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WHAT TIME IS *IN*?
SUBJECTIVE EXPERIENCE AND EVALUATION OF MOVING IMAGE TIME

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Abstract. This paper sketches the main lines and introduces the first results of a theoretical and empirical research set within the framework of Neurofilmology and focused on the Subjective Experience and Evaluation of Moving Image Time (SEEM_IT). In the first section, the paper reconstructs the state of the art of time studies in different disciplinary fields. The second section explains some underlying options of the research. Notably, it adopts the hypothesis (currently prevalent in neuroscience), that links time perception to movement and proprioception; and connects it to the idea that the perception of movement triggers processes of embodied simulation, which in turn are responsible for the perception of time. Film watching would, therefore, constitute a particularly rich and articulated experience of time. The last section presents the results of an experiment aiming to evaluate the role of editing styles in determining quantitative and qualitative aspects of SEEM_IT. The results show that fast-paced editing usually tends to produce a sensation of higher speed of both the time flow rate and the observed action rate, and an overestimation of the clip durations; however, the type of action displayed can modify this outcome.
Keywords: time perception, time consciousness, cinematic time, event segmenta-tion, embodied simulation, neurofilmology, film editing.

1. INTRODUCTION

This paper sketches the main lines, presents the starting hypotheses, and introduces the first results of a theoretical and empirical research focused on the subjective perception of time in the audiovisual – based experience. More precisely, we named our object of investigation the «Subjective Experience and Estimation of Moving Image Time» (SEEM_IT)[1].

The objective of the research is to investigate whether there are specific aspects of time perception (intended both as qualitative judgement of speed and as quantitative evaluation of duration) within the experience of watching moving images, compared to ordinary experience; and, if so, what this specificity consists in, and what stylistic

and semiotic features of moving images are linked to it. More broadly, we set the research within the framework of *Neurofilmology*: through a dialogue between film theory and neurocognitive science, we try to build an updated model of the spectator's experience.

In the first section, I introduce the issue of time experience, and in particular that of time perception and evaluation, as it has emerged and evolved in different and connected fields of study. The second section is devoted to elucidating four underlying assumptions of our research as well as many fundamental questions we posed. Finally, in the third section, I present and discuss the first results of an experiment on SEEM_IT we recently conducted at Università Cattolica del Sacro Cuore (Milan).

2. TIME AS A SCIENTIFIC ISSUE

Time is a central issue for many disciplinary traditions and fields, partially in dialogue with each other. *Philosophy of time and of time experience* presents a long-lasting reflection on what time is, viz. the problem of ontological consistency of time (Bardon 2013; Callender 2011; Dike, Bardon 2013); and how we experience it, namely the question of temporal perception and awareness (Dainton 2014; Le Poidevin 2015; Phillips 2017). More recently, a specific concern of reflections on time has become the explanation of the (apparently) irreconcilable difference between the denial of the reality of time postulated by contemporary physics, and its phenomenological and even neurocognitive evidence (Buonomano 2017; Mangabeira Unger, Smolin 2015; Rovelli 2018).

On the one side, philosophy of time is in dialogue with the *linguistic, semiotic, aesthetic and hermeneutic approaches to literary narrative time*. Scholars in this field of studies discuss linguistic and literary shapes of time representation (Currie 2007; Maini *et al.* 2005; Le Poidevin 2007; Meister, Schernus 2011; Scheffel *et al.* 2014) sometimes with reference to cinematographic examples (Bourne, Bourne 2016). A specific sub-topic concerns the possibility (Ricoeur 1984-1988) or on the contrary the impossibility (Currie 2004) of exchanges between fictional experiences of time and «real» ones – both in subjective and in social terms.

As a consequence of the latter point, analyses of fictional time sometimes come into dialogue with *socio-anthropological approaches to the historically and culturally defined shapes of time* – either concerning actual social timing practices and feelings, or temporal maps of collective memory. From this point of view, time becomes the object of many social and anthropological histories and inquiries (for general surveys see Adam 2004; Burges, Elias 2016; Crow, Heath 2002), as well of cultural geographies (Levine 1997). More recently, a critique to the *acceleration* and *homogenization* of time within the contemporary *timescape* emerged as a critical issue (Hassan 2009; Rosa 2013; Rosa, Scheuerman 2009; Stiegler 2016; Tomlison 2007), sometimes with explicit reference to media practices (Crary 2013; Keightley 2012).

On the other side, philosophical studies developed a dialogue with *psychological, cognitive and neurocognitive theories of time*, an area of studies that has experienced a vast revamp since the eighties. In this context, scholars underlined different aspects of *time experience* (broadly considered), and particularly its subjective dimension, its different «windows», and the multiplicity of psychological mechanisms and underlying neural dynamics responsible for its constitution, perception and evaluation (see among many others Arstila, Lloyd 2014; Benini 2017; Buonomano 2017; Meck, Ivry 2016; Merchant, de la Fuente 2014; Roenneberg 2012; Wearden 2016; Wittmann 2016; Wittmann, van Wassenhove 2009; Zimbardo, Boyd 2008. See also the non-specialistic, yet well-documented Burdick 2017; Hammond 2012; Klein 2007).

On the side of *film theory and cinema studies*, scholars developed more or less systematic analyses of time as a specific feature of the medium of film, in dialogue with all the others fields introduced above. However, despite a widespread and generic interest within the theories of classical cinema, the issue of time tended to disappear in the semiotic theories of the seventies (with the remarkable exception of Bettetini 1979); at the same time, in analytic aesthetics, movie time has been considered in comparison with the literary one, with a strong accent on the radical «presentness» of film experience (see the survey by Terrone 2017). More recently, this landscape has changed, under a twofold pressure. On the one hand, the increasing reception of Gilles Deleuze's works on film time (Deleuze 1986, 1989; see Mroz 2012). On the other hand, the presence of new, complex time architectures in contemporary cinema (Carruthers 2016; McGowan 2011; Mulvey

2006; Stewart 2007; Trifonova 2007) and television storytelling (Ames 2012; Mittel 2015). Accordingly, more general problems emerged, such as the «cultural» nature of cinematic time and its relations with the social shapes of time (Doane, 2002; Ethis 2006; Powell 2012); or the connections between the moving images of cinema and the static ones of photography (Reme 2015).

Finally, in the last years, many scholars have tackled the issue of *time experience in film viewing from a cognitive or neurocognitive perspective*. The problem has been mainly considered in relation to *event segmentation* (see for instance Zacks 2015; Tikka, Kaipanen 2014; for a critical survey see Poulaki 2015); however, in a few cases, that we consider essential forerunners of our work, scholars explicitly focused on the issue of Subjective Experience and Estimation of Moving Image Time (SEEM_IT) (de Wied *et al.* 1992; Manoudi 2015).

3. BASIC ASSUMPTIONS AND RESEARCH QUESTIONS

Our research is set within the framework of *Neurofilmology* (D'Aloia, Eugeni 2014): therefore, it aims to reconstruct, starting from experimental data, an overall model of audiovisual media spectator experience. Notably, in this case, we intend to investigate through which procedures the temporal aspects of the experience of film watching are constituted. This premise translates into five basic epistemic options of our research.

First, data collected from the neurocognitive field force us to *specify what we mean by «temporal experience»*, since the term (and more generally the question of «how the brain tells us the time») refer to a series of different neural and cognitive processes (Arstila, Loyd 2014; Block, Grondin 2014; Meck, Ivry 2016; Matthews, Meck 2014; Merchant, Harrington, Meck 2013; Merchant, de la Fuente 2014; Wittmann, van Wassenhove 2009). These processes are distinguished on the basis of three parameters. (a) *The kind of time perception experienced by the subject*: awareness of the «nowness» of present moment; feeling of temporal duration as an ongoing flow; (quantitative) computation and evalutation of temporal duration; (qualitative) judgement of temporal flow speed; identification of a pattern of (micro or macro) events in terms of simultaneity or succession. (b) *The type of task that the subject is to perform in relation to temporal experience*:

online identification, ordering and coordination of perceptions, events, movements, emotions; time computation of a defined time segment on the basis of a task previously received; retrospective, quantitative or qualitative discrimination of past temporal experience; perspective, quantitative or qualitative, evaluation of future temporal experience. (c) *The format of the time sliding window in which the subject operates*: the cell of the subjective present (the perceptual moment), up to around 30 milliseconds; the «temporal building block», lasting about 3 seconds; a window reaching up to about 15 seconds; a window of many minutes, demanding the intervention of working memory; wider windows related to the constitution of more complex temporal structures.

Second, recent neurocognitive research highlights the role of the body, its movements and actions as well as its proprioceptive feelings and emotional reactions in time experience (Altshuler, Sigrist 2016; Droit-Volet et al. 2013; Flaherty 2011; Gallagher 2011; Meck, Ivry 2016; Wittmann, van Wassenhove 2009; relevant precursors of this tendency have been Fraisse, 1964; Guyau 1890; Piaget 1969). Classical cognitive theories hypothesized the existence of a centralized «internal clock» directly responsible for the computation of subjective time. Recent neurocognitive theories tend to reject the idea of a unique subjective time estimation device and hypothesize the existence of many different (and perhaps more or less related) internal clocks linked to different neural mechanisms (for example the striatal beat-frequency model, within the broader context of cortical-striatal-thalamocortical circuits). First of all, however, many contemporary scholars outline the role of the body in perceptual temporal processing. In this respect, two main hypotheses (not reciprocally incompatible) have been advanced. On the one hand, regarding shorter durations (up to 3 seconds), time would be derived from the proprioceptive mechanisms of planning, executing and monitoring movements and related action plans. A particular role would be played in this context by the Supplementary Motor Area (SMA: see below). On the other one, within a larger time window (up to 15-20 seconds), time estimation would be linked to the progressive and regular accumulation of proprioceptive stimuli (in their incessant modulation and transformation and their connection with emotional reactions) in the right insular cortex. Accordingly,

> […] Subjective time is the time of the body, the perception of change, and related to bodily processes. […] Because I have a body, I perceive the

> passing of time. Physiological processes over time provide a temporal reference for processes in the external world. [As a consequence] subjective time passes at different rates, depending on the bodily state somewhere between relaxation and excitement. From this perspective, subjective time is «body time» (Wittmann 2016, 98).

Third, we have to consider the role of *mirroring mechanisms and embodied simulations* within the processes responsible for time experience. This point has not yet been well focused; nonetheless, it is interesting to observe that the above-cited Supplementary Motor Area (SMA) – located in the dorsomedial part of the frontal cortex and implicated both in planning temporal sequences of movements and in estimating the temporal duration of individual events – «is implicated even in non-motor forms of timing, for example, perceiving the duration of visual stimuli, and its activation is therefore independent of the need to execute, or even plan, an actual motor response.» (Coull, Vidal, Burle 2016, 14). Therefore, the hypothesis about an embodied nature of time experience seems consistent with the embodied simulation theory, namely with the idea that

> […] Our brain-body system re-uses part of its neural resources to map others' behavior. When witnessing actions performed by others, we simulate them by activating our own motor system […] The functional properties of mirror neurons (mirror mechanism, MM) characterize a parietopremotor cortical network. Thus, observing an action causes in the observer the activation of the same neural mechanism that is triggered by executing that action oneself (Gallese, Guerra 2012, 185).

Final, our fourth underlying assumption is that film, and more generally *audiovisual discourses present an unusually large number of movements and transformations and thus give rise (on the basis of the previous premises) to original and complex experiences of time*. The audiovisual experience «illustrates how the experience of duration is a construct» (Damasio 2006, 40), since «cinema is the only art that does not possess real time» (Leirens 1954, 23, my translation). And it basically does so thanks to different kinds of movements displayed to spectators or elicited from them: profilmic movements of actors and / or objects; movements of camera; durations of the single shots and cuts provided by editing procedures; discursive control of order, duration and frequency of the events (de Wied *et al.* 1992, 327); and also eye movements and other physical reactions triggered in the

spectator. We intend to leave aside for the moment the question of whether the forms of the temporal experience textually conceived in the audiovisual media can affect the shapes of the «real» individual or social experience of time (see above).

Starting from these underlying assumptions, we formulated the following questions for our research:

– To what extent do *editing styles* affect the determination of SEEM_IT and how do they relate to different types of movement considered above? In what terms can editing be considered a kind of movement or action?

– Is the *represented type of action* (in terms of transitivity, goal-orientation, emotional connotations) pertinent in determining SEEM_IT?

– What is the relation between *quantitative* (in terms of seconds: "internal length / duration of time – estimation" and *qualitative* ("subjective passage of time and speed of represented action judgement") aspects of SEEM_IT?

Additional questions (not tackled in this phase of the research) are:

– What is the role of *eye movements* in determining SEEM_IT? How can the proprioception of fixations and saccades affect SEEM_IT?

– Does a *narrative context* affect SEEM_IT?

– To what extent do the *alterations of action* as usually perceived (in terms of order, duration, frequency, speed, rhythm) and *violations of classical/continuity editing* (180-degree rule, jump cuts, etc.) affect the constitution of SEEM_IT?

– What are the neural correlates of SEEM_IT? In particular, what is the involvement of motor and premotor areas and mirroring mechanisms?

4. AN EXPERIMENT ON SEEM_IT

To obtain a first answer to these questions, we conducted an experiment in collaboration with a team of psychologists of Università Cattolica del Sacro Cuore in Milan. We hired a professional crew to shoot and edit adequate video clips to be used as experimental stimuli. To reduce noise in the stimuli, we shot without sound, with neutral

color in mise-en-scène (background, lighting, costumes), avoiding any expressiveness in acting style, and keeping the same actor for all actions. We asked the actor to perform: (1) a familiar, transitive, ingestive and clearly goal-oriented action (pouring and drinking some water); (2) a familiar, transitive, clearly goal-oriented, yet non-ingestive action (cutting some bread); and (3) an unfamiliar, non-ingestive and ambiguously oriented action (randomly moving some objects on a table). In postproduction, we edited each action according to three different styles: (A) *mastershot* (the entire action without any cut, medium long shot, frontal perspective); (B) *slow-paced editing*: 5 shots (4 cuts), with limited camera angle changes (2 to 4), continuity editing (match-on-action cut); (C) *fast-paced editing*: 11 to 13 shots (10 to 12 cuts), almost 1/sec, with high number of angle changes (7~), including pov shot, plongée, close-up and cut-in shots. We thus obtained nine video clips, organized according to a 3×3 matrix connecting our two targeted variables (a) and (b). Each series of clip was referring to the same action, yet differently edited, had the same duration (respectively 13,5", 11,0" and 11,8").

Seventy-six healthy subjects, with normal visual acuity and naïve as to the specific purposes of the study, were recruited. Each of the subjects was administered all the nine clips in a randomized order. An additional control clip was shown at the beginning of every experimental trial to limit a potential "novelty effect." For each clip, we used Likert scales (1 to 7 or 1 to 9) to measure: (i) emotional involvement; (ii) time passage speed judgement while watching the clip; (iii) action speed judgement. Moreover, we used a combined quantitative task to register (iv) video clip absolute estimated duration (in seconds, within a range from 0 to 30" – Accuracy and Absolute Error). Participants in the experiment had to express each of these judgments right after they watched each video clip.

In other words, taking into account the different sides of the temporal experience identified in the first point of the previous section, we have chosen to work on the quantitative estimation of temporal duration and on the qualitative judgement of temporal flow speed, through a retrospective determination, by using stimuli (and therefore investigating a time window) lasting about 15".

We analyzed all these data by using linear mixed models (LMM) and repeated-measures Analysis of variance (ANOVA). To prevent subjects from counting in their mind, and to obtain a different kind

of data, we asked them verbal reports of what they saw in each clip. Subjects' eye movements, too, were monitored for the whole duration of the experiment by using an eye-tracking device. We won't consider these items in this paper.

Concerning the results of our experiment, mean data showed *fast-paced editing (C)* to be the most emotionally involving editing style (i). Moreover, both (ii) time passage and (iii) action speed values were higher in this editing condition. Obtained p-values confirm that the effect of editing was strongly significant both with regard to (i) emotional involvement and to (ii) time passage and (iii) action speed (Figg. 1-3).

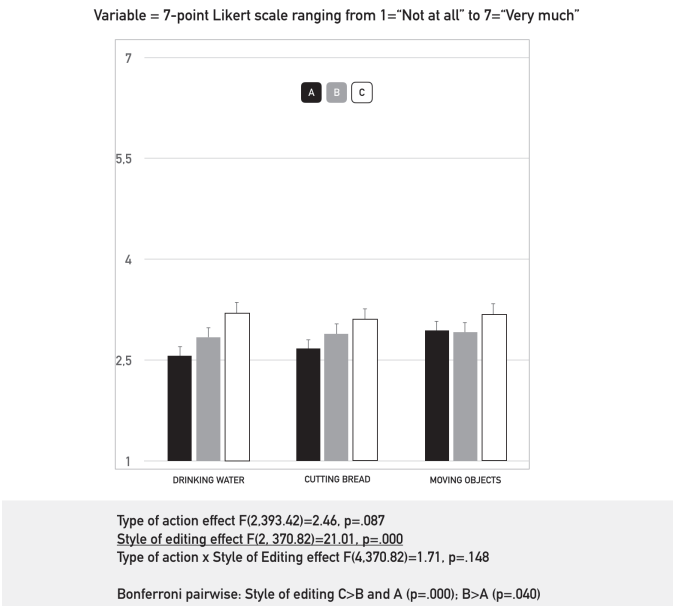
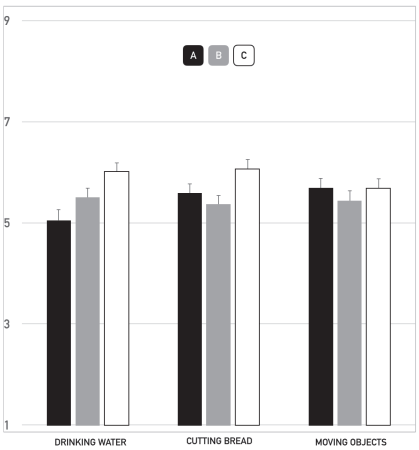


Fig. 1. Emotional involvement

Variable = 9-point Likert scale ranging from 1="Time dragged" to 9="Time flew"

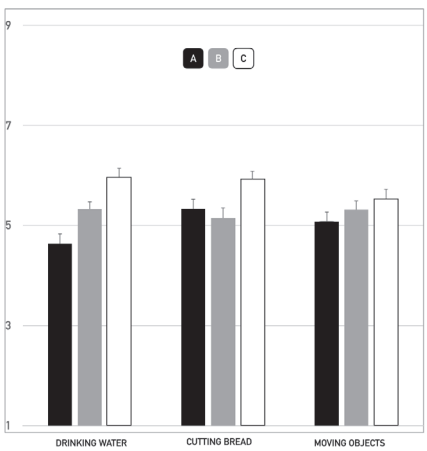


Type of action effect F(2,393.45)=.68, p=509
Style of editing effect F(2,382.63)=8.98, p=.000
Type of action x Style of editing effect F(4,282.98)=3.16, p=.015

Bonferroni pairwise: editing C>A and B (p<.01), B=A

Fig. 2. Time passage

Variable = 9-point Likert scale ranging from 1="Very slow" to 9="Very fast"



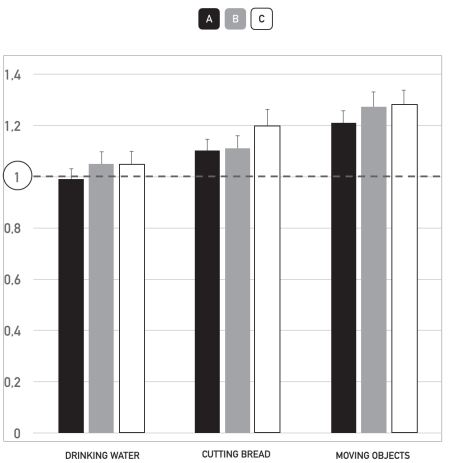
Type of action effect F(2,368.27)=1.07, p=.347
Style of editing effect F(2,380.09)=20.26, p=.000
Type of action x Style of editing effect F(4,248.43)=3.26, p=.012

Bonferroni pairwise: editing C>A and B (p=.000); B=A

Fig. 3. Action speed

The latter measures, however, were more markedly influenced by *the type of represented action*, attesting an interplay between the two targeted variables. For instance, mean data for (ii) time passage and (iii) action speed indicate that fast-paced editing (C) was perceived as making time and actions «fly» more than mastershot (A) and slow-paced editing (B), but *not in the case of action (3).* Only in the case of action (1), on the other hand, mastershot (A) triggered perceptions of time passage being slower than in slow-paced editing (B). Such interplay is confirmed by the fact that both (ii) time passage and (iii) action speed were significantly altered by the combined effect of editing and action (time passage: $p = .015$; action speed: $p = .006$).

As for (iv) the quantitative evalutations of time duration, mean data reveal that action (3) induced the highest temporal overestimation. Fast-paced editing (C) too provoked temporal overestimation when compared to mastershot (A). This means that accuracy was lower in these actions and editing conditions (Fig. 4).



Type of action F(2,357.92)=40.01, p=.000
Style of editing F(2,383.14)=4.70, p=.010
Type of action x Style of editing F(4,307.75)=.74, p=.563

Bonferroni pairwise: editing C>A (p<.000); C= B; B=A
Action 3>2>1 (p=.000)

Fig. 4. Accuracy in estimation of time duration

5. CONCLUSIONS

Although we are dealing with partial results, the experiment confirms that *the editing styles of moving images influence the SEEM_IT of the viewer, yet in close relation to the type of action displayed*. In particular, a *fast-paced editing* tends to produce a sensation of higher speed of both the time flow rate and the observed action rate, as well as an overestimation of the clip durations (also in relation to the production of a higher attentive and emotional involvement); however, an unfamiliar and ambiguously oriented action reduces the speeding effect, while further amplifying the perception of duration. On the contrary, unedited clips do not produce significant slowdowns in the perceived speed of time flow and the observed action, while providing an overestimation of perceived durations; but this principle is reversed for a highly familiar, ingestive action.

These results are consistent with the findings of the experiment conducted by Manoudi (2015), even though we additionally introduce and stress the role of the type of action displayed. Our findings are also compatible with the idea proposed by de Wied *et al.* (1992) according to which «duration experience under conditions of suspense in film results from the violation or confirmation of temporal expectancies» (325); however, we suggest to re-consider and update these expectancies in terms of embodied action-schemata, with the possible involvement of mirror mechanisms.

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ENDNOTES

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