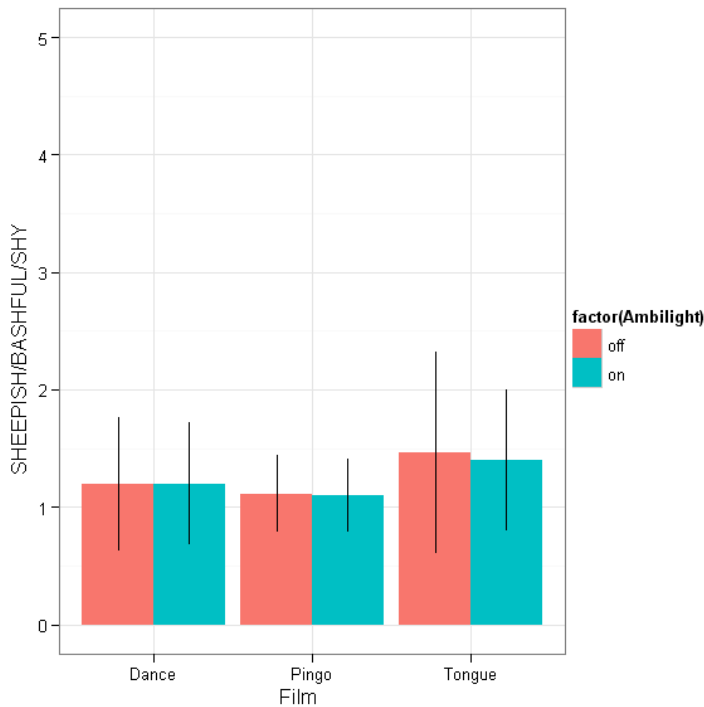$F(2,40) = 0.2439,$

$p < 0.7847$

Film

$F(2,80) = 1.0875,$

$p < 0.3420$

No significant effects were found and as such it seems that none of the participants tended to feel repentant/guilty/blameworthy during the entire experiment.

"To what extend did you feel SHEEPISH/BASHFUL/SHY during the movie?"

Ambilight

$F(1,40) = 0.0428,$

$p < 0.8372$

Position

$F(2,40) = 1.2640,$

$p < 0.2936$

Film

$F(2,80) = 5.2404,$

$p < \mathbf{0.007267}$

Film:Position

$F(4,80) = 2.8970,$

$p < \mathbf{0.027078}$

The ANOVA test showed no main effects of Ambilight and coach positions. However, a single significant effect was found between the Tongue and the Pingo clip ($p < 0.0154161$). From this it can be inferred that the participants tended to feel more sheepish/bashful/shy during the Tongue clip. A possible reason for this might have been the unknown language spoken by the characters. In addition a significant interaction was found between film clips and coach positions. Apparently, participants setting in the right position of the coach felt significantly more sheepish, bashful and shy, than the other test participants, when viewing the Tongue clip in oppose to the Dance clip ($p < 0.0460710$). We do not have a sufficient explanation for this difference and the reasons could be many (e.g. a broken spring). However since there was no significant effects across Ambilight conditions this difference is considered less important in the answering of the hypotheses.

"To what extend did you feel DELIGHTED/HAPPY/JOY during the movie?"
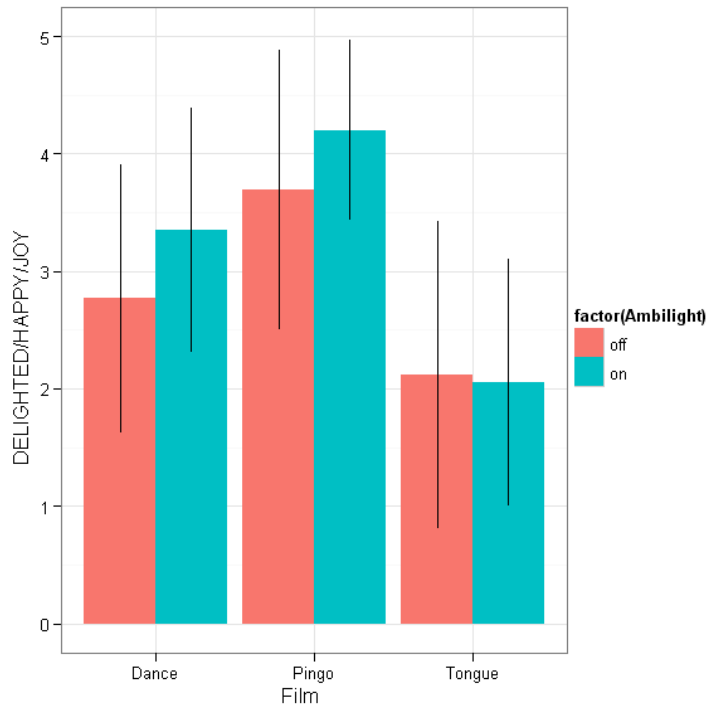
Ambilight

$F(1,40) = 3.1648$,

$p < 0.08284$
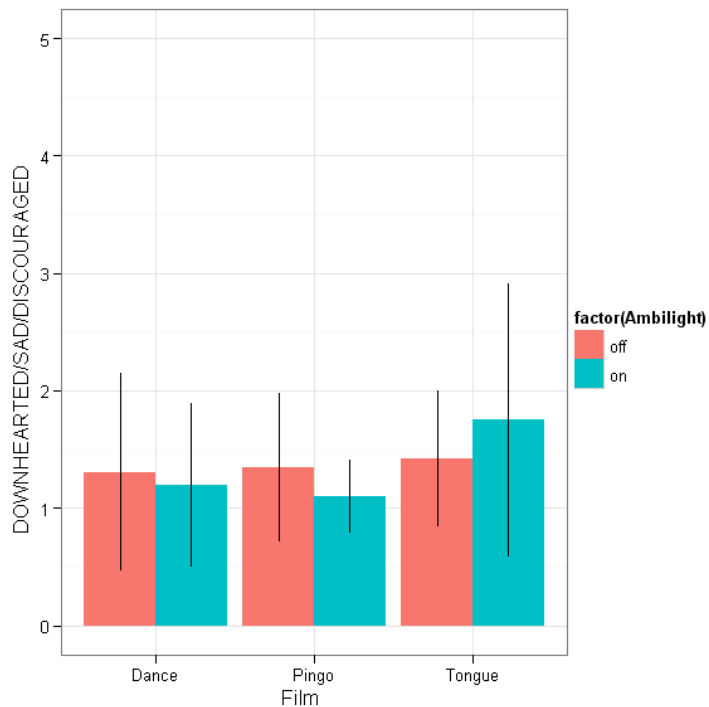
Position

$F(2,40) = 0.3879$,

$p < 0.68098$

Film

$F(2,80) = 30.7078$,

$p < \mathbf{1.270e\text{-}10}$

The ANOVA returned with no significant effects for Ambilight and coach positions. However, it is worth noting that the Ambilight condition is close to the significance-level ($p < 0.08284$), a larger sample might have resulted in this category reaching significance. In the meanwhile a significant difference was found between film clips. The TukeyHSD showed that participants felt significant distinct degrees of delight, happiness and joy in all the film clips ($p < 0.0006061$; $p < 0.0003070$; $p < 0.0000001$).

"To what extend did you feel DOWNHEARTED/SAD/DISCOURAGED during the movie?"

Ambilight

$F(1,40) = 0.0041,$

$p < 0.9496$

Position

$F(2,40) = 0.8825,$

$p < 0.4217$

Film

$F(2,80) = 2.8447,$

$p < 0.06405$

No significant effects were returned by the ANOVA for this category. Apparently, the participants did not tend to feel downhearted, sad or discouraged at any time during the experiment. However note that the different ratings in relation to film clips where close to reach a significant level.

"To what extend did you feel DISTASTE/DISGUSTED/REVULSION during the movie?"
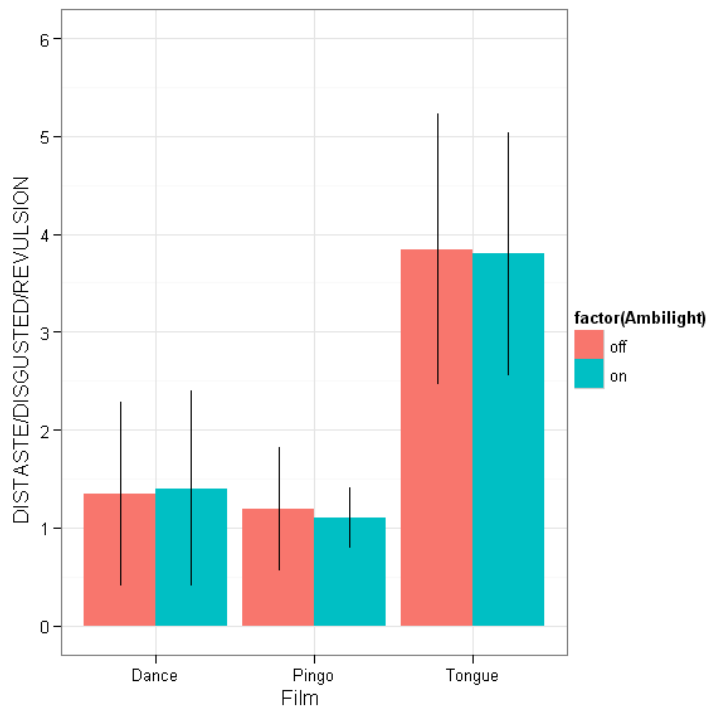
Ambilight

$F(1,40) = 0.0243,$

$p < 0.8770$

Position

$F(2,40) = 0.1724,$

$p < 0.8422$

Film

$F(2,80) = 112.2079,$

$p < \mathbf{2e\text{-}16}$

The ANOVA showed an expected main effect between film clips. As it appears in the plot, the TukeyHSD test showed that the Tongue clip was significantly more distasteful and disgusting then both the Dance- ($p < 0.0000001$) and Pingo clip ($p < 0.0000001$).

The DES items showed some, but little effects due to Ambilight. The Affect grid will be treated next to see if an effect can be located when emotions are rated according to more general definitions. As the Affect grid is made from an arousal scale and a pleasantness scale each will be treated separately in the same way as the DES items were.

The Arousal scale in the Affect Grid
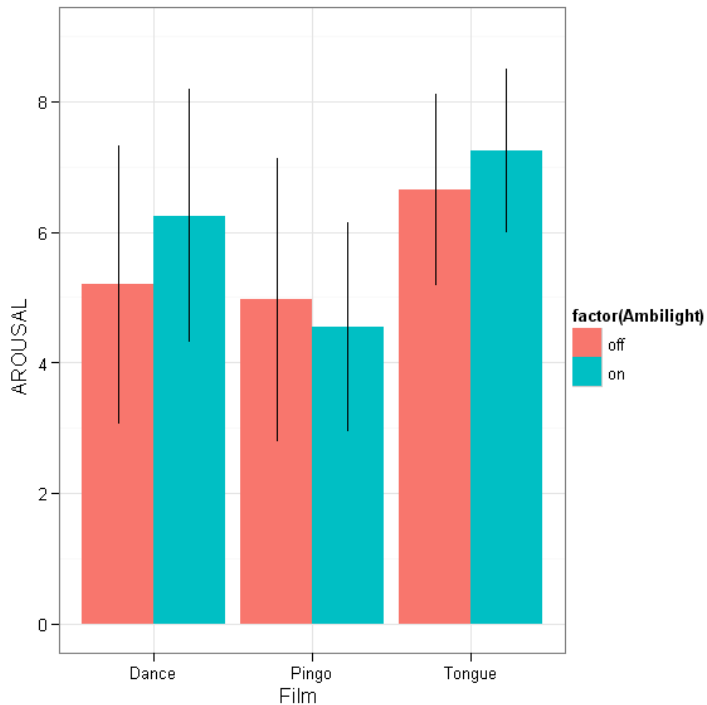
Ambilight

$F(1,40) = 1.7059,$

$p < 0.1990$
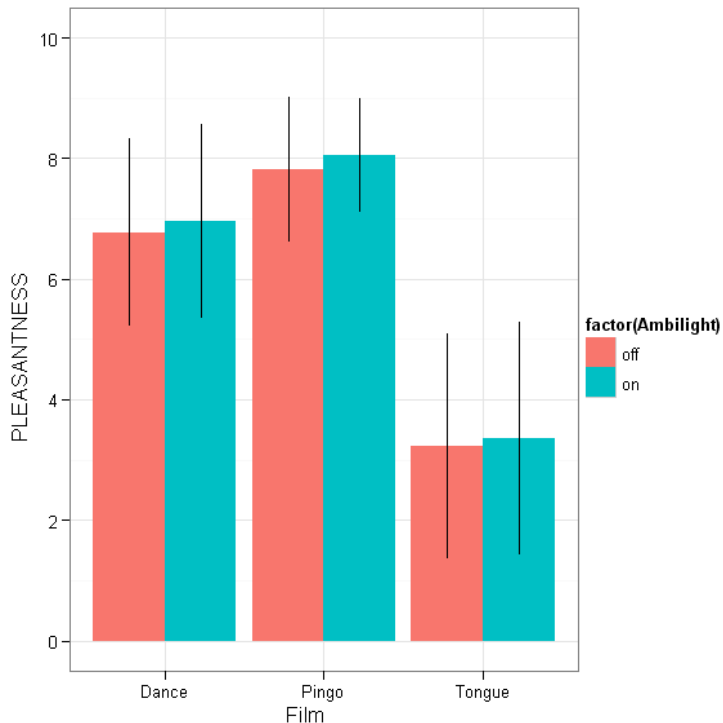
Position

$F(2,40) = 2.1290,$

$p < 0.1322$

Film

$F(2,80) = 17.1522,$

$p < \mathbf{6.325e\text{-}07}$

The ANOVA treatment only returned an expected main effect for between film clips. The TukeyHSD test showed that the Tongue clip was significantly more arousing than both the Dance- (p < 0.0027341) and Pingo clip (p < 0.0000002). A near significant interaction was found between the Pingo- and Dance clip (p < 0.0547502). As the arousal/pleasantness scale was used as a tool to achieve emotional different test material, these significant differences were expected.

The Pleasantness scale in the Affect Grid

Ambilight

$F(1,40) = 0.7142,$

$p < 0.40309$

Position

$F(2,40) = 2.7758,$

$p < 0.07432$

Film

$F(2,80) = 98.2836,$

$p <$ **2e-16**

The ANOVA test showed a significant relationship among the film clips. However it should be noted that the coach positions are close to being significantly different. A TukeyHSD investigation revealed that all the movies were significantly different in their pleasantness ratings (p < 0.0032782; p < 0.0000001; p < 0.0000001).

Since the Affect grid did not reveal any interesting effects, the might appear in the responses given to the included subpart of ITC-SOPI presence questionnaire. In instructions given with the ITC-SOPI questionnaire it was recommended that an average score was made from all the items. Therefore a single ANOVA test was enough to investigate the effects of Ambilight on the feeling of presence during several film clips.

Presence
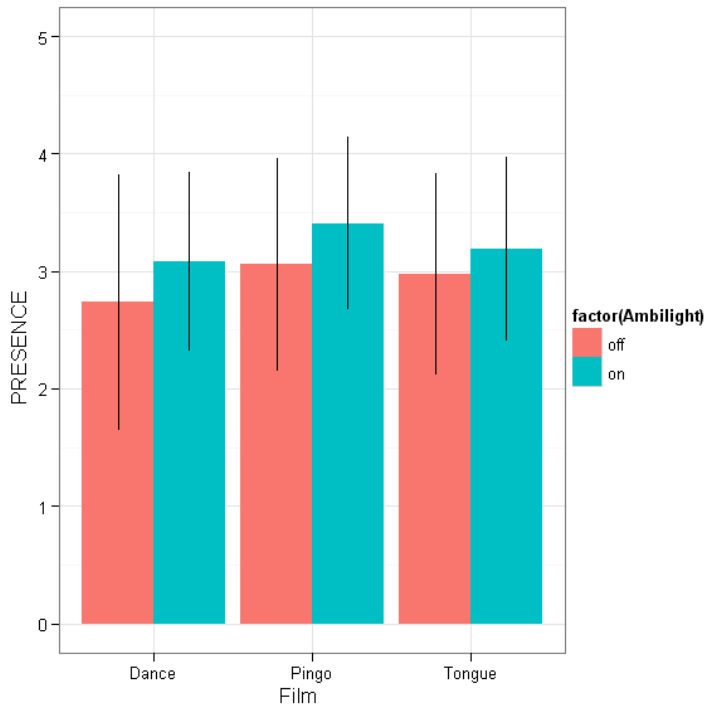
Ambilight

$F(1,40) = 3.4125,$

$p < 0.07211$

Position

$F(2,40) = 0.4568,$

$p < 0.63655$

Film

$F(2,80) = 1.6913,$

$p < 0.1908$

The ANOVA did not return any significant main effects. But, the Ambilight condition did come close to significance and all films got higher presence scores due to the addition of Ambilight. A reason why the scores do not reach a significant level could be the short durations of each film clip. If the length of the clips had been longer there might have been better prerequisites for elicitation of presence.

Another prerequisite for presence is that the participants were not distracted by the Ambilight or other elements. On the last page of the last questionnaire given to the test participants a single item asked them to rate how distracted they were by equipment during the experiment. These responses were treated by performing a two-way ANOVA test using only coach position and Ambilight as the independent variables.

Distraction
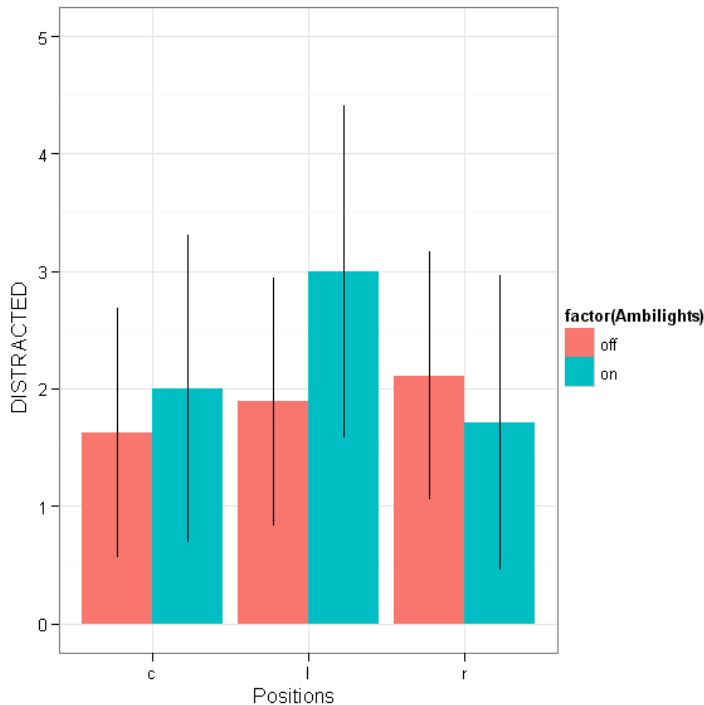
Ambilight

$F(1,40) = 0.2718$,

$p < 0.6050$

Position

$F(2,40) = 1.1538$,

$p < 0.3257$

Even though, the plot displays a peak for ratings given by participants viewing with Ambilight while setting on the left side of the coach, the ANOVA did not return any significant effects. In general it seems that Ambilight was not distracting to the participants.

To summarize with an emphasis on the effects of Ambilight, a list of the important findings is display in the following:

F_1: Ambilight made participants significantly more concentrated, attentive and alerted across all films and couch positions.

F_2: Ambilight was nearly significant in making the participants feel more delighted, happy and joyful across all films and couch positions.

F_3: Ambilight nearly had a significant effect on presence ratings across all films and couch positions.

F_4: Ambilight was <u>not</u> significantly distracting.

The interactions are not included in this list, as the interactions between film and ambilight cannot be applied directly to verify or reject the hypotheses. However they can be seen as evidence that the addition of ambilight significantly increases the emotional differences <u>between</u> film clips. The strongest finding was that Ambilight seemed to make the participants more concentrated, attentive and alerted.

10.4 Discussion

Now it is time to investigate and discuss the hypotheses in relation to the obtained findings. We will go over each hypothesis separately and discuss appropriate results. The discussion on each hypothesis will be ended with a conclusion resulting in a rejection, a confirmation or a declaration of the hypothesis as inconclusive. The discussion will end with a summary.

H_{A1}: The addition of ambilight increases pleasant emotions during exposure to films with a pleasant content.

To confirm this hypothesis it was expected that the participants seeing the Dance- and Pingo clip with ambilight would give significantly higher ratings on the pleasant scale in the affect grid. At the same time it was expected that appropriate pleasant DES scales would increase significantly in the two clips for this group as well.

The bars of the pleasantness scale is actually indicating a slightly increase in pleasantness in the ambilight condition seen in relation to the no-ambilight condition. However, no significant variance was found by the ANOVA and as such this finding is neither in favour nor against the hypothesis.

The finding F_2 has some importance in relation to this hypotheses. Apparently, the participants with the ambilight condition felt more delighted, happy and joyful in the Dance- and Pingo clip than the no-ambilight group during the same clips. However, the found variance was only nearly significant ($p < 0.08284$) and as such (according to the convention of a 0.05 alpha) the variance could be due to chance alone.

Judging the "positive"-findings in relation to the "negative"-findings makes it impossible to reject the hypothesis. However, we do not consider a nearly significant finding enough evidence to actually confirm this hypothesis. Therefore this hypothesis remains inconclusive.

Conclusion: Inconclusive

H_{A2}: The addition of ambilight increases unpleasant emotions during exposure to unpleasant content.

For this hypothesis to be confirmed it was expected that the pleasantness scale in the affect grid in the case of the Tongue clip would decrease significantly in the group with ambilight in relation to the group without ambilight. It was also expected that ratings given at appropriate DES scales in relation with the Tongue clip would increase in the ambilight group compared to the no-ambilight group.

Even though some of the DES bar plots for unpleasant emotions display an increase across the ambilight group and the no-ambilight group, none of them is significant. The pleasantness scale in the affect grid was not significant even though the bar plot actually displays a small increase in pleasantness for the Tongue clip. As such no evidence supports the hypothesis and it is therefore considered rejected.

Conclusion: Rejected

H$_{A3}$: The addition of ambilight increases arousal during exposure to arousing content.

In order for this hypothesis to be confirmed it would be expected that at least the arousal scale in the affect grid would increase in the Dance- and Tongue clip for the ambilight group (in comparison with the no-ambilight group). To strengthen the potential confirmation of the hypothesis appropriate DES scale ratings were expected to show the same pattern.

Again most of the DES plots yield inconsistent ratings in relation to arousal and none of them has a main effect across ambilight. The bar plot representing the arousal scale in the affect grid is actually consistent with the hypothesis, as the Dance- and Tongue clip increase in arousal ratings when they are viewed with ambilight. However this difference across the groups was not significant and could there for be due to pure chance. As there is a lack of support for the hypothesis in the results it is rejected.

Conclusion: Rejected

H$_{A4}$: The addition of ambilight decreases arousal during exposure to non-arousal content.

To confirm H$_{A4}$ it was expected as a minimum to see a significant decrease on the arousal ratings for the Pingo clip in the ambilight condition. Appropriate DES scales were expected to support the hypothesis by showing a significant increase due to ambilight in the ratings of the clip.

As with the previous hypothesis the arousal ratings were found insignificant across the ambilight condition even though the plot showed a decrease. As none of the results from the DES scales could add any support to this hypothesis it was also considered rejected.

Conclusion: Rejected

H$_{B1}$: The addition of ambilight is not significantly distracting.

The single item referring to the distraction of display devices during the experiment was expected to be insignificant if this hypothesis was to be confirmed. As the finding

Conclusion: Confirm ((F$_3$), F$_{12}$, F$_{13}$)

H$_{B2}$: The addition of ambilight does not decrease presence.

For this hypothesis to be considered true it was expected to find an increase or at least an insignificant decrease in presence ratings across all films. Likewise distraction was expected not to be of a significant character. The latter was reflected by the results as H$_{B1}$ clearly states. The bar plot of the presence ratings clearly show an increase in the ambilight condition across all film clips. However the presence ratings were only near-significant.

One of the results, from the DES scales, actually turns out to say more about presence in this case than about the emotional responses. It can be discussed whether the scale in which the participants had to report whether they felt more concentrated, attentive and alerted during a clip, actually is measuring an emotion. To be concentrated is arguable as an emotion, since it can be discussed if a bodily reaction is involved. However a state such as alertness seems more in line with a bodily reaction and our definition of emotion. The reason why concentration has been included in this DES scale might be because the measurement scales are originally adopted from research on facial expressions. While having to distinct emotions from expressions it might be useful to be able to tell expressions of concentration apart from other emotions such as happiness or fear. However in this case we actually think that this measure is more appropriate in relation to presence as immersion. The words "concentration" and "attentive" are similar in meaning to being involved and engaged, which can be used to characterize the state of presence as immersion. Both concentration, attentive, involved and engaged are according to our understanding of the words all descriptive of a state in which attention resources are allocated towards some kind of activity. As mental capacity has to be invested in order to feel presence, we think this measure gives a much better indication of a prerequisite to presence than of an emotional state. This is of course only the case if the participants rated the questionnaire item according to the words "concentrated" and "attentive" and not the word "alertness". With this in mind the finding F$_1$ loses part of its value as such we will only consider it near-significant as there are some uncertainty related with the three words used to describe this state of mind.

After assessing the evidence the hypothesis was confirmation. This is a result of no significant findings in distraction ratings and the fact that the plot showed that presence ratings were actually increasing in the ambilight condition across all film clips. The F$_1$ served as extra support for the confirmation of this hypothesis, but might be questionable since it is unknown whether most participants rated this questionnaire item according to the last words (alerted).

Conclusion: Confirmed

10.5 Conclusion

This thesis set out to independently examine whether the described intentions of the Ambilight system given by Phillips actually holds true in reality. After it became obvious that ambilight had the potential to carry information about a films atmosphere, we posted the following problem statement to express the intention of this study:

To what degree does the atmospheric information in the ambilight manifest in an enhanced emotional response related to the content of the viewed film?

Due to the initiation and execution of an experiment culminating with the analysis of 1092 pages of collected data from fifty-two participants, this question can now be answered. As expressed by the rejection of the hypotheses H_{A2}, H_{A3} and H_{A4} our findings yield little evidence, that ambilight manifests in enhanced emotional responses related to films portraying unpleasant, arousing and less arousing content. Furthermore the analysis of the results returned a nearly significant increase in a distinct pleasant emotion, described as delighted, happy and joyful, when pleasant content was viewed with ambilight. This indication might become significant if more data were collected and therefore this no conclusion can be made upon whether ambilight manifests in enhanced pleasant emotions or moods.

To address the observed tendency that ambilight could be distracting during film viewing, the experiment addressed a secondary dependent variable. This variable was whether mental engagement with the film could be kept - a concept known as presence as immersion. The measurements of this variable indicated a near significant increase in presence as immersion due to the addition of ambilight. As such it was concluded that the reason behind the rejected hypotheses were not due to a distraction created by the ambilight.

It should be noted that the test was only conducted on male test subjects and the results cannot be applied on females.

10.6 Future perspective

This report has been investigating how the ambilight technology influenced the movie watching experience. We have concluded that the ambilight does not enhance specific emotions. This could have different reasons, one is that our test is not capable of measuring emotions, which we believe not to be the case since we saw that the test were able to measure the difference in emotional response between movies. It could also mean that we are measuring the wrong thing and Phillips is wrong in claiming that the ambilight "enhances" the atmosphere of the movie. Since we measure no difference it is interesting to ask: does the ambilight have any effect what so ever? To answer that question we must understand that the ambilight does not try to change the atmosphere it tries to enhance it. It would be interesting to investigate what happens if the stimuli given by the ambilight were conflicting with the atmosphere given by the movie. As a starting point an experiment could be conducted where the ambilight is used in combination with an emotionally neutral image, and then investigate if the ambilight could influence the atmosphere of the neutral content. A whole other perspective is that since sound is used as a primary tool for setting the

atmospheres in a film, and it would be interesting to investigate what happens if the ambilight is expressing the emotions made by the soundtrack of the movie.

It is worth noting that it is possible to program the amBX for computer games, such that the game designer has full control over the lighting effects produced by the amBX. We conclude this discussion by stating that even though this report is not capable of confirming Phillips claims we believe that the addition of ambilight is a very interesting change in form that could prove to be an effective and interesting tool in remediation. It is however necessary with more research to understand the potential fully.

11 References

[1] Armstrong, D. (2006) Move Into the Light, Article at Forbes.com, Available at: http://www.forbes.com/forbes/2006/0814/106.html, Accessed 14-10-2009.

[2] The official web page of Phillips. http://www.consumer.philips.com, visited 03-11-2009.

[3] Diederiks, E. & Hoonhout, H. (2006) Radical Innovation and End-User Involvement: The Ambilight Case, Knowledge, Technology & Policy, 20(1), pp. 31-38.

[4] Bullough, J. et al. (2006) Impact of Surrounding Illumination on Visual Fatigue and Eyestrain While Viewing Television, Journal of Applied Science, 6(8), pp. 1664-1670.

[5] Seuntiens, P., Vogels, I. & Keersop, A. (2007) Visual Experience of 3D-TV with pixelated Ambilight, Proceedings of Presence 2007 the 10th Annual International Workshop on Presence.

[6] Mulder, I. & Vliet, H. (2008) In Search of The X-Factor to Develop Experience Measurement Tools, Probing Experience: From Assessment of User Emotions and Behaviour to Development of Products, Philips Research Book Series, Springer Netherlands.

[7] Darwin, C. (1872) The Expression of Emotion in Man and Animals, J. Murray, London, Chapter four, Available at: http://www.gutenberg.org/cache/epub/1227/pg1227.txt, visited 03-11-2009

[8] Izard, C. (1977) Human emotions, New York: Plenum Press.

[9] James, W. (1884) What is an Emotion?, Mind, 9(34), pp. 188-205.

[10] Lange, C (1887) Ueber Gemüthsbewegungen: Eine psychophysiologische Studie, Leipzig: Verlag Von Theodore Thomas, A English translation of a passage of the work is available at:
http://www.dominiopublico.gov.br/download/texto/ps000132.pdf , visited 03-11-2009

[11] Schachter, S. & Singer, J. (1962) Cognitive, Social, and Physiological Determinants of Emotional State, Psychological Review, 69, pp. 379-399.

[12] Russel, J. (1980) A Circumplex Model of Affect, Journal of Personality and Social Psychology, 39(6), pp. 1161-1178.

[13] Plutchik, R. (1982) A psychoevolutionary theory of emotions, Social Science Information, 21, pp. 529-553

[14] Larsen, R. & Fredrickson, B. (1999) Measurement issues in emotion research. In D. Kahneman, E. Diener & N. Schwarz (Eds.) Well-being: Foundations of hedonic psychology.

[15] Russell, J. et al. (1989) A Cross-Cultural Study of a Circumplex Model of Affect, Journal of Personality and Social Psychology, 57(5), pp. 848-856.

[16] Breuer, J. & Freud, S. (1895). Studien über Hysterie (Studies on hysteria), Leipzig, Germany, Franz Deuticke.

[17] A definition of "atmosphere" from Dictionary.com Unabridged, Random House, Available at: http://dictionary.reference.com/browse/atmosphere, visited 03-11-2009

[18] Biddle, S., Fox, K., Boutcher, S. (2000) Physical activity and psychological well-being, Routledge: London, pp. 66.

[19] Forgad, J. (1995) Mood and Judgment: The Affect Infusion Model (AIM), Psychological Bulletin, 117(1), pp. 39-66.

[20] Beedie, C., Terry P. & Lane, A. (2005) Distinctions between emotion and mood, cognition and emotion, 19(6), pp. 847-878.

[21] Alpert, M. & Rosen, A. (1990) A semantic analysis of the various ways that the terms "affect," "emotion," and mood" are used, Journal of communication disorders, 23, pp. 237-246.

[22] Ambilight patent available at: http://www.freepatentsonline.com/EP1763974.pdf, visited 03-11-2009

[23] "password" 29th edition available at http://www.research.philips.com/password/download/password_29.pdf, visited 03-11-2009

[24] amBX web page: http://www.ambx.com/, visited 03-11-2009

[25] http://www.ambx.com/ambx-technology, visited 03-11-2009

[26] Bordwell D, Thompsen K (2004) Film art: an introduction, 7th edn. McGraw Hill Higher Education, New York

[27] Terwogt, M. et al. (1995) Colors and emotions: Preferences and combinations, The Journal of General Psychology, 122(1), p. 5.

[28] Adams, E, & Osgood, C. E. (1973). A cross-cultural study of the affective meaning of color. Journal of Cross-Cultural Psychology, 4, 135-156.

[29] Byrnes, D. A. (1983). Color associations of children. The Journal of Psychology, 113, 247-250.

[30] Kreitler, H., & Kreitler, S. (1972). Psychology of arts. Durham, NC: Duke University Press

[31] Schaie, K. W. (1961). Scaling the associations of colors and moodtones. American Journal of Psychology, 74, 266-273.

[32] Wexner, L. (1954). The degree to which colors (hues) are associated with moodtones. Journal of Applied Psychology, 38, 432-445.

[33] Jacobs, K. & Suess, J. (1975) Effects of four psychological primary colors on anxiety state, Perceptual and Motor Skills, 41, pp. 207-210.

[34] Adams, E, & Osgood, C. E. (1973). A cross-cultural study of the affective meaning of color. Journal of Cross-Cultural Psychology, 4, 135-156.

[35] Goldstein, K. Some experimental observations concerning the influence of colors on the functions of the organism. Occupational therapy,1942,21, 147-151

[36] Valdez, P. & Mehrabian, A.(1994) Effects of Color on Emotions, Journal of Experimental Psychology, 123(4), pp. 394-409.

[37] Web site of University of Minnesota: http://www.sustland.umn.edu/design/colortechniques.html, visited 03-11-2009

[38] Lewis, C. (2005) Land & Light Workshop: Painting Mood & Atmosphere In Oils, North Light Books.

[39] From the internet movie database http://www.imdb.com/title/tt0181865/, visited 03-11-2009

[40] From the internet movie database http://www.imdb.com/title/tt1082868/, visited 03-11-2009

[41] Bech, S. et al. (1995) Interaction between audio–visual factors in a home theater system: Experimental results, Proceedings of the 99th convention of the Audio Engineering Society, p. 4096

[42] Kohlrausch, A. et al. (1996) Experiments on the audiovideo quality of TV scenes, In Hauske G, Heute U, Vary P (eds) Workshop on Quality Assessment in Speech, Audio and Image Communication, pp. 105–106

[43] Jumisko-Pyykkö, S. & Häkkinen, J. (2006) "I would like to see the face and at least hear the voice": Effects of Screen Size and Audio-video Bitrate Ratio on Perception of Quality in Mobile Television, Proceedings of the 4th EuroITV Conference.

[44] Chion, M. (1994). Audio-Vision. Sound on screen. Columbia University Press.

[45] From The Internet movie Database: http://www.imdb.com/title/tt0120815/, visited 03-11-2009

[46] From The internet movie database : http://www.imdb.com/title/tt0119174/, visited 03-11-2009

[47] Sergi, G. (2004) The Dolby era: Film sound in contemporary Hollywood, Manchester University Press.

[48] Cohen, A. (1993) Associationism and musical soundtrack phenomena, Contemporary Music Review, 9(1-2), pp. 163-178.

[49] Cohen, A. (2001) Music as a source of emotion in film, In P.N. Juslin and J. A. Sloboda (eds.) Music and emotions: Theory and Research, pp. 249-272.

[50] abstract by Robinson, J. available at http://nbn-resolving.de/urn:nbn:de:0222-000466, visited 03-11-2009

[51] From the internet movie database http://www.imdb.com/title/tt0368447/, visited 03-11-2009

[52]Gaver, W. (1988) Everyday listening and auditory icons, Unpublished doctoral dissertation, University of California, San Diego, CA.

[53] www.starwars.com, visited 03-11-2009

[54] Matlin, M. & Foley, H. (1997) Sensation and perception, forth edition, Allyn and Bacon.

[55] McVey, G. (1970) Television: Some Viewer-Display Considerations, Educational Technology Research and Development, 18(3), pp. 277-290.

[56] Francesca, C. et al. (2007) Losing sight of the bigger picture: Peripheral field loss compresses representations of space, Vision Research, 47(19), pp. 2506-2520.

[57] Calvo, M. & Nummenmaa, L. (2008) Emotional Scenes in Peripheral Vision: Selective Orienting and Gist Processing, But Not Content Identification, Emotion, 8(1), pp. 68-80.

[58] Wandell, B. A. (1995) Foundations of vision. Sunderland.

[59] Neville, H. & Lawson, D. (1987) Attention to central and peripheral visual space in a movement detection task: an event-related potential and behavioral study. I. Normal hearing adults, Brain Research, 405, pp. 253-267.

[60] Lucasfilm Ltd. (2000) Recommended Guidelines For Presentation Quality and Theatre Performance For Indoor Theatres, Available at: http://www.thx.com/library/pdf/guidelines.pdf

[61] Lund, A (1993) The Influence of Video Image Size and Resolution on Viewing-Distance Preferences, SMPTE, 102, pp. 406-415.

[62] Katzmaier, D. (2006) Philips Ambilight 42PF9731D 42-inch LCD HDTV, Sound & Vision Magazine. Accessed 18th November 2009.

[63] Gampat, C. (2008) Hands-On: Philips amBX Gaming Peripherals, GearLog. Accessed 18th November 2009.

[64] Mansill, B. (2007) amBX - lights, rumble, wind, Atomic Magazine. Accessed 18th November 2009.

[65] Merikle, P. (1998) Psychological investigations of unconscious perception, Journal of Consciousness Studies, 5(1), pp. 5-18.

[66] Rock, I., Linnett, C. & Grant, P. (1992) Perception without Attention: Results of a New Method, Cognitive Psychology 24, pp. 502-534.

[67] Merikle, P. & Joordens, S. (1997) Parallels between Perception without Attention and Perception without Awareness, Consciousness and cognition, 6, pp. 219-236.

[68] Bargh, J. & Pietromonaco, P. (1982) The Influence of Trait Information Presented Outside of Conscious Awareness on Impression Formation, Journal of Personality and Social Psychology. 43(3), pp. 437-449.

[69] Devine, P. (1989) Stereotypes and prejudice: Their automatic and controlled components, Journal of Personality and Social Psychology, 56, pp. 5-18.

[70] Eichman, E. (2000) Cognition and Emotion, Oxford University Press, USA.

[71] Murphy, S. & Zajonc, R. (1993) Affect, cognition, and awareness: Affective priming with optimal and suboptimal stimulus exposures, Journal of Personality and Social Psychology, 64, pp. 723-739.

[72] Calvo, M., & Lang, P. (2005). Parafoveal semantic processing of emotional visual scenes. Journal of Experimental Psychology: Human Perception and Performance, 31, pp. 502–519.

[73] Calvo, M., Castillo, M. & Fuentes, L. (2006) Processing of ''unattended'' threat-related information: Role of emotional content and context, Cognition and Emotion, 20(8), pp. 1049-1074.

[74] Calvo, M. & Castillo, M. (2005) Foveal vs. Parafoveal Attention-Grabbing Power of Threat-related Information, Experimental Psychology, 52(2), pp. 150-162.

[75] Bitner, M. (1992) Servicescapes: The impact of Physical Surroundings on Customers and Employees, Journal of Marketing, 56, pp. 57-71.

[76] Babin, B. et al. (2003) Color and shopping intentions: The intervening effect of price fairness and perceived affect, Journal of Business Research 56, pp. 541-551.

[77] Knez, I. (1995) Effects of indoor lighting on mood and cognition, Journal of Environmental Psychology, 16, pp. 39-51.

[78] Knez, I. and Kers, C. (2000) Effects of indoor lighting, gender, and age on mood and cognitive performance, Environment and Behavior, 32(6), pp. 817-831.

[79] Knez, I. (2001) Effects of colour of light on nonvisual psychological processes, Journal of Environmental Psychology, 21, pp. 201-208.

[80] Knez, I. (2001) Effects of Colour of Light on Nonvisual Psychological processes, Journal of Environmental Psychology, 21, pp. 201-208.

[81] Knez, I. (1995) Effects of indoor lighting on mood and cognition, Journal of Environmental Psychology, 15, pp. 39-51.

[82] From the internet movie database http://www.imdb.com/title/tt0120737/, visited 03-11-2009

[83] From the internet movie database http://www.imdb.com/title/tt0107290/, visited 03-11-2009

[84] Lombard M, Ditton T (1997) At the heart of it all: the concept of presence. Department of Broadcasting, Telecommunications and Mass Media, Temple University

[85] Ryan, M. (2001) Narrative as Virtual Reality: Immersion and Interactivity in Literature and Electronic Media, Johns Hopkins University Press, Baltimore, MD.

[86] Larsen, R. & Fredrickson, B. (1999) Measurement Issues in Emotion Research, In D. Kahneman, E. Diener & N. Schwarz (Eds.) Well-being: The foundations of hedonic psychology, pp. 40-60

[87] Baren J, Ijsselsteijn W (2004) Measuring presence: a guide to current measurement approaches. Available via: http://www.informatik.umu.se/*jwworth/PresenceMeasurement.pdf, visited 03-11-2009

[88] Lessiter, J. et al (2001) A Cross-Media Presence Questionnaire: The ITC Sense of Presence Inventory, Presence: Teleoperators and Virtual Environments, 10(3), pp 282-297.

[89] From http://www.dolby.com/uploadedFiles/zz-_Shared_Assets/English_PDFs/Professional/208_Dolby_Surround_Pro_Logic_Decoder.pdf, visited 03-11-2009

[90] Fletcher, A. (2006) Step up, Dance movie, Official website available at: http://www.paramountpictures.co.uk/stepup/

[91] Hanna, J. (1988) Dance, Sex, and Gender: Signs of identity, Dominance, Defiance, and Desire. Chicago: University of Chicago Press.

[92] Chivers, M. (2004) A Sex Difference in the Specificity of Sexual Arousal, Psychological Science, 15(11), pp. 736-744.

[93] Takashi, M. et. al (2001) Ichi the Killer, Japanese film based on Hideo Yamamoto's manga series of the same name.

[94] Palomba, D. et al. (2000) Cardiac responses associated with affective processing of unpleasant film stimuli, International Journal of Psychophysiology, 36, pp. 45-57

[95] Frankel, D. (2001) "Why We Fight", Disc 5, Part 9, Band of Brothers, official website available at: http://www.hbo.com/events/bob/index.html

[96] Jacquet, L. et. al. (2005) March of the Penguins, A French nature documentary film.

[97] Ulrich, R. et al. (1991) Stress recovery during exposure to natural and urban environments, Environmental Psychology, 11, pp. 201-230.

[98] Siegel, A. (1990) Multiple t Tests: Some Practical Considerations, TESOL Quarterly, 24(4). Pp. 773-75.