

THE MANIPULATION OF CONSTRAINTS TO TRAIN THE COMPLEXITY OF SOCCER: THE SMALL SIDED CONDITIONED GAMES

LA MANIPOLAZIONE DEI VINCOLI PER ALLENARE LA COMPLESSITÀ DEL CALCIO: GLI SMALL SIDED CONDITIONED GAMES

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Abstract

The characteristics of soccer show a high degree of complexity of this sport, which involves the continuous interaction of each individual athlete with teammates, opponents, the ball, the environment, the playing field and the rules (Machado et al., 2016). The behaviour of players and teams emerges from their interpretation of the various information coming from the game situations, namely constraints (Newell, 1986). The continuous interaction with and of these offers athletes numerous affordances (Gibson, 1979). Players self-organize to develop functional patterns of intra-individual, inter-individual and individual-environment coordination (Davids et al., 2013). By exploiting the manipulation of constraints, the coach can bring out useful action opportunities to improve tactical actions (Costa et al., 2015); the Small Sided Conditioned Games (SSCGs), through the manipulation, above all, of task constraints (playing area, number of performers, goals and rules), stimulate self-organization based on affordances present in the created context (Sangnier et al., 2019).

Le caratteristiche proprie del calcio mostrano un elevato grado di complessità di questo sport, il quale prevede l'interazione continua di ogni singolo atleta con i compagni di squadra, gli avversari, la palla, l'ambiente, il terreno di gioco e le regole (Machado et al., 2016). Il comportamento di calciatori e squadre emerge dalla loro interpretazione delle varie informazioni provenienti dalle situazioni di gioco, ovvero i vincoli (Newell, 1986). L'interazione continua con e di questi offre agli atleti numerose affordances (Gibson, 1979). I giocatori si auto-organizzano al fine di sviluppare schemi funzionali di coordinazione intra-individuali, inter-individuali e individuo-ambiente (Davids et al., 2013). Sfruttando la manipolazione dei vincoli l'allenatore può far emergere opportunità d'azione utili a migliorare le azioni tattiche (Costa et al., 2015); gli Small Side Conditioned Games (SSCGs), attraverso la manipolazione, soprattutto, dei vincoli di compito (area di gioco, numero di performer, obiettivi e

regole), stimolano l'auto-organizzazione sulla base delle affordances presenti nel contesto creato (Sangnier et al., 2019).

Key-words

Soccer, Small-Sided Conditioned Games, Constraints-Led Approach

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Introduction

The characteristics of soccer show a high degree of complexity of this sport, which involves the continuous interaction of each individual athlete with teammates, opponents, ball, environment, playing field and rules (Machado et al., 2016). Newell's (1986) model of interacting constraints supports the idea that the behavior of players and teams emerges from their continuous interaction with the environment and from their interpretation of information from game situations. The Constraints-Led Approach is an approach to teaching and coaching based on the fundamental concept of mutuality between performer and environment (Gibson, 1979) that encourages practitioners to understand and explore how various individual, task and environmental factors impact on the learning and shape the development of human behavior (Renshaw & Chow, 2018). The affordances (Gibson, 1979) always present in the environment guide the interaction of the players to develop functional intra-individual, inter-individual and individual-environment coordination schemes (Davids et al., 2013). The coach can exploit these intrinsic tendencies to self-organization by manipulating the constraints of the task. In football, self-organization based on affordances present in the context (Sangnier et al., 2019) can be exploited using Small-Sided Conditioned Games (SSCGs). Small-Side Conditioned Games are a useful tool for coaches when designing training activities for their athletes. The combination of game constraints (court size, number of players, scoring system rules, etc.) allows coaches to change the relationship between performer-environment interactions towards an expected outcome (Araújo et al, 2006), creating adaptations to the context competitive.

1. Theoretical framework

Dynamic System Theory

The theory of dynamic patterns is a mathematical theory that has been applied to all kinds of phenomena (Abraham & Shaw, 1992) including humans. It can be defined as a theory of change that seeks to capture, study and understand structural transitions and

system behavior in the environment (Corbetta & Verijken, 1999). Humans are, indeed, complex dynamic systems and are organized according to the principles of the Dynamic System Theory (DTS- Haken et al., 1985). In fact, the models of movement derive from the synergistic organization of the neuromuscular system based on morphological and biomechanical factors, environment and constraints of the task. The complex interaction between these components participating in motor behavior and the process of self-organization will produce the emergence of an individual response (Kelso, 1999; Kurz & Stergiou, 2004; Thelen & Smith, 1998). The system organizes itself and all its parts self-influence each other and because of their interaction. Research by DTS has suggested a considerable dependence in the behavior of complex dynamic systems on the initial conditions and the presence of states that attract the system called attractors (Abraham & Shaw, 1992). Self-organization models and therefore motor behaviors are defined by collective system variables or order parameters and are constrained by the control parameters that will produce the change (Kelso, 2000). According to DTS principles, a small change in a control parameter that limits the system can lead to abrupt changes in the general behavior of that system; this control parameter can come from the environment, from the subject, from the interaction with other subjects, from the interaction with the task. Practice or exposure to certain environmental conditions may guide, facilitate or alter the formation of differentiated motion patterns, depending on the initial conditions of the system (Angulo-Kinzler, 2001; Ulrich et al., 1998; Thelen et al., 1993). Since the DST allows to consider athletes as complex dynamic systems, self-organized and constrained by morphology, physiological, psychological and biomechanical factors, by the properties of the activity and the environment and highlights how these are greatly dependent on their initial condition and the distribution of attractors, also the training must be seen as an integrated and global process of self-organization (Torrents & Balagué, 2006). This means to bind the subject in the desired direction of the training process and it is possible to do so by changing the environment and conditions. The key ideas of DTS applied to sport capture the way athletes and sports teams undergo processes of adaptation to the time scale of performance, learning and the acquisition of skills and, although self-organizing tendencies in athletes are spontaneous, their specific expression is always shaped by personal, task and environmental constraints (Newell, 1986), which are boundaries that influence the behaviors that emerge from the athletes in sport (Button et al., 2020).

Dynamic Ecological Theory

Humans and other animals perceive and act on substances, surfaces, spaces, objects and events in the environment (Gibson, 1979). According to the perspective of Dynamic Ecological Theory, creative motor solutions emerge from the coupling perception-action within environmental constraints (Orth et al., 2017). The structure of the physical environment, the biomechanics of the body, the perceptual information and the demands of the task determine the boundaries within which the motor system can act by influencing the repertoire of available actions (Seifert et al., 2016). Moving creatively thus reflects an individual's ability to adapt in a unique and original way (Hristovski et al., 2011). Affordances represent, in fact, the opportunities of action defined in the framework of the complementary relationship between the environment and the individual.

The Dynamic Ecological Theory offers the possibility of understanding sports performance and how these can be improved in practice, through four fundamental principles: the individual-relationship environment represents the fundamental level of analysis understanding performance and learning in sport; behaviors emerge from tendencies of self-organization in multiple subsystems; inter-acting constraints shape these emerging behaviors; and designing action opportunities or affordance in learning contexts can guide the individual to use actions to explore the available perceptual information.

Constraints- Led Approach

The Constraints-Led Approach (CLA) is an approach for teaching and coaching based on the fundamental concept of mutuality between performer and environment (Gibson, 1979), which allows to understand and explore how the various individual factors, and environmental impacts on learning and shape the development of human behavior (Renshaw et al., 2019).

The CLA was born from the interactions of important theories on ecological dynamics described by Gibson (1979), moreover, the theoretical framework is enriched with the ideas of Kelso (1995) on the dynamics of coordination and with the ideas of Turvey & Ulrich (1991) on the functioning of natural physical systems. However, the greatest

theoretical contribution is that deriving from the thought of Newell (1986) on the way coordination emerges, on different time scales, under the control of constraints. This interdisciplinary approach has led to the affirmation of an interpretative framework of the development and performance of athletes that is the constraint-based approach (Davids et al., 2008).

The CLA emphasizes that it is necessary to design not only the environments but also the instructions that guide the actions and constraints of the task, to offer athletes the opportunity to discover and exploit information/action relationships and form stable couplings with information from the environment. The idea that task design also transfers learning from training to performance is based on the importance of coordination suggested by ecological dynamics following the concept of self-organization.

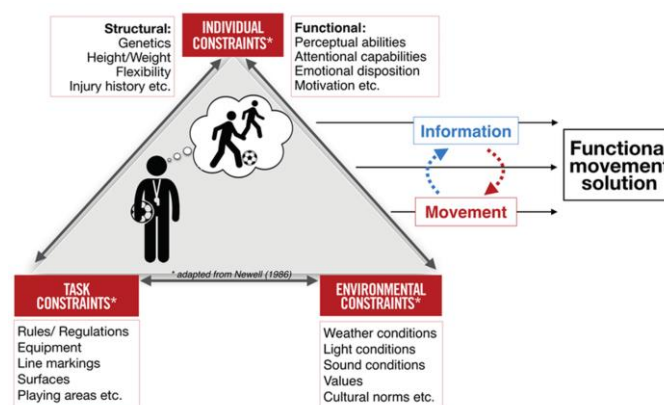


Figure 1: Three interacting constraint categories and examples to drive the coupling of information and movement (Source: Otte et al., 2021).

Small-Sided Conditioned Games

The Small-Sided Conditioned Games are modified games played on smaller fields, with rules adapted and involving players often lower than traditional football matches (Hill-Haas et al., 2011). These allow coaches to manipulate task constraints to shape specific tactical behaviors through changes and adjustments of the performance context and interacting constraints; moreover, they provide players with the maintenance of an environment like the competition.

2. Materials and Methods

During January 2022, a comprehensive search of six databases of literature (PubMed, EBESCO (Sportdiscuss), Web of Science, BASE, Scopus and SpringerLink) from 2016 through 2022 was undertaken. The principal search terms were as follows: “Manipulation of Constraints”, “Soccer” and “Small Sided Conditioned Games”. A standard data extraction template was developed to extract the main details for every eligible study in terms of author, objective, sample size, year of publication, age of participants, materials and methods used, results.

3. Results

Table 1 shows the results of the studies examined to support the use of SSCGs in football training. All the studies agree in the existence of how these effectively support the expected learning without distorting the context of performance typical of this sport. Attached, the table with all the details (Tab.2).

Authors	Results
Nunes et al. (2020)	The findings from this study suggest how coaches can use space manipulation in SSCGs as an important task constraint to shape players ‘performance behaviour across different age groups.
Caso & Van der Kamp (2020)	SSCG in soccer do indeed stimulate variability and creativity of individual actions.
Pizzaro et al. (2021)	The number of players can influence the tactical behaviour of the team. Training tasks intended to improve dribbling and shooting actions should use a smaller number of players whereas tasks intended to improve passing actions for ball possession should include a higher number of players.
Canton et al. (2021)	Modifying the position of the goals can foster original behaviours of young athletes and increase the tactical repertoire of players.
Oppici et al. (2017)	Despite performing the same skill (passing action), futsal and soccer task constraints shaped athletes’ perceptual skills.
Machado et al. (2016)	The players and teams tend to self-organize according to games rules used in SSCGs.

Praça et al. (2021) The progression to the target rule should be adopted to emphasize players' ability to use the width during the offensive phase.

Table 1. Summary of the results of the studies examined.

4. Discussion

In the studies examined, the SSCGs were designed by modifying activity constraints: the rules for the attribution of goals, the positioning of football goals, the positioning of specific players. The results of these studies support the manipulation of constraints (CLA) as an effective methodology to favour the development of functional coordination schemes within-individual, inter-individual and individual-environment and for the perception of affordances present in the environment. From a coaching perspective focused on mutuality between the performer and the environment, understanding the coupling of environmental information and movements during practice and manipulating task constraints is essential to direct athletes to perceive and explore relevant information during practice execution. Using SSCGs during training sessions allows coaches to take advantage of these continuous interactions between individuals, environment and task; they do not distort the complexity of the game, they are not isolated and decontextualized exercises.

5. Future prospects

The use of SSCGs as the main tool for the training of football, in the light of the theoretical framework above and the results of the most recent research, also highlights the need for an evaluation of the training process fully in line with these theories. It is therefore necessary to select tests that do not alter the complexity of this sport even at the time of evaluation; the Game Performance Evaluation Tool (GPET- García-López et al., 2013) is an evaluation tool that measures the decision-making process and the execution of technical-tactical actions in invasion games/sports, also validated for football, which well meets the need for a complex assessment.

Conclusions

Starting from the contemporary ideas of ecological dynamic theory, the science of complexity applied to motor learning and, using the Constraints-Led Approach, through the analysis of some studies conducted in football, this work aims to emphasize the use of SSCGs as a "tool" responding to the non-linear and complex characteristics of the motor learning process. Football is an open skill sport and this is well evidenced by the high degree of complexity of this sport, just think of the very high number of relationships that are typical of this game (between the performers, between the performers and the ball, with the context, etc.); the Small Sided Conditioned Games allow you to train the football player to this complexity by contributing not only to the development of technical and tactical skills but also to that of creativity, imagination and problem solving. In addition, the Small-Sided Conditioned Games can also be used with very young children because the extreme similarity with the performance environment allows the little athletes to be involved in moments of joy and fun essential in childhood.

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