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SPECIAL ISSUE

Structure and dynamics of European sports science textual contents: Analysis of ECSS abstracts (1996–2014)

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Abstract
The article discusses general structure and dynamics of the sports science research content as obtained from the analysis of 21998 European College of Sport Science abstracts belonging to 12 science topics. The structural analysis showed intertwined multidisciplinary and unifying tendencies structured along horizontal (scope) and vertical (level) axes. Methodological (instrumental and mode of inquiry) integrative tendencies are dominant. Theoretical integrative tendencies are much less detectable along both horizontal and vertical axes. The dynamic analysis of written abstracts text content over the 19 years reveals the contextualizing and guiding role of thematic skeletons of each sports science topic in forming more detailed contingent research ideas and the role of the latter in stabilizing and procreating the former. This circular causality between both hierarchical levels and functioning on separate characteristic time scales is crucial for understanding how stable research traditions self-maintain and self-procreate through innovative contingencies. The structure of sports science continuously rebuilds itself through use and re-use of contingent research ideas. The thematic skeleton ensures its identity and the contingent conceptual sets its flexibility and adaptability to different research or applicative problems.

Keywords: *Dynamical systems, modelling, analysis*

Introduction

The annual European College of Sports Science Congress is one of the biggest sports science events in the world. It routinely engages between 1000 and 3000 participants each year, including an ever-increasing number of participants from other continents. This makes it a true representative of the state-of-the-art and the development of the world sports science. Sports science as any science is a multilevel phenomenon. Many factors (such as financial, organizational, ideological) influence its development. However, it is always the research done and published or otherwise communicated that is the final and most important product out of that complex multilevel web of influences. European College of Sport Science (ECSS) abstract base is an ideal source of the textual content of such scientific products. Abstracts are condensed, minimally redundant, but sufficiently rich textual units that contain the most important information on the conducted research. Such textual contents open for the investigator the secret and not-so-secret world of researchers' inspirations, doubts, problems, beliefs and preferences. In short they reveal, although partially, the semantic world of researchers or research groups. These texts may be a valuable source of information for psychologists, sociologists, historians and philosophers of sports science. Such research may reveal important information about the structure, principles, contexts and the dynamics that channelize the walk of science products. One of the most influential, but typically latent content of science texts are, so-called, themes. Akin to music themes they shape and mould the more idiosyncratic lines of

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musical expression informing about the more basic states of creator's mind. In the following text, we make a brief discussion on the main properties of themes, their types and scope of use, and connect them with one of the most important concepts in dynamic systems – collective variables.

Themes and collective variables

In a series of publications, Holton (1965, 1973, 1975) developed the notion of themata (themes) in order to give an account of the psychology and history of science growth other than purely epistemological ones such as: the inductivist, falcificationist, conventionalist, instrumentalist and paradigmatic reconstructions of scientific growth offering along the way a reconciliation to Lakatosian (Lakatos, 1971) dichotomies of external (e.g. sources of inspiration) and internal (e.g. normative epistemological criteria) history of science. In some sense, as Holton himself explained many times, themata, being orthogonal to the theoretical preferences which can be corroborated or falsified, ensure their long-term persistence. They take often, but not always, a form of contrary dualities (e.g. continuity vs discreteness). Oppositions between themata may persist during long periods of 'normal science' but they may persist through revolutionary periods (e.g. the theme of continuity of space–time survived the relativity revolution; the duality of continuum-discreteness persists in quantum field theory). Already several decades before his first papers on this topic, thematic analysis was developed in other sciences, such as political science, that currently encompasses a vast number of science disciplines – in particular, Social sciences and Humanities. Along the process, the original notion of themes was substantially enriched. Usually, under the notion of thematic analysis, a vast body of research is being conducted seeking for essential thematic hubs of scientific or other sources of experience and meaning networks. Aside from their role as persistent metaphysical assumptions, in science, such themes may take more mundane versions, for example, forms of an object and/or problem of research, concepts or methods of research. As said above, one of the crucial properties of Holton's themes is their persistence in time. Themes survive for long periods and new ones rarely appear. They are mostly insensitive even to such dramatic events in science such as paradigmatic revolutions of the type that Kuhn (1962) describes.

This aspect of long *temporal persistence* of themes is especially relevant for our investigation because it is reminiscent of one equally important property of dynamic systems: collective variables. In these systems in the vicinity of, so-called, critical points, a separation in time scales of the dynamics of constituting components occur. Some of them become long-term acting components or collective variables and the rest fast-evolving components, which quickly *adapt* to and *follow* the behaviour of the long-term acting ones. Hence the system divides itself on, at least, two levels and a hierarchy between *guiding* and *guided* entities is being established. In the approach of Synergetics (Haken, 1983), these processes are known as 'slaving principle'. The long-term acting components enslave the behaviour of fast components and govern them. Conversely, as the slaved components act in a way the long-term acting components dictate, they actually contribute to the further stabilization of the latter. This effect is known as a *circular causality*. Hence a macroscopic collective variable starts to guide the behaviour of components and these stabilize the former. The occasional, contingent, fast-changing, components become *dependent* on the collective variable. Their behaviour becomes *conditional to* the behaviour of collective variable (Haken, 2000). In the stable regime, this continues to be the way in which the system stably performs.

It is tempting to identify the corpus of themes defined as temporally persistent contexts with the notion of collective variables as defined above. Both thematic body and collective variables have a role of a global context that guides the more contingent and short-lived entities. The contingent conceptual entities being guided in fact become dependent on the global context and conversely stabilize it. In other words, texts and their meanings produced in time may be conceived as dynamic systems. Over the time, a structure of science topics and subtopics is being formed. The main aim of present paper is to detect the current topical structure of sports science, discuss the dominant integrative trends and offer a possible way of general understanding of the dynamic processes that shape, maintain and dissolve its semantic world. In the text that follows, we will first try to define this structure and then to discuss the general dynamic properties of the sports science topics.

Methods

Data

The basic material for our analysis consisted of a total of 21998 (95% of) ECSS Congress abstracts produced over 19 years (1996–2014) generously provided by European College of Sports Science (Sportools GmbH Cologne). These abstracts were coming from 12 science topics and were ordered in a year-by-year fashion forming the basic data for further processing. Starting from 20 original science topics, some of the topics did not contain a sufficient number of textual units and consequently lacked a sufficient text basis for a meaningful Alceste analysis to be feasible. Also, majority of them had a discontinuous occurrence over the years, which disabled us to treat on equal footing all science topics in the dynamic analysis. Taking these limitations into account, the Alceste textual analysis software was used to provide information for obtaining the basic structure of sports science and possible integrative tendencies and a textual material for the dynamic analysis.

Structural textual analysis

Alceste textual analysis methodology (Reinert, 1998) was used to extract the dominant textual content from the abstracts. Alceste methodology is based on assumption that the speaker or writer, for example, a sports scientist or sports science group, during generating the discourse, for example, writing the abstract, is creating successive meanings and these meanings thereby impose a specific vocabulary. In other words, the speaker or writer creates his own lexical world or semantic field. Alceste methodology is trying to uncover these lexical worlds through several steps of text mining and statistical analyses by using the descendent classification of text segments (Reinert, 2003). The analysis provided pooled over 19 years descendent classification results for all 12 topics. The 12 descendent conceptual classifications obtained for each of the 12 science topics for a total of 19 years was used as a basis of interpretation of the sports science structure.

Dynamic textual analysis

The upward hierarchically classified concepts obtained by Alceste software were automatically extracted for each year (1996–2014). Hence, in total, for each of the 12 topics, results were obtained.[1] Two experts from Sports sciences agreed upon the types of terms that had to be excluded from the further analysis. Too general terms (e.g. decrease, drop, increase, data, university, "et al." study, introduction, method, result(s), significant, signal and use (using)) which were abundant in the vocabulary analysis were excluded from further analysis. These terms, especially methodological ones, were saved for other investigation that will be published elsewhere. Also, the non-scientific syntactic terms (i.e., adjectives, auxiliary verbs, propositions, indefinite and definite articles, infinitive terms and alike) were excluded from analysis, to enable a clear set of scientific vocabulary used in these areas. Also, specific muscles and muscle groups which were abundant were lumped together with the term muscle(s). We did the same procedure with the synonyms such as speed–velocity. These concepts were then used to form 12 Boolean $m \times n$ data matrices for each of the 12 science topics, where m signifies the number of concepts and n the number of years (Casari, Sander, & Valencia, 1995; Gogos et al., 2000; Joliffe, 2002). By pure observation of the structure of the data matrices, the existence of two types of concepts was detectable: concepts that were persistent over the whole 19-year period (long-term acting concepts) and concepts that were much less recurrent (short-term acting concepts). In other words, the data matrix contained concepts stable on the time scale of 10s of years and short-term concepts with characteristic time scale of years. *Collective variables* were then determined by principal component analysis principal component analysis (PCA) of each of the 12 science topic matrices (Jirsa, Friedrich, Haken, & Kelso, 1994). The Kaiser–Guttmann criterion (eigenvalue $\lambda \geq 1$) was used to define the number of salient principal components (PCs) of first order. The hierarchical analysis of oblique principal components hierarchical Principal Component Analysis (hPCA) (Fabrigar, Wegener, MacCallum, & Strahan, 1999) was then performed in order to check for existence and obtain a maximal dimensional reduction of the data (for the hPCA analysis, the software package Statistica 5.0. was used).

The main difference in the use of PCA in ordinary structural statistical analysis and its heuristic use in dynamic systems is in the dependence relations between the PCs explaining the dominant part of the variance and others that do not. While in its ordinary use there is no dependence relation whatsoever, in dynamic systems the PCs explaining negligibly small per cent of variance, that is, possessing small eigenvalues ($\lambda < 1$), are formally *dependent* on the system of PCs with higher eigenvalues ($\lambda \geq 1$). The coefficients of PCs satisfying $\lambda \geq 1$ are called order parameters (Haken, 2000, 1997; Levi, Schanz, Kornienko, & Kornienko, 1999). Hence, in the context of text analysis, salient PCs may be treated as long-term *guiding* common thematic patterns and the rest of the principal components as *guided*, short-lived and more unique conceptual patterns.

The identification of the dynamic structure of concepts divided on themes, subthemes (science topic specific themes) which persisted on time scale 10s of years and contingent-specific concepts (time scale of recurrence of a few years) was performed by summing the principal component scores weighted proportionally by eigenvalues of corresponding PCs. Long-term persistent component scores had high values on more than one first-order PCs and they formed the thematic core acting as a bridge between different PC contents. High values of component scores on more or all of the extracted PCs generated correlations among the primary principal components and lead to a further dimension reduction. Hence, themes defined as hubs (spread among subtopics of a scientific discipline or even wider) and long-term active concepts were subject to objective extraction from the data. In this sense, the highest order PCs may be defined as a common or *collective thematic skeleton* on which more detailed sub-thematic and contingent unique concepts represent the shorter-term properties of scientific research practices. The relationship of the interpreted subtopic structure given on Table I and the dynamic thematic analysis based on Boolean matrices (Table II) were the common concepts found in the descendent and the ascendant hierarchical Alceste classes. However, the Alceste classification is based on orthogonality assumption of extracted classes while the hPCA is not.

Results

Structure

On Table I the structure of topics and subtopics in Sports science is presented as revealed by the Alceste textual analysis of the descendent conceptual classes. The diversity of Sports science may be seen on more than one level first; one can see that there is a relatively wide distribution of the number of subtopics with Training and testing followed by Sports medicine and Orthopaedics and Nutrition showing the largest number of very strictly defined subspecialty areas.

Table I. Sports science topics and subtopics (% of textual units)

Biomechanics	Motor learning
1. Kinematic video-analysis (technology and methods) (39%)	1. Methods of motor learning (35%)
2. Neuromuscular–biomechanical nexus research (26%)	2. Electrophysiological muscle function analysis (methods and technology) (14%)
3. Sport technique and skill analysis (23%)	3. Neuromuscular – motor control research (14%)
4. Non-invasive muscle structure and function analysis (methods and technology) (12%)	4. Information-processing approach to motor learning (13%)
Coaching	5. Dynamic systems approach to motor learning (12%)
1. Biomechanical testing of motor abilities (29%)	6. Motor learning pedagogy (12%)
2. Physiological functional testing (26%)	Physiology
3. Performance analysis (18%)	1. Physiology and anthropometry in team sports (30%)
4. Physical preparation and training (14%)	2. Cardio-respiratory function (26%)
5. Sociology and philosophy of coaching (13)	3. Cell physiology (26%)
Health and fitness	4. Neuromuscular physiology (18%)
1. Body composition and motor abilities testing (25%)	Molecular biology and biochemistry
2. Social and psychological approaches to healthy lifestyle (25%)	1. Functional genomics of muscle cells (66%)
3. Obesity epidemiology (23%)	2. Biochemical blood markers of adaptation to exercise (25%)
4. Biochemical blood testing (14%)	3. Biochemistry of muscle cell adaptation to exercise (9%)
5. Functional cardio-respiratory testing (13%)	Physical education and pedagogics
Nutrition	1. Motor abilities testing (26%)
1. Sociology and psychology of nutritional practice (25%)	2. Pedagogy of coach – player communication (26%)
2. Methodology of research in nutrition (18%)	3. Physical education in schools (20%)
3. Skeletal muscle cell biochemistry of nutrition (18%)	4. Social and health aspects of physical activities (16%)
4. Carbohydrates and exercise (14%)	5. Testing methodology (12%)
5. Nutrition of power performance (13%)	Sociology
6. Nutrition and bone health (12%)	1. Sport policy and governance (35%)
Psychology	2. Body (movement) culture (25%)
1. Social psychology of sport and exercise (33%)	3. Sociology of physical activity (19%)
2. Mental preparation of athletes (28%)	4. Sport media research (11%)
3. Methodology of psychology (20%)	5. Statistical methods in sociology (10%)
4. Exercise psychology (19%)	Training and testing
Sports medicine and orthopaedics	1. Biochemical testing (18%)
1. Biochemical testing (22%)	2. Neuromuscular testing (16%)
2. Cardio-respiratory testing (22%)	3. Technique analysis (16%)
3. Sport injury prevention (16%)	4. Performance and motor abilities analysis in team sports (14%);
4. Biomechanical testing (15%)	5. Methodology of testing (11%)
5. Sport injury treatment and rehabilitation (13%)	6. Anthropometric and body composition assessment (9%)
6. Sport injury and illness epidemiology (12%)	7. Cardio-respiratory function assessment (9%)
	8. Age-related physical activity research (7%)

On the other end is Molecular Biology and Biochemistry defined by three also highly specialized subtopics. Another characteristic is the existence of overlapping subtopics as evident in Training and testing, Sports medicine and Orthopaedics and Coaching, but each one focused on different aspects defined by the topic. Yet another distinguishing characteristic is the existence of subtopics defined by multiple criteria. In most topics, they are specific data-acquisition/analysis techniques and tools, intervention practices, objects and problems of inquiry but in Motor Learning one can detect two theories as separate subtopics.

Concerning the issues of integration, two modes of integrative tendencies are clear in sports science (Figure 1). The first one, *multidisciplinary*, arises when the area of integration (the black oval) is a problem or object (phenomenon) of research or applicative intervention and more than one theory, data-acquisition and analysis technique or mode of inquiry are used to attain the solution (shown by converging arrows). This is a kind of many-to-one mapping logic. The other one is what may be titled as *unificatory integration* in which the area of integration is, for example, a theoretical framework, data-acquisition and analysis techniques or a mode of inquiry which are being used in diverse problems and objects (phenomena) of research and practice. In short it is a one-to-many mapping logic.

From the results of Alceste methodology, given in Table I, in a condensed form, we could extract the following main structural properties: (1) There are multidisciplinary (many-to-one mapping) as well as unifying (one-to-many mapping) tendencies in sports science; (2) Few topics may be classified as mono-disciplinary with respect to the phenomena they study (physiology, biomechanics, molecular biology and biochemistry). However, even these topics are multidisciplinary with respect to data-acquisition techniques and tools and concepts they use. (3) Most sports science topics are *methodologically* multidisciplinary with respect to the diverse data-acquisition tools and techniques (instrumental multidisciplinarity) used in same science topic; (4) Most sports science topics are *methodologically* almost unified with respect to the mode of inquiry (overwhelming presence of inductive-statistical mode of inquiry (Salmon, 1971) and simultaneously almost invisible use of Deductive-Nomological or Deductive-statistical mode of inquiry (Hempel, 1965). However, these modes of inquiry exist implicitly in biomechanics, physiology and biochemistry in a form of analytical mechanics, fluid dynamics and transition state theories. This state of affairs, on the other hand, does not provide a theoretical integration with respect to the general understanding of the vast set of phenomena inquired in sports science; (5) Theoretical unificatory tendencies were to a degree also detectable some through a line-to-line reading of text units produced by Alceste (e.g. each of the three theories: Achievement goal theory, Dynamical systems and Information-processing theories are visible in single sports science topics such as: Coaching, Motor Learning, Physical Education and Pedagogics, as well as Training and Testing). However, this depends on the concrete problems and objects of research.

Types of integration offered by research activities in points (2), (3), (4) and in some respects (5) may be called a *horizontal integration* since it methodologically integrates sports science topics at the same level of analysis and inquiry modes (e.g. same data-acquisition tools and techniques as well as inductive-statistical models may be easily observed in several sports science topics). *Vertical integration* is also visible and mainly underpinned by the inductive-statistical mode of inquiry. For example, research of the influences of gene expression on some performance variables or of physical activity on the gene expression and lactate accumulation may be found through a more detailed analysis of text units generated by Alceste. However, any type of theoretical vertical integration was invisible, although authors of this research personally know some cases.

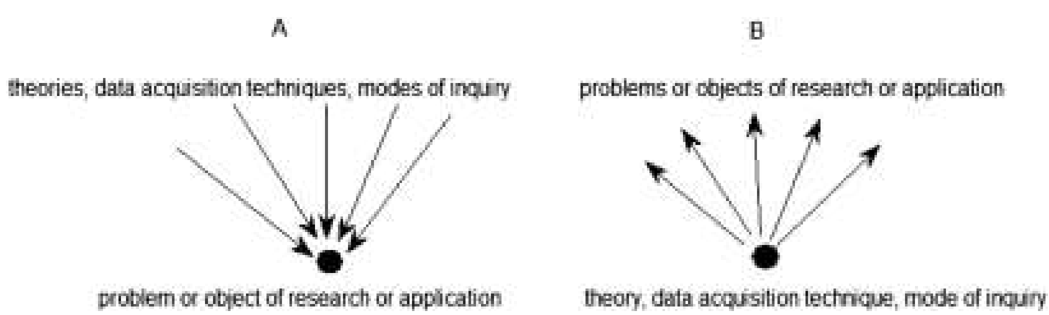

Figure 1. Two types of integration. (A) Multidisciplinary integration. (B) Unificatory integration.

Dynamics

The snapshot structure of sport science as revealed by the textual analysis is not timeless entity. The content of science topics and subtopics, the semantic worlds in Alceste terminology, vary and change in time. The hPCA revealed the following *general themes* (Table II): sport, perform(ance), train(ing), exercise, athlete(s), body, (physical) activi(ty),[2] that were present with high weights in all sports science subtopics. However, each of the 12 science topics was defined also by a set of highly weighted concepts that we call *subthemes* (Table II). Themes and subthemes formed the content of the second-order PCs for each sports science topic which can be named as *thematic skeleton*.

The dynamic systems approach, firmly rooted in formalisms of Synergetics (Haken, 2000, 1997; Levi et al., 1999), offers the following interpretation: The thematic skeleton, in fact, is formed by the long-term persistent concepts with characteristic time scale of persistence of 10s of years. However, large majority of concepts were with short-term persistence, that is, few years and then ceasing to be detectable (being off-the-radar of Alceste threshold). These concepts are specific adaptations, specifications of individual or group research ideas, contextualized by the long-term collective thematic skeleton. Conversely, these specifications, always refer to the collective thematic skeleton, ensure its stability and recurrence over the years. The long-term stable concepts, the thematic skeleton, form the equally long-term stable semantic world(s) of researchers that guides specific short-term research ideas/texts within the scientific topic as revealed by ECSS abstracts (Figure 2). For example, in Physiology, general sports science themes together with the long-term stable subthemes, for example, lactate, intensity, oxygen consumption and so on, are a part of the thematic skeleton, that guide and contextualize research ideas when semantically coupled with short-term, less recurrent, contingent concepts, such as altitude, eccentric, ski, female, health and so on. In Psychology, general themes coupled with long-term stable terms such as motivation, anxiety and group contextually guide the contingent, short-term active concepts such as male, coping, runner, children, age and so on. Note that if the thematic skeleton is different – for example, belonging to Sociological or Nutrition domain, then these same contingent concepts would be contextualized differently.

The analysis further showed that innovative (not detected in previous years) concepts and the lack of them in the subsequent year bring about fluctuations around the mean, long-term, correlation value of the yearly vocabulary vectors with the general thematic skeleton (Figure 3).

This behaviour represents an intermittent exchange of innovative and conservative, restoring, tendencies in the dynamics on the short-term yearly time scale.[3] In more detail, the balance between the short-term yearly influx of contingent concepts and the dissipation of some or all of them in the coming year leads to the formation of the mean value of the thematic skeleton (see also Figure 2). If the innovative concepts that decrease the correlation at the year they occur, remain in the next few years, that is, are not dissipated out, then they act partially as conservative forces that help to recover the system towards higher values. Innovations may become conservative by becoming more recurrent (attractive ideas) and hence become a part of the collective skeleton. In this way, research specializations and new research areas may be formed, by stabilizing the once innovative concepts and hence transforming them from short-term guided contingent into long-term active collective contextualizing thematic skeletons. It is interesting to note that while the influx of contingent concepts typically temporarily destabilizes the thematic skeleton, it actually provides its existence. The thematic skeleton cannot survive by itself. One cannot proceed doing a research based exclusively on thematic general concepts. The contingent concepts are those which enable it to manifest itself in novel research ideas and practices. The traditionally stable thematic skeleton (performance, exercise, sport, physical activities etc.) needs a more detailed, more contingent, novel aspects of research. Hence, the destabilization through conceptual diversification is a necessary condition for thematic skeleton's survival. That is how sports science's semantic world reveals itself as an open adaptive system. Openness enables a contingent influx of new ideas from which some are further incorporated and may, although rarely, become themes themselves. It dissipates others, again due to its openness. Adaptivity emerges from the synergy of the two properties: existence of a coherent thematic skeleton that provides it with identity and the diversity of specific contingent research concepts that provide it with flexibility and adaptability of research practices to detailed phenomena and problems.

The difference between the maximal value of the general thematic skeleton = 1 and the average correlation of yearly ECSS conceptual content measures the guiding strength of the thematic skeleton. The maximum value would correspond in case the conceptual content of yearly abstracts is identical to the thematic skeleton. The other extreme would signify the absence of long-term acting thematic skeleton. Conceptually, abstract texts would be so diverse

Table II. Thematic skeleton content by sports science topic

BIOMECHANICS		Effectiveness	8.20	Muscle	19.86	Control	18.34	Health	11.73
Force	25.08	Walk	7.94	**Physical**	19.38	Gene express	18.28	**Athletes**	11.58
Train	25.01	Program	7.44	**Perform**	19.12	Skeletal	18.01	Children	11.12
Angle	17.65	Programme	6.10	**Body**	18.58	Metabol	16.82	People	10.85
Velocity	16.94	**Activity**	5.97	Heart	18.44	Cell	16.77	Experien	10.15
Muscle	16.76	Develop	4.41	Cell	16.01	**Activity**	16.45	**TRAINING AND**	
Body	16.72	**NUTRITION**		**Athlete**	13.88	Type	15.30	**TESTING**	
Movement	16.67	Weight	22.77	Rest	12.66	Protein	14.77	Movement	21.42
Athlete	15.89	**Athletes**	20.83	Patient	11.72	Endurance	13.99	Gymnast	19.37
Sport	15.75	Enegy	20.59	Active	10.80	Muscle	13.96	Strength	18.69
Knee	15.49	Protein	18.68	Play	9.43	Regul	13.50	Maximal	18.67
Maximal	15.48	Intake	18.45	Factor	8.85	**Athlete**	13.19	**Athlete**	17.90
Perform	15.17	Ingest	17.64	**MOTOR LEARNING**		Blood	12.92	Speed	17.38
Jump	13.88	**Physical activ**	17.63	Task	24.00	Genotype	11.89	Power	17.25
Run	13.02	Muscle	17.60	Visual	21.54	CompartmenP	11.48	Intensity	16.85
Phase	11.60	Mass	16.87	Learn	21.44	**Perform**	11.33	Muscle	16.22
Position	10.88	Compartments	16.41	Motor	20.34	Gene	7.95	**Exercise**	15.94
Contract	9.68	**Perform**	15.80	Movement	18.04	Mitochondr	7.71	**Perform**	15.68
Joint	8.97	Body	13.96	Ball	17.50	Fiber	7.16	Sprint	15.53
Ankle	7.40	Blood	13.40	Control	16.37	**PHYSICAL**		**Train**	15.29
Exercise	5.75	Carbohydrate	12.93	**Phys activity**	16.23	**EDUCATION AND**		Run	14.87
						PEDAGOGICS			
COACHING		Supplement	12.13	Skill	15.26	Educat	18.66	Education	14.84
Athlete	18.54	Diet	10.02	Informat	14.31	Develop	15.80	**Physical active**	14.43
Perform	17.85	Rate	9.95	**Train**	14.27	Learn	15.52	**Sport**	13.86
Physical	17.64	Capacity	9.46	Muscle	14.15	**Sport**	14.00	**Body**	12.73
Train	15.12	**Train**	8.87	**Perform**	11.37	Coaches	13.94	Effectiveness	12.51
Aged	13.75	Player	8.14	Practice	10.14	Skill	12.58	Method	11.80
Game	13.59	**PSYCHOLOGY**		Play	8.98	**Physical**	12.30		
Develop	13.46	Psycholog	26.49	System	8.67	Social	11.63		
Exercise	13.08	Motivation	24.56	Force	7.53	Movement	11.15		
Speed	12.38	**Exercise**	20.48	Process	7.01	Age	10.84		
Play	12.17	Play	20.46	Velocity	6.49	Teacher	10.59		
Power	11.92	Group	19.60	**Sport**	5.91	Play	10.49		
Sport	11.42	Coaches	18.91	**PHYSIOLOGY**		School	10.42		
Run	11.12	Anxiety	18.74	Lactate	19.96	Motor	10.30		
Strength	10.97	Self	18.65	Intensity	17.97	**Activities**	10.25		
Team	10.75	**Athlete**	16.30	Oxygen uptake	16.92	**Perform**	10.23		
Jump	10.60	**Perform**	15.83	Rest	16.28	Children	8.38		
Body	10.60	**Physical**	14.82	**Train**	15.73	Game	6.75		
Coaches	9.09	Task	13.97	Blood	15.73	Ability	6.21		
Maximal	8.00	Cognitive	11.95	Work	14.56	Practice	6.14		
Velocity	7.55	Development	11.75	Maximal	14.29	**SOCIOLOGY**			
HEALTH AND		Orientat	10.06	Heart rate	14.25	Group	23.14		
FITNESS									
Weight	21.44	Team	9.24	**Activity**	12.25	Develop	20.36		
Train	20.64	Support	9.22	Concentr	12.17	Club	19.47		
Strength	19.55	Attent	9.11	**Perform**	11.72	Football	18.08		
Exercise	18.98	**Training**	8.07	Rate	11.70	**Activity**	17.39		
Risk	17.64	Skill	7.49	**BODY**	11.70	**Physical**	17.07		
Perform	17.51	**SPORTS MEDICINE**		**ATHLETE**	11.70	National	15.77		
		AND							
		ORTHOPAEDICS							
Health	16.83	Rate	28.38	Response	10.90	Play	15.03		
Body	16.64	**Train**	25.68	Run	9.77	Social value	14.96		
Fitness	15.77	Health	24.32	Recovery	8.62	School	14.84		
Muscle	15.45	Blood	23.57	**Exercise**	7.94	Educat	13.31		
Mass	14.51	Control	22.13	Power	7.93	Gender	13.06		
Physical	13.96	**Exercise**	22.09	**MOLECULAR**		Particip	13.04		
Sport	12.62	**Sport**	21.98	**BIOLOGY AND**		**Sport**	12.75		
				BIOCHEMISTRY					
Intervention	11.46	Injury	20.51	Response	18.45	Women	11.99		

Notes: Concepts in bold are the general themes with the 20 highest weighted principal component score sums in all science topics. Other concepts form the subthemes for each science topic. General themes and subthemes together form the general thematic skeleton for each science topic.

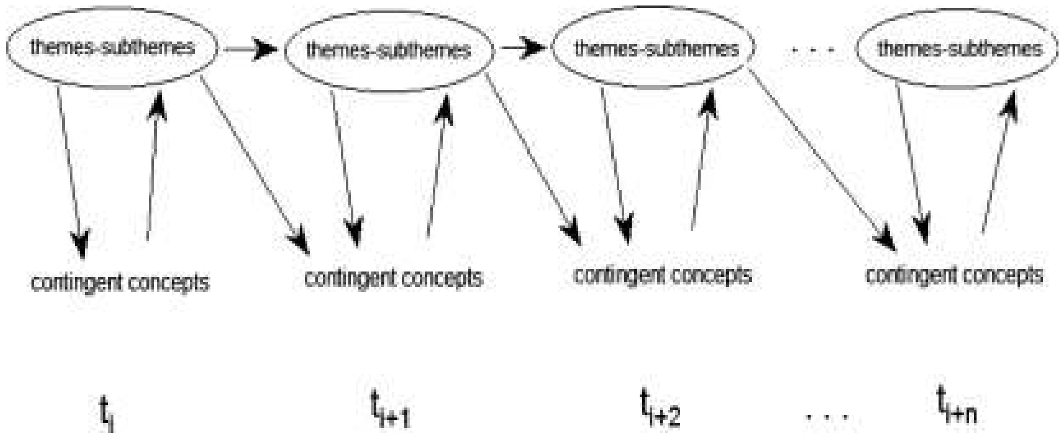

Figure 2. The circular causality of the sports science semantic world. Sports science general themes: sport, perform(ance), train(ing), exercise, athlete(s), body, (physical) activi(ty) together with subthemes specific for each research topic (see Table II) contextualize and guide (downward arrows) sets of contingent concepts, that is, specific research ideas as revealed by yearly ECSS abstract contents. Conversely, sets of contingent concepts by referring to themes-subthemes stabilize them (upward arrows) and ensure the researchers' semantic world survival in the subsequent years.

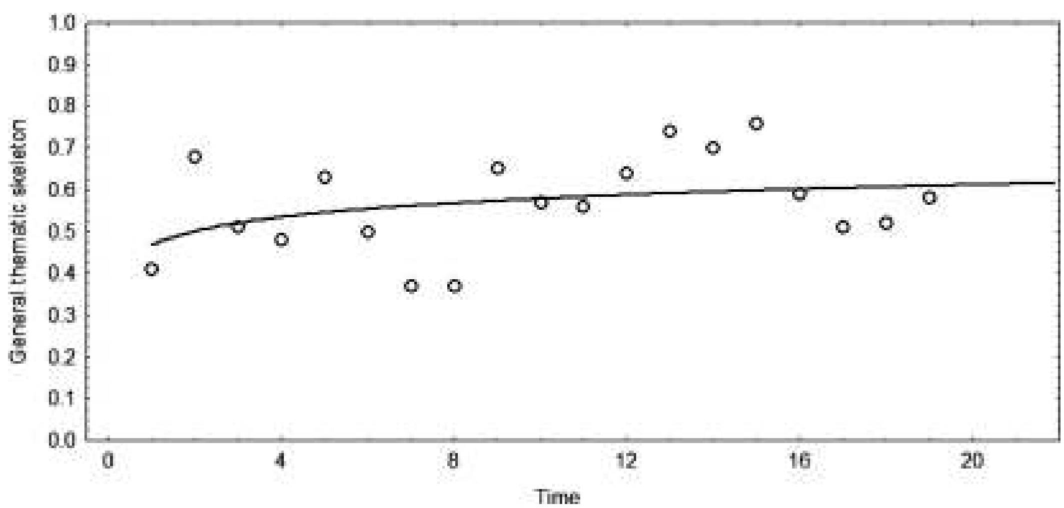

Figure 3. An example of short-term (yearly) correlation, that is, loading, fluctuations and the long-term (decades) mean (bold line) of the thematic skeleton. Yearly conceptual innovations in abstracts decrease the correlations from the mean value and the lack of them recover correlations toward higher values. Innovative and conservative forces compete and maintain the collective thematic skeleton.

Table III. From left to right in each row are given: the number of first-order PCs; V%: The per cent of explained variance by the first-order PCs and TS = Time mean value ± SD of yearly conceptual vector correlations (loadings) with the thematic skeleton

Biomechanics	**Motor learning**	**Physiology**
PC = 4; V% = 61.66; TS = .59 ± 10	PC = 4; V% = 52.26; TS = .52 ± 11	PC = 3; V% = 63.38; TS = .64 ± 12
Health and fitness	**Sociology**	**Molecular biology and biochemistry**
PC = 3; V% = 59.23; TS = .59 ± 10	PC = 5; V% = 49.92; TS = .43 ± 11	PC = 4; V% = 57.17; TS = .52 ± 17
Nutrition	Sports medicine and orthopaedics	**Training and testing**
PC = 2; V% = 50.60; TS = .59 ± 06	PC = 4; V% = 54.14; TS = .52 ± 19	PC = 4; V% = 58.43; TS = .53 ± 09
Physical education and pedagogics	**Coaching**	**Psychology**
PC = 5; V% = 55.69; TS = .46 ± 13	PC = 4; V% = 53.15; TS = .42 ± 23	PC = 4; V% = 58.46; TS = .57 ± 11

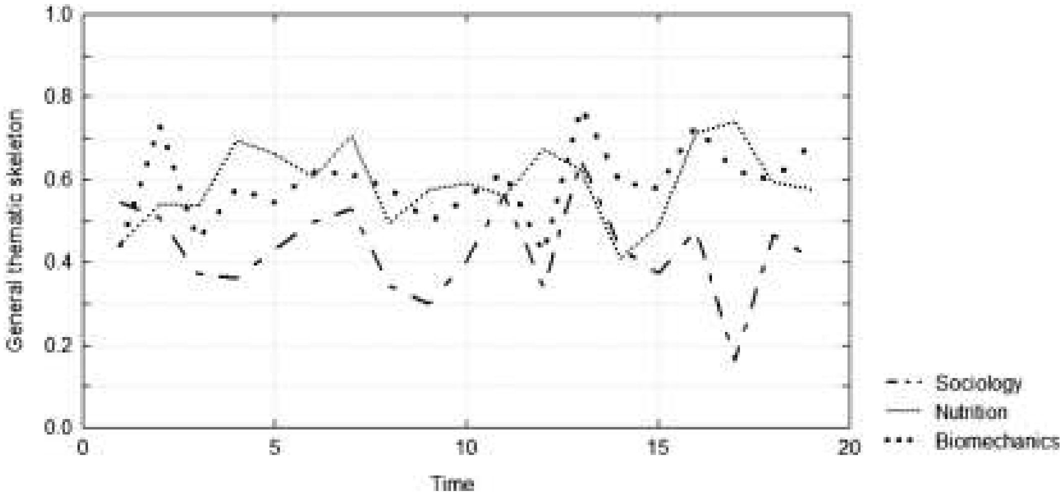

Figure 4. Loadings, that is, correlations, between yearly conceptual vectors (Time) with the general thematic skeleton. Sociology has lower mean value in comparison with Nutrition and Biomechanics, showing larger tendency to autonomy and a weaker thematic skeleton control of its subfields. On the other hand, Nutrition and Biomechanics show the opposite behaviour. See Table III for information concerning all science topics.

that no temporal persistent thematic structure could be detected.

Sports science topic thematic skeletons reside in-between these extremes. One can see from Figure 4 and Table III that there is a difference between different science topics with respect to the strength of their thematic skeleton. Physiology, Biomechanics, Health and Fitness, and Nutrition show relatively stronger constraints in guiding the contingent-specific vocabulary, then are Physical Education and Pedagogics, Sociology and Coaching. The latter show a tendency towards forming conceptually weakly interacting autonomous areas of investigation while the former possess thematic skeleton with firmer grip on the detailed research topics. This picture is reminiscent of metastable adaptive systems (Kelso, 2012) where tendencies for integration and autonomy coexist. It is important to note that the *structure* of (sports) science maintains itself through self-re-creation in time. The structure is dynamic and continuously rebuilds itself through use and re-use of contingent research ideas.

Concluding remarks

The sports science is an unprecedentedly vast area of research with a structure of multifaceted multidisciplinary and unificatory integrating tendencies that spread both ways – horizontally and vertically. These tendencies are basically underpinned by the common thematic corpus at the level of phenomena, problems and methods of research. These thematic corpuses were modelled and interpreted dynamically as collective thematic skeletons. What the collective long-term thematic skeleton does is contextually guiding the short-lived and more detailed research preferences as captured by the less frequently occurring vocabulary. In a more general sense the thematic skeleton plays a role of a *historical* guiding context within which more detailed guided research ideas develop on individual and group level forming in such way micro-cultures or micro-traditions of science investigation. This leads to a self-regenerating, procreative historical thematic context. A procreation of historical research traditions through contingencies. The past reinvents itself into the future, but each time enriched with new unique details. A kind of repetition without repetition in Bernstein's (1967) terms. In our view, this is an important insight in the way how instrumental the circular causality is in coupling the contingent detailed scientific ideas and the thematic traditional body. Contingencies diversify but simultaneously procreate the more coherent macroscopic thematic context. No long-time theme persistence without innovative contingency and no coherence without diversity. A qualitative change in historically traditional research means a significant intervention on the thematic, guiding level. In this way the circular causality creates the synthesis between the thematic thesis and contingent anthithesis.

In fact, the processes based on circular causality described in this text seem to belong to much wider class of processes such as the emergence and temporal procreation of ideologies, fads, scientific paradigms, fashions. In all these phenomena it is the collective long-term acting thematic field that emerges and then contextualizes and guides the individual attitudes, preferences, prejudices, behaviours, and conversely, individuals or groups, parts of the larger society, by thinking, writing and publishing or behaving in the imposed way further stabilize and help in procreating the traditional historical ideological narrative, defined by their typical long-term persistent thematic skeletons. The demise of such long-term temporal structures also occurs when the thematic corpus starts to decay, when no longer contingent innovations ensure its future.

Yet another short note: The current text may be viewed as a text about the texts or a meta-text. Its reading in order to find its themes may reveal the existence of crucial *complex dynamic systems themes* such as: collective variables, circular causality, time scales, time hierarchies, synergy and so on contextualizing the discourse about science themes. This offers a unique opportunity of applying dynamic systems principles in the text analysis research in sport, especially in understanding the dynamic changing properties of more involved themes which cannot be defined as one-word-concepts, but are contextualized within larger structures such as narrations and stories. The dynamics of the *fields of meaning and experience* either individual or collective or both, would be the ultimate goal of such an endeavour.

To remain consistent to our complex dynamical system approach and especially the circular causality between the long-term, slowly changing themes and fast-changing research concepts we are prone to "predict"[4] the following scenario of development of the sports science: The bottom-up causality approach which is dominant at present will be probably *complemented* by top-down causality research in future. While at the moment the causal link goes from molecular biology and biochemistry (fast adaptive processes) to the level of performance, health and well-being (slowly changing processes), we envision that in future researchers will conduct a research asking, for example, how social values influence the gene expression and how the latter stabilizes the former. We "predict" that sociological, psychological and phenomenological methods will be mixed by gene expression methods in order to unravel the complex dynamic circular causality extant in every athlete seen as socio-psycho-biological system. The social, phenomenological, psychological … and molecular contexts and constraints intertwined, because the time, change and consequently dynamics are ubiquitous.

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Notes

1. Due to a limited space of this article, these large sets of Alceste and PCA results cannot be presented in detail. The authors are at disposal to interested readers to provide them with all specific results they are interested in.
2. Some of the mentioned general themes were not present in all sports science topics among the listed first 20 concepts but were anyway close to the top of the list.
3. The stochastic behaviour on the level of primary PCs is also interesting, but it would take much more space to comment on it. That is why we constrain ourselves to comment only the level of the secondary PC level that we call the general thematic skeleton.
4. Keeping in mind that, in human affairs, the best way to predict the future is to foster it.

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