

the duration of markers whose rise time and fall time were varied, and that he used only 120 and 360 ms for the IOI (when the IOI was 120 ms, 340-ms markers were not employed). The results of Osawa's experiment showed a significant effect of the rise and the fall time, but only when the IOI was 120 ms and the first marker was 100 ms, which is the same as in the present experiment.

This effect may be explained in terms of *P-centers*. A P-center is defined as the moment of occurrence of a sound (Morton, Marcus, & Frankish, 1976). Some studies reported that the location of P-centers is affected by the rise time of sounds, i.e., the P-center of a sound occurs later as the rise time lengthens (e.g. Vos & Rasch, 1981; Gordon, 1987; Howell, 1988). From these studies, we can predict that, the perceived length of the time interval should decrease as the first marker's rise time increases, and that the perceived length of a time interval should increase as the second marker's rise time increases. These predictions are at least partially in agreement with our results. This suggests that the effects of rise and fall times observed in the present experiment were caused by the difference in P-centers.

It is interesting that the effects of the sound energy distribution did not appear when the IOI was 240 or 360 ms. This may mean that the processing of very short time intervals (120 ms) and the processing of longer ones (240 ms or longer) are different.

In summary, it was revealed that the perceived length of an inter-onset time interval is not affected by the sound energy distribution within marker durations systematically, except for the shortest time intervals of 120 ms.

#### Acknowledgments

Satoshi Osawa gave us advice on the design of the present experiment. This research was sponsored by Grants-in-Aid for Scientific Research (S) Nos. 14101001 and 19103003 from the Japan Society for the Promotion of Science and the 21st Century COE program entitled "Design of Artificial Environments on the Basis of Human Sensibility."

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## MOVEMENT RANKING SCALE OF HUMAN BODY STATIC IMAGES FOR SUBJECTIVE TIMING ESTIMATION

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#### Abstract

*Static images representing human bodies with greater suggestion of movement have been estimated as longer than those with lesser movement (Nather & Bueno, 2006a). This study aimed to obtain a reference scale of body movement intensity for static visual stimuli. Stimuli were photographic images of 16 sculptures of dancers made by Edgar Degas. These images were presented to two subject groups (trained and not trained in visual arts and classic ballet) whose task was to judge the intensity of the dancer's movement using a seven point scale. The data were used to build the Body Movement Ranking Scale (BMRS). Images with equal durations (ordered by BMRS's arithmetic or geometric progressions) were estimated as having different durations: 1.5- and 3.0-point stimuli were estimated as shorter than 6.0-point ones; 1.5- and 3.0-point were underestimated, and 6.0-point stimuli were overestimated regarding real time; 4.5-point ones were estimated to have the same duration of real time.*

The use of visual stimuli has been used to elucidate different aspects of temporal perception in humans (Nather & Bueno, 2006a,b). Nather and Bueno (2006a) studied the effect of movement representation in static two-dimensional images on subjective timing perception, using works of art as stimuli, which represented different positions of the human body, suggesting distinct movement intensities. Stimuli pairs, one of which had more movement representation than the other, were differentially estimated. Would movement representation in static works of art (such as paintings and sculptures) be enough to induce changes in time perception by the persons who observed them?

Movement perception in humans has been scientifically studied, through the use of either visual stimuli or systematic analysis of movement representation in works of art, such as paintings, photos, drawings, etc. (Brown, 1996; Cutting, 2002; Zanker, 2004). Brown (1996) showed that geometrical figures presented as static and in either slow or fast movement evoked temporal estimations that varied with the speed of the movement showed to the participants of the study. However, this research line would be helped by using a scale which could allow indicating, through points, the discrimination of corporal movements, differentially perceived in static, two-dimensional figurative pictures.

The work of Edgar Degas is, among other things, often discussed in reference to the function of the body movements represented in his paintings and sculptures (Argan, 1995; Grove, 2001), which implicitly contain temporal suggestions. In his ballerina sculptures, there is meticulous attention to corporal positions, in the face of classic ballet's choreographical construction, which proposes dance steps that can or cannot dislocate bodies in space (Achcar, 1986). It can be observed that Degas' concern was to reveal the implicit times of great ballet positions and the most likely mental representations of ballerinas' movement enfoldments: they can evoke, in both ballet dancers and persons who are not trained in dancing, subjective states of movement perception for the very movement expectation that is represented (Nather, 2007).

Studies of subjective timing and experimental aesthetics (Cupchick & Gebotys, 1988) have already demonstrated that subjects trained and untrained in the visual arts give distinct temporal estimations for different impressionist paintings. The use of images which allow movement induction to be assessed on a scale can give a more precise relationship between perceived movement and its subjective timing estimation.

The aims of the present study were to: (a) determine whether photographic images of different ballerina sculptures by Degas, which represent different corporal movements and dance steps, would be differentiated by participants trained and untrained in ballet dancing; (b) establish a movement point scale for the different ballet steps represented in static two-dimensional images.

### Method

Photographic reproductions of 16 sculptures of ballerinas by impressionist artist Edgar Degas were digitized from the photographic catalogue "Degas and Movement" (Marques, 1999), using an HP PSC 1315 image scanner with a 200dpi resolution (Figure 1).

The sculptures' digital images went through visual treatment using Adobe Photoshop 7.0 software package for brightness and saturation adjustment and size standardization. Each individual digital image was printed on size A4 white Canson paper (Photographic Card) using an HP PSC 1315 printer (best resolution). The final size of the sculptures on the Photographic Cards was approximately 12 cm, measured from the top of the head to the feet. Each sculpture occupied the central part of the card, which remaining card space remained blank. After the experimental session the participants of Group I answered a questionnaire with the following question: "What ballet step is represented in this sculpture?"

The data were collected in isolated rooms. Each participant was seated in front of a table in which the cards were presented randomly by the experimenter. The participant remained approximately 50 cm from the cards which were positioned in a previously determined place of the table. The images of the sculptures (stimuli) were presented to each individual of two 14-participant groups (males and females aged 13 to 26 years old): Group I (Dance-Trained) and Group II (Dance-Untrained). After the exhibition of each image, the subjects were asked to fill out Semantic Differential Scales (Likert-type 7 points), which contained the question concerning the parameter Movement: "Ranging from 1 to 7 points, would you say that this image represents the sculpture of a ballerina that is stationary or moving?"

The data were analyzed with analyses of variance (ANOVA) and Student's *t* test. A Dendogram cluster analysis was also performed, taking Euclidean Distances into account.

### Results and Discussion

The means from the Semantic Differential Scales for Movement, for both ballet-trained and ballet-untrained participants, as well as the classical ballet steps for each sculpture as pointed out by the ballet-trained participants are shown in Table 1.

The statistical analyses showed movement score mean differences among the 16 sculptures [ $F(15,208)=6.841$ ;  $p<0.01$ ]. The application of cluster analysis using the Dendogram and consideration of Euclidean Distances indicated 6 possible clusters among the sculptures, of which 3 contained more than 3 sculptures, while the other ones were represented by only one: a) Group A, with Stimulus 1 (ballerina at rest facing forward), with scores of approximately 1.0-1.5 points; b) Group B, with Stimulus 6 (ballerina performing the Spanish dance), with 4.0-4.5 points; c) Group C, with Stimulus 16 (standing ballerina looking at right foot), with 3.5 points; d) Group D with Stimuli 8, 9, 10, 11, 12, 14 and 15 (all the

sculptures representing great ballet positions, *Attitudes* or *Arabesques*), with scores between 5.0 and 6.0 points; e) Group E, with stimuli 2, 5 and 7, with scores ranging from 2.0 to 4.0 points; f) Group F, with stimuli 3, 4 and 13, also with scores ranging from 2.0 to 4.0 points. Note that, only Stimulus 8 does not represent a ballerina in a great ballet position; the movement represented in this sculpture by Degas suggests a preparation for a leap.

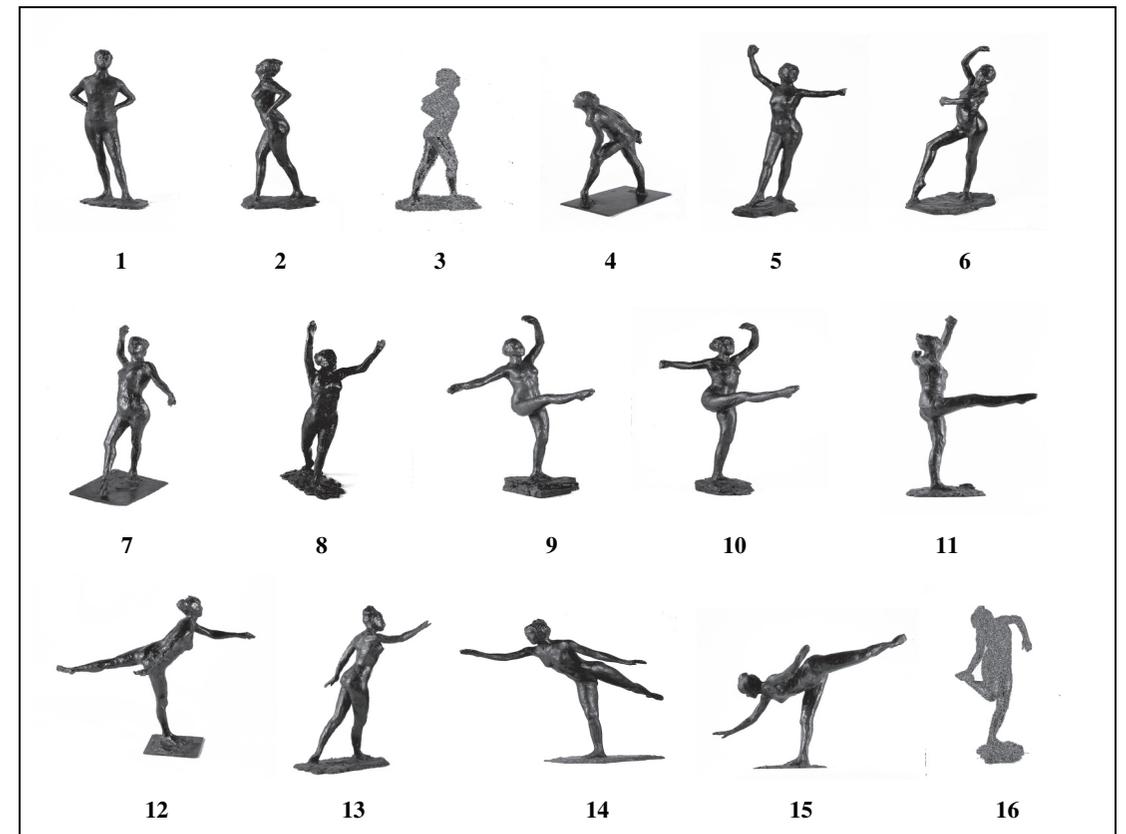


Figure 1. The 16 sculptures (stimuli) used in the experiment, which represented different body positions and ballet steps suggesting movement in distinct intensities: 1) *Ballerina at rest with her hands on the waist and her left leg in front* (facing forward); 2) *Ballerina at rest with her hands on the waist and her right leg in front* (facing to the right); 3) *Ballerina at rest with her hands on the waist and her right leg in front* (facing to the left); 4) *Ballerina rubbing her left knee*; 5) *Prelude to dance, with her right leg in front*; 6) *Spanish Dance*; 7) *Ballerina with a tambourine*; 8) *Ballerina advancing with her arms up and her left leg in front* (first study); 9) *Fourth position in front on the left leg*; 10) *Fourth position in front on the left leg* (second study); 11) *Fourth position in front on the left leg* (third study); 12) *Arabesque over the right leg with the left arm placed in front*; 13) *First time of the great arabesque*; 14) *Second time of the great arabesque*; 15) *Third time of the great arabesque*; 16) *Ballerina looking at the bottom of her right foot*. Information about facing forward, facing to the right and facing to the left was added to titles of the sculptures of ballerinas at a resting position with the purpose to differentially characterize them and facilitate text writing. Sculptures titles used in this study were adapted from the original titles in French.

Stimuli 2, 3, 4, 5, 7 and 13 (Groups E and F), according to the sculptures' titles *per se*, contain the sculptures of unmoving ballerinas or of those in body positions that do not

represent easily identifiable ballet steps (Table 1). Stimuli 2 and 3 (ballerina at rest, facing to the right and ballerina at rest, facing to the left) each received a *Chassé* indication. Seen in profile, this step may suggest the action of walking, since a *Chassé* indicates a connection between different ballet steps. Stimulus 7, in its turn, received four different denominations that indicate trunk movements (*Cambré*) or connection steps (*Tombé*) – in fact, its title (“*Ballerina with a tambourine*”) indicates a Provençal dance, that is, not necessarily a ballet dance. Stimulus 4, that is, the sculpture of ballerina rubbing her knee, did not receive any denominations. Stimulus 5 (“*Prelude to dance, with the right foot in the front*”), pointed as a *Tendu Devant* or *Degagé* position, indicates the same step by different dance schools: it is characterized by a forward leg movement without knee flexion.

Table 1 – Mean values and standard errors (brackets) of scores for the ballet-trained and ballet-untrained participants for parameter Movement of the 16 sculptures and ballet steps pointed out by the ballet-trained participants. N=28 subjects.

Stimulus – Sculpture Name	Group I	Group II	Classical ballet steps
1. “ <i>Ballerina at rest...</i> ” (facing forward)	1,14(±0,09)	1,42(±0,22)	-
2. “ <i>Ballerina at rest...</i> ” (facing to the right)	2,78(±0,49)	2,85(±0,60)	Failli1*, chassé1
3. “ <i>Ballerina at rest...</i> ” (facing to the left)	2,78(±0,56)	2,42(±0,59)	Chassé1
4. “ <i>Ballerina rubbing her left knee</i> ”	3,21(±0,43)	3,42(±0,65)	-
5. “ <i>Prelude to dance...</i> ”	2,92(±0,66)	3,42(±0,63)	Tendu 6, degagé3
6. “ <i>Spanish Dance</i> ”	4,14(±0,74)	5,07(±0,65)	Chassé1
7. “ <i>Ballerina with tambourine</i> ”	4,07(±0,65)	3,71(±0,54)	Cambré3, tendu2, chassé2
8. “ <i>Ballerina advancing... (first study)</i> ”	5,20(±0,63)	4,14(±0,60)	Chassé6, tombé2
9. “ <i>Fourth position in front on the left leg</i> ”	5,35(±0,45)	5,35(±0,52)	Arabesque5, attitude4
10. “ <i>Fourth position... (second study)</i> ”	5,28(±0,47)	4,85(±0,67)	Arabesque4, developpé4, relevé2
11. “ <i>Fourth position... (third study)</i> ”	5,71(±0,28)	4,35(±0,59)	Attitude4, relevé3, developpé2
12. “ <i>Arabesque over the right leg...</i> ”	5,00(±0,57)	4,78(±0,51)	Penché7, arabesque6
13. “ <i>First time of the great arabesque</i> ”	4,00(±0,58)	3,85(±0,60)	Tendu3, chassé2, arabesque1
14. “ <i>Second time of the great arabesque</i> ”	5,85(±0,51)	5,42(±0,53)	Arabesque7, penché4, relevé1
15. “ <i>Third time of the great arabesque</i> ”	6,00(±0,44)	5,64(±0,48)	Penché14
16. “ <i>Ballerina looking at the bottom of her right foot</i> ”	3,57(±0,51)	4,21(±0,67)	Passé1

\* The numbers in front of the steps indicate how many participants identified the sculpture with this ballet step. Note that, from their own names, sculptures 1-4, 5, 7 and 16 do not necessarily suggest dance steps. The names of the ballet steps reported by the participants were confirmed from the textbook of Achcar (1986).

The conjoint interpretation of the statistical analyses and of the ballet step names reported by the participants made it possible to point out the most salient sculptures in the experiment: (1) Stimulus 1 (“*Ballerina at rest...*”, facing forward), which received the lowest score and was not grouped even with Stimuli 2 and 3 – such stimuli depict the same human position in different angles (Figure 1); (2) Stimulus 6 (“*Spanish Dance*”) was also not included in any of the clusters; (3) Stimulus 15, with the highest score (6.0 points) and entitled “*Third time of the great arabesque*” was identified by 100% of the subjects as being a

*Penché*, which, according to classical ballet, is the conclusion of a great arabesque or its last position; (4) Stimulus 13, entitled “*First time of the great arabesque*”, was not grouped with the sculptures representing such ballet position.

In general, the mean scores of dance-untrained participants were similar to those of dance-trained individuals. The scores from untrained subjects also indicated differences in the movement scores among the sculptures [F(15.208)=4.040; p<0.01]. However, when these data were submitted to *Dendogram* analysis, 8 clusters were established for the 16 sculptures, of which only 3 were the most well-defined: a) Group A, with Stimulus 6 (ballerina in the Spanish Dance) with a score of approximately 5.0 points; b) Group B, with Stimuli 1, 2 and 3 – the three sculptures of ballerinas at rest and facing forward, to the right and to the left (scores from 1.5 and 3.5 points); and c) Group C, with Stimuli 9, 10, 11, 12, 14 and 15, the sculptures of ballerinas in arabesque and attitudes with scores of approximately 4.5 to 5.5 points. Again, the ballerinas in great ballet positions formed a homogeneous cluster which was separated from the other sculptures. Stimulus 13 was, once again, excluded from this cluster of sculptures.

*Body Movement Ranking Scale (BMRS)*. By comparing the data from dance-trained and untrained participants it was possible to separate the 16 sculptures by Degas according to body positions and dance steps represented in them. Additionally, these analyses allowed separating not only the sculptures of ballerinas performing in classical ballet, but also in other dance types, such as the Spanish or the Provençal dance. Nevertheless, the group of dance-trained participants more accurately pointed out the dance movements represented in the sculptures, allowing a more reliable determination of a movement scale, ranging from 1.5-6.0 points.

This scale specified an increasing order of movements that could be described as follows: unmoving ballerina facing forward (1.5 points); ballerinas in ballet connection movements or in movements that were not dance representatives, such as at rest, rubbing one’s knee, looking at the bottom of one’s foot, etc. (2.0-4.0 points); ballerina performing the Spanish dance (4.0-4.5 points) and ballerinas in great ballet positions, attitudes or arabesques (5.0-6.0 points). By choosing the most representative (evident) stimulus in this score distribution, a Body Movement Ranking Scale (BMRS), which presents an arithmetic and/or Geometric Progression was suggested by the mean values of scores from the ballet-trained and ballet-untrained participants: (1) Stimulus 1 (1.28 = 1.5-point) – ballerina at rest and facing forward, isolated from the other clusters, did not receive any referrals for ballet steps; (2) Stimulus 2 (2.81 = 3.0-point) – ballerina facing to the right, received two indications of a ballet connection step; (3) Stimulus 6 (4.60 = 4.5-point) – ballerina performing the Spanish dance, isolated from the other clusters; (4) Stimulus 15 (5.82 = 6.0-point) – ballerina in arabesque, the stimulus receiving the highest score in the cluster of ballerinas in attitude or arabesque, being recognized by 100% of the participants.

*Subjective Time Estimation*. The BMRS was utilized in studies of subjective time estimation in humans, in which figurative static, two-dimensional images with different representation of movements were used as stimuli (Nather & Bueno, 2008). The temporal estimations of 124 university students who reported being untrained in visual arts and in ballet were obtained in accordance with the prospective paradigm using the subjective time reproduction method (Block, 1990). Digital photographs of 4 ballerina sculptures (Stimuli 1, 2, 6 and 15) were randomly successively presented to the participants for 36 seconds on the screen of an LG Flatron monitor (30x40 cm). Subjects were positioned facing the central region of the laptop computer screen at a fixed distance of 50 cm. The Neutral Stimulus 13 (4.0-point) was used as training and discarded from the analyses. Statistical analysis of mean

time reproductions by the participants confirmed the general tendency observed in other experiments (Nather & Bueno, 2006a) that found differences in temporal estimations between stimuli with greater and smaller movement suggestions. Furthermore, the statistical analysis using BMRS showed that temporal estimations were related to the BMRS movement points: the mean value of 33.17 s for Stimulus 1.5-point was considered to be statistically similar to the value of 31.05 s for Stimulus 3.0-point; however, both were considered to be different from the value of 41.97 s for Stimulus 6.0-point. The mean value of 36.99 s for Stimulus 4.5-point was different from those for Stimulus 1.5, Stimulus 3.0-point and Stimulus 6.0-point. When comparing the mean values of the temporal estimations for Stimuli 1.5-point, 3.0-point, 4.5-point and 6.0-point with the exposure time of 36 s, it was observed that Stimulus 1.5-point and Stimulus 3.0-point were temporally underestimated; Stimulus 4.5-point produced a temporal estimation similar to the actual experimentation time; and Stimulus 6.0-point was temporally overestimated. These results show the appropriateness of the BMRS tool in studies of movement and time estimation.

#### Acknowledgements

This research was sponsored by grants from the National Counsel of Technological and Scientific Development (CNPq), the Coordination of Perfectioning of Staff of Superior Level (CAPES) and the Foundation of Support to the Research of the State of São Paulo (FAPESP). Thanks to Cláudio Perereira Bidurim for the statistic analyses contribution.

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## INFORMATIONAL MASKING: HOW COMPETING SPEECH INTERFERES WITH SPEECH COMPREHENSION

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#### Abstract

*Listeners often complain that they have trouble following a conversation when the environment is noisy. The environment could be noisy because of the presence of other unrelated but meaningful conversations, or because of the presence of less meaningful sound sources such as ventilation noise. Both kinds of distracting sound sources produce interference at the auditory periphery (activate similar regions along the basilar membrane), and this kind of interference is called energetic masking. However, in addition to energetic masking, the meaningful sound sources can and do interfere with the processing of the target speech at more central levels (phonetic and/or semantic), and this kind of interference is called informational masking. In this theme session, we will explore how we can use psychophysical techniques to distinguish between energetic and informational masking and to identify the perceptual (bottom-up) and cognitive (top-down) factors that can release a listener from informational masking.*

Imagine that you have just arrived in Toronto for Fechner Day 2008, and that you have arranged to go out for dinner with a group of old friends. You arrive at the restaurant, are seated at a table, and begin to reminisce about old times. However, because the “old times” were really long ago, you are finding it difficult to follow the conversation because of the reverberation in the room, the music that is playing too loud, and the other conversations that are taking place around you. As far as you can recollect, participating in such conversations in similar situations wasn’t so difficult 15 or 20 years ago. Are restaurants just noisier than they used to be? Is your hearing going? Or is your brain simply not able to handle a situation in which there are multiple targets to attend to, and multiple distractors to ignore and inhibit? In other words is your difficulty in following the conversation due to the fact environments are noisier and busier than they used to be, age-related hearing losses, or cognitive declines? And how do you go about finding the answers to these questions? The answer to the latter question is, of course, through the judicious application of psychophysical methodology.

#### Energetic masking, informational masking, and auditory scene analysis

The presence of concurrent sounds, other than that of the target, can interfere with the processing of speech in two different ways. First, the pattern of activity along the basilar membrane elicited by non-target sound sources can mask or obscure the pattern due to the target speech. This kind of peripheral interference is often referred to as “energetic” masking. Distracting sound sources, however, can interfere with the processing of speech at more central levels of processing. Consider, for the moment, when the distracting sound sources are