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University of Athens

Department of Philosophy and History of Science

Postgraduate Program Basic and Applied Cognitive Science

Master Thesis

"Investigation of the effects of editing techniques for time manipulation and continuity editing rules in time estimation"

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Table of Contents

Abstract

Filmmakers and editors, through long-term experience, have established editing techniques that help viewers experience a film as continuous in space and time, despite its discontinuous nature. One type of editing is the manipulation of the passage of time as it appears on the screen. So, an event could be presented either shorter or longer than it would actually take in real life, and, of course, in real time as it was recorded. Additionally, continuity editing rules create spatiotemporal continuity from discontinuous film material and, thus, easier narrative comprehension. These rules are used by filmmakers as the best way to achieve smooth transitions between shots and make the cuts almost invisible. Recently, however, it has been suggested that clear and coherent narration would lead to narrative comprehension, even when continuity errors occur. No previous studies have been conducted to examine whether or not editing techniques and continuity editing rules have perceptual and behavioral effects in time estimation. In the present study, therefore, we examined the validity of editing techniques in time manipulation and the effects of continuity editing rules and their respective violations in attention via time estimation. We presented edited videos of a series of events and, asked participants to verbally estimate their duration. The results revealed an overestimation in duration judgments for expanded-time edited scenes in comparison to compressed-, and real-time scenes. Thus, verifying filmmakers' goal to produce time modulations. On the other hand, continuity editing errors had no effect in participants' judgments, thus showing that clear and coherent film narration appears to be more important than editing.

Key words: Editing techniques; time manipulation; continuity; editing errors

Introduction

Film history counts 130 years since the first film screening in the 1890s, with continuous technological advancements quickly changing the "face" of cinema. From silent to talking movies, black-and-white to colored, hand drawn animation to computer animation, or 2D to 3D, there's always something new being added to how we experience motion pictures (Bordwell & Thompson, 1993; Stam, 2000). Important place in the film evolution is the parallel evolution of editing. A film scene consists of consecutive shots, distinguished usually by sharp transitions (cuts) from one shot to another, but connected via editing to show the best visual and continuous representation of the story (Cutting & Candan, 2013; Thompson, 2009). Editing refers to the process of organizing, reviewing, selecting, and assembling the picture and sound "footage" together into a meaningful story (Thompson, 2009). Multiple scenes from the same story combined together create the movie's narration.

Continuity and editing

Creating the sense of narrative continuity is the primary goal of editing. As continuity, film theorists refer to creating by all means, especially by editing, a smooth flow from one shot to another without distracting viewer's attention from the narration (Bordwell & Thompson, 1993). Editing techniques emerged through trial and error and self-experimentation (Smith, 2012). From the very beginning filmmakers and film editors realized that guiding the viewer's gaze and attention to desired points in the screen (usually particular objects, faces or movement) and manipulating appropriately the low-level features of the film (i.e., motion, light, color balance, shot duration), not only helped the understanding of the film's narrative but also the sense of spatiotemporal continuity (without noticing the discontinuous nature of the film; Brunick, Cutting, & DeLong, 2012; Cutting & Candan, 2015; Smith, 2012). With no intention of ignoring the contribution of other editing techniques, the well-known "Hollywood style" editing serves the above purposes. That is to make the transitions between shots as "invisible" as possible, to create continuity in space and time, and to help the viewers in focusing in the events or the storyline (Anderson, 1996; Bordwell & Thompson, 1993; Cutting, 2005; Reisz & Millar, 2010). The "Hollywood style" editing is based on a group of continuity editing rules that helps either to make a cut invisible by using, for example: a) shot-/ reverse-shot, where two shots edited together that alternate characters from reverse angles, b) eye-line match, where the first shot shows a character looking off screen, second shot shows where the character was looking at, c) to present space and time of the film story as continuous and linear by using the 180° rule (the angle between any two consecutive shots should not exceed the 180° of the imaginary line that connects 2 characters/objects or cuts through the middle of the scene in case of an action), and d) match-on-action cuts, where the action that begun in the first shot is continued or ended in the second shot (e.g., https://faculty.washington.edu/mlg/courses/definitions/ classicalHollywoodcinema. html).

We are perceptually evolved in a spatially and temporally continuous world and movies seem to be evolved so they can match to our cognitive and perceptual mechanisms (Cutting, 2005; Magliano & Zacks, 2011). Until recently, however, there was lack of interest in investigating the relation of cognition and film understanding. A recent cognitive turn and a more ecological approach to film theory gave a new perspective on film perception and comprehension by placing films and motion pictures in a natural context. That means that studying how we perceive and understand a motion picture, would also give us a better understanding of how the mind works (Anderson, 1996; Cutting, 2005; Cutting & Candan, 2013). Cognitive scientists concentrated especially in the role of continuity editing and how it works. In addition, there were some initial attempts of creating cognitive models focusing on how the human perceptual system creates coherence from discontinuous cinematic shots (Berliner & Cohen, 2011; Smith, 2012). Other studies also assessed the effect of film viewing in brain activity and eye movements, with eye movement being a useful methodological tool for investigating cognitive processes while watching a movie (Hasson et al., 2008; Magliano & Zacks, 2011; Rayner, 2009; Smith & Henderson, 2008; Smith, 2013; Zacks & Magliano, 2011).

A successful editing following the continuity editing rules should make the cut within a scene almost invisible, so that the viewers' attention stays undistracted and focused on the story. Smith and Henderson (2008) referred to this phenomenon as "edit blindness", the lack of awareness when cuts occur while watching a movie. Specifically, in their study, participants performed a cut detection task while watching excerpts from seven feature films, which were edited according to continuity editing rules. The results indicated that edit blindness occurred, especially in those scenes where there were cuts while an action was performed (match-on-action cut), probably due to the sudden onset of motion prior to the cut which could obscure the cut itself (Anderson, 1996; Bordwell & Thompson, 1993; Reisz & Millar, 2010). But edit blindness should not occur between independent scenes of the same story. Magliano and Zacks (2011) showed that continuity editing supports viewers to create a sense of consistency in successive shots of an event. At the same time, viewers were able to successfully segment the events from a movie excerpt, even when there were discontinuities in space and time (e.g., in parallel editing, where alternating two or more lines of action occurring in different places, usually simultaneously, viewers usually narratively link those actions and think of them as related). Action continuity was a better indicator on event segmentation than spatiotemporal discontinuities (Magliano & Zacks, 2011). So, according to the above-mentioned studies, a viewer is capable to segment an event, but has little awareness of cuts within the scenes.

There are some studies, however, that question the importance of continuity editing rules in film's comprehension. Instead, they suggest that editing errors and discontinuities do not obstruct or disorient viewers' attention and the most important for understanding the story line is the narrative consistency. Attention is primarily directed to understanding the succession of events, rather than to perceptual inconsistencies (Germeys & d'Ydewalle, 2007). d'Ydewalle and Vanderbeeken (1990) distinguished three categories of editing rules and their respective editing violations (first-, second- and third-order editing rules). First order violation refers either to some displacements of the camera or changes to image size that disturbs the smooth flow between the shots (i.e., jump cuts). Jump cuts are created by an elliptical cut between two shots that appears to be an interruption of a single shot (e.g., http://classes.yale.edu/film-analysis/htmfiles/editing.htm) due to the position of the camera that vary very slightly (less than 30 degrees, according to editors' experience). The instant changes of either background or figures in the scene between the two shots or changes in image size of the shots give the impression of jumping and disturb the smooth flow from one shot to the next one. Jump cuts are usually avoided in continuity editing because it draws attention to the structure of the movie (i.e., editing and cuts) obstructing viewers' attention to the narration. Second order violation refers to a violation of the 180^o rule by ignoring the action axis of the location (i.e., reversed angle shots) and obstructing viewers to create a spatial-cognitive schema of the scene. According to 180^o editing rule, when filming an event an imaginary line called axis of action is drawn through the middle of the scene or between the two major elements of the scene (e.g., in a conversation between two characters). Cameras, when filming, should stay within 180^o field and not cross the axis, ensuring that edited shots would keep the position of objects and the direction of action consistent (e.g., http://www.mediacollege.com/video/shots/). Thus, in the case of a conversation between two characters, the scene usually starts with an establishing shot of the two characters from a specific point of view showing the environment where the conversation takes place and at the same time indicating the axis that connects them. The next shots should continue showing each character from the same side of the axis, so that the first character should always look at the right, while the second at the left, and also preserving the spatial continuity of the scene (Bordwell & Thompson, 1993; Thompson, 2009). Third order violation occurs when the linear sequence of actions in a story is not obeyed (i.e., flashbacks). A series of studies examining the impact of the narration in film comprehension revealed that editing violations did not cause, as filmmakers expect, confusion to the viewers when narrative continuity and consistency is maintained (d’Ydewalle et al.,1998; d’Ydewalle & Vanderbeeken, 1990; Germeys & d’Ydewalle, 2007). From the above-mentioned studies, attention to the most informative points in the screen or to any kind of new information in the next shots reinforce the narrative continuity, even when editing violations occur.

Time and temporal continuity

Time is an essential part of a film, often overlooked in discussions of film theory. It is referred either to the duration of an event (subjective and/or objective) or to the event sequences that are depicted in the story (days, months, years). In a narrative film, the sense of time is usually dominated by the events in the story. A film story can take place in hours, days, months or even years. But due to film’s time constraints, a story cannot be told in the actual physical time. Therefore, one of the most important tasks of editing is controlling and handling the time of an action denoted in the film or the time of the whole story itself (Bordwell & Thompson, 1993). With proper use of editing, filmmakers and editors can manipulate the actual time of the film and the perceived flow of time.

Temporal continuity in film is equally important as spatially continuity. The selected order of shots in a movie scene is essential for delivering a specific part of the story. Changing the order can also change, even slightly, the story. Thus, spatial and temporal continuity ensures narrative continuity and editors have the control of creating it the way they wish. There are few temporal discontinuities, like flashbacks, that are allowed to exist in a film according to continuity editing rules (Bordwell & Thompson, 1993; Reisz & Millar, 2010). Temporal and spatial, rather than action, discontinuities have minor effects on behavioral event segmentation (Magliano, Miller, & Zwaan, 2001) and give filmmakers and editors the freedom to handle time of events in a movie.

According, once again, to editors' experience, the desired duration of an action may be modulated through various editing techniques, so that the viewers perceive the duration without "sacrificing" the narrative continuity. These techniques are used to indicate that a part of the diegetic time of an action is missing or to present an event that in real world lasts few seconds to last several minutes in the film (Bordwell & Thompson, 1993; Magliano & Zacks, 2011). There are three common ways to present time in a film: a) compressed time, where an action is presented in such a way that it lasts less in the film than it does in real world, b) expanded time, where the duration of an action lasts longer in the film than it does in real world, and c) real time, where the time of the action is exactly the same as the time it was recorded (e.g., http://www.mediacollege.com/video/editing/time/).

Latest technology offers many tools to achieve time compression or expansion (e.g., slow motion, fast forward, time remapping), but traditional editing utilizes the cut. The most common way to present a scene shorter than real time is by using the elliptical cutting (Bordwell & Thompson, 1993), where portions of an event are left out, but still shots are united carefully in points where the narrative continuity is not obstructed. On the other hand, when filmmakers want to slow down an event that in real time would be very quickly completed, then the scene is created by the same footage with multiple shots from different camera angles (Reisz & Millar, 2010; http://www.mediacollege.com/video/editing/time/expansion.html). Real-time scenes, they are either edited or composed of only one shot, presenting the event as it would take place in the real world.

The present study

As mentioned above, film editing techniques were developed by filmmakers and editors' experience and most of them have been used continuously through the years. After the cognitive turn in approaching film theory, many experimental studies investigated the perceptual and behavioral validation of these empirical techniques, but no experimental studies have been conducted to examine if editing techniques for time manipulation are perceptually and behaviorally correct, and if continuity editing errors affect time perception, even though the use of these techniques by filmmakers and editors are also purely empirical.

Given the lack of studies about time perception in films, the purpose of the present study is to examine whether or not the above-mentioned editing techniques, which are so often used from the editors to manipulate time, do indeed have an impact to viewers' sense of time. Two experiments were conducted. In Experiment 1, we examined the validity of the editing techniques for time manipulation. Do they really have an effect on our sense of duration of a scene? And if they do, are the effects the same as editors believe to be? Five short events were produced and, subsequently, edited in three ways (i.e., compressed-, expanded-, and real-time). Participants were asked to estimate verbally the duration of each scene presented. Given the fact that no previous research has been conducted on the effect of editing in time perception, we consider that filmmakers' empirical methods to manipulate time do have the predicted effect in viewers' sense of time given that continuity is achieved.

In Experiment 2, we examined the continuity editing rules and their respective violations in relation to time perception. Since attentional processes are related to timing (Zakay & Block, 1995; 1997), the question that arises is whether or not editing violations affect duration judgements due to, according to editors, distraction of attention. Scenes of five short events were produced by editing in two ways, according to a continuity editing rules (no jump cuts and the 180^o rule) and their respective editing violation (i.e., using jump cuts and crossing the axis of action). We adopted d'Ydewalle and Vanderbeeken's (1990) categorization of continuity editing rules, specifically first and second order continuity rules. Both versions of the each event (violated and with no violation) had the same duration and the same number of cuts and the difference (i.e., the violation) occurred only in between scenes. Once again, participants were asked to verbally estimate the duration of an event in each condition. According to the previous studies (d'Ydewalle et al., 1998; d'Ydewalle & Vanderbeeken, 1990; Germeys & d'Ydewalle, 2007), viewers' attention is not distracted when a continuity editing error occurs and narrative continuity is the center of film comprehension. In our study, therefore, we hypothesize that a continuity editing error of a given event will not be 'powerful' enough to distract participants' attention and, thus, to change participants' duration judgements between a scene with or without violations.

An action in a movie, from the simplest one to the most complex one includes many intense and fast movements, and depending on filmmakers intention it may take place in a one continuous long shot or it may be created from joint shots. In the second case, editors use the match-on-action cut, where they choose where to cut an action in more than one shot, transferring the action or the results of the action to the next shot, making it seem to continue uninterrupted (e.g., http://classes.yale.edu/film-analysis/htmfiles/editing.htm). For the purpose of the present study, a match-on-action cut was chosen for all events, for the following reasons: a) an action takes place in a spatiotemporal context, b) viewers' attention is focused on the movement (Anderson, 1996), and c) is most potent to produce edit blindness (Smith & Henderson, 2008) due to the sudden onset of motion.

Methods

Participants

Thirty participants (age range: 18-39 years, M = 31.9 years of age, 13 females and 17 males) took part in both Experiments 1 and 2. All participants had normal or corrected to normal visual acuity and were naïve as to the purpose of the study.

Stimuli and Apparatus

Five different everyday events were recorded by a professional director using a Nikon Digital SLR Camera D5100. For each event, multiple different angles were recorded for appropriate editing of the final scenes. The scenes depicted the following events: a) a seated man lighting and smoking a cigarette (Cigarette scene), b) a woman descending some stairs, opening the front door, and leaving the house (Stair scene), c) a woman making some tea and drinking it (Tea scene), d) a woman entering the living room, phoning someone, and leaving the room (Phone scene), and d) a woman placing some paper in the typewriter and typing (Typewriting scene).

All actions were edited with the simple match-on-action cut, where the cut from one shot to another occurs when an action is being performed, in which the action is continued from one shot to the next. The editing was reviewed and approved by a professional editor.

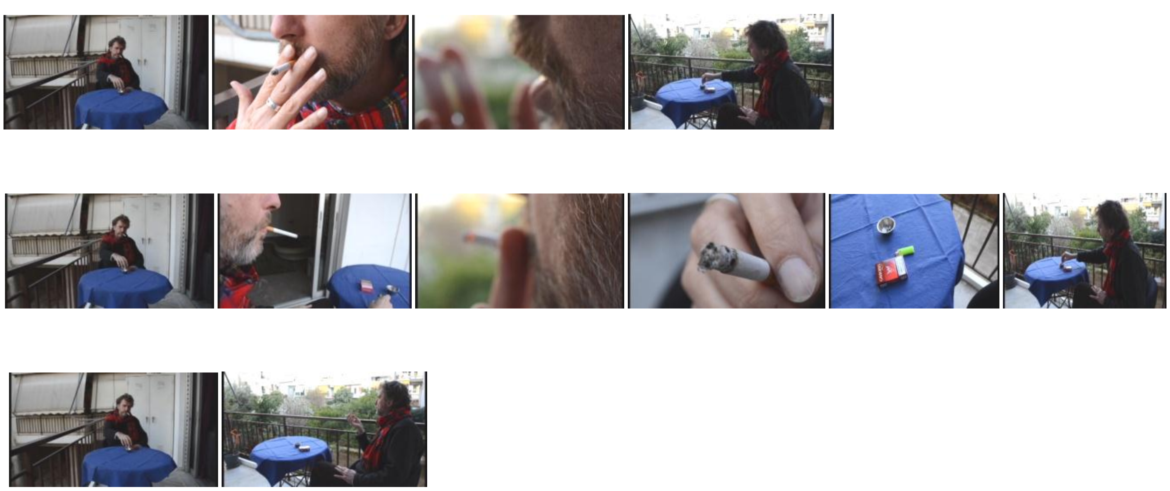
For Experiment 1, every action was edited in 3 different ways: Real-, Compressed-, and Expanded-time editing (see Figure 1). This was done in order to manipulate the perceived flow of time. Thus, 15 new scenes, 3 for every event, were created. For each event, the Real-time scene was composed of one cut, the Compressed-time scene of 4 cuts, and the Expanded-time scene of

6 cuts. Additionally, the first and the last shot for every different scene of each event was the same, so that the compression or the expansion of time was manipulated only in between cuts and not in the beginning or the end of the scene. The editing and different number of cuts (i.e., 1, 3, and 5 cuts) in every scene resulted in different video durations, thus, static frames were added at the beginning and the end of each video so that their physical duration was the same. The static frames were extracted from the first and last frames of each video using Adobe Premiere Pro CS6. All cuts were according to the principles and key techniques used in continuity editing.

The final durations for each action scene were:

Event Scene	**Duration (secs)**
Cigarette	22
Phone	25
Cup of tea	26
Stairs	16
Typewriting	16

A)



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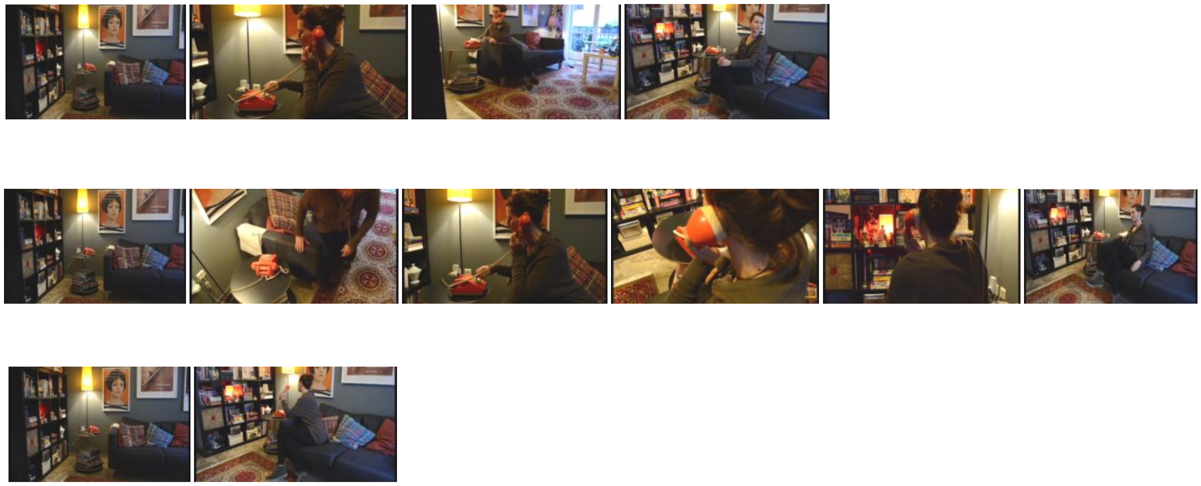
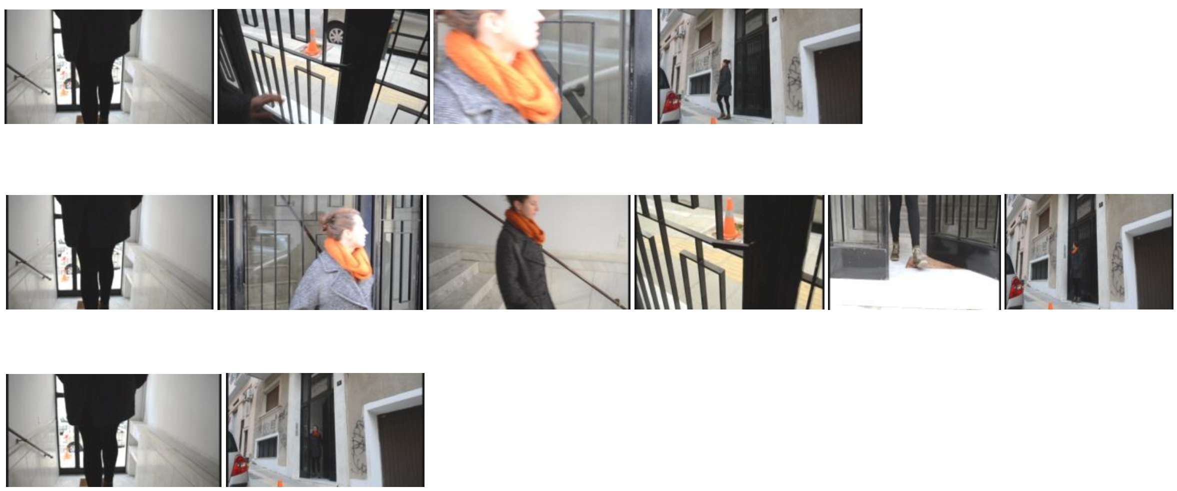
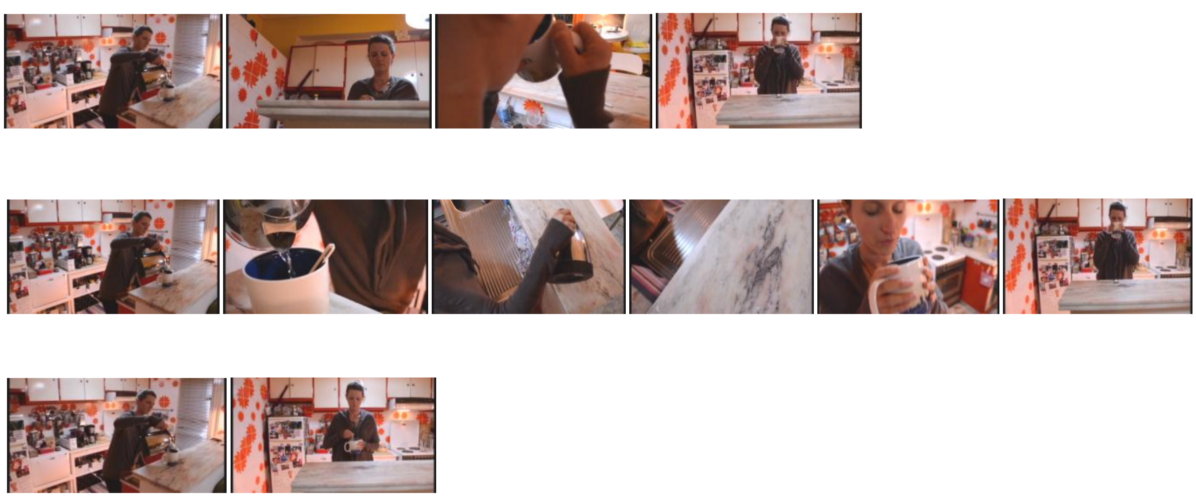


C)



D)



E)

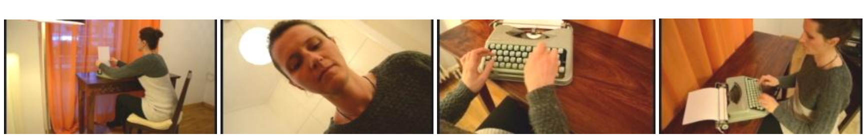
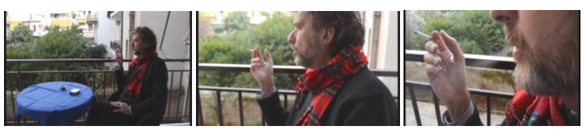
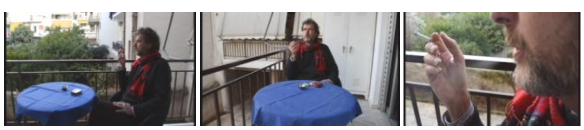


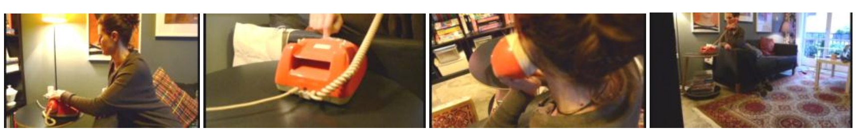
Figure 1. Static frames in linear position extracted from the original videos used as stimuli in Experiment 1. Every frame displays the first frame of each shot in the scene. Videos A (cigarette), B (phone), C (stairs), D (tea) and E (type) show the events in compressed-, expanded-, and real-time.

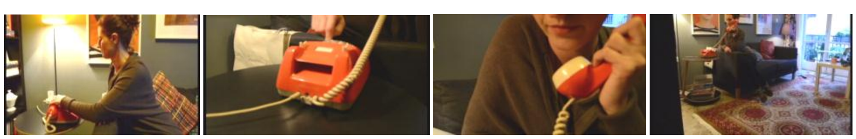
For Experiment 2, where the continuity rules were investigated, we created 9 pairs of videos same as those used in the Exp. 1 (i.e., 2 pairs for the: Cigarette, Cup of tea, Stairs, and Typewriting scene and 1 pair for the Phone scene), using the match-on-action cut (see Figure 2). For each pair of videos, one version was edited following a given continuity rule in the editing, while the other was edited so that it violated the given rule. As mentioned above, we used 2 specific continuity rules and their violations, following the categorization suggested by d'Ydewalle and Vanderbreeken (1990), jump-cuts and the 180 degree rule/axis of action (first- and second-order editing violations, respectively). All videos had 3 cuts (except from the Phone scene, which had 4 cuts) and, as in Exp. 1, the first and the last shot of the videos from the same pair were identical and only the in between shots were different, so as to create the given violation. The video duration was again made identical for each pair using static frames extracted from the first and the last shot of each video. The following table shows the final pairs of stimuli, the kind of continuity rule, and duration:

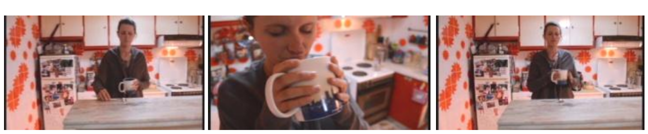
Pairs of Stimuli	Continuity Rule	Duration (secs)
Cigarette 2	180 degree rule	14
Cigarette 5	Jump cut	14
Phone 5	180 degree rule	15
Stairs 1	180 degree rule	7
Stairs 5	Jump cut	7
Cup of tea 4	180 degree rule	13
Cup of tea 5	Jump cut	13
Typewriting 2	180 degree rule	8
Typewriting 6	Jump cut	8

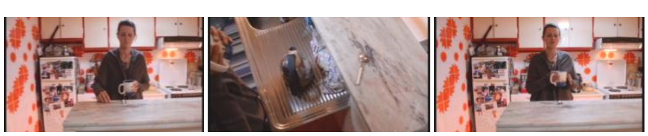
A) 

B) 

C) 

D) 

E) 

F) 

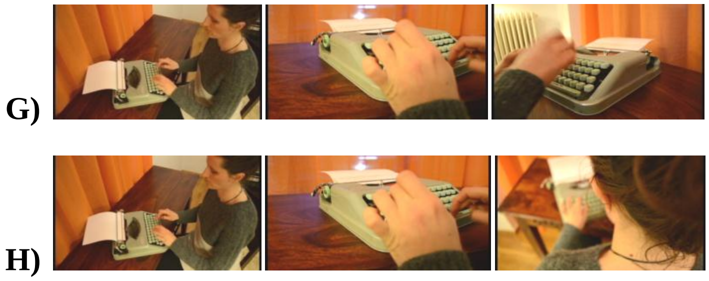


Figure 2. Selection of static frames in linear position extracted from the original videos used as stimuli in Experiment 2. Every frame displays the first frame of each shot in the scene. Videos A, and E display the events edited with a first order editing violation (i.e., jump cuts), while videos B, and F the events edited according to the respective editing rule. Videos C, and G display the events edited with a second order editing violation (i.e., 180 degree/ axis of action), while videos D, and H the events edited according to the respective editing rule.

The auditory stream was removed from all videos. The stimuli were presented on a Toshiba laptop. The experiment was conducted using Presentation programming software (Version 18.1; Neurobehavioral Systems Inc.). Five repetitions of each condition in Exp. 1 (Real-, Compressed-, and Expanded- time) and in Exp. 2 (Violation and No-Violation type) were presented. The videos were presented in two different blocks in both experiments. The order of stimulus presentation was randomized.

Experimental procedure

Participants performed a verbal estimation task. Specifically, at the beginning of every block the instruction "How long did the video last? Choose a time between x and y seconds" appeared, where "x and y" corresponded to the range of time (in seconds) the participants were to choose from. After watching a video, participants were asked to type the perceived duration of the video in order to continue on to the next video. Among the other timing procedures (i.e., reproduction and production), we chose, despite the disadvantages, verbal estimation for 2 reasons: a) the actual duration of the stimuli were long enough, so that to make production or reproduction of the perceived duration a difficult and tiring for the participants task with questionable results, and b) primary goal of the present research is to investigate the over- or underestimation of the perceived duration between the conditions.

Two different groups of videos and their matched intervals for Experiment 1 (Cigarette, Phone, and Cup of Tea scene with the interval of 15 to 35 seconds and Stairs and Type Scene with the interval of 5 to 25 seconds) and two groups of videos for Experiment 2 (Cigarette, Phone, and Cup of Tea scene with the interval of 5 to 25 seconds and Stairs and Type Scene with the interval of 1 to 15 seconds) were created.

Participants were seated approximately 60 cm from the screen in a dimly light room. A short practice block was provided in order to familiarize the participants with the experimental procedure. Participants were instructed to watch carefully every video and not to use any counting or other time-keeping strategies.

Results

Analysis

In order to identify whether the type of editing may influence the perceived duration, we analyzed participants' accuracy and coefficient of variation (CV). Accuracy (i.e., estimated time divided by the original duration in each condition) refers to how close the participants' responses were to the original duration of each video presented (i.e., whether participants had underestimated or overestimated the original duration), while CV (i.e., the ratio of the standard deviation to the mean duration judgement) indicates the extent of variability of the participant's responses in each condition, with higher CV indicating greater response variability. Repeated-measures analyses of variance (ANOVA) were performed using SPSS. Bonferroni corrected t-tests (with point of statistical significance set $p<0.05$) were used for all post-hoc comparisons.

Experiment 1: Editing techniques for time manipulation

Two-way repeated measures ANOVA was performed with Editing Time (Compressed- vs. Expanded- vs. Real-time) and Stimulus Type (Cigarette, Phone, Stairs, Tea, and Type Scene) as the within-subjects factors for Exp.1

Accuracy

In regards to accuracy, main effects for Editing Time [$F(2,58) = 20.432$, $p<0.001$, $\eta^2 = 0.413$] and the interaction of Editing Time and Type of Stimulus were significant, while no effect of Type of Stimulus was obtained [$F(4,116) = 1.925$, $p=0.111$, $\eta^2 = 0.062$]. Specifically, the main effect of Editing Time showed that the Expanded-time scene was further overestimated (M = 0.939) than both Real-time (M = 0.895) and Compressed-time (M = 0.870) scenes (see Figure 3). Additionally, Real-time (M = 0.895) scenes were also overestimated in duration judgement than Compressed-time (M = 0.870) scenes. Looking further into pairwise comparisons between the stimuli, some differences in duration judgements appeared to be significant, with participants to overestimate mainly the duration Cigarette and Phone scene with M = 0.944 and 0.909, respectively, in contrast to the other 3 stimuli (Stairs, Tea, and Type scene with M = 0.888, 0.878, and 0.886, respectively). These differences could have been driven by the event type presented and the selection of the edited shots, with some scenes to include more static shots than the others. Experimentation with more participants may reveal more significant effects in participants' duration judgements.

Analysis of the data also resulted in a Editing Time by Stimulus Type interaction [$F(8,232) = 11.086$, $p=0.000$, $\eta^2 = 0.277$]. Underestimation of participants' duration judgement occurred in every compressed edited scene compared to the respective expanded edited scene (Cigarette, Phone, Stairs, Tea, and Type scene with M = 0.905, 0.900, 0.816, 0.872, and 0.855 for compressed editing and M = 0.974, 0.920, 0.940, 0.889, and 0.972 for expanded editing, respectively). Also, duration judgements of real-time edited scenes (Cigarette, Phone, Stairs, Tea, and Type scene with M = 0.954, 0.907, 907, 0.873, and 0.831, respectively) were underestimated in comparison to duration judgements of expanded edited scenes, but overestimated in comparison to duration judgements of compressed edited scenes.

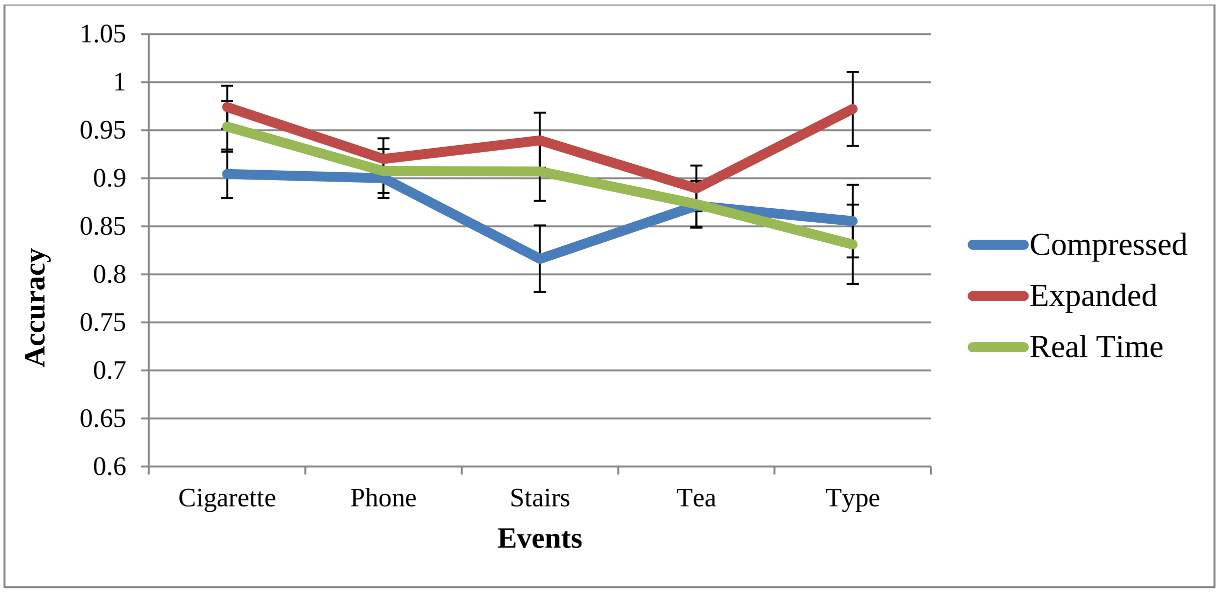


Figure 3. Mean accuracy of Editing time (Compressed-, Expanded-, and Real-time) and of Stimulus type (Cigarette, Phone, Stairs, Tea, and Type). The error bars represent the standard errors of the means.

Coefficient of variation (CV)

In regards to CV, a main effect of Stimulus type [F(4,116) = 6.518, p=0.000, η^2= 0.184] was obtained, but no effect in Editing Time [F(2,58) = 0.100, p=0.905, η^2= 0.003] was significant (see Figure 4). Specifically, a main effect of the type of stimulus was significant, where the participants' judgment about Type and Stairs scene duration had shown the greatest variability (M = 0.146 and 0.141, respectively). Significant variability of the duration judgements had also been noted on the other 3 scenes (Cigarette, Phone, and Tea with M = 0.104, 0.107, and 0.106, respectively), while comparison between the 5 stimuli did not reach significance, except on the comparison between Tea and Type scene (M = 0.106 and 0.146 respectively).

At last, there was an effect in the interaction between Editing Time and Type of Stimulus [F(8,232) = 2,076, p=0.039, η^2= 0.067]. A more detailed examination of the pairwise comparisons reveals variability in participants' judgement, particularly in Type scene between the means of Expanded- and Real-time editing (M = 0.123, and 0.169, respectively), with Type scene in Real-time editing showing greater variability rather in Expanded-time editing.

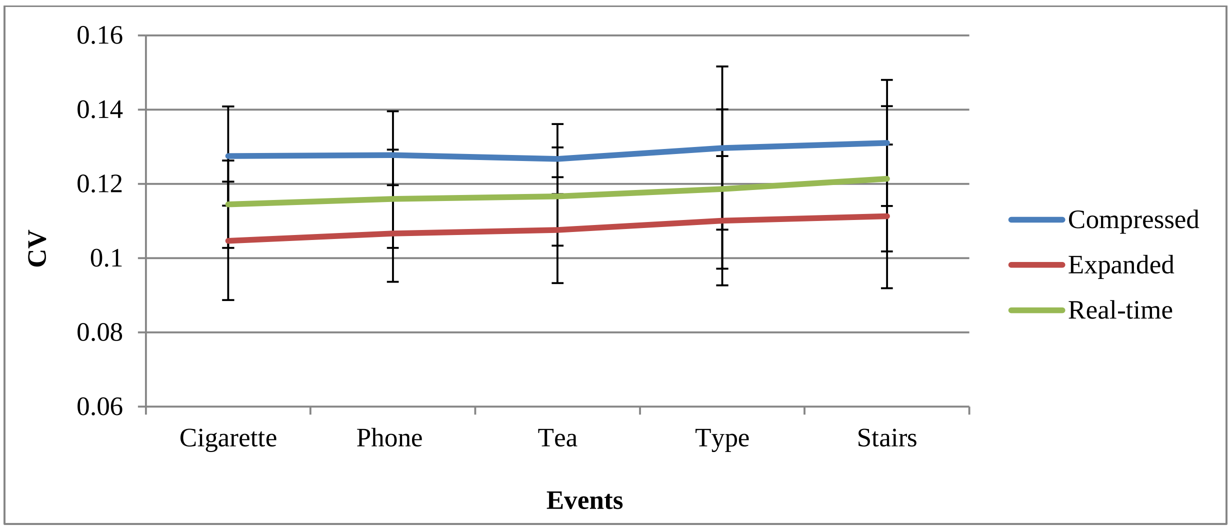


Figure 4. Mean CV of Editing time (Compressed-, Expanded-, and Real-time) and Stimulus type (Cigarette, Phone, Stairs, Tea, and Type) in Experiment 1. The error bars represent the standard errors of the means.

Overall, the analysis in Experiment 1 showed a great underestimation in participants' duration judgement when the scenes were edited with the compressed- and real-time editing and an overestimation with the expanded-time editing. Variability due to editing type in participants' judgement was, in general, no significant, with judgments in compressed-time scenes (i.e., the version of the scenes which was overall underestimated compare on the other two versions) to show greater variability rather than the expanded- and real-time scenes. A significant variability in participants' responses was driven by the type of stimuli, which can be explained by the different events presented or the different proportion between dynamic and static shots in each scene.

Experiment 2: Continuity editing rules and violations

Two-way repeated measures ANOVA was also performed for Experiment 2, with Violation of an editing rule (Violation vs No Violation) and Stimulus Type (Cigarette, Phone, Stairs, Tea, and Type Scene) as the within-subjects factors. Two different analysis were performed, one for the scenes which were edited based on the first order editing rule (jump-cuts) and its violation, and one for the scenes edited based on the second order editing rule (180 degree rule) and its violation. Once again, for the analyses reported here, Bonferroni corrected t-tests (with point of statistical significance set to $p < 0.05$) were used for all post-hoc comparisons.

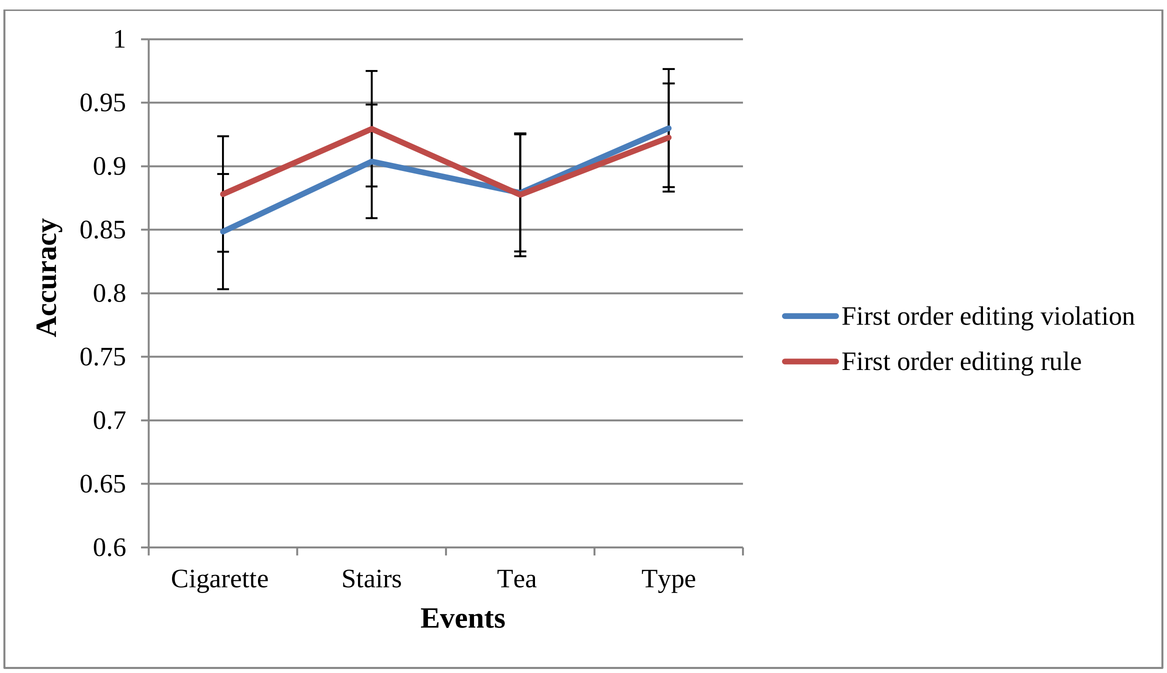
Accuracy

In regards to accuracy, no significant effect was obtained for Violation Type [$F(1,29) = 1.312$, $p=0.261$, $\eta^2 = 0.043$], Stimulus type [$F(3,87)=0.909$, $p=0.440$, $\eta^2 = 0.030$] and the interaction between Violation Type and Stimulus type [$F(3,87) = 1.041$, $p=0.379$, $\eta^2=0.035$] in scenes edited according to the first order editing rule (see Figure 5A). Regarding the accuracy of the duration judgements about the scenes edited according to the second order editing rule, main effects of Stimulus type and Violation by Stimulus type interaction were significant, while once again no effect of the Violation type was obtained (see Figure 5B). In detail, a main effect of Stimulus type occurred [$F(4,116) = 6.109$, $p=0.000195$, $\eta^2=0.172$] , with participants being more accurate in their duration judgments in Phone, Tea, and Type ($M = 0.969$, 0.907, and 0.941, respectively) scenes as compared to the Cigarette and Stairs ($M=0.818$, and 0.806, respectively) scenes. Also, the interaction of Violation by Stimulus type was significant [$F(4,116) = 22.915$, $p=0.000$,

η^2=0.441]. Specifically, the duration of the Stairs scene with a violation in editing was overestimated compared to the Stairs scene that followed the continuity rule (M = 0.884 and 0.729, respectively). The opposite, significant though, result occurred from the comparison between the two versions of Type scene, where the duration of the first version (Violation) was underestimated compare to the second one (M=0.887, and 0.995, respectively). As mentioned above, this effect may be due to the kind of event presented and the selected shots of each scene.

No effect of the Violation type was obtained in participants' duration judgement [F(1,29)=0.918, p=0.346, η^2=0.031], which is in agreement with the results of the analysis of the data from the scenes followed and violated the first order editing rule.

A)



B)

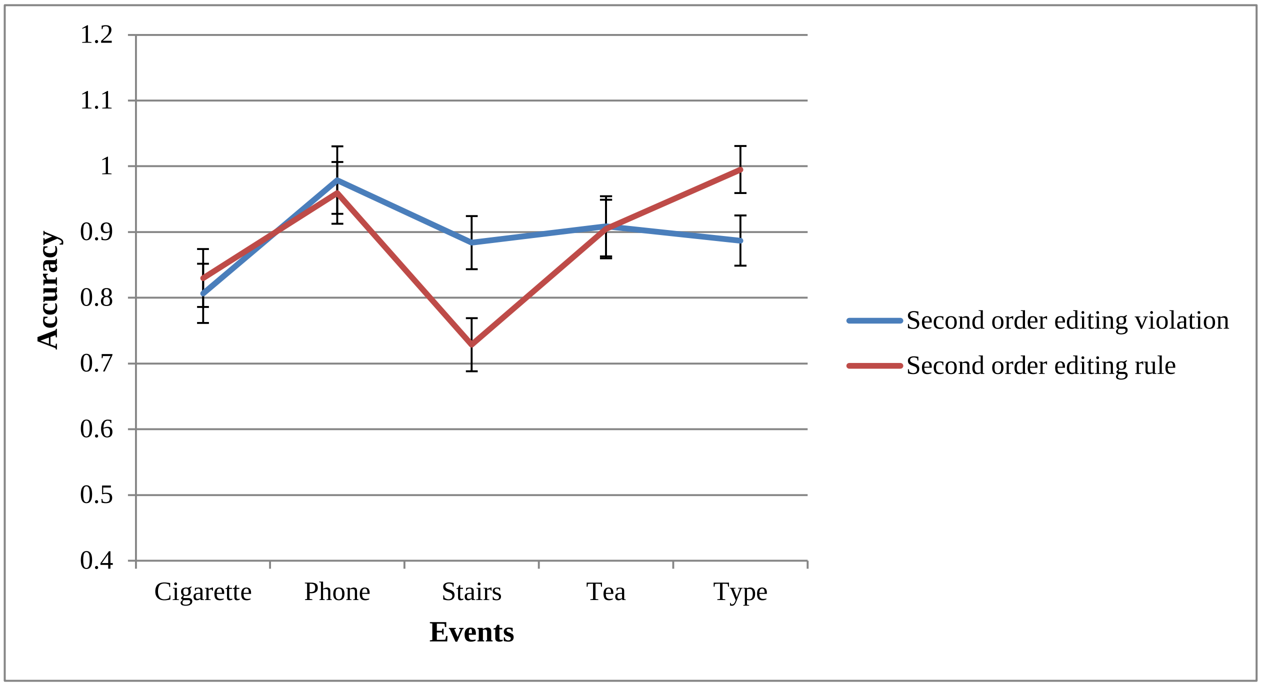


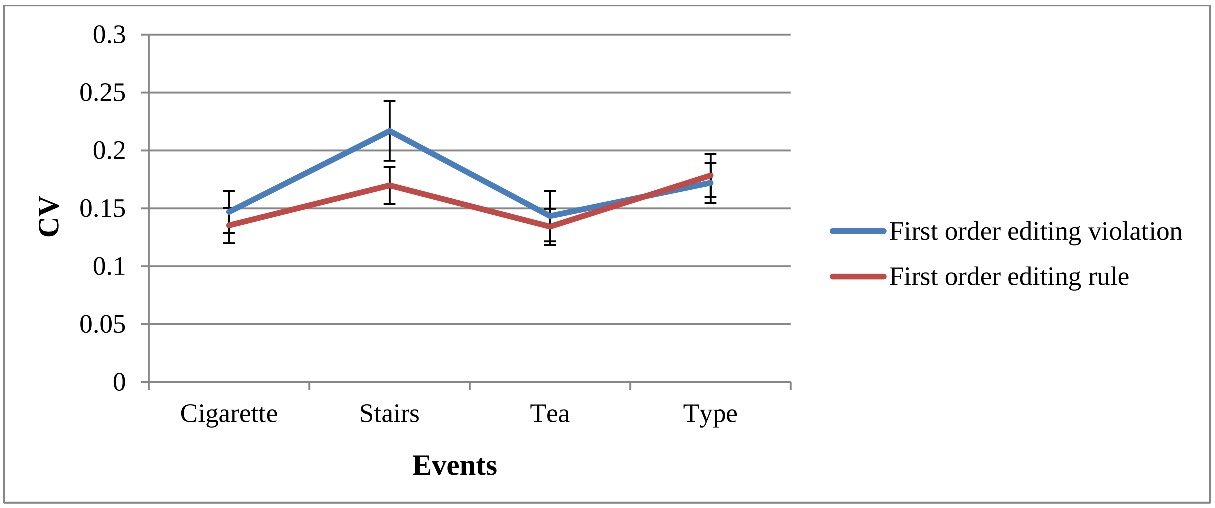
Figure 5. Mean accuracy of Violation and No violation of first (A) and second (B) order editing rule and of Stimulus type (Cigarette, Phone, Stairs, Tea, and Type). The error bars represent the standard errors of the means.

Coefficient of variation (CV)

In regards to CV, a main effect of Stimulus type for the scenes edited according the first order editing rule was significant, but there were no effects of the Violation type and the interactions Violation by Stimulus type (see Figure 6). Specifically, the main effect of Stimulus type [$F(3,87)=6.976$, $p=0.0003$, $\eta^2=0.194$] revealed great variability in participants' responses, which was higher in the Stairs and Type scene (M = 0.193 and 0.175, respectively) compare to the other two scenes (Cigarette: M = 0.141 and Tea: M = 0.139).

Analysis of the data regarding the scenes based on the second order editing rule and its violation showed, the same as above, significant effect of the Stimulus type, while no effect of Violation Type and the interaction Violation type by Stimulus type was obtained. The effect of Stimulus type [$F(4,116)=3.432$, $p=0.011$, $\eta^2=0.106$] showed a variability in all responses for each scene, with higher variability for Stairs and Type scene (M = 0.186 and 0.184, respectively) and lower for the Cigarette, Phone and Tea scene (M = 0.142, 0.124, and 0.151, respectively). Worth to mention here is that participants' duration judgements for Stairs and Type scenes showed the highest variability among all other scenes in both violation cases (first and second order editing rules).

A)



B)

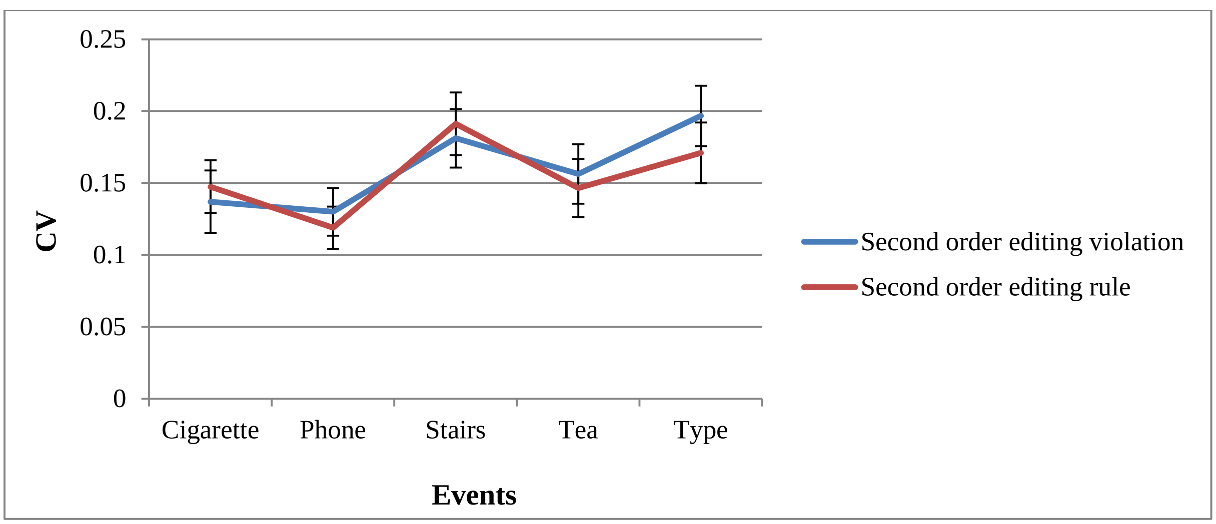


Figure 6. Mean CV of Violation and No violation of first (A) and second (B) order editing rule and Stimulus type (Cigarette, Phone, Stairs, Tea, and Type) in Experiment 2. The error bars represent the standard errors of the means.

Discussion

The main purpose of this investigation was to test whether or not the application of editing techniques used in movies to manipulate the perceived flow of an event time and continuity editing rules would have an effect in viewers' time estimation. This is the first study that focuses on the investigation of editing and time perception.

In Experiment 1, we found that the editing techniques used in order to manipulate the perceived duration of an event (compressed-, expanded-, and real-time editing) had a significant effect in participants' duration judgements. These results are in agreement with filmmakers' intention (Bordwell & Tompson, 1993). That is, expanded-time scenes were overestimated in comparison to the respective versions of compressed- and real-time scenes. Additionally, underestimation occurred for the compressed-time scenes when compared to the real-time scenes. In Experiment 2, we found that there was no significant difference in time estimation between the scenes with and without editing violation, indicating that attention modulation due to editing errors does not affect viewers' sense of time.

Timing studies have led to proposing cognitive models, so that to explain how we experience time and to clarify aspects of psychological time (i.e., succession, duration and temporal perspective; Block, 1990). In order to explain the results of the present study according to our scientific purposes and the characteristics of the experiments' set-up, two cognitive models seemed better fit, change-based model (Poynter, 1989) and Attentional Gate Model (AGM; Zakay & Block, 1995; 1997). Specifically, in Experiment 1 we apply change-based model since the number of cuts (i.e., number of changes) in the edited events are the main characteristic of the experiment's stimuli and AGM in order to clarify the role of attention in duration estimation, while in Experiment 2 we investigate only the role of attention processes in relation to timing, since continuity editing rules' main purpose is to maintain attention in the narrative of the presented events and away of the structure of the scenes.

According to previous literature on timing change hypothesis for time perception, duration estimation is often modulated by the number of changes presented in an event (Block, 1990; Poynter, 1989; Poynter & Homa, 1983), with higher number of changes leading to a lengthening of the perceived time, since change is considered as a psychological indicator of time passage (Poynter, 1989). Specifically, Poynter and Homa (1983) suggested that the number and magnitude of the changes and the organization of the events in an interval affect duration judgments. In Experiment 1, the main characteristic that differentiates the 3 edited versions of the scenes is the number of cuts, which can be linked with the number of changes in the stimuli. If so, more cuts in a scene should lengthen the perceived duration, while fewer cuts would result in the opposite. The results from Experiment 1 could partially be explained by this hypothesis regarding change. Change-based models could explain the overestimation in expanded-time edited scenes due to the larger number (5) of cuts. Overestimation, though, in real-time scene where only one cut was contained in comparison to the compressed-time version of the scenes (i.e., 3 cuts) cannot to be explained by the change hypothesis, since compressed-time scenes have larger number of changes than real-time, which should have led to an overestimation of perceived duration. Thus, changes seems not to be the explanation of our effects either because, according to previous studies, viewers usually are not aware of edits in match-on-action scenes, a phenomenon called edit blindness (Smith & Henderson, 2008) or because viewers, like in real world (change blindness) viewing, are not aware of any unexpected changes that occur between shots, even changes in objects or characters that happened to be the center of attention (Levin & Simons, 1997).

Duration estimation of events is influenced by several factors, either external (i.e., the amount of presented information, task difficulty etc.), or internal (i.e., mood, time estimation strategies, etc.; Zakay & Block, 1997). According AGM on timing (Zakay & Block, 1995; 1997) arousal and attention are two mechanisms that affect time estimation. Arousal increases the frequency of the pulses in the first component of the model (pacemaker) and attention determines the accumulation of the pulses through the switch. If we apply this model for the purpose of Exp. 1, we would assume that duration judgments of edited scenes in the expanded-time version due to more shots, thus, more non-temporal information, would be further underestimated in comparison to the real- or compressed-time edited scenes. Once again, the results from Exp. 1 showed the opposite pattern; that is, expanded-time scenes were judged as longer in duration than the other two conditions. Thus, the AGM is not suitable to explain the overall overestimation of participants' judgments in expanded-time scenes, but it can partially explain the overestimation in real-time scenes in comparison to the compressed-time.

Low-level features in movies (shot duration, motion and movement, luminance, and color) are supposed not only to support film's narrative, but also to help guide the viewers to fully comprehend the movie (Brunick et al., 2013). Looking for the reasons that affected participants' duration judgments in Exp.1, questions arise about the importance of low-level features, in general, and shots' duration, in particular, over time perception. The average length per shot in films has been steadily declined linear over the decades, with long shots to be considered any shot that exceeds one minute (Brunick et al., 2013; Cutting & Candan, 2015; http://classes.yale.edu/filmanalysis/htmfiles/ editing.htm). Brunick et al. (2013) examined the importance of low-level features in a movie, including shot duration and its effect in film comprehension. Due to the differences we found in the results of Exp. 1 and the fact that shot duration in each condition is different caused by the number of cuts (i.e., more cuts, shorter the duration of the shots), we assume shot duration as a possible factor that affect time estimation. On the one hand, longer shots, as in real-time scenes, give the time to viewers to collect more information from the scene (Brunick et al., 2013), while, on the other hand, shorter shots usually guide the attention only to the central point of interest in each shot with a limit in information extraction. The amount of non-temporal information extracted from shots may be the cause of differences in time estimation. That would suggest that, in experiments as the present one, greater amount of non-temporal information extracted from longer shots would lead to an underestimation of time estimation, while, on the other hand, perceived duration of scenes with short shots and, thus, limited amount of non-temporal information would be overestimated, since attention would be mainly allocated to time rather the event itself (Zakay & Block, 1995).

Additionally, the stimuli used in Exp. 1, were edited according to the editing techniques for time manipulation and match-on-action cut was used for scenes due to higher possibility of edit blindness (Smith & Henderson, 2008). Thus, an action unfolded in every shot of the scene in any way it was edited. Most of the shots included movement as part of the action, but surely there were shots in the scenes that were of more static character. Potentially the significant variability found in time estimation was due to the type of events presented in the stimuli (i.e., some events are by nature more dynamic than others) and the different proportion of static and dynamic shots in each scene.

Our study's findings validate the empirical editing methods on time manipulation. More shots from different camera angles offer the sense of a longer action, while missing action parts give the impression of a shorter duration. We suggest that for an explanation about this timing illusion, we should investigate further the features of the shots, which are also empirical manipulated by the filmmakers, in relation to attentional processes.

In Exp. 2 the possible effects of continuity editing violations in time estimation were examined. Theories of how we perceive film continuity (i.e., active perception; Berliner & Cohen, 2011; Attentional Theory of Cinematic Continuity, AToCC; Smith, 2012) propose that attention has a central role in understanding continuity, since continuity editing rules are supposed to create a spatiotemporal cognitive schema where attention is guided to the most informative points and away from the discontinuities (Smith, Levin, & Cutting, 2012). Specifically, AToCC describes perceptual stages where attention is driven by natural cues of the movie (i.e., sound, motion, gaze cues etc.), guiding focus to specific areas in the screen away from the following cut and reorienting in the new information that the new shot shows, while at the same time meets viewers' expectations about what it has to followed in the next shot. If so, that means that when editing errors occur, attention should be distracted and viewers may not be able to make sense of the scene. Even though it is a strong belief that editing a film according to continuity editing rules make film comprehension much easier for viewers, a modern view on this subject suggests that a concrete narration is much more important than editing rules that only guide you where and when to cut (d'Ydewalle & Vanderbeeken, 1990). Not following editing rules doesn't lead to confusion and disorientation (Germeys & d'Ydewall, 2007).

Applying AGM for the purposes of Exp. 2, we suggest that scenes with an editing error disorient viewers and are distracting enough, so that attentional resources are allocated to more non-temporal information. Therefore, according to the model, the gate flickers at varying frequencies, allowing only few pulses to pass through (Zakay & Block, 1995; 1997) and that would lead to an underestimation of the violated scenes compared to the scenes according to continuity rules. Findings of Exp.2 cannot be satisfactorily explained by AGM, since there were no effects of editing errors in time estimation.

The absence of significant effect in Exp. 2 reinforces the suggestion that coherent narrative continuity is more important, so that spatiotemporal discontinuities would not affect viewers' attention (d'Ydewalle & Vanderbeeken, 1990; Germeys & d'Ydewalle, 2007). Even though continuity editing rules are massively accepted from cinematographers, these findings suggest that violations of both first and second order editing rules do not distract viewers' attention (d'Ydewalle & Vanderbeeken, 1990) and timing mechanisms for duration estimation "work" the same for both versions of the scene (i.e., with or without violation). This indicates that there may not be any exclusive interrelationship between continuity editing rules and attention.

At last, it is essential to mention some important constraints due to the chosen task of the present study. Verbal estimation is a task where the participants experience an interval and afterwards they are asked to quantify this experience and estimate its duration verbally. Some of the disadvantages of the particular task are: a) there is no exact picture of the perceived time, especially in short durations, and participants tend to use certain values of hundreds and not in between values, b) verbal estimates' variability is usually greater than estimates obtained by other methods (Zakay & Block, 1997), therefore, there is a need for an interval–guide given to the participants, c) the possibility of higher standard errors is also greater, and d) there is no model which can explain how participants' perform this task. In the present study, due to the long duration of the edited scenes, verbal estimation was chosen as the best method, with the experiment's setup to be carefully planned in order to minimize the effects caused by the task. The given intervals led to less variability in duration judgment. As mentioned above, the main purpose of the study was to investigate the over- or underestimation of the perceived duration between the conditions, thus, the exact perceived duration is not required and larger errors are acceptable.

Overall, the results from the two Experiments found that empirical editing techniques for time manipulation can modulate one's perception of duration, but continuity editing rules cannot. Filmmakers and editors' experience is perceptually and behaviorally only in part approved. Further examination in editing and film perception in relation to time is suggested, with central interest of examination the role of attention and low-level features in movie scenes in time perception.

References

Anderson, J. D., (1996). The reality of illusion: An ecological approach to cognitive film theory. Carbondale, IL: Southern Illinois University Press.

Berliner, T. & Cohen, D. J., (2011). The illusion of continuity: active perception and the classical editing system. *Journal of Film and Video*, 63, 44-63.

Block, R. A. (1990). Models of psychological time. In R.A. Block (Ed.). Cognitive models of psychological time (pp. 1-35). New York, NY: Psychology Press.

Bordwell, D., & Thompson, K., (1993). Film art: An introduction (4^{th} ed.). New York, NY: Mc Graw Hill.

Brunick, K. L., Cutting, J. E., & DeLong, J. E., (2013). Low-level features in film: What they are and why we would be lost without them. In A. Shimamura (Eds) *Psychocinematics: exploring cognition at movies* (pp. 133-148). New York: Oxford.

Cutting, J. E., 2005. Perceiving scenes in film and in the world. In J. D. Anderson & B. F. Anderson (Eds.) *Moving image theory: Ecological considerations* (pp. 9-27). Carbondale, IL: University of Southern Illinois Press.

Cutting, J. E., & Candan, A. (2015). Shot durations, shot classes, and the increased pace of popular movies. *Projections: The journal for movies and mind*, 9(2), 40-62.

Cutting, J. E., & Candan, A., (2013). Movies, evolution, and mind: From fragmentation to continuity. *The Evolutionary Review*, 4(3), 25-35.

d'Ydewalle, G., & Vanderbeeken, M., 1990. Perceptual and cognitive processing of editing rules in film. In R. Groner, G. d'Ydewalle & R. Parham (Eds.) *From eye to mind: Information acquisition in perception, search, and reading* (pp. 129–139). Amsterdam: Elsevier Science Publishers B.V. (North-Holland).

d'Ydewalle, G., Desmet, G., & Van Rensbergen, J., 1998. Film perception: The processing of film cuts. In G. Underwood (Ed.) *Eye guidance in reading and scene perception* (pp. 357–367). Oxford: Elsevier.

Germeys F. & d'Ydewalle, (2007). The psychology of film: perceiving beyond the cut. *Psychological Research*, 71, 458–466.

Hasson, U., Landesman O., Knappmeyer B., Vallines I., Rubin N., & Heeger D.J., (2008). Neurocinematics: The Neuroscience of Film. *Projections*, 2(1), 1-26.

Levin, D.T., & Simons, D.J. (1997). Failure to detect changes to attended objects in motion pictures, *Psychonomic Bulletin & Review*, 4(4), 501-506. Magliano J.P., Miller J., Zwaan R.A., (2001). Indexing space and time in film understanding. *Applied Cognitive Psychology*, 15(5), 533–545.

Magliano, J.P. & Zacks, J.M., (2011). The impact of continuity editing in narrative film on event segmentation. *Cognitive Science*, 8, 1489-1517.

Poynter, W. D. (1989). Judging the duration of time intervals: A process of remembering segments of experience. In I. Levin & D. Zakay (Eds.), *Time and human cognition: A life-span perspective* (pp. 305-321). Amsterdam: Elsevier.

Poynter, W. D., & Homa, D. (1983). Duration judgment and the experience of change. *Perception & Psychophysics*, 33, 548-560.

Rayner, K., (2009). Eye movements and attention in reading, scene perception, and visual search. *The Quarterly Journal of Experimental Psychology*, 62(8), 1457-1506.

Reisz, K. & Millar, G., (2010). The technique of film editing (2nd ed.). London: Focal Press.

Smith, T. J., (2012). The attentional theory of cinematic continuity. *Projections: The Journal for Movies and the Mind*, 6(1), 1-27.

Smith, T. J., (2013). Watching you watch movies: Using eye tracking to inform cognitive film theory. In A. P. Shimamura (Ed.), *Psychocinematics: Exploring cognition at the movies* (pp. 165-191). New York: Oxford University Press.

Smith, T.J. and Henderson, J.M., (2008). Edit Blindness: The relationship between attention and global change blindness in dynamic scenes. *Journal of Eye Movement Research*, 2(2), 1-17.

Stam, R., (2000). Film theory: An introduction (1st ed.). Massachusetts, USA: Blackwell Publisher Inc.

Thompson, R., (2009). Grammar of Edit (2nd ed.). Burlington, USA: Focal Press

Zacks, J. M., & Magliano, J. P., (2011). Film understanding and cognitive neuroscience. In F. Bacci & D. P. Melcher (Eds.) *Art and the Senses* (pp. 435-454). New York, NY: Oxford University Press.

Zakay, D., & Block, R. A. , (1995). An attentional-gate model of prospective time estimation. In M. Richelle, V. De Keyser, G. d'Ydewalle, & A. Vandierendonck (Eds.), *Time and the dynamic control of behavior*, Liège , Belgium : Universite de Liege.

Zakay, D., & Block, R. A. (1997). Temporal cognition. *Current Directions in Psychological Science*, 6, 12-16.

Acknowledgements

We express our gratitude, to Mr. Thanasis Vlachopoulos, the director, Mrs. Olga Manoudi and Mr. Aris Stamatiadis, the actors, and Mr.Haris Farros, the editor, for their contribution in making the stimuli videos. And of course, we would like to thank all the participants who patiently took part in the experiments.