

## **BODY MOVEMENTS AND TIMING ESTIMATION RELATED TO VISUAL OBSERVATION OF DIFFERENT IMAGES REPRESENTING DISTINCT BODY POSITIONS**

Francisco Carlos Nather\*, José Lino Oliveira Bueno\*, Daniela Cristina Carvalho De Abreu\*\* and Matheus Machado Gomes\*\*

*\*Department of Psychology and Education, University of São Paulo, Faculty of Philosophy Sciences and Letters of Ribeirão Preto, São Paulo, Brazil*

*\*\*Department of Biomechanics, Medicine and Rehabilitation of Locomotor Apparatus, University of São Paulo, Faculty of Medicine of Ribeirão Preto, São Paulo, Brazil*

*\*fnather@usp.br and jldobuen@ffclrp.usp.br*

### **Abstract**

*Body positions representing movements of distinct intensities induce distortions in time estimations. Probably, the observation of body movements in static images generates the experience of movement that can induce real movements in the observer. This study examined whether static images inducing movement can generate real movements in the participants' bodies, and whether these real movements were related to the intensity of observed movement. According to the Body Movement Ranking Scale, stimuli were photographic images of 2 dancer sculptures: static and dancing ballerina (1.5- and 6.0-point stimuli). Images were presented at a random order to the participants positioned on a force platform, whose tasks were to observe each image and estimate its presentation time duration. Participants moved more when they observed the dancing ballerina (6.0-point). Also, 6.0-point stimulus was overestimated. This result showed that images of body movements internally generate unconscious body oscillations suggesting that different processes are involved in the subjective time distortions.*

Static images of human body movements can induce dynamic mental representations related to the memory of recognizable movements (Freyd, 1983; Kourtzi & Kanwisher, 2000). The observer can anticipate future body positions of a movement (Verfaillie & Daems, 2002) and identify those positions that suggest a fall (Bonnet; Paul & Nithart, 2005), because the perception of human actions is also limited to biomechanical properties of their parts (Shiffar & Freyd, 1990, 1993).

Images of dancer sculptures representing different body positions generated changes in subjective time perception of observers (Nather & Bueno, 2009, 2010). When observing these images, individuals differentially process the induced movements which implicitly contain temporal suggestions generating temporal distortions (under and overestimations). For example, the induced movements of body positions recorded by the Body Movement Ranking Scale (BMRS) that presents 1-7 points of represented movement intensities of different photography of Degas' dancer sculptures (Nather & Bueno, 2008) showed that an unmoving dancer (1.5 points) was underestimated, and a dancer taking a great ballet step (6.0 points) was overestimated.

Using the same images, Nather, Bueno and Bigand (2009) verified that the head and the torso tended to be more visited by the eyes at the unmoving dancer (1.5 points) but the arms and the legs were more visited at the dancer taking a great ballet step (6.0 points). The different asymmetries from the relations among the positions of body parts (head, torso, arms and legs) of these two images generate distinct movement perception (see Cutting,

2002) probably in function of perception of postural balance elicited by visual perception. However, the question is: if the visual perception of motion can modulate the perception of time, what is the relation of visual perception and body movements induced by distinct and static body positions? Specifically, would different body positions representing movements of different intensities be able to induce body movements?

The postural control is related to the intricate relationship between perception of movement and motor action (Barela; Jeka & Clark, 1999, 2003; Feldman, 2009). To maintain the corporal balance, the postural control system captures sensorial information (visual, vestibular and proprioceptive) of body displacement to produce an appropriate muscular action related to this body movement. In studies that use force platforms to assess corporal balance, the visual information may reduce the movement of individuals depending on the size and distance of the target that was used as fixation point of view (Paulus; Straube & Brandt, 1984; Paulus; Straube; Krafcyk & Brandt, 1989). The use of area, velocity and amplitude of center of pressure (COP) displacement as indicators of balance (Gomes & Barela, 2007; Salavati et al., 2009) may indicate changes in postural control of individuals through small body displacements related to the body oscillations depending on the kind of visual stimuli used as fixation point.

The aims of the present study were to verify: (a) whether photographic images of different body positions inducing different intensities of movements can generate real movements in the participants' bodies; and (b) verify whether these real movements (body oscillations) were related to the intensity of observed movement in the images. The induced movement of static images will be recorded by the Body Movement Ranking Scale (BMRS) that presents 1-7 points of represented movement intensities of different photographs of Degas' dancer sculptures (Nather & Bueno, 2008).

## Method

Nineteen students (mean 24.26 years old; 8 males) untrained in Visual Arts and Classical Dance at the University of São Paulo (Brazil) participated in the experiment.

Time estimations were registered by *Wave Surfer* program installed in a HP Pavilion Notebook PC ZE5375. The prospective paradigm of time estimation with the reproduction method was used, and the total time of presentation of each stimulus was 36 seconds. The force platform EMG System (Brazil) was used to record the body movements. The Area, Velocity, Standard Deviation, Amplitude and Total Displacement of center of pressure (COP) were chosen to describe the participants' balance. The variables Standard Deviation and Velocity were calculated only for anterior-posterior (AP) direction. Two photographs of Edgar Degas' dancer sculptures (1.5- and 6.0-point stimuli), which are the extreme values of Body Movement Ranking Scale - BMRS (Nather & Bueno, 2008) were used as stimuli (Figure 1). The images of sculptures went through a visual standardization processing in Adobe Photoshop 7.0 program. The final size of images on the screen (29") was of approximately 30x40 cm in the resolution 1024x768 *dpi*. The pictures occupied the central position of the computer screen, and the rest of the screen was filled with white color.

Each participant was individually led to the experimental room and asked to go up the force platform. Then they were instructed to remain comfortably standing up with their feet in open shoulders width and arms hang at lateral body sides. The tasks were verbally explained: to observe each image, and after each observation, to estimate its duration time. All participants were positioned facing the central region of the screen (1.70 cm high) at a fixed distance of 40 cm. The stimuli were presented randomly. The data were submitted to Wilcoxon Test considering paired data and Mann-Whitney Test considering not paired data.

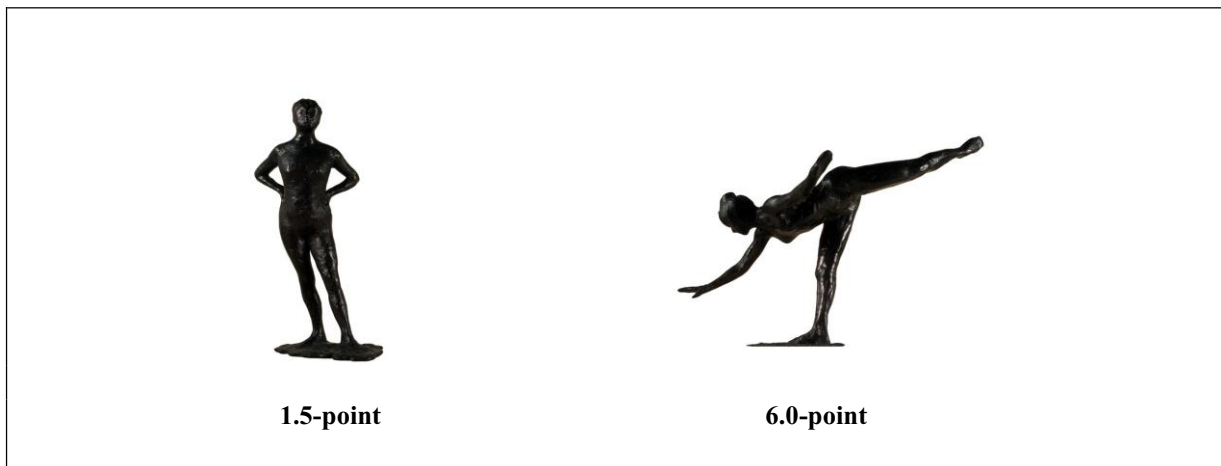


Figure 1. The stimuli used in the experiment: 1.5- and 6.0-point according to BMRS.

### Results

Data of movement parameters showed that the 6.0-point stimulus (more movement) generated greater body oscillations than the 1.5-point stimulus (less movement): total area [W=-2.09; p<0.05], total amplitude [W=-2.37; p<0.05], velocity [W=-2.02; p<0.05] and displacement [W=-2.65; p<0.01] (Figure 2). Deviation A/P parameter was not statistically different. However, when participants estimated the duration time of images only values of total amplitude parameter were statistically different [W=-2.47; p<0.05].

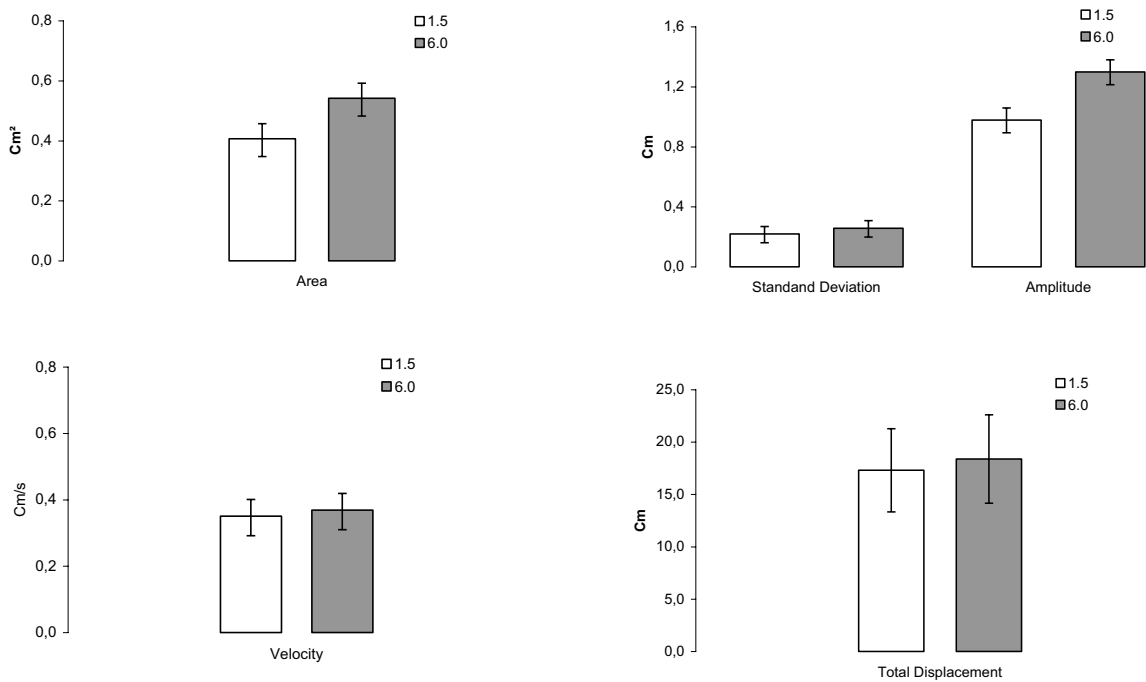


Figure 2. Mean values and standard deviation of Area, Velocity, Standard Deviation, Amplitude and Total Displacement of COP to 1.5- and 6.0-point stimulus.

Mean values of temporal estimations showed that both stimuli were overestimated [ $F(6.17)=3.16$ ;  $p<0.01$ ]. Furthermore, the mean value of  $45.89\pm 10.07$  s (1.5-point stimulus) was not statistically different of  $45.33\pm 13.32$  s (6.0-point stimulus) [ $F(0.01)=4.11$ ;  $p>0.05$ ]. These time distortions contrasted with those of previous studies: the 1.5-point stimulus was underestimated in relation to actual time exposition of 36 s, and it was estimated shorter than 6.0-point stimulus (Nather, 2007; Nather & Bueno, 2008, 2010).

## Discussion

The literature of movement perception have shown that the visualization of body movements in static images activates cortical areas related to the visual perception of movement and to the motor activation of neuronal circuits that perform the observed actions (e. g., Kourtzi; Kanwisher, 2000). Further, the physical responses of the observer seem to be precisely located in those parts of the body that are being viewed because mirror neurons (see Rizzolatti & Craighero, 2004) reconstruct actions by observation of static pattern that an action induces (Freedberg & Gallese, 2007).

This study showed that the visualization of distinctly body positions also generates body oscillations related to the intensity of movement observed. The dancer taking a great ballet step (6.0-point) elicited greater body oscillations than the unmoving dancer (1.5-point). Since these body oscillations are associated to the displacement of center of mass of the body, the simple observation of a human action suggesting a great postural balance generated imperceptible *imbalance movements* at the observer. These imperceptible movements can be related to a facilitatory effect specifically at the muscles that are been visualized by increase of corticospinal excitability (Urguesi; Moro; Candidi & Aglioti, 2006).

Another possibility to explain these data is related to the eye movements. According to Paulus, Staube and Bandt (1984), it is assumed that the gaze fixation point at the eyes' level reduces postural movements (oscillations) causing a better postural performance. Eye-tracking movement results obtained by Nather, Bueno and Bigand (2009) showed that the dancer in a great ballet step (6.0-point) demanded more attention to the different body parts (arms and legs) than the unmoving dancer (1.5-point). Thus, body positions that represent more movement demand oriented attention to different points of an image. This pattern of eye movements can affect the postural balance inducing body oscillations.

How to explain the mean values of time estimations obtained in the image of unmoving dancer (1.5-point stimulus)? In our previous studies (Nather, 2007; Nather & Bueno, 2006, 2008, 2010), images with 1.5 to 2.5 score of movement generated temporal underestimations in the participants. Probably, the overestimation obtained to 1.5-point in this study is related to the time interval between the visualization of images and the time estimations (response time) that was higher than 30 s, while it was virtually instantaneous in the previous studies.

Firmino (2009) and Firmino and Bueno (2008) pointed that the response time is an important factor in studies of subjective time perception. Using musical stimuli, the authors showed that the time interval between the listening of sounds and the time estimations (response time) alters subjective time perception in function of sources of memory required by the participants. Therefore, the temporal overestimation in 1.5-point stimulus may be more related to the kind of task employed, that implicitly generated decay of working memory (explicit memory).

The human visual system is highly tuned to perceive actual motion and to extrapolate dynamic information from static pictures of human bodies captured in different movement (Urguesi et al., 2006). Inherently, human beings are capable of detecting and recognizing the movement of static visual stimuli, because the implicit action transmits

information about the paths of past and future actions, that implicitly generate expectation of the movement that is about to happen or has just happened. Actions could be predicted and anticipated by actual observation of actions, or those actions that will be performed (Kilner; Vargas; Duval; Blakemore & Sirigu, 2004).

### Acknowledgements

F. C. Nather received a CNPQ Doctoral scholarship and is a recipient of a FAPESP Post-Doctoral Scholarship. J. L. O. Bueno received a Research Grant and a Research Productivity Scholarship from CNPQ.

### References

- Barela, J. A., Jeka, J. J. & Clark, J. E. (1999). The use of somatosensory information during the acquisition of independent upright stance. *Infant Behavior and Development* **22**, 87-102.
- Barela, J. A., Jeka, J. J. & Clark, J. E. Postural control in children. Coupling to dynamic somatosensory information. *Experimental Brain Research* **150**, 434-42 (2003).
- Bonnet, C., Paulos, C., & Nithart, C. (2005). Visual representations of dynamic actions from static pictures. *Perception* **34**, 835-846.
- Cutting, J. E. (2002). Representing motion in a static image: constraints and parallels in art, science, and popular culture. *Perception*, 31(10), 165-1193.
- Feldman, A.G. (2009). New insights into action-perception coupling. *Exp Brain Res* **194**, 39-58.
- Firmino, E. A. (2009). *Dimensões cognitivas espaço-temporais do senso tonal da música. (Space-temporal cognitive dimensions of tonal sense of music)*. 135 p. Doctor Thesis. Faculty of Philosophy, Sciences and Letters of Ribeirão Preto, University of São Paulo, São Paulo, Brazil.
- Firmino, E. A. & Bueno, J. L. O. (2008). Tonal modulation and subjective time. *Journal of New Music Research* **37**, 275-297.
- Freedberg, D., & Gallese, V. (2007). Motion, emotion and empathy in esthetic experience. *Trends in Cognitive Sciences* **11**, 197-201.
- Freyd, J. (1983). The mental representation of movement when static stimuli are viewed. *Perception & Psychophysics* **33**, 375-381.
- Gomes, M. M. & Barela, J.A. (2007). Postural control in Down syndrome: the use of somatosensory and visual information to attenuate body sway. *Motor Control* **11**, 224-234.
- Kilner, J. M., Vargas, C., Duval, S., Blakemore, S. J., & Sirigu, A. (2004). Motor activation prior to observation of a predicted movement. *Nature Neuroscience* **7**, 1299-1301.
- Kourtzi Z., & Kanwisher, N. (2000). Activation in human MT/MST by static images with implied motion. *Journal of Cognitive Neuroscience* **12**, 48-55.
- Nather, F. C. (2007). *Percepção de movimento e tempo subjetivo nas artes visuais (Movement perception and subjective time in the visual arts)*. 182 p. Doctor Thesis. Faculty of Philosophy, Sciences and Letters of Ribeirão Preto, University of São Paulo, São Paulo, Brazil.
- Nather, F. C., & Bueno, J. L. O. (2006). Efeito de imagens estáticas com diferentes representações de movimento sobre a percepção subjetiva de tempo (Effect of static images with different representations of movement under the subjective perception of time). *Psicologia: Reflexão & Crítica (Psychology)* **19**, 217-224.

- Nather, F. C., & Bueno, J. L. O. (2008). Movement ranking scale of human body static images for subjective timing estimation. In *24<sup>th</sup> Proceedings of the Annual Meeting of the Society for Psychophysics* (pp. 185-190). Toronto, Canada.
- Nather, F. C., Bueno, J. L. O., & BIGAND, E. (2009). Time estimation and eye-tracking movement in human body static images. In *the 25<sup>th</sup> Proceedings of Annual Meeting of the Society for Psychophysics* (pp. 399-404). Galway: Ireland.
- Nather, F. C., & Bueno, L. L. O. (2010, submitted). Effects of static images with different intensities of human body movement in the subjective time perception, *Perceptual & Motor Skills*.
- Paulus, W. M., Straube, A., & Brandt, T. (1984). Visual stabilization of posture: Physiological stimulus characteristics and clinical aspects. *Brain: a journal of neurology* **107**, 1143-1163.
- Paulus, W., Straube, A., Krafczyk, S., & Brandt, T. (1989). Differential effects of retinal target displacement, changing size and changing disparity in the control of anterior/posterior and lateral body sway. *Experimental Brain Research* **78**, 243-252
- Rizzolatti G., & Craighero L. (2004). The mirror-neuron system. *Annual Review of Neuroscience* **27**, 169-192.
- Salavati, M., Hadian M. R., Mazaheri M., Negahban H., Ebrahimi I., Talebian S., Jafari A. H., Sanjari M. A., Sohani S. M., Parnianpour M. (2009). Test-retest reliability [corrected] of center of pressure measures of postural stability during quiet standing in a group with musculoskeletal disorders consisting of low back pain, anterior cruciate ligament injury and functional ankle instability. *Gait Posture* **29**, 460-464.
- Shiffrar, M., & Freyd J. J. (1990). Apparent motion of the human body. *Psychological Science* **1**, 257-264.
- Shiffrar, M., & Freyd, J. J. (1993). Timing and apparent motion path choice with human body photographs. *Psychological Science* **4**, 379-384.
- Urgesi C., Moro, V., Candidi, M., & Aglioti, S. M. (2006). Mapping implied body actions in the human motor system. *The Journal of Neuroscience*, **26**, 7942-7949.
- Verfaillie, K., & Daems, A. (2002). Representing and anticipating human actions in vision. *Visual Cognition* **9**, 217-232.