Viewer's Attention Flow When Watching Audiovisual Cuts

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Abstract Audiovisual works have plenty of cuts, but viewers hardly notice them. Movie edition creates a discontinuity in audiovisual works. We analyze the effects of cuts on 36 subjects, using electroencephalography (EEG) techniques. Cuts result in an increase of attention in viewers by decreasing their eyeblink rate. They also cause a spread of potentials from the occipital area to the frontal area at around 200 ms after the cut, as the perception of the media content progresses to more-complex areas of process. Our results are coherent with previous studies on early discrimination of visual stimuli. The mentioned flow of potential happens differently depending on the style of edition in which cuts are inserted. Cuts in continuous narrative have a lower impact on the visual zone than do cuts in chaotic and fragmented narrative. However, the opposite is found in the prefrontal area, with a higher activity when continuous and lifelike narrative is being watched. These results can be applied for the management of attention when creating media content.

1 Audiovisual Cuts

Cinema appeared in the last years of the 19th century (Gubern, 1973). After some years of experimentation, in the 1910s, the analysis of edition started to become a topic of great interest in communication studies (Gunning, 1994; Münsterberg,

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1916). Some experiments, such as (Kuleshov, 1974) and Pudovkin (2013), and some written works, such as (Eisenstein, 1988), showed that cuts and style of edition were key to the creation of films. Cuts are the most common transition between shots (Cutting, 2016; Cutting et al., 2011). Many researchers have investigated the impact that cuts have on the perception of media content (Francuz & Zabielska-Mendyk, 2013; Germeys & d'Ydewalle, 2007; Magliano & Zacks, 2011), proving that the use of cuts affects the understanding of the meaning of the story (Carroll & Bever, 1976; Eisenstein, 1977).

The level of attention required to understand narrative content in audiovisual works can be studied by analyzing viewers' eyeblink rate (Nakano et al., 2009; Shultz et al., 2011). Eyeblinks are fast movements that close and open the palpebral fissure and have the physiological function of wetting and protecting our cornea and the psychological one of managing attention (Cruz et al., 2011). Blinking is something that we constantly do without being aware of. A decrease of attention produces an increase of spontaneous eyeblink rate (SBR), while an increase of attention decreases the SBR (Wiseman & Nakano, 2016; Zheng et al., 2012). In this investigation, we analyzed how cuts and the style of edition containing them have an impact on viewers' SBR.

Cuts have also been studied from an electrophysiological viewpoint. In the 1950s, Gastaut and Bert proposed the study of cinema through electroencephalography (EEG). They found that any audiovisual content, regardless of how banal it may be, had an impact able to modify the EEG of a normal adult (Cohen-Séat et al., 1954; Gastaut and Bert, 1954). Despite those interesting studies not being followed up as a topic in communication research, there are some concrete studies in neuroscience developed during the last few decades. Reeves and colleagues showed the presence of alpha waves in central and occipital areas connected to edits (Reeves et al., 1985). More recent studies have proven that the relation between the shots that cuts connect is crucial for the brain activity of viewers (Francuz and Zabielska-Mendyk, 2013; Geiger and Reeves, 1993; Lang et al., 1993). Here, we also analyze the brain activity linked to cuts in different styles of edition.

2 Methods

2.1 Stimuli

We presented two stimuli having the same narrative content and the same duration (198 s), but with different style of edition. Both were movies: one followed a continuous style of edition with smooth transitions and clear presentation of the visual content, based on the Hollywood style of edition rules; the other stimulus was chaotic, discontinuous, with a faster style of edition, inspired by musical video clips and their style of edition—we called this stimulus MTV-style movie. The Hollywood-style movie had 33 shots with an average shot length (ASL) of 5.9 s, and the MTV-style movie had 79 shots with an ASL of 2.4 s.

2.2 Experimental Setup

The stimuli were presented on a 42-inch HD LED display (Panasonic TH42PZ70EA, Panasonic Corporation), at 150 cm from the participants, with Paradigm Stimulus Presentation (Perception Research System Incorporated). Continuous EEG was recorded using the wireless Enobio® system (Neuroelectrics) (Martín-Pascual et al., 2018). Twenty electrodes placed according to the International 10–20 System were used, one of which was for electrooculogram (EOG). Electrodes were referenced to mastoid electrodes. We also recorded participants's faces with an HD (1920 width × 1080 height pixels) video camera at 25 frames per second (Sony HDR-GW55VE, Sony Corporation).

2.3 Participants

Thirty-six participants (six women), aged 28–56 (43.97 ± 8.07), with normal or corrected-to-normal visual acuity, were recruited for this experiment. Written informed consent was obtained from all participants prior to participating in the study. All procedures were performed in accordance with relevant guidelines and regulations for human research. The study had the approval of the Ethics Commission for Research with Animals and Humans (CEEAH) of the University Autònoma de Barcelona, Spain.

2.4 Analysis

We used EEGLAB (Swartz Center for Computational Neuroscience, UC San Diego) (Delorme and Makeig, 2004) open-source software (version 15.3) running on MATLAB R2013a (The Mathworks Inc.) under MacOS version 10.9.5 (Apple Inc.), for the EEG analysis. For rejecting bad channels, artifacts, and wrong recordings with continued data with visible movement artifacts, we visually inspected our recorded data and also used the ADJUST plug-in for EEGLAB (Mognon et al., 2011). We used the DIPFIT plug-in for EEGLAB to locate dipoles. We analyzed viewers' eyeblinks using Brainstorm (Neuroimage, USC) (Tadel et al., 2011) also running on MATLAB R2013a. We applied Brainstorm's filers for detecting eyeblinks to the EOG signal, following Tadel and colleagues (Tadel et al., 2015). The results were contrasted manually with the blinks of the recordings.

3 Results

3.1 Decrease of Eyeblinks After the Cuts

We compared the eyeblink rate (blinks per minute) of participants ($N = 36$) from the cut to 1 s after it with their eyeblink rate, while they were watching the rest of the movie. Each participant was exposed to 112 cuts, so we analyzed responses to 4032 cuts. We found significant differences between the eyeblink rate 1 s after the cut ($11.074\,\text{min}^{-1} \pm 7.659$) and the rate during the rest of the stimulus ($12.328\,\text{min}^{-1} \pm 7.609$), $t(35) = -2.719$, $p = 0.01$, Student's paired t-test. According to our results, cuts decrease viewers' eyeblink rate during the 1 s after them. We also found significant statistical differences between those conditions when viewers watched the Hollywood-style movie with inserted cuts ($t(35) = -2.513$, $p = 0.017$, student's paired t-test). However, no significant differences were found when watching the MTV-style movie with inserted cuts ($t(35) = -1.482$, $p = 0.147$, student's paired t-test).

3.2 Spread of Potential from the Occipital to the Frontal Area

We computed ERPs associated to cuts within a time window of 500 ms before the cut and 1000 ms after the cut. We found that as the time after the cut progresses, there is a spread of potential from the occipital area to the frontal area, see Fig. 1. According to our results, this process is engaged after each cut is perceived in a media content. It is coherent with previous studies about visual perception (Hegdé, 2008; Milner and Goodale, 1995); thus, cuts can be understood as tools for resetting visual perception in viewers watching media content.

3.3 Styles of Edition Affect the Perception of the Cuts

We found that the style of edition in which cuts are inserted affects the viewers' processing. The cuts in a Hollywood-style movie result in a higher activation of the medial and (mostly) frontal areas, while cuts in an MTV-style movie produce a higher potential in occipital areas. Those differences appear after the cut and are maintained during the whole second after it, see Fig. 2. We can connect those results with previous studies studying the speed of processing conscious and unconscious stimuli in the human visual system (Thorpe et al., 1996). Cuts in a continuous narrative present a lower impact on the visual cortex, while there is a higher conscious processing. However, cuts in a chaotic and fragmented narrative cause a higher level of potential in the visual area, with a lower impact on conscious processing.

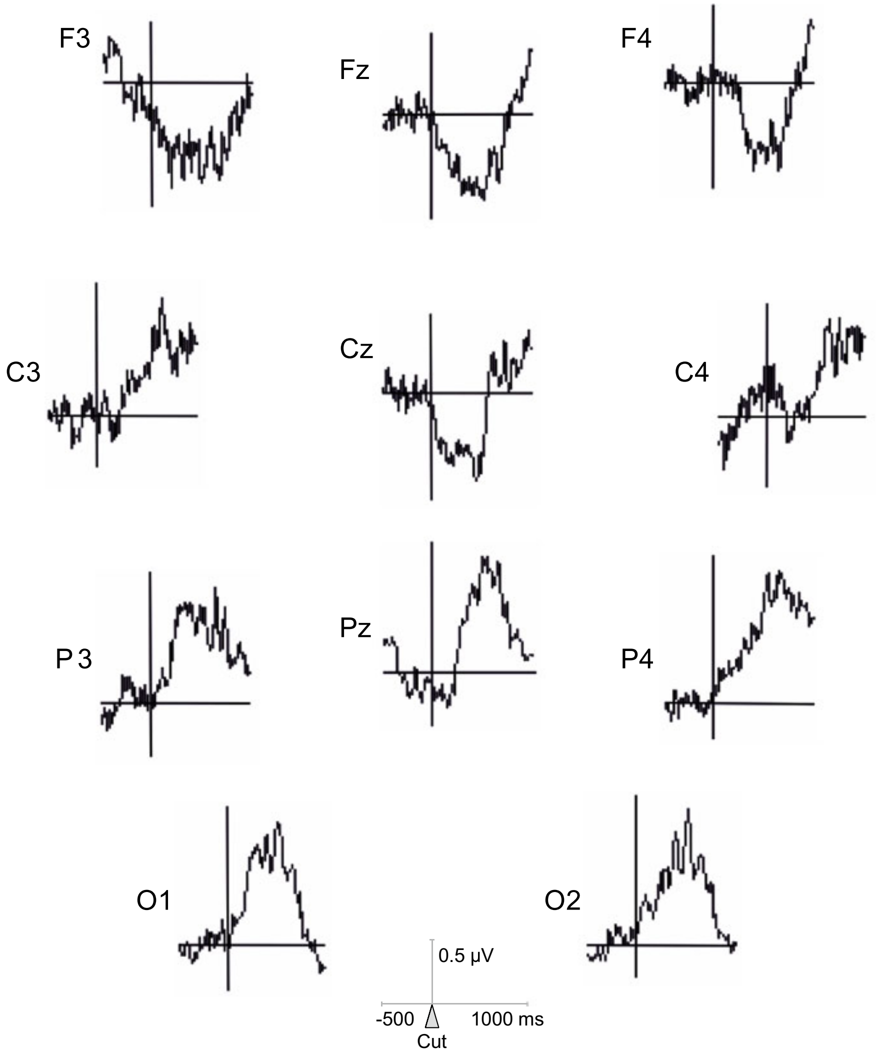

Fig. 1 Average ERPs for occipital, medial, and frontal electrodes after the cut

4 Conclusions

Media creators use cuts to present visual content with specific intentions. Sometimes, they want to clearly show what is happening in the scene; at other times, they want to be deliberately chaotic due to a stylistic or narrative strategy. During the last few decades, this has evolved, with an increase in stylistic fragmentation (Bordwell, 2002). Approaching the same narratives in different formats affects viewers' perception (Andreu-Sánchez et al., 2017b; Nakano and Kitazawa, 2010). We know

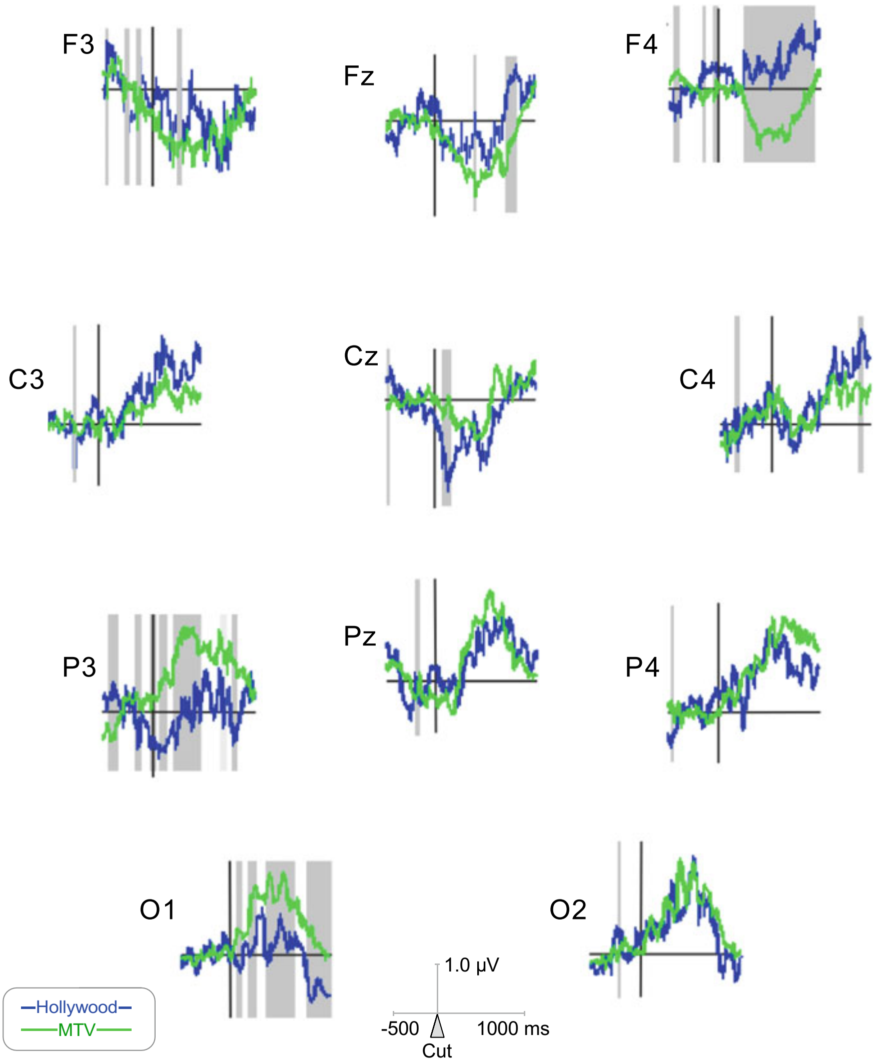

Fig. 2 ERPs for Hollywood-style (classic editing rules) and MTV-style movies (such as video clips), for occipital, medial, and frontal electrodes. Gray shadows indicate statistical differences found between them ($p < 0.05$, t-test)

that narratives in media content affect viewers’ attention (Nakano et al., 2009). We also know that the different styles of edition used for presenting narratives affect viewers’ eyeblinks (Andreu-Sánchez et al., 2017a). One of the most important elements for creating differences in the styles of edition is the cut. We found that cuts trigger a decrease of eyeblinks in viewers 1 s after them (Andreu-Sánchez et al., 2018). According to our results, this inhibition of the eyeblinks is clear when cuts are inserted in Hollywood-style movies, but is not so clear for cuts in an MTV-style movie. The reason could be related to the average shot length (ASL) in each case. In the Hollywood-style movie, we used an ASL of 5.9 s (a total amount of 33 shots presented in a movie of 198 s), while in the MTV-style stimulus, the ASL was 2.4 s (79 shots presented in a movie of 198 s). So, since the cuts in the MTV-style movie do not clearly decrease viewers’ eyeblinks during the following second after them, we suggest that this is because there are so many cuts that viewers tend to avoid blinking while watching the whole movie (Andreu-Sánchez et al., 2017a).

Cuts are not always perceived by viewers (Smith and Henderson, 2008), and yet, we found that they produce a specific spread of brain activity from the occipital area throughout the visual cortex, to the prefrontal and frontal area, where higher processes are managed. Our results are coherent with previous studies on early discrimination of visual stimuli (Thorpe et al., 1996). The most interesting part of this is that whenever media creators present a different shot in their audiovisual works, they are triggering the reset of this well-known process of visual perception for any visual stimulus change. However, this process is different depending on the style of edition in which cuts are being perceived. We found that cuts in continuous, classical style editing have a higher impact in prefrontal and frontal areas, while cuts in chaotic-style editing have more impact in the occipital area. These results would be coherent with the previous comparison of related with unrelated cuts (Francuz and Zabielska-Mendyk, 2013). According to that, related cuts have a higher impact in the prefrontal area, while unrelated cuts have theirs in the occipital area. We suggest that the clear presentation of related content activates areas of higher processing. The unclear presentation of unrelated content has a high impact on the visual cortex, but for some unknown reason, that impact does not flow to higher-processing areas. In future research, it would be very interesting to contrast the discontinuity caused by the cuts with the perceptive segmentation of discrete real events and selective attention (Zacks et al., 2007).

Since the spontaneous eyeblink rate is a predictor of dopamine-related cognitive function (Iwaki et al., 2019; Jongkees and Colzato, 2016), it would be of interest for future investigations to understand how dopamine concentration can be different in viewers based on the style of edition, and how that can have an impact in visual processing (Silkis, 2007).

The results from this investigation can also be applied in the communication area to teach media workers how they can manage viewers’ attention by using cuts and style of edition. We understand that this knowledge is highly valuable for media professionals and can have a great impact on future audiovisual creation.

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