Human Movement Science 33 (2014) 14–24

Contents lists available at ScienceDirect

Human Movement Science

journal homepage: www.elsevier.com/locate/humov

Coordination tendencies are shaped by attacker and defender interactions with the goal and the ball in futsal

Luís Vilar [a,b,c,*], Duarte Araújo [a,c], Bruno Travassos [d,e], Keith Davids [f,g]

[a] Faculty of Human Kinetics, Technical University of Lisbon, Estrada da Costa, 1495-688 Cruz Quebrada, Portugal
[b] Faculty of Physical Education and Sports, Lusófona University of Humanities and Technologies, Campo Grande, 376, 1749-021 Lisboa, Portugal
[c] CIPER – Interdisciplinary Centre for the Study of Human Performance, Estrada da Costa, 1495-688 Cruz Quebrada, Portugal
[d] Department of Sports Sciences, University of Beira Interior, Convento de Sto António, 6201-001 Covilhã, Portugal
[e] CIDESD – Research Center in Sports, Health Sciences and Human Development, Convento de Sto António, 6201-001 Covilhã, Portugal
[f] Centre for Sports Engineering Research, Sheffield Hallam University, UK
[g] FiDiPro Programme, University of Jyväskylä, Finland

ARTICLE INFO

Article history:
Available online 11 January 2014

PsycINFO classification:
3720
3020

Keywords:
Ecological dynamics
Interpersonal coordination
Dyadic systems
Constraints
Team sports

ABSTRACT

This study examined how the location of the goal and ball constrained the interpersonal coordination tendencies emerging of attacker-defender dyadic systems in team sports. Additionally, we analysed how the positioning of defenders constrained the emergent coordination tendencies between the ball carrier and supporting teammates. To investigate these tendencies in team sports, ten futsal games were filmed to observe inter-individual interactions. Movement trajectories of players and ball were digitized during 52 outfield attacker-defender interactions involving thirteen goal-scoring sequences. Relative phase was used as a measure to express participant coordination tendencies in these dyadic systems (in-phase or symmetry – 0°; anti-phase or anti-symmetry – 180°). Stable in-phase patterns of coordination emerged between specific values of an attacker's distances to defenders and the goal (19% frequency from 0° to 29° of phase relations) and between specific values of distances of ball carriers to defenders and teammates (14% frequency from 0° to 29° of phase relations). A stable pattern of coordination of −60° emerged between values of an attacker's distances to defenders and the ball (18% frequency from 0° to 29° of phase relations). Distances of attackers to the goal and ball, and

* Corresponding author at: Faculty of Human Kinetics, Technical University of Lisbon, Estrada da Costa, 1495-688 Cruz Quebrada, Portugal. Tel.: +351 214 196 777; fax: +351 214 151 248.
E-mail address: lpvilar@fmh.utl.pt (L. Vilar).

0167-9457/$ - see front matter
http://dx.doi.org/10.1016/j.humov.2013.08.012

distances of ball carriers to defenders, seemed to be coupled in a specific manner to guide interpersonal coordination tendencies between players during competitive performance in the team sport of futsal.

1. Introduction

People often produce actions in social contexts, such as team sports, in which their movements are coordinated in relation to movements of others. The structure of such interpersonal coordination tendencies has been a popular topic with human movement scientists seeking to understand how people interact intentionally or sub-consciously with others in space and time (Schmidt, Fitzpatrick, Caron, & Mergeche, 2011; Travassos, Araújo, McGarry, & Vilar, 2011). Research in team sports, conducted from the perspective of ecological dynamics, has sought to explain successful performance by examining how players coordinate their movements with those of other performers, and how this coupling is regulated by information (Araújo, Davids, & Hristovski, 2006; Vilar, Araújo, Davids, & Button, 2012).

A key principle of ecological dynamics is that analysis of interpersonal coordination in social neurobiological systems, such as sports teams, should consider the individual-environment relationship as the relevant scale for understanding sport performance (Davids & Araújo, 2010). Coordination is considered to emerge from continuous spatial–temporal interactions of players (both teammates and opponents) with key task constraints, such as the location of the ball and the goal (Vilar, Araújo, Davids, & Travassos, 2012). Such constraints surround a complex system and reduce the number of organisational states that are available to it, pushing coordination of system components towards stable states of organisation (i.e. in dynamical systems language: towards attractors) (Warren, 2006).

In team sports, spatial–temporal interactions between players and key-features of the game, such as specific locations of the ball and the goal, play an important role here, since it are these constraints that players harness as information to regulate cooperative actions with teammates during successful performance. Spatial–temporal constraints in sport performance often change on a moment-to-moment basis due to the complex relations between performers (Fajen, Riley, & Turvey, 2009). For example, at any moment in the team sport of futsal (5-aside indoor association football game), a passing line between defenders may open and an opportunity to pass the ball may be offered to a ball carrier (Travassos et al., 2012). Milliseconds later a defender may move into the line of the ball's trajectory with the ball receiver, and the opportunity to perform a successful pass is no longer available. The instability that characterizes performance constraints in team sports makes opportunities for action continuously arise and dissipate instantaneously, leading to fluctuations in the organisational states of games (e.g. characterised by increased variability in the way that attackers and defenders coordinate their actions) (Araújo & Davids, 2009). When these game fluctuations are powerful enough to destabilise the existing equilibrium between attacking and defending players, a symmetry-breaking process emerges. That is, a previously stable state of the game transits to a new dynamic state of organization (e.g. an attacker dribbles past a first defender, inducing a second defender to cover and leading to a structural change in a defending team) (Davids, Glazier, Araújo, & Bartlett, 2003).

Previous research on interpersonal coordination tendencies in team sports has examined interactions within attacker-defender dyadic systems (i.e., 1v1 sub-phases of competitive matches) (Bourbousson, Sève, & McGarry, 2010a; Travassos et al., 2011). For example, in futsal, attacker and defender interpersonal coordination tendencies have been investigated using relative phase as a dynamic measure, enabling a quantitative expression of coordination processes emerging between the players entrained in a momentary dyadic system (Travassos et al., 2011). When both players in a dyad move forwards and backwards simultaneously, an *in-phase* (0°) coupling tendency may be identified. On the other hand, an *anti-phase* (180°) mode of coordination emerges when one system agent is moving forward and the other is moving backwards at the same time (Kelso, 1995). Previous analyses of movement trajectories of attacker-defender dyads comprising directly competing opponents (identi-