Visual perception of biological motion direction and velocity: global and local factors

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Introduction

Since the studies of Johansson (1973), the special sensibility of the human visual system for detection of biological motion patterns is frequently referred on literature in this area. Those patterns are regulated by specific biomechanical and functional parameters, which would contribute to the robustness of the visual skills (Cutting, Moore & Morrison, 1988). The aim of this study is to understand the role of global and local factors on the visual perception of vectorial components of biological motion, as velocity and direction, introducing translation features on biological motion stimulus.

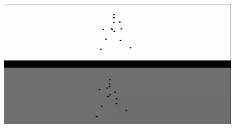
On global factors, our hypothesis is that the environment should impair the perception of biological (non-rigid) motion. Stone & Thompson (1992) found a consistent effect of contrast on speed matching tasks with the simultaneous presentation of two moving gratings. When the moving gratings are presented one above the other, a lower-contrast stimulus appears to move slowly than a high-contrast stimulus. We used this approach to verify how background contrast affects the discrimination of speed of biological motion.

To identify the role of local factors on the discrimination of biological direction and velocity, we are working in the frame of the sensorimotor loop. This approach is supported by behavioral and neurophysiologic findings. Indeed, it seems that the observer action characteristics interact with his/her perception of an anthropomorphic movement. Likewise, human premotor areas are specifically activated by biological stimulus. Our hypothesis is that the visual discrimination of vectorial components of biological motion would be constrained by the observer motor program.

Global factors

Methodology

Stimuli. Two allongated horizontal bars were located 0.3° above and below the center of an 4.29x3.20° image, with varied contrast levels. In each bar was presented a black 13 point-light walker (PLW) with 0.97x0.44°, in a orthogonal view from the right to the left.



Task. Identification of the faster PLW (up or down).

Duration. Stimuli of 1 second; interstimuli (with a center-cross of 0.44x0.44°) of 1.5 second

Variables.

Motion type ➡ rigid (1 frame); biological (30 frames)

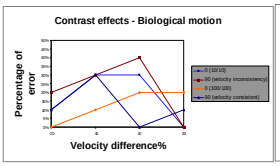
Background contrast level ➡ 10% and 100%

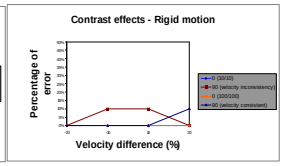
Velocity difference ➡ -20%, -10%, 10%, 20%

(velocity reference – 2°/sec)

Preliminary results

Data in the graphic (which refers to one of 3 subjects) show the relation between the contrast levels of the two backgrounds with the velocity of the stimuli. The innaccuracy of velocity match performance was highest when the levels of velocity and contrast were contraditory. The magnitude of the contrast effects was highest in biological motion condition.





Local factors

The main feature of the steering of the locomotion is a systematic anticipation of the vision in relation to the rest of the body. This phenomenon is known as an "I go where I look" strategy (Grasso et al., 1996). Briefly the biomechanical characteristic of the human locomotion is specified by a temporal organisation of corporal segments from the head to the feet.

The consequences of this top-down temporal organisation is a top-down spatial organisation, too. It means that each change of trajectory begin by a rotation of the top of the body to the inside part of the path (Patla et al., 1999).

So, in mechanical terms, a major specificity of the human steering locomotion is an angular offset between the Z-axis of the top and the down part of the body, which is absent for a rigid object.

This biomechanical property would underlie a major influence of the trunk orientation on the perception of body direction, assuming that the observer does activate his/her motor program to estimate such perceptual direction.

Methodology

Our experimental paradigm is based on a comparison between the human movement and the non-living movement.

1: Recording of the human locomotion by a biomechanical system of movement analyse (e.g. VICON). Then, importation of the data in a software of 3D modelling (Maya) to create a "point-light" walker (see in the bottom image, on the right, a trunk).

2: Generation of a circular trajectory of the walker which is in conflict with the trunk orientation.

3: The subject's task is to discriminate the direction of this biological stimulus by comparison with an non-biological stimulus, which must be equivalent in term of vectorial movement (e.g. an upside down trunk, on the left part of the image).

A perception based on a motor program would suggest a discrimination bias according to the trunk orientation.

Discussion

In terms of global factors, effects of contrast in the velocity-matching performance with rigid, as Stone & Thompson (1992) already did, and specially with biological motion stimulus were observed. These preliminary results are inconsistent with previous studies which stressed the robustness of biological motion over impairing factors. Therefore, further studies should be done on the environmental interference on the perception of biological motion (structural complexity of stimulus, type of motion, background, …).

References

Cutting, J.E., Moore, C. & Morrison, R. (1988). Masking the motion of human gait. *Perception & Psychophysics*, **44(4)**, 339-347.

Grasso, R., Glasauer, S., Takei, Y., Berthoz, A. (1996). The predictive brain: anticipatory control of head direction for the steering of locomotion. *Neuroreport,* **7**, 1170-1174.

Johansson, G. (1973). Visual perception of biological motion and a model for its analysis. *Perception & Psychophysics*, **14**, 201-211.

Patla, A.E., Adkin, A. & Ballard, T. (1999). Online steering: coordination and control of body center of mass, head and body reorientation. *Exp. Brain Res,* **129**, 629-634.

Stone, L. & Thompson, P. (1992). Human velocity perception is contrast dependent. *Vision Res.*, **32**, Nº8, 1535-1549.