Cognitive Movie Psychology:

Effects of Sound, 3D, and Viewing Context

on Movie Perception

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Abstract

In this dissertation thesis, we look into various aspects of cognitive movie psychology. We start with a look into Münsterberg's *The Photoplay. A psychological study*, which was published a hundred years ago in 1916. Taking his work as a starting point, we explore how the field of cognitive movie psychology has changed over the last century and relate current work to Münsterberg's book. We found that a lot of initial questions that Münsterberg had posed 100 years ago are still relevant today. After analyzing how the field grew over the last decade, we present six empirical studies, subdivided into three parts, namely „depth and motion", „memory and imagination", and „emotions". In the chapter „depth and motion", two studies explore the effect of framing on depth perception. In the first study we were particularly interested in physical frames. We thus built a cinema model and examined its effect on a variety of measures, such as judged screen size. We found that the context, in our case the miniature movie theater, does enhance immersion and more than outweigh the negative effects of the reduced viewing angle. In the second study, we looked at 3D-effects by comparing 2D-, 3D-, and artificial 3D-versions of the same film sequences. In accordance with the literature, we found that 3D-movies produce more immersion and motion sickness than do 2D-versions of the same movie. Remarkably, real 3D and artificial 3D, which was added in post-production, did not differ for most of our perceptual measures. The chapter „memory and imagination" contains a study on the CSI effect and a study on camera angle. The CSI effect describes learning from crime series. Contrary to common belief, we found that watching forensic crime series does not teach the audience to become better criminals. We did find, however, that the elevation and angle of the camera used to film a given scene had an effect on perception of trustworthiness and attractiveness of the protagonist. Camera postions at eye-height produced highest ratings. The last chapter contains two studies on emotions. We conducted a series of experiments to explore the underlying mechanisms of

canned laughter and canned screams. We found that canned laughter and real laughter work through two distinct mechanisms. Canned laughter makes a movie appear funnier by activating cognitive mechanisms of facilitated bonding, whereas real laughter adds a layer of social proof, which is absent with fake laughter. Nevertheless, canned and real laughter produced higher amusement ratings for all movies, whereas only real but not canned screams had the effect of increasing fear. In a second study, we examined the possibility to use film and music to introduce the Kuleshov effect. The Kuleshov effect is quite old but has only recently been proven to work. We were interested in the effect of non-diegetic sound to elicit emotions. We found that music was a great tool to set the tone of a scene and by doing so, were able to auditorily induce the Kuleshov effect. The gathered data from the empirical studies allow an analysis of factors that influence movie perception. We found that sound, stereopsis, and viewing context all matter. We concluded the thesis with an outlook on open questions and further research directions.

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1. INTRODUCTION[1]

Exactly 100 years ago, in 1916, Hugo Münsterberg published the book *The Photoplay. A psychological study*. In it, he laid the foundation for a whole new field: cognitive film psychology. In the book he briefly covered the technical history of the film before he went on to discuss depth and motion, attention, memory and imagination, and emotions, topics that would fit well in a cognitive psychology book today. He concluded the book with a discussion about the esthetics of movies in a more philosophical manner. As we will see, Münsterberg had already anticipated and touched upon most of the current issues. The focus of this thesis will be to look at some of the latest developments in cognitive film psychology 100 years after Münsterberg. The introduction will relate current work to Münsterberg's book while the rest of the thesis is dedicated to explore various open questions that exist in the field today.

Cognitive film psychology focuses on the perception of films and how this is influenced by various aspects of cinema. The research method of choice is empirical, which stands in stark contrast to the psychoanalytical approach that dominated film research in the 60s and 70s. Many psychological disciplines, from social psychology to neuroscience, have contributed to the advance of cognitive film psychology. The common base is a cognitive explanation for observed phenomena, one that lies in neuronal mechanisms of the observer. Clinical psychology stands out in that clinical scholars are usually more interested in how mental illnesses are portrayed in films rather than how they are perceived. However, how these portrayals affect viewers and their understanding of mental illnesses qualifies as a subject of cognitive film psychology.

Before the *cognitive revolution*, most psychological works on film were psycho-analytical. Two notable exceptions were Münsterberg's *Photoplay* (1916) and Arnheim's *Film as Art* (first published 1932 in German and 1957 in an extended version in English).

[1] Parts of the introduction are prepared for submission by Baranowski, A.B. et al. (submitted). *100 years after Münsterberg: From photoplay to cognitive film psychology*.

Both were experimental psychologists of German origin who emigrated to North America. In their works, they discussed many of the challenges with which film psychologists still struggle today. In the subsequent years only a few scattered studies appeared in press. Following the *cognitive revolution* in psychology in the 50s and 60s of the last century, two important analysis of film appeared. Hochberg and Brooks published an essay called *Film Cutting and Visual Momentum* (1978) and Gibson devoted a chapter to *Motion Pictures and Visual Awareness* in his *Ecological Approach to Visual Perception* (1979).

Hochberg and Brooks argued, in a Helmholzian tradition, in this and subsequent publications (1978, 1986, 1996) for top-down processes in film viewing. The minimum the observers mind has to archive is perceptual inference, enabling us to see what most likely fits the sensory pattern. Potential matches depend on previous knowledge which is stored in perceptual maps as schemata. The availability of this knowledge depends on real world experiences, including cinematic experiences, which are shared by the film makers and viewers. Gibson on the other hand defended a bottom-up approach. He argued that the properties within the virtual events on the silver screen lead to perceptual occurent awareness. The movie, and not the movie-goer, constructs a virtual reality.

The rise of cognitivism in film psychology went hand in hand with the rise of cognitive psychology in general and cognitive film studies in particular. In 1985, Bordwell published *Narration in the Fiction Film*. This book did for film studies what Neisser's *Cognitive Psychology* (1967) did for psychology. It concentrated existing knowledge and proposed a holistic framework that was logical and appealing. By doing so, *Narration in the Fiction Film* did maybe not start, but certainly catalyze, the cognitive revolution in film studies.

In *Narration in the Fiction Film* Bordwell explained narration (the flow of story information) with a cognitive approach. He argued that many of the strategies filmmakers use to tell stories are exploiting general human perceptual and cognitive capacities. This stood

against the mainstream school of thought at the time - semiology - which saw movies as an audiovisual language with its own syntax and semantic. This also meant that storytelling in film was seen as highly cultural determined and learned over time, something that we know today does not hold true (Messaris, 1994; Schwan & Ildirar, 2010). In the following year's scholars from many disciplines contributed to the rise of cognitive film studies. In the slip-stream of this new movement cognitive film psychology formed as a sub-discipline of its own.

The 90s saw a substantial increase in literature covering films from a psychological angle (e.g. Grodal, 1999; Tan, 1996). Two notable examples were Messaris's *Visual Literacy: Image, Mind, and Reality* (1994) and Anderson's *Reality of Illusion* (1998). Messaris synthesized the psychological and anthropological research on audience media response. He found that visual images and their usual combination in movies were not profoundly different from reality, making it possible to read them for anyone even without previous media experience. In the tradition of Gibson, Anderson looked at movies from an ecological perspective. He gave an extensive overview over the empirical work that has been done, and, like Messaris, concluded that film perception is not radically different from normal perception.

With the turn of the century, the field has seen efforts to base previous findings on a neuropsychological foundation. In *Embodied Visions: Evolution, Emotion, Culture, and Film,* Grodal proposes the PECMA model (for Perception-Emotion-Cognition-Motor-Action), in which perceived stimuli are first emotionally evaluated before they go on to be cognitively analyzed. Hasson and colleagues (2008) proposed that studying the brain on movies should be a sub-discipline in its own right, calling it neurosinematics. Based on the term, Shimamura proposed a broader focus, calling the new discipline psychocinematics. In his book *Psychocinematics: Exploring Cognition at the Movies* (2013) he brings together some of the

most senior film scholars alive to discuss different aspects of what such a discipline would entail. Here, history makes a full cycle, with Münsterberg already proposing such a field.

In the following, we will look at how the areas which Münsterberg discussed in 1916 have developed over time. We first analyze Münsterberg's predictions of the technical developments of the film and go on to evaluate the advances in the areas Münsterberg has discussed. After an overview of the state of cognitive movie psychology we will present 6 empirical studies that are intended to further our understanding of movie psychology. The dissertation thesis is concluded with a brief, general discussion of the presented work.

1.1 Historical Developments

In the first two chapter of the photoplay, Münsterberg analyses the historical development of the moving picture in the 19th century. He differentiates between the outer and the inner development of film. The outer development is classified as the technical advances from Stampfer's Stroboscope, Plateau's Phenakistoscope, and Horner's Zoetrope in the 1830th to the first public film presentations in Paris by the brothers Lumière and the standardization of film that followed in the next 20 years. In the inner development Münsterberg discusses how the content of film has changed and shifted towards a more and more sensational seeking medium.

The interested reader will probably know most of the film history of the 19th century already, which is covered in many introductionary books on film studies (see e.g. Enticknap, 2005). One lesser known fact described by Münsterberg is an observation by Faraday (1831). Faraday noticed that when he looked at two aligned fast moving cogwheels, the one in the back changes its apparent frequency. The reason for this is that the cog in front moved at a different frequency than the one in the back. The cog in the back is then presented as a series of short samples rather than a continuous moving object and the apparent movement dictated by the difference in frequency of the two cogs. This stroboscopic effect gained prominence in

the film maker community as the wagon-wheel effect. When cyclically moving objects like spoked wheels or propellers are filmed, they may appear to move slower, backwards, or stand still, depending on the speed of the moving object and the frame rate of the camera (Finlay, Dodwell, & Caelli, 1984; Finlay, Dodwell, 1987). Curiously, the wagon-wheel effect can also occur under continuous illumination, which has led some authors to conclude that the visual system works much like a camera, i.e. by not processing a dynamic flow of visual images but by sequential presentations of discrete frames (Purves, Paydarfar, and Andrews, 1996). However, further evidence supports the idea that the visual system processes images in a constant stream and motion-reversal is caused by perceptual rivalry, which originates as the brain generates multiple and possible wrong interpretations of visually ambiguous scenes (Kline, Holcombe, & Eagleman, 2004).

In the 20th century, three major developments had a lasting effect on film production and style: the introduction of sound in the 1920s, the establishing of color film around the 1940s, and the digital revolution in the second half of the 20th century (Thomson & Bordwell, 2009). Some might argue that stereo film should be added to this list but it came and went several times in the last century (with a 3D bubble about every 30 years, starting in the 1920s) and thus far has not left a lasting impact on film style. It might be considered a revolution in the 21st century but as long as it is necessary to produce for every 3D movie a 2D version for the home video market, it is unlikely to unfold its full potential.

Münsterberg acknowledged the potential of film for educational purposes but also warned of the potential abuse for propaganda (which is not surprising given that the book was written in the midst of WWI). Media effect research was born out of the question what potential effects media exposure has on the consumer. Looking particularly at films, research showed that they are well suited for teaching and could even replace whole lectures (e.g. Schacter & Szpunar, 2015; Schreiber, Fukuta, & Gordon, 2010; Solomon, Ferenchick, Laird-Fick, & Kavanaugh, 2004). Evidence for consumer manipulation without their knowledge is

less conclusive. In a large study by Paluck and colleagues (2015), scenes about topics like drunk driving and registering for voting were purposefully depicted in three prime-time nationally-broadcast Spanish-language telenovelas in the US, with an estimated weekly viewership of 1.2 million on average. The study did only find weak effects and no lasting behavioral changes of the viewership over the course of 20 weeks. While the discussion continues e.g. for the effect of the portrait of violence in movies on aggressive behavior (Bushman & Huesmann, 2006; Paik & Comstock, 1994), cultivation theory argues for a more indirect effect on viewers. Instead of direct social learning (Banduras, 1965), Cultivation theory predicts that the more time people spend watching a certain format, the more likely they are believing it is reality (Cohen & Weimann, 2000). Although there is good evidence for some of the claims (Griffin, 2014), other claims could be disproved (Chapter 4). Additionally, while there has been a great deal of public concern of subliminal manipulation of viewers, there is no evidence that supports such fear (Wiseman, 2009).

1.2 Depth and Movement

1.2.1 Depth

Münsterberg had already realized that perception of depth and movement in film is not trivial. How is it possible that a series of two-dimensional flat images become a vivid representation of a three-dimensional scene?

Natural viewing of a scene provides multiple cues to the depth arrangement of the objects in it. The filmed scene differs substantially from the natural scene: The eyes accommodate to the physical distance of the projection screen rather than to the distance of the object. The same is true for convergence of the two eyes. Additionally, stereopsis disparity of the two retinal images is mostly lacking. Münsterberg was aware of these potential problems and concluded that watching movies is somewhat like looking at a scene monocularly.

Münsterberg correctly points out that we do not lose our depth perception when looking merely with one eye. The monocular cues to depth are rather powerful, and some were already known at the time, e.g. differences of apparent size, perspective relations, lighting, shading, and depth from motion (Münsterberg, 1916). In subsequent years, further monocular depth cues have been discovered and the list grew to about 15, depending on which classification system is used (Goldstein, 2013; Kaufman, 1974). Thus, monocular depth cues allow the human visual system to extract and perceive three-dimensional space.

The binocular cue of stereopsis, that is the disparity between the two retinal images resulting from slightly different angles with which each eye sees the world, produces a different quality of depth perception. Münsterberg acknowledged this and proposed to use red-green anaglyph lenses to produce such 3D effects. This had just been successfully tested with short film reels at the Astor Theater in New York City by Porter and Waddel in 1915. However, it was not until 1922 that the first feature length film was screened in 3D for a larger audience (*The Power of Love*; Zukor, 1953). Today, many movies are shown in 3D (mostly with polarization filters rather than anaglyphic filters), because they are associated with a more immersive experience, as compared to the 2D version (IJsselsteijn, de Ridder, Hamberg, Bouwhuis, & Freeman, 1998; Read, & Bohr, 2014; Yang et al., 2012). Audiences are also willing to pay more for 3D movies. Many films originally produced in 2D are later digitally converted to 3D, which is cheaper than shooting in stereo, but it produces similar 3D-effects, even when done in an automated and unrealistic fashion (Chapter 3).

Side-effects of visual discomfort in 3D movies, such as headaches or nausea caused by the conflicting cues to depth, have turned out to decrease as 3D-technology improves (Kooi & Toet, 2004; Lambooij, IJsselsteijn, Fortuin, & Heynderickx, 2009). However, the conflicting cues of convergence and accommodation remain present in 3D-movies. In the past, it was outright impossible to integrate these depth cues into movies. With newer technology, in particular head-mounted displays, however, it is conceivable. To manipulate convergence in

head-mounted-displays, one could change the distance between the two monitors or the orientation of curved monitors that bend towards the nose. It is then possible to show elements that are supposed to be very close to the viewer (on the part of the screen that is) closer to the nose, forcing the eyes to converge. Accommodation is the change of optical refraction power by changing the form of the lens. To enable the eyes to have the impression of different distances through accommodation, it would be necessary to equip head-mounted displays with flexible lenses. By slightly changing the focus point of the artificial lens, eyes would have to change their accommodation to adjust. Done in the right way, the ciliary muscle would produce the same signals as in a real world scenario. One could even go further and produce a whole film with light field cameras, which collects the intensity of light in a scene, allowing to focus at any depth level in post-production. Eye-tracking could then be used during film presentation to focus the film only at the level of depth where the eyes are currently resting.

Münsterberg also raises the issue of sitting position and setting. A lot of research has been done on sitting position and it was found that the human visual system is surprisingly tolerant towards distortion (e.g. Cutting, 1987; Vishwanath, Girshic, & Banks, 2005). The setting in which a movie is watched, on the other hand, plays an important role in movie perception. Elements that remind the consumer of the artificial nature of the viewing will likely reduce the immersion whereas elements that hide this fact lead to more movie enjoyment (Chapter 2).

1.2.2 Movement

Another central question is how the series of discrete images is perceived as one continuous stream of visual information. Münsterberg, citing Wertheimer (1912) and others, proposed that apparent motion is the mechanism underlying motion perception in film. He argued that the spaces between pictures presented in quick succession, only changing to a

certain degree, are filled in by the brain. Wertheimer had demonstrated this effect neatly with two lines, one vertical and one horizontal, which he showed participants alternating at different speeds. He found that participants perceived the line as toppling over and falling when presented with an interstimulus interval of about 200ms, and called this effect apparent motion. Note that this particular apparent motion falls in the range of beta motion and not phi motion, as sometimes reported (Steinman, Pizlo, & Pizlo, 2000; Wertheimer, 1912). This theory was controversial at the time. Many researchers believed that the fusion of positive afterimages, called persistence of vision, and not apparent motion was responsible for the impression of movement (e.g. Marbe, 1910). Evidence for apparent motion grew, and by the 1970th few vision researchers believed that persistence of vision were the cause for motion perception in movies (Anderson & Fischer, 1978). However, persistence of vision grew popular with film scholars and has been wrongfully cited as source for motion perception in many textbooks over the years (e.g. Cook, 2001; Metz, 1991; Sobchak & Sobchak, 1980).

As the presentation speed of an apparent motion stimulus increases, the observer perceives alternatingly flashing objects as two flickering objects rather than one object moving back and forth. Further increasing presentation speed removes the impression of flicker, and two steady objects are perceived. This flicker fusion threshold is at about 50 Hz in humans but it depends on various factors, e.g. brightness and color of the stimulus, and physiological factors like age (Landis, 1954). In Münsterberg's time, films were shown with 16 fps to 25 fps (see Brownlow, 1980, for a discussion of projection speed in the early days) and had considerable flicker, hence the nickname flick for a movie. Only with the introduction of sound in the mid-1920th was the frame rate fixed to 24 fps for technical and economic reasons. The flicker remained visible, and further experimentation led to the introduction of the multi-blade shutter. Instead of showing each picture only once, the shutters were designed to show each picture twice or three times, raising the flicker-rate to 48 or 72 Hz, significantly reducing and even eliminating the perception of screen flickering

(Anderson, 1998). Only by morphing the stream of stable images, by filling the blanks according the laws of apparent motion are we able to perceive a smooth continuous movie.

1.3 Attention

Münsterberg determined that when we follow a film as intended, our attention is guided by the decisions of the director. The director can direct the attention of the audience by the use of *mise en scène*, with refers to the spatial structure of the images. This includes setting, costumes, lighting, and the staging of action (Bordwell & Thompson, 2010). Thus, attention is directed by exogenous factors that originate outside of the audience (luminance, color, edges, and motion), rather than endogenous factors (internal plans, desires, and viewing task), which Münsterberg called involuntary and voluntary attention, respectively (Pashler, 1998; Smith, 2013).

To test whether visual attention is truly guided by a film, it is necessary to evaluate were people look during a screening (as eye fixation usually translates into encoding of visual information; Henderson & Hollingworth, 1999). A great tool to explore the visual gaze is eye-tracking, which can record were people look with a high spatial and temporal resolution. In static images, past research demonstrated that there are universal areas of interest (e.g. faces, task-relevant objects), although people look at these locations over a period of time (Mannan, Ruddock, & Wooding, 1995). Stelmach and colleagues noticed that when showing short video clips to a group of people, their gaze was highly synchronized (Stelmach, Tam, & Hearty, 1991). This effect was later dubbed attentional synchrony (Smith & Henderson, 2008) and subsequently documented in a wide range of films (e.g. Goldstein, Woods, & Peli, 2007; Hart et al., 2009; Hasson et al., 2008; Marchant, Raybould, Renshaw, & Stevens, 2009; Sawahta et al., 2008; Nyström & Holmqvist, 2010).

In order to predict which factors lead to attentional synchrony, Mital and colleagues (2011) recorded eye movements of 251 participants watching films chosen from a wide range

of categories. They then tested which low-level visual features of the videos were predictive of gaze direction. It turned out that luminance and color did not influence gaze. By comparison, motion contrast was an excellent predictor for gaze. In particular, when a small area of the screen was moving in contrast to a static background, high attentional synchrony was found. Other studies had similar results in that relative motion was the best predictor for gaze direction (e.g. Berg, Boehnke, Marino, Munoz, & Itti, 2009; Vig, Dorr, & Barth, 2009). Additionally, Mital et al. (2011) found that faces have a high salience in videos. Especially, close medium shots (showing and actor cut off at around the breast) led to high attentional synchrony with the focus on the face, and low variance in the gaze behavior. For an excellent review of the use of eye-tracking in film research, see Smith (2013).

Münsterberg also noted that while our attention is usually led by the director choices, film viewers might pay attention to aspects of a film that are of particular interest to them, such as the location, a particular technology or actor. Newer studies support that endogenous factors do play a role in how observers direct their attention. One of the earliest studies to show this effect was Yarbus (1967). He presented participants with a painting and gave them various tasks. Depending on the task, participants would attend different areas of the painting that were relevant to the viewing task. Smith and Mital (2011) repeated the design for film scenes and found a similar effect. When instructed with a specific task, participants ignored salient features like movement and focused on task-relevant objects. Further, Dorr and colleagues (2010) showed an increase of attention synchrony with the onset of a new shot and decrease in attention synchrony with added viewing repetition of unedited natural scenes and Hollywood movie trailers.

Because exogenous focus decreases with the length of a shot, new features have to be introduced to win back the focus of the audience. This can be done by movement, but also by editing. Cutting and colleagues (2011) noted that this is exactly what happened in Hollywood movies. Average shot length decreased continuously from 1935 to 2010 while movement and

motion increased. However, attention fluctuates over time with a fractal pattern (1/*f*, sometimes called pink noise), as operationalized by reaction time. This means that people are not able to pay the same amount of attention all the time and have periods of high and low attention that can be described by calculating 1/*f*. Curiously, Cutting, DeLong, and Nothelfer (2010) found that shot length in Hollywood movies became more grouped over time with alternating clusters of short and long shots. Pattern of shot length approached that of 1/*f* over the last 70 years, resembling the attention fluctuation of the human mind.

1.4 Memory and imagination

Münsterberg understood movies as a reflection of our mental processes. Instead of merely binding our attention, movies imitate it. Movies are already presented in a form that mirrors the mental coding of memories. This seems to be particularly true of episodic (events) and less for semantic (factual knowledge) memory. In the following we only look at episodic memory, because movies are story telling devices that are structured in episodes. Educational films are different but were not considered in Münsterberg's writings.

There are important similarities and differences in how we remember or imagine events and how they are portrayed in movies. The biggest difference is that memories are truly multisensory, with all senses being engaged. Film captures visual and auditory information, but memories can also be formed in other modalities, such as olfaction and touch. The most important similarity between memory and film is their structure. Both present selected simplified versions of events and rely on the ability of the mind to fill in the missing parts.

This seems to be applicable to how movies tell events (Schwan, 2013). Stories are constructed by using stereotypes of people (Thomas & Johnston, 1981) and experiences (Bordwell, 1985) to let viewers form simplified representations of the portrayed events. Thus, simplifications are deliberately used by movie makers, either to help the audience to com-

prehend a story, or to lead them astray. Representation in memory works in a similar way. When asked to remember a person, people tend to have a stereotypical representation of that person rather than recalling each and every occasion they interacted with him or her (Schneider & Carbon, 2015). Likewise, episodic information is stored in a selective and aggregate form, leading to the memory of an event's gist (Baddeley, 2009; Koriat, Goldsmith, & Pansky, 2000).

Stories in movies, with few exceptions, are not presented in real time. Instead, movies tend to compress or slow down time and only present episodes that are of particular interest to the story. Therefore it is possible in movies to travel freely through time. Past and future events can be cut next to one another, implying causal connections that usually would not be visible. This is possible because the audience fills in the gaps and is able to comprehend the story. Schwan and Garsoffky (2004) found that there was hardly any difference in participant's recollection of an event, regardless of whether they saw only a summary or the whole event. Thus, narrative structure can be rather independent of event structure. Our episodic memory is similarly flexible, such that Tulving coined the term *mental time travel* for it (1983). Instead of recalling events in a strict temporal order, it is possible to jump in time and mentally represent past and possible future events independently of their occurrence.

Movies are flexible in temporal structure, but also in spatial structure. The camera can jump in space to any location at any time. Movie makers usually choose the perspective that is easiest to comprehend. This is reflected for example in the 180 degree rule, which states that when filming a dialog between two characters, the axes between them should be seen as a spatial dividing line. The camera should always stay on one side of the room and never jump the line, because it leads to the characters being presented reversed on the screen. Another example is when filming a car that leaves a scene on the right side of the frame. It should then be entering from the left side of the frame in the next shot. Not following this rule leads to disorientation of the audience and should therefore be avoided (Huff & Schwan, 2012).

Viewing position also matters for recognizing objects or events (Blanz, Tarr, & Bülthoff, 1999). It is for example easiest to identify a clock from a frontal view and shoes from above (Konkle & Oliva, 2011). This also extends to social situations and character traits; for instance, low camera angles produce images of strength, high camera angle images of weakness, and eye-level shots elicit trust (Chapter 5).

With respect to spatial structure, film and memory differ. Whereas it is possible for the imagination to jump in perspective, we usually remember events from familiar viewpoints. Overall, film does have close links to mental representation in memory, which should be added to the list of cognitive mechanisms that are reflected in movies.

1.5 Emotions

Münsterberg argued that the purpose of film is to elicit emotions. He wrote that „to picture emotions must be a central aim of the photoplay" (Münsterberg, 1916; 112). In his book, he described several methods according to which movies efficiently elicit emotional responses. Tan later called this an *emotion machine* (1996). Much of the techniques that were used at the beginning of the century are still in use today. This includes the projection of the emotional state of the actor on the mise en scène, e.g. rain that symbolizes sadness, and the use of particular camera settings and movements, e.g. a high camera angle to indicate helplessness, in addition to the portrayal of emotions by the actors themselves.

Münsterberg differentiated between empathic emotions and individual emotional responses to film. He argued that the movie-goer empathizes with the protagonist and will mirror his/her emotions. The movie-goer imagines being the protagonist and identifies with the protagonist's plans and desires. At the same time, viewers have their own history and personality, and the movie will trigger individual responses that are independent of the emotions depicted by the actor. Additionally, the story might activate emotions that move contrary to the protagonist's mental state. It is, for example, possible that an audience member

feels sympathy for a character that has lost a loved one while simultaneously feeling happy and thankful for his or her healthy family.

This distinction is also made by modern movie psychologists. Oatley (2013), for instance, differentiates between three modes of emotion elicitation: (1) Identification and empathy are based on the ability and willingness of the audience to assume the actor's place. (2) Appraisal and sympathy relate to the cognitive evaluation of cues in relation to the viewer's own ambitions and interests. (3) Immediate elicitation of emotional attention is technically not a category of its own, but rather represents immediate and involuntary low-level appraisal and sympathy. Seeing a fight will elicit excitement, seeing a love scene will elicit arousal. This mode is nicely substantiated by a cartoon film made by Heider and Simmel (1944). Shown are only two triangles and a circle that move in relation to each other and in relation to five straight lines that from a box. However, schemas of fighting and love were evoked, accompanied by the corresponding emotional responses (Heider & Simmer, 1944; Oatley & Yuill, 1985).

One of the earliest experimental demonstrations of empathic emotions in film was given by the Russian director Lev Kuleshov around the time Münsterberg wrote his book. He filmed then-famous actor Ivan Mozhukin looking into the camera with a neutral expression and intercut the face with several objects/people. It is said that the patrons who watched the short film interpreted the unchanged facial expression differently depending on the object. For instance, the face appeared to look sad when juxtaposed with a coffin but hungry when presented next to a soup bowl. It is not clear if the experiment actually took place because the original material was lost. Be this as it may, this interaction effect of stimulus and context has been replicated and dubbed „Kuleshov effect" (Barratt et al., 2016; Mobbs et al. 2006). The effect shows that people are empathic to the actors on the screen and are able to „see" the emotions they are going through. Whether the audience is willing to identify with the actors and „feel" with them depends of course on the story and on the individual attitude of the

movie goer (see also Suckfüll, 2013, for an overview of individual modes of movie reception).

The individual response of each audience member can differ from the empathic reaction towards the actors. People derive pleasure from horror movies (Hoffner & Levine, 2005), or they experience *Schadenfreude* upon the protagonist's misfortune (van Dijk & Ouwerkerk, 2014). The source of such reactions is appraisal. Instead of empathizing with the character on screen, the audience relates the events of the movie to their own experiences and evaluates them under that premise. Movies are carefully plotted to activate emotional scripts that are shared by a wide range of people (Bordwell, 1985; Tan, 1996). Appraisal can happen on multiple levels. The progression of the plot might lead to positive appraisal and a happy feeling. Appraisal of an accident might have the opposite effect. Visual stimuli like a pretty landscape or a gruesome battle scene usually activate similar emotional scripts in all audience members.

Münsterberg discarded the use of sound. He felt that non-diegetic sound has its place in film but that diegetic sound would only distract from the movie content. He was wrong with respect to the latter but quite on target with respect to the former. Nowadays, it seems clear that non-diegetic sound is a great tool to produce emotions. Music can be used to set the tone of a scene and auditive and visual stimuli in combination are able to produce a synergetic effect which neither one is able to archive by itself. One of the most overt means to use non-diegetic sound is canned laughter. It is almost exclusively used in series and is surprisingly efficient in activating scripts of comedy and humor. The movie *Natural Born Killers* used a laugh track in the flashback to the protagonist’s abusive childhood home. It was used as a media satire but also demonstrated how canned laugher dominates the tone of a scene and might even turn repulsive content into a light-hearted experience.

Canned laughter may not be deemed necessary in movies because they are made to be shown in theaters where a larger audience will produce appropriate reactions. These reactions

serve as a feedback loop and increase the emotional intensity of the experience. To test whether this contention is true, we (Chapter 6) conducted a series of experiments where participants saw movie clips supplemented with canned or real laughter. We found that the effect of a real audience laughing is stronger than that of a laugh track. Surprisingly, it seemed that real laughter was contagious while canned laughter merely served to give the audience a feeling of inclusion. It increased the experienced bonding with an imaginary audience to a larger degree than it increased the subjective funniness of the material. In a further study, we could show how efficient music is in producing emotions by auditively inducing the Kuleshov Effect (Chapter 7).

1.6 The Esthetics of the Photoplay

Münsterberg's book consists of two parts, the psychology and the esthetics of the photoplay. While the psychology part is still relevant today, his outlook on esthetics is strongly influenced by the circumstances of his time. Münsterberg argues two main points in the esthetics. He tries to establish film as an art form in its own right and separate it from theatre, and to define art as the antonym to nature and reality.

In 1916, film was still at its earliest developmental stage and had many limitations. Münsterberg recognized that a movie was not a mere adaption of a theatrical play, but had potential to be a separate art form. At the time, many films were recreations of stage plays, and Münsterberg stressed the importance of a script that was written to fit the emerging field. Otherwise, movies would stay in the shadows of theater for a long time. Today, there is no discussion about the fact that books, theater scripts, and film scripts have to be written with the designated medium in mind in order to unleash their full potential.

Münsterberg goes on to argue that „It [the artwork] becomes art just in so far as it overcomes reality, stops imitating and leaves the imitated reality behind it" (Münsterberg, 1916; 144). In that context, it is understandable that Münsterberg did not approve of sound in

film. He thought of non-diegetic music as a necessity to keep the audience engaged but disapproved of diegetic sound like a gunshot or the whistling of a locomotive. Likewise, he argued that color would bring the film closer to reality and therefore weaken its artistic value. Similar arguments are brought up time and again when art forms evolve. Like sound and color, the introduction of stereoscopy in film today is seen critical by many. However, art and technology have always inspired and enriched each other. Film makers will continue to push the limits of the field, and in the end, we the movie goers will decide with our consumer behavior which technology will prevail.

1.7 Aim of the dissertation

Having outlined the state of cognitive movie psychology in the light of Münsterberg, we aim to advance our understanding of mechanisms underlying film viewing. In particular, we present six empirical studies that explore various aspects of movie perception.

In the thesis, we limited ourselves to explore categories proposed by Münsterberg, even if this is not explicitly mentioned in the individual studies. We focused on three of the four cognitive categories introduced above, namely „depth and motion", memory and imagination", and „emotions". The only chapter we do not cover is attention, which is owed to the time limitation of a PhD project. Each chapter consists of two studies, each containing several experiments.

In the chapter „depth and motion", two studies explore the effect of framing on depth perception. In the first study we were particularly interested in physical frames. We thus built a cinema model and examined its effect of a variety of measures, such as judged screen size. In the second study we looked at 3D-effects by comparing 2D-, 3D-, and artificially composed 3D versions of the same film sequences.

The chapter „memory and imagination" contains a study on the CSI effect and a study on camera angle. The CSI effect describes the effect of crime series on a variety of agents and

possible consequences for society. We were interested in the claim that watching these series would educate or improve criminal skills. The study of camera angle explored the activation of cognitive scripts based on the elevation and angle of the camera used to film a given scene.

The last chapter contains two studies on emotions. We conducted a series of experiments to explore the underlying mechanisms of canned laughter. We also introduced a scream track to see if that would change the evaluation of the visual material. In a second study we examined the possibility to use film and music to introduce the Kuleshov effect.

The gathered dada from the empirical studies allow an analysis of factors that influence and are able to alter movie perception. The goal of the analysis is an empirically driven categorization of these factors and to identify and understand the cognitive mechanisms involved.

PART I

DEPTH AND MOTION

2. THE BIG PICTURE: IMMERSION AND SIZE PERCEPTION IN THE HOME THEATER[2]

2.1 Abstract

Despite the fear of the entertainment industry that illegal downloads of films might ruin their business, going to the movies continues to be a popular leisure activity. One reason why people prefer to watch movies in cinemas may be the surround of the movie screen or its physically huge size. To disentangle the factors that might contribute to the size impression, we tested several measures of subjective size and immersion in different viewing environments. For this purpose, we built a model cinema that provided visual angle information comparable to that of a real cinema. Subjects watched identical movie clips in a real cinema, a model cinema, and on a display monitor in isolation. Whereas the isolated display monitor was inferior, the addition of a contextual model improved the viewing immersion to the extent that it was comparable to the movie theater experience, provided the viewing angle remained the same. In a further study we built an identical but even smaller model cinema to unconfound visual angle and viewing distance. Both model cinemas produced similar results. There was a trend for the larger screen to be more immersive, however, viewing angle did not play a role in how the movie was evaluated.

2.2 Introduction

In the United States and Canada, the movie box office revenues increased by 5.62 % each year from 2007 – 2011, and they amounted to 10.2 Billion US dollars in 2011 (MPAA, 2012). Also, the number of moviegoers increased steadily by 1.22 % per year over the last four years, leading to a total of 225 Million moviegoers in 2012. However, while the overall number of moviegoers is increasing, rising ticket-prices prompt moviegoers to go to the

[2] Paper published as Baranowski, A.M. et al. (2014). The big picture: Effects of surround on immersion and size perception. *Perception*, *43*(10), 1061-1070.

movies less frequently, in particular during tough economic times (Nawoj, 2012). Still 67% of all U.S. American and Canadian citizens over the age of two continue to go to the movies more than once a year (MPAA, 2012).

One important reason for consumers to choose to go to the movie theater could lie in its social value. Indeed, more than one third of Americans in their late teens and early 20s choose to see a movie to accompany a friend or acquaintance and would not have chosen to make the trip to the theater on their own accord (Watts, 2011). Here we are concerned with another potential reason to prefer the big silver screen in movie theaters. The theater setting may provide a sensation of grandeur that is hard or impossible to reproduce at home. Past research suggests that this may be the reason, but it is not conclusive. A bigger screen produced more attention and arousal (e.g. Reeves, Lang, Kim, & Tatar, 1999), better evaluation (e.g. Lombard, 1995), more immersion (e.g. Lund, 1993), and in some studies even better memory for the viewed content (e.g. Detenber, & Reeves, 1996). More recent studies, however, suggest that many would-be effects of the big screen can be attributed to visual angle, that is to the size of the retinal image, which is a function of physical screen size and viewing distance of the observer from the screen. We shall call this the **visual angle hypothesis**. Evidence for the importance of viewing angle as compared to physical screen size in the human movie experience has been found in studies that have varied screen size and viewing angle independently. Under these circumstances viewing angle may override the effect of real screen size, typically increasing apparent screen size. Larger visual angle goes along with increased arousal (Lin, Imamiya, Hu, & Omata, 2007), better memory, and more positive evaluation of the movie content (Bellman, Schweda, & Varan, 2009).

We take the visual angle hypothesis to be unable to fully explain the visual aspects of the big screen experience in the movie theater. Even when equating the viewing angle of a home theater with that of a cinema, the experience of the former does not seem to be as monumental. For instance, Troscianko, Meese, and Hinde (2012) found that larger physical

screen size led to more immersion for a given constant viewing angle. Somehow, the cinema experience seems to be more immersive, but what are the visual factors contributing to this experience? We entertain that in an addition to viewing angle, the surrounding context of the screen plays an important role. In the real world, objects never occur in isolation, they interact with their environment, which is offering additional information to be explored by the visual system (Oliva & Torralba, 2007). We propose that the visual system is unable to discount this context, even in a dark movie theater. In other words, the **surround hypothesis** takes immersion and experienced screen size to depend only partially to the visual angle. It also depends on the features of the surrounding context, such as other people in the foreground, furniture etc.

As we do not know which aspect of the surround might play the decisive role, we decided to start by removing the entire surround. We assumed that this could best be done by using a scaled-down cinema model that could be removed from the presentation screen altogether. Using a model has the added advantage that a display screen can be compared to an identical screen with or without the model movie theater surrounding it. The model might provide a reference frame that makes the screen seem bigger. The effect might be a contrast effect comparable to the Ebbinghaus illusion, provided one can assume that the elements of the inducing surround are comparably smaller (e.g. Roberts, Harris, & Yates, 2005). A larger subjective screen size in turn might lead to more immersion (e.g. De Cesarei & Codispoti, 2006). The cinema model also may preactivate stored representations of cinema visits which could induce scaling properties of the experience (Friedman, 1979). Be this as it may, the use of a model should reveal whether or not the surround has an effect on perceived size and immersion.

2.3 Experiment 1

To test the surround hypothesis and to find out if context cues influence movie perception, we presented a movie episode on a high-resolution screen. Either the screen was embedded within a cinema model; or the cinema was replaced by an empty room of the same dimensions. We expected that watching a movie in the model cinema leads to an overestimation of the screen size, more enjoyment of, and more immersion into the movie, compared to the empty room condition. Stimuli were presented binocularly and in 2D (no stereo in the movie) in all experiments.

2.3.1 Method

We built a model of an art cinema in the city of Mainz at a scale of 1:16 (Figure 1). The curtains next to the screen, seats, carpets, wall paper, and ceiling were modeled. Also small puppets served as movie-goers. The empty room was an empty black box of identical dimensions, but no internal model of the cinema.

Fifty six (29 female, 27 male; mean age = 32.45 years, *sd* = 17.52) visitors of a science fair participated in this study on a voluntary basis. After obtaining informed consent from the participants, we placed them in front of the empty room and the cinema model. We positioned the empty room and the cinema model next to each other, with the open sides facing the participants. The latter could switch back and forth between both setups at their leisure. Both setups contained a 24 inch (30x53 cm) full HD computer screen of the same manufacturer, build, and settings. The movie “Gulliver's Travels” (2010) was shown in a loop and in synchrony on both screens.

Figure 1. The upper panels show the model cinema from the perspective of the participants (left) and in a full shot (right). The lower panels show the original cinema, which was also used as a condition in experiment 2.

Participants then received headphones and a questionnaire containing the following questions. “Which screen seems larger”, “If you had to choose, in front of which setup would you rather watch the movie”, and “Stand in front of each setup for a while; then decide where you get more immersed into the movie”. After each of these forced-choice questions, participants had to rate how strong the preference was on a Likert-like Scale from 1-6 (1 corresponding to “weak” and 6 to “strong”). We further assessed whether previous media experience had an effect on any of the answers. This was not the case.

2.3.2 Results

For all three questions, participants expressed a preference for the cinema model (Figure 2). To test if these differences were significant, we used a binominal test. Results indicated that the screen of the cinema model was judged to be larger 71 % of the time, n (15+37) = 52, p = .003, the movie was more fun to watch in front of the cinema model 80% of the time, n (10+41) = 51, p < .001, and the movie was more immersive when seen via the cinema model 64% of the time, n (20+35) = 55, p = .044. On average, participants who decided in favor of the cinema model were more confident about their respective choices as compared to those who preferred the empty room (Figure 2).

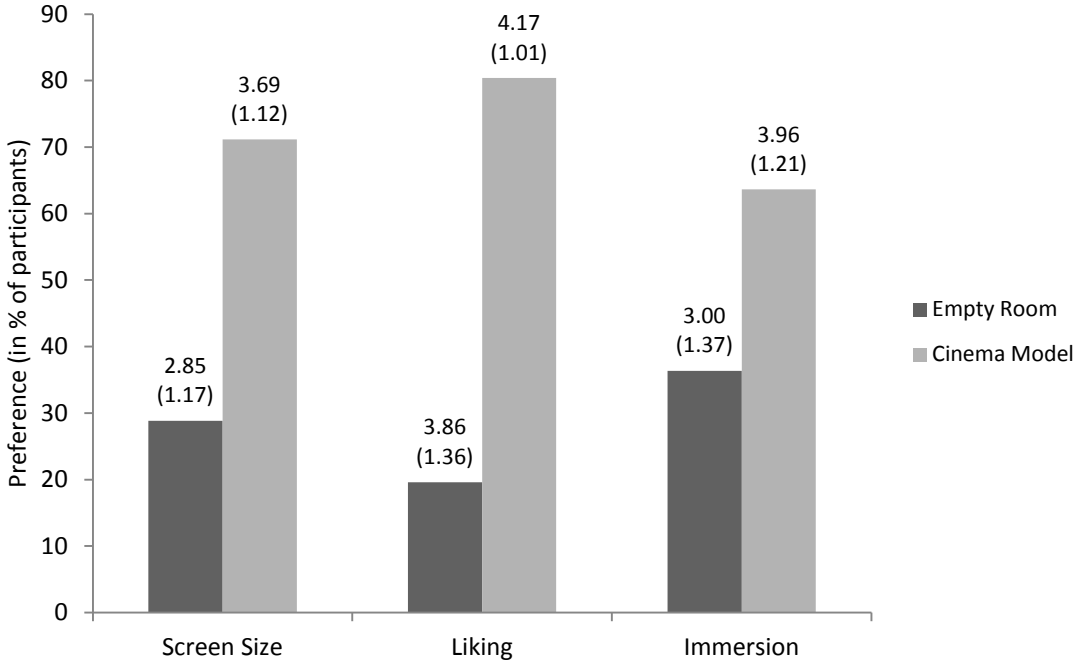

Figure 2. Results of Experiment 1: in all three categories participants preferred the cinema model over the empty room with the same proportions. The numbers on the bars indicate how confident participants felt about their respective choice on a scale from 1 - 6 (with standard deviation in parentheses).

2.3.3 Discussion

The results reveal that when forced to choose, participants clearly preferred to watch the movie in the cinema model compared to the empty room. They also took the screen of the cinema model to be larger than that of the empty room, even though both had the exact same size. The weakest effect was found for immersion, yet the difference was still significant. Participants found the movie in the cinema model to be more immersive. Those subjects who produced preferences against this majority vote were less convinced of their choice than was the majority of their respective choice.

2.4 Experiment 2

This experiment had two goals. First, we sought to replicate the preference for the rich context with a different paradigm that did not rely on forced choice. Second, we wanted to compare the laboratory data to a real-life situation. We tested the hypothesis that the effect is strong enough to survive outside the situation of a direct comparison with a between-subject design. We also wanted to know if the viewing angle correlates positively with immersion and perceived screen size, as some authors have concluded (e.g. Murray, Boyaci, & Kersten, 2006; Wu, 2011). We were doubtful about this conclusion since a wider viewing angle (which typically is tantamount to sitting closer to the screen) necessarily leads to a reduction of visible context cues. And our Experiment 1 has shown that context cues did have a positive effect when controlling for viewing angle.

2.4.1 Method

One hundred and sixty students of the University of Mainz (114 female, 46 male; mean age = 24.43 years) participated in this study in exchange for partial course credit or five Euros. About half of the participants where psychology students. The rest were students from various fields.

We crossed four viewing conditions with two viewing distances, all of which were varied between-subjects. The first viewing condition featured a 24 inch (30 x 53 cm) computer screen on a table that was covered with a black cloth. The second condition was identical with the exception that the room lights were switched off. The third condition used the elaborate cinema model from Experiment 1 (with the same screen as in the first two conditions and the room lights turned off), and the fourth condition was an actual cinema (see Figure 1). Each participant was randomly assigned to one condition with the stimuli presented at a viewing angle (horizontal screen width) of either 25° or 80°.

After obtaining informed consent, participants were instructed that they would see a short movie clip, about which they would later have to answer some questions. The experimenter then blindfolded the participants, led them into the laboratory and helped them sit down in an armchair in front of the screen. A head cushion was used additionally to minimize participants' head movements. After being presented with the first ten minutes of Gulliver's Travels (2010), participants were asked to fill in a questionnaire which included questions about previous media experience, screen size, scene length, and emotions the movie may have elicited (Klauer, Voss, & Stahl, 2011). We also used a Likert-like rating scale from 1-7 for immersion, social richness, and social realism (Bracken, 2007; after Lombart et al., 2000), as well as a memory test. The memory test consisted of seven multiple-choice items, asking trivia about the movie. The cinema condition constituted an exception, for practical reasons, all participants who were assigned to this condition watched the movie at the same time.

2.4.2 Results

We used a MANOVA with the independent variables viewing condition (cinema, model, screen solely, screen with lights on) and viewing distance (25º vs. 80º) in a 4 × 2 between-subjects design. Additionally we tested for potential effects of age or gender, both of which had no significant influence on the dependent variables. The means and standard deviations of the dependent variables can be found in Table 1.

Table 1

*Means and standard deviations (in parentheses) for Experiment 2. Data are averaged across viewing distance since it did not yield any significant differences. Overestimations are indicated by positive numbers. Significant differences between two or more groups are marked with * (at alpha < .05) and ** (at alpha < .01).*

	Light on (*n* = 40)	**Screen (*n* = 40)**	**Model (*n* = 40)**	**Cinema (*n* = 40)**
Error in Height Estimation (in %)	9.62 (18.67)	17.00 (27.93)	20.26 (42.18)**	-6.58 (31.64)**
Error in Width Estimation (in %)	1.33 (14.89)	9.87 (23.46)	14.53 (49.59)**	-9.95 (38.12)**
Error in Time Estimation (in %)	23.03 (35.28)	25.24 (32.60)	17.62 (38.73)	22.79 (29.90)
Immersion	4.03 (0.91)**	4.09 (0.85)**	5.08 (0.75)**	5.39 (0.75)**
Social Richness	4.64 (0.93)	5.01 (0.88)	4.96 (0.78)	4.96 (0.79)
Social Realism	3.38 (1.29)*	3.99 (1.37)	4.27 (1.24)*	3.78 (1.13)
Sad	2.70 (1.80)*	1.85 (1.61)	1.76 (1.58)*	2.55 (1.50)
Funny	4.48 (1.48)	4.90 (1.58)	4.66 (1.16)	4.90 (0.93)
Entertaining	4.88 (1.34)	5.03 (1.94)	5.10 (1.41)	4.85 (1.31)
Well made	4.60 (1.41)	4.93 (1.51)	4.81 (1.37)	4.42 (1.39)
Memory test (in %)	67.50 (22.87)	70.71 (18.00)	71.43 (19.41)	72.14 (17.70)

A Pillai-trace test indicated a significant effect of condition, $F(3, 156) = 4.25$, $p < .001$, $\eta_p^2 = .26$, but not of viewing distance, $F(1, 158) = .82$, $p = .62$, $\eta_p^2 = .06$, or the interaction of the two, $F(7, 152) = .53$, $p = .98$, $\eta_p^2 = .04$. A contrast analysis of the viewing condition reveals that participants overestimated the screen height, $F(3, 156) = 5.37$, $p = .002$, $\eta_p^2 = .10$, and width $F(3, 156) = 4.87$, $p = .003$, $\eta_p^2 = .09$ in the cinema model, compared to

the real cinema. Participants were also more immersed in the real cinema and the cinema model condition compared to the computer screen condition, regardless of whether the lights were switched on or off, $F(3, 156)=25.57$, $p < .001$, $\eta_p^2 = .35$ (Figure 3). Also, participants in the model condition perceived the movie to be more realistic, $F(3, 156) = 2.97$, $p = .034$, $\eta_p^2 = .06$, but less sad, $F(3, 156) = 3.42$, $p = .019$, $\eta_p^2 = .07$, than participants in the computer screen condition, where the lights were left on. All other variables did not yield significant results.

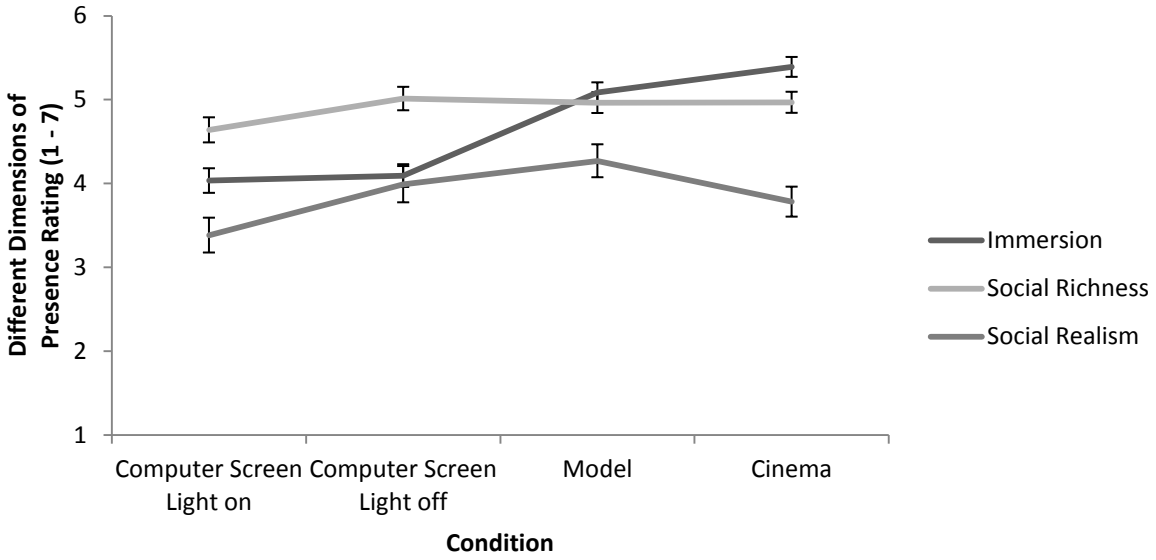

Figure 3. Results of Experiment 2: for all dimensions of presence, participants rated the cinema model as comparable to the real cinema. While there seems to be a trend for social realism, surrounding does not seem to play a role in the perception social richness.
Error bars represent ± 1 SEM.

2.4.3 Discussion

The results suggest that there is no general effect of viewing angle with respect to apparent screen size and immersion. In fact, we did not find any significant differences that were explained by viewing distance. However, the model tended to work even better with the

larger visual angle. We can also conclude that by using a cinema model, a visual cinema experience can be modeled that leads to the same amount of immersion as the real cinema. These findings stress the importance of contextual cues on movie perception, and show that the model can serve as a surrogate of the physical context, leading to a similar quality of the visual experience.

2.5 Experiment 3

The main aim of our third experiment was to systematically cross visual angle with screen size to disentangle their potential effects.

2.5.1 Method

Eighty-one psychology students of the University of Mainz (60 female, 21 male; mean age = 23.16 years) participated in this study in exchange for partial course credit. Due to technical problems during testing, one female participant was excluded from the analyses.

We crossed two viewing conditions with two viewing distances in a between-subjects design. The first viewing condition featured the same cinema model already used in Experiments 1 and 2. The second condition used an additional cinema model at the scale of 1:100. The new model had the same looks and properties as the larger cinema model (scale 1:16). For the screen of the smaller cinema model we used an iPhone 5s with a 4 inch screen (5.16 x 9.025 cm). Each participant was randomly assigned to one of four conditions: The stimuli were exhibited at a viewing angle (horizontal screen width) of either 25° or 80° for each of the cinema models (iPhone and monitor). To accommodate the lower resolution of the smartphone screen, we played the movie with 720p (HD) in all conditions.

The methods while viewing the movie were similar to those of Experiment 2. After obtaining informed consent, participants were led into the laboratory, blindfolded, and helped to sit down in an armchair. In Condition 1, featuring the larger model cinema, the procedure of Experiment 2 was repeated. In the second condition (miniature model), the experimenter placed the smartphone into a holder mounted in front of the participants, which was fixed to the arm chair. The miniature cinema model was likewise attached to the holder. The whole construction was designed to provide the same comfort and viewing angle as Condition 1, while also ensuring that the visual angles were the same. In both conditions a head cushion was used to limit participants' head movements.

After watching the movie clip, participants were asked to fill in the same questionnaire already used in Experiment 2. We added one additional question on immersion to validate our immersion scale, which was as follows: "Immersion is defined by completely being absorbed by the story and not noticing your surroundings. How strong was your feeling of immersion?" The answer options were on the same Likert-like scale from 1 - 7, with 1 being the lowest and 7 being the highest possible rating (see also Troscianko et al., 2012).

2.5.2 Results

Using Pillai's trace, there was no significant effect of Condition, $F(1, 38) = 1.76$, $p = .075$, $\eta_p^2 = .25$, Viewing distance, $F(1, 38) = .84$, $p = .61$, $\eta_p^2 = .14$, or the interaction of the two, $F(3, 36) = .63$, $p = .81$, $\eta_p^2 = .11$. However, there was a trend for the larger screen to produce more immersion ($M = 4.49$, $SD = 0.14$) than the small screen ($M = 3.95$, $SD = 0.13$). The smartphone screen was overestimated in width by 50% compared to the monitor which was overestimated by 11%.

To validate the immersion scale, we correlated the immersion ratings with the direct immersion question. There was a significant relationship between the two, with $r = .61$, $p < .001$. To test whether immersion is dependent on apparent screen size, we correlated the immersion scale with participants' screen size estimations. Screen width and height were both significantly and positively correlated with immersion, $r = .36$, $p = .001$ and $r = .37$, $p = .001$ respectively.

2.5.3 Discussion

The results of Experiment 3 support the findings of the previous experiment. Viewing angle does not explain any group differences. Sitting close to the screen does not make it seem bigger, nor does it make the experience more immersive. Moreover, we did not find any

significant differences between the screen sizes, however, there was a trend: The bigger the screen, the more immersive the experience.

2.6 General Discussion

Three conclusions can be drawn from our experiments. Firstly, our results are inconsistent with the idea that viewing angle is responsible for the higher degree of immersion that is often attributed to movie theaters. In our experiments, the best predictor for immersion was the presence or absence of context information that indicated movie theater experience. Secondly, actual screen size played a favorable role for immersion when controlling for viewing angle. Previous studies might have missed the effect of pure screen size because the size difference between the compared screens had not been large enough. Thirdly, the effect of screen size can be overridden when adding appropriate context information to the smaller screen. Under these conditions the smaller screen was as immersive as the large silver screen.

A potentially contributing factor to the increased immersion in the case of the model may be that the cinema model was novel for most subjects, and greater novelty is known to produce increased arousal (Pratto, John, & Kim, 1997) which in turn might lead to more immersion (Troscianko, Meese, & Hinde, 2012). Future studies might test how sizable such novelty effects may be.

In summary, our data support the surround hypothesis. The surround provided by the cinema model produced a significant overestimation of screen size and led to deeper immersion. The effects were more stable in a within-group than in a between-group design. Other variables, such as elicited emotions and memory, were hardly affected by the surround.

3. GENRE-DEPENDENT EFFECTS OF 3D FILM ON PRESENCE, MOTION SICKNESS, AND PROTAGONIST PERCEPTION[3]

3.1 Abstract

Do the increasingly popular 3D movies change how we perceive the content of the movie? We presented short (3.21 min) film sequences to observers equipped with shutter glasses. Three genres (horror, action, and documentary) were crossed with three between-subjects viewing conditions (director's 3D, artificial 3D, and 2D). Observers had to rate how the film impressed them in terms of arousal, motion sickness, presence, and immersion. They also judged the personality, attractiveness, and intelligence of the protagonist in all viewing conditions. Not surprisingly, horror films produced more arousal and presence than action films. Documentaries scored lowest on presence. Action movies produced the highest immersion ratings. 2D viewing tended to produce less presence than 3D viewing. Surprisingly, artificial 3D was indistinguishable in terms of presence from the director's 3D. The same was true for motion sickness: 3D viewing, regardless whether intended by the director or introduced artificially, was more nauseating than 2D viewing. We also found a genre effect regarding the impression of the protagonist, the latter was more agreeable in documentaries presented in 2D. The same protagonist was judged to be less extroverted and weighing more when viewed in director's 3D. We conclude that 3D film has complex effects that interact with the film genre. Directors should consider these interactions when planning to produce a 3D movie.

3.2 Introduction

With the rise of 3D movies and 3D TV, several questions arise. Supporters of this technology argue that 3D viewing produces a whole new level of immersion while critics are

[3] Paper published as Baranowski, A.M. et al. (2016). Genre-dependent effects of 3D film on presence, motion sickness, and protagonist perception. *Displays, 44,* 53-59.

concerned with the health-related issues this technology might cause. Both, advantages and disadvantages have been studied in recent years (see e.g. Read, & Bohr, 2014). Two issues have been largely ignored in the scientific literature, the interaction of genre with 3D technology and the perceptual difference between director's 3D (movies that are shot with two cameras and merged to one film) and artificial 3D (movies that are shot with one camera and later converted into 3D in post-production). We first spell out how these two issues might affect the viewer directly, for instance producing more visual discomfort or presence, and then outline how they might affect the viewers' evaluation of the movie, making it more likeable or more annoying. We then report an extensive experiment that shows how film genre and viewing mode interact with regard to effects on the viewer and the viewer's perception of movie content.

3.2.1 Effects on the viewer

One of the biggest problems associated with 3D movies is that prolonged viewing may cause visual discomfort. Carrier, Rab, and Vasquez (2011) found that 3D movie viewers were almost three times more likely to experience headaches and over four times more likely to experience eyestrain than did 2D movie viewers, when watching a feature length movie in a theater. The most common complaints related to 3D movies have been nausea, visually induced motion sickness (VIMS), headaches, and eyestrain (Keshavarz, & Hecht, 2012; Read, & Bohr, 2014; Solimini, 2013; Solimini, Mannocci, Di Thiene, & La Torre, 2012; Yang et al., 2012). Lambooij, IJsselsteijn, Fortuin, & Heynderickx (2009) identified three factors that may cause visual discomfort: (1) changing demands on accommodation-vergence linkage over time, which might be caused by fast movement; (2) three-dimensional artifacts resulting from inadequate depth information, which produce spatial and temporal inconsistencies, for instance conflicts between depth cues and geometrical distortions; and (3) an unnatural amount of blur, leading to ambiguous depth percepts. Particularly the last factor points toward

a problem with automated 2D-to-3D conversion, which might result in a surplus of blur. In another study, Kooi and Toet (2004) found that visual discomfort increases with errors in stereo presentation. Both studies indicate that artificial 3D might increase visual discomfort, which is already higher in director's 3D than in 2D (Solimini, 2013).

While 3D movies have been associated with visual discomfort, they have also been linked to a heightened feeling of presence in some studies (IJsselsteijn, de Ridder, Hamberg, Bouwhuis, & Freeman, 1998; Read, & Bohr, 2014; Yang et al., 2012). Presence itself is a very heterogeneous concept. In the context of movies it is usually used to describe a feeling of how much the consumer is „lost" in the movie or experiences a sense of „being there". For further discussion of the concept see Lombard and Ditton (1997). Other factors like memory, attention, or elicited emotions seem not to be affected by 3D-presentations (Bombeke, van Looy, Szmalec, & Duyck, 2013; Bride et al., 2014; Carrier, Rab, Rosen, Vasquez, & Cheever, 2012; Ji, Tanca, & Janicke, 2013).

Few studies have investigated the effect of genre on 3D movies. Ji und Lee (2014), for example, discovered that 3D documentaries produced higher levels of narrative engagement and 3D action movies engendered more enjoyment and presence, compared to their 2D counterparts. A further study by Janicke and Ellis (2013) found that sports content in 3D led to higher enjoyment, but this was not so in a movie trailer. In contrast, Rooney and Hennessy (2013) found higher levels of perceived apparent reality related to 3D but observed no significant group differences in attention, emotional arousal or satisfaction for the fantasy movie *Thor* (2011). However, data where obtained by questioning movie goers after they had left the cinema and not in a laboratory setting. These findings indicate that 3D movies produce genre specific effects on the subjective experience of movie goers. These were movies originally produced with 3D technology involving two cameras (or a stereo camera with two lenses). We refer to this technology as director's 3D.

3.2.2 Protagonist perception

In this study, we focused on the perception of the protagonist in three particular genres: action movies, horror movies, and documentaries. This choice was, in part, motivated by a pre-study in which we tested 175 subjects who saw a documentary, a dance film, and two short stories either in 2D or in director's 3D (Wandmacher, 2014). We found that 3D produced higher presence ratings except for the documentary. We also found that subjects liked the documentary in the 2D version just as well as in the 3D version. In contrast, subjects preferred the 3D over the 2D versions of the short stories. One problem we encountered was that we used custom-made movies (in co-operation with a local film school Rhein-Main Hochschule; Zeitbasierte Medien), some of which received only moderate presence ratings. To minimize such potential floor effects, we have decided to use mainstream movies made with the intent to please large audiences.

One factor that might contribute to a feeling of general discomfort when watching 3D movies is perceptual impact of binocular disparity. The differences between the two retinal images contribute decisively to depth perception at close range in so-called personal space (see e.g. Grüsser, 1983; Hecht, Koenderink, van Doorn, 1999; Howard & Rogers, 1995). With the introduction of sizable disparity, observers are likely to experience objects as closer than in 2D viewing, where such disparity is absent. This feeling of proximity to the events on screen may in turn generate more presence. For instance, Wilcox, Allison, Elfassy, and Grelik (2006) asked subjects to rate their level of comfort in response to objects and people in a stereoscopic projection and in real life. They found that observers showed the same strong negative reactions to violations of their personal space in 3D as in the natural environment. This effect translates to movies and is amplified when movie protagonists are filmed at close range (Bryan, Perona, & Adolphs, 2012).

Almost no studies exist that compare the impressions made by protagonists as a function of 2D vs. 3D viewing. This is surprising given how important it is to evaluate such

potential 3D effects. Not only movies but also teleconferences or even private telephone conversations of the future are very likely to be held in stereoscopic projection. One reason could be that most experts to not expect significant differences here because such differences have not been found in direct communication settings. One study that supports this suspicion is by Hauber, Cockburn, Billinghurst, and Regenbrecht (2012). The authors compared conferences either transmitted in 2D, 3D, or in real life. They found that real life conferences were preferred to video conferences but did not find significant differences between 2D and 3D videos except for social presence. Conference calls in 2D were just as warm, personal, sensitive, sociable, pleasant, formal, and positive as in 3D. 3D may play a very different role when watching movies, and we thus investigated if stereoscopic viewing makes a difference in this domain.

3.2.3 The current study

We conducted a 3x3 mixed design with the within factor genre (action, horror, documentation) and the between factor viewing condition (director's 3D, artificial 3D, 2D). We expected the artificial 3D condition, which merely doubled each frame with a slight offset between the eyes, to produce the highest amount of visual discomfort, operationalized as visually induced motion sickness, followed by director's 3D and 2D. We also assumed that horror movies would produce the highest amount of visual discomfort, because of the disgust and arousal they should produce. We further expected artificial and director's 3D to produce a higher amount of presence and immersion, compared to 2D presentations.

Concerning the protagonist perception, we were concerned that ratings might involve deliberations about viewing modalities and introduced a task in which subjects had to assume a comfortable distance to the picture of the protagonist. They should prefer a larger distance in the director's 3D, compared to the 2D condition if 3D moves the protagonist perceptually closer. Based on our preliminary findings, we also expected the subjects to prefer a larger

distance in documentaries, compared to action and horror movies. We thought that a higher presence in the 3D version would also lead to a higher identification with the protagonists, which in turn should result in more favorable personality ratings. The stereo presentation should further result in a more intense experience which in turn might let the protagonist appear more intense, as operationalized with ratings of body height, weight, and attractiveness.

3.3 Methods

3.3.1 Participants

One hundred and eight (84 female and 24 male) psychology students participated in the experiment in exchange for partial course credit. Mean age was 25.11 (*SD* = 8.08) years. We only used subjects with self-reported normal or corrected-to-normal vision.

3.3.2 Film selection

We selected 6 popular movie clips that were all shot in director's 3D based on their genre. We used two action movies (Gravity, 2013; The Amazing Spiderman, 2012), two horror movies with splatter elements (Final Destination 5, 2011; One Way Trip, 2011), and two documentaries (Pina, 2011; Die Huberbuam, 2012). Of each movie a 3.21 min. scene was chosen, which was representative for the genre. We deliberately chose short scenes in order to present several movie clips representing different genres within subjects in one session. We know that 3-minute sequences are sufficient to induce a representative level of visual discomfort (Keshavarz & Hecht, 2012). Moreover, the same study has shown that longer exposure to 3D movies raises the visual discomfort, thus increasing the risk of participant drop-out. Any effects of 3D on visual fatigue found with short exposure times would therefore potentially underestimate the effects, making them more likely in full length movies. The 2D and 3D versions of the films were readily available. The artificial 3D version was produced by duplicating the 2D image and moving both seven pixels (horizontal visual angle

0.34°) apart. We used the commercial software Leawo Video Converter, which uses similar algorithms for 2D to 3D converting like those found in modern 3D TV.

3.3.3 Effect on the viewer

To assess the severity of VIMS in each condition, we used the Fast Motion Sickness Scale (FMS; Keshavarz & Hecht, 2011). The FMS consists of verbal ratings ranging from zero (no sickness at all) to 20 (frank sickness). FMS scores were acquired 3 times during each trial; once each before stimulus exposure, during the exposure at 1.40 min., and right after the testing. Then, we asked subjects to rate presence (0 = no presence, 20 = complete presence), immersion (0 = not realistic, 20 = extremely realistic), and vection (0 = no traction, 20 = clear feeling of traction) on a comparable scale. Note that we explained presence in terms of the feeling of being there, whereas immersion was taken to refer to the technical sophistication of the 3D impressions and effects. We did not use further behavioral measures, such as posturography, because they are too unspecific to differentiate between VIMS (e.g. Riccio & Stoffregen, 1991) and presence (e.g. Tossavainen et al., 2001). To assess arousal, we used the Self-Assessment Manikin scale (SAM; Bradley & Lang, 1994). After each movie scene subjects filled out the SAM on a scale from 1 (calm) to 9 (aroused).

3.3.4 Protagonist perception

To assess personality aspects of the main character, the short Big-Five-Inventory-10 (Rammstedt & John, 2007) was used. The BFI-10 consists of 10 questions, two for each personality factor (extraversion, neuroticism, openness, conscientiousness, and agreeableness). After each film clip, subjects filled out the BFI-10, judging the personality of the protagonist. They further rated his/her sympathy and attractiveness on a scale from 1 (not at all) to 5 (very high). Subjects were also asked to estimate the protagonists' size, weight, and IQ (IQ = 100 being average). After filling out the questionnaire, we instructed the subjects to imagine they

were to meet the protagonist of the movie on the street and would ask him/her for directions. They then approached as closely towards a DinA4 picture of the main actors' head, as they would do in real life. The picture was always hung at the eye level of the subject. This measure of interpersonal distance was taken from the picture to the center of the subject's head.

3.3.5 Procedure

Each subject saw all genres (6 movies) in different orders, but only one viewing condition. The average rating for the two films per condition was then used for further analysis. Each viewing condition was seen by 36 subjects.

Upon arrival in the laboratory, subjects were seated 1.75 meters (horizontal viewing angle 60°) from the screen (1.06 m tall and 1.90 m wide) (Figure 4). The distance (and therewith the viewing angle) was chosen, because previous studies indicated that smaller (e.g. Wu, 2011) and larger viewing angles (e.g. Baranowski & Hecht, 2014) lead to a lower level of presence, which in turn might have distorted our results. We always tested three subjects together. We recorded the position of each subject and later controlled for position effects by testing position as independent variable against the dependent variables. No effect for position was found. Subjects first received a written description of the experiment and then gave informed consent. They were told that they could close their eyes and stop the experiment at any time without giving a reason, but no subject exercised this option. The film clips were shown in random order and the light was switched off during the movie presentation. Five seconds after each movie scene had finished, ambient light was switched on and subjects filled in the rating scales and were tested for interpersonal distance. Subjects had to wear 3D shutter glasses (Crystal Eyes 3 Stereo 3DTM Eyewear, Stereo Graphics®) during all conditions, including the 2D condition, to control for potential effects produced by the glasses.

All movie clips were shown in 16:9 with a resolution of 1280 x 720 pixels. The entire experiment lasted about 75 minutes.

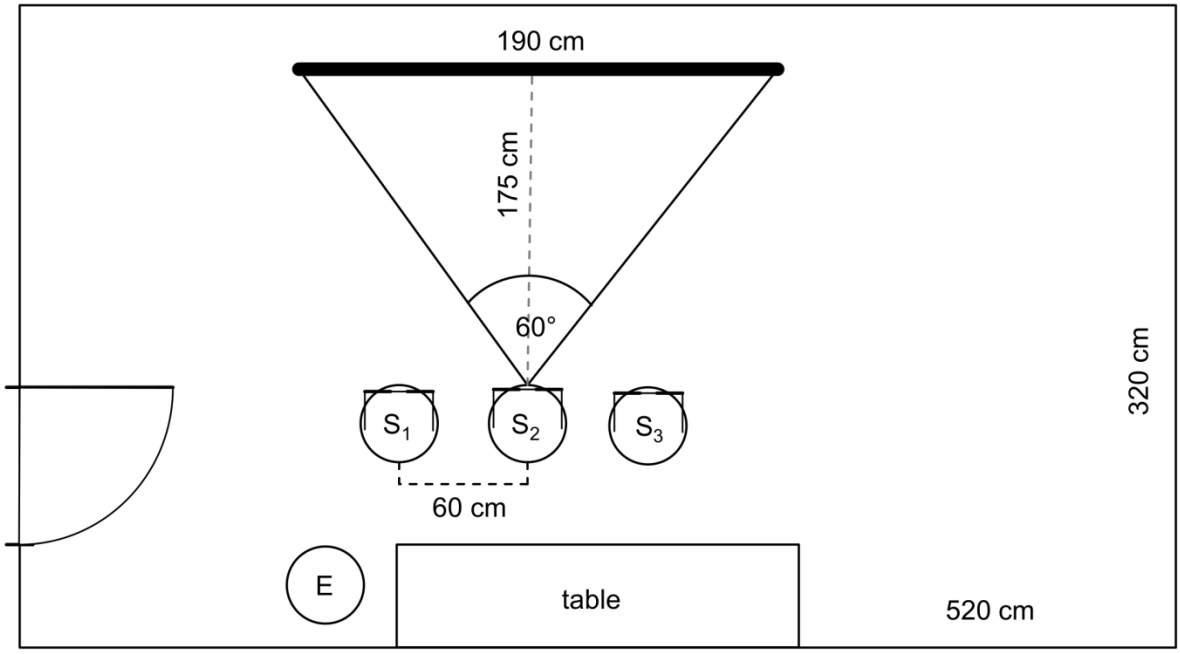

Figure 4. Set-up of the experiment. Three subjects were testes simultaneously. Note that subjects wore shutter glasses during all conditions, including 2D presentation.
E = experimenter, S = subject.

3.4 Results

We performed a 3 x 3 mixed design MANOVA, with the between-subjects variable **viewing condition** (2D, artificial 3D, director's 3D) and the within-subjects variables **genre** (action movie, horror movie, documentary). The dependent variables consisted of scales for VIMS and the perception of the protagonists, and were analyzed separately.

3.4.1 Effect on the viewer

A Pillai-trace test indicated significant main effects of genre, $F(10, 96) = 48.73$, $p < .001$, $\eta p^2 = .84$, and viewing condition, $F(10, 204) = 3.17$, $p < .001$, $\eta p^2 = .13$, as well as

an interaction between them, $F(20, 194) = 1.68$, $p = .039$, $\eta p^2 = .15$. A univariate test of the genre, using Greenhouse-Geisser correction for unequal sphericity, revealed that all dependent variables differed significantly between genres. We further used contrast analysis to see, which conditions exactly differed from each other. When all three conditions differed significantly from each other, we only report the main effect for better readability.

We found that horror movies ($M = 5.18$, $SD = 3.00$) produced significantly more VIMS than action movies ($M = 3.35$ $SD = 2.45$), which in turn produced more VIMS than documentaries ($M = 2.48$, $SD = 2.38$), $F(1.62, 172.99) = 130.51$, $p < .001$, $\eta_p^2 = .55$. Horror movies ($M = 5.70$, $SD = 1.76$) also lead to the highest arousal, followed by action movies ($M = 4.44$, $SD = 1.62$), and documentaries ($M = 3.48$, $SD = 1.37$), $F(1.81, 195.65) = 117.87$, $p < .001$, $\eta_p^2 = .53$. Action movies were more immersive ($M = 11.85$, $SD = 3.31$) than horror movies ($M = 8.48$, $SD = 3.48$), which were more immersive than documentaries ($M = 6.47$, $SD = 3.49$), $F(1.92, 202.39) = 85.59$, $p < .001$, $\eta_p^2 = .45$. Action movies also produced the highest values of vection ($M = 4.47$, $SD = 3.60$), followed by horror movies ($M = 2.07$, $SD = 2.70$), and documentaries ($M = 1.28$, $SD = 1.99$), $F(1.76, 190.08) = 60.00$, $p < .001$, $\eta_p^2 = .36$. Horror movies ($M = 10.59$, $SD = 3.95$) and action movies ($M = 10.33$, $SD = 3.68$) did not differ in their presence ratings ($F(1, 107) = 7.52$, $p = .488$, $\eta_p^2 = .01$), but both were significantly higher those for documentaries ($M = 6.47$, $SD = 3.49$), $F(1.85, 196.51) = 53.21$, $p < .001$, $\eta_p^2 = .34$ (Figure 5).

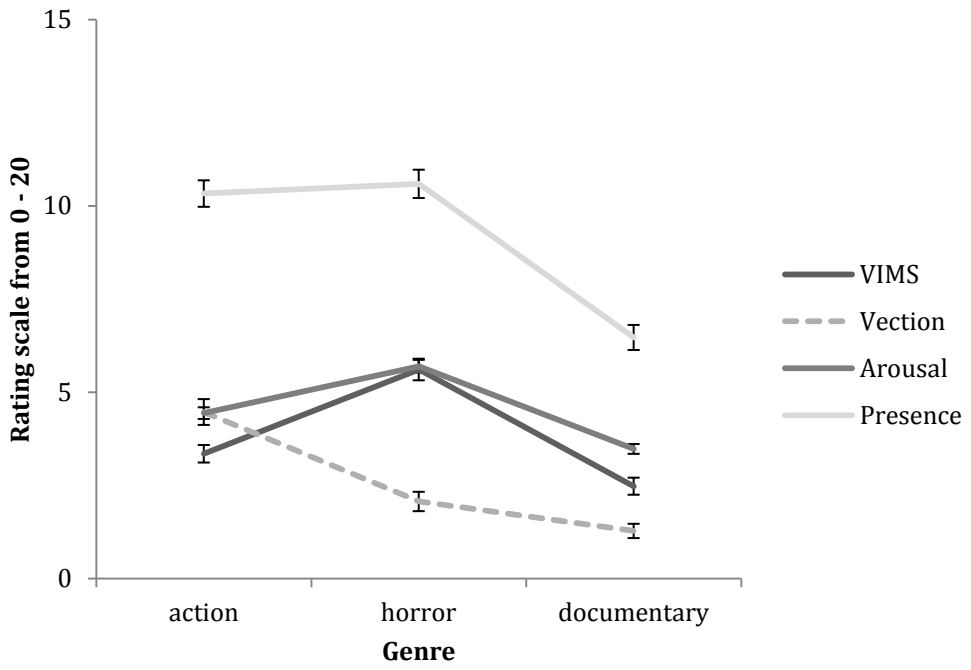

Figure 5. Ratings of VIMS, vection, arousal, and presence. All ratings were given from 0- 20, except for arousal, which was rated on the SAM scale from 1 - 9.

Error bars indicate SEM.

Using a one-way MANOVA with the independent variable viewing condition (2D, artifical 3D, director's 3D) we found a significant differences for the dependent variable VIMS and immersion. Post hoc analyses were performed using the Scheffé tests with $p < .05$ to identify exactly where significant differences exist. We found that overall artifical 3D ($M = 4.81$, $SD = 2.12$) and director's 3D ($M = 3.98$, $SD = 2.44$), produced significantly more VIMS than did the 2D condition ($M = 2.65$, $SD = 1.95$), $F(2, 107) = 9.00$, $p < .001$, $\eta_p^2 = .15$. The artificial 3D condition also produced higher presence ($M = 9.99$, $SD = 2.28$) than the 2D condition ($M = 8.59$, $SD = 2.50$); the director's 3D condition ($M = 8.79$, $SD = 2.69$) did not differ from either, $F(2, 107) = 3.29$, $p = .041$, $\eta_p^2 = .06$. We further found an interactive effect on of genre and viewing condition for immersion, $F(4, 105) = 2.90$, $p = .025$, $\eta_p^2 = .05$ (Figure 6).

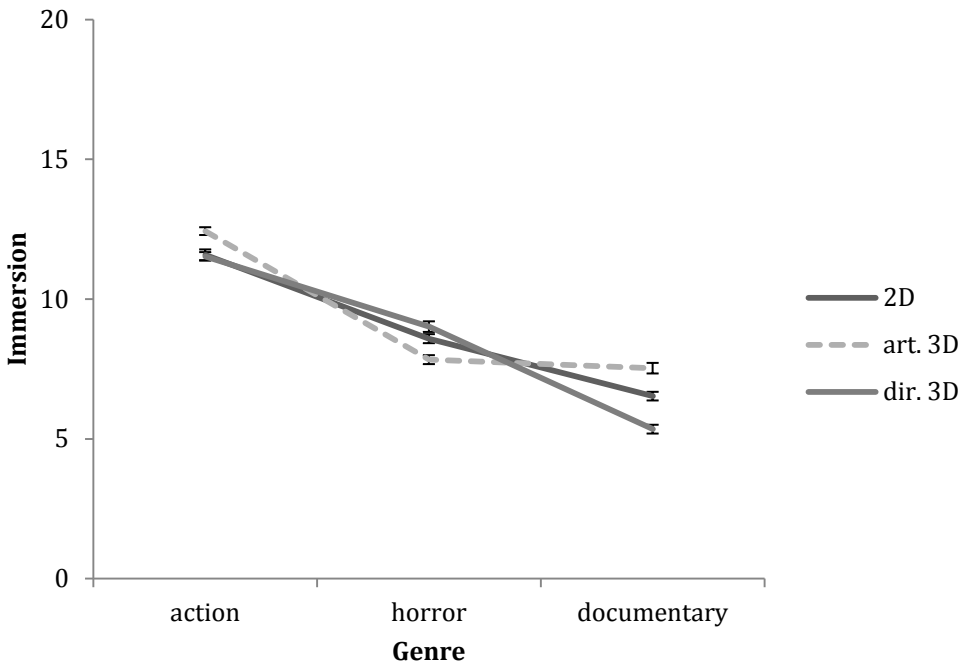

Figure 6. Interaction between genre and viewing condition for immersion. 2D and artificial 3D worked better for action movies and documentaries while director's 3D worked best for horror movies.

Error bars indicate SEM.

3.4.2 Perception of the Protagonist

A Pillai-trace test found significant main effects of genre, $F(24, 80) = 51.99$, $p < .001$, $\eta p^2 = .94$, but not the viewing condition, $F(24, 186) = 1.45$, $p = .091$, $\eta p^2 = .16$, or the interaction between the two, $F(48, 162) = 0.97$, $p = .524$, $\eta p^2 = .22$. A univariate test of the genre, using Greenhouse-Geisser correction for unequal sphericity, revealed that the dependent variables of the protagonist's neuroticism, openness, conscientiousness, interpersonal distance, sympathy, attractiveness, IQ, height, and weight differed significantly between genres (Table *2*).

Table 2

*Effects of genre on the dependent variables. Significant differences between two or more groups are marked with * (p < .001); n = 108*

Variable	*df*	error *df*	*F*	*p*	η_p^2
Neuroticism	1.77	186.08	292.67	< .001*	.73
Extraversion	1.73	181.79	1.28	< .277*	.01
Openness	1.98	208.08	42.87	< .001*	.29
Agreeableness	1.96	205.82	0.87	< .416*	.00
Conscientiousness	1.96	205.91	164.16	< .001*	.61
Interp. Distance	1.89	198.90	33.90	< .001*	.24
Sympathy	1.94	203.93	24.11	< .001*	.18
Attractiveness	1.81	190.96	86.23	< .001*	.45
IQ	1.74	183.52	88.61	< .001*	.45
Height	1.99	209.91	101.61	< .001*	.49
Weight	1.95	204.99	45.60	< .001*	.30
Length	1.94	204.31	1.12	< .325*	.01

A contrast analysis of the genre revealed that subjects found the protagonists in horror movies to be more neuroticistic (M = 3.87, SD = 0.74) than in action movies (M = 2.68, SD = 0.60), and both more so than in documentaries (M = 1.96, SD = 0.46), with $F(1, 105) = 220.41$, $p < .001$, $\eta_p^2 = .67$, and $F(1, 105) = 119.15$, $p < .001$, $\eta_p^2 = .53$, respectively. Subjects also found the protagonists in action movies the most likeable (M = 3.81, SD = 0.65), attractive (M = 3.64, SD = 0.78), and intelligent (M = 116.22,

SD = 8.94), followed by horror movies (M_{lik} = 3.38, SD_{lik} = 0.67, M_{att} = 3.27, SD_{att} = 0.69, and M_{IQ} = 104.09, SD_{IQ} = 7.76), $F(1, 105) = 24.05$, $p < .001$, $\eta_p^2 = .19$, $F(1, 105) = 17.46$, $p < .001$, $\eta_p^2 = .14$, $F(1, 105) = 170.46$, $p < .001$, $\eta_p^2 = .62$, and documentaries (M_{lik} = 3.17, SD_{lik} = 0.78, M_{att} = 2.41, SD_{att} = 0.75 and M_{IQ} = 108.43, SD_{IQ} = 8.63), $F(1, 105) = 40.20$, $p < .001$, $\eta_p^2 = .28$, $F(1, 105) = 124.48$, $p < .001$, $\eta_p^2 = .52$, $F(1, 105) = 53.85$, $p < .001$, $\eta_p^2 = .34$. Documentaries produced higher openness ratings (M = 4.00, SD = 0.54) than action movies (M = 3.53, SD = 0.60), $F(1, 105) = 49.29$, $p < .001$, $\eta_p^2 = .32$, or horror movies (M = 3.49, SD = 0.51), $F(1, 105) = 71.02$, $p < .001$, $\eta_p^2 = .40$. The main characters in the documentaries were rated as more conscientious (M = 4.49, SD = 0.44) than in action movies (M = 4.31, SD = 0.53), $F(1, 105) = 9.81$, $p = .002$, $\eta_p^2 = .09$, who in turn were rated more conscientious than in those in horror movies (M = 3.49, SD = 0.53), $F(1, 105) = 184.70$, $p < .001$, $\eta_p^2 = .64$ (Figure 7).

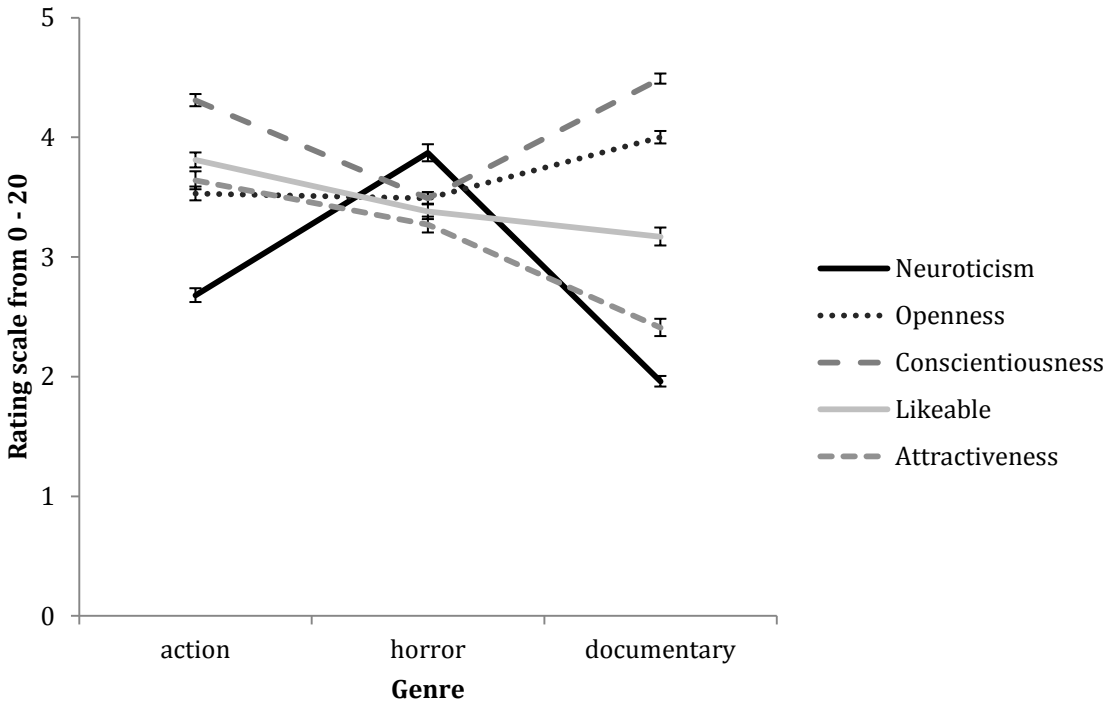

Figure 7. Ratings of neuroticism, openness, conscientiousness, likeable, and attractiveness. Error bars indicate SEM.

Also, documentaries produced the highest values for interpersonal distance (M = 87.81 cm, SD = 21.98 cm), compared to horror movies, (M = 82.42 cm, SD = 20.17 cm), $F(1, 105) = 23.91$, $p < .001$, $\eta_p^2 = .19$, which produced higher values than action movies (M = 78.42 cm, SD = 20.72 cm), $F(1, 105) = 14.50$, $p < .001$, $\eta_p^2 = .12$. The main actors in documentaries were also estimated to be taller (M = 178.19 cm, SD = 3.83 cm) and heavier (M = 70.95 kg, SD = 5.58 kg) than the actors in action movies (M = 174.67 cm, SD = 3.74 cm, and M = 67.24 kg, SD = 3.85 kg), with $F(1, 105) = 76.34$, $p < .001$, $\eta_p^2 = .42$, and $F(1, 105) = 54.19$, $p < .001$, $\eta_p^2 = .34$, respectively, and horror movies (M = 172.49 cm, SD = 3.10 cm, and M = 66.91 kg, SD = 4.04 kg), with $F(1, 105) = 203.02$, $p < .001$, $\eta_p^2 = .66$, and $F(1, 105) = 77.91$, $p < .001$, $\eta_p^2 = .43$, respectively.

3.5 Discussion

In accordance with our hypothesis, we found that horror movies produced the highest amount of discomfort (VIMS). We also found that 3D movies produced overall more presence than 2D movies. We did, however, not find a difference between artificial and director's 3D. This is surprising given the amount of sophistication and money that goes into producing 3D movies. The straight-forward algorithm used to transform 2D into 3D images created impossible retinal disparities. Disparity-selective neurons in the V1 and V2, which are tuned for absolute disparity (Tsutsui, Taira, & Sakata, 2004), might show roughly comparable firing rates for director's and artificial 3D. However, disparity-selective neurons in V4 and the middle temporal visual area (MT or V5) are tuned to relative disparity. In director's 3D, the relative disparity mimics real life vision with no disparity at the fixation point and strong disparity at locations behind or in front of this point. Additionally, disparity crosses at the fixation point, features not present at artificial 3D. Instead the disparity is the same at any given point in the picture, which should be reflected in neurons in V4 and MT. Nonetheless, the visual system did not complain any more than it did with director's 3D. This may betray the

quality of 3D technology or the tolerance of the visual system. Be this as it may, compared to director's 3D, the artificial 3D did not add any visual discomfort in the viewer.

Our data indicate that action movies produced the highest level of immersion and vection while they did not differ from horror movies in their generation of presence. This is easy to explain when looking at the budget spent for each genre. Our action movies had an average production cost of roughly 165 Mio. US-Dollars, the horror movies of roughly 20 Mio. US-Dollars, and the documentaries of roughly 2 Mio. US-Dollars (IMDb, 2015). This is representative for the industry, with most money spent on action movies and least on documentaries. Under these circumstances, action movies should be technologically most advanced, which would be reflected in more immersion and vection. Presence, in contrast, is more dependent on the story than on technology and both, action and horror movies, had an exciting story line that was more captivating than the documentaries.

We also found a significant interaction between genre and viewing condition for the dependent variable immersion. Horror movies produced the highest immersion with director's 3D and the lowest with artificial 3D, but the ratings were reversed for documentaries. This is hard to explain since there was no difference for most measures between artificial and director's 3D. We suspect that this difference can be attributed to the ratings of the climbing documentary. It included shots of mountains with a separation between the two cameras of up to 10 meters. This makes the mountains look like a toy scenery (similar to the tilt shift technique in 2D) and reduces the realism of a scene. The artificial 3D did not include such large discrepancies and made the documentary more immersive. This is speculative, however, and we would need more stimuli to back up such a claim.

Protagonists were perceived as more attractive, likeable, and intelligent in the action movies, compared to the horror movies, which in turn produced higher ratings than documentaries. This is in line with the budget spent making the movies and hiring attractive actors.

Attractiveness ratings also correlated with perception of intelligence and likeability (Dion, Berscheid, Walster, 1972; Kleisner, Chvátalová, & Flegr, 2014) in previous studies.

Our data suggest that protagonists are seen as more conscientious in documentaries than in horror movies, with the action movies lying somewhere in-between. However, the ratings for neuroticism were reversed. The main characters in horror movies were perceived as more neurotic than in action movies or documentaries. This can be probably explained by the different plots. Whereas the protagonists in the documentaries were in control and obviously knew what they were doing, the protagonists in the horror movies were portrayed as poorly prepared and in distress. The main characters in the action movies were shown in scenes were they had to overcome obstacles that were challenging and in part out of their control, making them seems less conscientious and more neurotic.

As expected, we found that subjects preferred larger interpersonal distances in documentaries, compared to action and horror movies. We assume that this is because documentaries are already quite realistic and subjects want to keep some distance to not be overwhelmed by the experience. Additionally, we found that protagonists in documentaries are perceived as least attractive, which also correlates with interpersonal distance (Langlois et al., 2000). Contrary to our hypotheses, there was no effect of stereopsis on the perception of the protagonists. We only found a non-significant trend for protagonists in 2D movies to be more agreeable than in 3D. Considering that subjects prefer a larger interpersonal distance in documentaries, we recommend avoiding stereopsis when producing person-centered documentations.

We conclude that 3D viewing has minimal effects on the perception of the protagonist, but considerable effects on the viewer's sensations. Also, artificial and director's 3D were practically indistinguishable for our subjects, which goes against the common wisdom that the stereo-disparity of the eyes has to be correctly reproduced. The visual system appears to be surprisingly tolerant when it comes to fusing the information of the left and the right eye into

a single stereoscopic image. Finally, there were strong genre effects. 3D technology may be helpful for action and horror movies, but this is not the case for documentaries.

PART II

MEMORY AND IMAGINATION

4. THE POLICE CHIEF'S EFFECT: DO VILLAINS BENEFIT FROM FORENSIC TV SERIES?[4]

4.1 Abstract

The *CSI effect* describes the impact of popular crime television series such as *CSI: Crime Scene Investigation* on the public perception. One aspect of the CSI effect, that has not been scientifically researched yet, is the police chief's effect. This phenomenon describes how criminals learn about forensic evidence through these shows and adopt countermeasures to prevent detection. We used multiple approaches to tackle the issue. First, we analyzed crime statistics to see whether crime rates have increased and/or detection has declined since the appearance of CSI. Second, we asked 24 convicted criminals and a control sample about their impression of the usefulness of crime shows for committing a crime. Third, we asked 20 heavy crime series consumers and a control group of non-watchers to slip into the role of a criminal to steal a laptop, and clean a murder crime scene. Last, a sample of 120 representative subjects committed a murder and cleaned up the crime scene on a model scaled 1/25. Taken all experiments together, we did not find supportive evidence for the police chief's effect. We conclude that the police chief's effect is based on fiction, not on facts.

4.2 Introduction

In 2002, Time Magazine published an article on the technological advances in crime fighting (Kluger, 2002). In this article, the author mentions the concern of forensic scientists who fear that the public perception of criminal laboratories is unrealistically shaped by television drama. Kluger also points out the challenges for the, largely jury based, North American legal system. Juries might be compromised by inflated expectations with regard to

[4] Paper submitted as Baranowski, A.M., et al. (submitted). *The police chief's effect: Do villains benefit from forensic TV series?*

forensic evidence, leading to a higher number of acquittals than there would be without forensic television dramas. This was dubbed the CSI effect, after the popular franchise CSI: Crime Scene Investigation. The CSI effect was soon used to describe any effect popular crime series might have on the public, including on criminals, the police, and potential students of forensic sciences (for an overview of the media coverage of the CSI effect, see Cole & Dioso-Villa, 2009).

In this chapter we will investigate whether the CSI effect can be backed up experimentally. We will focus on one aspect that has been dubbed 'police chief's effect', and has not yet been researched. This effect describes the potential pick-up of criminal know-how from forensic television series, which would be a challenge for the crime fighting community. Even though no evidence for this effect has been presented yet, researchers and the media are very credulous of the Police Chief Effect (e.g. Cole & Dioso-Villa, 2009; Sarapin & Sparks, 2015; Cavander & Detusch, 2007). We will first describe the CSI effect and evaluate and challenge the evidence that has been presented thus far. We then report 4 experiments designed to expose the effect.

CSI was first aired in the United States in 2000 and in Europe in 2001 (IMDb, 2013). The original show follows the fictitious entomologist Gil Grissom and his team of criminologists, as they use physical evidence to solve murders in the nightly Las Vegas. The plot is driven by the use of science to find the culprit, rather than the revelation of psychological motive. In doing so, the scientific process is presented as objective and infallible (Allen, 2007). Thus it is not surprising when the writers let the protagonist say things like: „People lie, Professor. The only thing that we can count on is the evidence" (Mendelsohn, Shankar, & Smight, 2009).

Anecdotal evidence suggests that criminal justice television shows have affected people's perception and expectations of the legal system since they first appeared. In fact, each decade seemed to produce its own program-specific effect. Already a century ago fo-

rensic scientists were complaining about what we could call the *Sherlock Holmes effects* (Wolffram, 2013). The public allegedly had skewed expectations on how forensic science was conducted and what it could tell, as a result of Arthur Doyle's famous detective stories. In the 1960s, attorneys complained about the popular crime drama *Perry Mason*, in which a defense attorney always exposed the real culprit in a tense finale, inducing in jurors a „*Perry Mason* syndrome": Particularly attorneys were concerned that jurors no longer expected the prosecutor to prove guilt beyond reasonable doubt but the defense to prove the accused's innocence (Podlas, 2010). In the 1970, Medical Examiner *Quincy* managed to find fingerprints case after case, exaggerating expectations of fingerprint evidence of the jurors. In the 1980s, *Judge Judy* and *Court TV* shaped the expectations of jurors (Harvey & Derkson, 2009). And in the 1990s, *NYPD Blue* and *Law & Order* taught their viewers the *Miranda* rights, which are the right to silence warning given by the United States police to criminal suspects who are in police custody (Steiner, Bauer, & Talwar, 2011). Viewers around the world got so used to hearing the *Miranda* warning, that they expect to hear it when they are interrogated by police, even outside the USA, were different laws might apply (Voigt, 2010). During the last decade, CSI joined a growing list of TV shows that are said to skew the public perception of the legal system.

However, what is new and makes the CSI effect so interesting are the high exposure as well as the social implications. CSI: Las Vegas was listed by Eurodata TV Worldwide as the most watched international dramatic series for five times. In 2012, it reached 63 million viewers, making it the most watched show in all categories worldwide (Bibel, 2012). CSI: Crime Scene Investigation produced two spin-offs, *CSI: Miami* in 2002 and *CSI: New York* in 2004. Together with books, comics, games, and toys the CSI franchise reaches a mass audience. CSI and other crime drama television series proved to be very popular in the last decade. This is attributed in part to the terror attacks on the World Trade Center in 2001 (Allen, 2007). People in the USA might feel they live in a dangerous place and crime shows

give them reassurance that the good will prevail. Together with the success of the original CSI series, this has prompted many similar shows, focusing strongly on the investigative process of the police, such as *Bones*, *Crossing Jordan*, *Criminal Minds*, *Numb3res*, and the *NCSI* franchise.

4.2.1 Evidence of the CSI effect

There are different effects attributed to watching CSI. Cole and Dioso-Villa (2007) have conducted a content analysis of the media coverage of the CSI effect. They found six types of causal claims which they named after the social actors who tended to articulate the supposed effect, with the most prominent being the strong prosecutor's effect, the defendant's effect, and the police chief's effect.

The strong prosecutor's effect is the most worrisome for the jury-based legal system. It describes the impression of some prosecutors that jurors demand to see more forensic evidence in trials, which in turn might lead to more acquittals in the absence of such evidence. In other words, it is suggested that jurors are acquitting more frequently in cases were forensic evidence is lacking than they would, if CSI and similar series did not exist. The weak prosecutor's effect describes the change in prosecutors, not juries' behavior. The claim is that prosecutors question potential jurors about their television viewing habits in voir dire, presenting negative evidence testimony and request legally unnecessary forensic tests. However, while it fits in the media narrative of the CSI effect, it is actually a reaction to the CSI effect, not a causal effect to the series itself.

Experts see the strong prosecutor's effect and the defendant's effect usually as two sides of the same effect, which manifest in more acquittals or more convictions respectively. We will refer to both aspects as the prosecutor's effect, describing that juries are influenced by crime drama series, in any direction. The first study on the prosecutor's effect was conducted by Watkins (2004), who surveyed 53 prosecutors and defense attorneys. A staggering

79% felt that forensic crime dramas created unrealistic expectations in the jury. Also, 73% said they had experienced at least one improper acquittal verdict because of a lack of forensic evidence. Further prosecutor surveys yield similar (Maricopa County Attorney's Office, 2005; Robbers, 2008; Stevens, 2008). The problem with such studies is that they build on a collection of anecdotal evidence, rather than measuring actual juror's behavior and motivation. Prosecutors are likely biased towards attributing an acquittal to the CSI effect rather than, say, insufficiency of the evidence.

In an attempt to measure the jurors' decision-making process directly, Podlas (2005) presented 306 students with a rape trial scenario where forensic evidence was neither provided nor necessary. Students were asked to reach a verdict of guilty or not guilty. Podlas did not find any difference between students who regularly watched crime drama series and students who did not. Both groups reached a „legally correct" not guilty verdict with the same frequency and did not differ significantly in their expectation of forensic evidence. Shelton, Kim, and Barak (2006) surveyed 1027 individuals called to jury duty. Participants were asked about their television viewing habits and presented with various scenarios of criminal cases and charges. They then were asked what evidence they would expect for each case and what verdict they would reach based on the provided evidence. The results indicated some marginal differences between CSI viewers and non-CSI viewers. Participants who frequently watched crime dramas had generally higher expectations for all kinds of evidence, including non-forensic evidence. However, these expectations did not translate into different verdicts. The only significant difference was found for a rape case, where CSI viewers were actually more likely to convict on the basis of eyewitness testimony. In subsequent studies the prosecutor's effect could be refuted. If differences occurred they were only marginal and unsystematic (Call, Cook, Reitzel, &. Mcdougle, 2013; Holmgren & Fordham, 2011; Jenkins, Do, Movshovich, & Schuller, 2008; Okita, 2007; Podlas, 2006; Schweitzer & Saks, 2007; Shelton

et al., 2006; Smith, Stinson, & Patry, 2011). Considering the presented data, we come to the conclusion that the prosecutor's effect is largely a media scare and not present in real data.

Whereas the prosecutor's effect assumes that consumers learn wrong information from forensic series, the police chief's effect postulates that consumers gain correct information. Evidence for the police chief's effect is scarce and an experimental examination still lacking. The impression that a reduction in physical traces found by the police at crime scenes coincides with the rise of forensic TV shows (e.g. Beauregard & Bouchard, 2010; Durnal, 2010) is supported merely by anecdotal evidence and not by hard data. We conducted an exhaustive database search and contacted several crime fighting and statistical agencies but were not able to obtain data on the matter.

In forensic TV series, physical evidence plays a decisive role in solving most cases. A content analysis of the first two seasons (46 episodes) of CSI, conducted by Podlas (2006), did examine the show's presentation of forensic evidence, finding that forensic issues appeared in 85% of the episodes examined. She also found that the most common crimes investigated in the series were murder and rape. Ley, Jankowski, and Brewer (2012) showed that in 86% of a sample of 51 random episodes of CSI, DNA evidence was used by the investigators. Certainly, anybody watching these series should be aware of the danger of leaving DNA or other traces behind.

In real life, the type of crime correlates with how much physical evidence is collected or found. Baskin and Sommers (2010, 2012) found that in 79% of homicide incidents but only in one-third of assault and robbery incidents, physical evidence had been collected, a number close to that found for TV series, Inconsistent with common belief, whether or not forensic evidence was found on the crime scene did not influence outcome of the cases.

In a sample of 222 rape events collected in Canada, Beauregard & Bouchard (2010) could show that most offenders directed their efforts toward protecting their identity, neglecting to either destroy or clean up DNA that could be recovered at the crime scene. Also,

the use of detection avoidance strategies did not increase the offender's chance to escape prosecution. A further study (O'Neal, Decker, Spohn, & Tellis, 2013) of 841 sexual assault complaints found that only 11.7% to 15.6% of offenders used condoms during their assault. This is particularly interesting, when compared to a study by Blackledge (1996), where in 25% of 80 examined cases of sexual assault perpetrators used condoms. It does not seem that the proportion of condom use during sexual assault has changed much over the last 15 years.

These data do not support a police chief's effect. However, the absence of proof is no proof of absence. It might well be that there is less evidence left at crime scenes today than there was 20 years ago. Since there is no systematic study to examine this claim, it is also not possible to dismiss it. The police chief's effect might also work in more subtle ways, and the perpetrators who are not caught might just benefit most from watching forensic crime series.

4.2.2 The present study

Looking at the literature, we can safely assume that there is a negligible, if any, prosecutor's effect. However, it is not possible to deduce whether there is a police chief's effect. In order to shed some light on the matter, we designed four experiments. In the first experiment we looked at crime clearance rates for mayor crimes from before and after CSI was introduced in the USA and Germany. If there was such a strong effect as some have claimed, this should reflect in a drop in the clearance rate. In the second experiment we wanted to know from experts, what they thought of the police chief effect. We therefore asked convicted criminals a variety of questions on the subject. We compared their answers to a sample of students of the German secondary modern school and to university students. In Experiment 3 we asked 20 heavy crime series consumers and a control group of non-watchers to slip into the role of a criminal and to pretend stealing a laptop, and to clean a murder crime scene. If a police chief's effect exists, it should alter how many traces are left at the crime scene. We also tested for forensic awareness with an explicit knowledge test. In the last experiment, we tested

which factor predicted efficient criminal behavior the best. One hundred eight subjects committed a mock crime and were tested for implicit knowledge as a function of age, gender, education, forensic crime series consumption, technical prowess, and personality.

4.3 Experiment 1

4.3.1 Methods

We used linear regression modeling to compare crime clearance rates before and after the first airing of CSI in 2000/2001. If CSI viewership has an educational effect on criminals, there should be a drop in clearance rates. We were aware that crime statistics are influenced by many factors such as socioeconomic changes (e.g. the eastern European expansion of the EU), changes in laws and policy making (e.g. stricter definitions of sexual assault), and changes in statistical measures (e.g. the merger of East and West German crime statistics). However, if there were a significant reduction in crime clearance rates, this might be an indication of the CSI effect at work.

We used the database provided by the German Federal Bureau of investigation (BKA, 2015) and the American Federal Bureau of Investigation (FBI, 2015) for crime clearance rates. Data from 1993 - 2012 were included in the analysis (Figure 8). The independent variable was before and after airing of the pilot of CSI (in the U.S. 2000, in Germany 2001). Dependent variables were the clearance rate of all committed crimes, murder, rape, robbery, and theftFigure 8.

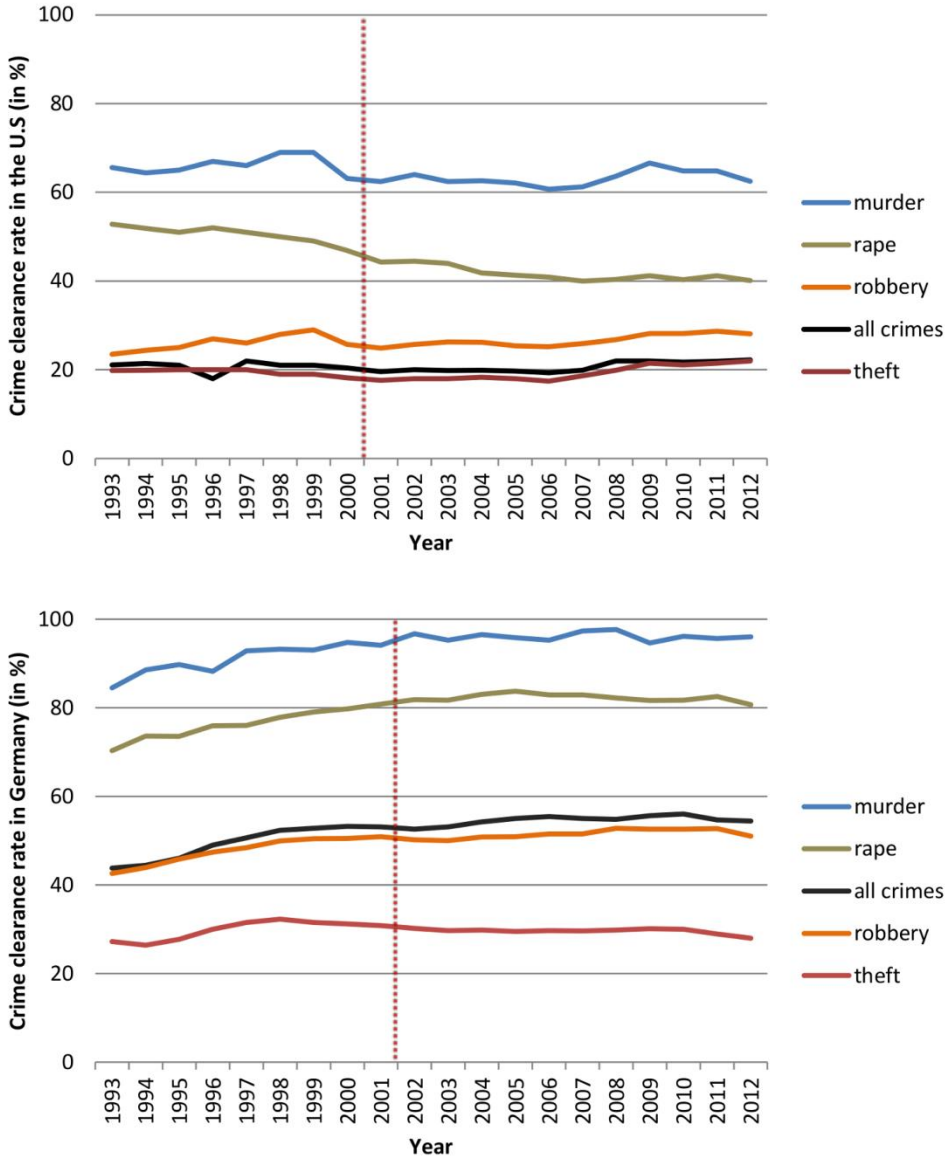

Figure 8. Time series of crime clearance rates in the US and in Germany. The dotted red line indicates the first airing of CSI.

4.3.2 Results

We conducted a linear regression analysis for each dependent variable (Table 1) and found that the clearance rate for murder was significantly lower after the introduction of CSI in the US sample, $F(1, 18) = 7.62$, $p = .013$, $d = 1.38$. The same was true for the rape clearance rate, $F(1, 18) = 76.53$, $p < .001$, $d = 4.38$. Other crime clearance rates did not differ significantly in the US sample. However, in the German sample all clearance rates with the exception of theft increased significantly. The total clearance rate rose with $F(1, 18) = 18.47$,

$p < .001$, $d = 2.16$, murder with $F(1, 18) = 22.66$, $p < .001$, $d = 2.39$, rape with $F(1, 18) = 31.63$, $p < .001$, $d = 2.83$, and robbery with $F(1, 18) = 14.70$, $p < .001$, $d = 1.92$ (Table 3).

Table 3

Results of regression analysis of crime clearance rate in the US and Germany.

	B	*SE B*	β
USA			
Total	-0.15	0.53	.07**
Murder	-2.50	0.91	-.55***
Rape	-8.45	0.97	-.90***
Robbery	-0.85	0.68	.28**
Theft	-0.20	0.64	.08**
Germany			
Total	-5.15	1.19	-.71***
Murder	-5.09	1.07	-.75***
Rape	-5.96	1.06	-.79***
Robbery	-3.75	0.98	-.67***
Theft	-0.27	0.68	-.09***

* $p < .05$, ** $p < .01$, *** $p < .001$

In order for the reduction in murder and rape clearance rate of the US sample to be meaningful, the slope of the curve that describes the rate would have to change rather abruptly after the introduction of CSI. This was, however, not the case: We calculated a *t*-test for independent samples on the slopes. As independent variable we subtracted each year from the previous, using data from 1993 - 2009, which amounts to a first-order time-series analysis.

Murder clearance rates showed a steady decline (M_{befor} = -0.40, SD = 2.66, M_{after} = 0.52, SD = 1.69), which did not continue after the introduction of CSI, $t(14) = -0.83$, $p = .422$, $d = .44$. The same was true for rape clearance rate (M_{befor} = -1.06, SD = 1.05, M_{after} = -0.39, SD = 0.92), $t(14) = -1.36$, $p = .194$, $d = .73$. In other words, the murder clearance rate dropped 0.22 percentage points each year before CSI was first aired, but the reduction reversed to a growth of 0.11 points each year. The rape clearance rate dropped 0.97 percentage points each year before and slowed down to 0.56 points each year after the intervention.

4.3.3 Discussion

The first thing that stands out is the big difference between German and U.S. crime clearance rates and their progression. Bondeson (2009) warns against directly comparing two different crime statistics. Both statistics were obtained from different agencies with different methodologies and within different judicial systems. The countries may also apply different criteria to decide when a crime is cleared. Many factors can affect this decision, including internal policies and practices of recording and reporting crimes. There also exist systematic differences between the two countries. For example, the U.S. are faced with more gang and firearm related homicides. These crimes are particularly hard to solve (Baskin & Sommer, 2010).

In the U.S. we found the hypothesized downwards trend for murder and rape clearance rates after the introduction of CSI, however, only when using large averaging windows. With smaller windows we notice that the downward trend started before the onset of the TV-series and actually slowed down after onset. This means that the introduction of CSI was not the cause of the general trend.

One mayor problem of any study working with official crime statistics are the un-reported case. A large number of crimes go unreported or undetected and never make it into the official statistics. Brinkmann and colleagues (1997) estimated in a large scale study in

Germany that 50% of murders go undetected. They identified as the main reason the low number of autopsies that were conducted (in only 3% of all deaths in Germany). The low number of autopsies persists and is similarly low in the U.S. (5% according to Shojania & Burton, 2008). Consequently, it might well be, that criminals who used knowledge they obtained from forensic crime series do not appear in the official crime statistics because they manage to evade detection.

All this makes the interpretation of the results problematic. To find out if people who watch crime shows make for better criminals, it is necessary to conduct a laboratory experiment. Before doing so, we went to a prison to ask „experts", namely convicted criminals, what they thought of series such as CSI, and their potential to provide useful information about evading prosecution.

4.4 Experiment 2

4.4.1 Methods

Participants

Twenty-four male convicted criminals participated in the study. The control group consisted of 23 students (7 female, 16 male) of a German secondary modern school (Hauptschule), matched for education, and a university student sample (18 female, 12 male). The pupils were on average 16.55 years old (SD = 1.10) while the university students were older (M = 24.90 years, SD = 4.85). For anonymity reasons, the age of the inmates was not collected but all were in their early twenties. The criminals were convicted on charges of violent crimes or drug-related offenses. All subjects participated voluntarily, the university students received partial course credit.

Material

The questionnaire consisted of a 55 questions. Most answer options were ratings from 0 (not at all) to 5 (very much). The first question was „Which means are particularly good for masking ones identity?" with 5 answer options (e.g. face mask, gloves). Next, we asked „Where do you think offenders get their ideas for the measures described above?" (e.g. internet, friends), followed by „In which series does one get the best ideas?" (e.g. CSI, *Dexter*). We then asked „How important are the following measures to avoid leaving behind traces?" (e.g. gloves, cleaning the crime scene) followed by questions about subjects' TV viewing habits. Further questions included their own perceived ability to cover their tracks and the police's ability to track them. We then asked multiple questions about empathy (e.g. „I am easily moved to tears", „I am not interested in other people's problems"; Jackson, 1976) and emotional security (e.g. „I seldom feel blue", „I have frequent mood swings"; Saucier, 1997). Two questions about learning opportunities (e.g. tricks of the police, possibilities of law enforcement agencies) and limits (e.g. unrealistic methods, crime labs are usually overloaded) of the show followed. The questionnaire ended with a knowledge test consisting of 10 true/false questions (e.g. „To evaluate the correct time of death, it is important to assess the quantity of insects on a corpse", „Forensic dentistry is mainly used to assess the identity of a decomposed corpse"). For each question, subjects were asked how sure they were of their respective answer.

Procedure

After obtaining authorization from the Hessian Ministry of Justice, 24 inmates were questioned in a prison for male young adult offenders (18 - 24 years) in Germany in the summer of 2013. Convicts were selected by prison staff based on the level of education. Inmates were on their way or had already completed the compulsory basic secondary schooling.

Prisoners were questioned in three groups. After obtaining informed consent, they received the questionnaire and were asked to fill it in. They had the chance to ask questions throughout the entire experiment. Two researchers and one staff member were present during the whole procedure. After the questioning was finished, the purpose of the experiment was fully disclosed. Subjects were debriefed and had the opportunity to withdraw their consent. Nobody chose to exercise this option.

The second group consisted of 23 students of a German secondary modern school. The education was similar to that of the inmates, but they were slightly younger. All pupils filled out the questionnaire. During the questioning, one researcher and one teacher were present. At the end, pupils were fully briefed about the experiment and had the chance to withdraw their consent.

The student sample consisted of 30 psychology students. As before, the students were questioned in a group setting and had the chance to withdraw their consent at any time. After the experiment, the university students received partial course credit, while the other groups did not receive any reward for their participation.

4.4.2 Results

We used a one-way MANOVA with the independent variable group (inmates, pupils, students) in a between-subjects design. Post-hoc analyses were performed using Scheffé tests. We found that criminals thought gloves were more useful to conceal their identity (M = 4.17, SD = 1.52) than did pupils (M = 3.52, SD = 1.59) and students (M = 2.63, SD = 1.82). The effect of group on the opinion about gloves was significant, $F(2, 74) = 5.75$, $p = .005$, $\eta_p^2 = .14$. The groups did not differ significantly in their opinions on the usefulness of other means to conceal identity. Students and pupils also thought more strongly that the main source of ideas for criminals for countermeasures against detection was the internet (M = 4.17, SD = 1.52, and M = 3.80, SD = 1.47 respectively), compared to inmates (M = 2.75, SD = 1.47), F(2,

67) = 10.02, p = .009, η_p^2 = .13. Criminals were more likely to state that their main source of information were friends and acquaintances (M = 3.30, SD = 1.61), compared to pupils (M = 2.59, SD = 1.68) and students (M = 2.07, SD = 1.36), F(2, 74) = 4.22, p = .018, η_p^2 = .11 (Figure 9).

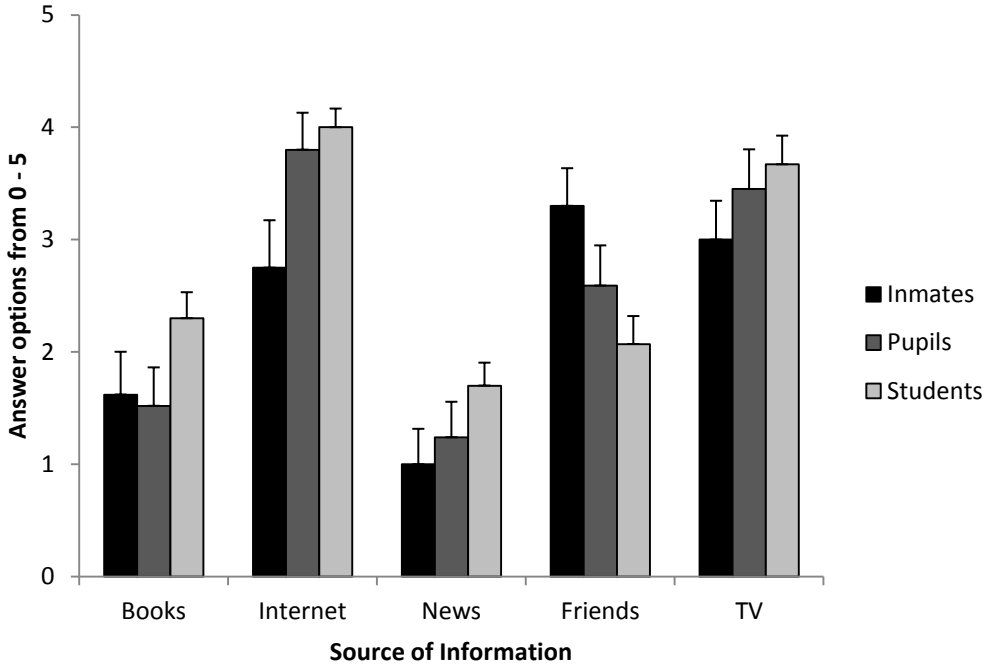

Figure 9. Preferred source of information by group. Students and pupils thought the internet was the best way to get information on how to commit a crime while inmates found friends and acquaintances the best source of information.

When asked about specific TV-series, students thought that Bones (M = 2.64, SD = 1.09), Dexter (M = 2.95, SD = 1.17), and Crossing Jordan (M = 2.52, SD = 0.98) where particularly good in teaching how to commit crimes, compared to inmates (M = 1.50, SD = 1.55, M = 1.53, SD = 1.64, and M = 1.07, SD = 1.44), with F(2, 74) = 3.85, p = .028, η_p^2 = .13, F(2, 74) = 4.31, p = .019, η_p^2 = .15, and F(2, 74) = 9.47, p < .001, η_p^2 = . .28. For pupils only Crossing Jordan stood out. They thought, as did the inmates, that it was not particularly useful (M = 1.00, SD = 1.27), compared to the other series. However, students' assessment of Bones

(*M* = 1.81, *SD* = 1.33) and Dexter (*M* = 1.81, *SD* = 1.97) did not differ from the other two groups. University students and pupils watched a similar amount of TV (*M* = 2.40, *SD* = 1.19, and *M* = 2.04, *SD* = 1.46), compared to inmates who watched less (*M* = 1.13, *SD* = 0.63), $F(2, 74) = 8.14$, $p < .001$, $\eta_p^2 = .18$. However, there were no group differences in how many forensic series they watched, $F(2, 74) = 0.50$, $p = .607$, $\eta_p^2 = .01$.

Inmates thought they were particularly good at covering up a crime (*M* = 3.92, *SD* = 1.47), compared to students (*M* = 2.40, *SD* = 1.10), while pupils did not differ from the other groups in their self-assessment (*M* = 3.30, *SD* = 1.49), $F(2, 74) = 8.71$, $p < .001$, $\eta_p^2 = .19$. Inmates also had a lower level of empathy (*M* = 2.63, *SD* = 0.76) than the psychology students (*M* = 3.19, *SD* = 0.65), the pupils again did not differ from the other groups (*M* = 2.83, *SD* = 0.83), $F(2, 74) = 4.08$, $p = .021$, $\eta_p^2 = .10$.

Students and inmates agreed that a number of forensic methods shown on TV are rather unrealistic (*M* = 3.53, *SD* = 1.37, and *M* = 3.64, *SD* = 1.39), compared to pupils (*M* = 1.75, *SD* = 1.55), $F(2, 74) = 7.12$, $p = .002$, $\eta_p^2 = .26$. However, students thought criminal labs usually have to perform considerably more work than it is portrayed in TV shows (*M* = 3.24, *SD* = 1.30), compared to inmates (*M* = 1.73, *SD* = 1.39). Pupils were somewhere in the middle and did not differ from the two other groups (*M* = 3.53, *SD* = 1.37), $F(2, 74) = 4.41$, $p = .018$, $\eta_p^2 = .03$.

In the forensic knowledge test, students answered significantly better (*M* = 5.50, *SD* = 1.72) than pupils (*M* = 4.09, *SD* = 1.47) and inmates (*M* = 4.13, *SD* = 1.73), $F(2, 74) = 6.41$, $p = .002$, $\eta_p^2 = .15$. The test had 10 questions that were answered with true/false, meaning that 5 correct answers were expected by chance. All three groups did not differ in their overall confidence of their answers (students *M* = 69.32%, *SD* = 13.87, pupils *M* = 61.05%, *SD* = 27.29, and inmates *M* = 69.83%, *SD* = 17.58 ($F(2, 74) = 1.37$, $p = .261$, $\eta_p^2 = .04$).

4.4.3 Discussion

In our sample, convicted criminals answered that the best source of information on how to commit a crime are friends or acquaintances. Students and pupils thought the best source of information would be the internet. Inmates still thought that there are learning opportunities in TV series, but not much so.

We also found that students did best in the explicit knowledge test. This indicates that education might be an important factor in how well someone commits a crime. We only asked criminals who were caught. It might well be, that the criminals who did not get caught are the ones who are actually watching forensic TV series and thus are not represented in our sample. However, in our sample all three groups roughly watched the same amount of forensic TV shows, and it is thus unlikely that the inmates we interviewed were special, compared to the general population, in their TV viewing habits.

In the next experiment we invited extreme forensic TV series watchers and non-watchers into our laboratory and let them commit mock crimes. If there is an advantage in watching these series before committing a crime, this experiment should uncover it.

4.5 Experiment 3

4.5.1 Methods

Participants

Forty psychology students (female = 31, male = 9) participated in the experiment in exchange for partial course credit. Mean age was 23.26 (*SD* = 3.75).

Screening

To acquire a sample of two extreme groups, we screened 196 students for their TV watching habits. The screening questionnaire only focused on series with forensic content, and subjects ratings were later aggregated to a total score between 0- 100, where 0 meant they watched no

series at all, and 100 that they were big fans of all kinds of forensic shows. On average the sample had a score of 35.26 (*SD* = 22.19). Subjects with at least one standard deviation above the mean were placed in the „CSI-watcher" group (*M* = 68.14, *SD* = 15.40), while subjects with at least one standard deviation below the mean were selected for the control group of „none-watchers" (*M* = 5.93, *SD* = 11.20).

Material

We created an assessment form for each of the two mock crimes our subjects were asked to commit. In the first crime subjects were asked to steal a laptop. We checked for fingerprints, footprints, and whether they avoided to be seen by a mock-up security camera. The scale ranged from 0 - 3, 0 meaning they did not do anything to avoid leaving traces, and 3 they did everything right and left no traces at all. The numbers in between were reserved for cases when subjects tried but did not or only partly succeeded in covering their tracks. A real hidden camera was also placed in the room to evaluate the subjects' behavior. We did this because we did not want to distract the subjects with an experimenter's presence. In the end the sum score of a subject was used to quantify how well they did.

The second task was to clean up a crime scene. We used an assessment consisting of 10 items, which were again rated on a scale from 0 - 3. Items consisted of fingerprints of the subject, fingerprints of the murderer, footprints of the murderer, clues left by the victim, blood traces of the victim, weapons, bullets, cartridge cases, fiber traces, and the use of bleach to efface the blood stains. Two forensic experts validated the items.

After the experiment, subjects received a questionnaire with questions about their TV viewing habits and general demographics. They were also asked if they would have done anything differently in retrospective and whether they thought one can learn to commit a crime from watching forensic series. We included a scale of social anxiety with 5 questions (e.g. „I talk to many different people at a social gathering.", and „I often feel uneasy in the

presents of others.", *Cronbach's* α = 0.62.), a scale on immersion in the role with 4 questions (e.g. „It was easy for me to get immersed in the given scenario.", and „The two scenarios were realistic.", *Cronbach's* α = 0.76.), and a scale for criminal energy with 8 questions (e.g. "Stealing is morally wrong", and „I cheat to get ahead", *Cronbach's* α = 0.86.).

The questionnaire finished with an explicit forensic knowledge test. It was the same test as in Experiment 2. It had 10 true/false questions, and after each question subjects were asked how confident they felt about their respective choice.

Procedure

Subjects were invited into an office room of the psychological institute. After obtaining informed consent, they received instructions to „steal" a laptop. Subjects were told that other members of the institute were not aware of the ongoing experiment, so they better not get caught. This was to induce a certain stress level that would be also present in a real-life theft. Subjects later confirmed that this intervention had worked. They were also told that an inspector would later investigate the crime scene such that they would avoid leaving any traces. They then were handed a big box with many item, some of which were useful, e.g. rubber gloves, and some of which were distractors, e.g. a metal chain.

Subjects went into the room which was out of sight from the office. The door was closed but not locked and a doormat, covered with dirt, was lying in front of it. If they stepped on the doormat they would leave a footprint there. A surveillance camera was directed at the laptop. A subject standing in the doorway was invisible to the camera, however, when entering carelessly their image would have been caught. We placed a drinking glass on the laptop. It was placed with another glass and a bottle of water, so that it did not look out of place. When touching it without any protection, the subject's fingerprints would be left on the glass.

After successfully returning the laptop to the office, the researcher handed the subjects a second story. In it subjects were told that the local mafia boss was happy with their work

and wanted them to clean up a crime scene for him. A second experimenter was introduced as a member of the syndicate who would provide a waste disposal service. Everything subjects would place in a certain box, the experimenter would make sure to annihilate. They again could use the box from the previous „crime" with helpful items and distractors to clean the crime scene. A layout of the mock-up murder crime scene can be found in Figure 10.

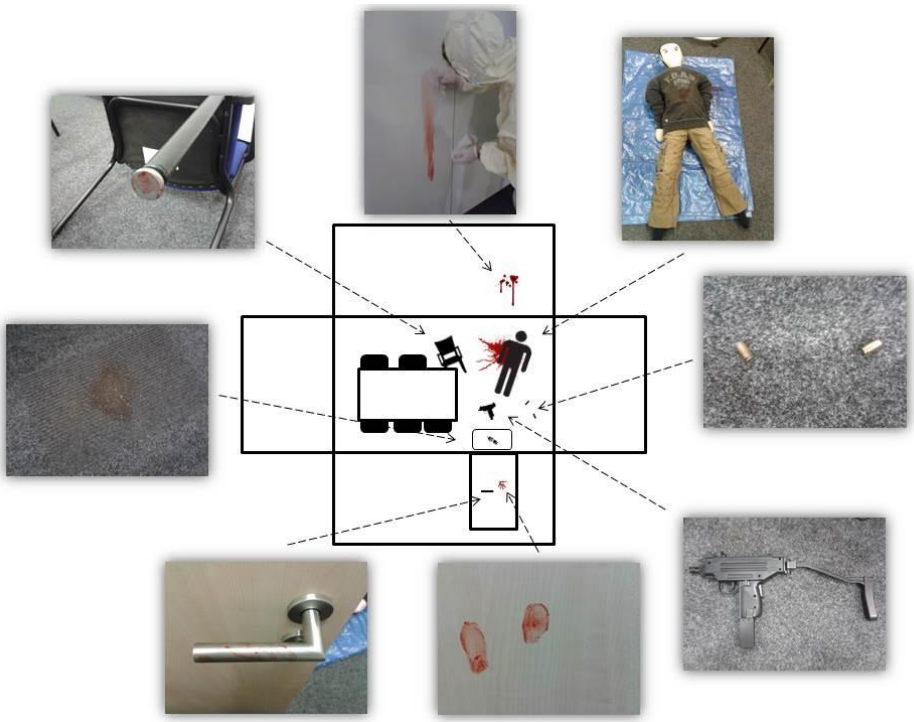

Figure 10. Exploded diagram of the mock-up murder crime scene for the implicit knowledge test.

After subjects finished cleaning up they came back to the office to fill out the questionnaire. They were then thanked for their participation and fully debriefed on the aim of the experiment. The experimenter did not know during the whole experiment to which group the subject belonged. Subjects knew of course how much forensic TV series they had watched, but they did not know until after the experiment according to which criteria the groups had been selected. The whole experiment lasted about an hour.

4.5.2 Results

We used a one-way MANOVA with the independent variable forensic TV series consumption (high vs. low) in a between-subjects test (Table 4). Both groups left a similar amount of forensic traces on the crime scenes. Also, they did not differ in their level of social anxiety or how much they were immersed in the experience. The only significant differences between the two groups were their level of criminal energy, with CSI watchers having a higher level than none-CSI watchers. Both groups scored similarly in the explicit forensic knowledge test, and CSI watchers were somewhat more confident about their results.

Table 4

Mean scores and standard deviations of the two groups in Experiment 3.

	None-CSI	CSI	*F*	*p*	*d*
Theft	3.90 (3.40)	4.75 (3.11)	0.68	.415	0.27
Murder	19.60 (5.10)	19.90 (4.20)	0.04	.840	0.07
Social anxiety	1.47 (0.64)	1.53 (0.63)	0.07	.797	0.10
Immersion	3.03 (1.06)	2.67 (1.04)	1.06	.311	0.35
Criminal energy	0.97 (0.65)	1.51 (0.92)	4.64	.038	0.70
Knowledge test	6.45 (1.79)	6.05 (2.16)	0.41	.528	0.21
Confidence	60.23 (17.93)	69.34 (14.36)	3.16	.083	0.58

4.5.3 Discussion

Both groups left a similar amount of forensic traces on both crime scenes. CSI-watchers tended to be more self-assured about their answers. Note, however, that this difference was neither large (Cohen's $d = 0.58$) nor significant.

There was a significant difference between the groups in their level of criminal energy. This might be explained by the fact that people who are attracted by forensic crime series are

generally more criminally minded. However, the scale ranged from 0 - 5, and it is more likely that the sample of non-watchers (M = 0.97) was extremely law-abiding rather than the CSI-watchers being particularly criminal (M = 1.51).

One large problem with the study was the inviting nature of the material in the box. Subjects might have felt to a certain extent that they should use the material we presented them with. This could have led to existing differences not being detected in our study because non-watchers compensated their lack of knowledge by relying on using everything in the presented box that made some sense in the situation. What speaks against this argument is the fact that the non-watchers actually scored higher in the explicit knowledge test than did the regular consumers of such series.

In the next experiment we eliminated this problem and also tested for alternative hypotheses. If TV consumption cannot explain criminal success, what can?

4.6 Experiment 4

In this experiment, subjects had to use their previous knowledge to conceal any would-be evidence that could incriminate a murderer. The crime scene was enacted using a doll-house like setup.

4.6.1 Methods

Participants

Subjects were grouped by age, gender, and education. We formed 5 age groups of 24 subjects each, ranging in age from 20 - 30 , 30 - 40, 40 - 50, 50 - 60, and 60 - 70 years respectively. In each age group 6 members had a low education (German secondary modern school = Hauptschulabschluss), 6 had a middle education (junior high school = Realschulabschluss), 6 had high education (A level = Abitur), and 6 had higher education (university degree = Studium). Of all 120 subjects, 50% were female, equally distributed across all conditions.

Twelve subjects filled out the questionnaire incomplete and were excluded from further analysis. All subjects participated voluntarily.

Material

We built a miniature crime scene in the tradition of Frances Glessner Lee (Figure 11) at a scale of 1/25. The model measured 34 x 29 cm. We used an assessment form consisting of 28 items, which were rated on a scale from 0 - 3, 0 meaning the subject did not do anything to avoid leaving traces. A rating of 3 indicated they thought that they had done everything perfectly and had left no traces at all. Items were grouped by place were traces were left, according to the instructions story. Item groups were the kitchen (fingerprints, hairs, coffee cup), the living room (e.g. fingerprints, hairs, laptop, murder weapon), the bathroom (fingerprints, hairs, trash bin, washbasin), the door area (fingerprints, mailbox, tire tracks), the perpetrator (traces on clothing), the car of the perpetrator (soil at the underfloor/tires, damage to the paintwork, navigation system), and footprints (at the house, around the house). An additional „penal" category was introduced, in case subjects wanted to disguise the murder as a robbery gone wrong, but left traces like breaking a window from the inside or not taking any things of value. The sum score of all items was used in the end to quantify how well subjects did. Two forensic experts validated the assessment form and gave valuable insight.

Figure 11. Model crime scene in scale 1/25.

After the experiment, subjects received a questionnaire, which consisted of 5 sub-sections. The first section contained questions about education, monthly income, and professional background of their parents. The second section contained a scale on forensic interest from 1 - 6 („How much are you generally interested in forensics?", „How much are you interested in series/movies that deal with forensics?", and „How much are you interested in books that contain forensics?"), *Cronbach's* $\alpha = 0.73$. Section three contained four questions about TV consumption („How much do you watch the following series?", „Please write down your favorite TV series.", „How much TV do you watch daily?", and „How much forensic TV series or films do you watch in a week?" This was followed by a rating of their own technical knowledge, answer categories ranging from 1 - 6. The four questions/statements were „How well would you describe your understanding of science and technology?", „Products and offers that use the newest technology are very useful.", „You prefer to use the most recent technology.", and „In the areas you are interested in, you are informing yourself regularly about recent technological developments.", *Cronbach's* $\alpha = 0.72$ (taken from Karrer, Glaser, Clemens, & Bruder, 2009). The last section consisted of the short BFI-10 (Rammstedt & John, 2007) to assess personality. The BFI-10 consists of 10 questions, two for each personality factor.

Procedure

After signing a consent form, subjects received a written story they were asked to imagine happening. There were two versions of the story that differed only with regard to the gender of the aggressor and the victim. Both were matched to the gender of the subject. In the story the subjects were told they got stuck in a traffic jam on a motorway after attending a conference. To avoid waiting they take a shortcut using a country road they know. They pass by the house of an old friend who had an affair with their spouse years ago. Both reconciled half-heartedly afterwards but had not seen each other since. The protagonist decides to stop by and

say hello, after considering that the affair was five years back. At first, both get on well but after a while they get into a fight, which leads to the protagonist to stab and subsequently kill the host. The subjects were then shown the model house in which two Playmobil figures were placed, one with a knife in its hand, and one lying on the floor. Throughout the story, the protagonist figure was moved through the house and left traces.

Subjects were instructed to try to conceal the murder. Thanks to the traffic jam they would have an alibi and needed only to worry about other ways they might get caught. Subjects then used the Playmobil figure to show the experimenter what they would do in this situation. The experimenter observed and rated the subject during the experiment. They were told that all normal household items could be found and used in this house. After the subjects had finished, they received a questionnaire and were thanked for their participation.

4.6.2 Results

All 108 subjects were included in the analysis. We conducted a linear regression, including sex, age, education, forensic interest, forensic TV series, and technical interest as predictors (Table 5). A separate linear regression for the Big Five personality traits was conducted.

Sex (p = .007), age (p = .007), and education (p = .028) were significant predictors for the experiment outcome. However, there are several intercorrelations that weakened the regression model. Technical interest was significantly correlated with sex, $r(106) = .29$, p = .002, meaning men had a stronger technical interest than women. While technical interest alone was no good predictor for the experimental outcome, working in technical jobs was. The two job groups engineer and craftsmen/technical jobs (M = 16.88, SD = 6.07) did significantly better than the other job groups combined (M = 13.99, SD = 4.11), $t(29.24) = -2.10$, p = .044. The only other group that did that well where teachers (M = 16.74, SD = 5.39), who were excluded from this analysis because the group was too heterogeneous.

Table 5

Regression coefficient and odds ratio of regression analysis. The sum score of forensic skills test is the reference category. Sex was coded as follows: 1, female; 2, male. Age was in absolute number of years. Education was coded as 0, no school degree; 1, secondary modern school; 2; junior high school, 3; A-level, and 4; university degree. Forensic interest, forensic TV series consumption, and technical interest ranged from 1 (low) - 5 (high). Only predictors with p < .05 were included.

Predictor	N=108		
	B	SE *B*	Exp (*B*)
Sex	2.59	0.95	0.27
Age	-0.09	0.03	-0.25
Education	0.86	0.39	0.20
Forensic interest	-	-	-
Forensic TV series	-	-	-
Technical interest	-	-	-

Forensic interest and watching forensic TV series was also significantly correlated, $r(106) = .68$, $p < .001$. Each on its one did not particularly well predicting our experimental outcome, $r(106) = .09$, p = .308, and $r(106) = .15$, $p = .154$, respectively. However, when we only looked at the subjects who wrote down forensic TV series as their favorite series, we found it was too be a good predictor, $r(106) = .29$, $p = .002$. This was again strongly correlated with forensic interest, $r(106) = .41$, $p < .001$. Age also had a weak negative correlation with forensic interest $r(106) = -.09$, $p = .353$.

We performed a median split on forensic interest and forensic TV consumption and divided each group in two. Not surprisingly, subjects who did neither watch forensic TV shows nor were interested in forensics performed the worst (M =14.05, SD = 5.16). Subjects

who watched a lot of forensic TV series but had no particular interest in forensic science did slightly but not significantly better (M =14.59, SD = 4.85). Both, subjects who were interested in forensics and did not watch forensic TV series (M =16.81, SD = 4.05) and subjects who had high interest in forensics and high consumptions of these series (M =16.37, SD = 4. 47) outperformed the other groups significantly, $\chi^2(3) = 8.07$, $p = .045$.

We conducted a linear regression for the Big Five personality traits. The only good predictor was the personality trait openness, B = 1.10, SE B = 0.54, and Exp (B) = 0.21. Subjects scoring high on openness were more successful erasing evidence. All other traits did not help explain further variance. It is noteworthy that in our sample women where more neurotic, $r(108) = -.43$, $p < .001$, and conscientious $r(108) = -.28$, $p = .004$, both correlating negatively but not significantly with task success, $r(108) = -.17$, $p = .066$, and $r(108) = -.10$, $p = .312$, respectively.

4.6.3 Discussion

Our initial model indicated that males in their twenties with high education would be potentially the best criminals. However, further analysis revealed that all these factors were, in part, mediated by other variables. It seemed that education is an important predictor in how well someone did. However, some of our best subjects had the lowest education. This can be explained by their choice of profession. Technical jobs and engineers did by far best, leaving all other groups behind. And while engineers have high education, craftsmen do not (also in the German system some have extensive education, just not in the classical school system). This also explains in part why men did better than women in our experiment, as 83% of engineers and craftsmen where male. The other factor we identified for the sex difference is the strong correlation between women and neuroticism in our sample. It is not far-fetched to assume that high neuroticism prevented subjects from performing well in our task, especially where we induced stress by having unexpected visitors show up in the scenario. Teachers also

did comparatively well, however, the problem interpreting this result is that their sample was quite heterogeneous. Some of the educators taught in the humanities while other taught science, technology, engineering, and mathematics (STEM) subjects. Because we did not obtain data in which field which teacher worked, their results cannot be interpreted in a meaningful manner.

We found forensic interest and consumption of forensic TV series to be strongly correlated. However, the group that performed best in our test consisted of subjects who were strongly interested in forensic topics but did not exhibit much forensic TV consumption. Subjects who only watched forensic crime series but were not interested in forensic science performed as poorly as did subjects who were neither interested in forensic science nor watched these series, while subjects who were only interested in forensic science but did not watch forensic crime shows outperformed both groups. This might also explain in part the age effect that we found. Old people were less interested in forensics and watched less forensic series. We also think, part of the age effect is that the formal education lies further back and while all subjects in their twenties had learned about DNA in school, few of the over fifty-year-olds had.

We also found that openness was a good predictor for task success. We had assumed that conscientiousness would be a good predictor because we thought conscientious people would clean the crime scene more thoroughly. It turned out, however, that conscientiousness actually correlated negatively with how well subjects did. Openness might do well in such an experiment because open people probably had it easier imagine the scenario and committing fully to it. This is speculation, however, and we have no further data to back up this claim.

4.7 General Discussion

The police chief's effect provides a potential explanation for structural changes in how crimes are committed by implicating forensic TV series. We do see more advanced techniques applied by present-day criminals as compared to crimes committed 20 years ago, according to police reports. It is thus possible that someone who plans to commit a crime is inspired by an episode of CSI, as has happened in some cases in the past (e.g. State v. McKinney, 2008). Are these cases negligible, or is there a demonstrable effect?

The present study has attempted to find evidence for the police chief's effect at several levels. We employed a wide range of methods to cover more ground than usually done. We interviewed convicted criminals, and we also used experimental laboratory settings to find the effect. At none of these levels were we able to find conclusive evidence for the effect. Merely the last experiment was compatible with the chief's effect but can be explained more parsimoniously in terms of forensic interest. Thus, the police chief's effect does not exist as a broad phenomenon.

How then do reports about criminals who use advanced techniques to evade prosecution come to be? Whereas the police chief's effect is not real, the complaints about criminals who get smarter are. One possible explanation is put forth by the tech effect (Shelton, Kim, and Barak, 2006). Forensic science and technology have advanced enormously over the past century. Fifty years ago almost no one had heard of DNA evidence, which has become general knowledge today. While it takes expert knowledge to really understand how DNA testing works, it suffices for criminals to know that they should not leave their own DNA at the crime scene.

One way to explain this dynamic change over time is to imagine police and criminals in a constant arms race. As soon as a forensic procedure gains certain popularity, it loses efficiency for the investigators, and they have to develop new procedures just to keep the crime clearance rate constant. Such arms races are common in many organisms, such as para-

sites, where it has been dubbed the Red Queen Effect (Van Valen, 1973) borrowing from Lewis Caroll's sequel to „Alice in Wonderland" (1865, 1995), „Through the Looking Glass" (1871, 1995). In Looking Glass land, the Red Queen explains to Alice the nature of the land: „Now here, you see, it takes all the running you can do to keep in the same place." This dynamic helps to understand why investigators may feel that criminals are getting ever more sophisticated although the data do not betray any changes in clearance rates.

5. EFFECT OF CAMERA ANGLE ON PERCEPTION OF TRUST AND ATTRACTIVENESS[5]

5.1 Abstract

Film theories have long proposed that the vertical camera angle influences how the scene and the character in it are interpreted. An elevated camera (high-angle shot) should diminish the qualities of the actor, whereas a lowered camera (low-angle shot) should elevate the actor in perspective as well as in the viewer's opinion. We were interested in how this holds up for the impression of trustworthiness and attractiveness that the spectator receives of the actor. We filmed 12 actors in a scenario inspired by a TV show called *Split or Steal*, which features a one-time version of the prisoner's dilemma. Subjects had to rate trustworthiness and attractiveness of the actors, and also judge if the actors would lie or tell the truth. We found that actors were rated as most trustworthy when filmed from eye-level, and less so when the camera was lowered or raised. Camera elevation had no effect on attractiveness. Also, personality ratings of the actors were not altered by varying camera angle. We conclude that context plays an important role in how camera angle interacts with actor perception.

5.2 Introduction

Television and film use conventions which are referred to as the „grammar" of the audiovisual medium. These conventions suggest that editing techniques and camera angle convey meaning and thus modify the interpretation of a given scene (Chandler, 2001). Convention has it that a low-angle-shot, where the camera is placed below a person's eye-point, should make the actor appear larger and more powerful. This perspective emphasizes the

[5] Paper submitted as Baranowski, A.M. et al. (submitted). *Effect of camera angle on perception of trust and attractiveness.*

dominance of the actor. In contrast, a high-angle shot, where the camera is positioned above the eye-level of the actors, looking down, is taken to diminish the actor's status and establishes impotence and vulnerability. For neutral scenes and factual programs, the shot from eye-level is recommended. It leads to a natural perspective perception, with observer and subject being on the same level (for detailed discussions and film conventions see Boorstin, 1991; Bordwell & Thompson, 2010; Eisenstein, 1949; Münsterberg, 1916).

Elevation of the camera angle can vary greatly from barely noticeable to bird's-eye or worm's-eye view. Giannetti (1972) argues that the variation of camera angle in the same situation conveys changes in perception that are mostly quantitative. A slight elevation may produce subtle emotional changes while strong deviations from eye-level might have a dominating influence on the atmosphere of the scene. The more extreme the camera angle, the more likely it is to reinforce or alter the narrative structure. By varying the angle, the director conveys meaning. A person filmed from above suggests a meaning that can be opposite to that conveyed when the same person is filmed from below, everything else being equal.

Despite these conventions found in basic textbooks and theoretical literature on film, comparatively few empirical studies have been conducted to evaluate the effect of vertical camera angle on perception. Most of the existing studies have focused on source credibility of television speakers (Avery & Long, 1976; McCain, Chilberg, & Wakshlag, 1977; McCain & Wakshlag, 1974; Tiemens, 1970) and/or have measured Osgood's semantic differential for evaluation, potency, and activation (Avery & Long, 1976; Mandell & Shaw, 1973; Meridian, 1987; Sevenants & d'Ydewalle, 2006). They have found some evidence for an effect of camera angle on the viewer's perception. However, the findings are quite heterogeneous, which might be caused by the use of different content, different measure instruments and scales, and different camera angles (Figure 12).

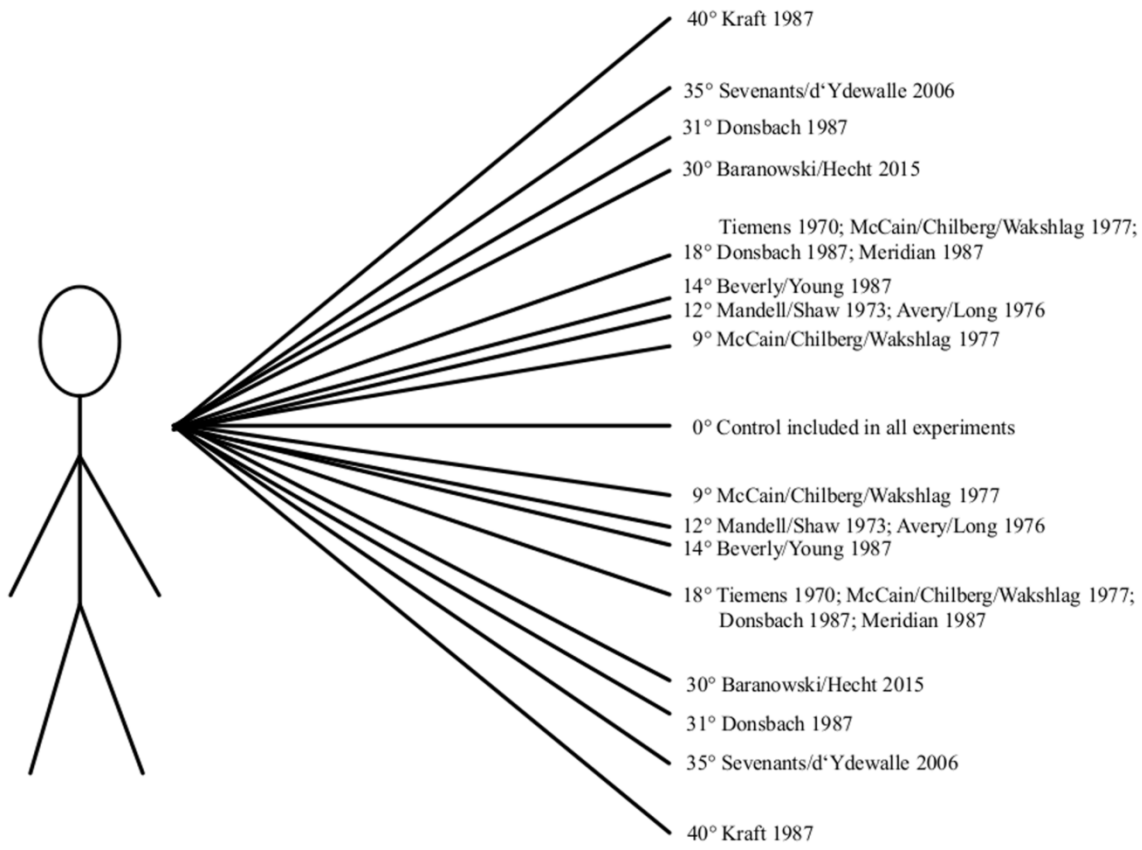

Figure 12. The vertical positive and negative camera angles (elevation) that have been used in previous studies. Note that McCain & Wakshlag (1974) did not provide a camera angle in their original report. Figure adapted from Kepplinger (2010).

Tiemens (1970), for example, found that one of three newsreaders was rated higher on „communicative ability" and „knowledgeability" when filmed from a lower vantage point compared to a high vantage point. However, none of the newsreaders was rated differently regarding their „authoritative" and „convincing" nature. Avery and Long (1976) also found only minor differences for varying camera-angles. An elevated camera-angle resulted in higher sociability ratings.

McCain, Chilberg, and Wakshlag (1977) had expected the opposite effect, and ended up arguing that power and dominance concepts contained in the writings of film theorists are not similar enough to the multi-dimensional construct of source credibility to warrant comparable results. High power- and dominance-ratings of a television source should correlate

negatively with credibility ratings. For three of the four dimensions of source credibility for a television speaker, McCain et al. (1977) found according results. A higher camera angle led to a higher rating of competence, composure, and sociability. Only dynamism was not associated with camera angle.

Two studies have looked at the interaction of narrative and camera angle (Kraft, 1987; Sevenants & d'Ydewalle, 2006). Kraft (1987) showed participants six short four picture stories, e.g. „The Encounter" (two dogs greet each other) or „The Dented Car" (a man and a woman are involved in a mild car accident). Camera angle was varied for both characters in the story. Kraft found that low angles produced an image of strength, action, and superiority; eye-level shots produced parity; and high angles created impressions of weakness, passivity, and insignificance. In a similar design, Sevenants and d'Ydewalle, G. (2006) showed that a low-angle shot elicited significantly more potency (which was also found by Mandell & Shaw, 1973; but not by Meridian, 1987).

McCain and Wakshlag (1974) also looked at the effect of the camera angle on perceived interpersonal attractiveness. They presented eight taped auditions to their students, in which students applied for the position of newscaster at a campus newspaper. The tapes had varying camera angles and screen sizes. The authors concluded that low-angle shots may increase credibility and attraction, but only when used sparingly. The study emphasizes that shots are interdependent and camera angles are perceived in relation to one another. This was replicated in a second study (McCain, Chilberg, & Wakshlag, 1977). To our knowledge, no other study has been conducted using moving images to address the relationship between camera angle and attractiveness. However, there have been many studies with photographs that tend to show that women are perceived to be more attractive when pictured from a high camera angle, whereas for men no such trend exists (e.g. Rudder, 2010; Schneider, Hecht, & Carbon, 2012).

In the present study we were interested in looking at the effects of camera elevation on trustworthiness and attractiveness. Past studies have focused on the construct of source credibility of television speakers while we wanted to focus on interpersonal trust. We thus designed an experiment in which actors were speaking directly into the camera, as if they were speaking to the subject, and the subject alone. In line with McCain, Chilberg, and Wakshlag (1977), we hypothesized that eye-level shots would elicit the most trust, compared to high- and low-angle camera shots. We also assessed interpersonal attractiveness. When using existing films, camera elevation is confounded with context and narrative. We sought to remove these confounds by recording one scene simultaneously with cameras positioned at different elevations. We also expected men that are pictured from below, to be rated as more attractive, because those shots tend to produce a sense of power and strength, which should be an attractive trait for men according to evolutionary psychology (e.g. Buss & Schmitt, 1993).

5.3 Methods

5.3.1 Participants

Thirty-four psychology students (female = 17, male = 17) participated in the experiment on a voluntary basis. Age ranged from 20 to 37 (M = 24.50, SD = 3.39). All subjects had normal or corrected-to-normal vision.

5.3.2 Materials

Twelve actors (6 female, 6 male) were filmed separately for 15 seconds each. We produced frontal head and shoulder close-ups and recorded with identical camera settings, merely differing in elevation. The actors were instructed to perform an individual script consisting of two to three sentences spoken directly into the camera, as if they were speaking directly to the audience. Each script was similar but varied slightly from the others, to keep a certain level of authenticity. In the clip, the actors had to convey their trustworthiness to the viewer. The look

was inspired by a TV show called *Split or Steal*, which features a one-time version of the prisoner's dilemma. Actors were filmed in front of a green-screen, which was filled with a TV show studio in post-production. The camera was placed on a tripod one meter away from the actors, and three different shots (low angle, eye-level, and high angle) of each character were taken (Figure 13). In order to ensure that the camera position did not vary in addition to its elevation, we opted to make three recordings rather than using three cameras mounted on a rack. The vertical angle for the low- and high-angle pictures was approximately 30° off eye-level, and we shot in 1080p. Each actor was instructed to maintain a fixed expression and use the exact same words during all three performances.

Figure 13. Screenshot of the stimulus used. Camera angle was varied vertically by 30 degrees from the eye-level. The look of the scene was inspired by the TV show Split or Steal.

5.3.3 Questionnaire

The questionnaire consisted of four parts. Part one was composed of one dichotomous question, asking whether the person in the video decides to split (i.e. share the money) or steal (i.e. keep all the money). The question aimed to implicitly test trustworthiness. Part two asked „I found the person in the video…" followed by a scale from 1- 10, one meaning „not attractive at all" and ten „very attractive". This was followed by five questions taken from the German translation of the Specific Interpersonal Trust Scale - SITS (Johnson-George & Swap, 1982). The questions we selected consisted of „I would expect the person in the film to play fair", „the person in the film would never intentionally misrepresent my point of view to others", „I could expect the person in the film to tell me the truth", „I would be able to confide in the person in the film and know that he/she would want to listen", and „If the person in the film knew what kinds of things hurt my feelings, I would never worry that he/she would use them against me, even if our relationship changed". The last section consisted of the short Big-Five-Inventory-10 (Rammstedt & John, 2007) to assess the personality of the actors. The BFI-10 consists of 10 questions, two for each personality trait (openness, conscientiousness, extraversion, agreeableness, and neuroticism) on scales from 0 - 4. We replaced „I" in the BFI-10 with „the person in the film".

5.3.4 Procedure

Each subject was tested individually. Upon arrival in the laboratory, subjects were seated 30 cm (horizontal viewing angle 45°) from the screen (72 cm x 42 cm). The seat was individually adjusted, so that subject's eye level was at middle of the screen. The room was darkened and sound was provided via headphones. After signing a consent form, subjects received a written instruction for the experiment. They were told that they should imagine participating in the game show called Split or Steal. The concept resembled that of the prisoner's dilemma. The actors in the film clips had the chance to steal or to split the money.

If both the actor and the subject decide to split, each will get half the money. If only one decides to split and the other decides to steal, the uncooperative player receives all the money. Should both participants decide to steal, they both walk away empty-handed. After each clip, the subjects had to decide whether the character in the film was trustworthy.

For each of the 6 conditions (3 camera elevations x 2 sexes), the subject saw two movie clips, amounting to a total of 12 clips. The average rating for the two films per condition was then used for further analysis. The film clips were shown in random order and subjects filled in a questionnaire after each presentation. The whole experiment lasted about half an hour. After they finished, subjects were thanked for their participation and fully debriefed.

5.4 Results

We conducted a 3 x 2 (camera angle: low, eye-level, high x sex: female, male) two-way rmMANOVA with the dependent variables trust, attractiveness, and the Big-Five personality traits. Using Pillai's trace, we found main effects for camera angle ($F(14, 70) = 1.79$, $p = .048$, $\eta_p^2 = .25$) and sex ($F(7, 14) = 4.15$, $p < .011$, $\eta_p^2 = .68$). The interaction between the two was not significant ($F(14, 70) = 0.89$, $p = .567$, $\eta p2 = .15$). A univariate test of camera angle, using the Greenhouse-Geisser correction, indicated a significant effect on trust ($F(1.76, 27.14) = 5.80$, $p = .015$, $\eta_p^2 = .23$), but not on attractiveness ($F(1.96, 39.19) = 1.39$, $p = .261$, $\eta_p^2 = .07$). The camera at eye-level was associated with higher trust ratings. There was no effect of camera angle on personality traits, except for a non-significant trend on conscientiousness ($F(1.76, 35.23) = 1.94$, $p = .164$, $\eta_p^2 = .09$). The same procedure for sex unveiled a main effect on attractiveness ($F(1, 20) = 5.89$, $p = .025$, $\eta_p^2 = .23$), but not on trust ($F(1, 20) = 1.40$, $p = .190$, $\eta_p^2 = .08$). We also found an effect for the personality traits agreeableness ($F(1, 20) = 2.22$, $p = .010$, $\eta_p^2 = .29$), conscientiousness ($F(1, 20) = 7.42$, $p < .001$, $\eta_p^2 = .42$), and neuroticism ($F(1, 20) = 4.76$, $p = .041$, $\eta_p^2 = .19$).

A contrast analysis revealed that actors were rated as more trustworthy when filmed from eye level (M = 5.03, SD = 1.45) compared to a low (M = 4.27, SD = 0.81), $F(1, 20) = 8.89$, p = .007, η_p^2 = 31, or high camera angle (M = 4.57, SD = 1.19), $F(1, 20) = 3.36$, p = .082, η_p^2 = .14 (Figure 14). Elevated and lowered camera angle did not differ with respect to trust ratings. We further found that the female actors were rated to be more attractive (M = 5.79, SD = 1.50) than male actors (M = 5.06, SD = 1.38), while men were rated as more agreeable (M = 2.13, SD = 0.50), conscientious (M = 2.40, SD = 0.57), and neurotic (M = 2.00, SD = 0.67) than women, M = 1.88, SD = 0.67, M = 1.94, SD = 0.45, and M = 1.78, SD = 0.64 accordingly.

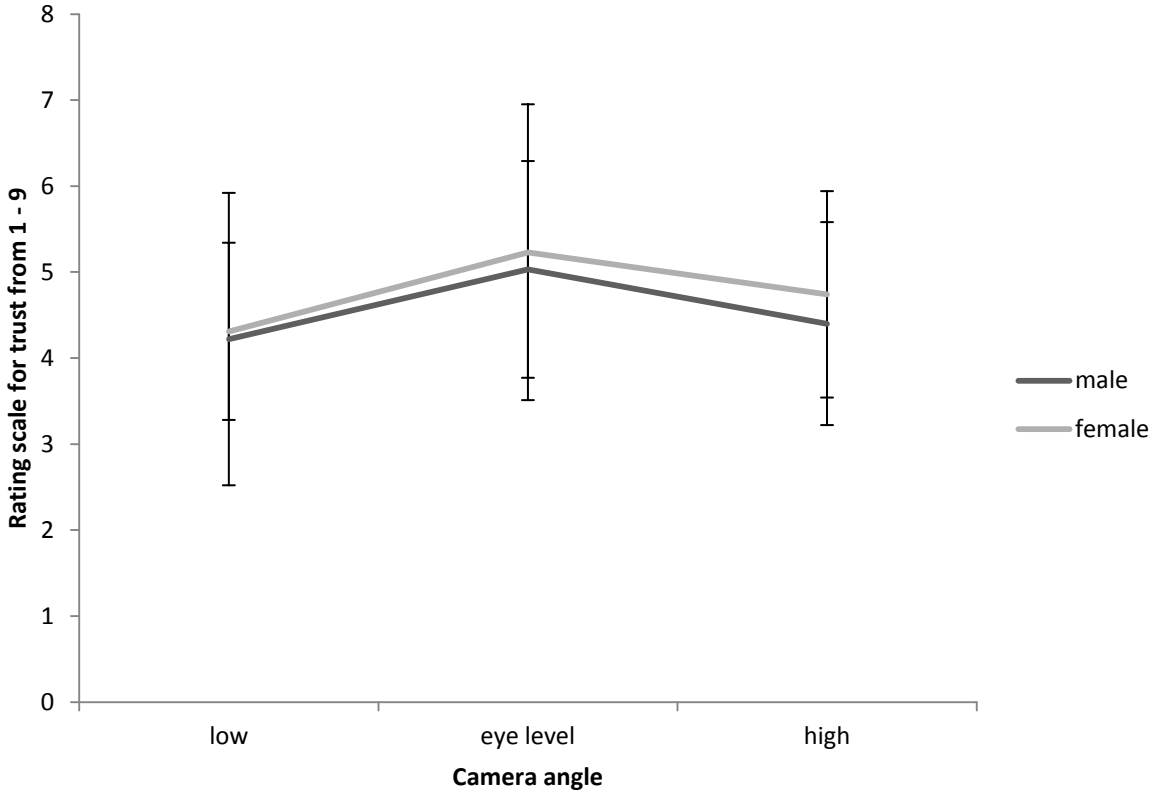

Figure 14. Ratings for trust by camera angle and sex. Actors filmed at eye level were trusted most. No interaction between camera angle and sex of the actor was found.

Error bars represent 1 SEM.

5.5 Discussion

In accordance with our hypothesis, we found that actors were rated as most trustworthy when filmed from eye-level. Low- and high-camera angles were equally associated with less trust. These results deviate from earlier findings obtained with still pictures or film scenes that were not controlled for context cues. Also, given the short clip, the impression of trustworthiness obtained here may differ from for the impression of credibility that can only be conveyed in the context of more elaborate narratives. We deliberately asked for personal trustworthiness within the tightly controlled setting of our self-generated film clips. It seems that when narrative-based context cues are removed, trustworthiness is highest when the camera maintains eye-level. Elevated or lowered camera directions reduced the actor's perceived trustworthiness. Note that compared to earlier studies, we have used rather large vertical camera angle differences of 30°. Thus, we cannot rule out that more subtle angle changes, e.g. around 10°, might have produced different results. However, when inspecting the stimuli (see Figure 13) we did not receive the impression that the 30°-conditions looked particularly unnatural. It remains to be seen if our results can be replicated for smaller angle differences.

We did not find an effect of camera angle on attractiveness of the actor. It could be that the camera angle differences that we have used were too small to produce sufficient distortions of the facial proportions. Rudder (2010), for example, describes a camera angle of 70- 80° to be attractive for women, and Schneider et al. (2012) have used 45°. We suspect, however, that attractiveness ratings are strongly context dependent and shots that might be favorable in one scene are disadvantageous in another scene. It is conceivable that camera angle changes in the range that we have used might affect attractiveness ratings in a romantic context.

We further found that our female actors were generally rated as more attractive than our male actors. This is a pattern that tends to emerge when rating attractiveness of females

and males. It seems that females are rated more favorable when taking a representative sample of the population in most conditions, which is reflected in many psychological studies (see e.g. Baranowski & Hecht, 2015).

Male actors were rated as significantly more agreeable, conscientious, and neurotic than were female actors. One possible explanation is that while attractive people are associated with many positive traits, attractiveness correlates negatively with perception of integrity and concern for others (Eagly, Ashmore, Makhijani, & Longo, 1991). This translates to conscientiousness and at least some aspects of agreeableness.

In conclusion, our study showed that an eye-level camera angle is unsurpassed when attempting to elicit trust. This is useful when thinking of teleconferences and video-chats, were it might be important to transport trust. However, when taken together with previous findings, we argue that context plays an important role in how camera angle interacts with actor assessment. Further studies should systematically vary context and camera angles.

PART III

EMOTIONS

6. CANNED EMOTIONS. EFFECTS OF GENRE AND AUDIENCE REACTION ON EMOTIONS ELICITED IN MOVIES[6]

6.1 Abstract

Laughter is contagious and TV stations have exploited this idea by adding so-called canned laughter to their shows. However, the theoretical foundations of why a laugh track might work remain unclear. We designed a series of experiments with a total of 110 participants to test two main competing theories in this context. Social proof theory explains the effect of a laugh track by the social proof consumers get from the people heard on the laugh track. Facilitated bonding theory, explains the effect with the social function of laughter to facilitate group building and bonding. We introduced a scream track in addition to a laugh track, to examining the validity of the two theories. We found that the facilitated bonding theory explains our data best for the artificial laugh track. However, in the presence of real emotional displays, social proof seems to carry the impact of the sound effects.

6.2 Introduction

Laughter is highly contagious. In ancient Greece, as well as in Rome, some audience members where paid to laugh at specific places in comical theater performances, so that the naive audience members would join in. The audience was thought to rate the piece as funnier and better in the presence of the induced laughter. In 16th century France, and later also throughout the rest of Europe, many play-houses hired so called „claqueurs" who were instructed to clap and cheer at designated scenes. Particularly „rieurs", a special form of „claqueur", would laugh loudly at jokes. This practice largely died out in the mid-20th century in Europe and America (Provine, 2000).

[6] Paper submitted as Baranowski, A.M. et al. (submitted). *Canned emotions. Effects of genre and audience reaction on elicited emotions in movies.*

However, with the rise of radio and TV, a new form of enhancement by way of laughter emerged. The TV-show *I love Lucy* (CBS, 1951 - 57), also known as the mother of sitcoms (situational comedy), was filmed and broadcast in front of a live audience. For viewers at home this meant that they could hear the audience react to the actors on stage while watching the sitcom at home. The studio audience being visible at times to the viewer greatly enhanced the home theater experience. In a next step, the live audience was replaced with an artificial one: *The Hank McCune Show* (NBC, 1950) completely forwent a live audience, and is noted as the first show to make use of a so-called laugh track or canned laughter. The laugh track consists of pre-recorded laughter that is later added to the show with the purpose to give the viewers at home the feeling as if it was filmed in front of a live audience. In other countries like Germany, where the voices of the screen actors are routinely dubbed, the original audience laughter is almost always replaced by a new laugh track to account for differences in timing that becomes necessary in translation (for a more exhaustive review of the history of the laugh track see Provine, 2000).

Over the years, the movie industry experimented widely with laugh tracks. One notable example albeit not an intentional experiment, is *M*A*S*H* (CBS, 1972 - 83). *M*A*S*H* was filmed without a laugh track, but when it aired in America, canned laughter was added to ease concerns about humor in a wartime setting. When shown in Britain, the laugh track was omitted, giving the show a noticeably different flavor. However, reactions from critics and academics were largely similar in both countries, suggesting that the success and meaning of a show had been minimally affected by the laugh track (Mills, 2009). This leads to the question to what extent and under which circumstances a laugh track has an effect on the audience.

6.2.1 Studies on Canned Laughter

Market research was used by the television industry to see whether the audience is favoring sitcoms with a laugh track over sitcoms without laugh track. Even though the results of such research are usually not made public, anecdotal evidence suggests that the laugh track can provide a decisive edge. One example is the sitcom *Hogans Heros* (CBS, 1961 - 71), which failed at the test screening without a laugh track but received excellent ratings with it (Shandley, 2011).

Smyth and Fuller (1972) were the first to study the effect of the laugh track in an academic setting. Other experiments which included a laugh track had been conducted earlier, but they did not intentionally study its effects, such as a study by Leventhal and Mace (1970). Smyth and Fuller (1972) found that when adding a laugh track to a verbal recording of a joke, participants laughed more and longer and rated the material to be funnier. In a further study with a similar design, Fuller and Sheehy-Skeffington (1974) were able to replicate the initial results.

In contrast, Chapman (1973) did not find that participants rated jokes accompanied by a laugh track as significantly funnier than the same jokes without the laugh track, however, the added laugh track generated more overt laughter. Participants who heard the jokes with the pre-recorded audience reaction laughed more and longer in response to the jokes. In general, however, mirth and subjective ratings of how funny a movie is, appear to be highly correlated. Nonsanchuk and Lightstone (1974) found an interesting interaction when they varied the funniness of the stimuli. Under the influence of the laugh track, less funny jokes became funnier, whereas jokes that were already funny were not rated more favorably. However, in this experiment, participants believed they heard the laughter of actual people that were in a booth next to theirs. Chapman and Chapman (1974) also demonstrated that when a confederate of the same age laughed openly at humorous material, it enhanced laughter, smiling, and ratings of funniness in children.

Cupchik and Leventhal (1974) tested potential gender effects of canned laughter. They showed that females reacted more expressively and gave higher funniness ratings to cartoons that featured a laugh track than did males. However, self-observation of their expressiveness produced significantly lower funniness ratings. This might be because women are taught to be generally more self-conscious in our society, thus, pointing out their expressiveness might lead to these results (Fine, 2010). The overall relationship between self-consciousness and funniness ratings was confirmed by Porterfield et al. (1988). Higher ratings of self-consciousness predicted lower ratings of funniness of movie clips when accompanied with canned laughter, but when unaccompanied no group difference was found.

Taken together, the findings on gender differences remain inconclusive. While some authors did find that women were more strongly affected by the laugh track (e.g. Fuller & Sheehy-Skeffington, 1974; Leventhal & Cupchik, 1974), others did not (e.g. Chapman, 1973; Martin & Gray, 1996; Platow et al., 2005). It is noteworthy that when authors did find gender differences, it always pointed towards females being more affected by the laughter. Hupfelder (1999) found that gender differences were mediated by empathy values. When controlling for empathy in his study, the gender differences mostly disappeared.

Another study has demonstrated that there was more change in the laughter or humor ratings when canned laughter was presented to a participant in isolation as compared to a group of participants (Pistole & Shore, 1979). Yet, in another study, the pre-recorded laughter had the completely opposite effect (Donoghue, McCarrey, & Clement, 1983). In this study, the presence of a confederate actually enhanced the effect of the laugh track.

In all studies mentioned thus far, canned laughter had always accompanied actual humorous material. Provine (1992) isolated the laughter and presented pre-recorded laughter without a movie. Results confirmed that laughter itself evoked laughter, even if it appeared in isolation.

Lawson, Downing, and Cetola (1998) studied how the cognitive evaluation of humorous material is affected by a laugh track. They found that perceivers' cognitive evaluations were influenced less by audience laughter that they were told was pre-recorded, as compared to laughter that they were told was live. Lawson et al. argued that only the live audience is regarded as an authentic evaluation of the material and, thus, a reliable cue of the funniness of the material. This is in line with findings of Platow et al. (2005), who showed that canned laughter had more impact on judgment and overt laughter of participants who believed it came from members of an in-group (i. e. university students of the same university).

Lieberman et al. (2009) researched the effects of a laugh track on audience response to four episodes of *The Andy Griffith Show*. They found that the laugh track had no effect, with the exception a negative impact on one of the episodes that stood out positively in terms of perceived humor and overall enjoyment. It also possessed a more complex story structure, higher levels of satire, and other distinctive elements. This supports the notion that canned laughter can improve weak jokes, whereas good jokes are not affected or even harmed by canned laughter (see also Nonsanchuk & Lightstone, 1974). Further support comes from a recent study by Vraga et al. (2014) who looked into the effect of audience laughter in late night shows. They found that the laughter supported the credibility of host and show when unknown, while reminding the viewers of the comedic intentions of a known host. This allows the host more freedom to present information and conduct interviews in a pointed manner, because the viewer is constantly reminded of the humorous context.

6.2.2 Social proof versus facilitated bonding

We can summarize this body of research saying that canned laughter raises funniness ratings of the associated material as long as this material does not achieve top ratings (i.e. ceiling effect). It remains unclear, however, how this effect is best explained. We hold that the many different hypotheses that have been proposed in the past, can be grouped into

either one of two competing theories, the ***social proof theory*** (e.g. Cialdini, 1993; Furnham, 2011; Lawson, Downing, & Cetola, 1998; Platow et al., 2005; Porterfield et al., 1988) and what we call the ***facilitated bonding theory*** (e.g. Chapman, 1973; Fuller, & Sheehy-Skeffington, 1974; Nonsanchuk & Lightstone, 1974; Smyth & Fuller, 1972; Provine, 2000). There are multiple studies showing that laughter follows certain rules in daily interaction (e.g. Glenn, 2003; Jefferson, Sacks, & Schegloff, 1987). In the context of canned laughter, however, a stimulus-response like mechanism for laughter is assumed in both theories.

Social proof theory suggests that people base their evaluation of funniness on evidence provided by their social environment. When people hear laughter, this offers social proof that something is funny. The necessity for social proof is higher when the viewer is less sure about the material. The theory thus suggests that people are particularly drawn to social proof when they are in an ambiguous situation (Cialdini, 1993). The laughter itself is what Giles and Oxford (1970), who identified seven types of laughter, call humorous laughter. The theory, however, implicates an attitudinal reaction. The viewer hears laughter and uses this information to reevaluate the funniness of the perceived material. Consequently, the person rates the material as funnier and shows more signs of mirth.

This mechanism has been shown to be prominent in fear reactions in the context of danger assessment. Fear reactions, as all emotional expressions, are thought to serve two prime functions; prepare the organism to react to a stimulus occurring in the environment and communicate critical social information (Chapman, Kim, Susskind, & Anderson, 2009; Eibl-Eibesfeldt, 1989; Ekman, 1992). The fearful face can alert other members of a group to an impending threat (Shariff & Tracy, 2011). Wilkowski and Meier (2010), for example, could show that fear expressions facilitated avoidant, „flight"-oriented motor behaviors. Other researchers found specific amygdala response to fearful faces, supporting the social-communicative function of fear (Williams, Moris, McGlone, Abbott, & Mattingley, 2004).

Thus, the fear reaction of others is used as an additional source of information when assessing the danger of a stimulus.

Facilitated bonding theory, in contrast, focuses on the positive social nature of laughter. It centers on the function of laughter in aiding members of a small group to engage in smooth interactions. The viewer reacts to laughter with an automated response to facilitate bonding. Most laughter is a form of social cue or interaction (Giles & Oxford, 1970). Provine (2000), for example, found that only about 15% of laughter occurring in daily conversations was laughter in response to something loosely defined as funny, while the rest of the time it was a form of social signal. He could also show that laughter alone as a stimulus is enough to elicit laughter in participants, eliminating the need for funny material (1993). In the context of canned laughter, participants might laugh as a response to the material to achieve a feeling of positive bonding with other would-be viewers. Note that only positive stimuli would facilitate such bonding, whereas negative stimuli should hamper or at least not facilitate bonding.

The main problem with past experiments is that they have used a paradigm that is inherently unable to differentiate between the two theories. At this point, both theories can equally well explain the main effects of canned laughter that have been found thus far. Either participants find the material funnier because they use the canned laughter as social proof (and adapt their ratings accordingly), or participants find the material funnier because they react cheerful to laughter as a social cue, and adapt their cognition accordingly. We would like to put the theories to a test by forcing different predictions.

Thus, we designed an experiment in which participants saw short movie clips with either pre-recorded laughter or no audience reaction. As a third factor we introduced canned screaming, which consisted of pre-recorded screams and other oral expressions of fear. We also varied the movie genre because we expected that audience reactions would be most efficient in congruent contexts, that is, screams should elicit no or less fear in a comedy as compared to a scary movie. In a second experiment, we used human confederates instead of

pre-recorded reactions to test for differences. Finally, we conducted a third experiment to test weather social proof theory could be used in a different setting to influence participants' ratings.

We predicted that if the facilitated bonding theory applies, the reaction to canned laughter should be unique to laughter and not transfer to fear. However, if social proof theory holds true, then both positive and negative canned emotions should affect audience judgment, as they follow the same mechanism. This should in particular be the case in Experiment 3, where only social proof alone could qualify as an explanation.

6.3 Pre-study

In order to obtain believable stimulus material of varying emotional quality, we needed film clips which we were confident would elicit the intended responses. Movies reflect the zeitgeist and vary over culture and time, so it was important to get a current sample of movie clips (Backhaus & Brandenburg, 2014). We selected our own sample, using a method very similar to that used by Gross and Levenson (1995).

6.3.1 Methods

Participants

Thirty psychology students (24 women, 6 men) participated in exchange for partial course credit. The participants were on average 24.25 (*SD* = 5.59) years old. In this and all subsequent experiments we only used participants with normal or corrected-to-normal vision.

Film selection

Initially, we assembled a list of about 200 full-length commercial films by looking at various websites and collecting recommendations from colleagues and friends. Of this list, roughly 50 films were selected for close screening based on discreteness. That is, the movie

had to include scenes that produced one dominant emotion (amusement, fear) or no emotions at all. The list was further reduced to 18 movies (6 comedies, 6 scary movies, and 6 movies with neutral scenes). We use the term scary movies for movies that rely heavily on *jump-scares*, in contrast to horror movies, which rely on more on horrific imagery (of course, these two sub-genres are overlapping and a clear separation is not possible). Of each movie, 3 short film clips were produced by editing especially (un)emotional scenes.

Procedure and questionnaire

We showed the 54 movie clips (x_{length} = 133 sec., *SD* = 25.35 sec.) to groups of 3 to 6 participants. In total, 30 students saw all movie clips in a two hour session. We tested for satiation effects, because of the large number of clips shown, but did not find that ratings systematically changed over time. Also, clips were shown in a randomized order to exclude possible sequence effects. Prior to the experiment, participants signed a consent form and answered several demographic questions. The experimenter pointed out that the clips contained scary scenes, and that participants could close their eyes or stop the experiment at any time. At this point, the participants also received the rating questionnaire which they should fill out after each film. That is, they could read through it and ask questions if anything had remained unclear. The experimenter then told them to relax and clear their mind of all thoughts, feelings, and memories before each clip. Subsequently, the light was turned off and the experimenter presented the first clip on a large projection screen (1,50m × 2,65m). Participants were sitting on average 3 meters in front of the screen. After each movie scene, ambient light was switched on, and participants filled out a 16-item emotion self-report inventory (items with German translation used in the sample were: amusement/lustig, anger/wütend, arousal/erregt, confusion/verwirrt, contempt/verachtend, contentment/zufrieden, disgust/angeekelt, embarrassment/verlegen, fear/ängstlich, happiness/erfreut, interest/interessiert, pain/verletzt, relief/erleichtert, sadness/traurig, surprise/überrascht, and tension/gespannt). The scale ex-

tended from 0 (not at all) to 8 (very strongly). We translated the scale from Gross and Levenson (1995), who in turn had adapted it from Ekman, Friesen, and Ancoli (1980). We included two additional items, liking and immersion, and asked participants after each film clip whether they had already seen the movie, and if they had chosen to close their eyes. A cover sheet explained all emotions and the two additional items in a few sentences, to make sure the meaning of the original rating scale was not lost in translation.

6.3.2 Results

Among the 54 film clips, we selected the 9 clips that had elicited the most (i. e. highest intensity) amusement, the 9 most fearful clips, and the 9 clips that had elicited the lowest levels of emotion. This final selection included funny scenes from *The Naked Gun: From the Files of Police Squad!* (1988), *Anger Management* (2003), and *Along Came Polly* (2004), scary scenes from *The Ring* (2002), *The Exorcism of Emily Rose* (2005), *Boogeyman* (2005), *Paranormal Activity* (2008), and *The Haunting in Connecticut* (2009), and neutral scenes from *Patch Adams* (1998) *Gangs of New York* (2002), *Garden State* (2004), *King Kong* (2005), and *Black Swan* (2010). In order for a film to be „neutral", the average rating of all emotions had to be less than 1 on the 9-point scale. In Figure 15, the mean ratings for all 27 clips are presented, broken down by genre. Both, comedy (M = 4.51, SD = 1.79) and scary movies (M = 4.39, SD = 1.97) were similarly intensive with an average value around 4.5. Also, the remaining emotions were similarly low in all three conditions (M_{comedy} = 1.46, SD = 1.26; M_{scary} = 1.69, SD = 1.43; M_{rest} = 1.92, SD = 1.25).

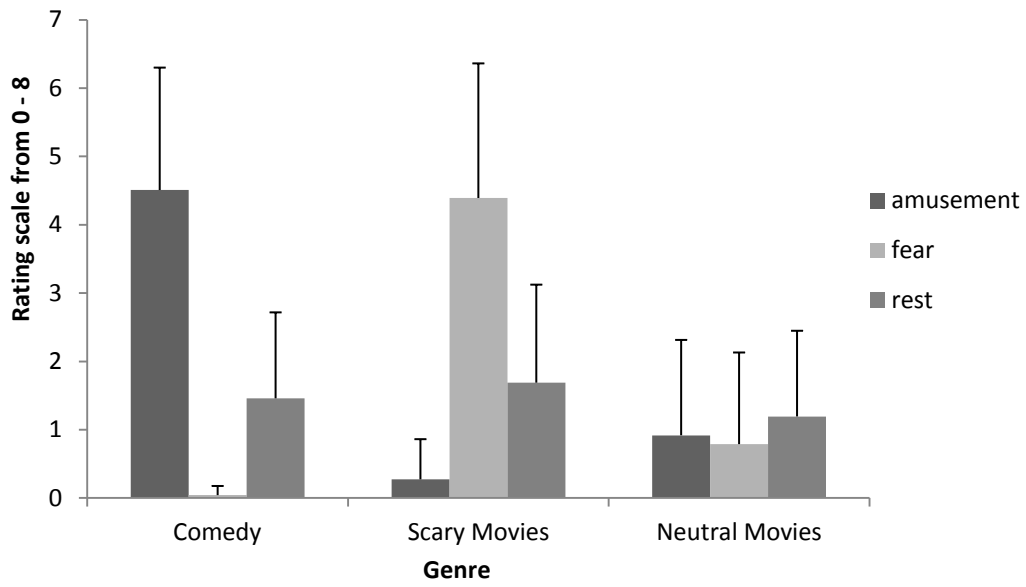

Figure 15. Mean intensity of emotional ratings for the target emotions (error bars represent standard deviations).

We also assessed the discreteness of the emotions of each clip, which was operationalized by deriving an idiographic hit rate index. The index consisted of the percentage of participants who indicated that they had felt the target emotion at least three points more intensely than the non-target emotion. In the case of the comedies, the hit rate was 94.10%, in the case of scary movies it was 92.71%. When we reduced the difference to only one point but included other basic emotions (amusement, anger, contentment, disgust, fear, sadness, surprise; Gross & Levenson, 1995), the hit rate dropped to 69.10% and 49.79% for comedies and scary movies respectively.

6.3.3 Discussion

The movie clips selected in the pre-study seem to adequately elicit the desired emotions. The intensity is similar to that found in other studies in the field while the discreteness is slightly lower (e.g. Gross & Levenson, 1995). The division into three categories worked very well with a high hit rate and we can assume in the subsequent studies that they

are valid. The movies selected in the pre-study were used in Experiment 1 and 2. In Experiment 3, slightly different movies were used due to the objective of the experiment. This will be detailed in the methods section of Experiment 3.

6.4 Experiment 1

We designed this experiment to test between social proof and facilitated bonding. If the social proof explanation was true, we would see the same results for canned laughter as for canned screaming. If instead facilitated bonding holds, we would expect opposite results for laughter and screaming sound tracks. The experiment was a fully crossed within-subject 3 **genre** (comedy, scary movie, neutral movie) × 3 **audience sound** (canned laughter, canned screams, no audience sound) design. Thus, each participant saw all conditions.

6.4.1 Methods

Participants

Four male and 26 female psychology students participated in the experiment in exchange for partial course credit. Mean age was 23.40 with *SD* = 5.81.

Audience reaction

We created for each of the 27 film clips three versions. In the neutral version, no audience reaction was used. In the other two conditions we introduced either canned laughter or canned screams. The audience reactions were collected from multiple internet sources. The stimuli had roughly the same length and were placed in each film 8 - 10 times. We tried to make sure that the audience sound could be interpreted as a reaction to the content of the material, albeit a sometimes unfitting one. Each individual clip had as much laughter in the canned laughter condition as screams in the canned screaming condition.

Questionnaire

The same questionnaire as in the pre-study was used in Experiment 1. It included demographic questions as well as the 16-item emotion self-report inventory. The scale for each emotion ranged from 0 (not at all) to 8 (very strong). Amusement and fear were our target emotions whereas the others served as distractor items. As before, we included an item for liking and another for immersion, and asked participants after each film if they had been familiar with it, and if they had closed their eyes. A cover sheet explained all emotions and the two additional items in a few sentences.

Procedure

Each student was tested individually in a within subject design. We used the same laboratory and the same screen as in the pre-study. Upon arrival at the laboratory, participants were seated 3.40 meters (horizontal viewing angle 45°) from the screen (1.50 m × 2.64 m) (see Figure 16). They first received a written description of the experiment which described the procedure, and were then told that we tested for surround effects on movie perception. Additional sound would be present during some clips, but they should not get too distracted by it. Participants then signed a consent form and were told that they could close their eyes and stop the experiment at any time without giving a reason. They were also informed of the fact that some information about the experiment might be disclosed to them only after the testing. Then, participants received the questionnaire and were asked to read the definitions for the rating scales.

For each of the 9 conditions, the participant saw three movie clips (e.g. three different scary movie clips with canned laughter), amounting to a total of 27 clips. The average rating for the three films per condition was then used for further analysis. The film clips were shown in random order and the light was switched off during the movie presentation. Five seconds after each movie scene had finished, ambient light was switched on and participants filled out

the rating scales. Sound track volume was controlled for and was between 60 - 70 dB. The whole experiment lasted about 1.5 hours. We tested for satiation effects but did not find that ratings systematically changed over time.

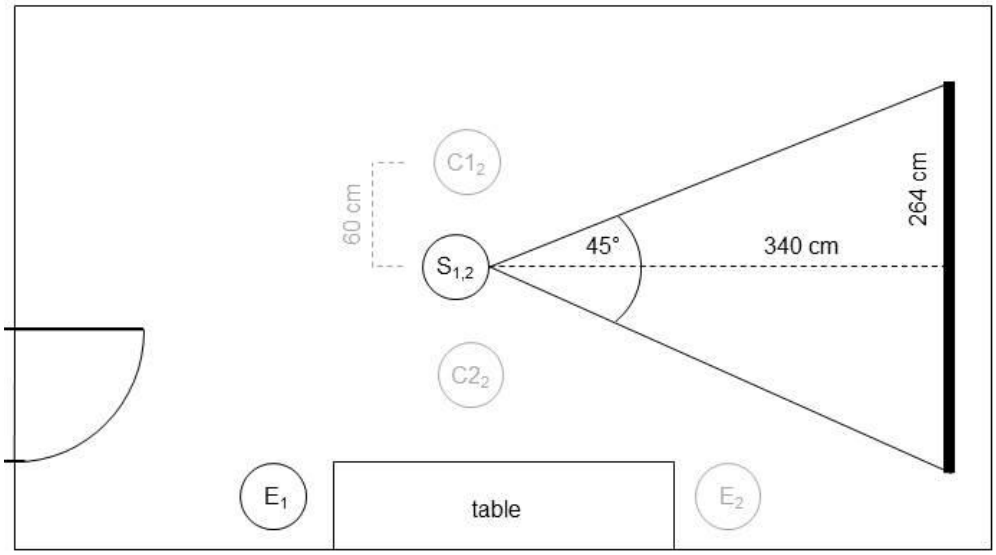

Figure 16. Set-up of Experiments 1 and 2. The seats marked in grey were only present in the second experiment. Inferior numbers indicate to which experiment/s the seats belonged. The pre-study took place in the same room with a very similar set-up.

E = experimenter, S = subject, C = confederate.

6.4.2 Results

Main findings

We performed a 3 × 3 (**genre**: comedy, scary movie, neutral movie × **audience sound**: canned laughter, canned screaming, no audience sound) two-way rmMANOVA with the dependent variables amusement, fear, liking, and immersion. A MANOVA was calculated to protect subsequent ANOVAs against *p*-value inflation. Mean scores of the dependent variables in relation to genre and audience sound are presented in Figure 17.

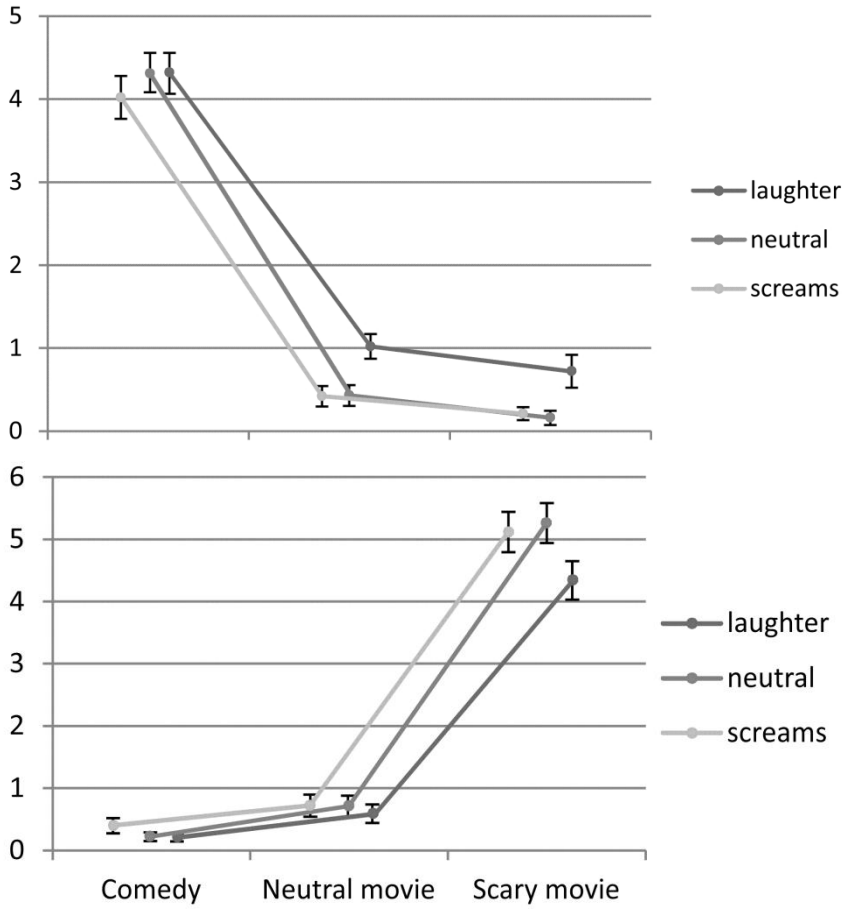

Figure 17. Mean scores of the dependent variables amusement (top) and fear (bottom) divided by genre and audience sound. Ratings ranged from 0 (not at all) to 8 (very strongly). Error bars indicate standard deviations.

A Pillai-trace test indicated significant main effects of genre, $F(10, 20) = 90.31$, $p < .001$, $\eta_p^2 = .89$, and audience sound, $F(10, 20) = 3.79$, $p < .001$, $\eta_p^2 = .26$, but no interaction between them, $F(10, 20) = .53$, $p = .98$, $\eta_p^2 = .04$. Univariate test of genre, using Greenhouse-Geisser correction for unequal sphericity, revealed that amusement ($F(2, 28) = 401.56$, $p < .001$, $\eta_p^2 = .93$), fear ($F(2, 28) = 271.65$, $p < .001$, $\eta_p^2 = .90$), liking ($F(2, 28) = 19.11$, $p < .001$, $\eta_p^2 = .40$), and immersion ($F(2, 28) = 10.79$, $p < .001$, $\eta_p^2 = .28$), differed among genres. The same procedure for audience sound unveiled a main effect for amusement ($F(2, 28) = 16.37$, $p < .001$, $\eta_p^2 = .36$), fear ($F(2, 28) = 8.03$, $p < .001$, $\eta_p^2 = .22$), but not for liking ($F(2, 28) = 1.14$, $p = .324$, $\eta_p^2 = .04$), or immersion ($F(2, 28) = 1.78$,

p = .186, η_p^2 = .06), We also found an interaction of genre and audience sound for rated fear (F(4, 26) = 8.03, p < .001, η_p^2 = .22) and immersion (F(4, 26) = 8.03, p < .001, η_p^2 = .22), but not for liking (F(4, 26) = 1.78, p = .186, η_p^2 = .06) and the remaining emotions (F(4, 26) = 1.78, p = .186, η_p^2 = .06). There was also a non-significant trend of an interaction of genre and audience sound for amusement (F(4, 26) = 1.81, p = .081, η_p^2 = .08).

Contrast analysis

A contrast analysis of the genre revealed that participants found comedies more amusing than neutral movies (F(2, 28) = 426.08, p < .001, η_p^2 = .94), which they found in turn more amusing than scary movies (F(2, 28) = 19.21, p < .001, η_p^2 = .40). Scary movies aroused more fear than neutral movies (F(2, 28) = 299.12, p < .001, η_p^2 = .91), which again were more scary than comedies (F(2, 28) = 4.71, p = .003, η_p^2 = .26). Participants liked comedies (F(2, 28) = 30.03, p < .001, η_p^2 = .51) and neutral movies (F(2, 28) = 21.74, p < .001, η_p^2 = .43) more than scary movies but were less immersed in them, F(2, 28) = 17.04, p < .001, η_p^2 = .37, and F(2, 28) = 11.46, p < .001, η_p^2 = .28 respectively. A contrast analysis of the audience sound showed that movies with a laugh track aroused higher amusement and less fear than movies without sound (F(2, 28) = 18.22, p < .001, η_p^2 = .37, and F(2, 28) = 11.66, p = .002, η_p^2 = .29) or with a scream track (F(2, 27) = 30.44, p < .001, η_p^2 = .51, and F(2, 28) = 10.55 p = .003, η_p^2 = .27).

We found a significant interaction between genre and audience sound. When watching a scary movie, the laugh track (as compared to the scream track) was significantly more efficient in reducing fear than it was when watching a comedy (F(4, 26) = 4.97, p = .034, η_p^2 = .15) or a neutral movie (F(4, 26) = 5.30, p = .029, η_p^2 = .15). Also, the laugh track was more efficient than no audience sound in reducing fear when comparing neutral to scary movies (F(4, 26) = 9.33, p = .005, η_p^2 = .24). Comedies where significantly more immersive with a laugh track while neutral movies were more immersive without one (F(4, 26) = 5.06,

p = .032, η_p^2 = .15). The same was true for scary movies. While comedies where most immersive with canned laughter, scary movies were most immersive with canned screams ($F(4, 26) = 12.14$, p = .002, η_p^2 = .30).

6.4.3 Discussion

The data suggest that we induced the desired target emotions with the movie selection. Comedies were rated as amusing and scary movies as scary, while neutral movies hardly elicited any emotions. Also, participants liked comedies and neutral movies more than scary movies, but the latter were more immersive. This should not be surprising because people usually prefer feeling happy to feeling scared. The higher immersion might reflect the higher intensity of fear compared to the intensity of amusement during the comedy (Cohen's d = 0.44). However, the data also showed that each genre produced the highest level of immersion with the appropriate audience reaction. Comedies were most immersive when playing a laugh track, scary movies when playing a scream track, and neutral movies when there was no audience sound at all.

On top of this, we found a general effect for the laugh track. No matter to which genre we added it, participants felt generally more amused than when there was no audience sound (d = 0.46) or canned screaming (d = 0.56). There was a clear trend for the laugh track to work best in the neutral and scary conditions. When looking at the effect between no laughter and canned laughter for comedies, it can be statistically neglected (d < .01). This finding supports former studies indicating that a laugh track works best in movies of weak comical content (Nonsanchuk & Lightstone, 1974). One alternative reason why the laugh track worked for the scary movies might be an incongruence effect. Laughter following a scary event might seem quite odd, and the incongruity itself might generate amusement. Our analysis revealed further that the laugh track was most efficient in reducing fear in scary movies, which were the only movies that elicited any noticeable fear.

Overall, there is a clear effect of the laugh track, whereas the scream track does not differ from no audience sound. This supports a differential effect of positive and negative emotion as predicted by facilitated bonding theory.

6.5 Experiment 2

In order to determine if these findings can be generalized to more realistic displays of emotion, or if they might be limited to artificial canned emotions, we designed another experiment that replaced the laugh and scream tracks with actors exhibiting the same emotions.

6.5.1 Methods

Participants

Thirty participants (18 female, 12 male) participated in the study voluntarily. Three participants saw through the cover story and were subsequently excluded from further analysis. Participants were on average 23.19 years old (*SD* = 5.64). Two-thirds of the participants were university students.

Material

The same films as in Experiment 1 were used. The only difference was that none of the clips had audience reactions. The reactions were produced by confederates. These were students trained in a four-hour session to deliver a very similar performance to the canned reactions in Experiment 1. The confederates were trained to show the same rehearsed reaction at any given scene. Their laughter and screams were less intense than those of the sound-track in the previous experiment to avoid overacting or appearance of artificiality. Laughter was operationalized by smiling, grinning, snorting, and loud laughter. Fear was operationalized by

tension, nervous twitching, heavy breathing, and screaming. Neutral emotions were conveyed by sitting quietly and avoiding quick movements, strong facial expressions or loud noises.

The questionnaire was substantially reduced to decrease testing time. We only kept the target items of amusement and fear as well as the distractor items interest, sadness, and embarrassment. Further, the feeling of immersion and liking was rated. The scale ranged from 0 (not at all) to 5 (very strongly). We included the questions „Did you notice anything unusual during the experiment?" and „If so, did that affect your answer pattern?" to assess the validity of our cover story.

Additionally, the experimenter observed the participants' behavior and rated it on amusement and fear. The scale was coded from 0 (neutral face) to 5 (loud laughter, closes eyes or looks away).

Procedure

Upon arrival at the laboratory, participants met one of the confederates who was already „waiting" for the experiment to start. The second confederate arrived shortly after the participant. All three „participants" were led into the laboratory. They were told that the objective of the experiment was to test the effect of sitting angle on movie perception. Subsequently, they were asked to draw a number out of a hat. The numbers were rigged to ensure that participants would sit between the two confederates separated by 60 cm on either side. As in the previous experiment, participants were sitting 3.40 meters away from the screen, amounting to a vertical viewing angle of 45°. Laboratory and screen were the same as in Experiment 1 (see Figure 17).

Participants and confederates filled out a consent form and acknowledged that they could close their eyes or stop the experiment at any time. They consented to rate the movies and were made aware that not all details of the study could be disclosed in the beginning but that a full debriefing would follow after the testing. They then received the questionnaire and

had an opportunity to ask questions. After they had finished, the light was switched off, and the experiment proceeded as Experiment 1. In the end, participants were fully debriefed about the purpose of the experiment and were able to withdraw their consent.

6.5.2 Results

Main findings

All values were transformed to a 0 - 8 scale by multiplying the values with 1.5. This only affected the descriptive values, so that they could be compared to Experiments 1 and 3. Subsequently, these values are reported here (Figure 18). Note that the interference statistic is not changed by this procedure.

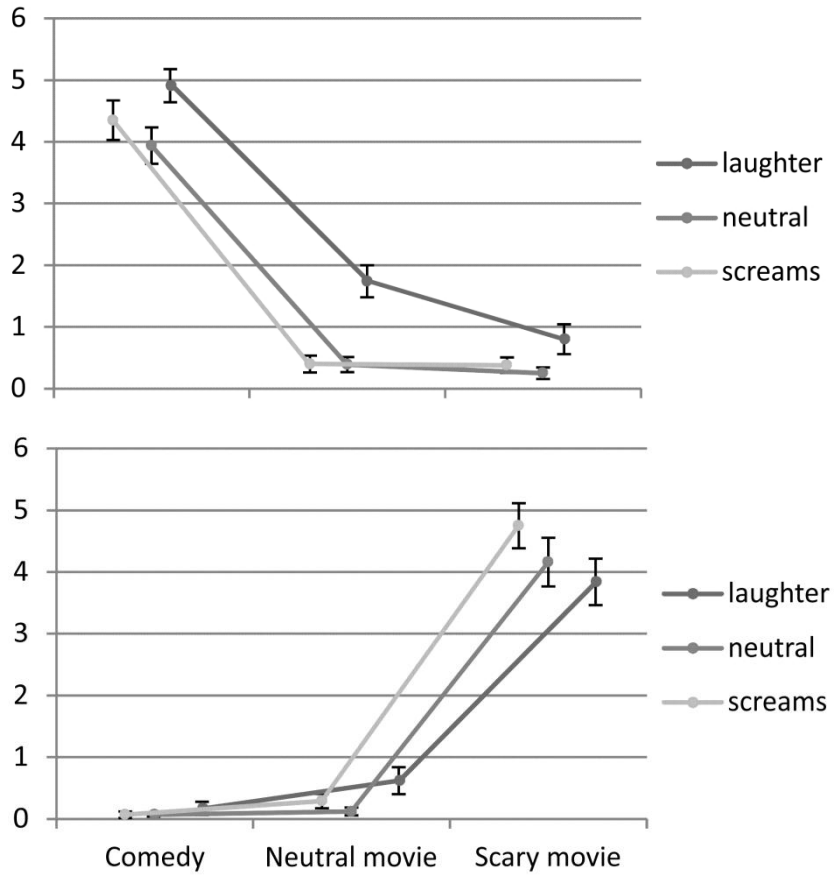

Figure 18. Means and standard deviations for the target emotions amusement (top) and fear (bottom). Values ranged from 0 (not at all) - 8 (very much).

We conducted a 3 × 3 (genre: comedy, scary movie, neutral movie × audience sound: laughter, screams, no reaction) two-way rmMANOVA with the dependent variables amusement, fear, liking, and immersion. Using Pillai's trace, we found main effects for genre ($F(8, 22) = 65.27$, $p < .001$, $\eta_p^2 = .82$) and audience reaction ($F(8, 22) = 6.18$, $p < .001$, $\eta_p^2 = .31$), as well as an interaction between the two ($F(16, 14) = 3{,}48$, $p < .001$, $\eta_p^2 = .11$). Univariate test of genre, using the Greenhouse-Geisser correction, indicated a significant effect on amusement ($F(2, 28) = 585.93$, $p < .001$, $\eta_p^2 = .89$), fear ($F(2, 28) = 130.54$, $p < .001$, $\eta_p^2 = .82$), liking ($F(2, 28) = 22.37$, $p < .001$, $\eta_p^2 = .44$), and immersion ($F(2, 28) = 5.85$, $p = .008$, $\eta_p^2 = .17$). We also found an effect of audience sound on amusement ($F(2, 28) = 26.42$, $p < .001$, $\eta_p^2 = .48$), and liking ($F(2, 28) = 3.19$, $p = .048$, $\eta_p^2 = .10$), but not on immersion ($F(2, 28) = 0.24$, $p = .789$, $\eta_p^2 = .01$). There was a non-significant trend of fear ($F(2, 28) = 2.85$, $p = .076$, $\eta_p^2 = .09$). The MANOVA indicated a significant interaction between genre and audience sound on fear ($F(2, 28) = 8.60$, $p < .001$, $\eta_p^2 = .23$), but not on liking ($F(2, 28) = 2.51$, $p = .120$, $\eta_p^2 = 06$). There was also a non-significant trend on amusement ($F(2, 28) = 2.69$, $p = .060$, $\eta_p^2 = .09$) and immersion ($F(2, 28) = 2.51$, $p = .066$, $\eta_p^2 = .08$).

Contrast analysis

A contrast analysis revealed that comedies were rated to be more funny than neutral movies ($F(1, 29) = 237.20$, $p < .001$, $\eta_p^2 = .89$) and scary movies ($F(1, 29) = 282.82$, $p < .001$, $\eta_p^2 = .91$). Also, neutral movies were rated as more amusing than scary movies ($F(1, 29) = 8.32$ $p = .007$, $\eta_p^2 = .22$). In turn, scary movies aroused more fear than neutral movies ($F(1, 29) = 130.31$, $p < .001$, $\eta_p^2 = .82$) or comedies ($F(1, 29) = 138.80$, $p < .001$, $\eta_p^2 = .83$). Comedies were less scary than neutral movies ($F(1, 29) = 7.14$, $p = .0120$, $\eta_p^2 = .20$). Participants liked comedies more than neutral movies ($F(1, 29) = 10.57$, $p = .003$,

η_p^2 = .27), which they liked more than scary movies (F(1, 29) = 13.43, p = .001, η_p^2 = .31). However, they found scary movies significantly more immersive than comedies (F(1, 29) = 9.70, p = .004, η_p^2 = .25). Confederates' laughing led to higher mirth scores than when they did not laugh (F(1, 29) = 41.95, p < .001, η_p^2 = .59) or showed signs of fear (F(1, 29) = 22.94, p < .001, η_p^2 = .44). Also, participants liked movies more when there was laughter than when there was none (F(1, 29) = 6.00, p = .021, η_p^2 = .17).

There was a significant interaction between genre and audience sound for the fear ratings. Whereas the screams of confederates had almost no effect during the comedy, they heightened the fear level during scary movies, opposite to the effect of the confederates' laughter (F(1, 29) = 20.63, p < .001, η_p^2 = .42) or to neutral reactions (F(1, 29) = 7.12, p = .012, η_p^2 = .20). The same was true for the neutral movies versus the scary movies. Compared to no reaction, the confederates' signaling of fright aroused stronger fear in the congruent scary movies than in the incongruent neutral movies (F(1, 29) = 9.89, p = .004, η_p^2 = .25).

Experimenter ratings of participants' amusement and fear correlated highly with self-reported emotions. Amusement was correlated with r = .57, p < .001 and fear with r = .63, p < .001. Thus, when participants felt amused or scared, they usually showed it.

6.5.3 Discussion

Experimenter ratings of participants' emotions correlated highly with self-reported experience. We introduced this measure to validate our questionnaire. We are aware that a single experimenter rating, when the experimenter is aware of the condition, does have serious limitations, however, the findings support our claim that participants reported genuinely on their experiences.

Most of the findings in this experiment showed the same pattern as observed in Experiment 1. That is, each genre produced the corresponding emotions. Also, participants liked

comedy and neutral movies more than scary movies but were more immersed in the scary movies. In accordance with Experiment 1, the movies with the appropriate audience reaction produced the highest level of immersion. We found a general effect for audience laughter; with it participants felt more amused than when confederates showed no reaction (d = 0.79) or signs of fear (d = 0.62).

There were, however, two important differences. Firstly, the confederates' laughter raised amusement ratings in all conditions, including the comedies (with d = 0.63). In Experiment 1, this had not been the case. Secondly, the scream track had an enhancing effect on congruent scary movies when the screams were real - which was not the case for the canned screams used in Exp. 1 (d = 0.28). This difference with respect to the scary movies is compatible with a role of social proof when evaluating one's fear level, but not with positive bonding.

6.6 Experiment 3

To test if social proof had an influence on the amusement ratings of our participants, we developed an experiment that was sure to work only under the social proof paradigm. In Experiment 3, participants were exposed to confederates who explicitly rated the emotions of movies, as opposed to only implicitly showing them by laughing or screaming in the presence of the participant.

6.6.1 Methods

Participants

Twenty participants (10 female, 10 male) participated in the study voluntarily. None of the participants knew the Asch (1951) conformity experiments, as evaluated in the questionnaire. Mean age was 21.50 years (SD = 3.56).

Material

In this experiment we used 24 comedies and scary movies. Half of these were not particularly intense, with low to medium ratings (M = 3.22, SD = 1.58; M = 2.92, SD = 1.13), while the other half consisted of the movies previously rated to be most funny (M = 4.54, SD = 1.29) and most scary (M = 4.68, SD = 1.34). Participants saw three samples of each of the eight movie conditions that resulted when fully crossing genre (comedy vs. scary), intensity (high vs. low), and social pressure (consistent vs. inconsistent).

A questionnaire was given to the participants after the experiment. The questions „How well could you immerse yourself in the movies?", „How likeable did you find the other participants?", and „How much did the ratings of the others influence your ratings?" were answered on 9 point Likert-like scales ranging from 0 (not at all) - 8 (very much). Participants were further asked if they had answered faithfully, how many of the movies they had already known, and if they knew the Asch conformity experiment. The questionnaire ended with questions about age, sex, and occupation.

Procedure

In each screening, the participant, three confederates, and one experimenter participated. Upon arriving at the laboratory, the participant had to wait with the confederates until the experimenter was ready. This gave confederates a chance to talk to the participants, which facilitated the formation of an in-group atmosphere. Then the experimenter asked the group to come in, explained the cover story, and pointing out the pilot character of the study asked for quick verbal ratings of the presented movies. Scary movies and comedies where shown in blocks, so that participants either began with 10 scary movies (rating them on scariness) followed by 10 comedies (rating how funny they were), or they began with the comedies followed by the scary movies. The rating scales ranged from 0 (not at all) - 8 (very much). To ensure that the participant would be last with her/his ratings (and thus had already heard all

the other ratings) a manipulated lottery for the seats was conducted (Figure 19). Initially, participants were informed that scary movies would be shown as part of the experiment and that they could close their eyes or stop the experiment at any given time.

The first six movies presented in each genre, three of high intensity and three of low intensity, were non-critical trials. Confederates rated these clips with the same intensity as had the participants in the pre-study, producing consistent social pressure. In the next six film clips, the critical trials, confederates always rated the scenes opposite to the original intensity ratings. This meant that movies with low ratings on the amusement/fear scale were rated in the critical trials to be of high intensity, and vice versa, producing inconsistent social pressure.

After the experiment, participants received a questionnaire. Once finished they were fully debriefed about the purpose and the goal of the experiment and had the chance to withdraw their consent.

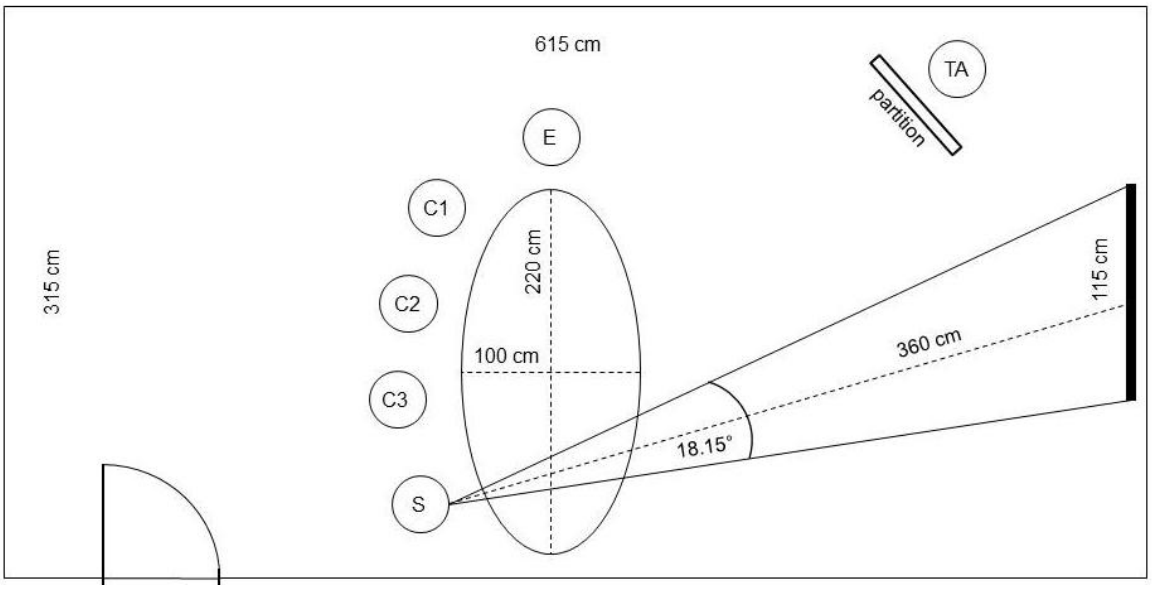

Figure 19. Set-up of Experiment 3. E = experimenter, C_{1-3} = confederates, S = subject, TA = technical assistant.

6.6.2 Results

We calculated the difference between the initial ratings of the movies in the pre-study and the current ratings produced by the participants. Deviation from the mean rather than the mean itself was used to compare all 3 conditions against each other. If we had used the means, high and low valence movies would differ by definition and a meaningful comparison would not be possible. We then performed a 2 × 2 × 2 (genre: comedy vs scary movie × valence: high vs low × social pressure: consistent vs inconsistent) rmANOVA with the dependent variable amusement for comedies and fear for scary movies. Mean scores of the dependent variables are presented in Table 6.

Table 6

Mean differences between original intensity ratings and participants' judgments. Negative numbers indicate the opposite direction to the confederates' ratings. The numbers in parentheses indicate standard deviations.

	Comedy		Scary movie	
	High valence	Low valence	High valence	Low valence
Consistent social pressure	0.28 (0.94)	-0.18 (0.92)	0.42 (1.04)	-0.62 (0.90)
Inconsistent social pressure	2.23 (0.98)	-1.97 (1.29)	1.66 (1.24)	-1.29 (1.08)

We found main effects for genre, valence, and social pressure, but no effect for the interaction of these variables, using univariate test with Greenhouse-Geisser correction. Comedies led to higher deviations in the emotion ratings than scary movies ($F(1, 19) = 7.80$, $p = .012$, $\eta_p^2 = .29$). We also found that movies with high valence lead to more variance than movies with low valence ($F(1, 19) = 7.80$, $p = .012$, $\eta_p^2 = .29$). When participants were exposed to inconsistent social pressure, this lead to a stronger deviation from the original movie

ratings than when consistent social pressure was applied, $F(1, 19) = 133.93$, $p < .001$, $\eta_p^2 = .88$ (Figure 20).

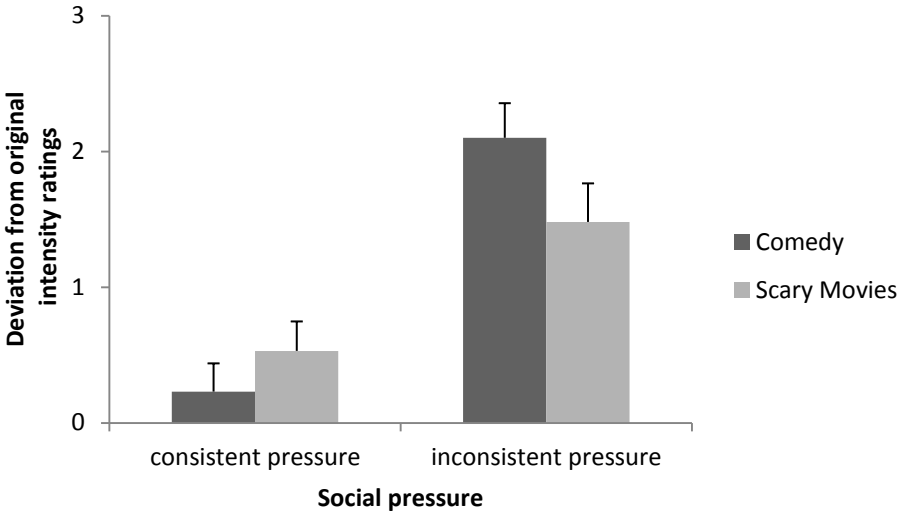

Figure 20. Inconsistent pressure led to a stronger deviation from the original movie rating than inconsistent pressure. Error bars represent standard deviation.

6.6.3 Discussion

Social pressure produced remarkably strong changes in the emotional assessment of the movie. This was the case for both comedies and scary movies, albeit with even higher deviations in the emotion ratings in comedies than in scary movies. We speculate that participants have been somewhat less prone to social pressure and more reliant on their „gut feeling" during scary movies compared to comedies. This might reflect that humor is typically more of a social agent than fear. The data also show that movies with high valence produced more variance in the ratings than movies with low valence. One explanation for this could be that we feel emotions in high valence situations more clearly and are thus less inclined to follow the judgment of others. This is supported by previous research, which found that social proof worked particularly well in ambiguous situations (Cialdini, 1993).

6.7 General Discussion

Why do laugh tracks continue to be added to many sitcoms? When measuring the emotional reactions to thus enhanced movies, the former appear to be intensified by the laugh track. We sought to determine whether universal social proof processes can explain the effect. If this is the case, the negative siblings of the laugh track - such as added screaming in horror movies - should have a similar enhancing effect. Alternately, if the impact of the laugh track is carried by positive social bonding, then the effect should be unique to laugh tracks. In other words, scream tracks should have no comparable enhancing effects.

To test this conjecture, we added an unusual sound track of canned screaming to clips from different film genres. Enhancing effects of such negative sounds could not be attributed to facilitated bonding with the would-be audience but rather would indicate general social proof. An indeed, the first experiment supports facilitated bonding theory. The laugh track increased the amusement ratings of the audience as compared to a neutral track, whereas the scream track did not differ from the neutral track.

Giles and Oxford (1970) already showed that laughter can serve as social cue. In Experiment 1, this seems to be the dominant function of the laugh track. It serves as an invitation to laugh along rather than serving as additional information about the funniness of the material.

We also considered whether the inconsistency of laughter in scary movies might affect participant judgments. Informal interviews after the experiment indicated that it had an effect, but that it was not the main reason why participants found movies with a laugh track funnier. In fact, participants noticed the different tracks in the beginning but did not pay attention to them after the first couple of clips. When quizzed about where we used which track, participants were not able name the movies reliably.

These findings clearly support facilitated bonding and argue against general social proof. However, maybe this merely holds for canned emotions, possibly not generalizing to

live emotions. Thus, we conducted Exp. 2 and 3 to assess if the facilitated bonding carries over to real displays of emotion.

The results of the second experiment indicate that this is not the case. Quite in agreement with social proof theory, the social environment did bias emotional ratings regardless of content and direction. In Experiment 2, confederates of the experimenter, rather than the anonymous sound track, produced laughter or screams. Laughter led to higher amusement ratings and screams led to an increase in fear.

The third experiment further tested the social proof concept by administering either consistent or inconsistent social proof. Four confederates provided the setting for the participant. Displays of emotion inconsistent with the movie had strong effects, likewise for positive (laughter) and negative (screaming) emotions, thus providing clear support for social proof.

This is in line with the Asch (1951) conformity experiments, which showed that not just behavior but also perception may be altered by the judgment of other people. Participants considered the opinion of others before they made their own decision. Shariff and Tracy (2011) additionally showed that both emotions, happiness and fear, can serve to convey social proof. In their review article they provide evidence for the communicative function of emotions in various contexts.

Why does it look like facilitated bonding in the case of canned laughter whereas it looks like social proof when emotions are displayed by live actors? Apparently, evidence for social proof cannot be easily faked. The stronger and more universal effect of social proof seems to require stronger and more authentic data than the bonding effect. One cannot go wrong bonding with a positive would-be audience, but one could potentially go wrong bonding with a negative audience. Thus, observers appear to be willing to bond with rather artificial positive moods indicated by a laugh track, but not so by an artificial negative scream track.

Our study focused solely on quantitative differences that occurred due to artificial or real display of emotions. In our and other laboratory studies, the material that was shown was stripped of its context. Factors such as knowledge of the show and its characters, watching it over a longer period, and placing it in a cultural and social context, might change the evaluation of a laugh track. This leaves open the possibility that the facilitating effects we have found for canned laughter may not work in some cases not considered here.

In sum, we found that effects of canned laughter are best explained by facilitated bonding, whereas effects of real laughter are best explained by social proof. The predominant function of laughter changes according to the setting within which the spectators are placed. In the setting of watching TV, the spectator maximizes the positive emotional experience by allowing for positive bonding while avoiding the potentially unpleasant effects of social proof.

7. THE AUDITORY KULESHOV EFFECT: MULTISENSORY INTEGRATION IN MOVIE EDITING[7]

7.1 Abstract

Almost a hundred years ago, the Russian filmmaker Lev Kuleshov conducted his now famous editing experiment in which different objects were added to a given film scene featuring a neutral face. It is said that the audience interpreted the unchanged facial expression as a function of the added object (e.g. an added soup made the face express hunger). This interaction effect has been dubbed "Kuleshov effect". In the current study, we explored the role of sound in the evaluation of facial expressions in films. Thirty participants watched different clips of faces that were intercut with neutral scenes, featuring either happy music, sad music, or no music at all. This was crossed with the facial expressions of happy, sad, or neutral. We found that the music significantly influenced participants' emotional judgments of facial expression. Thus, the intersensory effects of music are more specific than previously thought. They alter the evaluation of film scenes and can give meaning to ambiguous situations.

7.2 Introduction

In the wake of the 20th century, the Soviet filmmaker Lev Kuleshov (1899–1970) conducted a series of experiments. In one experiment, he filmed then-famous actor Ivan Mozhukin looking into the camera with a neutral expression and intercut the face with a bowl of soup, a female in a coffin, a girl playing, or a beautiful woman lying on a couch. Unfortunately, the original footage was lost and reports about the experiment are somewhat conflicting (Hill, 1967; Pudovkin, 1970). All reports agree on that the audience who watched the short film interpreted the unchanged facial expression of Mozhukin differently depending on the object. The face was interpreted as sad in the presence of the coffin but hungry when

[7] Baranowski, A.M., et al. (in press). The Auditory Kuleshov Effect: Multisensory integration in movie editing. *Perception.*

the soup was added. This technique of intercutting faces with emotional context to alter the viewers' interpretation of the faces, is nowadays cited in almost every introductory film study book and has been dubbed Kuleshov effect.

Only in recent years have researchers begun to study the Kuleshov effect, and only three studies on it have been published so far. A first attempt to replicate the original study by Prince and Hensley (1992) did not find any evidence for the existence of the Kuleshov effect. They presented a close-up of a face to 137 students, edited together with a shot of a little girl playing, a woman lying in a coffin, and a bowl of soup. The film was professionally made and edited and stayed close to the alleged design of the original experiment. However, this was a single-trial between-subject experiment, which is prone to noise in the data.

Mobbs et al. (2006) presented very short (4 s) film sequences consisting of negative, positive, or neutral valence. After this context manipulation, 14 participants had to rate the emotional expression of mostly neutral faces, some of which were edited to appear slightly happy or sad. Film sequences and faces were separated by a jittered interstimulus interval of between 4 and 8 seconds. Participants rated the faces for emotional expression and mental state. Additionally, Mobbs and colleagues used fMRI to detect neuronal activity changes in the brain. They found that positive context leads the participants to rate the faces as happier, whereas negative context led to higher ratings of sadness. The fMRI data also suggested that the emotional context had been particularly salient and activated regions related to emotion processing such as the amygdala. While the study supports the Kuleshov effect, the design is somewhat problematic. In particular, object shots were shown before the faces, reversing the order of the original Kuleshov effect. To collect fMRI data, the authors were also forced to leave a time gap between the presentation of the context scene and the face, thus removing the direct transition from scene to face and reducing the chance that they are perceived as temporally connected.

More recently, Barratt and colleagues (2016) tested 36 participants using 24 film sequences across five emotional conditions (happiness, sadness, hunger, fear, and desire) and a neutral control condition. The stimuli were presented by first showing the still image of a neutral face, followed by a short video clip ending with the same neutral face. Participants were asked to rate the emotional expression of the faces, as well as valence and arousal. Barratt et al. (2016) found that participants tended to choose the appropriate category more frequently than the alternative options, while the answers to the valence and arousal questions also went in the expected directions (but were only significant for the sadness and desire conditions).

The rationale behind the Kuleshov effect is that a given facial expression is always perceived relative to the entire context. The facial close-up provides an emotional range, which is further interpreted. A laughing person is most likely not sad, but the context is used to determine the degree of happiness perceived by the viewer. In particular, if the facial expression stays neutral, the context will provide information that is used to evaluate the emotional state of the actor (Carroll, 1996). Studies of contextual influence on affective face processing have shown similar effects outside the realm of films. Contextual cues are used to assess facial expressions (Carroll & Russell, 1996; Wallbott, 1988; Wieser & Brosch, 2012; Zhang, Fu, Chen, & Fu, 2014).

Do similar effects exist for non-diegetic sound? Non-diegetic effects of sound are almost universally employed in modern day film. For instance, Bouhuys, Bloem, and Groothuis (1995) demonstrated that music can be used as an affective primer to influence a viewer's evaluations about a character's emotions. Likewise, Tan, Spackman, and Bezdek (2007) found that music is an effective primer for emotions and additionally for expected intentions. Eldar and colleagues (2007) presented participants with neutral film clips containing emotional music. They found that the emotional evaluation of the clips changed in accordance with the music. A further study showed that empathy-related judgments of film

characters were modulated by music. The protagonist was rated as more likable when accompanied by melodramatic music as compared to tense music (Hoeckner, Wyatt, Decety, & Nusbaum, 2011). Jolij and Meurs (2011) manipulated the mood of the participants with music. In a subsequent stimulus detection task, they found that not only were faces congruent with the participant's mood easier detected. Participants produced a high number of false alarms, seeing faces congruent with their mood, which were not there.

In addition, neurophysiological studies have confirmed the enhanced affective effect of combined congruent auditory and visual stimuli. Baumgartner, Esslen, and Jäncke (2005), for example, found that psychophysiological measures (heart rate, skin conductance, respiration and skin temperature) as well as alpha-power-density as measured by EEG, for sad, happy, and fearful faces, in combination with congruent music, increased, compared to pictures or music alone. In an fMRI study with a similar design, Baumgartner, Lutz, Schmidt, and Jäncke (2006) found increased activation of brain areas associated with emotion processing, when presenting visual and auditory stimuli simultaneous. Most importantly, the fusiform gyrus (FG) and areas involved in the auditory processing like the superior temporal gyrus (STG) showed increased activation. In agreement with Baumgartner et al. (2006), Jeong et al. (2011) found increased activation in the fusiform gyrus (FG) and the superior temporal gyrus (STG) in congruent conditions for sad and happy faces, while they found activation to be greatest in FG for incongruent conditions. The authors suggested that there is an increased activation in areas related to auditory stimuli in congruent conditions, while incongruent conditions result in a higher activation of regions involved with the processing of facial information.

Music elicitation of emotions can be explained by several factors including association/memory, empathic responses, cognitive evaluation and signaling (Hanser, & Marks, 2013). Film music often works by association and memory. Sounds that have strong associations with particular emotions are used to activate these associations in the viewer. The

advantage of the use of sound to elicit emotions is that they directly and quickly activate associated emotions in the perceiver (Kamiyama et al., 2013; Logeswaran & Bhattacharya, 2009). Combining the sound with congruent visual information usually leads to an enhanced intensity of the emotional reaction while incongruent pairing can produce paradox results (Pavlović & Marković, 2011).

In the current study we tested whether next to these non-diegetic sound effects, the emotions induced by a soundtrack are able to change the perceived expression of a face seen in the film. In other words, is there an auditory Kuleshov effect? If this is so, changing the emotional tone of a neutral film sequence by playing emotional music (Eldar et al., 2007), should alter the perception of a facial expression. We chose happy and sad music, because these are the most distinctive musical categories, and crossed them with happy and sad facial expressions. Our main hypothesis was that the evaluation of the facial expression changes according to the emotional category of the music.

We also aimed at improving the design of previous studies on the visual Kuleshov effect. Barratt et al. (2016) rightfully pointed out that the Kuleshov effect relies on point-of-view editing. This means that the scene of the onlooker and the film scene must be temporally and spatially connected; the onlooker is actually looking at the emotional scene. If this is not the case, the Kuleshov effect cannot work because the facial expression of the observer is not linked to the emotional scene.

To increase the likelihood of the viewer to infer such a relation, Persson (2003) proposes eight conditions that should be met: (1) the actor does not look directly into the camera; (2) the object shot is presented from the perspective of either the actor or an observer; (3) the object shot is preceded and followed by a glance shot; (4) the environment of the actor close-up matches the environment of the object; (5) the actor changes their behavior just before the cut in the first shot; (6) the actor shows some form of reaction in the second glance shot; (7) the soundtrack for all shot is continuous; and (8) the spatial relation between the

actor and the object is established beforehand. In our stimuli, we managed to realize all but the fifth rule (see Method section for details). Reactions (if present) always followed the object shot.

We also crossed the music with facial expression, making our study a 3 x 3 (facial expression: neutral, happy, sad x music: neutral, happy, sad) design. There were two reasons to include different emotional expressions in our study. First, we wanted to explore the intersensory integration of music and facial expression. Would the visual modality carry more weight such that a smiling face with sad music is still perceived as happy? Second, the fully crossed design is preferable to merely change the soundtrack, as it reduces demand characteristics (see Barratt et al., 2016).

We hypothesized that the intersensory cross-talk is mutual, that is we expected to find that soundtrack and facial expression both contribute to the perceived emotionality of the film clip.

7.3 Methods

7.3.1 Participants

Thirty psychology students (female = 21, male = 9) participated in the experiment on a voluntary basis. Age ranged from 20 to 31 years (M = 23.40, SD = 3.60). All subjects had normal or corrected-to-normal vision.

7.3.2 Materials

Four actors were filmed separately with identical camera settings. The actors were sitting at a 30° angle with respect to the camera and a computer screen was visible on the left side of the frame. In accordance with Mobbs et al.'s (2006), the actors looked at the screen, which allowed for the use of multiple neutral scenes and settings that would not have been possible if we tried to create the illusion that the actor was actually present in the neutral

context scene. This is a departure from the original Kuleshov design, where the illusion was created that the actor was actually present in the viewed scene. The camera was placed on a tripod one meter away from the actors, and a head and shoulder close-up was produced. In post-production, we produced nine versions of each clip. In the beginning, the actor was always looking with a neutral expression at the computer screen for 3 seconds, followed by a neutral scene of random events (e.g. a man walking down a hallway, a woman grocery shopping) that lasted 15 seconds, taken from the video platform YouTube. The sound of these neutral scenes was muted. Afterward, we cut back to the actor for another three seconds, amounting to a total of 21 seconds for each clip. In the last shot, the actor had a neutral, happy, or sad facial expression. To ensure authentic reactions, we asked the actors to watch congruent self-selected emotional stimuli during filming. Six researchers then validated each facial expression independently. The neutral expression was in accordance with Kuleshov's original experiment, while happy or sad facial expressions were a departure from the original design. These emotional expressions were included to explore the intersensory integration of music and facial expression. In addition, crossing music with facial expression reduced demand characteristics of the stimulus material. The clips were edited in accordance with Persson's (2003) eight rules for creating a point-of-view structure (p. 6), increasing the likelihood for a Kuleshov effect to appear (see Barratt et al., 2016, for a discussion of these rules and their relation to the Kuleshov effect). Additionally, we added happy or sad music to each clip or kept it without music as control. We considered using white or pink noise as a control, but while some people find it neutral, others find it calming or annoying. The music was taken from various online film music databases, and only unknown music was chosen. All music was emotionally categorized by the composer and was only instrumental. Six researchers additionally validated the music with high concordance.

7.3.3 Procedure

Each participant was tested individually. Upon arrival in the laboratory, participants were seated 3 meters from the screen (size 115 cm x 65 cm; horizontal visual angle 22°). The room was darkened, and sound was provided via speakers. After signing a consent form, we asked participants to watch 27 film clips, 3 for each of the 9 conditions (3 music x 3 facial expressions). Every clip was followed by a pause during which participants had time to fill in a short questionnaire. Participants were instructed to rate the perceived emotional state of the actor in each clip on the six basic emotions anger, disgust, fear, happiness, sadness, and surprise (Ekman & Friesen, 1971) on scales ranging from 0 (emotion not present) to 5 (emotion strongly present). Target emotions were happiness and sadness, whereas the others served as distractors. This was to ensure that participants reported all emotions they perceived and avoid demand characteristics that would have been present if only one emotion was allowed to select. Additionally, this way, paradox emotions that could result from incongruent music and facial expressions were recorded. The average ratings of the target emotions for the three films per condition were then used for further analysis. The film clips were shown in random order and the whole experiment lasted about an hour. After they finished, participants were asked whether they had previously seen any of the short video clips and were debriefed. None of the participants had seen any of the short video clips before.

7.4 Results

As illustrated in Figure 21, music and facial expression mutually influenced the emotional ratings. We conducted a 3 x 3 (facial expression: neutral, happy, sad x music: neutral, happy, sad) two-way rmMANOVA with the dependent variables happiness and sadness. Using Pillai's trace, we found main effects for music ($F(4, 26) = 5.42$, $p = .003$, $\eta_p^2 = .46$), facial expression ($F(4, 16) = 22.02$, $p < .001$, $\eta_p^2 = .77$), and a significant interaction between the two ($F(8, 22) = 3.06$, $p = .018$, $\eta_p^2 = .53$). Music significantly

influenced happiness ($F(2, 58) = 9.52$, $p < .001$, $\eta_p^2 = .25$) and sadness ratings ($F(2, 58) = 3.29$, $p = .044$, $\eta_p^2 = .10$), as did the facial expression ($F(4, 16) = 34.42$, $p < .001$, $\eta_p^2 = .54$ and $F(4, 16) = 9.00$, $p < .001$, $\eta_p^2 = .24$, respectively). An interaction effect existed only for sadness ratings ($F(4, 116) = 4.54$, $p = .002$, $\eta_p^2 = .14$), but not for happiness ratings ($F(4, 116) = 0.63$, $p = .590$, $\eta_p^2 = .02$).

A contrast analysis revealed that our actors were rated as significantly less happy when accompanied by sad music ($M = 1.19$, $SD = 0.62$), as compared to happy music ($M = 1.74$, $SD = 0.64$) or no music at all ($M = 1.47$, $SD = 0.65$), with $F(1, 29) = 15.42$, $p < .001$, $\eta_p^2 = .35$ and $F(1, 29) = 9.54$, $p = .004$, $\eta_p^2 = .25$, respectively. Happy music had the reverse effect on sadness ratings, making actors look less sad ($M = 0.70$, $SD = 0.47$) compared to sad music ($M = 1.00$, $SD = 0.77$), with $F(1, 29) = 3.12$, $p = .037$, $\eta_p^2 = .14$. The no music condition received intermediate ratings ($M = 0.91$, $SD = 0.64$) but did not differ significantly from either of the two groups (Figure 21).

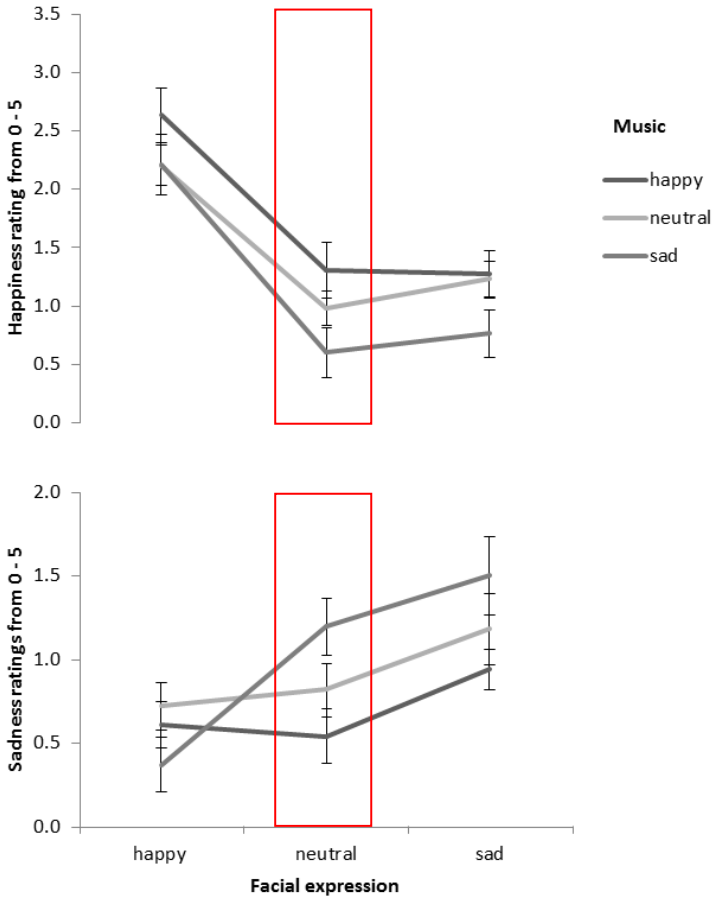

Figure 21. Happiness and sadness ratings for music crossed with facial expression. The expected effect was strongest in the neutral facial condition (red boxes).

Error bars indicate SEM.

The facial expression of the actors had a strong effect on perceived emotions. Happy faces were rated as happier (M = 2.35, SD = 0.80) than neutral (M = 0.96 SD = 0.59) or sad (M = 1.09 SD = 0.97) faces, with $F(1, 29) = 93.54$, $p < .001$, $\eta_p^2 = .76$ and $F(1, 29) = 30.25$, $p < .001$, $\eta_p^2 = .51$, respectively. Likewise, sad facial expressions lead to significantly higher sadness ratings (M = 1.21, SD = 0.79) than neutral (M = 0.85, SD = 0.75) or happy (M = 0.57, SD = 0.44) faces, $F(1, 29) = 93.54$, $p < .001$, $\eta_p^2 = .76$ and $F(1, 29) = 30.25$, $p < .001$, $\eta_p^2 = .51$.

7.5 Discussion

Faces were rated as happier when they watched scenes accompanied by happy music. And they were rated as less happy when they watched scenes accompanied by sad music. This intervention worked well and in accordance with our hypothesis. Participants rated faces that watched a scene accompanied by happy music as less sad than when accompanied by sad music. Sad music did not lead to significantly higher sadness ratings than no music, however, when looking only at the neutral faces, the music had the expected effect for all categories. Happy music made neutral faces seem significantly happier and sad music made neutral faces significant sadder.

The interaction effect seems to be carried by the happy faces in the sad music condition. They did not reduce the sadness ratings as expected, but rather seemed to increase them. Happy faces were rated least sad when accompanied by sad music and sadder when accompanied by happy music or no music at all. An explanation for this trend would be that happy faces are generally perceived as more arousing than sad faces (Barratt et al., 2016) or that the sad music is so out of character that it has a reversed effect. Note that no such reversal occurred for happiness ratings.

The facial expressions of our actors worked very well. The intended emotions were correctly categorized in almost all cases in the neutral condition. Other emotions than happiness and sadness were rarely chosen and produced negligible mean ratings.

The effect sizes for music ($\eta_p^2 = .46$) and facial expression ($\eta_p^2 = .77$) were large, but the ratings were skewed toward the bottom of the scale, indicating a floor effect. It turned out that the scale ranging from "*emotion not present"* to *"emotion strongly present"* was not fully used. Further studies on the Kuleshov effect should take this into account. Emotions are clearly perceived in the face of the actor, but their verbal coding was weak.

To explore the interaction of the auditory and visual information further, it would be interesting to use a 3 x 3 x 3 design, where music, facial expressions, and context are varied.

In addition, the questionnaire could include more nuanced emotions to detect more subtle changes. Ratings of valence and arousal might further be added to help explain variance.

In sum, we could demonstrate an auditory Kuleshov effect. The emotional timbre of non-diegetic music influences how viewers judge the film clip. Facial expression and music both contribute to the resulting impression, thus there is multisensory integration. However, it is still not clear how exactly the Kuleshov effect works. There are two general explanatory models for the Kuleshov effect (Barratt et al., 2016; Mobbs et al., 2006). Firstly, it is possible that the visual (or in our case auditory) stimuli of the object shot induce emotions in the participants, who project their own emotional state onto the actor. Secondly, a more popular explanation suggests that we set the observed face in the context of the object shot and cognitively adapt our perception. To pit these hypotheses against each other will be a challenge for further studies.

8. GENERAL DISCUSSION

Let us now look at the conclusions that can be drawn from our attempt to use contemporary experimental paradigms to address the main questions already posed by Hugo Münsterberg. We found that our operationalizations led to strong effects with regard to the interpretation and appreciation of movies. Depth perception, memory, and emotions were all affected in various ways.

In the first study we demonstrated that the surround plays an important role in immersion and movie appreciation. Previous studies stressed the importance of visual angle but neglected the context in which a movie is consumed. We found that the context, in our case a movie theater, does affect immersion and can even override the effects of visual angle. Our findings could be used to design cases for mobile devices, or to enhance the viewing experience provided by mobile phones or tablets.

In a second study on depth perception, we researched the effects of 3D on the movie recipient. In accordance with literature, we found that 3D-movies produce more immersion and motion sickness than do 2D-versions of the same movie. Remarkably, real 3D and artificial 3D which was added in post-production did not differ in perception for most of our measures. The visual system appears to be surprisingly tolerant when it comes to fusing the information of the left and the right eye into a single stereoscopic image.

Our studies on memory effects also yielded unexpected results. Contrary to common belief, the Police Chief's Effect does not exist. This fits the larger picture of a general skepticism towards media, seeing the consumer as a passive subject, easily manipulated, rather than as a self-determined individual actively interacting with his/her surroundings. Another instance of this discussion is the controversy surrounding violence in media. A number of myths have been purported about violence in media, partly aided by exaggerated research results.

One such example is a study by Whitaker and Bushman (2012). They asked participants to play violent video games for 20 minutes, and found that they shot more often at the head afterwards. They concluded that violent video games teach gamers how to use weapons and aim more often at the head, because games reward such behavior. We replicated this study in the same year but added a control condition of a violent movie that included headshots (unpublished manuscript available via the author). We also used firearm handling as an experimental condition. We did not find that playing the violent video game, or being a gamer in general, had any effect on how well participants handled the weapons. Additionally, playing the game as well as watching the violent movie, did lead to more headshots. This demonstrates that gamers did not learn to shoot at the head by action reinforcement, as the passive video consumer produced the same behavior. In our experiments, this resulted in worse shooting performance by both groups because the head is a smaller target and thus harder to hit. The study demonstrates how careful one has to be when designing and interpreting studies on media effects.

To research emotion elicitation through movies, we used a canned laughter paradigm and the Kuleshov effect. We found that canned laughter and real laughter work through two distinct mechanisms. Canned laughter makes a movie more funny by activating cognitive mechanisms of facilitated bonding, whereas real laughter adds a layer of social proof, which is absent with fake laughter. Nevertheless, canned and real laughter produced higher amusement ratings for all movies, whereas only real screams had the effect of increasing fear.

The Kuleshov effect is quite old but has only recently been proven to work undoubtedly. Like with canned laughter, we were interested in the effect of non-diegetic sound to elicit emotions. We found that music was a great tool to set the tone of a scene and by doing so were able to auditorily induce the Kuleshov effect. Thus, film is not only a visual but an audiovisual medium, an aspect often neglected in the current literature.

In all studies presented in this thesis, we have exclusively used behavioral and observational data. We renounced the use of physiopsychological and neuroimaging measures for several reasons. We used electrodermal activity and heart rate variability in a pre-study for the experiment on the cinema model, but results were too unspecific for our purposes. We had also considered using facial electromyography (fEMG) to get a better reading of emotions in the study of canned laughter. However, this could have only been used in Experiment 1 because the tools for measuring fEMG on multiple participants were not available. The same problem occurred with physiopsychological measures in the experiment on stereoscopic viewing, because multiple participants were tested simultaneously. We have not considered using Functional neuroimaging (fMRI) for our research questions. In the past, there were problems with the low temporal resolution of fMRI. In the last decade, using neuroimaging for movie research became feasible and has been used on several occasions (Hasson et al., 2008; Raz, Hagin, & Hendler, 2013). Still, fMRI poses major challenges when working with movies, e.g. when it comes to producing an immersive experience for the viewer. We will likely see more and more studies using this technology with the improvement of temporal resolution and the wider availability at research facilities.

Another field of future enquiry will be virtual reality. This new technology enables more immersive experiences with customized stereopsis and head tracking, allowing for free movement in a virtual reality. In how far this technology will be integrated into the movie industry is yet to be seen, but the possibilities and new research paradigms that come with it are manifold.

Future studies should also focus on social and individual context. Thus far, few studies have considered the actual implication of the circumstances in which a movie is watched. Factors like expectations, company, physical and psychological state, and previous knowledge are all understudied.

In conclusion, we can see that one hundred years after Münsterberg, cognitive movie psychology has emancipated itself as a subject in its own right. Publications have shown that his intuitive classification of different cognitive processes was useful and is still used today. Naturally, as time progresses, movie psychology has become a rich field with more nuances and further chapters. However, the initial questions that Münsterberg had posed 100 years ago are still relevant and inspiring today.

9. BIBLIOGRAPHY

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