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UNDERSTANDING MICRO AND MACRO INTERACTIONS IN SOCIAL NEUROBIOLOGICAL SYSTEMS

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ABSTRACT

The approach of complex systems as a form of new approach provides an opportunity to replace the dominant, mechanistic view of sport-related phenomena. By analyzing the micro and macro relationships of complex system components, the observer can describe well the set of states of the system. The transition between these states can be induced by internal and external forces. Understanding the motivations of smaller groups and successfully integrating this knowledge to understand higher-level elements of the system facilitates the understanding of complex transitions. The novelty is in this research that micro and macro changes are integrated as a common driver and they generate something entirely new property for the whole system. In a case study, a small soccer team is presented as a complex system. There are statuses examined and elaborated in which this small team and the members go through the observed period (2005-2009) which can be similar to other complex systems. The case study successfully mirrored the behavioural dynamics of agents in a social neurobiological system, exemplified by interactions of statuses in a team sport.

KEY WORDS

complex system, soccer, changes

CLASSIFICATION

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INTRODUCTION

Complex systems (teams, tactics) observed in sports consist of structurally and functionally heterogeneous components that interact (usually informatively and/or mechanically) with different intensities and spanning different spatial-temporal scales [1]. They are purposeful changing their behaviour and adjusting to the constraints that arise [2]. This feature significantly increases their level of complexity and is a major challenge for modelling techniques. In such systems, new forms of behaviour are constantly appearing under varying constraints, without being designed or enforced previously. This is one of the main characteristics of sport-related phenomena.

However, complex systems can behave in a simple way because their interacting components can form large coalitions of cooperative elements that reduce the dimension of the behaviour [3]. In this way, a complex system achieves simple behaviour and can be treated as a simple system at the macroscopic level [4]. On the other hand, the complex system regulates itself, it is created in a selfless organization without control, patterns, structures, can begin and then something unique happens, a completely new quality of the system is created [5]. This new quality is called the emergent feature of the complex system. More than 35 years ago, the science of complexity influenced some trends in the sport. Nowadays, systematic research has been established to observe the coordination dynamics [6]. Coordination dynamics is defined as the science of coordination, that describes, explains, and predicts how patterns of coordination form, adapt, persist, and change in living things. The aim of this field of work is to understand principles and laws that lead the dynamics of behavioural pattern formation under changing constraints (i.e., boundary conditions) [7]. These constraints may be classified into three sub-classes: task constraints, personal constraints, and environmental constraints [3]. These constraints are also reflected in the case study.

LITERATURE REVIEW

The complex system has many components, which can be complex systems themselves [8], and components can belong to multiple systems at one time [9]. There are dynamic links or interactions between the elements which reinforce or weaken each other. (positive and negative feedback) [10]. The nature of interaction can be energy, material or information exchange, or a combination of these [11]. Emergence plays a central role in theories of integrative levels and of *complex systems.* In short, it means that the system creates a new quality characteristic of it.The emerging property is somewhat expedient, but this global objective is not present in the components that make up the system: the components have local interactions, but they all make up something entirely new, which is the specific feature of the whole system [12].

Another important concept in complex system theory is a swarm intelligence [13]. Ants and bees are social insects and that individuals do not have special intelligence, but by means of interpersonal relationships (communion by pheromones) a "super-intelligence" is formed (super-intelligent in the sense that it is above the level of individuals) [14, 15]. This is typical for big cities as well. Therefore, the economic efficiency of big cities, if we look it at citizens level is far better than the villages [16]. One other simple definition of a complex system is that if we change some input parameters of the system a little bit, then the output parameters will change significantly [17]. From this simple definition, we can see that the modelling of a complex system is a very hard task [6].

METHODOLOGY

A very good example of the complex system is the social and economic organizations of people like cities [16]. In this research, were observed a soccer team as the social and

economic organizations of people. A methodology for analyzing collective behaviour within the team was used. In this case, the integrated levels interact at different scales during the performance [18]. Different techniques, tactics, physical abilities, decisions, thinking or physiological processes, creativity or social dynamics are no longer seen as isolated or independent aspects, but as interdependencies and commonalities [12]. New proposals make it possible to generate both multi-personal and individual learning and coaching strategies [19]. System behavioural variability acquires a functional value and can provide information about the states of the system (its resilience and adaptability to changes, or, conversely, its inability or inflexibility) [8, 20].

Previous studies have shown that different systems in a sports environment are very sensitive to the limitations and small changes of variables in critical areas [6, 19, 21]. The success of these investigations was that they showed some universal properties of the dynamics of complex systems, which were originally unchanged at the organizational level of the case. Various authors have studied the impact of new methods on training practitioners and the new role of athletes and coaches [21, 22]. The differentiated learning approach suggests that teams find optimal performance patterns [23] by adding noise during exercise [24]. The coaches or athletes explore the state space until they find the best solution. This research has focused on decision making and creativity in sport. For example, New activities may arise if you allow a coach or a team to explore the new region of the action workspace. The stochastic movements the environment may give rise to the invention of new and functional actions [25]. For this approach, it is important that there are independent system agents among which are defined relations. (players, coach, etc.).

CASE STUDY: SMALL SOCCER TEAM AS A COMPLEX SYSTEM

This case study describes and evaluates the novel applicability of network methods in understanding human interpersonal interactions in social neurobiological systems [24] such as a small-town soccer team on period 2005-2009 (“Electro – Vojvodina” – Szabadka – Serbia). It will be presented how collective system networks are supported by the sum of interpersonal interactions that come into view from the activity of system agents (such as players or coach of a soccer team). For example, It was observed how the interactions between the coach and the team members, influenced the team’s mood or tactics and the back effect of these changes.

During this research, were strived to make the states of the system well distinguishable. The transition from one state to the next was always time-consuming (usually half of the year). Driving forces behind each transition have tried to describe as simply as possible.

First, it will be listed the system agent and then list the attributes associated with them. In cases where it is not clear, it is also specified the attribute what value can take. Finally, system stages and transition are listed in chronological order.

The aim of the model creation is to contribute to the clarity of observed systems, Figure 1. The key elements (Agents) of system are players, coach, mood and tactics of team level. Each agent has certain attributes that can be changed over time.

Sorted list of attributes of agents:
The attributes of Players: age, experience, position in the team, motivation**.**
The attributes of Coach: experience, sport diplomatic influence, motivation**.**
The attributes of mood of the team:

- good (the players attend the training, they meet each other in private life, there are regular out-of-work activities with family members, there are constant fans),
- medium (the attendance of the training is enough, there are no common activities, few fans),
- bad (unsatisfying attendance of training, there are no common activities, there are no fans),

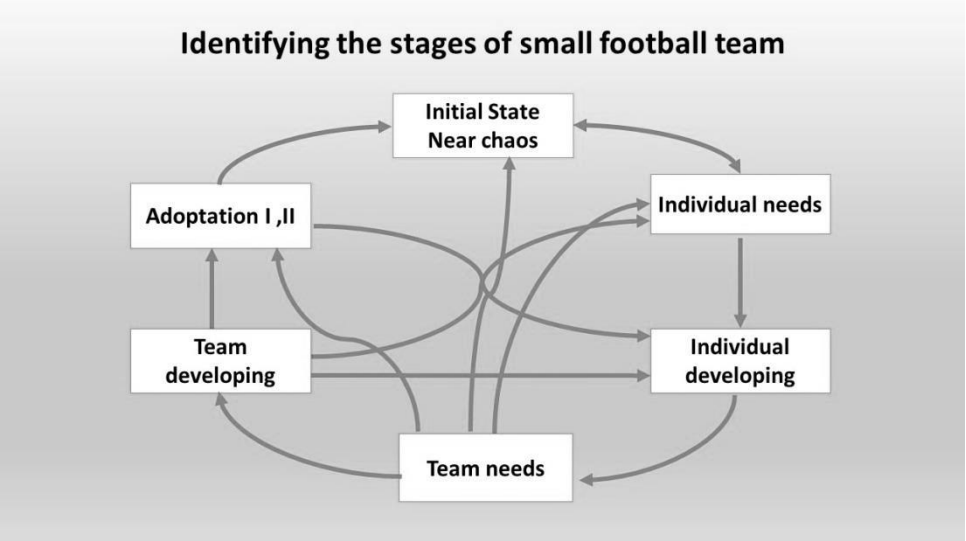

Figure 1. Stage diagram of the small soccer team.

The attributes of tactics of the team:

- good (Technical elements exist and consider the opponent's peculiarities),
- medium (Technical elements exist, but there are no adaptations to the opponent yet),
- bad (Technical elements do not exist – only individual solutions).

IDENTIFYING THE COMPLEX SYSTEM STAGES AND TRANSACTIONS BETWEEN THEM

In the initial stage will be listed all attributes of the system agents separately. In the following sections, only possible changes are shown.

Stage: Initial state – Near to chaos (season 2005/06 autumn, see Figure 1).

At the beginning of the observation, the team is on the edge of disruption. Coach motivation is very low.

Players:

- age: the average age of players 26 years,
- experience – more years,
- motivation – medium,
- position in the team – there are no positions defined for single players.

Coach:

- experience – high,
- sport diplomatic influence – high,
- motivation – low.

Team mood: Medium.

Tactics: Bad

The driving force behind transition: The old coach leaves the club. The most experienced player takes on the coach's role.

The new coach:

- experience – little,
- sport diplomatic influence – little,
- motivation – extremely high, the aim is to win the championship.

Stage: Individual needs (season 2005/06 – spring, see Figure 1)

The new coach transforms the team into the new state. The championship begins. The coach starts the training. Repairs the general mood with the increase of the quantity of the running and starts to map the players' motivation. Tries to develop smaller groups inside the team (forwards, defenders, midfielders, goalkeeper – according to the players' claims). Player's motivation increases. The team performance is good in the championships, they can surprise their opponents.

Stage: Individual developing (season 2006/07 – autumn)

During the season the coach tries to change the motivation of the players. Based on a unique survey, makes a personal workout plan. As a result, the motivation of some players improves, but the team's events are missing.

Stage: Team needs and Individual needs and Initial state (season 2006/07 – spring)

The coach's experience increases. The average age of players is growing (no new players). The coach tries to transform the posts within the team according to the team needs, so the motivation of the players is deteriorating, but the team's tactical repertoire increases. Some players are leaving the team. The team is near to chaos again.

Stage: Team developing and Individual needs and Individual developing (season 2007/08 – autumn)

Involving young talented players into specific posts within the team. The average age of players decreases. Because of the new players, motivation in the level of the team is reducing. The team score is moderate.

Stage: Adaptation I and Individual developing (season 2007/08 – spring)

Tactics level increases – adaptation to the opponent. The atmosphere is excellent. Motivation is appropriate. The team leads the championship, but another team is eliminated, and the points scored are recalculated. The coach has a low degree of sports diplomacy, so after the recalculation, they finish in the second place.

Stage: Adaptation II and Individual developing (season 2008/09 – spring and autumn)

Team tactics level increases – adaptation to the opponent. The atmosphere is excellent. Motivation is appropriate. The team is leading the championship, the changing in the rule of sending the referees does not affect the team negatively because the coach has a high degree of sports diplomacy, the team wins the championship.

Stage: Near to chaos (again) – Season 2009/10

There is a significant change in the coach's life: he has a new job and the old team members are no longer motivated. Some key players take advantage of success, transferring to other teams. This results in a drop at the tactical level. The coach leaves the team, no new young players arrive, a new coach is to be chosen. Return to the initial state.

CONCLUSION

Sport is not only a social phenomenon in our world but also a true bank of experiments in human behaviour. It provides an opportunity to study effectively and efficiently the effects of intensive change in complex life systems at many levels (psychological, social) [26]. On the

one hand, the study of complex systems in sport might lead to a better understanding of evolutionary processes, optimization of resource extraction/allocation, and economic transactions; strategies for economic and ecosystem resilience and sustainability [27]. Analysis of factors influencing performance, motivation and determination can often be understood through interactions (synergies) [8]. For example, a player's performance depends not only on his own knowledge, his team role but also on the state of the receiving environment.

The observed system undergoes many macro changes, see Figure 2. Because of the inefficiency, increasing tension forced the actors to change roles: From player to coach, as well as from individual player to team member role. Despite the initial stumbling block, the coach's experience grew, and the quality of the player's motivation improved. However, they did not consider that the opponent also learned their playing style, since they were built on simple elements from individual solutions. The breakthrough was finally brought by the evolution of team attributes. They were already able to adapt to the circumstances at the team level, to adapt to their opponents [28]. The collapse began on the one hand with the loss of motivation and became complete by an external factor. This could have been avoided so that a resource must be maintained to maintain development. For example: develop an assistant coach then team is not so dependent on one person.

In summary, studying the complex systems of sport can bring some specific and general benefits. On the one hand, it can help improve sports and human performance by creating new strategies for teams and coaches. Improved understanding of human social networks, including player psychological drivers and group participation; developing a policy of participation in sport and education of young people [29]. The principles governing these group interactions are expected to apply to other biological collectives, where dynamics derive from a mixture of competition and physical principles [1, 30, 31]. These include superorganisms such as ant colonies birds and penguins [14]. Because of the potential for obtaining rapid empirical feedback on formal models, the modelling of sport-related phenomena requires particular attention from the point of view of science and complex systems theory [30]. Sophisticated sciences can contribute to changing the mechanical view prevalent in sport and can usefully contribute to understanding complex systems.

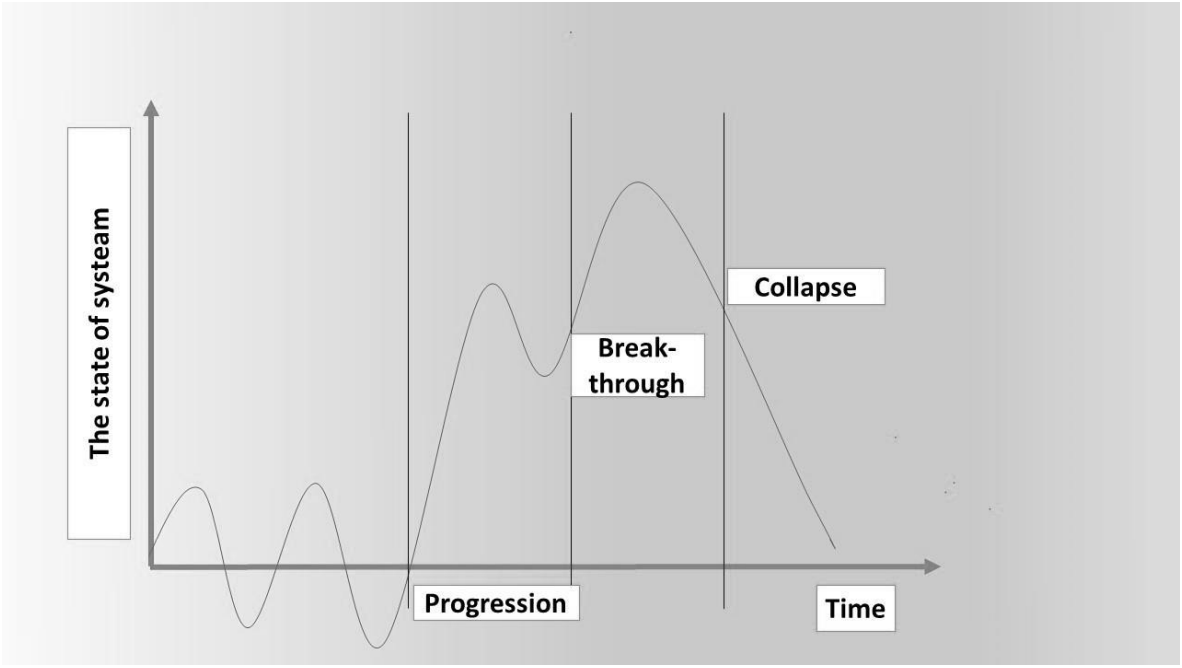

Figure 2. System macro changes (decreasing or increasing its performance).

LIMITATIONS AND FUTURE WORK

In this research, the development of only one team has monitored during the observed period. However carefully selected the parameters of the coach, the players and so on, some important attributes may have been missed depending on the special circumstances. In the future, this research would extend to more teams, other sports and more parameters. Future challenges include the influence of key control parameters on the non-linear behaviour of team-environment systems and the possible relationships between dynamics and constraints that affect team sports on different spatial-temporal scales.

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