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The two- to three-second time window of shot durations in movies

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Abstract: Movie shots of singular scenes have a preferential duration of 2 to 3 s regardless of producers, movie types, and cultural environments. This observation suggests that the temporal structure of movies matches a neural mechanism of information processing in the time domain.

Keywords: duration; movie; temporal integration; time window

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Given that one phenomenon can be observed with various tasks, it is reasonable to assume a global mechanism. The time window of 2 to 3 s has been observed with many different experimental paradigms such as the spontaneous alteration of ambiguous figures, temporal reproduction, sensorimotor synchronization, speech segmentation, intentional movements, or attentional control (Bao et al., 2015) and also on the neural level such as the amplitude modulation of mismatch negativity indicating an oscillatory temporal regularity (Wang et al., 2016). In addition, this temporal constancy extends to artistic artifacts such as motifs of classical music and verses of poems in different cultures (Zhao et al., 2018). Does this time window also exist in other artistic forms such as movies? Does the virtual reality world on the screen also obey basic principles of information processing in the brain? To answer these questions, the present study focused on the durations of movie shots.

As examples, we analyzed the duration of segments in two movies, *The Stranger*, directed by Orson Welles (1946), and *The Lifeboat*, directed by Alfred Hitchcock (1994) on the basis of the transcript written by Strobel (1981, 1983). The duration of such segments or shots in these movies was originally recorded with a temporal resolution of 0.5 and 1 s, respectively. We converted the data into a unified 1 s resolution using the moving average

method to better compare the distribution between the two different movies. Both data sets showed a typical positively skewed curve with a mode at 2 s, as shown in Figure 1A and 1C. The distribution is asymmetric; the positive skewness is due to a large number of longer shots. To overcome some fluctuations, we conducted a model fitting of the raw data. According to previous research, the distribution of movie shot durations follows the log-normal distribution (DeLong, 2015). The data we analyzed fit well log-normal distribution with R-square higher than 0.95 for all cases. Note that the distributions of the shot lengths do not follow an exponential decay, which would have indicated a passive and not an active temporal control.

Having observed a similar mode of shot length distribution in the two sample movies, we further asked whether various movies directed by different directors with diverse cultural backgrounds also show in their shot lengths a similar time window. Thus, we further applied the same method to analyze the shot durations of another two movies: *Interstellar*, directed by Christopher Nolan in 2014 (<http://www.cinematics.lv>) and the animation *Tokyo Godfathers*, directed by Satoshi Kon in 2003 (*Storyboard Collection Book: Tokyo Godfathers* by Satoshi Kon in 2018. Tokyo, Japan: Fukkan.com). The distribution and fitting curves of the shot durations in these two new

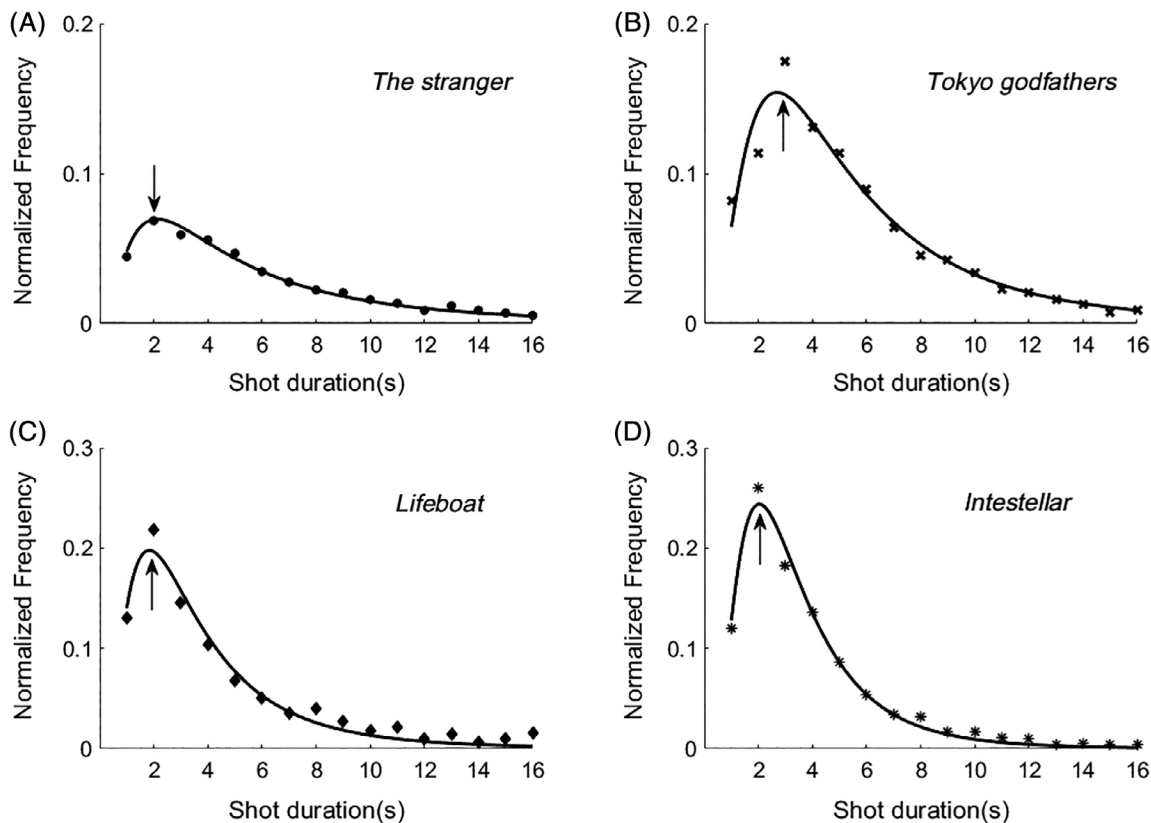


Figure 1. Normalized frequency distribution of shot durations in movies. Fitting curves are illustrated using log-normal distribution function. The mode of each distribution is indicated by an arrow.

examples are shown in Figure 1B and 1D. Although the shooting time of the four analyzed movies varies from the early 20th century to the 21st century, and the directors come from Europe, North America, and Japan, all modes of these shot duration distributions lie within 2 to 3 s, regardless of producers, movie types, and cultural environments. It seems that there is an optimal time window in the cutting of movies, irrespective of the habits of the directors, the various forms of art, and the different shooting periods of the movies. Note that we emphasize the modes other than the average shot length because they are a more representative index for a skewed distribution.

The striking feature is that the same pattern exists in different movies from different regions and in different periods. The fact that movie producers favor a shot length of 2 to 3 s seems to be a universal phenomenon. What could be the reason? Typically, in a movie, the director creates a story taking into account both logic and aesthetics. Except for some experimental movies that use only one shot throughout the movie (e.g., *Rope* by Hitchcock in 1948), shot length is defined or implicitly selected by the content of the story. Long shots correspond to peaceful

stories or magnificent scenes whereas short shots are used more in chasing, violence, horror, thrilling, and other high-tempo situations. When a new scene appears, attention is drawn to it and gradually decays over time. The purpose of film cutting is to replace a scene with a new scene at an appropriate rhythm, such that the attention can be constantly captured and maintained, and the abruptness is reduced to the minimum. We hypothesize that a shot length of 2 to 3 s fits such a purpose. For example, when a ship appears on the screen for 3 s in *The stranger*, the audience forms the concept that the main character is onboard and heading to the United States for the hunt. The duration should not be too short to confuse the audience nor should it be too long to be boring. In a movie when a scene is followed by the next one, what is expected to happen has to guarantee the continuous flow of the story. It turns out that a time window of 2 to 3 s (Bao et al., 2015) provides an optimal temporal frame for anticipations and, thus, allows for maintaining the identity of the story. If anticipations are violated too much due to too short or too long temporal frames, the flow or coherence of the story and its identity would break down, and the viewer would no longer

be involved in the story and could not identify effortlessly with the sequence of events. The concept of maintaining identity is considered to be a general principle for aesthetic appreciation. Besides the identity of the artwork, the identity of the viewer also matters because it provides a basis for belongingness to a cultural environment in which the artwork is embedded (Bao et al., 2016).

Taken together, the present study shows that a time window of 2 to 3 s also applies to the shot durations in movies. Such temporal integration is suggested to be a universal mechanism of cognitive processing in the human brain. This time window of 2 to 3 s helps the producer to better tailor the movie, making the cut more dynamic and the story more coherent, thus more easily capturing the attention of the audience.

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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