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LOW-LEVEL FEATURES OF FILM: WHAT THEY ARE AND WHY WE WOULD BE LOST WITHOUT THEM

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THE NARRATIVE OF a film is often cited as the driving force for viewers' attention to and engagement in a film. The narrative is also conceptually the most vivid for film viewers; it is not often that viewers, when asked for their opinions on a film, discuss their strong feelings on the ordering of cuts or other structural elements. The reality is that average filmgoers are concerned largely with plot and story (the narrative), and they consider the "details" of film-making only insofar as they contribute to a better understanding of the former.

There are obvious exceptions to this theory: films without narrative (typically the *avant-garde*) force the viewer to rely on only sensory information and give more weight to the visual information that is otherwise overlooked (Bordwell & Thompson, 2003). However, for the purposes of this chapter, we will refer specifically to popular, or Hollywood, films in our discussions of film and movies. This sample of films is particularly relevant because, in most cases, popular Hollywood films are made to mimic reality. Movies are projected in a way that movement appears biologically appropriate.[1] The color in modern movies is intended to mimic color stimuli in the real world. From a young age, we learn the nuances of continuity editing, so much so that adults often fail to notice cuts (the junction of two shots) when viewing a movie (Bordwell, 2002; Bordwell, 1985; Messaris, 1994; Smith & Henderson, 2008; see the section on "Hollywood Style" in the introductory chapter of this book). Filmmakers attend meticulously to all of these elements in production and in editing, crafting the amount of motion, light, and color balance in each scene. These elements express in the final film as *low-level features*, which include any physical, quantitative aspect that occurs regardless of the narrative and can include shot structure, shot scale, color, contrast, and movement.

[1] One of the most important technological breakthroughs in movies was achieving a projection rate congruent with critical flicker fusion; this allows static images projected rapidly to appear fluid and movement to appear biological (de Lange, 1954; Landis, 1954). Movement will be discussed as part of the "Visual Activity" section of this chapter.

The common explanation for attending to the details in low-level feature elements on the part of the filmmakers usually stems again from the narrative. Most people believe that each of these film features is adjusted simply to visually underscore the narrative that binds the film together. However, in light of recent research, we believe this unidirectional view should be abandoned in favor of a more bidirectional approach. The current unidirectional view holds that the narrative exists and that low-level features of a film exist *only* to support that narrative. While this may be true in some cases, we also endorse the view that without low-level features, the viewer would be unable to fully comprehend the narrative. Our ability to follow a story, understand where scenes begin and end, and identify film structure would all be heavily impaired without filmmakers' careful use of low-level features. The color of, motion in, and structure of a movie helps the viewer identify changes, a crucial part of identifying and constructing any narrative.

This chapter will examine five particular low-level features and how they affect viewers' perceptions of pieces of the narrative, particularly acts and scenes: shot duration, temporal shot structure, visual activity (a combination of motion and movement), luminance, and color.

Shot Duration

Shot duration influences our perception of the storyline by gauging the amount of information we can encode in the shot. The briefer the shot, the fewer our opportunities to extract and encode information. The amount of information viewers are able to extract from a shot determines what kind of judgments they can make about on-screen actions. Shot duration also guides interpretations about tension, urgency, and mood.

Shot duration and the average of all shot durations across an entire film (sometimes known as "average shot length" but here referred to as *average shot duration* or *ASD*[2]) are among the most common low-level film statistics. A great deal of data currently exists on average shot duration for films ranging from the early 1920s to the present. Average shot duration is typically measured in one of two ways. The first method involves counting the number of shot transitions in a film (including cuts, dissolves, fades, etc.) and dividing the duration of the film in seconds by the number of shots. The second method involves identifying the duration of each shot in seconds and taking an average of all of the shots in the film. Despite some question that ASD may not be the most indicative statistic of shot length (DeLong, Brunick, & Cutting, in press; Redfern, 2010), it is still a very widely used metric.

There is little question that shot length has been decreasing over time. In an extensive review of over 7,000 films, Salt (1992, 2006) examined shot durations in Hollywood films from 1913 to 2006 and found a steady linear decline in ASD. This finding has been corroborated by Cutting, DeLong, and Nothelfer (2010) in their sample of films from 1935 to 2005, as shown in Figure 7.1.[3]

[2] The use of the terms *average shot length* and *ASL* has recently become problematic as the term *length* in film can refer to either duration (a time metric) or scale (a measure of the camera's focal length). Many scholars have abandoned the use of *length* altogether, replacing the term with the more appropriate terms *shot duration* and *shot scale*. For the purposes of this chapter, we will use the diversified terms to avoid confusion.

[3] For a complete list of the sample of 160 films, see the supplemental material and filmography sections of Cutting et al. (2010) and Cutting, Brunick, DeLong, Iricinschi, and Candan (2011a).

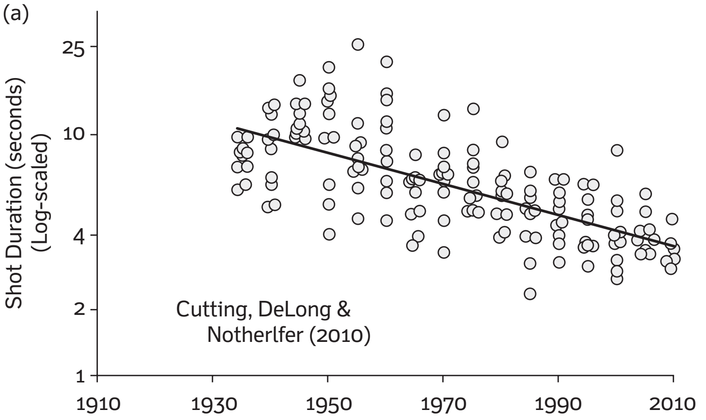

FIGURE 7.1 Decreases in average shot duration (ASD) as shown by data from Cutting and colleagues. Average shot length has been steadily decreasing in films over at least 80 years. Adapted from Cutting, DeLong & Nothelfer (2010).

The natural question that arises from this steady decrease in ASD is one of threshold: How short can ASD become and still allow for the viewer to adequately comprehend the narrative in the movie? So far, the metrics of ASD deal with the entire film; in fact, partial-film or within-scene ASDs can be dramatically lower than the whole-film ASD without detriment to the viewer's comprehension of that particular scene.

An excellent example of a movie with a large variance in shot length is Martin Campbell's 2006 film *Casino Royale* (2006), the 21st film in the James Bond series. The film's plot escalates to a climactic truck chase scene between Bond and an operative on the tarmac of the airport, which occurs 45 minutes into the film and lasts for about 6 minutes in total. The whole-film ASD is 3.30 seconds; the ASD of just the shots within this sequence is just 1.44 seconds. In *The Bourne Ultimatum* (2007), a car chase ensues between Bourne, Vosen's hired assassin, and members of the CIA. The car chase sequence lasts a mere 2 minutes but contains 87 shots, over 70% of which are shorter than 1 second in length. Despite the within-scene ASD being very short, viewers are able to comprehend the actions taking place within the scene. But what exactly does the viewer extract from such jarring, fast-paced visual input? Viewers naturally have a bias for looking at the center of the screen, and after a cut, most viewers reorient their gaze to the screen's center (Mital, Smith, Hill, & Henderson, 2010; Tatler, 2007; Tseng, Carmi, Cameron, Munoz, & Itti, 2009). The frequency of cuts in these cases keeps viewers riveted to the center of the screen, where most of the action takes place.

There is a limit on the rate at which we can extract information from very short visual presentations. Psychologists have used a method of rapidly presenting information in a sequence to see how presentation speed affects how we extract information. This technique, known as the rapid serial visual presentation paradigm (RSVP), has been studied extensively with words and static images, though it has not been studied systematically with film shots or dynamic scenes. When words or varied static images are presented very quickly (as many as 20 images or words per second), our ability to recognize and recall the individual images or words decreases dramatically (Chun & Potter, 1995; Lawrence, 1971). It is possible that sequentially presented shots also have this same lower bound threshold; if the viewer is confronted with a series of one- and two-frame shots, does the viewer fail to encode information from those shots? If so, does this failure have consequences for comprehension of the narrative, or can the viewer mentally fill the gaps? Certainly viewers are capable of accounting for gaps in space and time in a film; as viewers, we are accustomed to continuity editing and elliptical editing and are able to negotiate advances in time and incomplete presentations of space (e.g., Berliner & Cohen, 2011; Levin, 2010; see Smith, this book). Viewers of *The Bourne Ultimatum* have no doubt that a car chase is occurring on-screen and are able to identify that Bourne is fleeing from his assailants. Indeed, we may be *more* driven to examine these scenes to gain more visual information, coined as "visual momentum" by Hochberg and Brooks (1978a). Yet, narratives that contain very quick shot sequences can be disorienting and chaotic to viewers. As viewers, we may have no idea the direction Bourne is fleeing and therefore do not expect the collision between Bourne's car and the concrete barrier; our lack of spatial awareness keeps us from recognizing the imminence of his collision, and we are more alarmed and startled by its occurrence.

Shot duration also influences the viewers' perceptions of pacing and tempo within the film. Short shots tend to be clustered together to create action sequences, while dramas containing dialogue in shot/reverse-shot format tend to have clusters of longer shots (Cutting et al., 2010). Manipulating the shot duration affects viewers' perceptions of tempo (Adams, Dorai, & Venkatesh, 2000); thus, we as viewers may derive much of our understanding of tension within an action movie from composition of shot durations.

Temporal Shot Structure

The durations of shots are certainly important in determining what kinds of information the viewer can extract from a shot; perhaps equally important, however, is how shots are patterned in relationship to each other. That is, a single shot can provide some visual information, but how this shot is positioned relative to other shots, and how shot patterns function across a movie, provides information about the film's pacing, as well as some information about how viewers attend to a movie.

The scale of this shot patterning is important to define. As discussed earlier, sequences of shots taken from a portion of a film can work together to alter perceptions of tempo and rhythm for the narrative. However, scholars often discuss these sequences in isolation from the rest of the film; that is, we might speak of how the short shots contained within a chase scene affect the tension of the chase. In the memorable climactic scene of *The Silence of the Lambs* (1991), Clarice (Jodie Foster) and the FBI agents track down serial killer Buffalo Bill's (Ted Levine's) home. Fast-paced shots interleave the FBI agents reaching the house of the killer while Clarice follows a lead in the killer's hometown; the viewer then discovers that the FBI team has tracked down the wrong house, while Clarice arrives at the killer's true location alone. These short shots (ASD = 4.01 seconds) are then quickly replaced with much longer duration shots of Clarice hunting the killer through his basement while the killer also pursues her (ASD = 6.76 seconds). The abrupt change from short shots makes the lengthy shots feel uncomfortably long; this combined with the predator-and-prey scene taking place on-screen creates a suspenseful scene and a tense viewer (Carruthers & Taggart, 1973). The contrast between short- and long-duration shots is a crucial part of pacing within this scene, but these shots and their pacing also have implications for the entire film. New research has shown that seemingly unrelated shots that are far apart in a film may also have a mathematical relationship to one another and may also be important in constructing a pattern that engages the viewer's attention from the beginning of the film.

Attention, especially the measuring of attention at any given time, has been a difficult intellectual endeavor for psychologists and filmmakers alike. We know our minds wander and our attention vacillates, but pinpointing attentional vacillation scientifically has proved difficult (Smallwood, McSpadden, & Schooler, 2007, 2008). Recent work in eye fixation has illuminated a great deal about the perception of film and of dynamic scenes (Mital et al., 2010; Smith, in press; Smith & Henderson, 2008; see Smith, this book). Additionally, psychologists have made advances in discovering the possible mathematical underpinnings of attention. In particular, Gilden, Thornton, and Mallon (1995) measured performance by adults on a cognitive reaction time task. In such a task, a participant might be asked to respond to something that involves some sort of cognitive engagement, like whether a series of letters presented on a screen forms a word. This differs from a noncognitive task, like responding when a light is turned on or off. Specifically, people do not perform uniformly in cognitive tasks that take place across a long period of time; their reaction times tend to vary across trials (Gilden, 2001). Presumably, we do not constantly shift in our ability to perform in cognitive tasks; instead, it is hypothesized that our attention to a particular task ebbs and flows over the course of the task. The greater our attention to a task, the faster the reaction time, and if our attention shifts away from the task, our reaction time becomes longer on that trial. This attention fluctuation occurs constantly during any sort of cognitive task, including in viewers watching movies.

These vacillations in attention follow a distinct mathematical pattern known in the signal analysis literature as "pink noise" or "1/*f* noise." 1/*f* (pronounced "one over f," where *f* stands for "frequency") is a type of power law. In this case, power (which is related to the amplitude of the function) has a decreasing, inverse relationship to frequency (hence, 1/frequency).[4] The pattern's classification as a type of noise suggests that it both is complex and contains some unexplainable variance.

Attention is not the only place in which we find this mathematical pattern; it is crucially also found in the structure of contemporary Hollywood films (Cutting et al., 2010). Cutting and colleagues found that, beginning around 1960, the shot structure of Hollywood films began to increasingly approximate the 1/*f* pattern. That is, shot structure in films is beginning to change in a complex but reliable way over time. This shift has made the shot structure of more recent films more in line with the attentional fluctuation patterns found by Gilden and his colleagues. Critically, this pattern governing human attention is also the pattern present in shot structure; there seems to be a link between our attentional capabilities and how films are designed.

There are two important points to take from Cutting and colleagues' findings. The first is that this pattern in shots has emerged gradually. Filmmakers capture attention using both plot and low-level features like shot structure. Indeed, we might find a movie without complex characters or plotlines (like the film adaptation of *Charlie's Angels*, 2000) more

[4] For more in-depth explanations of power spectra and 1/*f* noise patterns, see Newman (2005). An explanation of pink noise and its relationship to attention and film is discussed in Cutting et al. (2010).

engrossing simply because its high adherence to a $1/f$ shot pattern capitalizes on capturing our attention.[5]

The second point is that filmmakers do not consciously impose this pattern on their films. It seems likely that professional filmmakers have learned how to engross viewers over time; after a great deal of experience with film composition, they have internalized patterns that they find engrossing and then implement them in their own work. It is also possible that even a naïve filmmaker might generate $1/f$ patterns in shot structure simply because filmmakers rely on their own attentional rhythms to construct their projects. Either way, one would be hard-pressed to find movie directors and editors who crafted their film based on mathematical equations.

Shot length and structure are two of the major components in low-level influence, but examining only these features would entirely ignore the content of the film. A large number of visual, auditory, and even viewer-generated components compose the content of a film. The soundtrack, implied off-screen events, the narrative, and visual experiences are all part of content. The next few sections of this chapter will explore nonnarrative visual content of cinema.

Visual Activity

Arguably, the main reason movies are such a lifelike art form is that they depict movement as it occurs in the real world. Early in the inception of movies, filmmakers carefully calibrated movie presentation to make it mimic natural action in the most realistic way possible. The introduction of 24 frames per second as the standard rate of projection arose from the use of synchronous sound in film; to avoid distortion of sound, and to enhance the naturalness of on-screen movement, movie projection was synchronized to this speed (Anderson, 1996; Salt, 1983).

Within a movie, there are two types of on-screen activity that can occur. The first is *motion*, which refers to any action by an agent in front of the camera. An actor moving his or her lips or body, a car in a chase sequence, and the collapse of a building would all be defined as motion. The other is *camera movement,* which refers to any change in perspective that occurs by a shift in camera position or lens length. Pans, tilts, and zooms are all forms of camera movement. Many shots have movement, and almost all shots contain motion.

This distinction is one that psychologists have used for years. James Gibson (1954) defines them as they relate to an observer rather than a camera. That is, motion is produced by an object or agent in an individual's visual field, while movement is a change in the visual field resulting from the observer's visual shift or change in position. The terms *allocentric movement* and *egocentric movement* have also been respectively used to refer to motion and movement in spatial learning domains.

Though the distinction between camera movement and on-screen motion is useful in a descriptive sense, people generally do not consciously distinguish between the two when processing visual information. The human visual system is able to process movement of the

[5] This is not to imply that viewers have difficulty following or attending to films that do not at all follow the $1/f$ pattern. These films are simply not tuned for our attentional rhythms in the same way the pattern has emerged in modern films.

head, body, and eyes together with motion taking place outside the individual; without this automatic processing of both motion and individual movement together, our perception of the world would likely be jarring or impossible. In the same way, viewers can typically integrate on-screen motion and camera movement to obtain seamless visual input. Because, in both domains, the human visual system appears not to differentiate computationally between the two types of activity, it seems appropriate to combine both motion and movement into one index on on-screen action, which Cutting and colleagues refer to as *visual activity* (Cutting et al., 2011a; Cutting, DeLong, & Brunick, 2011b).

The amount of visual activity is measured by examining the difference between two static frames that are nearly adjacent in their position in the movie.[6] The intensities of corresponding pixels are compared between the two frames. Identical frames (which, when shown sequentially, would show no movement) also have identical pixels, and thus no pixel change between the two frames would be present. Differences in pixels between two images suggest movement when shown sequentially, and visual activity is a measure of the amount of change across all pixels. Figure 7.2 shows frame pairs along with their difference images, a visual representation of the change between the two frames. The change between the frames is equivalent to how much movement occurs across the frames.

The amount of visual activity in film across all genres has increased steadily from 1935 onward (Cutting et al., 2011b). However, the amount of visual activity across an entire film is much lower than most people might expect; Cutting and colleagues found that, averaging across an entire film, the similarity across frames is very high, and the amount of change across the whole film is low.[7] For certain genres, this figure differs. For instance, action films

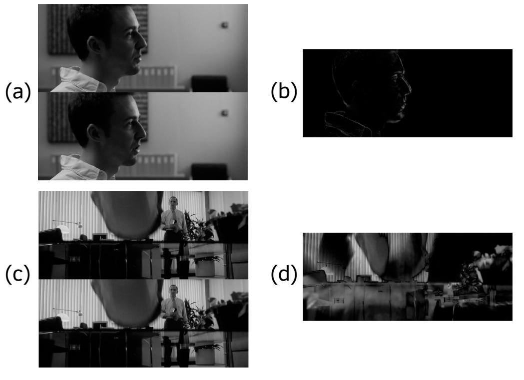

FIGURE 7.2 Near-adjacent image pairs (a and c) from *Fight Club* and their difference images (b and d). Panel (a) shows a pair of images with little difference between them; this results in the perception of low motion when they are projected. Panel (b) depicts the amount of motion occurring between the two frames in white and the nonmoving parts in black. Panel (c) shows a high-motion image pair; more motion (shown in white) is present in Panel (d).

[6] Due to digitization issues, especially in animated films and older films, adjacent frames are often identical or blurred together. To overcome this, we compared sets of frames that were "lag 2," for instance, frames 100 and 102, frames 101 and 103, and so forth.

[7] This is based on statistics for interframe correlations; this statistic is discussed in more detail in Cutting et al. (2011b).

and adventure films tend also to show higher amounts of visual activity than other genres, although comedies are not far behind. Emerging research has begun to suggest that these genres are so distinct in their levels of visual activity that removing all other visual cues (by phase scrambling the movie) still allows viewers to identify the genre correctly (DeLong, in preparation). Contrary to what we might believe, it seems that visual activity is not just an artifact of a visual narrative; instead, it guides our classification of a film as a member of a particular genre.

Given that motion and camera movement occur in nearly every shot, and that genres like action and adventure tend to have high motion content (spawning the term *action packed*), it would seem reasonable to conclude that visual activity across films is high. For this reason, Cutting and colleagues' finding that whole-film visual activity is relatively low is particularly surprising. Viewers of an action film like *Die Hard 2* (1990) tend to remember the so-called high-octane sequences with more vividness, such as the sequence where John McClane (Bruce Willis) leaps from a circling helicopter to engage the traitorous Colonel Stuart (William Sadler) in combat on the wing of his escape plane. We tend to remember less from the low-action sequences, though these tend to dominate the movie. *Die Hard 2* is filled with low-activity sequences of passengers making phone calls from the airplane, Trudeau (Fred Thompson) contacting surrounding aircraft from the control tower, and Stuart's operatives planning their attack from the church. While the amount of visual activity is fairly low across entire films, the variance of activity in scenes is fairly high. That is, activity in particular scenes fluctuates, and research is showing that fluctuation helps guide the viewer in parsing the movie's events.

Indeed, visual activity is one of the cues viewers use to decide where movie events begin and end. Visual activity is an important cue in determining event boundaries in the real world as well; Zacks and colleagues (Speer, Swallow, & Zacks, 2003; Zacks, 2004;Zacks, Speer, Swallow, & Maley, 2010) found motion as a helpful cue in segmenting real-world action as well as film. They suggest two levels of events, both in the real world and in movies: coarse grained and fine grained. In the psychological research on event boundaries, fine-grained events tend to be characterized by the advent of or an increase in motion (Zacks, Speer, & Reynolds, 2009; Zacks & Swallow, 2007; Zacks, Swallow, Vettel, & McAvoy, 2006). Scene boundaries in movies tend to be marked by an increase in movement (Cutting, Brunick, & Candan, in press). This suggests that filmmakers are helping the viewer mentally segment the film into events by introducing motion to signal the start of a new scene.

One important question to arise deals with the interaction of visual activity and shot duration. Though the overall increase in visual activity over the years occurs independent of shot length, each feature places limits on the other. For example, in a very short shot, there is a limit on how much natural-looking motion can occur. If human motion looks too fast or too slow, it no longer appears natural. Similarly, a certain amount of time (or a certain number of frames) is required to portray particular realistic motions in full. Indeed, it appears certain limits do exist in terms of how the visual system tolerates interactions between shot length and visual activity (see "High Visual Activity Films and Film Sequences" in Cutting et al., 2011b). Large amounts of visual activity are best tolerated in sequences of short-duration shots, especially when this sequence is followed by some relatively low-motion shots for a reprieve. Long-duration shots generally must contain less motion to be well tolerated by the visual system. This notion of being "well tolerated" comes from films that violate these rules. Films such as *Cloverfield* (2008) and *The Blair Witch Project* (1999), known to some viewers as queasicam films, combine very high visual activity with unusually long shots. This combination is known for creating disorientation and nausea in some viewers, disrupting not only viewers' digestion but also their processing of the narrative.

Luminance

Another low-level feature heavily implicated in content is luminance, which is a measurement of how much light is present in an image or a series of images. Luminance is controlled not only during shooting by the director and cinematographer but also in postproduction by the editor, who can manipulate the contrast and exposure of the film.

Unlike visual activity, in which viewers can only tolerate certain levels of movement over certain periods, luminance is something the viewer can tolerate and encode at all levels, though in its extreme forms, it can interfere with our ability to extract content. Sequences can occur in near-complete darkness or in very white light, and although the visual information the viewer can extract in these extreme situations may be limited, even this limited information can enhance the narrative. Horror movies often make use of near-complete darkness, giving the viewer very short, quick suggestions of movement to unsettle the viewer. The "found footage"–style horror film *Apollo 18* (2011) reveals the final moments of the classified 18th Apollo mission as the crew struggles to survive attacks from extraterrestrial parasites. Captain Ben Anderson (Warren Christie) attempts to explore a nearby crater using a strobe light after finding an abandoned but functional Russian lunar module. Anderson walks slowly into the crater in complete darkness, with only occasional flashes of his strobe light providing any visual input. He finds the remains of a cosmonaut and tries to flee the crater in darkness. The viewer hears his yelling for his partner and the sound of his footsteps while otherwise experiencing the scene in darkness. The limited exception to the darkness is the few four-frame strobe light shots that only allow the viewer to see Anderson's feet. Horror films like this one[8] often make use of complete darkness to enhance the narrative and heighten the viewer's sense of suspense. Including more light might compromise the helplessness the viewer feels when he or she is, essentially, blind during the movie experience.

Viewers see the other extreme of the luminance spectrum somewhat less often. Very bright light and high luminance in a shot often give the scene a sense of other-worldliness. In the conclusion of *Harry Potter and the Deathly Hallows: Part 2*, Voldemort (Ralph Fiennes) attempts to kill Harry Potter (Daniel Radcliffe) and sends him into "limbo," where he meets the spirit of his now-deceased former headmaster, Dumbledore (Michael Gambon). The high luminance in the scene makes the environment appear as though it cascades endlessly behind Dumbledore and Harry. The brightness of this scene contrasts strongly with the rest of the very dark film, heightening the sense of importance that the scene carries.

For the most part, however, most films are composed of slighter luminance changes. Figure 7.3 shows a series of images from *Finding Nemo* (2003). The range of luminance can be measured on a scale of 0 (black) to 256 (white), with the numbers between representing

[8] Other notable examples from the genre include *The Blair Witch Project* (1999), *The Descent* (2005), *Quarantine* (2008), and *Buried* (2010).

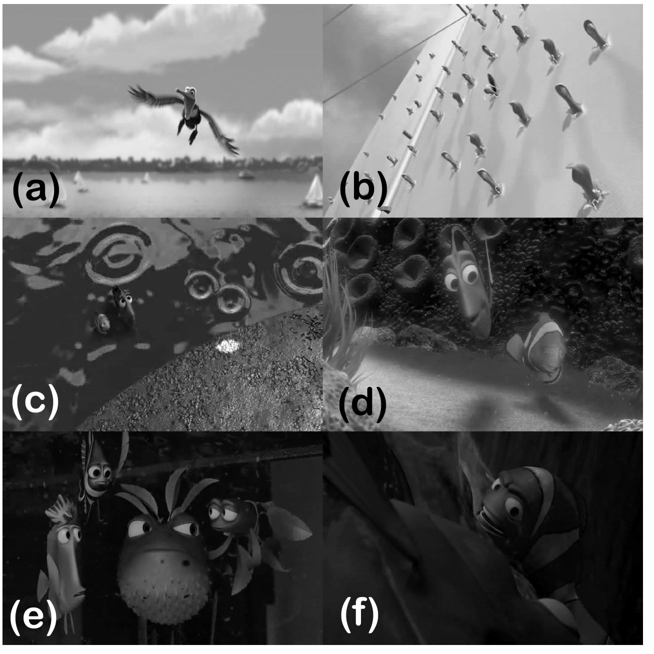

FIGURE 7.3 Stills of varying luminances from the film *Finding Nemo* (2003). Stills (c) and (d) are frames with luminance values close to the whole-film luminance value of 130 (median luminance C = 126; median luminance D = 128). Stills (a) and (b) represent relatively high luminance for the film (median luminance A = 210; median luminance B = 221), while (e) and (f) represent relatively low luminance for the film (median luminance E = 86; median luminance F = 85).

the intermediate grays. To calculate luminance for a film, we measure the luminance value of each pixel in each frame of the film.[9] The median luminance for each frame of the film is then averaged across the entire film. *Finding Nemo* has a whole-film luminance of about 130; Figures 7.3c and 7.3d show frames from the movie that have comparable luminance values. Figures 7.3a and 7.3b show frames from the film that have relatively high luminance (luminance = 210 and 221, respectively), while Figures 7.3e and 7.3f show frames with lower than average luminance (respective luminance values of 86 and 85). Like *Finding Nemo*, many contemporary films have a "central" luminance value across the entire film, usually between 100 and 130. And despite that we often think children's films are "brighter" than other Hollywood films, forthcoming research suggests they do not actually differ significantly in brightness from one another.

Whole-film luminance has been steadily decreasing over time (Cutting et al., 2011a). Technological advances in film have allowed for less light to be used on set to capture a scene on film, whereas older filming techniques required exceptional amounts of external lighting, even for nighttime scenes (Salt, 2009). While the account of why luminance has decreased

[9] Because images displayed on a computer screen can have a distorted grayscale presentation, the images were all gamma corrected (reverse transform of 1/2.2) before the mean luminance value of the whole film was calculated. This allows for a more accurate luminance value that better approximates what a viewer would see on a movie screen.

may purely be technical, it is likely that the change has more to do with engaging the attention of the viewer. When viewed in a dark theater, a lower luminance film allows for better perception of local contrast and brightness changes, which serve as cues to where the viewer should be looking (Enns, Austen, Di Lollo, Rauschenberger, & Yantis, 2001; Smith, in press). In other words, a lower luminance film makes it easier for filmmakers to reorient our gaze to particular places on-screen. This is not to say all films are uniformly dark; there is still a percentage of much brighter films that vary dramatically in luminance from darker films. In fact, films with higher overall luminance tend to help cue the viewer about the genre of the film; in particular, comedies tend to have higher luminance overall than do dramas or action films (DeLong & Helzer, 2010).

Local luminance changes are not the only factor in helping the viewer understand the narrative; luminance changes are also one of the most important low-level features in helping the viewer segment scenes. In this context, "scene" specifically refers to what Bellour (1976) calls subsegments or subscenes, which are equivalent to psychological events. Parsing the narrative into scenes or events is an important part of the movie-viewing process: The amount of change across a cut helps the viewer determine if the new shot is within the same scene or the start of a new scene (Hochberg & Brooks, 1990; Zacks & Magliano, 2011). Cutting and colleagues (in press) had eight viewers watch a subset of films from their database (see Cutting et al., 2010) and parsed them into scenes. Though the parsing of each film differed among individual viewers, there was a high overall degree of agreement between viewers on where scene boundaries were located. Changes in luminance alone accounted for about 2% of parsing variability between viewers. While this may seem low in this context, this volume of change within a very large corpus is nontrivial.

Luminance is closely tied, both in this analysis and in general, to color. It seems fitting to next discuss color, both how it works in tandem with luminance and how it functions in the movie experience independently.

Color

The use of color in movies has been examined extensively, not to mention pushed to the limits by directors throughout the years. Color is also a popular topic of study by psychologists and has been since as early as the 19th century. Naturally, color was introduced as a component of films relatively early in the evolution of film; the earliest films were hand-painted, tinted, or toned, and then Kinemacolor was introduced in 1908, followed by the invention of Technicolor in 1916 (Salt, 2009). By 1940, color was in full range, appeared realistic to viewers, and was used in many movies. Today, noncolor commercial films are extremely rare.

Color, unlike luminance, has been quantified in multiple different ways, known as "color spaces." Color spaces aim to allow scientists to express a color as a numeric value, much the same way the 0 to 255 space allows us to express luminance. However, since the parameters of color are complex and nonlinear, a number of color spaces arose, and the same color is represented differently depending on which color space is used. Nonetheless, there are certain color parameters that influence our viewing regardless of the color space we conceptualize them in. The first is *hue*, which refers, in a gross sense, to the color itself; we tend to have names for hues (blue, green, cyan, etc.). The second is *saturation*, which roughly represents the boldness of the color; for example, a pastel blue and a very bold blue can have the same hue, but the pastel blue would be less saturated than its counterpart. Pink is generally conceived of as a less saturated form of red.

Humans tend to prefer saturated colors over nonsaturated colors. This preference occurs across cultures, sexes, and age groups (Eyesnck, 1941; Katz & Breed, 1922; Palmer & Schloss, 2010). Recent research has shown that since color film became the standard in the 1940s, saturation in films has been steadily increasing. The exception to this trend is in the subgenre of children's films; films geared toward young audiences have not been increasing in saturation, but have consistently had very high saturation levels across time. Despite that adult-geared films have experienced an uptick in saturation over time, even at their most saturated they are significantly more muted than children's films (Brunick, Cutting, & DeLong, 2012).

Hue, which tends to be the more easily identifiable color dimension, also plays a significant part in our narrative understanding. Finding a whole-film hue in a modern Hollywood movie may not be particularly useful or interesting; in many cases, the hue would likely be a shade of brown or black and would give us little information regarding the film as a whole. The exception to this is animated films, particularly animated children's films, which can ignore real-world constraints by constructing lighting and color for each individual shot. Indeed, emerging research shows that hue may be a potent cue in helping children devise the intentions of characters in a children's film (Brunick, Cutting, & DeLong, 2012).

Instead of being useful on a whole-film basis, hue instead seems to be most useful for scene segmentation, much the way luminance is. Like luminance, color (hue) accounts for some of the variance between viewers in parsing scenes. Color change makes up over 4% of this variance, much more than luminance does (Cutting et al., in press). Changes in time, space, or content seem to be accompanied by a supplementary change in color. *Inception* (2010) leaps between "dream levels," all of which seem to exhibit a signature color. In *American Beauty* (1999), Lester Burnham's (Kevin Spacey's) fantasy sequences involving his daughter's friend Angela (Mena Suvari) are marked by the heavy use of saturated reds (often in the form of rose petals). *Wall•E* (2008) uses colors to demarcate changes in not only scenery (Wall•E's trash-ridden world is brown while EVE's home, the Axiom, is composed of clean blues and whites) but also the characters themselves.

Color is, without a doubt, important in cinema because it is important to our visual system. Instantaneous changes in a scene (in the case of movies, cuts) are often readily detected because of changes in visual features like color.

Final Thoughts

Imagine, if you can, a movie that has been stripped of its narrative, sound, and most of its visual content. The film's shot structure and shot lengths would remain intact, but the shots themselves would contain only luminance and color blurred with suggestions of motion. While you might be a puzzled and confused viewer while attempting to watch it, the research discussed in this chapter suggests that you could probably find a good deal of structure in what might seem to be a hazy mess. It is likely that the changes in luminance and color would be good signals of "event" boundaries, and you might even find yourself attending to the film more merely because of the patterns present in the shots. You could probably identify a suspenseful sequence from a series of fast-paced shots, and you might even know the hero was triumphant because of his color signature on the screen. Given the penchant for humans to organize things and create stories from events, you might even construct your own narrative of what is going on on-screen.

If we, as viewers, can derive this much from seemingly random visual input, then it seems that our understanding of a narrative, when coupled with these low-level features, is enhanced much more than we originally thought. While we may not be completely impoverished at understanding a (albeit hypothetical) movie that contained no low-level features, our narrative coherence would certainly suffer. As a result, furthering the quantitative study of film and its components does not, as some say, do a disservice to film studies, but rather enhances our understanding of film as well as perception.

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