

Science and Soccer

Second edition

Edited by

Thomas Reilly and A. Mark Williams

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Science and Soccer

Science and Soccer, second edition offers a unique, comprehensive and accessible analysis of the science behind the world's most popular sport, and important guidance on how science translates into performance. Fully revised and updated to include the very latest scientific research, it examines every key facet of the game, including:

- players' anatomy, physiology, psychology and biomechanics
- coaching and training methods
- nutrition
- injury prevention and rehabilitation
- soccer surfaces and equipment
- match analysis techniques
- growth and development in youth players
- talent identification.

Including contributions from leading international sport scientists with extensive experience in contemporary professional soccer, this book represents a unique resource for students and academics in sport science. It is also essential reading for all professional support staff working in the game, including coaches at all levels, physiotherapists and club doctors and sport scientists.

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1 Introduction to science and soccer

Thomas Reilly and A. Mark Williams

Introduction

Football is the world's most popular form of sport, being played in every nation without exception. The most widespread code is association football or soccer. The sport has a rich history though it was formalized as we know it today by the establishment of the Football Association in 1863. The game soon spread to continental European countries and later to South America and the other continents. The world's governing body, the Federation of the International Football Association (FIFA), was set up in 1904 and the first Olympic soccer competition was held 4 years later. The United Kingdom (UK) won the final 2–0, defeating Denmark, another nation playing a leading role in the popularization of the game. Uruguay played host to the first World Cup tournament in 1930. This competition is held every 4 years and is arguably the tournament with the most fanatical hold on its spectators and television audiences. So far, only seven nations have won the tournament – Uruguay, Argentina, Brazil, Germany, England, Italy and France. Whilst they may represent the top teams at elite level, the popularity of the game is reflected in the millions who participate in soccer at lower levels of play.

1.1 Development of sports science

In recent years, there has been a remarkable expansion of sports science. The subject area is now recognized both as an academic discipline and a valid area of professional practice. Sports science is well respected within its parent disciplines, for example, biomechanics, biochemistry, physiology, psychology, sociology and so on. A new maturity became apparent as the sports sciences were increasingly applied to address problems in particular sports rather than to sports in general. One of these specific applications has been to soccer.

The applications of science to soccer predated the formal acceptance of sports science as an area of study in university programmes. South American national teams used specialists in psychology, nutrition and physiology in the preparation of squads for the major international tournaments from the early 1970s. The comprehensive systems of scientific support accessible to Eastern European athletes since the 1970s dwarfed the commitments of Western countries to top-level sport. The gulf was notably wide with respect to British soccer, where the sports scientist was more often than not shunned or at best frostily welcomed.

In the 1980s, it became apparent that the football industry and professionals in the game could no longer rely on the traditional methods of previous decades. Coaches and trainers were more open to contemporary scientific approaches to preparing for competition. Methods of management science were applied to organizing the big soccer clubs and the training of players could be formulated on a systematic basis. In general, the clubs that

moved with the times were rewarded with success by gaining an advantage over those that did not change.

It has taken some years for the knowledge accumulating within sports science to be translated into a form usable by practitioners. Efforts have been made to compile scientific knowledge and expertise and make them more widely available to the soccer community. In recent years, the majority of professional soccer clubs have employed sports scientists in the quest for a competitive edge. The revision of this textbook is but another step in the direction of updating the relevant knowledge base.

1.2 Science and football

The First World Congress of Science and Football, held at Liverpool in 1987, represented a milestone in the application of science to football. The Congress embraced all the football codes, but a definite attempt was made to establish common threads between them. The broad aim was to bring together those scientists whose research work was directly related to football and practitioners of football interested in obtaining current information about its scientific aspects. Practitioners included players, trainers, coaches, managers and administrators. The list of Congress themes (Table 1.1) demonstrates the scope of topics that were communicated.

The Congress is held every 4 years under the auspices of the World Commission for Science and Sports (WCSS). This meeting at Liverpool was followed by the Second World Congress on Science and Football at Eindhoven in the Netherlands (1991), the Third World Congress at Cardiff (Wales) in 1995; the fourth event was at Sydney, Australia, in 1999 and the fifth event at Lisbon in 2003.

Many national governing bodies of soccer set up their own system of scientific support. Mostly, this was implemented through their sports medicine programmes. An example was the Football Association's National Training and Rehabilitation Centre at Lilleshall in the early 1980s. As the Centre was abandoned when the Football Academies took over the responsibility for nurturing soccer talent within the professional clubs, scientific personnel were appointed to the Academies. The development of the Academies was promoted by the Technical Department of the Football Association and reflected the perceived potential of sports science as a component of systematic support. This trend applied also to the science input to the world's ruling body, FIFA, which historically had been through the medium of its Medical Committee.

A consensus statement concerned with food and nutrition as they applied to soccer was approved at FIFA headquarters in 1994. The event marked another milestone in the progress of scientific information related to the game. A parallel within the Football Association was

Table 1.1 Congress themes at the First World Congress on Science and Football

Clothing and footwear	Structuring football skills and practices
Football surfaces	Physiology of training and match-play
Biomechanics of kicking	Nutritional factors in football
Computer-aided match analysis	Playing in heat or cold
Team management	Football at altitude
Group dynamics in match-play	Coaching the problem player
Decision-making by referees	The injury-prone player
Soccer violence	Post-injury fitness testing
Pre-match stress and performance	Strain in adolescent footballers

the launching of the journal *Insight* in 1997, the official publication of the Football Association's Coaches Association and the more systematic implementation of sport science support services to England international squads.

1.3 Academic programmes in Science and Football

The first academic programmes in sports science were studied in the UK in 1975. The background to and development of these undergraduate courses have been described elsewhere (Reilly, 1992). The disciplines included in the pioneering programmes were biology, biochemistry, physiology, biomechanics, mathematics, psychology and sociology. Contemporary programmes may incorporate economics, recreation, sport development, coaching and computer science but the major thrust of scientific method is maintained.

Whilst the professional preparation of coaches in some countries includes substantial components of sports science, the emphasis is firmly on coaching competence rather than intellectual skills. The first formal academic programme in Science and Football was offered at Diploma level at Liverpool John Moores University in 1991. The syllabus was dedicated to scientific subjects applied to football. The programme was extended in 1997 to a full-blown Bachelor of Science degree in Science and Football. Some of its core modules are shown in Table 1.2.

Formal academic activity is not restricted to undergraduate, or postgraduate courses. The University of Leicester set up its research unit in the 1980s to focus on sociological aspects of soccer. It was funded by the Football Trust and made a major contribution to the study of the 'football hooligan' phenomenon throughout the decade. Later on, in the 1990s, the University of Liverpool set up an MBA course dedicated to the study of football management: each Masters student must conduct a major research project relevant to contemporary soccer management. As the new millennium began, FIFA supported a European-wide Masters course which was directed towards the history of football and the involvement of a number of universities from various countries within the European Union.

The Research Institute for Sport and Exercise Sciences at Liverpool John Moores University supports an active programme of postgraduate research in scientific aspects of football. Most notable achievements elsewhere have included the award of a DSc degree for a thesis on physiological investigations directly related to soccer play (Bangsbo, 1993). In Sweden, as well as in the UK, there were instances of doctoral theses being shaped round physiological investigations of exercise, of the type that occurs in soccer (e.g. Balsom, 1995;

Table 1.2 Core modules for the
BSc (Hons) in Science
and Football (soccer)

Core programme

Applied sciences and football
Performance analysis in football
Ergonomics of football
Mental training for football
Physiology of football
Skill acquisition in football
Research project

Drust, 1997) and of the unique behavioural characteristics underlying expert performance in the game (e.g. Williams, 1995).

1.4 The field of study

Clearly, there are many aspects of science and soccer and plenty of subject areas which have benefited from scientific knowledge and know-how. These include the natural and physical sciences, the disciplines allied to medicine and the social sciences.

An ergonomics model of the application of science to the game itself is illustrated in Figure 1.1 (Reilly, 1991). It shows how the role of the scientist is to match the characteristics of individuals to the demands of the game. This is a complex problem in team sports where eventual success is determined by how the collection of individuals forms an effective unit. There are implications for fitness testing, training and player selection. The study of the organization of the entire group is also highly relevant.

Similarly, the prediction of performance is more difficult by far in soccer than in individual sports. In competition, success may be determined by choice of tactics of either team. There are also elements of chance that determine the outcome of critical events and tilt the balance of the contest. This makes even the most complex of game theories hard to relate to the outcome of a particular match. Nevertheless, match analysis can be approached from a scientific perspective.

The physical sciences provide insights into the nature and appropriateness of artificial pitches. There have also been applications to the design of shoes and evaluations of the need

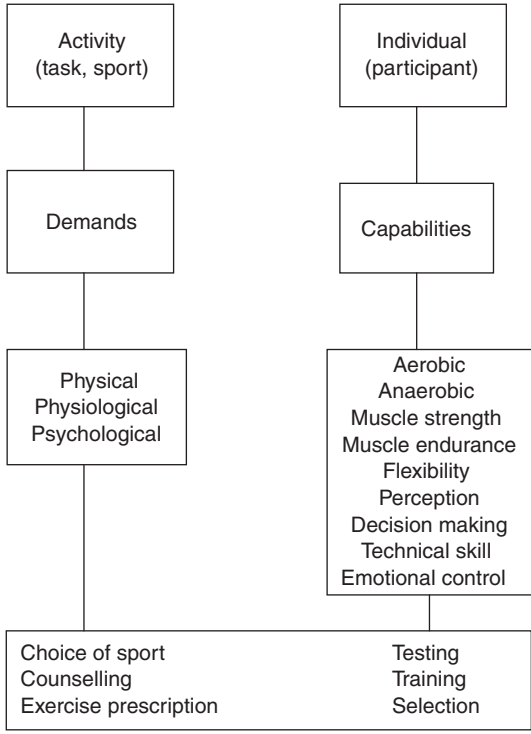


Figure 1.1 An ergonomics model of sports participation (modified from Reilly, 1991).

for protective equipment. Principles of biomechanics are relevant in considering prevention of soccer injuries. The physical sciences also embrace agronomy, the cultivation of grasses and the maintenance of playing conditions in cold and wet weather.

The widest field of application of sports science to soccer is probably apparent in the behavioural disciplines. The many opportunities for investigation include the study of crowds and their control, the management of large groups and the organization of personnel, the stresses on playing officials and on management of the clubs.

1.5 Soccer as an art

Followers of soccer frequently criticize the game as lacking creativity and flair. Some critics may go so far as to blame use of scientific methods by soccer teams for lack of entertainment. Underlying these points is the fact that soccer at top level has an obligation to entertain the viewing public but financial rewards to the players often depend on their securing victory. Consequently, fear of failure to win may motivate players to err on the side of caution and emphasize defence rather than attack. The negative emphasis on preventing the opposition from playing to its strength may leave the 'fans' disenchanted.

The coach and trainer may use scientific information to avoid errors and to maximize the chances of preparing the team well. The style of play and choice of tactics are judgements made by the coach on the basis of the best available information about one's own team, the opposition and the playing conditions. The scientific support may be utilized to guide the right course for the practitioner and so in no sense is science taking over control of the game. What is unarguable is that at elite level, soccer is played at a faster tempo than in previous decades, and players are better prepared all-round for performing their roles.

The professional soccer player is comparable with the actor in that hours of practice or rehearsal underpin the preparation for public performance. The expertise of the player or actor is judged largely on a subjective basis by a critical audience of the public event. Spectators at a soccer match differ from the theatre audience in that their perceptions of the event are mostly partisan and their passion is more overtly expressed.

That soccer itself is an art rather than a science is exemplified by the craft of great players like Zinadine Zidane or Brazil's Rivaldo, the erstwhile guile of Diego Maradona, the precision of David Beckham or the speed of Michael Owen. The game is aleatory and is partly determined by chance or strokes of individual genius. This uncertainty of outcome is part of its appeal.

A scientific approach towards preparation for play can nevertheless enhance the enjoyment of both players and spectators. It can achieve this goal by enabling the team to play to its potential. This realization of possibilities can apply to the recreational player participating for pleasure, or the professional playing for material reward. It can apply to the parents gaining satisfaction from watching talented offspring at play or to the home supporter whose zeal may border on passion and prejudice. It is this microcosm that is subjected to scientific scrutiny in the chapters that follow.

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