THE PRESENTATION OF LONG TERM DURATION OF BODY MOVEMENT IN IMPRESSIONIST ARTWORKS DIFFERENTLY DISTORT THE PERCEPTION OF TIME

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Abstract

This work verified whether images implying movement exposed for fixed different durations affect the perception of time. Undergraduate participants observed pictures of sculptures of dancers by Edgar Degas for 9, 18, 27 or 45 seconds (G9, G18, G27 and G45 groups, respectively) and the stimuli were randomly presented in arithmetical (1.5-, 3.0- and 4.5-point) or geometrical (1.5-, 3.0- and 6.0-point stimuli) progressions. The reproduction method to record the time estimations of the subjects was used. Data analysis showed that time was not distorted in the G9, G18 and G45 groups, except: 6.0-point stimulus was overestimated in geometrical (G9) and 1.5-point was underestimated in arithmetical (G45) progressions. However, time distortions in the G27 group were modulated by different implied movement intensities as was observed in previous works that used 36 s of image exposure. These results show that different processes involving the visual perception of movement in static images are also associated to the different exposure duration.

Time perception is surprisingly subject to distortions. Temporal judgments are constructions of the brain which are also easy to experimentally manipulate (Eagleman, 2008). Cognitive functions such as attention, working memory and long term memory determine temporal judgments (Brown 1997; Wittmann, 2009).

Time distortions have been related to methodological procedures, different paradigms and the *duration* of stimuli. Shorter intervals would be more sensory in nature (Block, 1989; Beher, Desjardins, & Fortin, 2007). Durations of milliseconds to few seconds (2-3 s) have been related to the biological models of the subjective time. Intervals close to 3 s tend to be estimated accurately, whereas longer intervals (above 5 s) are not only related to the sensorial perception and tend to be distorted (Ulbrich, Churan, Fink, & Wittmann, 2007; Noulhiane, Pouthas, & Samson, 2008).

Longer intervals seem to be more cognitively mediated (Block, 1989; Zakay & Block, 1997). Therefore, durations of several seconds and minutes were used in researches focusing not only on the sensorial perception but also on the cognitive processes of time perception and, because of this, related to cognitive models of the subjective time.

Static images of short (milliseconds) and long (above 5 s) durations have been used to explain different aspects of time perception. For example, pictures of objects such as shoes, houses and fruits were used in studies with short duration (milliseconds). They showed that an unexpected image affect time perception (Eagleman & Pariyadath 2009). Pictures of people exposed for 2, 4 and 6 s caused time distortions related to the arousal levels evoked by "positive" and "negative" emotional contents of the images (Angrili, Cherubini, Pavese, & Manfredini, 1997).

Artworks were used to test the effects of pleasure on time perception (Cupchick & Gebotys, 1988). Using impressionist paintings the authors showed that time distortions reflected the interpretive activity evoked by artworks when the subjects observed the paintings for 36 s. Furthermore, time distortions were also related to the duration of exposures: when the paintings were exposed for 18 s and 72 s they were respectively over- and underestimated. However, the authors did not inform what aspects (characteristics) of the paintings were related to these time distortions.

Long duration exposure of 36 s was used in several studies that verified the effect of body movements in static images on subjective time perception (e. g., Nather & Bueno, 2006, 2011). In these researches two, three or four pictures of Edgar Degas' ballerinas in different ballet steps were randomly presented to the subjects. Using the reproduction method, these researches revealed that the processing of motion experience modulates the perception of time generating under- and overestimations. Further study using the same ballerina images in the bisection method showed that short exposures of 0.4 to 1.6 s strongly affected the perception of time than exposures of 2 to 8 s (Nather, Bueno, Bigand, & Droit-Volet, 2011). These works confirmed that an important characteristic of a static image – implied movement – affects time perception independently of the duration of exposure.

Subjective time literature had pointed that subjects tend to overestimate the short intervals and underestimate the long ones. Lewis and Miall (2009) used different time exposure to verify how the duration of stimuli affect time perception in terms of scalar property of interval timing. They studied time across a broad range of intervals (milliseconds to minutes) to support the hypothesis that distinct clock mechanisms are used for different subsets of time rankings. They demonstrated a gradual increase in precision of timing as the intervals measured increase (see also Bizo, Chu, Sanabria, & Killen, 2006; Merchant, Zarco, & Prado, 2008).

Several subjective time experiments have used static images of different semantic contents and durations to verify, for example, the effects of pleasure and emotions on time perception (e. g., Angrili et al., 1997; Droit-Volet & Meck, 2007; Droit-Volet & Gil, 2009). However, the use of static images having implicit scalar property (implied movement) presented by different durations would inform important aspects of subjective time perception. The aim of the present study was to verify whether the induced movements by different body postures affect time perception when they are presented for different longer durations (9, 18, 27 and 45 s). Therefore, Degas' ballerinas were used for ranking 1.5 to 6.0 points of induced movement according to the Body Movement Ranking Scale - BMRS (Nather & Bueno, 2008).

Method

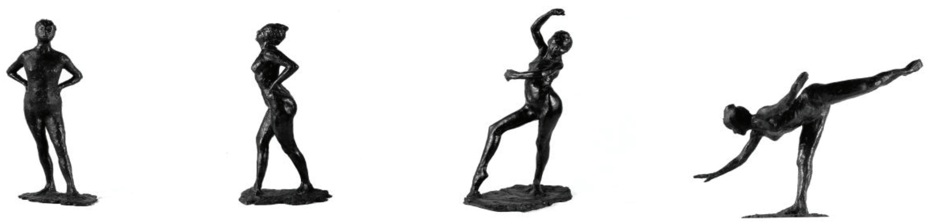
The experiment was approved by the Ethics Committee of the University of São Paulo School of Philosophy, Sciences, and Letters in Ribeirão Preto, Brazil.

One hundred and twenty-two undergraduate students (50 men; M age = 20.94 yr., SD = 2.58) untrained in visual arts and ballet dance from University of São Paulo of Ribeirão Preto participated of the experiment. They reported having normal or corrected-to-normal vision. The experiment was performed during daylight hours in an isolated, soundproofed room at the University of São Paulo. The lights were off during the experiment.

Digital photographs of four ballerinas sculptures by Edgar Degas were used as stimuli: "Ballerina in Repose with her Hands on the Waist and her Left Leg in Front" (facing forward) (1.5-point), "Ballerina in Repose, with her Hands on the Waist and her Right Leg in Front" (facing to the right) (3.0-point), and "Spanish Dance" (4.5-point), and "Third Stage of the Great Arabesque" (6.0-point) (Figure 1).

Exposure of stimuli and recording of time estimations were done by *Wave Surfer* program installed on an HP notebook. The tasks were orally explained to the participants. They were positioned facing the central region of the LG 19" monitor and were asked not to count time. The stimuli were exposed by pressing the "presentation" key and their time exposure were finalized after 36 s. At this moment, the monitor was filled with white color indicating that the participant could initiate time estimation. Then, immediately after each time observation the participant reproduced the presentation duration by pressing the "initiate" key. The experienced duration of each stimulus was finalized by pressing the "finished" key (reproduction method).

The stimuli were presented to four groups of participants according to its fixed time of exposure of 9, 18, 27 or 45 s: G9 (n=30), G18 (n=30), G27 (n=31) and G45 (n=31) groups, respectively. Three stimuli grouped in arithmetical (1.5-, 3.0- and 4.5-point stimulus) or geometrical sequences (1.5-, 3.0- and 6.0-point stimulus) were randomly presented to each group in a manner that half of the participants of each group observed only one of these two progressions orders. The sequences of stimuli presentation were randomly ordered. Training stimulus (4.0-point) was presented before each sequence in order to make the participant familiar with the experimental task but these data were not used in the analyses.



1.5-point **3.0-point** **4.5-point** **6.0-point**

Figure 1. The four sculptures (1.5-, 3.0-, 4.5- and 6.0-point stimuli) used in the experiment. The stimuli were obtained from the "Body Movement Ranking Scale" (Nather & Bueno, 2008). © Edgar Degas. Paris, France 1834-1917, MASP Collection, Museum of Art of São Paulo Assis Chateaubriand. Pictures of João L. Musa.

One Way (ANOVA) analyses without repeated measures were used to compare time estimation data in the G9, G18, G27 and G45 groups in both arithmetical and geometrical progressions. One Way (ANOVA) analyses were also used considering the mean values of the two progressions (see italics, Table 1). Student-Newman-Keuls test was used for *post hoc* comparison of these analyses. Student *t* test was used to compare the time estimations data with the actual time of exposures of 9, 18, 27 and 45 s of G9, G18, G27 and G45 groups respectively.

Results

Mean values of time estimations of the G9, G18, G27 and G45 groups are presented in Table 1. The time estimations analysis (ANOVA) of Groups G9 and G45 did not show a significant main effect between stimuli in both arithmetical and geometrical progressions. The analysis of mean (M) progressions of these groups presented similar result. However, in relation to the real time of exposition the 1.5-point stimulus in the G45 group was underestimated in arithmetical progression [$t(30)=2.29$; $p<.05$] and considering the mean values of the two progressions [$t(60)=2.98$; $p<.01$]; the 6.0-point stimulus in the G9 group was overestimated in geometrical progression [$t(28)=-2.01$; $p<.01$]. Group G18 analyses did not show any temporal distortions.

Data analyses of Group G27 revealed distinct time distortions among stimuli in the geometrical progression [$F(2, 42)=6.91$; $p<.01$] and considering the mean values of the two progressions [$F(3, 89)=4.63$; $p<.01$]. *Post hoc* comparisons showed that in geometrical progression the 1.5- and 3.0-point stimuli were estimated shorter than 6.0-point stimuli; and considering the mean values of the two progressions the 1.5- and 3.0-point stimuli were estimated shorter than both 4.5- and 6.0-point. In both analyses 1.5- and 3.0-point were not statistically different, as well as 4.5- and 6.0-point were not different considering the mean values of the two progressions. These results showed that the stimuli inducing less movement were estimated with shorter duration than those inducing greater movements.

The comparisons of stimuli time estimations with the actual time of 27 s of image exposures showed that 1.5- and 3.0-point stimuli were underestimated in geometrical [$t(28)=2.02$; $p=.05$] and [$t(28)=3.05$; $p<.01$] and considering the mean values of the two progressions [$t(60)=2.471$; $p<.01$] and [$t(60)=1.98$; $p<.05$]. On the contrary, the 6.0-point stimuli were overestimated [$t(28)=-2.26$; $p<.05$].

Table 1. Mean values and standard errors (brackets) of the participants' temporal estimations for 1.5-, 3.0-, 4.5- and 6.0-point stimuli from the BMRS (Nather & Bueno, 2008) of Groups G9 (n=30), G18 (n=30), G27 (n=31) and G45 (n=31). Values are expressed in seconds.

Group	Progression	1.5-point M (SD)	3.0-point M (SD)	4.5-point M (SD)	6.0-point M (SD)
	Arithmetical	8.93 (1.80)	9.10 (2.85)	9.58 (1.94)	
G9	Geometrical	9.43 (1.81)	10.28 (2.45)		11.05 (2.54)+
	Mean (M)	*9.18 (1.79)*	*9.69 (2.68)*	*9.58 (1.94)*	*11.05 (2.54)+*
	Arithmetical	18.62 (5.84)	17.61 (5.36)	18.11 (5.92)	
G18	Geometrical	18.40 (2.69)	17.70 (4.06)		18.73 (3.51)
	Mean (M)	*18.51 (4.47)*	*17.66 (4.66)*	*18.11 (5.92)*	*18.73 (3.51)*
	Arithmetical	25.93 (2.70)	26.69 (4.67)	28.97 (6.27)	
G27	Geometrical*	24.40 (4.96) -	24.14 (3.62) -		29.11 (3.61)+
	*Mean (M)***	*25.19 (4.06) -*	*25.46 (4.33) -*	*28.97 (6.27)*	*29.11 (3,61)+*
	Arithmetical	40.75 (7.40) -	44.26 (12.21)	44.26 (10.28)	
C45	Geometrical	42.20 (5.84)	42.20 (5.92)		43.79 (8.10)
	Mean (M)	*41.45 (6.62) -*	*43.26 (9.59)*	*44.26 (10.28)*	*43.79 (8.10)*

Note: The values of the 4.5- and 6.0-point stimuli were repeated because these stimuli were presented once in the arithmetical or in the geometrical progression. (-) Underestimated; (+) Overestimated; (*) Indicate 1.5 = 3.0 < 6.0; and (**) Indicate 1.5 = 3.0 < 4.5 = 6.0.

Discussion

Presented for different durations, the images of body positions inducing distinct movements altered the subjective time perception. The results of 27 s of exposure agreed with those of previous studies using fixed duration of 36 s of exposure (Nather & Bueno, 2006, 2011). These researches emphasized that subjective time was modulated by induced movement: 1.5- and 3.0-point (less movement) were estimated shorter than 4.5-point (intermediate movement) and 6.0-point (higher movement). Also, 1.5- and 3.0-point stimuli were underestimated and

6.0-point stimulus was overestimated, but 4.5-point stimulus was accurately estimated (see Table 1).

On the other hand, modulatory effect of induced movement on time perception was not confirmed for 9, 18 and 45 s exposures. However, an interaction effect between time exposures and progressions of stimuli was observed: 6.0-point stimulus was overestimated in geometrical progression for 9 s of duration and 1.5-point was underestimated in arithmetical progression in 45 s duration.

The effects of duration in artworks were previously related (Cupchick & Gebotys, 1988). Using the same impressionist paintings, the authors verified overestimations when they were presented for 18 s. On the other hand, they pointed out that exposures for 36 s allowed the subjects to process the pictorial characteristics of the paintings in which generated time estimations related to the content of paintings. Because of this, they explain that longer exposures (72 s) caused underestimations due to the decrease of interest by the subjects.

This study was conduced by using the reproduction method in the prospective paradigm of subjective time as in previous studies using 36 s durations (Nather & Bueno, 2006, 2011). Taking this into account, it is possible to infer that the induced movement was more interactive with the durations ranging at 27 and 36 s. Why did the time distortions, related to the implied movement, occurred effectively at these durations of exposures?

According to Eagleman (2008), short and long durations can explain different biological and cognitive processes involved in internal time, because time distortions can be induced by properties of the stimuli themselves. Several cognitive processes, such as working memory, long-term memory, attention and decisions are involved in prospective time perception and different neural systems are involved in temporal processes depending on the duration of the processed duration (Wittmann, 2009). For example, Nather and Bueno (2012) used a methodological procedure (exploration time) in which the subjects were allowed to observe the images for any length of time and, immediately after each image was observed, recorded the duration as they perceived it. They verified that in mean, the subjects observed the images of Degas' ballerinas for 18 s and overestimated the images representing more movement (4.5- and 6.0-point stimuli).

This study used longer durations. It is possible to point out that long intervals evoke adjustments in subjects between the physical passing time and the time experienced internally according to the interaction between the procedure adopted and stimuli durations. Thus, the synchronization of real time and experienced time would involve different strategies of attention and sources of memory.

Artworks exposed for different durations in different methodological procedures have confirmed that body movement representation in static artwork images affect time perception. However, the time distortions were not totally coincident because of the time durations of exposures and procedures of the experiments (see Nather & Bueno, 2011, 2012; Nather et al., 2011). From this perspective, it was pointed out the necessity to run more parametric experimental studies involving systematic comparisons of time perception across different task conditions and different durations.

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