
# Investigating How Film Lighting Techniques Influence Viewers' Emotional Arousal, Emotional Valence and State Empathy

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**Abstract**

The present study explores the relationship between film lighting techniques and viewer's emotional responses. The main focus was to investigate whether viewer's emotional arousal, emotional valence and their state empathy would increase with higher levels of low-key lighting. Low-key lighting indicates the shadow areas in the film scenes. Higher level represents a higher contrast between the light and shadow areas. A within-subject experiment ($N = 75$) composed of 15 short film clips from three different genres (action, drama and romance) was designed to examine the effect. Participants were video recorded and their facial emotions during film watching were analysed by FaceReader. A state empathy scale (Shen, 2010) consisting of 12 questions was collected after each film clip. Results showed that viewers were more aroused, and produced more negative emotions when there were higher shadow proportions in the scenes for the drama and romance genres. For the action genre, results indicated the opposite effect, viewer's arousal and valence decreased with larger shadow areas. Moreover, contrary to the hypothesis, viewers did not empathize more with the film characters with higher levels of low-key film lighting. Both state empathy and associative empathy decreased with higher contrast of light and dark areas in the scenes. No relationship was found between low-key lighting, affective empathy, and cognitive empathy. Together the findings suggest that low-key lighting does not always predict higher emotional responses. Viewer's emotions and empathy were also influenced by film genres, the content, and individual differences.

*Keywords:* film study, film formal features, film lighting, emotional arousal, emotional valence, state empathy, affective empathy, cognitive empathy, associative empathy

## Table of Content

**Investigate how film lighting techniques influence viewer's emotional arousal, emotional valence and state empathy**

Film watching is a good way to experience different emotions within a short period of time (Johnson-Laird & Oatley, 2016). The emotional experiences that films offer to viewers is one of the major incentives from watching films (Tan, 2011). Besides the content of the film, its form and presentation also contribute to shifting and turning of viewer's emotional responses (Detenber & Lang, 2010). Content refers to the story, narratives, characters, and plot, while form and presentation are about how the content is presented to the viewers (Detenber & Lang, 2010; Geiger & Reeves, 1993). Additionally, both formal features and presentation features in the film can enhance the film watching experience. Formal features are the ones under the control of the producer and cannot be changed by the viewers (Detenber & Lang, 2010). Presentation features on the other hand, such as screen size, volume and viewing distance can be adjusted by the viewers (Detenber & Lang, 2010). Although both formal and presentation features are both interesting subjects related to viewer's emotional responses for films, the focus of this paper will be about the impact of film's formal features on viewer's emotional responses.

Film formal features enable viewers to follow, understand the story, and to identify film structures (Brunick, Cutting, & DeLong, 2013). More importantly, film formal features influence viewer's attention, cognitive and emotional responses (Detenber & Lang, 2010; Lang, 2000). These formal features include colour, motion, lighting, editing pace, shots, etc. (Tarvainen, Westman, & Oittinen, 2015). Viewer's emotional responses such as reported arousal and valence are influenced by the formal features such as camera angle, motions, shot scales, brightness and colour (Cummins, Keene, & Nutting, 2012; Detenber & Lang, 2010; Tarvainen, Westman, & Oittinen, 2015).

Film formal features can also have an impact on viewer's emotional engagement with the characters. Emotional engagement refers to viewer's emotions towards the characters, in which they feel the character's emotions (empathy), and feel for them (sympathy) (Busselle & Bilandzic, 2009). In film watching, viewer's empathic engagement is crucial for understanding characters (Vaage, 2010). Previous research indicated that viewers' emotional engagement increased with larger faces of the characters (Balint, Svanera, Schoft, Benini, & Rooney, submitted for publication). Viewer's empathy level also increases with the level of understanding and processing of the films (Lang, 2000). Film formal features such as camera perspectives, shot scales, and music all contribute to empathizing with the characters (Boero & Bottoni, 2008; Wang & Cheong, 2006; Vaage, 2010). Therefore, the importance of understanding how viewers empathize with the film characters should not be neglected.

Lighting is fundamental to the aesthetics of television programs and films (Zettl, 2011). Lighting in media and visual designs can affect the feelings, perceptions and emotions of audiences directly, dramatic effects in films heavily rely on lighting (Grodal, 2007; Zettl, 2011). Previous research found that changes in the luminance in film scenes has a noticeable impact on viewer's film watching experience (Brunick, Cutting, & DeLong, 2013). Luminance is a measurement of how much light is present in an image (Brunick, Cutting, & DeLong, 2013). It is not precisely the same as lighting. Lighting is defined as the manipulation of the light and shadow areas on the screen, and is an important formal feature in films (Zettl, 2011). Film lighting is essential for audiences to see actions, build emotions, and guide attentions (Shafiee & Bidin, 2016). There are many lighting techniques in films to establish different scenes, characters and even film genres (Ramaeker, 2014; Zettl, 2011). For instance, high-key lighting and low-key lighting (Wang & Cheong, 2006). Previous research on film lighting showed that it can enhance the plot, set a mood or create an atmosphere for

the viewers (Poland, 2015; Shafiee & Bidin, 2016). Hence, the relationship between film lighting and viewer's emotional responses is an interesting topic to be further explored.

Although there is a growing body of research focusing on different film formal features and the impact on emotional responses and viewer's empathy level, there are only limited research on film lighting techniques. Therefore, the connections between film lighting with viewer's emotional responses will be further investigated in the present study. This paper will attempt to answer the following research question: how do different film lighting techniques impact audience's emotional arousal, emotional valence, and empathy?

## Theoretical Framework

Films and psychology have helped each other in many ways in the past century, as both videos and films are still being widely used in the studies of perception and emotions (Tan, 2011). Narrative information in films are structured in a certain way by the filmmakers to attract viewer's attention and influence their cognitive and emotional responses (Bordwell, 1985). A good film can lead to many complex emotions: comedies are not only happy, thrillers are not just about anxious feelings, and tragedies are not limited to sadness (Johnson-Laird & Oatley, 2016). Moreover, in a good film, viewers feel empathy and sympathy with the film characters as well (Busselle & Bilandzic, 2009; Tan, 2011). Thus, it is interesting to see how emotions and films are tightly related to each other. In order to understand the relationship between film lighting and viewer's emotions, the use of film formal features will first be discussed, which will be followed by the concept of film lighting. Then, the concepts of emotions such as emotional arousal, emotional valence will be clarified, as well as empathy. Lastly, the relationship between film formal features and emotions, including film lighting and viewer's emotions and empathy will be further discussed.

### LC4MP

According to the Limited Capacity for Mediated Processing (LC4MP) model (Lang, 2000), video messages consist of both structural information and content. Structural information, also known as formal features, influence viewer's motivation as well as cognitive and emotional responses (Detenber & Lang, 2010; Lang, 2000). The LC4MP model argues that the formal features of video messages can elicit orienting responses in viewers, and trigger automatic attentional processes of viewers (Lang, 2000). Hence, based on the LC4MP model, it is sensible to conclude that formal features of videos, television and films have an influence on viewer's cognitive and emotional responses.

There are high-level and low-level formal features in terms of film aesthetics. High-level features are the overall aesthetic effects of film such as the complexity and beauty, while low-level formal features refer to the elements which help to achieve the aesthetic effects (Tarvainen, Laaksonen, & Takala, submitted for publication; Tarvainen, Westman, & Oittinen, 2015). Low-level formal features can be checked individually from the artwork as a whole (Tarvainen, Westman, & Oittinen, 2015). Low-level formal features are grouped into three main categories: visual, audio and temporal (Brunick, Cutting, & DeLong, 2013; Tarvainen, Westman, & Oittinen, 2015). The visual features include lighting, colour, motion, depth and framing (Tarvainen, Westman, & Oittinen, 2015; Wang & Cheong, 2006). Audio consists of music, dialogue and sound effects (Tarvainen, Westman, & Oittinen, 2015). Shot duration as well as music tempo are considered as temporal features (Tarvainen, Westman, & Oittinen, 2015). Film aesthetics are strongly supported by low-level formal features (Tarvainen, Westman, & Oittinen, 2015). In addition, low-level formal features contribute greatly to viewer's ability to follow, understand and identify the stories in films, and can also predict viewer's mood (Brunick, Cutting, & DeLong, 2013; Tarvainen, Westman, & Oittinen, 2015).

In order to investigate the relationship between film lighting and emotions, film lighting as an important low-level formal feature will be further explained.

**Light and Film lighting**

Light is a key element for visual perception which orients us in space and time (Zettl, 2011). Although light itself is in fact invisible, it allows visibility (Roberts-Breslin, 2018; Zettl, 2011). Lighting is the control of the light and shadow areas and its basic purpose is to manipulate our perception of the environment and change how we feel about things, events or people (Zettl, 2011). Lighting is linked with feelings and moods carried by the scene, object or people (Grodal, 2007).

Film lighting as a low-level formal feature creates visual effects and enhances the film watching experience for the viewers (Grodal, 2007; Shafiee & Bidin, 2016). Most of the film-making involves three-point lighting: the back light, the fill light, and the key light (Ramaeker, 2014; Roberts-Breslin, 2018). The back light is placed at the back of an object or a character, to separate the object or character from the background (McGregor, 2014). The fill light illuminates the shadows on the character and the background (Ramaeker, 2014). The key light provides the illumination to the scenes and creates the impression of depth by casting shadows (Ramaeker, 2014; Roberts-Breslin, 2018). There are many different types of lighting styles created by the three-point lighting, such as flat lighting, presentational lighting, motivated lighting (Roberts-Breslin, 2018). More importantly, high-key and low-key lighting (Roberts-Breslin, 2018).

The two main aesthetic lighting techniques for establishing mood and atmosphere in films are high-key and low-key lighting (Wang & Cheong, 2006; Zettl, 2011). Low-key and high-key lighting are also the most frequently employed film lighting techniques (Wang & Cheong, 2006). High-key lighting does not put too much emphasis on the contrast between the light and dark areas (Ramaeker, 2014; Wang & Cheong, 2006). While low-key lighting is highly selective and puts emphasis on the contrast between the light and dark areas in the scenes (Shafiee & Bidin, 2016; Zettl, 2011). Starting from the late 1940s, light level in films was decreasing in Hollywood films (Cutting, Brunick, & DeLong, 2011). By 1980s, low-key lighting was widely applied in films across genres (Ramaeker, 2014). The two major differences between high-key and low-key lighting are the general level of light and the proportion of shadow area (Wang & Cheong, 2006). In summary, high-key lighting has a low proportion of shadow area, while low-key lighting contains a high proportion of shadow areas.

This lighting technique of highlights and shadows has widely been used since the Classical Hollywood films up until now (Shafiee & Bidin, 2016). The typical high-key

lighting scenarios are joyful, with less tension and a warm atmosphere. They reflect light-heartedness, and uplifting feelings (Poland, 2015; Wang & Cheong, 2006; Zettl, 2011). High-key lighting is mostly employed in commercials, music videos and comedies (McGregor, 2014). On the contrary, low-key lighting is mostly used to reflect sad, frightening or suspense scenes (Wang & Cheong, 2006; Zettl, 2011). Low-key lighting usually creates feelings of sadness, fear, surprise and anxiety (Shafiee & Bidin, 2016; Wang & Cheong, 2006). The use of different lighting techniques help filmmakers tell their stories in an aesthetic way, with film lighting being a powerful tool for inducing and changing feelings and emotions in films (Grodal, 2007).

**Emotions**

Emotion is a complex concept and agreeing on a universal definition has been a difficult task for psychologists. Some considered emotions share the same process as motivation while some define emotions as bodily changes, and others explain emotions as subjective feelings that are experienced and reported by the individual (Zimbardo, 1979). Regardless of the complexity that comes with understanding the concepts, emotions occur and influence individuals in their daily life (Izard, 2009; Zimbardo, 1979). Nevertheless, emotion is frequently defined as "a temporary change in affect or feeling state, elicited by an effectively salient situation, that involves coordinated, multiple systems, including physiology, brain activity, behaviour, and conscious experience" (Hamann, 2012, p.458). There have been two main conceptualizations of emotions, the discrete emotions theory, and dimensional theory. The discrete emotions theory proposes that emotions are innate (Izard, 2007; Zimbardo, 1979). There are a small number of basic emotions such as happiness, anger, sadness and complex emotions are made up of basic emotions (Ekman, 1992; Hamann, 2012; Izard, 1977; Izard, 1992). Dimensional theory of emotions states that all emotions can be mapped on to two or more affective dimensions (Osgood, May, & Miron, 1975; Russell,

1980; Yik, Russell, & Barrett, 1999). There are three commonly known dimensions (Osgood, May, & Miron, 1975): evaluation-pleasantness, potency-control, and activation-arousal. Moreover, the two-dimensional model consists of valence-arousal (Russell, 1980) is widely used in emotion research.

Furthermore, there are many components of emotions. For instance, Zimbardo (1979) named three components: the neurophysiological component, the experiential component (i.e., physiology, cognition), and the expressive component (e.g., facial expressions, body movements). A more recent study (Fontaine, Scherer, Roesch, & Ellsworth, 2007) presented six components of emotions: appraisals of events, psycho-physiological changes, motor expressions, action tendencies, subjective experiences, and emotion regulation. Izard (2009, p.3) concluded that emotion feeling is "a phase of neurobiological activity that is experienced as motivational and informational and that influences thought and action, a felt cognition, or action tendency".

Some of the concepts within the discrete emotions theory are very important for the current study in order to understand viewer's emotional responses to films. More specifically the basic emotions (Ekman, 1992; Hamann, 2012; Izard, 2009) and the universal facial expressions (Ekman, 1970; Ekman, 1972). The theory of basic emotions proposes that "emotion categories are biologically inherited and are basic in the sense that they cannot be broken down into constituent psychological elements" (Hamann, 2012, p.461). The basic emotions consist of joy/happiness, interest, sadness, anger, disgust, and fear (Izard, 2007; Izard, 2009). Emotions are not only sensory perceptions (e.g., visual, auditory perceptions), but also involve nonverbal behaviour such as bodily perceptions (e.g., pain, thirst) (Scarantino, 2016), and facial expressions (Lazarus, 1991). One of the most important components of emotions is emotional expressions. Because of the multi-level perceptions of emotions, such as heart-rate, skin-conductance, and facial expressions they are being widely

used to measure emotions in communication research (Detenber & Lang, 2010). A commonly used measure for facial expressions is the universal facial expressions which consist of six facial expressions: happy, surprise, sad, fear, disgust, and anger (Ekman, 1970). The concept of universal facial expressions is summarized with the following characteristics: if the same emotions are elicited in different cultures and there is no interference by display rules, then the same facial expressions will occur, because the facial muscle movements are innately determined and universal (Ekman, 1972; Zimbardo, 1979).

Emotion feeling also varies from low to high levels of intensity. Russell's (1980) emotion model (figure 1) is a widely used two-dimensional model to illustrate the emotional arousal and emotional valence. Arousal on the vertical axis represents the intensity of emotion, while valence on the horizontal axis indicates the type of emotion ranging from unpleasant to pleasant (Detenber & Lang, 2010; Mo, Niu, Su, & Das, 2018). Moreover, pleasure and arousal are positively correlated even though they are conceptually different, such as delighted (plus on both pleasure and arousal) or bored (minus on both pleasure and arousal) (Russell, 1980). Valence is a fundamental component of emotional responding (Barrett, 2006), the displeasure-pleasure dimension appears inevitable in the concept of emotion (Russell, 1991). The dimensions of emotional valence and emotional arousal are essential physiological responses of emotions and account for the majority of the variance in emotional responses (Detenber & Lang, 2010).

Although the discrete emotions theory and the dimensional emotions theory propose different conceptualizations, they are in fact closely related, and both play an important role in emotion studies. A recent study (Hamann, 2012) showed that different visual stimulus generated different basic emotions. Basic emotions can be mapped on to a two-dimensional framework (figure 2) to create in-depth understanding of emotions (Hamann, 2012). For example, seeing a snake created fear (high arousal and negative valence), while seeing a

neutral object such as a chair did not generate much emotion (neutral). The arousal and valence levels can be different as well while the emotions remain the same (Hamann, 2012). Seeing a smiling baby created happiness (high arousal and positive valence), while seeing beautiful sunset also created happiness but lower arousal. In summary, emotion is a complex concept and it should not be determined by one component or a single theory.

Therefore, the present study employed both the discrete theory of emotions and the two-dimensional theory of emotion, in order to create a deeper understanding of viewer's emotions when watching films. On top of the theories of emotion, an understanding of viewer's emotional engagement in films remains crucial as well.

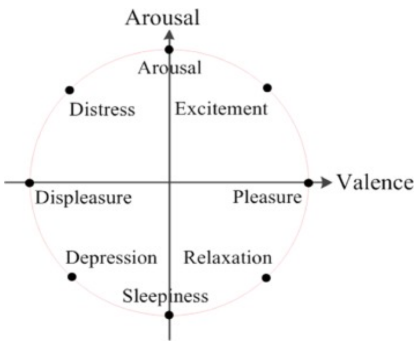


*Figure 1*. Russell's emotion model (1980)

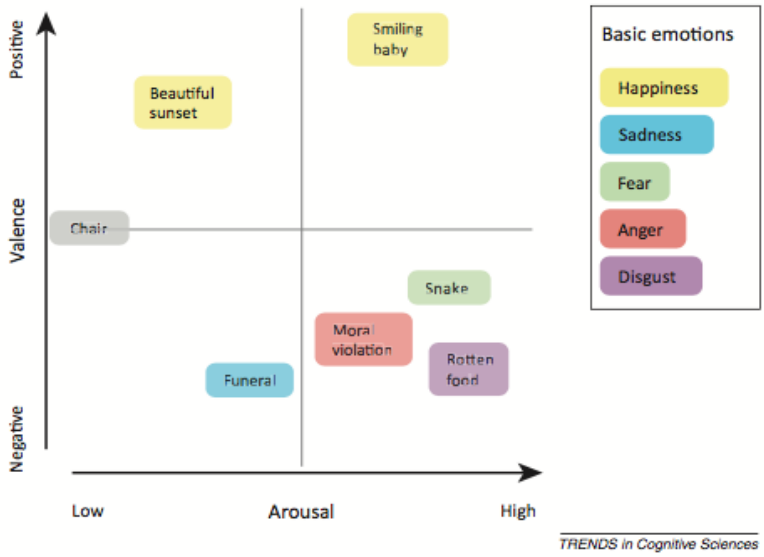


*Figure 2*. Basic emotions within a two-dimensional framework (Hamann, 2012).

**State Empathy**

Emotional engagement refers to the extent to which viewers were emotionally affected by the story (Hoeken & Sinkeldam, 2014), their feelings with (empathy), and feeling for (sympathy) the characters (Busselle & Bilandzic, 2009; Sukalla, Bilandzic, Bolls, & Busselle, 2016). Empathy during message processing can be described as a process through which the viewers understand, process, and are influenced by believable media messages (Shen, 2010). In combination with the LC4MP model (Lang, 2000), this explains empathy in film watching as well. Viewer's empathy level depends on their level of understanding, processing of the films, as well as the credibility of the films.

Empathic engagement is important for viewers to understand characters in films (Vaage, 2010). State empathy can be defined as a process through which people share "another's feelings by placing oneself psychologically in that person's circumstances" (Lazarus, 1991, p.287). State empathy has been mainly studied for its involvement in social processes, and focused on understanding the extent to which people experience emotions of others (Shen, 2010; Westman, Shadach, & Keinan, 2013). There are three core dimensions of state empathy in film watching. Affective empathy is the recognizing and understanding of the character's feelings (Shen, 2010; Shen, 2018). Cognitive empathy, or perspective-taking, refers to identifying, understanding and adopting the character's point of view (Shen, 2010; Shen, 2018). Associative empathy, also known as identification, viewers experience the narrative as if they are the film character (Shen, 2010; Shen, 2018).

In order to fully understand viewer's empathy in film processing, it is necessary to bring up narrative engagement. A high level of narrative engagement enables viewers to immerse themselves into the narrative world (Green & Brock, 2000) and enjoy the film watching experience (Busselle & Bilandzic, 2009). Narrative engagement is closely related to transportation (Green et al., 2008; Chen, 2015), absorption (Balint, Hakemulder, Kuijpers,

Doicaru, & Tan, 2016), identification with characters (Joffe, 2008; Kim et al., 2009), flow (Csikszentmihalyi, 1997) and persuasion (Chen, 2015; Joffe, 2008). Viewers who are more transported into the story have higher affective empathy (Johnson, 2012). The outcomes of narrative engagement can affect attitudes (Green et al., 2008; Zwarun & Hall, 2012), beliefs (Green et al., 2008) and behaviours (Kim et al., 2009; Zwarun & Hall, 2012).

There are many features of narrative engagement which are in common with the core dimensions of state empathy, and contribute greatly to viewer's emotional engagement with characters. For instance, perspective-taking (cognitive empathy) and identification (associative empathy). More importantly, empathy is a part of identification (Cohen, 2001). Hence, it is of vital importance to understand identification in order to recognise state empathy. Identification involves perspective-taking, and is a core aspect of identification (Balint, Klausch, & Polya, 2016; Van Krieken, Hoeken, & Sanders, 2017). Perspective-taking is the progression that the audience "feels he or she understands the character and the motivations of his or her behaviour" (Cohen, 2001, p.256). Identification is "an imaginary process that entails merging with the character and sharing the character's knowledge about the narrated events, adopting the character's goals, and sharing the character's emotions" (Tal-Or & Cohen, 2010, p.404). Deep narrative absorption, being mentally engaged with a specific character, and to lose self-awareness while watching films, all contribute to an increased identification with the characters (Tal-Or & Cohen, 2010).

Previous findings are in line with Shen's research (2010), there are multiple levels when identifying with a film characters: viewers feel affinity towards the character (affective empathy) (Tal-Or & Cohen, 2010). Then they adopt the character's goals and point of views (cognitive empathy) (Tal-Or & Cohen, 2010; Hoeken & Fikkers, 2014). Eventually become the character, and experience the narrative world through the character's eyes (associative empathy) (Cohen, 2001; Tal-Or & Cohen, 2010). Moreover, likeability and credibility of the

characters also increase identification (Moyer-Gusé, 2008). Involvement, enjoyment and emotional responses increase with strong identification, and result in great impact as well such as persuasion, change in attitude and behaviours (Cohen, 2001; Moyer-Gusé, 2008).

Additionally, identification does not only have an impact on viewer's empathy level, viewers also experience emotions differently depending on the level of identification (Hoeken & Fikkers, 2014). The types of emotions (valence) and intensity of emotions (arousal) from a story are influenced by the extent to which viewers identify with a character, as viewers tend to share similar emotions as the characters they favour (Hoeken & Sinkeldam, 2014). Viewer's emotional arousal increases with higher immersion (Visch, Tan, & Molenaar, 2010). The emotional valence depends on whether the characters succeed or fail to reach their goal, and the emotional arousal depends on the extent to which the viewers care about a character (Van Krieken, Hoeken, & Sanders, 2017).

In summary, emotional engagement in the films can enhance the narrative experience and bring enjoyment to the viewers, especially when viewers develop empathy towards the characters.

**Film formal features, film lighting with Emotions and Empathy**

There is a growing body of research suggesting that low-level formal features in films evoke viewer's emotional responses and influence empathy (Balint, Klausch, & Polya, 2016; Deterber & Lang, 2010; Soleymani, Kierkels, Chanel, & Pun, 2009). Emotional arousal can be influenced by different camera perspectives in a film (Cummins, Keene, & Nutting, 2012). For instance, first-person point of view appears to be more engaging and arousing for the viewers than third-person point of view (Krcmar & Farrar, 2009). Shots of close-ups increase arousal (Canini, Benini, & Leonardi, 2011). Motions and fast pacing in films increase emotional arousal as well (Detenber & Lang, 2010; Detenber, Simons, & Bennett, 1998; Tarvainen, Westman, & Oittinen, 2015). Colour also has an effect on arousal, particularly the

lightness and saturation of colour positively affected the pleasure level. These results are in line with previous research suggesting that the brightness of the colour created strong emotional experience (Detenber, Simons, & Reiss, 2000; Valdez & Mehrabian, 1994). Although viewers might be more aroused with motions and fast pacing, these two low-level formal features have none or only little effect on emotional valence (Detenber & Lang, 2010). Low-level formal features such as brightness, colour saturation and music do appear to influence emotional valence (Detenber, Simons, & Reiss, 2000; Tarvainen, Laaksonen, & Takala, submitted for publication; Tarvainen, Westman, & Oittinen, 2015). The use of different formal features helps filmmakers to achieve the emotional impact on viewers.

Viewer's emotional engagement with characters is influenced by many low-level formal features as well. Camera perspectives, motions and fast pacing influence viewer's engagement and attention (Cummins, Keene, & Nutting, 2012; Simons, Detenber, Cuthbert, Schwartz, & Reiss, 2003). Different point of view structures in film encourage viewers to engage emphatically by eliciting imagination (Vaage, 2010). Shot scales increase audience's tendency to mentalize toward the character and evoke empathic responses (Vaage, 2010). To be precise, close-up shots increase viewer's empathy (Cao, 2016; Wang & Cheong, 2006). Close-ups of sad faces produce more references to viewer's own emotions compared to close-ups of neutral faces and long-shots (Rooney & Balint, 2018). Music appears to be a very powerful feature as well, which has an impact on audience's emotional responses towards the characters and influence empathy (Boero & Bottoni, 2008). These low-level formal features enable films to elicit powerful and various emotions in a short amount of time, as well as making the viewing experience enjoyable. Nevertheless, compared to other low-level formal features, very little research has been done on the effects of film lighting techniques on reported viewer's emotions and empathy.

Having said this, the relationship between lighting and emotions has been investigated in many domains, such as indoor lighting, lighting in computing technologies, and games. Bright lighting setting in shops greatly affected the pleasure level of the consumers (Quartier, Vanrie, & Van Cleempoel, 2014). Different types of room lightings in the office greatly affect mood and cognitive performance (Knez & Enmarker, 1998). It was also proven that a positive mood was preserved in certain levels of brightness and colour of the lighting settings (Knez, 1995). Lighting is also an important aspect in creating intimate spaces restaurants (Wardono, Hibino, & Koyama, 2012). Apart from the indoor lighting research on emotions and mood, Knez and Niedenthal (2008) found out that the combination of lighting and colour induced the highest level of pleasantness in game users. Moreover, light perception affects emotions and feelings in affective computing as well (Sokolova & Fernandez-Caballero, 2015), to be specific, mood can be affected by exposure to bright light. These studies showed that different settings of lighting have an impact on people's emotions and it is not limited to indoor environments.

To date, there are limited studies focusing on film lighting techniques and viewer's emotional responses. Only until recently, Poland (2015) conducted a study to investigate the impact of different lighting techniques on viewer's emotional responses and character assessment. It was a between-subject design where participants viewed videos with the same content in different lighting conditions (high-key, low-key, and available light), the stimulus for each condition was equally ten minutes (Poland, 2015). Lighting techniques was the independent variable and there were multiple dependent variables in the study. Firstly, Poland (2015) hypothesized three emotional responses corresponding to the lighting techniques: high-key lighting stimulated light-heartedness (positive emotions, e.g., happy), low-key lighting stimulated suspensions (negative emotions, e.g., scared), and available light stimulated rawness (i.e., feeling of real). The study also investigated the relationship between

film lighting and character likeability, character credibility and film genre. The study found out that low-key lighting in videos evoked higher levels of negative emotions than high-key lighting (Poland, 2015). However, the study did not find supporting evidence that high-key lighting could evoke higher levels of positive emotions than low-key lighting (Poland, 2015). Results showed a contrary effect, audiences viewed low-key lighting stimulus to be more positive than the ones who viewed high-key lighting (Poland, 2015). Moreover, audiences also reported to produce stronger emotional responses and higher believability towards the characters in low-key lighting (Poland, 2015). Viewers reported low levels on all emotional responses in high-key film lighting (Poland, 2015).

In Poland's research (2015), low-key lighting was the main film lighting technique to contribute to viewer's emotional responses. This study contributed to the current limited knowledge of the relationship between film lighting and viewer's emotions. However, one single research is not enough to cover all aspects of film lighting techniques and thoroughly investigate the possible emotional impact.

**Research question and hypotheses**

Previous research revealed that lighting in different domains (e.g., indoor lighting, lighting in games and computing technologies) play an important role in influencing emotions and mood. Although a former study found evidences of low-key film lighting evoking strong emotional responses, the relationship between film lighting and viewer's emotional responses remains largely unexplored compared to other low-level formal features. To address this research gap, the current study tests and answers the following research question by means of the following.

**Research question:** How do different film lighting techniques impact audience's emotional arousal, emotional valence and empathy?

**Hypothesis 1:** Film lighting techniques will affect emotional arousal, in a way that higher level of low-key lighting is associated with higher level of emotional arousal.

**Hypothesis 2:** Film lighting techniques will affect emotional valence, in a way that higher level of low-key lighting is associated with higher level of negative emotional valence.

**Hypothesis 3:** Film lighting techniques will impact viewer's empathy, in a way that higher level of low-key lighting predicts higher state empathy.

**Hypothesis 3a:** Film lighting techniques will impact viewer's state empathy, in a way that higher level of low-key lighting predicts higher affective empathy.

**Hypothesis 3b:** Film lighting techniques will impact viewer's state empathy, in a way that higher level of low-key lighting predicts higher cognitive empathy.

**Hypothesis 3c:** Film lighting techniques will impact viewer's state empathy, in a way that higher level of low-key lighting predicts higher associative empathy.

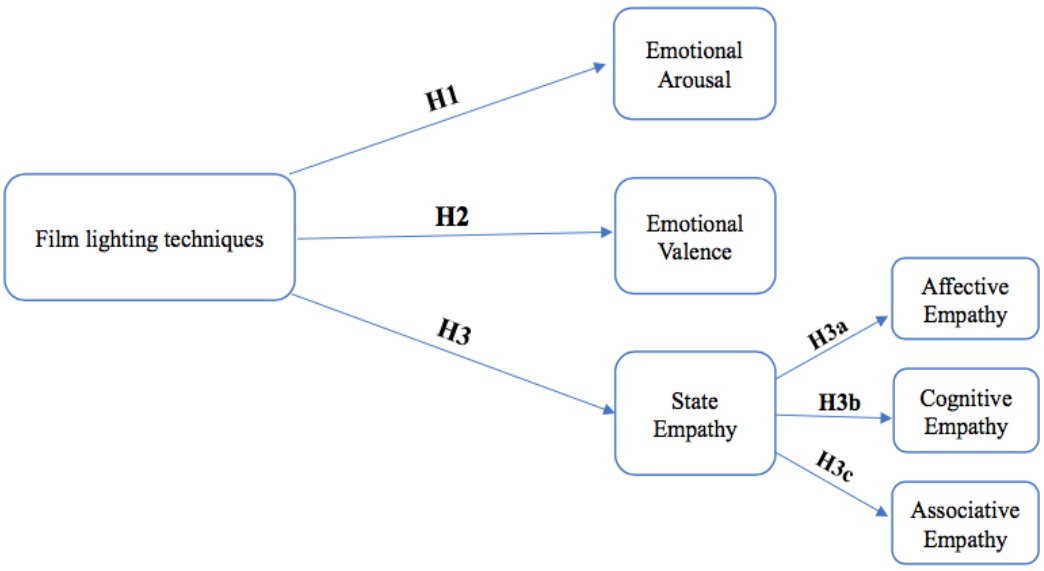


*Figure 3*. Conceptual model of the variables in the study.

# Method

## Participants

A sample of total 75 participants was recruited from the Tilburg University student participant pool, together with convenience sampling. Due to some technical issues, not every session was completed and recorded. Since the stimulus materials and questionnaire were completely in English, it was important that participants' level of English was proficient for this study. All completed participants reported average, good and excellent English level, hence, no participant was excluded based on this requirement. Thus, in total 71 participants completed the study (24 males, 47 females; *M* age = 24.44, *SD* = 4.45, range between 19 and 40 years old) and 66 valid video recordings were collected.

## Design

A within-subject experiment built in Qualtrics software (Qualtrics, n.d.) was conducted with film lighting techniques as the independent variable, and emotional arousal, negative emotional valence, and viewer's empathy as dependent variables. Each participant watched 15 film clips for a total of 36 minutes. The films clips were of three different film genres: action, drama and romance. The order of the film genres was randomized, on top of that, the films within each genre were also randomized. The randomization was to reduce the chances of the order of film clips or other factors influencing the results.

## Stimulus material

The stimulus set consisted of 15 self-contained film clips lasting between two to four minutes in length, the overview of the stimulus materials can be found in table 1. The films were selected from IMDB with a rating higher than 7.0 between the year 2000 and 2018. The clips belong to three different genres: action, drama and romance. They are all from different films of different directors with different actors/actresses. None of the stimulus materials contain loud background music, all scenes selected were completely in English. There were no subtitles added in the film scenes. Moreover, for each genre, it was attempted to obtain

equal amount of indoor and outdoor scenes. Each scene contains two to three characters, and the selected scenes present interactions (e.g., dialogue, actions, etc.) between the characters. All film clips were presented in the standard high-definition (HD) display resolution of 1280x720 pixels (720p). The complete stimulus material can be found via the link in Appendix C.

Table 1

*Overview of the film stimulus material*

| Film | Year | Director | IMDb rating | Indoor/ Outdoor | Scene starting time | Scene ending time |
|---|---|---|---|---|---|---|
| | | | *Action* | | | |
| Baby Driver | 2017 | Edgar Wright | 7.7 | Outdoor | 00:44:41 | 00:46:43 |
| Django Unchained | 2012 | Quentin Tarantino | 8.4 | Outdoor | 00:53:14 | 00:55:29 |
| Pirates of the Caribbean: The Curse of the Black Pearl | 2003 | Gore Verbinski | 8.0 | Indoor | 00:42:24 | 00:43:32 |
| Kingsman: The Secret Service | 2014 | Matthew Vaughn | 7.7 | Mixed | 00:17:53 | 00:19:54 |
| Taken | 2008 | Pierre Morel | 7.8 | Indoor | 00:13:08 | 00:15:46 |
| | | | *Drama* | | | |
| Black Swan | 2010 | Darren Aronofsky | 8.0 | Indoor | 00:19:26 | 00:21:48 |
| Memories of a Geisha | 2005 | Rob Marshall | 7.4 | Outdoor | 00:26:26 | 00:28:26 |
| The Pursuit of Happyness | 2006 | Gabriele Muccino | 8.0 | Outdoor | 01:21:30 | 01:23:30 |
| Shutter Island | 2010 | Martin Scorsese | 8.1 | Indoor | 01:26:16 | 01:29:40 |
| The Prestige | 2006 | Christopher Nolan | 8.5 | Indoor | 01:10:23 | 01:12:44 |
| | | | *Romance* | | | |
| Me Before You | 2016 | Thea Sharrock | 7.4 | Outdoor | 00:40:17 | 00:42:36 |

| | | | | | | |
|---|---|---|---|---|---|---|
| La La Land | 2016 | Damien Chazelle | 8.1 | Outdoor | 01:41:15 | 01:43:03 |
| Silver Linings Playbook | 2012 | David O. Russell | 7.8 | Outdoor | 00:55:43 | 00:58:46 |
| The Curious Case of Benjamin Button | 2008 | David Fincher | 7.8 | Indoor | 02:24:44 | 02:27:18 |
| The Light Between Oceans | 2016 | Derek Cianfrance | 7.2 | Mixed | 01:49:00 | 01:51:25 |

**Measures**

Film lighting technique as the independent variable was measured automatically by a computer program. Both emotional valence and emotional arousal as dependent variables were measured by FaceReader (Noldus, n.d.). Finally, the other dependent variable, empathy was measured by a self-report questionnaire which consisted of 12 questions after each film clip. The FaceReader was chosen because it is an efficient way of measuring continuous facial expressions. FaceReader is able to measure both emotional valence and emotional arousal at the same time. FaceReader also showed good capability of measuring emotions with video or film stimulus in many different studies, as the accuracy rate was of about 88% (Terzis, Moridis, & Economides, 2010; Lewinski, Fransen, & Tan, 2014; Lewinski, 2015; Fanti, Kyranides, & Panayiotou, 2017).

**Demographics.** Three questions asked about participant's demographics: gender, age, and educational background. The complete questionnaire for the study can be found in Appendix B.

**Controls.** All stimulus materials and questions were completely in English, so it was important that participants' level of English was proficient for this study. Participants could select their current English level from five options: excellent, good, average, poor, and terrible. The study would automatically end if participant chose poor or terrible. Same rule applied for participants who were younger than 18 years old.

**Film lighting technique.** The lighting values from each film clip were automatically generated by a computer program with 15 frames per second. There were two values generated from the film clips: one represented the brightness and the other value represented the proportion of shadow area in each frame. Values consisting of brightness were the high-key lighting, and values consisting of shadow area represented low-key lighting. Typically, values consisting of high-key lighting were larger than 1, with higher values indicating brighter film scenes. Values of low-key lighting were smaller than 1, where higher values indicated the film scene contained more shadow areas, and the contrast between the light and dark areas of the scene is higher.

**Emotional Arousal.** FaceReader assigned a value 0 or 1 to each expression which indicates the intensity, while 0 means the absence of expression, 1 means the presence of expression (Loijens & Krips, n.d.). Facial expressions are complex, there could be multiple expressions occurring at a same point, therefore, the sum of the values at a particular time point normally is not equal to 1 in the data overview (Loijens & Krips, n.d.). The measure for emotional arousal is based on the activation of 20 Action Units of the Facial Action Coding System (Ekman, Friesen, & Hager, 2002). Values of emotional arousal for the present study contained the average value of the six basic emotions: happy, sad, surprise, anger, disgusted, and scared.

**Emotional Valence.** Emotional valence indicates whether participants´ emotional state is either positive or negative (Loijens & Krips, n.d.). Out of the six facial expressions FaceReader can detect, 'surprised' was not used to calculate valence due to the fact that it can be either positive or negative. Hence, 'happy' is the only positive expression, 'sad', 'angry', scared' and 'disgusted' are all included in the negative expressions (Loijens & Krips, n.d.). Therefore, the value of negative emotional valence for the present study consisted of the average value of sad, anger, disgusted and scared.

For the current study, the values of emotional arousal and emotional valence were generated by FaceReader in a number format with 15 frames per second as well. To test the hypotheses, the average value of emotional arousal and negative emotional valence were first calculated per frame for each participant of every film clip. Then the grand average was calculated per frame for every film clip with all valid participants. Finally, two variables containing the aggregated emotional arousal and negative emotional valence were calculated for all the frames from all the films.

**Empathy.** Empathy was measured using the State Empathy scale (Shen, 2010). The State Empathy scale is a self-reported questionnaire consisting of 12 questions, with three subscales. The questions were measured with a 7-point Likert scales (1= strongly disagree, 7 = strongly agree). The subscales were: affective empathy, cognitive empathy, and associative empathy. The complete scale had good reliability, with each subscale showing good reliability as well (table 2). Participants were asked to fill in the questionnaire after each clip, hence, a total of 15 self-report questionnaires on empathy were collected from each participant. To test the hypothesis, the mean of each subscale was calculated, and the mean of the complete state empathy scale was calculated as well.

Table 2
*Reliability of the State empathy scale and the subscales*

| Scale | *α* | *M* | *SD* |
|---|---|---|---|
| **State Empathy** | .92 | 4.67 | 1.46 |
| **Affective Empathy**<br>- The character's emotions are genuine<br>- I experienced the same emotions as the character when watching this film clip<br>- I was in a similar emotional state as the character when watching this clip<br>- I can feel the character's emotions | .82 | 4.73 | 1.39 |
| **Cognitive Empathy**<br>- I can see the character's point of view<br>- I recognise the character's situation<br>- I can understand what the character was going through in the clip<br>- The character's reactions to the situation are understandable | .82 | 5.09 | 1.37 |
| **Associative Empathy**<br>- When watching the film clip, I was fully absorbed<br>- I can relate to what the character was going through in the film clip<br>- I can identify with the situation described in the film clip<br>- I can identify with the characters in the film clip | .84 | 4.19 | 1.63 |

**Procedure**

Each individual experimental session lasted about 60 minutes and the total length of the film clips was 36 minutes. The study was conducted in a fixed small-size study room at Tilburg University. One fixed laptop was used throughout the data collection period, to avoid the influence of presentation features. There were two mini speakers attached to the experiment computer with set volume. First, participants received information about the study and the experiment. They were informed about the video recording using the built-in web camera on the laptop and that their facial expressions would be recorded throughout the experiment. Video recordings were all done by iMovie. They were asked to sign the consent form (Appendix A) once they agreed to participate in the experiment voluntarily. There was one trial session conducted before the actual experiment to ensure the functionality of the web camera and accurate data collection.

After they signed the consent form, prior to the actual experiment, each participant's ideal sitting distance to the screen for video recording was adjusted to ensure both participant's comfort and recording quality. Then, the web camera was turned on and the researcher left the room. During the experiment, participants were asked to first answer some background information questions such as age, gender, education and current English level. The questionnaire ended if the participant reported 'poor' and 'terrible' as English level, and if age was younger than 18 years old. After that, 15 film clips were displayed one after the other with randomization. An invisible timer which was customized to the length of each film was set up before each film clip. Therefore, participants were required to finish watching each film clip completely in order to continue with the study. After each clip, a questionnaire consisting of 12 questions on empathy had to be completed. Once the experiment was over, a thank you message was displayed and participants could leave their email addresses if they wished to receive future study results.

**Data collection method**

Participant's background information and the empathy scale for each film clip were collected via Qualtrics online. Video recordings through a built-in web camera were used to collect facial expressions of participants. Current study required data concerning viewer's emotional responses during the actual film watching. To ensure the accuracy of the manual video cutting for data analysis, there was a 3-second "DING" sound with a plain black background incorporated in each film clip, both at the beginning and at end of all film clips. In that way, the researcher could cut the recordings based on each film clip's sound wave pattern, exactly three seconds after the first "DING", and right before the second "DING" appeared. All video recordings were cut in the free video editor Shotcut.

FaceReader was then used to process all video recordings in order to analyse emotional arousal and emotional valence. FaceReader can recognise six basic facial

expressions: happy, sad, angry, surprised, scared, and disgusted (Loijens & Krips, n.d.; Lewinski, 2015). The categories were developed based on Ekman's (1970) research of universal emotions. FaceReader first detects the presence of a face from the video recording or the built-in camera on the laptop (Lewinski, 2015). It can directly classify the face from image pixels and using artificial neural network to recognise patterns based on the Deep Face classification method (Loijens & Krips, n.d.). More importantly, it uses the neural network to recognise the emotional expressions (Lewinski, 2015). Additionally, FaceReader was calibrated to correct for person-specific biases (Loijens & Krips, n.d.). The calibration is an automatic mechanism built in FaceReader, participant calibration was performed to balanced out facial expression, personal biases towards a certain expression were removed (Loijens & Krips, n.d.).

**Data analysis plan**

Hypothesis 1 and 2 will be tested by Spearman correlation using SPSS, with film lighting as independent variable, emotional arousal and negative emotional valence as dependent variables. Hypothesis 3, 3a, 3b and 3c will be tested with linear regression using SPSS, with film lighting as the predictor, state empathy and its three sub-dimensions (affective empathy, cognitive empathy, associative empathy) as outcome.

## Results

Preliminary analysis showed that the complete dataset was not normally distributed, so more weight should be put on the bootstrapped 95% CI values. For the regression analysis, the Cook's distance values did not violate the assumptions. Due to some data retrieval failure, FaceReader was not able to analyse every participant's facial recording for each film clip, hence, valid sample sizes of each film clip and the dependent variables are listed in table 3 together with the descriptive values.

Table 3

*Overview of the independent and dependent variables' descriptive statistics*

| | N | *M* | *SD* |
|---|---|---|---|
| | *Baby Driver* | | |
| Low-key lighting | - | 0.79 | 0.07 |
| Emotional Arousal | 61 | 0.02 | 0.00 |
| Negative Emotional Valence | 61 | 0.02 | 0.00 |
| | *Django Unchained* | | |
| Low-key lighting | - | 0.29 | 0.11 |
| Emotional Arousal | 61 | 0.02 | 0.00 |
| Negative Emotional Valence | 61 | 0.02 | 0.00 |
| | *Pirates of the Caribbean* | | |
| Low-key lighting | - | 0.75 | 0.09 |
| Emotional Arousal | 60 | 0.02 | 0.00 |
| Negative Emotional Valence | 60 | 0.02 | 0.00 |
| | *Kingsman* | | |
| Low-key lighting | - | 0.58 | 0.23 |
| Emotional Arousal | 60 | 0.02 | 0.00 |
| Negative Emotional Valence | 60 | 0.02 | 0.00 |

| | | | |
|---|---|---|---|
| | *Taken* | | |
| Low-key lighting | - | 0.59 | 0.08 |
| Emotional Arousal | 62 | 0.02 | 0.00 |
| Negative Emotional Valence | 62 | 0.02 | 0.01 |
| | *Black Swan* | | |
| Low-key lighting | - | 0.67 | 0.14 |
| Emotional Arousal | 63 | 0.02 | 0.01 |
| Negative Emotional Valence | 63 | 0.03 | 0.01 |
| | *Memories of a Geisha* | | |
| Low-key lighting | - | 0.97 | 0.05 |
| Emotional Arousal | 58 | 0.02 | 0.00 |
| Negative Emotional Valence | 58 | 0.03 | 0.00 |
| | *Pursuit of Happyness* | | |
| Low-key lighting | - | 0.72 | 0.11 |
| Emotional Arousal | 62 | 0.02 | 0.00 |
| Negative Emotional Valence | 62 | 0.03 | 0.01 |
| | *Shutter Island* | | |
| Low-key lighting | - | 0.71 | 0.14 |
| Emotional Arousal | 59 | 0.02 | 0.00 |
| Negative Emotional Valence | 59 | 0.03 | 0.01 |
| | *The Prestige* | | |
| Low-key lighting | - | 0.86 | 0.09 |
| Emotional Arousal | 60 | 0.02 | 0.00 |
| Negative Emotional Valence | 60 | 0.02 | 0.00 |
| | *Me before You* | | |
| Low-key lighting | - | 0.40 | 0.09 |
| Emotional Arousal | 63 | 0.02 | 0.00 |
| Negative Emotional Valence | 63 | 0.02 | 0.01 |

| | | | |
|---|---|---|---|
| | *La La Land* | | |
| Low-key lighting | - | 0.29 | 0.08 |
| Emotional Arousal | 62 | 0.02 | 0.00 |
| Negative Emotional Valence | 62 | 0.02 | 0.00 |
| | *Silver Linings Playbook* | | |
| Low-key lighting | - | 0.49 | 0.17 |
| Emotional Arousal | 59 | 0.02 | 0.01 |
| Negative Emotional Valence | 59 | 0.02 | 0.01 |
| | *The Curious Case of Benjamin Button* | | |
| Low-key lighting | - | 0.67 | 0.13 |
| Emotional Arousal | 63 | 0.02 | 0.00 |
| Negative Emotional Valence | 63 | 0.02 | 0.01 |
| | *The Light between the Oceans* | | |
| Low-key film lighting | - | 0.54 | 0.11 |
| Emotional Arousal | 63 | 0.02 | 0.00 |
| Negative Emotional Valence | 63 | 0.02 | 0.01 |
| | *Aggregated Value* | | |
| Low-key lighting across all films | - | 0.62 | 0.19 |
| Emotional Arousal across all films | 916 | 0.02 | 0.00 |
| Negative Emotional Valence across all films | 916 | 0.02 | 0.00 |
| | *Empathy* | | |
| Overall State Empathy | 71 | 4.82 | 1.06 |
| Affective Empathy | 71 | 4.85 | 1.09 |
| Cognitive Empathy | 71 | 5.17 | 1.14 |
| Associative Empathy | 71 | 4.44 | 1.34 |

*Note.* N represents the valid sample size for each variable.

**Hypothesis 1 & Hypothesis 2: Exploratory correlational analysis**

To test hypothesis 1, namely that higher level of low-key lighting is associated with higher emotional arousal, and hypothesis 2 that higher level of low-key lighting is associated with higher negative emotional valence. Spearman correlation was first conducted with each film's low-key lighting, emotional arousal and negative emotional valence. Spearman's correlation was used because it is a robust test to explore associations between the time series variables. The outcomes of the Spearman correlation are presented in the table 4 for each film, and separated by genres.

**Action films.** Emotional arousal had one positive significant correlation for *Baby Driver* and one non-significant result for *Django Unchained*. Emotional arousal had significant negative correlations in three films (*Pirates of the Caribbean, Kingsman,* and *Taken*), which indicates that viewers were not more aroused when value of low-key lighting was higher. Negative emotional valence was found to have significant negative correlations with four films (*Django Unchained, Pirates of the Caribbean, Kingsman,* and *Taken*). This means that higher level of low-key lighting does not associate with negative emotional valence for these films. In other words, viewers did not produce more negative emotions when there was higher contrast of the light and dark areas in the film scenes. There was one non-significant result for *Baby Driver* concerning negative emotional valence. Overall, most of the results from action films were significant but contrary to the expectations.

**Drama films.** Emotional arousal had three positive significant correlations for *Black Swan, Memories of a Geisha,* and *The Prestige*. Emotional arousal had significant negative correlation in two films (*Pursuit of Happyness,* and *Shutter Island*), indicating that viewers were not more aroused when the value of low-key lighting was higher. Negative emotional valence had a significant negative correlation for one film (*Pursuit of Happyness*). There was one non-significant result for negative emotional valence (*Shutter Island*), and three positive

significant correlations for *Black Swan, Memories of Geisha,* and *The Prestige*. The data partially support that higher level of low-key lighting is associated with higher arousal and higher negative emotional valence.

**Romance films.** Emotional arousal had three positive significant correlation for *Me before you, La La Land,* and *The Light between the Oceans*. The results indicated viewers were more aroused with higher level of low-key lighting. Moreover, emotional arousal had a significant negative correlation in one film (*The Curious Case of Benjamin Button*) and one non-significant result (*Silver Linings Playbook*). Negative emotional valence had a significant negative correlation in one film (*The Curious Case of Benjamin Button*). The rest all had a positive significant correlation (*Me before You, La La Land, The Light between the Oceans* and *Silver Linings Playbook*). This means that the data supports that higher level of low-key lighting is associated with higher negative emotional valence for these films.

To examine the effect, the correlation values for each film was first transformed to Fisher-Z using the website https://www.psychometrica.de/correlation.html (Lenhard & Lenhard, 2014). Then the Fisher-Z values were aggregated for each film genre. The reason for the conversion is because Fisher-Z converts correlations into an almost normally distributed measure, it is important for averaging the correlations for the films (Lenhard & Lenhard, 2014). The aggregated Fisher-Z values for emotional arousal and negative emotional valence of each film genre were then transformed back to the correlations *r* to check for the effect sizes (table 5). In summary, emotional arousal for action films had a small effect but on the opposite direction. Negative emotional valence for action films had a small to medium effect also on the opposite direction. The results indicate that for action films, contrary to the hypotheses, viewer's emotional arousal and negative emotional valence did not increase with the higher level of low-key lighting. For both drama and romance genre, the effect sizes of emotional arousal and negative emotional valence were small. This means

that for drama and romance genres, both hypotheses were supported: higher level of low-key lighting is associated with higher emotional arousal and higher negative emotional valence.

**Hypothesis 1 & 2: Linear regression analysis**

Finally, to further investigate the relationship between film lighting key and audience's emotional arousal and negative emotional valence, a regression analysis with low-key lighting as predictor and emotional arousal as outcome was performed. The regression analysis showed that emotional arousal cannot be predicted by low-key lighting $b = .00$, $\beta = .20$, $t\,(12) = .72$, $p = .487$. Furthermore, a regression analysis with low-key lighting as predictor and negative emotional valence as outcome was performed. The regression analysis showed that negative emotional valence also cannot be predicted by low-key lighting $b = .01$, $\beta = .49$, $t\,(8) = 2.04$, $p = .062$.

In summary, even though the regression analyses were not significant, the correlational analyses did indicate there were associations between low-key lighting, emotional arousal, and negative emotional valence. Some results were contrary to expected, indicating that viewers are more aroused and had higher negative emotional valence when the value of low-key film lighting was lower. Therefore, hypothesis 1 and 2 were partially supported by the data.

Table 4

*Outcome of the Spearman Correlation of the dependent variables*

| | *r* | *p* | 95% CI Lower | 95% CI Upper |
|---|---|---|---|---|
| | *Action* | | | |
| Emotional Arousal *Baby Driver* | .26 | <.001 | .22 | .31 |
| Negative Emotional Valence *Baby Driver* | .04 | .098 | - | - |
| Emotional Arousal *Django Unchained* | .01 | .544 | - | - |
| Negative Emotional Valence *Django Unchained* | -.07 | .001 | -.12 | -.02 |
| Emotional Arousal *Pirates of the Caribbean* | -.42 | <.001 | -.46 | -.38 |
| Negative Emotional Valence *Pirates of the Caribbean* | -.46 | <.001 | -.49 | -.42 |
| Emotional Arousal *Kingsman* | -.29 | <.001 | -.33 | -.25 |
| Negative Emotional Valence *Kingsman* | -.49 | <.001 | -.52 | -.45 |
| Emotional Arousal *Taken* | -.38 | <.001 | -.42 | -.34 |
| Negative Emotional Valence *Taken* | -.35 | <.001 | -.39 | -.31 |
| | *Drama* | | | |
| Emotional Arousal *Black Swan* | .22 | <.001 | .17 | .26 |
| Negative Emotional Valence *Black Swan* | .13 | <.001 | .08 | .18 |
| Emotional Arousal *Memories of Geisha* | .38 | <.001 | .34 | .42 |
| Negative Emotional Valence *Memories of Geisha* | .38 | <.001 | .34 | .41 |

| | | | | |
|---|---|---|---|---|
| Emotional Arousal<br>*Pursuit of Happyness* | -.05 | .047 | -.10 | .00 |
| Negative Emotional Valence<br>*Pursuit of Happyness* | -.05 | .024 | -.10 | -.01 |
| Emotional Arousal<br>*Shutter Island* | -.05 | .004 | -.09 | -.01 |
| Negative Emotional Valence<br>*Shutter Island* | -.01 | .479 | - | - |
| Emotional Arousal<br>*The Prestige* | .19 | <.001 | .14 | .24 |
| Negative Emotional Valence<br>*The Prestige* | .15 | <.001 | .10 | .20 |
| | *Romance* | | | |
| Emotional Arousal<br>*Me before You* | .07 | .002 | .02 | .11 |
| Negative Emotional Valence<br>*Me before You* | .25 | .001 | .21 | .29 |
| Emotional Arousal<br>*La La Land* | .48 | <.001 | .44 | .52 |
| Negative Emotional Valence<br>*La La Land* | .41 | <.001 | .37 | .46 |
| Emotional Arousal<br>*Silver Linings Playbook* | -.01 | .720 | - | - |
| Negative Emotional Valence<br>*Silver Linings Playbook* | .10 | <.001 | .06 | .13 |
| Emotional Arousal<br>*The Curious Case of Benjamin Button* | -.09 | <.001 | -.13 | -.04 |
| Negative Emotional Valence<br>*The Curious Case of Benjamin Button* | -.20 | <.001 | -.24 | -.16 |
| Emotional Arousal<br>*The Light between the Oceans* | .26 | <.001 | .21 | .30 |
| Negative Emotional Valence<br>*The Light between the Oceans* | .17 | <.001 | .12 | .21 |

Table 5

*Conversions of Fisher-Z and correlation r for each film genre*

| | Fisher-Z | *r* |
|---|---|---|
| *Action* | | |
| Aggregated Emotional Arousal | -.174 | -.172 |
| Aggregated Negative Emotional Valence | -.286 | -.278 |
| *Drama* | | |
| Aggregated Emotional Arousal | .143 | .142 |
| Aggregated Negative Emotional Valence | .124 | .123 |
| *Romance* | | |
| Aggregated Emotional Arousal | .152 | .151 |
| Aggregated Negative Emotional Valence | .152 | .151 |

Note. r effect size, ±.1 small effect; ±.3 medium effect; ±.5 large effect (Field, 2014, p.270).

**Hypothesis 3, 3a, 3b, 3c: Linear regression analysis**

In order to test hypothesis 3, namely that lighting technique will impact viewer's empathy, in a way that low-key lighting predicts higher state empathy, linear regression tests were conducted. Different from the correlational analysis where the low-key lighting of each film was used for testing, the value of aggregated low-key lighting of the 15 films was calculated and used as the predictor of the linear regression tests.

Firstly, to investigate the relationship between film lighting and overall audience's state empathy, a regression analysis with low-key lighting as predictor and overall state empathy scale as outcome was performed. The regression analysis showed that state empathy and low-key lighting is negatively related, $b$ = -.50, β = -.09, $t$ (46) = -2.94, $p$ = .009, 95% CI [-.85, -.16]. The model explains 0.8% of the variance in audience's empathy, $R^2$ = .09, $F$ (1, 1063) = 8.62, $p$ = .003. The negatively related finding indicates that viewer's empathy level was lower when the value of the low-key lighting is higher. In other words, viewers were

more likely to empathize with the film character when the shadow areas in the film scenes were smaller.

To test hypothesis 3a, a regression analysis to investigate the relationship between low-key lighting and viewer's affective empathy was not significant, showing that affective empathy cannot be predicted by low-key lighting, $b$ = -.31, β = -.05, $t$ (44) = -1.73, $p$ = .085. The regression analysis to test hypothesis 3b, which investigate the relationship between low-key lighting and viewer's cognitive empathy, was also not significant, showing that cognitive empathy cannot be predicted by low-key lighting, $b$ = -.01, β = -.05, $t$ (25) = -1.53, $p$ = .126.

Finally, a regression analysis with low-key lighting as predictor and associative empathy as outcome was performed to test hypothesis 3c. The regression analysis showed that associative empathy and low-key lighting was negatively related, $b$ = -.91, β = -.13, $t$ (36) = - 4.25, $p$ = .001, 95% CI [-1.33, -.50]. The model explains 1.7% of the variance in associative empathy $R^2$ = .13, $F$ (1, 1063) = 18.09, $p$ < .001. Based on the negatively related finding, it can be assumed that viewers have less associative empathy when the value of the low-key lighting is higher. So, higher proportion of shadow areas in the scenes decreased viewer's associative empathy.

Although the relationship between age and gender with empathy was not a part of the hypotheses, it was worth checking if there were any individual differences in empathy. Additional regression analysis with age and gender as predictors and state empathy as outcome were performed. The regression analysis showed that age and state empathy is positively related, $b$ = .04, β = .18, $t$ (21) = 5.91, $p$ = .001, 95% CI [.30, .06], which indicates that state empathy level increases with age. The model explains 3.2% of the variance in associative empathy $R^2$ = .18, $F$ (1, 1063) = 18.09, $p$ < .001. However, the regression analysis investigated the relationship between gender and state empathy was not significant, showed

that male and female do not differ in their empathy level when watching a film, $b = .07$, $\beta = .03$, $t(40) = 1.07$, $p = .286$.

In summary, although significant relationships were found between low-key lighting, associative empathy, and the state empathy, they were negative related which was contrary to what was hypothesized. Viewer's age did influence their empathy level, but not gender. Moreover, according to the data, viewer's affective empathy and cognitive empathy did not increase with higher level of low-key film lighting. Overall, higher level of low-key lighting does not predict higher empathy, meaning hypothesis 3, 3a, 3b, and 3c were not supported.

## Discussion

This study investigated whether low-key lighting has an impact on audience's emotional arousal and negative emotional valence in films. Moreover, it also investigated whether low-key lighting influences viewer's empathy level. The findings partially supported hypothesis 1 and 2, that low-key lighting evokes higher emotional arousal and higher negative emotional valence. Low-key lighting significantly affected the overall state empathy, and associative empathy, however, the direction of effect was opposite to what was predicted. Namely, higher level of low-key lighting was associated with lower state empathy and lower associative empathy. Therefore, together with the non-significant results for affective empathy and cognitive empathy, the present study did not find evidence to support the idea that higher levels of low-key lighting increase viewer's empathy level.

### Film lighting, Emotional arousal and Emotional valence (H1 & 2)

The value of low-key lighting in the present study indicates the shadow area in the scene, higher value represents larger areas of shadow, and it indicates higher contrast on the light and dark areas in the film scenes. Hypothesis 1 investigated whether higher level of low-key lighting is associated with higher emotional arousal. For the action film genre, with the exception of one positive significant result, most of the results were significant in the opposite direction. This means that viewers were not more aroused with higher contrast of light and shadows in the film scenes. From the drama and romance genres, data from six films supported the hypothesis. Positive correlations were found between higher level of low-key lighting and higher emotional arousal. This means that higher contrast between the light and dark evoked higher emotional arousal in the films. Overall, because of the opposite significant results than expectation, hypothesis 1 was partially supported. The effect sizes of the positive correlations were small.

Hypothesis 2 predicted that higher level of low-key lighting increases emotional valence. It was partially supported by data as well. The effect size of the correlation for action films was small to medium size. However, contrary to the hypothesis, scenes with higher contrast of light and shadow did not evoke higher negative emotional valence. On the other hand, for the drama and romance genres, data from seven films supported the hypothesis. The positive correlations had small effect sizes. That means higher contrast of light and dark areas in the scenes for drama and romance films did evoke higher negative emotional valence.

In summary, the outcomes are not fully in line with previous study on film lighting and emotions. Low-key lighting in videos evoked high levels of negative emotions and higher level of overall emotional responses (Poland, 2015). The majority of the drama and romance films supported hypothesis 1 and 2. Larger shadow areas in the film scenes were associated with higher emotion intensity, and more negative emotions. However, there was hardly any increase in emotional arousal and negative emotional valence when there were larger shadow areas in the action films.

Viewers often experience positive emotions (e.g., happy, joy) if the outcome of a story is in line with the same expectations as theirs. Otherwise, they would experience negative emotions (e.g., sad, anger) because the story is not in line with the expectations, such as criminals do not get punished or good people do not receive rewards (Hoeken & Sinkeldam, 2014; Raney, 2004). Emotional valence is about the type of emotion ranging from unpleasant to pleasant (Detenber & Lang, 2010). Negative emotional valence is focused on the negative emotions (sad, fear, disgusted, scared) in the current study. This could serve as a possible explanation for the contrary outcome of the action films. The stories of the action films could be in line with viewer's expectations so that they did not produce unpleasant emotions. Nevertheless, this is only an assumption, more attention should be focused on the differences between film genres.

Audiences react to film lighting differently with genres. Poland (2015) indicated that audiences react to film lighting style and plot consistently. In the same study, results showed that viewers associate genre based on lighting style regardless of the plot. Many participants in Poland's study (2015) identified the film by lighting style over plot, where participants identified high-key lighting with comedy, and low-key lighting to film noir. Participants in the current study were not informed of film genres at any point. All selected film scenes were rather similar. Due to the similarity of the film clips, action films did not contain intense actions, the particular genre might not seem obvious to the viewers. Thus, the film scenes could have led them to relate the film lighting to another genre. Previous studies (Oliver, 2008; Visch & Tan, 2009) found significant results supporting that genres correlated with specific emotions and feelings. For example, drama related with sadness, comedy is happy, and action related with impressive feelings (Oliver, 2008; Visch & Tan, 2009). This could be a possible interpretation for the opposite effect of the action films. Viewers in the present study may not experience the specific emotions related to the genre. Hence, they did not have the expected emotional changes.

Having said this, film lighting is not the only parameter for viewers to identify genres. There are three cognitive processes that help viewers to identify film genres: animacy attribution, emotional responses, and the amount of deviation from reality (Visch & Tan, 2009). Moreover, the actual story or even elements from other formal features could have also influenced viewers' emotions. Formal features and plot are closely related in films, they help each other in delivering the story. Plot is one of the key ingredients in a story. If characters are the driving force of the story, the plot represents a sequence of actions which guides the story (Hart, 2011). Even though film lighting is a powerful tool to manipulate emotions in film, it does not stand alone from the plot (Poland, 2015). More importantly, film

lighting has to correspond with the narrative style in order to trigger higher emotional responses (Poland, 2015).

To summarize, although lighting remains important for the complete film viewing experience, viewers' emotional responses might not only rely on lighting. Especially when the film genre is not clear, viewers fill the details in based on the lighting techniques and other elements.

**Film lighting and State Empathy (H3, 3a, 3b, & 3c)**

There were no significant results found between the relationships of higher level of low-key lighting, affective empathy and cognitive empathy. Hypothesis 3a and hypothesis 3b were not supported. Moreover, contrary to hypothesis 3 and hypothesis 3c, viewers did not empathize more with the film characters when the value of low-key lighting was higher. There were significant results for the overall state empathy, and associative empathy, but only in the opposite direction. This means that viewers empathize more with the characters of the film when the value of low-key lighting is lower. In other words, viewers tend to empathize more when the contrast between light and dark in the scenes are lower. The findings do not correspond with previous studies in which character's likeability and believability were higher with low-key lighting compared to high-key lighting (Poland, 2015). Viewers' overall emotional responses were also higher in low-key lighting compared to high-key lighting (Poland, 2015). In agreement with the previous study (Poland, 2015) which indicated that low contrast of bright and shadow areas in the scenes did not evoke strong emotions and emotional responses to the characters.

In order to be empathize with the film characters, transportation and identification is of vital importance (Johnson, 2012; Moyer-Guse, 2008; Vaage, 2010). Moreover, being able to identify with the characters, to feel with and feel for the characters, viewers should be fully absorbed and immersed to the narrative (Busselle & Bilandzic, 2009; Tal-Or & Cohen, 2010).

State empathy is positively associated with persuasion (Shen, 2010) and identification (Cohen, 2001). However, by looking at the means of the three sub-dimensions of state empathy, expect cognitive empathy, affective empathy and associative empathy both represented somewhere between 'neither disagree or agree' and 'somewhat agree' (1 = 'completely disagree'; 7 = 'completely agree'). Affective empathy ($M$ = 4.85, $SD$ = 1.34) is the point at which viewers recognise and understand characters (Shen, 2010). Cognitive empathy ($M$ = 5.17, $SD$ = 1.14), recognised as perspective-taking, viewers started to adopt the character's point of view, is a core part of identification (Balint, Klausch, & Polya, 2016; Shen, 2010). Associative empathy ($M$ = 4.44, $SD$ = 1.34), also known as identification, which is crucial for state empathy (Shen, 2010). All three sub-dimensions as well as the complete state empathy ($M$ = 4.82, $SD$ = 1.06), did not receive high mean scores indicating that viewers were highly emotionally involved with the characters. Therefore, it is sensible to assume that viewers did not strongly identify with the film characters, which in result of the opposite effect than expectations. A possible explanation for this could be due to the fact that film clips were not long enough for the viewers to be fully immersed yet. All film clips in the present study were between two to four minutes. Previous study revealed that longer film duration led to higher emotional and cognitive responses (Balint, Klausch, & Polya, 2016).

Moreover, participant's personal preferences for films might have influenced the empathy level as well. Some participants indicated that they were more engaged in the story which they had watched before. They explained that familiarity with the story and characters allow them to feel more involved, and they could relate their feeling to the whole story but not only a short clip. This is in line with previous research showing that viewers have higher self-reported emotional engagement with narratives that have stronger emotional content (Sukalla, Bilandzic, Bolls, & Busselle, 2016). Nevertheless, there are not a lot of supporting evidences on this aspect, but future research could consider it.

Furthermore, additional test showed there was no relationship between gender and state empathy. This is contrary to previous findings where women reported higher empathy compared to men (Mehrabian, Young, & Sato, 1988; Rueckert & Naybar, 2008; Schieman & Van Gundy, 2000). Additionally, accurate recognition of facial expressions is important for empathic responding (Besel & Yuille, 2010). Women were more accurate than men when recognising subtle facial emotions (Hoffmann, Kessler, Eppel, Rukavina, & Traue, 2010).

On the other hand, age did influence viewer's state empathy in the present study as state empathy increased with age. This is also contrary to previous finding showing that self-reported empathy was lower for older people (Schieman & Van Gundy, 2000). The reason for lower self-reported empathy in older adults, is that older adults have lower emotional arousability and are less concerned with social approval (Schieman & Van Gundy, 2000). On the other hand, gender and age influences each other on empathy, gender differences in self-reported empathy are smaller for older people than younger ones (Schieman & Van Gundy, 2000). All in all, gender and age play a role in influencing empathy under diverse settings.

In summary, the current study did not find evidence which were fully in line with Poland's study (2015) on film lighting and emotions. Nonetheless, it still shed light on how film lighting affect viewer's emotions and empathy. Summary of the hypothesis test results can be found in table 6. The manipulations of lighting, contrasts between light and dark areas in the film scenes, is a complex technique to evoke the corresponding emotions. Low-key lighting did not always trigger strong emotions and empathy. Viewers tend to empathize more with the film characters when the contrast between light and shadow is lower. Film lighting techniques should be closely connected to the story in order to create an effect on emotions and empathy. Moreover, there are other factors influencing viewer's emotional responses as well, such as film genres, story transportation and immersion experience, individual differences (e.g., age, gender, transportability) and personal preferences.

Table 6
*Summary of Hypothesis Test Results*

| Hypothesis | | Findings |
|---|---|---|
| H1 | Film lighting techniques will affect emotional arousal, in a way that higher level of low-key lighting is associated with higher level of emotional arousal. | Partially supported |
| H2 | Film lighting techniques will affect emotional arousal, in a way that higher level of low-key lighting is associated with higher level of emotional valence. | Partially supported |
| H3 | Film lighting techniques will impact viewer's empathy, in a way that higher level of low-key lighting predicts higher state empathy. | Significant in the opposite direction |
| H3a | Film lighting techniques will impact viewer's state empathy, in a way that higher level of low-key lighting predicts higher affective empathy. | Not supported |
| H3b | Film lighting techniques will impact viewer's state empathy, in a way that higher level of low-key lighting predicts higher cognitive empathy. | Not supported |
| H3c | Film lighting techniques will impact viewer's state empathy, in a way that higher level of low-key lighting predicts higher associative empathy. | Significant in the opposite direction |

**Implications for New Media Design**

Even though not all hypotheses were fully supported, findings of this study are still relevant for new media designers who want to engage audiences by using videos or moving images. Lighting being the essential element in modern films and videos, may not be the only powerful tool to evoke strong emotions and empathy in films (Poland, 2015). The combination of other low level formal features together with the actual narrative creates a consistent viewing experience which may trigger stronger emotional responses. Furthermore, media messages are able to evoke a wide range of emotions, when done properly, media messages are able to change one's attitude, beliefs and behaviour (Nabi, 2009). In other words, the actual content remains very important as well as the storytelling techniques, where formal features are carefully incorporating in moving images. Therefore, understanding the relationships of formal features, emotions and empathetic reactions is not only helpful for film and video producing, it is also useful for media messages in general.

**Limitations and Future Research**

Although the current study had many control variables to ensure the quality of the data, it is not without limitations. This study used a fixed room to carry out the experiment, everything was kept the same way in the room throughout the data collection period. However, there were uncontrollable environmental factors such as external noises which might have influenced viewers' concentration level. Moreover, the lights in the room was of sustainable design which turn on by motion detection, with quietly sitting viewers, the lights in the room were constantly turned on and off automatically. This might have influenced viewers' concentration as well. Overall, being interrupted or distracted might have influenced the film watching experience. Hence, the external environmental factors may have influenced the identification as well which decreased the empathy level.

Secondly, due to some technical difficulties, not every participant's video recording was collected successfully. A total of 66 full video recordings were collected from 75 participants. On top of that, even though clear instructions were given to all participants, there were still some video recordings which could not be analysed by FaceReader due to issues such as covered faces, tilted head, sitting distance too far from the screen, etc. Furthermore, there might be some human errors in the video recordings data. The current study was not able to build the complete experiment in FaceReader due to product license restrictions. Therefore, all video recordings were first recorded by the built-in webcam of the experiment laptop, then the researcher manually cut all video recordings from all participants, only the parts containing the actual film viewing were kept. All edited video recordings were grouped by films and then imported to FaceReader for analysis. Even though this study tried to be as accurate as possible with all video recordings, there still might be deviations of edited recording in terms of quality and length. On top of the above mentioned, the incorporated "DING" sound in the film clips of present study might have distracted some

viewers, which could have decreased the narrative immersion experience. For future studies, it would be less disruptive to have the complete experiment implemented in FaceReader.

Thirdly, the accuracy rate of FaceReader is about 88% (Fanti, Kyranides, & Panayiotou, 2017; Lewinski, 2015; Lewinski, Fransen, & Tan, 2014). Although it is a good tool to analyse basic emotions, it does not analyse beyond the six basic emotions. It is also important to know that facial expressions occur rapidly after exposure to image stimuli: 300 - 400 ms (Dimberg & Thunberg, 1998). FaceReader generates time series data, film lighting values were time series data as well, so there should be some time logs set in future statistical tests to analyse facial expressions with moving image stimuli.

Based on the above listed limitations, future research could look more in depth at the relationships between film lighting and emotional responses with different experimental design. For instance, similar to Poland's study (2015), future research could consider setting up a between-subject design, keep the content of the stimulus material the same, only manipulate the lighting in the clips to examine the effect, e.g., increase brightness or shadow area. The present study mainly investigated key light techniques in films, specifically low-key lighting. Since majority of the films nowadays employ three-point lighting (the back light, the fill light, and the key light), future study could investigate on other lighting techniques.

Moreover, lighting and colours are two tightly connected concepts in many indoor lighting research. Different brightness and colour of the lighting settings influence mood, pleasure level, even office performance (Knez, 1995; Knez & Niedenthal, 2008; Quartier, Vanrie, & Van Cleempoel, 2014). In film studies, luminance and colour both as low-level formal features are closely related (Brunick, Cutting, & DeLong, 2013). Luminance is not the same as lighting, it is a measure of light and brightness in the scene (Brunick, Cutting, & DeLong, 2013). Although luminance and lighting are different from each other, they both guide viewers to segment different scenes (Brunick, Cutting, & DeLong, 2013; Shafiee &

Bidin, 2016). On the other hand, colour affects both emotional arousal and emotional valence (Detenber, Simons, & Reiss, 2000). Viewers produce higher intensity emotions and more positive emotions when watching a clip with colours compared to a black and white clip (Detenber, Simons, & Reiss, 2000). Moreover, there are many aspects of colour that influence viewers' reactions differently, such as the saturation and hue (Brunick, Cutting, & DeLong, 2013). Hence, combining lighting and colour, or luminance and colour might be an interesting topic for future studies to focus on film with mood and emotions as well.

Moreover, there are also individual differences in empathy including nationality, age, gender, and personality (Besel & Yuille, 2010; Slavny & Moore, 2018; Vaage, 2010). The current study did not ask for viewer's nationality, but it could be a factor influencing emotional responses. According to previous research (Kim, Seo, Yu, & Neuendorf, 2014), participants from South Korea reacted to the same films differently than the American participants. South Koreans prefer contradictions for affective and physical responses, while American viewers reported less emotions (Kim, Seo, Yu, & Neuendorf, 2014).
Future research could also run pre-tests to check participant's transportability in narratives, empathy traits or personality traits in order to understand different types of viewers to ensure generalizability. Additionally, the current participants population consisted of mainly university students, which might limit the generalizability of the study, future research could attempt to collect data from a more diverse population.

Lastly, future studies could also consider reducing film quantity but increase the length of selected film clips to further investigate the effect of film lighting or other formal features on viewer's emotional responses.

## Conclusion

Although not all hypotheses of current study were fully supported, it still contributes to deepen the understanding of the impact of film lighting on viewer's emotional arousal, negative emotional valence and empathy. Findings of the present study indicate that film lighting as one of the formal features is closely connected with film genres. Moreover, lighting should be tightly employed with the actual plot to create a greater impact on emotions. Facial expression is one of the many ways to investigate emotions, and FaceReader was a good tool to measure continuous emotions. Narrative immersion and identification with characters are key elements to increase viewer's empathy level. The relationship between film formal features, emotions, and empathy are complex. Therefore, future study should focus on more than one aspect of the relationship to provide more in-depth knowledge. In conclusion, using the correct storytelling techniques to tell a story is crucial for new media designers to create emotional impact.

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## Appendix A: Consent form

### Informed consent form

*Investigating how viewers respond to films and characters*
Researcher: Yunting Huang
Supervisor: Dr. K.E. Balint

***To be signed by the participant.***

Purpose of research

In this research, we are interested in investigating the impact of films on viewer's emotional responses and emotional engagement towards the film characters.

Specific procedure to be used

This research will be conducted with 15 short film clips, participant's emotional responses while watching the film clips will be recorded by the web camera. The emotional engagement subscale will assess the emotional engagement towards the film characters after each clip.

**Please note: Your facial movements will be recorded throughout the experiment.**

Duration of participation

The experiment will take approximately 45 to 60 minutes.

Anonymity and confidentiality

Your data and results of the study will only be published in aggregated format in a master thesis, at conferences and journals, anonymously and confidentially. Strict confidentiality of the data will be upheld. Your responses will not be associated with any identifying information. Your anonymous data will be kept for this project only, no other individuals except the researcher and the supervisor will have access to the data. Publications will present aggregated results only, no visual recording of participants' faces. Visual data will not be shared for secondary data analysis.

Voluntary nature of participation

You have the right to terminate the experiment at any point, without any reason given, should you feel uncomfortable with the experiment procedure. Data gathered in case of termination will be discarded. No penalty will be applied in case of termination. You also have the right to get your results deleted from the database after completing the experiment. You need to request it in the following one week.

Contact information

If you have any questions about this research project, you can contact the researcher via email: Yunting Huang

You can leave your email address at the end of the experiment for the general results and main findings. After successfully complete the study, you will receive 1 point from the human subject pool automatically.

Complaints

If you have any complaints about this research, please direct them to the secretary of the Ethics Committee of the Faculty of Humanities and Digital Sciences of the University of Tilburg, dr. J.M.N.E. Jans, room D256, P.O. Box 90153, 5000LE, Tilburg, .

Documentation of informed consent

I have had the opportunity to read this consent form and have the research study explained. I have had the opportunity to ask questions about the research project and my questions have been answered.

I understand that collected information and video content will be used only for this analysis and/or scientific presentations. I am hereby informed that all data collected will be securely stored and encrypted by the researcher.

I am prepared to voluntarily participate in the experiment described above.

Participant's signature: Date:

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***To be signed by the researcher.***

I have provided explanatory notes about the research. I declare myself willing to answer to the best of my ability any questions which may still arise about the research.
I declare that the data and results of the study will only be published anonymously and confidentially to third parties.

Name researcher:

Signature:

Date:

## Appendix B: Survey outline

Dear participant,

Thank you for participating in this study!

The present study is a part of the Master thesis conducted by Yunting Huang. The main goal of the study is to investigate how viewers respond to scenes from fiction films. During this experiment, you will be watching 15 short film clips, and answer some questions after each clip. During this study, the web camera will be used to record your facial expressions throughout the whole process. The total experiment will take about 60 minutes, and participant from Tilburg University will be rewarded with 1 credit point from the human subject pool for participation. This experiment will be conducted completely in English, including all film clips, hence, sufficient level of English will be required.

If you have any questions, please contact Yunting Huang via

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After signing the consent form and agree to participate in the study voluntarily, please click on the arrow in the right corner to continue.

1. Your gender:

- ○ Male
- ○ Female
- ○ Other

2. Your age:

_____

3. What is your highest education level?

- ○ High school graduate
- ○ Some college
- ○ Bachelor
- ○ Master
- ○ PhD

4. How would you rate your current level of spoken and written English?

- ○ Excellent
- ○ Good
- ○ Average
- ○ Poor
- ○ Terrible

In the next section of this study, 15 short film clips will be displayed. After each film clip, we would like you to answer some questions about your experience with the film.

Randomized films

The following statements are about your experience DURING the film scene. Some of the items refer to the character, please think about the character which you identified more in the film clip when rating your agreement. There are no right or wrong answers.

| | Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree |
|---|---|---|---|---|---|---|---|
| The character's emotions are genuine. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I experienced the same emotions as the character when watching this film clip. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I was in a similar emotional state as the character when watching this film | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| clip. | | | | | | | |
| I can feel the character's emotions. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I can see the character's point of view. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I recognise the character's situation. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I can understand what the character was going through in the film clip. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The character's reactions to the situation are understandable. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| When watching the film clip, I was fully absorbed. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I can relate to what | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| the character was going through in the film clip. | | | | | | | |
| I can identify with the situation described in the film clip. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I can identify with the characters in the film clip. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Debriefing:**

Thank you for your participation!

This study has a focus on cinematic techniques, such as colour, cut-rate, lighting. We are interested to see whether these features impact the viewer's emotional responses and emotional engagement towards the film characters. Your facial expressions have been recorded to analyse the emotional responses. The short survey you filled in after each clip will be used to excess the emotional engagement towards the film characters. If you wish to receive the study results of this project, please leave your email address on the separate sheet provided by the researcher. Please remember that your results are confidential and you can choose to withdraw your results within the following one week.

## Appendix C: Stimulus material

Link to the stimulus material for present study:

https://drive.google.com/drive/folders/1kt5DumLxvbo2pVetYr5rNLZZ3W6f9brZ?usp=sharing