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Practice effects on intra-team synergies in football teams

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ABSTRACT

Developing synchronised player movements for fluent competitive match play is a common goal for coaches of team games. An ecological dynamics approach advocates that intra-team synchronization is governed by locally created information, which specifies shared affordances responsible for synergy formation. To verify this claim we evaluated coordination tendencies in two newly-formed teams of recreational players during association football practice games, weekly, for fifteen weeks (thirteen matches). We investigated practice effects on two central features of synergies in sports teams – dimensional compression and reciprocal compensation here captured through near in-phase modes of coordination and time delays between coupled players during forward and backwards movements on field while attacking and defending. Results verified that synergies were formed and dissolved rapidly as a result of the dynamic creation of informational properties, perceived as shared affordances among performers. Practising once a week led to small improvements in the readjustment delays between co-positioning team members, enabling faster regulation of coordinated team actions. Mean values of the number of player and team synergies displayed only limited improvements, possibly due to the timescales of practice. No relationship between improvements in dimensional compression and reciprocal compensation were found for number of shots, amount of ball possession and number of ball recoveries made. Findings open up new perspectives for monitoring team coordination processes in sport.

1. Introduction

In team games, like association football, the rhythmic movements of players forward and backwards on field (MFB) in competing teams represent the patterns formed when attacking and defending. Such movements occur fundamentally in the goal-to-goal direction and have been previously described in analyses of small-sided games (e.g., Frencken, Lemmink, Delleman, & Visscher, 2011) and regular football 11-a-side competitive fixtures (e.g., Frencken, De Poel, Visscher, & Lemmink, 2012; Lames, Ertmer, & Walter, 2010).

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In the coaching literature it is advocated that rhythmic and coordinated movements of players on a team (i.e., advancing up-field to attack and moving back to protect the goal and defend) require coordinated movements of performers to support the necessary team cohesion to outperform opponents (Bangsbo & Peitersen, 2002, 2004; Hughes, 1994; Worthington, 1974). Evidence for this assumption is exemplified by data from the study of Duarte, Araújo et al. (2013) where large synergistic relations in professional football teams were observed (through cluster phase measures), mainly in the longitudinal direction of the field.

Synergies are temporary assemblages of components constrained to behave as a single functional unit (Kelso, 2012; Riley, Shockley, & Orden, 2012) through the formation of compensatory low-dimensional relations (Kelso, 2009) that continuously emerge and change in complex systems using inherent self-organization processes (Kelso, 1995, 2012). The notion of a synergy has existed in the human movement sciences for over a century (Latash, Scholz, & Schöner, 2007), most commonly associated with the problem of coordination by the central nervous system of redundant motor system degrees of freedom to regulate functional movement behaviours (Bernstein, 1967). The formation of synergies between parts of the body during goal achievement (Davids, Button, Araújo, Renshaw, & Hristovski, 2006; Kelso, 1998) has been considered to lead to a reduction in system dimensionality by harnessing degrees of freedom that are specific to a particular task, while abandoning nonessential ones (Beek, Jacobs, Daffertshofer, & Huys, 2003).

Coordination between players in a sports team displays the same hallmark properties of within-individual movement control by involving the continuous (re) organization and reduction of a team's degrees of freedom (i.e., the numerous movement and action possibilities of individual players) when attacking and defending together (Keith Davids, Seifert, & Orth, 2015; Riley, Shockley, & Orden, 2012). This process is termed dimensional compression and refers to the coupling of independent degrees of freedom of players so that a synergy possesses a lower dimensionality (Fau, Kelso, Saltzman, & Schoner, 1987). Synergy formation processes can be depicted in match play during a team's MFB rhythmic movements where teammates try to move synchronously in space and time in order to maintain team cohesion in achieving performance goals. To do so, they must discard other movement possibilities that do not support this team behaviour at specific moments during performance (e.g., running back towards a team's own goal line when the other teammates are strategically running forward to support an attack).

Reciprocal compensation is another important property of a synergy and refers to the ability to compensate for any perturbations to one system component by adjustment in remotely linked parts to preserve its functional integrity (Kelso, 2012; Latash, Scholz, & Schoner, 2002; Riley et al., 2012). In other words, each component of a synergy possesses the ability to react to changes in others (Riley, Richardson, Shockley, & Ramenzoni, 2011). For instance, during a fast break attack, the movements of attackers towards the opposition goal may leave gaps in remaining team sectors that can be compensated by teammates readjusting their movement direction and speed to link up with the forwards.

1.1. The role of shared affordances in guiding the formation of team synergies

An important related concept in explanations of synergy formation in team sports is the concept of *affordance*. An important conceptualisation of affordances views them as information sources in a performance environment, which may be directly perceived in offering specific actions from individuals (Gibson, 1979; Turvey, 1992). Information is perceived as opportunities for action and emerges from the continuous interactions of an athlete with key features of a performance environment studied at the ecological scale of analysis (Araújo, Davids, & Hristovski, 2006; Fajen, Riley, & Turvey, 2008). Humans can perceive affordances for themselves and also for other individuals to intentionally regulate behaviours so that cooperative actions eliminate the unnecessary degrees of freedom to achieve a common intended goal (Mark, 2007; Marsh, Richardson, & Baron, 2006; Stoffregen, Gorday, & Sheng, 1999). As mentioned earlier, perceiving the possibility to move towards the opposition goal also implies perceiving the same possibilities and intentions in teammates so that team cohesiveness can be maintained. According to Gibson (1979) *"behaviour affords behaviour (p. 135)"* signifying how coordination tendencies among team players may emerge through shared affordances during competitive performance. Thus, synergies are formed on a platform of a shared (mainly visual and non-verbal) communication channels used by teammates to collectively perceive affordances for team behaviours (Passos, Cordovil, Fernandes, & Barreiros, 2012; Silva, Garganta, Araújo, Davids, & Aguiar, 2013). Shared affordances are crucial in synergy formation because they enable dimensional compression and reciprocal compensation by reducing the number of independent degrees of freedom (i.e., the multitude of coordinating options for players) and supporting fast compensatory actions (i.e., allowing players to respond to each other's actions in order to ensure the attainment of team goals) (Araújo, Silva, & Davids, 2015; Araújo, Silva, & Ramos, 2014; Riley et al., 2011; Silva et al., 2013). In football teams this process is predicated, for example, on the multitude of coupled movement behaviours between teammates resulting in reduced times from their co-positioning during attacking and defending team movements.

1.2. Current understanding of synergies in team sports

Many researchers have claimed that synergies (also commonly referred as couplings) form the basis of interpersonal coordination in team sports (e.g., Duarte, Araújo, Correia, & Davids, 2012; McGarry, Anderson, Wallace, Hughes, & Franks, 2002; Silva et al., 2013). These claims justify the pertinence and need for studies addressing the emergence of intra-team synergies in team sports like association football. Most of the existing studies in team coordination processes have focused attention on the degree of movement coordination in dyads or sub-groups of players in team sports like football. To this