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Introduction

- Recent research demonstrates that the way we perceive the external space relies on a pre-reflective internal simulation of the body in action, which provides a sort of measurement unit by which perception is filtered (Coello et al., 2007; Witt & Proffitt, 2008).
- Space is also socially scaled. The portion of Extrapersonal space (i.e. the space beyond reaching distance) judged as "Near" (Near Extrapersonal Space = NES) is indeed wider when adopting as reference frame (RF) a human body free to move, as compared to a static object, a wooden dummy or a human body with restricted movement potentialities (Fini et al., under review).
- In the present study we wanted to investigate whether the NES extension is due to a motor simulation mechanism induced by seeing a human body able and prone to cover a distance by walking.
- To this aim, we used the extrapersonal space categorization task preceded by a series of different priming stimuli evoking or not a walking biological motion (Exp. 1), a walking biological motion at different speeds (Exp. 2) and the intention to cover or not the distance (Exp. 3).

Materials and Methods

Exp. 1: 30 healthy subjects (23 females, all but 5 right handed, mean age 20,9 years, range 18-30). An avatar (Other RF) or a green beach umbrella (Object RF) were located 45° to the right (left) of the central camera representing the participant's perspective, and a target red beach umbrella was located along a central vector aligned with the avatar at 27 different distances (from 2m to 54m) (Figure 1 A/B).

Stimuli were presented through the psychophysical *limits method*, with progressively increasing or decreasing target distance until the subject did not report a perceived change from Near to Far or vice-versa. Such point represented the NES threshold and was called Judgment Transition Threshold (JTT).

Each experimental series was preceded by a video in which a point-light biological motion display was presented on a black background. There were two biological motion displays: a canonical walker and a spatially-scrambled version of it (scrambled stimulus).

Exp. 2: 21 healthy subjects (18 females, all but 1 right handed, mean age 21,9 years, range 18-28). The virtual scene was the same as in Experiment 1. In Experiment 2 we only investigated the avatar as RF. Each experimental series was preceded by three different videos : a canonical walker, a runner, and a slow walker (Figure 2).

Exp. 3: 31 healthy subjects (18 females, all but 3 right handed, mean age 22,4 years, range 18-28). The scene was the same as in Experiment 1 and 2 with the difference that the Other RF could face the target (RF facing the target, RF_O) or turned around by 180° (RF oriented away from the target, RF_180) (Figure 3). Two different motion primes were used: a point-light display depicting a person standing up from a chair and a point-light display depicting a person sitting down on a chair (Figure 3).

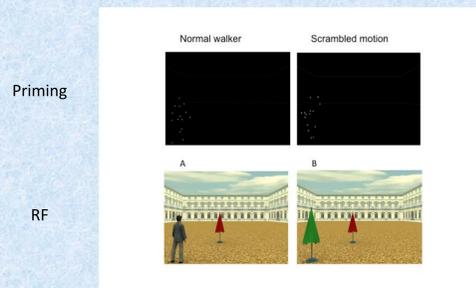


Figure 1

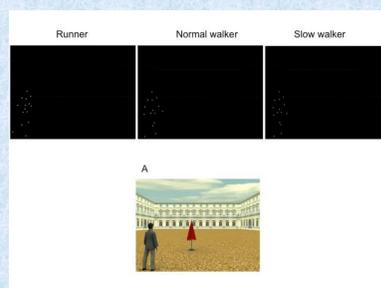


Figure 2

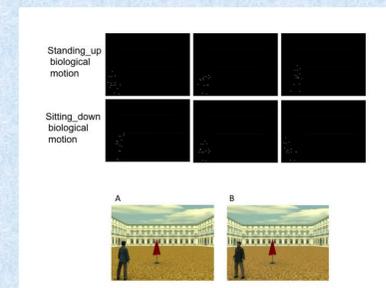


Figure 3

Results

Exp 1:

- Two-way repeated-measures ANOVA with Type of Motion (point light walker and scrambled) and Reference Frame (RF, Avatar and Object) as within-subjects factors.
- Main effect of the Type of Motion ($F(1,29) = 6,12, p < 0.03$) and Type of Motion by RF interaction ($F(1,29) = 7,23, p < 0.03$).
- The point-light walker induced a wider NES when adopting as RF the human body (10,45 m) as compared to the object (10,01 m) (Duncan Post Hoc tests, Figure 4).
- Crucially, no difference between the avatar (9,34 m) and the object (9,63 m) was found when we used the scrambled motion as a prime.

Exp 2:

- One-way ANOVA with Type of point-light Motion (runner, walker, slow walker) as within-subjects factor.
- Main effect of the Type of Motion ($F(2,40) = 4,79, p < 0.03$), due to a significantly extended NES after the point-light runner (12,39 m) as compared to the other two point-light motions (walker: 11,62 m, $p < 0.03$; slow walker: 11,81 m $p < 0.03$) (Figure 5). In accordance with our predictions the speed (slow versus fast) and the type of movement (running versus walking) have an influence on the NES.

Exp 3:

- Two-way repeated-measures ANOVA with Type of point-light Motion (standing up; sitting down) and RF Orientation (Oriented or Not-Oriented towards the target) as within-subjects factors.
- Main effect of RF Orientation ($F(1,31) = 5,50, p < 0.03$), with a wider NES for the Oriented compared to the Not-Oriented RF. Furthermore, significant interaction between the Type of Motion and the RF Orientation ($F(1,31) = 7,82, p < 0.05$) (Figure 6). The NES with the standing up motion priming was significantly wider when adopting the Oriented RF (12,40 m) compared with the other conditions: Not-Oriented RF preceded by the standing up motion priming (11,74 m), $p < 0.05$; Oriented RF (12,06 m), and Not-Oriented RF (12,05 m) preceded by the sitting down priming motion, $p < 0.05$.

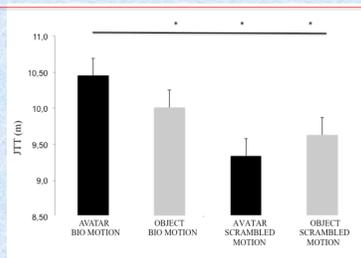


Figure 4



Figure 5

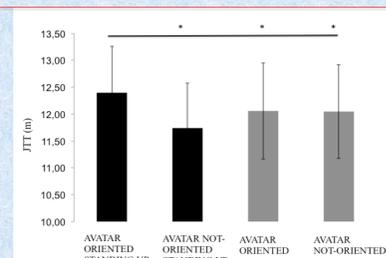


Figure 6

Discussion

- Participants primed with a point-light walker compared to a scrambled motion display showed a wider NES extension when the RF was a human body (Exp 1).
- The walking speed of the motor priming affected the NES extension: priming with a point-light runner compared with a point-light walker induced a greater NES extension (Exp 2).
- When the motor priming was a standing up motion, that expressed an inferred intention to walk towards the target, and the RF was oriented towards the target, a wider NES extension was observed; conversely, when the standing up motion was followed by the Not-Oriented RF, the effect of the priming disappeared.

Conclusions

The NES extension is affected by the biological motion in combination with the semantic expressed by the RF. These results suggest that observing someone able and prone to cover a distance led to simulate the intended, inferred and afforded action, i.e walking action, and the simulation mechanism tailors our extrapersonal space perception.

References

Witt, J. K., & Proffitt, D. R. (2008). Action-specific influences on distance perception: a role for motor simulation. *Journal of Experimental Psychology: Human Perception and Performance*, 34(6), 1479

Coello, Y., & Delevoeye-Turrell, Y. (2007). Embodiment, spatial categorisation and action. *Consciousness and cognition*, 16(3), 667-683.