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Flexible perception-action strategies: The influence of segmental and global motion information on follow-the-leader coordination

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Abstract. Interpersonal coordination in sports can be studied by examining interactions between agents. Evidently, individuals differ in their ability to interact with others (cf. 'interact-ability'), which critically depends on their sensitivity to information for (inter-)action. Recently, we found that agents could access different information sources for the same task goal, yet it subtly affected temporal and spatial aspects of the interactive synchrony. The current study further examined what strategies agents adopt to deal with different types of information. Participants performed a follow-the-leader task in a virtual reality setting in several conditions. In the reference condition, a leader was presented as a back-and-forth walking animated avatar. In the other conditions, various aspects of motion information were either suppressed or emphasized. We emphasized movement of body segments using a point-light display. In other conditions we showed a mannequin (i.e., an avatar without moving limbs) with various combinations of the subtle, but potentially pertinent, lateral and vertical displacements that occur during gait. Another set of conditions showed different shapes (a mannequin, cylinder and sphere) that only displayed the optical size change corresponding to the back-and-forth displacement. Point-estimate relative phase revealed a tighter temporal synchrony when movements of body segments were shown. In contrast the virtual interpersonal distance was best maintained when only optical size change was displayed. These findings support the notion that a perception-action strategy is strongly shaped by its dynamic environment. Different skill levels of adopting such flexible behaviour may explain an individual's interact-ability.

Humans can coordinate their movements with each other efficiently in complex and dynamic situations. For example, on a daily basis humans can navigate effortlessly through crowds of people, drive a car through traffic, or play sports. In many situations, there are no (obvious) rules or constraints that determine how inter-personal coordination emerges, some less tangible construct (e.g., social norms, mood or skill) may dictate how behaviour unfolds. In sports, the emergent interaction can arguably be linked to an individual's skill to interact with others effectively – their 'interact-ability' [1]. Through visual and motor experience humans learn to attune and calibrate their actions with information presented by others to satisfy mutual goals. The present study explores how such information may be available along a proposed spectrum of global and local sources of motion information.

The study employs a follow-the-leader task where followers have to maintain their initial distance with the leader (cf. [2]). The leader is a pre-recorded video display of a back- and forwards moving leader shape. A variety of shapes were presented to manipulate the availability of available motion information (see Fig. 1).

Fig. 1: Leader shapes as presented to the follower participants; the arrows indicate the cadence movement of the static displays. From left to right: point-light, avatar, cadence XY, cadence Y, cadence X, fixed, cylinder and sphere.

The spectrum is suggested to have segmental motion information on one end, requiring more local perception of parts of the object in relation to each other (i.e., the limbs). The other end is suggested to consist of a global perception of the optical size change of an object [3]. In-between cadence information, referring to the up-and-down movements that occur during gait, is suggested to play a role. In the reference condition, a leader was presented as a back-and-forth walking animated avatar. It was based on a 15 segment model of a pre-recorded leader participant. In the other conditions, various aspects of motion information were either suppressed or emphasized. We emphasized movement of body segments using a point-light display. In other conditions we showed a mannequin (i.e., an avatar without moving limbs) with various combinations of the subtle, but potentially pertinent, lateral and vertical displacements that occur during gait. Another set of conditions showed different shapes (a mannequin, cylinder and sphere) that only displayed the optical size change corresponding to the back-and-forth displacement.

Fig. 2: Temporal synchronization (left) reflected by the relative phase and spatial synchronization (right) represented by virtual interpersonal distance. Averages and 95% confidence intervals are displayed.

Synchrony between follower and leader was analysed using a point-estimate relative phase and an estimate of the virtual interpersonal distance. The first informs about the temporal synchrony and to

what extent there was a lead-lag relationship. A negative value indicates a phase-lead of the leader, scaled to 2π . The second informs about a visual angle based measure of spatial synchrony. A negative value indicates an overall decrease of distance between follower and leader. It was revealed that local information led to a tighter temporal synchrony, whereas global information to a close spatial synchrony. These findings contribute towards understanding how individuals can coordinate their movements in dynamic environments. It suggests that in order to act most efficiently it is important to be able to flexibly switch and prioritize different information sources. Such flexible behaviour to pertinent motion information could be the underlying process that construes interactivity.

Scientific Validation

This paper has been unanimously validated in a collaborative review mode with the following reviewers:

- Rafaela Carolina da Silva, from Universidade Estadual Paulista "Julio de Mesquita Filho" – Brazil
- Laura Melinda Stan, from Faculty of Economics and Business Administration, West University of Timisoara, Romania
- Angel Ric, from Complex Systems and Sport Research Group, National Institute of Physical Education of Catalonia (INEFC), University of Lleida, Spain

[1] Meerhoff, L.A. & De Poel, H.J. (2014). Asymmetric interpersonal coupling in a cyclic sports-related movement task. *Hum Movement Sci*, 35, 66-79.

[2] Meerhoff, L.A., De Poel, H.J., & Button, C. (2014). How visual information influences coordination dynamics when following the leader. *Neurosci Lett*, 582, 12-15.

[3] Rio, K.W., Rhea, C.K., & Warren, W.H. (2014). Follow the leader: Visual control of speed in pedestrian following. *J Vis*, 14(2), 1-16.