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Asymmetric interpersonal coupling in a cyclic sports-related movement task

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ABSTRACT

In interactive sports, teammates and/or opponents mutually tune their behavior. Expert performance thus implies certain interactive abilities, which critically depend on perceptual coupling. To illustrate this assertion, we examined the coordination dynamics with asymmetric interaction of dyads performing a sports-related cyclical movement task. In pairs, basketball players performed lateral defensive slides in in-phase, until a cue prompted them to switch to antiphase coordination. We assessed how these switches were mediated by phase adaptations of each agent under bidirectional (i.e., agents facing one another) and unidirectional (i.e., one agent facing the back of the other) visual interaction conditions. This imposed asymmetry in visual coupling exemplified an imbalance in the interaction (or 'interact-ability') between two agents. The results concurred the asymmetric coupling: during the switch the agent facing the other adapted his phasing more than the other agent. Furthermore, also in the bidirectional condition the coupling revealed dyad-intrinsic asymmetries (e.g., related to implicit follower-leader strategies). Together, this illustrates that interpersonal coordination is characterized by asymmetric coupling between the agents, and highlights how mutual perception of pertinent information mediates interpersonal coordination. This study offered a first step towards analyzing interpersonal coordination dynamics in relation to 'interact-ability'.

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1. Introduction

In the sports science literature, there have been numerous attempts to identify the core factors underlying expertise in sports (e.g., Reilly, Bangsbo, & Franks, 2000; Starkes & Ericsson, 2003; Vaeyens, Lenoir, Williams, & Philippaerts, 2008). Traditionally, sports expertise has mainly been linked to distinguished individual characteristics in terms of physical (e.g., physiological, biomechanical, anthropometric) features, such as strength, speed, agility and technique (e.g., Hoare, 2000). Additionally, individual proficiency in terms of psychological characteristics, like self-regulation, motivation or self-efficacy, has gained increased recognition (e.g., Toering, Elferink-Gemser, Jordet, & Visscher, 2009). Although such characteristics can tell us a lot about qualities of an athlete, they do not capture the whole picture (Pearson, Naughton, & Torode, 2006). In that respect, particularly important for interactive (i.e., multi agent) sports, the individual athlete's skill to interact with his/her environment has received relatively little attention. Moreover, as the mere goal of sports is to compete with others, whether or not in teams, almost all sports participation is fundamentally defined by interactions with teammates and/or opponents. This implies that the action goals of each individual athlete are always linked (or shared to some degree) to those of other athlete(s). As such, there is *mutual* interdependency and, accordingly, the behavior of an individual athlete cannot be conceived independent from that of the other athletes in question. This argument implies that in competitive sports, expert performance requires excellent interactive abilities. Such 'interact-ability' comprises an agent's ability to link to pertinent perceptual information for sound decision-making. In this study, we aim to illustrate this assertion by analyzing the coordination dynamics of a dyad performing a cyclical movement task.

The complex interactions of human performers with their environments in sports present rich, ecological constraints (Davids, Button, Araújo, Renshaw, & Hristovski, 2006), such as the consideration of a defender's position, speed and skill in relation to a teammate's position, speed and skill when making a pass. In the team coordination literature, one way of explaining the interactions between athletes is by means of shared mental models (e.g., Cannon-Bowers, Salas, & Converse, 1993; Entin & Serfaty, 1999). In this view, each individual athlete has a mental representation that consists of both the current shared tactical situation and a mutual understanding of each team members' function. Alternatively, one could adopt a more dynamical approach, which is particularly suitable given the high temporal and dynamical demands in interactive sports. From an ecological dynamics perspective, decision-making in multi-agent situations emerges from the relationships that two or more agents have with environmental constraints, that is, how they *mutually* interact with their *shared* environment (Silva, Garganta, Araújo, Davids, & Aguiar, 2013). An important notion is that capturing these often subtly expressed but fundamental interactions in an experimental task, is only meaningful to the extent the task is representative of the natural situation (Araújo, Davids, & Hristovski, 2006). For interactive sports, arguably the most dynamic and influential part of the environment to interact with are the other participating athletes, both teammates and opponents. A dynamical systems approach offers innovative tools for uncovering the dynamics of multi-agent systems in sports (e.g., McGarry, Anderson, Wallace, Hughes, & Franks, 2002). For instance, recent research has characterized (sub-phases of) interactive sports behavior in terms of the dynamics of interpersonal distance and velocity of a dyad, or distance and phase relation between the centroid position of two groups of players (e.g., Bourbousson, Seve, & McGarry, 2010a, 2010b; Frencken, De Poel, Visscher, & Lemmink, 2012; Palut & Zanone, 2005; Passos et al., 2008).

The research foundations for these studies were highly inspired by the work of R.C. Schmidt and coworkers, who examined interpersonal coordination of dyads (e.g., Schmidt, Bienvenu, Fitzpatrick, & Amazeen, 1998; Schmidt, Carello, & Turvey, 1990) and later discussed potential applications for sports (Schmidt, O'Brien, & Sysko, 1999). To date, many studies have demonstrated that coordination of cyclical movements *between*-persons abides by similar coordinative phenomena as *within*-person coordination (for recent reviews, see Schmidt, Fitzpatrick, Caron, & Mergeche, 2011; Schmidt & Richardson, 2008), as formalized by a model of two coupled oscillators (Haken, Kelso, & Bunz, 1985) and its extensions (e.g., Kelso, Del Colle, & Schöner, 1990; Schöner, Haken, & Kelso, 1986; Treffner & Turvey, 1996).