One Hundred Years of Photoplay

Hugo Münsterberg's Lasting Contribution to Cognitive Movie Psychology

Andreas Baranowski and Heiko Hecht

Abstract: One hundred years ago, in 1916, Hugo Münsterberg was the first psychologist to publish a book on movie psychology, entitled *The Photoplay: A Psychological Study*. We revisit this visionary text, which was an anticipation of the field of cognitive movie psychology. We use the structure of his book to look into advances that have been made within the field and evaluate whether Münsterberg's initial claims and predictions have borne out. We comment on the empirical development of film studies regarding perceived depth and movement, attention, memory, emotion, and esthetics of the photoplay. We conclude that the most of Münsterberg's positions remain surprisingly topical one hundred years later.

Keywords: anniversary, cognitive movie psychology, experimental movie psychology, Hugo Münsterberg, photoplay, review

> *"The photoplay tells us the human story by overcoming the forms of the outer world, namely, space, time, and causality, and by adjusting the events to the forms of the inner world, namely, attention, memory, imagination, and emotion."*
> *— Münsterberg (1916: 173)*

One hundred years ago, in 1916, Hugo Münsterberg published the book *The Photoplay: A Psychological Study*. In it, he formulated a comprehensive film theory that has remained surprisingly topical. He briefly covered the technical history of film before he went on to discuss depth and motion, attention, memory and imagination, and emotions—topics that befit any cognitive psychology book today. Münsterberg presented these chapters in an ordered fashion corresponding to his concept of cognitive thought as ranging from the lowest to the highest level of mental function. He concluded the book with a dis-

cussion of the esthetics of movies in a more philosophical manner. As we will see, Münsterberg had already anticipated and touched on most of the issues that are being researched today. The focus of our observation will be to look at some of the claims Münsterberg made and to relate them to the latest developments in cognitive movie psychology. We will not look at Münsterberg's contribution to general film theory, which has been covered in detail by Allan Langdale (2002).

Today, cognitive movie psychology focuses on the perception of films, and the research method of choice is empirical, which stands in stark contrast to the psychoanalytical approach that dominated film research in the 1960s and 1970s. Many psychological disciplines, from social psychology to neuroscience, have contributed to the advance of cognitive movie psychology. The common base is a cognitive explanation for observed phenomena that embraces an information-processing approach. This is, we argue, where Münsterberg's ideas would have to be located. In contrast, the noncognitive perspective would be assumed by clinical psychology, whose 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 movie psychology.

Before the cognitive revolution, most psychological works on film were along the lines of clinical psychology—that is, they were mostly psychoanalytical. Two notable exceptions were Münsterberg's *Photoplay* (1916) and Rudolf Arnheim's *Film as Art* (first published in German in 1932 and as an extended version in English in 1957). Both authors 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.

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By the time *The Photoplay* was published, Münsterberg was already a well-known Harvard psychology professor. He had published extensively on applied and experimental psychology and was an outspoken proponent of friendly German-US relations. As a passionate spectator of live theater plays, Münsterberg had initially been reluctant to even watch a film, because he thought this would have been considered undignified for a Harvard professor. However, after seeing his first film, *Neptune's Daughter* (Herbert Brenon, 1914), he completely changed his mind. He started to explore film and started numerous correspondences with filmmakers. This exploration would result in *The Photoplay,* one of the first comprehensive film theories. The theory was in line with nineteenth-century mechanical understanding of the human mind. The mind receives sensory input that leads to a reaction in the perceiver. In accordance with this notion, he ordered the chapters in his book on cognitive processes from perceptual input over attention toward the emotional response.

During the decades after Münsterberg's death in 1916, his work on film received little consideration. Richard Griffith, who edited the first reprint of *The Photoplay* in 1970 and brought it back to public attention, argued that people wanted to forget Münsterberg's work because it reminded them of how poorly they had treated him in the era of World War I. As a champion of German-US relations, Münsterberg received much hostility before and during the war. Arno Press of New York also published a second reprint of *The Photoplay* in 1970. Further reprints appeared in 2002 and 2004, demonstrating a renewed interest in Münsterberg's work on film.

In the years after the initial publication of *The Photoplay,* under the auspices of behaviorism, merely a few scattered studies appeared on the topic of film psychology. In the wake of the cognitive revolution, two important analyses of film appeared. Julian Hochberg and Virginia Brooks (1978) published an essay called "Film Cutting and Visual Momentum," and James Gibson (1979) devoted a chapter to "Motion Pictures and Visual Awareness in his Ecological Approach to Visual Perception."

Hochberg and Brooks argued, in a Helmholtzian tradition, for the decisive nature of top-down processes in film viewing (Hochberg 1986; Hochberg and Brooks 1979, 1996). The observer's mind draws perceptual inferences, causing us to see what most likely fits the sensory pattern. Potential matches depend on previous knowledge, which is stored as perceptual maps or schemata. The availability of this knowledge depends on real-world experiences, including cinematic experiences that are shared by the filmmakers and viewers. Gibson (1979), in contrast, defended a bottom-up approach. He argued that the properties within the virtual events on the silver screen lead to perceptually occurent awareness. The movie, and not the moviegoer, furnishes 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, David Bordwell published *Narration in the Fiction Film*. This book did for film studies what Ulric 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, Bordwell maybe not started but certainly catalyzed the cognitive revolution in film studies. He 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. This view has been refuted more recently (Messaris 1994; Schwan and Ildirar 2010). In the following years, scholars from many disciplines contributed

to the rise of cognitive film studies. In the slipstream of this new movement, cognitive movie psychology formed as a subdiscipline of its own.

The 1990s saw a substantial increase in studies treating film from a psychological angle (e.g., Grodal 1999; Tan 1996). Two notable examples were Paul Messaris's *Visual Literacy: Image, Mind, and Reality* (1994) and Joseph Anderson's *The Reality of Illusion: An Ecological Approach to Cognitive Film Theory* (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 even for viewers without previous media experience. In the tradition of Gibson, Anderson looked at movies from an ecological perspective. He gave an extensive overview of the empirical work that had 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,* Torben Grodal (2009) proposes a model of perception-emotion-cognition-motor-action (PECMA), in which perceived stimuli are first evaluated emotionally before they go on to be analyzed cognitively. Uri Hasson and colleagues (2008) proposed that studying the brain on movies should be a subdiscipline in its own right, which they baptized neurocinematics. Based on the term, Arthur Shimamura (2013) proposed a broader focus, calling the new discipline psychocinematics. In his book *Psychocinematics: Exploring Cognition at the Movies,* he brought together some of the most senior film scholars alive to discuss different aspects of what such a discipline would entail. Münsterberg would certainly feel reconfirmed in his proposal to establish such a discipline.

In the following, we look at how the areas that Münsterberg discussed in 1916 have developed over time. We first analyze Münsterberg's predictions of the technical developments of the film and then evaluate the advances in these areas. We conclude with an outlook on new research topics and areas Münsterberg has not touched on.

Historical Developments

In the first two chapters of *The Photoplay,* Münsterberg analyzes the historical development of the moving picture in the nineteenth century. He differentiates between the outer and the inner development of film. The outer development comprises the technical advances from Stampfer's stroboscope, Plateau's phenakistoscope, and Horner's zoetrope in the 1830s to the first public film presentations in Paris by the brothers Lumière, as well as the standardization of film that followed in the next twenty years. With regard to the inner development, Münsterberg discusses how the content of film has changed

and shifted toward an increasingly sensation-seeking medium.

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The interested reader will probably know most of the film history of the nineteenth century, which is covered in many introductory books on film studies (see, e.g., Enticknap 2005). One lesser-known fact described by Münsterberg is an observation by Michael Faraday (1831). Faraday noticed that visual intermittency produces perceptual continuity. He describes a cogwheel that is rotating too fast to be able discern the individual cogs (the eye fixated). If a second cogwheel rotating at the same speed is placed behind the first, strangely, he could discern individual cogs slowly moving. The reason for this is that the cog in front must have moved at a slightly different rate than the one in the back. The cog in the back is then represented as a series of short samples rather than as a continuously moving object, and the apparent motion is determined by the difference in frequency of the two cogs. This stroboscopic effect gained prominence in the filmmaker community as the wagon-wheel effect. When cyclically moving objects like spoked wheels or propellers are filmed, they may appear to move slower, move backward, or stand still, depending on the speed of the moving object and the frame rate of the camera (Finlay and Dodwell 1987; Finlay et al. 1984). 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, that is, by not processing a dynamic flow of visual images but by sequential presentations of discrete frames (Purves et al. 1996). However, further evidence supports the idea that the visual system does process images in a constant stream. Motion reversal is caused by perceptual rivalry with regard to the correspondence mapping in self-similar stimuli. The rivalry originates as the brain generates multiple contradicting interpretations of visually ambiguous scenes (Kline et al. 2004)

In the twentieth century, three major developments had a lasting effect on film production and style: the introduction of sound in the 1920s, the rise of color film around the 1940s, and the digital revolution in the late twentieth century (Thompson and Bordwell 2009). Some might argue that stereo film should be added to this list, but it came and went several times in the past one hundred years (with a 3-D bubble about every thirty years, starting in the 1920s). Thus far, it has not left a lasting impact on film style. It might be considered a revolution in the twenty-first century, but as long as it is necessary to produce, for every 3-D movie, a 2-D version for the home video market, it is unlikely to become universal.

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 World War I. Generally, he

felt that the advantages of the new technology were greater than its potential dangers, and he endorsed film as a mass medium. He argued, "The masses of today prefer to be taught by pictures rather than by words" (1916: 27). He was particularly intrigued by the opportunity to use film as an educational device. On numerous occasions in and outside his book, he approved of such educational exploit of filmmaking. Research showed that Münsterberg was right and that films are well suited for teaching and could even replace whole lectures (e.g., Schacter and Szpunar 2015; Schreiber et al. 2010; Solomon et al. 2004). However, Münsterberg, who had previously written on the psychology of advertising, was also concerned about the potential for audience manipulation. The jury is still out on this topic, as recent studies on the evidence for implicit consumer manipulation are not conclusive. In a large study by Elizabeth 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 United States, with an average of 1.2 million viewers a week. The study did only find weak effects and no lasting behavioral changes of the viewership over the course of twenty weeks. Yet, television commercials and product placement are generally seen as efficient tools and are extensively used by the industry. Additionally, although there has been a great deal of public concern of subliminal manipulation of viewers, no conclusive evidence supports such fears (Wiseman 2009).

Depth and Movement

Depth

Münsterberg became the first of a number of theoreticians, including André Bazin and Christian Metz, to point out the strong impression of three-dimensional reality created in cinema, and he argued that this ability was a central aspect of its psychological appeal. He wrote, "It is flat like a picture and never plastic like a work of sculpture or architecture or like a stage. Yet this is knowledge and not immediate impression. We have no right whatever to say that the scenes which we see on the screen appear to us as flat pictures" (1916: 19).

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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 the same for the entire filmed scene. 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, such as "the differences of apparent size, the perspective relations, the shadows, and the actions performed in the space" (Münsterberg 1916: 50). In subsequent years, further monocular depth cues have been discovered, and the list grew to about fifteen, depending on the classification system (E. 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 3-D effects. Edwin Porter and William Waddell had just successfully tested this with short film reels at the Astor Theatre in New York City in 1915. Münsterberg believed that this technology had tremendous potential and would be a great tool to enhance the cinematic experience. However, the production of 3-D movies was costly and technically underdeveloped. It was not until 1922 that the first feature-length film was screened in 3-D for a larger audience (*The Power of Love,* Nat G. Deverich and Harry K. Fairall) (Zukor 1953). Today, many movies are shown in 3-D (mostly with polarization filters rather than anaglyphic filters), because they are associated with a more immersive experience, as compared to the 2-D version (Ijsselsteijn et al. 1998; Read and Bohr 2014; Yang et al. 2012). Audiences are also willing to pay more for 3-D-movies. Many films originally produced in 2-D are later digitally converted to 3-D, which is cheaper than shooting in stereo. Surprisingly, this postproduction often violates natural disparity relations but nonetheless has 3-D-effects that rival those produced properly with two cameras (Baranowski et al. 2016). Side effects of visual discomfort in 3-D-movies, such as headaches or nausea caused by the conflicting cues to depth, have turned out to decrease as 3-D-technology improves (Kooi and Toet 2004; Lambooij et al. 2009). However, the conflicting cues of convergence and accommodation remain present in 3-D-movies. Münsterberg also raises the issue of sitting position and setting. He argues, "We ought to sit where we see the objects in the picture at the same angle at which the camera photographed the originals" (1916: 55). This was later discussed in great detail by film theorists such as Jean-Louis Baudry (1974). In the meantime, empirical work performed on sitting position has revealed that the human visual system is surprisingly tolerant toward distortion even when seated in an aisle seat in the front row (e.g., Vishwanath et al. 2005). The setting in which a movie is watched, in contrast, plays an important role in movie perception. Elements that remind the consumer of the artificial nature of the viewing situation will likely reduce the immersion, whereas

elements that hide this fact lead to more movie enjoyment (Baranowski and Hecht 2014).

Movement

Another central question is how the series of discrete images is perceived as one continuous stream of visual information. Münsterberg argued that because there is no real movement, only a series of single images morphed into one film, the perceived motion must be a product of our mind. As is the case with 3-D depth, so is perceived motion in film the outcome of a mental process, rather than absolute reality of space or time. He believed that the primary data for mental activity was sensory information (something he had already discussed in earlier works as "action theory"). This was in concordance with Eisenstein's notion of a unidirectional connection between film and mind. Note that this notion is also akin to Gibson's bottom-up approach to film perception.

Münsterberg, citing Max Wertheimer (1912) and others, proposed that apparent motion is the mechanism underlying motion perception in film (Münsterberg 1916: 61). 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, presented in two locations alternatingly at different speeds. He found that participants perceived the line as toppling over and falling when presented with an interstimulus interval of about 200 milliseconds, 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 et al. 2000; Wertheimer 1912). Only the latter was supposed to be phenomenally indistinguishable from real motion. 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 continuous (phi) motion (e.g., Marbe 1910). Evidence for apparent motion grew, and by the 1970s, few vision researchers believed that persistence of vision was the cause for motion perception in movies (Anderson and Fisher 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 2004; Metz 1991; Sobchak and Sobchak 1980).

As the presentation speed of an apparent motion stimulus increases, the observer perceives the 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 hertz for isolated high-contrast stimuli in humans, and considerably lower in the movies. The threshold de-

pends on various factors, such as brightness and color of the stimulus, physiological factors like age (Landis 1954), and the context and complexity of the stimulus. In Münsterberg's time, films were shown at 16 to 25 frames per second (for a discussion of projection speed in the early days, see Brownlow 1980) and often produced considerable flicker, hence the nickname "flick" for a movie. Only with the introduction of sound in the mid-1920s was the frame rate standardized and fixed at 24 fps for technical and economic reasons. The flicker remained noticeable until further experimentation led to the introduction of the multiblade shutter. Instead of showing each picture only once, the shutters were designed to interrupt each picture frame twice or three times by a black interval, 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 to the laws of apparent motion are we able to perceive a smooth continuous movie.

Attention

Münsterberg separates attention as higher mental processes as distinct from perception as a lower mental process. He writes, "The mere perception of the men and women and of the background, with all their depth and their motion, furnishes only the material" (1916: 72). Perception merely supplies the material for mental activity. The chaos of the stimulus that lies in the outer world becomes only manageable with selective attention.

Münsterberg determined that when we follow a film as intended, our attention is guided by the decisions of the director. The director can guide the attention of the audience by the use of mise-en-scène, which refers to the spatial structure of the images. This includes setting, costumes, lighting, and the staging of action (Bordwell and 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). Here again we find a position that is congenial with Eisenstein, whose early theory of a "montage of attraction" explains how attention of the spectator is drawn and directed by the film medium.

In the early days of film, it was impossible to experimentally test whether involuntary visual attention is truly guided by a film. However, since the invention of eye-tracking technology, it has become the method of choice to evaluate where people look during a screening (assuming that eye fixation translates into the encoding of visual information; Henderson and Hollingworth 1999). In static images, as past eye-tracking research has demonstrated, there are universal areas of interest (e.g. faces, task-relevant objects; Mannan et al. 1995). Lew Stelmach and colleagues (1991) noticed that when showing

short video clips to a group of people, their gaze was highly synchronized. This effect was later dubbed attentional synchrony (Smith and Henderson 2008) and subsequently documented in a wide range of films (e.g., R. Goldstein et al. 2007; Hart et al. 2009; Hasson et al. 2008; Marchant et al. 2009; Sawahata et al., 2008; Nyström and Holmqvist 2010).

In order to predict which factors lead to attentional synchrony, Parag 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, high attentional synchrony was found when a small area of the screen was moving with respect to a static background. Other studies supported these results by showing that relative motion was the best predictor for gaze direction (e.g., Berg et al. 2009; Vig et al. 2009). Additionally, Mital et al. (2011) found that faces have a high salience in videos. Especially, close medium shots (showing an actor cut off at around the chest) led to high attentional synchrony (with 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's choices, film viewers might pay attention to aspects of a film that are of particular interest to them, such as the location or a particular technology or actor. He pointed out, "We might sit through the photoplay with the voluntary intention of watching the pictures with a scientific interest in order to detect some mechanical traits of the camera, or with a practical interest, in order to look up some new fashions, or with the professional interest, in order to find out in what New England scenery these pictures of Palestine might have been photographed" (1916: 78). Newer studies support the notion that endogenous factors (i.e., voluntary attention) do play a role in how observers direct their attention. One of the first to study this effect in images was Alfred 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. Tim Smith and Parag 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, Michael 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 must be introduced to win back the focus of the audience. This can be done by movement, and by editing. James Cutting and colleagues (2011) noted

that this is exactly what happened increasingly in Hollywood movies. Average shot length decreased continuously from 1935 to 2010, while movement and motion increased. Moreover, attention, as operationalized by reaction time, fluctuates over time with a fractal pattern (1/*f*, sometimes called pink noise). This means that people are not able to pay the same amount of attention continuously. Instead, they have periods of high and low attention that can be described by calculating 1/*f*. Curiously, Cutting and his colleagues (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 1/*f* over the past seventy years, resembling the attention fluctuation of the human mind.

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 so for semantic (factual knowledge) memory. In the following, we only look at episodic memory, because movies are storytelling devices that are structured in episodes. Educational films are different but were not considered in Münsterberg's writings.

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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 stories (Schwan 2013). The latter employ stereotypes of people (Thomas and Johnston 1981) and experiences (Bordwell 1985) to let viewers form simplified representations of the portrayed events. Thus, simplifications are deliberately used by moviemakers, either to help the audience comprehend a story or to lead them astray. Representation in memory works in a similar fashion. When asked to remember a person, people tend to have a stereotypical representation of that person rather than recall the multitude of past interactions with them (Schneider and 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 et al. 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 to travel freely through time in movies. 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. Stephen Schwan and Bärbel Garsoffky (2004) found that participants' recollection of an event were identical, regardless of whether they merely saw 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 (1983) coined the term "mental time travel" for it. Instead of recalling events in strict temporal order, it is possible to jump in time and mentally represent past and possible future events independently of their occurrence. In the words of Münsterberg: "The objective world is molded by the interests of the mind. Events which are far distant from one another so that we could not be physically present at all of them at the same time are fusing in our field of vision, just as they are brought together in our own consciousness" (1916: 106–107).

Movies are flexible not only in temporal structure but also in spatial structure. The camera can jump in space to any location at any time. Moviemakers 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 dialogue between two characters, the axis between them should be seen as a spatial dividing line. The camera should always stay on one side and never jump the line, because it leads to reversal of the character representation on the screen. Another example is when filming a car that leaves a scene at the right side of the frame. It should then be entering from the left side of the frame in the next shot. Disobeying this rule leads to disorientation of the audience and should therefore be avoided (Huff and Schwan 2012). Viewing position also matters when recognizing objects or events (Blanz et al. 1999). It is, for example, easiest to identify a clock from a frontal view and shoes from a bird's-eye view (Konkle and Oliva 2011). This also extends to social situations and character traits; for instance, low camera angles produce images of strength and high camera angle images of weakness (Baranowski and Hecht 2017a; Sevenants and d'Ydewalle 2006).

With respect to spatial structure, film and memory differ. While 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.

Emotions

Münsterberg argued that a purpose of film is to elicit emotions, which he thought were the most sophisticated of the mind's operations. He wrote, "To picture emotions must be a central aim of the photoplay" (1916: 112). In his book, he described several methods according to which movies efficiently

elicit emotional responses. Ed Tan (1996) later called Hollywood movies "emotion machines." Most of the techniques, which Münsterberg aptly described as being employed at the beginning of the century, are still in use today. This includes the projection of the emotional state of the actor onto the mise-en-scène (e.g., rain symbolizing sadness), the use of particular camera settings and movements (e.g., a high camera angle to indicate helplessness), and the portrayal of emotions by the actors themselves.

Münsterberg differentiated between empathic emotions and individual emotional responses to film. He argued that the moviegoer empathizes with the protagonist and will mirror their emotions. The moviegoer 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 exhibited by the actor. They may even run contrary to the protagonist's mental state. It is, for example, possible that an audience member feels sympathy for a character who has lost a loved one while simultaneously feeling happy and thankful for their own healthy family.

Modern movie psychologists likewise make this distinction between empathic and individual emotional state. Keith 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, and (3) immediate elicitation of emotional attention. The third mode may be partially overlapping with the first two, but it is nicely illustrated in a cartoon film made by Fritz Heider and Marianne Simmel (1944). Simple geometrical objects, such as triangles and a circle, move in relation to each other and in relation to five straight lines forming a box. Surprisingly, this simple motion immediately evokes schemas of fighting, love, revenge, and so on, accompanied by the corresponding emotional responses (Heider and Simmer 1944; Oatley and Yuill 1985).

The Russian director Lev Kuleshov gave one of the earliest experimental demonstrations of empathic emotion in film around the time Münsterberg wrote his book. He filmed the then-famous actor Ivan Mozhukin looking into the camera with a neutral expression, and intercut the face with several objects. 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 has been lost. Be this as it may, this interaction effect of stimulus and context has been replicated and dubbed the "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 the characters 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 moviegoer (for an overview of individual modes of movie reception, see also Suckfüll 2013).

The individual response of each audience member can differ from the empathic reaction toward the actors. People derive pleasure from horror movies (Hoffner and Levine 2005), or they experience schadenfreude from the protagonist's misfortune (Van Dijk and Ouwerkerk 2014). The source of such reactions is appraisal. Instead of empathizing with the character on the 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.

Interestingly, one of the few cases where Münsterberg's opinion differed—to some extent—from the ensuing mainstream developments is the use of sound, which he discarded. He argued, "A photoplay cannot gain but only lose if its visual purity is destroyed" (1916: 203). He felt that nondiegetic sound has its place in film but that diegetic sound would only distract from the movie content. Münsterberg was wrong with respect to the latter but quite on target with respect to the former. Nowadays, it seems clear that nondiegetic 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 is able to achieve by itself. One of the most salient means to use nondiegetic sound is canned laughter. It is almost exclusively used in series and is surprisingly efficient at activating scripts of comedy and humor. For instance, the movie *Natural Born Killers* (Oliver Stone, 1994) 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 laughter 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 big-screen 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 (Baranowski and Hecht forthcoming) conducted a series of experiments in which 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 did the subjective funniness of the material. In a further study, we could show how efficiently music can produce emotions by auditively inducing the Kuleshov effect (Baranowski and Hecht 2017b).

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 to separate it from theater, both of which define art as the antonym to nature and reality.

Münsterberg's book consists of two parts, the psychology and the esthetics of the photoplay. His outlook on esthetics is strongly influenced by the circumstances of his time.

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 the 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 explicitly 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 must be written with the designated medium in mind in order to unleash their full potential.

Münsterberg goes on to argue that "[the artwork] becomes art just in so far as it overcomes reality, stops imitating and leaves the imitated reality behind it" (1916: 144). In this context, it is understandable that Münsterberg did not approve of sound in film. He thought of nondiegetic music as a necessity to keep the audience engaged but disapproved of diegetic sound, such as 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 frowned upon by many. However, art and technology have always inspired and enriched each other. Filmmakers will continue to push the limits of the field, and in the end, we the moviegoers will decide with our consumer behavior which technology will prevail.

Conclusion

Münsterberg already had a solid understanding of most psychological mechanisms involved in film viewing. A hundred years later, we must admire that many of his predictions and assumptions had been right on target. He (1) predicted the use of (anaglyphic) 3-D, (2) took apparent movement for the psychological foundation of movement perception, (3) differentiated between

voluntary and involuntary attention, (4) described the flexibility of the temporal structure in film and mental processes, and (5) separated empathy from appraisal in emotional reactions.

In the esthetic domain, Münsterberg's judgments fared less well. His attempt to separate stage theater from film did not prevail. In particular, he argued that the artistic value of films would diminish the closer they came to reality. He therefore disapproved of the use of color and diegetic sound. Both of these predictions were disproven over time, with some of the most memorable movies making great use of color and sound.

One important topic missing from Münsterberg's work is the role of narration. He covered part of it with his discussion of memory and imagination but barely integrated it into the context of storytelling. Nor did he consider psychophysiological methods to understand film perception. Such methods were already available at the time, albeit not as accessible as today (e.g., Danziger 1982). Today, psychophysiological methods play a prominent role in movie research, with more complex technologies like EEG and fMRI gaining traction. In the future, new presentation technologies, such as virtual reality, will pose new research questions and allow for a further understanding of movie perception.

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 at the time and remains so to this day. 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 a hundred years ago are still relevant and inspiring today.

Andreas Baranowski studied psychology at the universities of Klagenfurt and Salamanca. He finished his studies in 2011 with a master's degree in psychology. Since 2011, he has been a research assistant in the Department of Experimental Psychology at Johannes Gutenberg University of Mainz, where he earned his PhD in 2016. His research focuses on visual perception and cognitive movie psychology. E-mail: baranowski@uni-mainz.de

Heiko Hecht studied psychology and philosophy at the University of Trier and psychology at the University of Virginia, where he received his PhD. He has held positions at the University of Munich (LMU), NASA's Ames Research Center, the Center for Interdisciplinary Research at Bielefeld University, and the Massachusetts Institute of Technology. Since 2002, he has been professor of experimental psychology at the Johannes Gutenberg University of Mainz. His research focuses on still and moving images, intuitive physics, and virtual reality. E-mail: hecht@uni-mainz.de

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