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## Science and football: evaluating the influence of science on performance

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### Abstract

The scientific study of football has its origins in the early research completed in the 1970's. Since these early efforts the available scientific knowledge base related to football has developed substantially. The ability of this scientific information to influence practice in the day-to-day activity of football organisations, especially elite teams, has been largely taken for granted. The close examination of this impact can lead to more uncertainty regarding the usefulness of the scientific data to the sport. Few articles are available that have attempted to critique the link between science and football practice. As such, the aims of this article are 2-fold; (i) to examine the historical background to "science and football" and to analyse the influence of sports science research on the current practice of coaches and practitioners within the sport and (ii) to identify potential ways to increase the influence of scientific research on practice in the "real world".

**Keywords:** football, research, applied practice

### Introduction

"Science" and "football" are not terms that would intuitively be linked together by a substantial number of individuals. Success in football is frequently explained by the "artistry" of both managers and players. As a consequence, terms such as intuition, imagination, quick decision-making and personality are more likely to be associated with victories than any principles and processes associated with scientific investigation. Such popular explanations are, however, more likely to be related to the general myths and preconceptions that surround winning in professional sport in the minds of the majority, rather than any comprehensive explanation of the factors that may contribute to effective on-field performance. Despite football being classified as a traditional sport, it is not completely isolated from the potential of innovations to provide a competitive edge to both individual players and coaches in the search for a winning formula. It is this specific context that provides the basis for the relationship between science and football. The launch of this special issue of the *Journal of Sports Sciences* entitled "The Journal of Science and Medicine in Football" provides an opportunity to evaluate the relationship between science and football from both a historical and current perspective. Such

analysis also provides a platform for the consideration of the future direction of the link between the two areas. As such, the aims of this article are 2-fold: (i) to examine the historical background of "science and football" and to analyse the influence of sports science research on the current practice of coaches and practitioners within the sport and (ii) to identify potential ways to increase the influence of scientific research on practice in the "real world"

### Brief history of the "science of football"

The origins of science and football are difficult to trace back with a great degree of accuracy as a consequence of the difficulties in completing searches for material that precede the electronic cataloguing systems that we commonly use today. A large number of football-related research papers that still have influence today date back to the 1960's and 1970's, though these works may not be the earliest recorded. Papers from this time period include the seminal research work on movement analysis by Reilly and Thomas (1976) and the fundamental investigations on intermittent exercise completed in Scandinavia in the 1970's (Åstrand, Åstrand, Christensen, & Hedman, 1960). These research outputs were

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important not only for the clear fundamental information they provided on the topics in question but also for the inspiration of other generations of researchers in Europe and across the world to investigate the sport of football in more detail.

As the scientific knowledge base increased in relation to both the theoretical and practical understanding of the sport, there became a need to develop appropriate frameworks to facilitate information exchanges between the academics and the practitioners within the sport. The International Council of Sports Science and Physical Education responded to such needs by supporting the formation of sports-specific steering groups, under the banner of the World Commission of Science and Sport. The steering group for science and football was formed around 1986, with a remit to attempt to bridge the gap between theory and practice within football. Initial progress on this remit was achieved by both the successful completion of the First World Congress of Science and Football in Liverpool in 1987 and the publication of its proceedings. Other conferences in Eindhoven (1991), Cardiff (1995), Sydney (1999), Lisbon (2003), Antalya (2007) and Tokyo (2011) have followed similar formats ensuring that the opportunity for scientists and practitioners to communicate has remained. The success of these conferences in communicating information on a wide range of football codes resulted in the development of a companion series of events in 2008 specifically focussed on association football (soccer). The First World Congress of Science and Soccer was held in Liverpool in May of this year bringing together around 400 scientists and people working within the industry to discuss and debate current topics in the sport. Subsequent conferences in Port Elisabeth (2010) and Ghent (2012), as well as the planned event in Portland in 2014 have ensured that there remains a specific knowledge transfer opportunity for those parties who are purely interested in this sport.

Recent years have also seen the publication of sport-specific edited books (Reilly, Richardson, Stratton, & Williams, 2004; Williams, 2013) and special issues of journals (Maughan, Zerguini, Chalabi, & Dvorak, 2012; Williams & Drust, 2012). These publications can be seen to be reflective of the willingness of other organisations (e.g. publishers) to recognise the continuing maturity of the knowledge base about the sport. The availability of sport-specific information in these formats has also served the increasing number of educational programmes that have developed. The first formal university accredited educational programme related to football was developed by Liverpool John Moores University in 1991. Other "team sports" specific programmes now exist in universities in places as diverse as Australia,

Copenhagen and the Far East. The increased scientific understanding of football has also resulted in the transformation of the coach education programmes delivered by national governing bodies around the world. This contemporary approach has not just been focussed on the traditional technical/tactical coaching programmes delivered by these organisations but also new syllabuses focussed on sport science and medicine. Such qualifications have utilised research-driven curricula to underpin both the knowledge- and skill-based content given to candidates in a belief that such approaches will improve the quality of practice in high-performance environments and facilitate player development.

### **The influence of science on the modern game**

The preceding section, when analysed, is suggestive of a rapidly developing knowledge base that has moved to inform the actions and behaviours of significant individuals (e.g. coaches, players, medical staff, etc.). More focussed recent attempts to address specific real-world questions in dedicated applied research projects (e.g. Impellizzeri, Rampinini, Coutts, Sassi, & Marcora, 2004) have, in theory, further enhanced the integration of science and practice. Such observations suggest that the application of science to football is now accepted by practitioners without much question.

Evidence to support these views can be obtained by examining the approaches used by professional clubs and national associations across the world in the delivery of their performance programmes to players. The majority of the UK's professional soccer teams no longer rely on just the influence of the team manager, coaching staff and a limited number of medical personnel to influence the outcome of competitive matches. It is now far more common for clubs to operate with a more diverse range of sport science-related support staff who fulfil specialist roles related to the development of both the individual and the team. It is common that such staff span a spectrum of experience and educational qualifications from hugely experienced individuals with high-level qualifications to recent graduates in their first professional position. The preparation and organisation of training as well as pre-game, within-game and post-game strategies are all possible areas that are open to a scientific approach in the modern football. This information would include issues as diverse as travel arrangements, sleep schedules, pre- and post-game nutrition, warm-ups, cool downs, analysis of both technical/tactical performance and evaluations of the stresses and strains associated with match play. Science can also inform the strategies used to develop young players within the sport, be they recreational players or aspiring

individuals located within developmental programmes at professional and semi-professional clubs. It may also have a role to play in operationalising the organisational strategies and frameworks within which all the individuals involved in the club operate. Such a broad range of influence illustrates the potential for science to impact the player across the key areas that determine both an individuals and a team's performance.

The presence of specific staff within organisations is in itself not comprehensive evidence of the influence of scientific evidence on the day-to-day running of football clubs. While it is generally acknowledged that evaluating the impact of science in the "real world" is very difficult, it has been suggested by Finch (2006) that research must be accepted, adopted and complied with by athletes and sports bodies that it is targeted at to have impact. The "translational value", the extent to which research actually impacts behaviour at the "coal face" (Cushion, Ford, & Williams, 2012) would therefore seem to be an important consideration in judging influence. Evaluating such concepts is incredibly difficult, especially in organisations that are traditionally closed to the analysis of outside agencies. One approach that may provide an indication of the translational value of the research is a detailed examination of the available literature base. Close inspection of the aims of related research projects and their associated methodologies can enable informed judgements to be made as to the potential influence of the findings of such papers to impact issues that face practitioners. They can also be judged in relation to the sporting culture that exists within such organisations, as any support strategy/intervention, no matter how well designed or how strong in terms of rationale or scientific basis will not be used, if it cannot be easily assimilated into the existing environment (Finch, 2006).

No framework currently exists with which to comprehensively evaluate football science-related research especially that which relates to performance-orientated questions (Atkinson, Batterham, & Drust, 2008). Bishop in 2008 proposed an applied research model for the sport sciences. This model, while focussed on providing a framework by which research efforts may be better integrated and directed towards improving sport performance, can also be used to broadly classify the types of research that are available in the area. While a small number of studies are available that have attempted to evaluate the usefulness of specific interventions in elite competitive environments with top-class players, the vast majority of the available research is purely descriptive. The localisation of research publications at this level implies that the evidence base upon which practitioners can draw to support their activity is relatively small, as such descriptive

information may only be useful in promoting our understanding of what elite football populations not supporting the production of strategies that may facilitate improvements in performance. The direct translational value of the available knowledge from this research is probably also low, as the information is divorced from factors that may influence its application. Taken together, this evidence would suggest that it is unlikely that scientific data shapes and drives the design, planning and implementation of strategy in the real world as frequently as is envisaged by the academic community that produces the data. This may be the case even when allowing for the time lag that has been identified for the translation of research into routine practice in disciplines such as medicine (Sussman, Valente, Rohrbach, Skara, & Pentz, 2006).

Attempting to understand the reasons for this perceived lack of translational value will provide the framework by which strategies can be devised to improve the impact of science in the real world. It is clear that such situations will not be attributable to any one isolated factor. It is much more likely that the translation value of research is influenced by the complex interplay of a myriad of factors that may be altered as a consequence of either the specific research in question or specific aspects of the environment which is attempting the application. While simple issues such as the inaccessibility of peer-reviewed research articles to non-subscribers may, at a very simple level, influence the appliance of research, other factors seem worthy of introduction. Glasgow, Lichtenstein, and Marcus (2003) have suggested that the gap between research and practice can be a consequence of issues such as limited time and resources of practitioners, the insufficient training of these populations and/or the lack of feedback and incentives for use of evidence-based practice. Inadequate infrastructure and systems and/or organisations that are able to support translation of research findings into real world process may also be an issue (Glasgow et al., 2003). The epistemological beliefs of practitioners (e.g. the dominance of knowledge gained experientially over all other forms) that encourage the development of mental models that validate and acknowledge current and past activities as successful (Cushion et al., 2012) may also play a part. A dominant influence may also be linked to an inherent discrepancy between the motivating factors of researchers (to generate new knowledge) and applied practitioners (to improve performance and team/individual success) within their practice.

The purpose of scientific research is to produce new knowledge and new skills that can be used in society (Gibbons et al., 1994). This process is complicated by the broad classification of "knowledge" that is implicit in such definitions. Atkinson and

Nevill (2001) have suggested that scientific research within the context of sport and exercise sciences can be either “applied” or “basic”. That is to say that the approach to the research and the available knowledge that is generated is fundamentally affected by the perspectives of the research team and their approaches to generating and answering relevant questions. Such perspectives are shaped not just by personal experience and interest, but by external considerations that are relevant for any researcher’s academic career (e.g. the availability of funding, perceived requirement to produce research of high impact). As a consequence, researchers choices of project, especially if it is basic research, frequently leave them open to the criticism that the issues that they are studying are not directly relevant to practitioners in the real world as they are not pertinent to facilitating improvements in high-level performance (Abraham & Collins, 1998). This ambition is by far the major motivating factor amongst this population.

Research that is applied in nature is also frequently limited in its application. The limited access that scientists have to elite performers has led to individuals such as Bishop (2008) stating that a majority of the available applied research is purely prospective in nature. That is to say that it has come about as a consequence of data that is available as opposed to that which has been collected as part of a structured research strategy to promote understanding. As a result, the data available is frequently descriptive in nature and as discussed previously of little impact in the “real world”. “Effectiveness” research (projects that evaluate the impact of an intervention under real world conditions; Glasgow et al., 2003) would seem to be more important, as such projects are seen as fundamental to influencing applied practice (Green & Glasgow, 2006). Such studies in science are rare, as they are frequently replaced by more efficacy-related research (experimental investigations under optimal conditions with high degrees of control; Glasgow et al., 2003) within sport and exercise sciences, either through choice or necessity. The conclusions from such projects are undoubtedly beneficial to an understanding of football performance, yet are sometimes considered limited as a consequence of a failure to understand issues around implementation (Finch, 2006).

Implementation is associated with context. Context seems to be a crucial issue in the impact of scientific research on real world practice. While it is clear that there is some degree of generalisability from research studies, it is unlikely that the available data provides the best evidence for any given footballer(s) at a specific time point within a given environment (Bishop, 2008). The lack of context can also be illustrated by the limited amount of research that is actually completed within the competitive arena, a

consideration Cushion et al. (2012) believes will inherently restrict any application of data to high-level performance. The current failure to adequately investigate the efficacy of the translation of scientific football research into practice (Bishop, 2008) may however limit the extent to which such statements can be fully supported. The acceptance of the influence of tradition, emulation and historical precedence in professional football (Cushion, Armour, & Jones, 2003) would support the idea that context is a highly relevant consideration in determining what may and may not influence practice from a scientific perspective.

### **Promotion or relegation: enhancing the role of science in football**

The previous sections of this article have attempted to outline the development of the scientific literature base related to soccer. The content presented also provides an original evaluation of this research’s influence on the activities of practitioners within the field. It is suggested that the majority of the currently available research has a relatively limited impact in shaping the core principles of the operational procedures of football organisations, especially at the elite level. This relatively low level of influence would seem to be multifactorial in origin. It would therefore seem logical that any attempt to develop a strategy(s) to enhance the role of science within football should be concerned with a range of considerations. Issues that have the potential to bring the “real world” of practice and the scientific disciplines closer together would seem to be one group of factors that are important to include. The development of a greater level of understanding of the approaches to applied practice within the football industry by the scientist, and a better appreciation of the scientific methodology of developing, collecting and interpreting data within the practitioner community, would provide a platform for the creation of more mutually beneficial operational frameworks. The development of a new and more “integrated” knowledge production as a consequence of such strategy may enable research to be completed that better comprehends the complex practical and environmental challenges associated with effectiveness-focussed research. This would seem to automatically facilitate the translation of research findings into performance-based solutions thereby enhancing the impact associated with research outputs in the area.

Enhancing such an understanding in specific communities can be achieved through a process of education (Kolb & Kolb, 2005). Education, whether formal or informal in its organisation, is fundamental in enabling individuals to both challenge their existing views of the world as well as create novel, conceptual

and intellectual paradigms. Providing educational opportunities for both scientists and applied practitioners where it is possible to challenge their traditional epistemological beliefs would therefore seem important. The completion of these learning experiences may provide a basis for the development of hybrid philosophies of practice as well as a more effective application of the existing research models that are available within the subject area. Intrinsic to such approaches would be an awareness of the relative strengths and weaknesses of knowledge that can be generated via experiential approaches and that created using scientific methods. Such educational opportunities are not widely currently available in either traditional coach education or academic frameworks. The development of such innovative educational opportunities would therefore seem to be a crucial requirement if the application of science is to be enhanced within the sport.

A change in the frameworks used to generate new knowledge has the potential to also provide the stimulus for new research models for football-orientated research. Such additions to the available research models is only likely to occur as the application of these new learning approaches (discussed above) is consistently and formally applied to important research questions. Few publications are available that exclusively outline philosophical or practical approaches to developing research frameworks that can be used within the context of sports sciences. Bishop (2008) is one of the few available research articles that outlines a research model that is directly applied to sport and exercise sciences. The model proposes an 8-stage framework that can be used by individuals to build an evidence base to improve sport performance. The steps in the model are represented as discrete components of a research loop that is "bi-directional and iterative" (Bishop, 2008, p. 255). This allows for the accommodation of both unexpected findings within existing research projects as well as the development of new research directions from either acquired knowledge or performance innovations.

The model proposed by Bishop, provides an important starting point for understanding potential approaches to structure-applied sport science research. It may not, however, be completely applicable to the conceptual views associated with applied football science research articulated here. Though Bishop is clear in his view that his is not a rigid framework, his approach seems to place an emphasis on the importance of the completion of significant amounts of underpinning research prior to any attempts to complete projects that have the potential to directly impact on day-to-day activities in the real world. While this strategy clearly has a number of benefits (i.e. the development of comprehensive

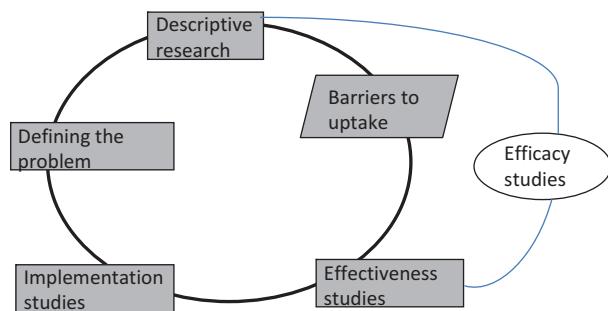


Figure 1. Schematic representing a revised research model (Bishop, 2008) for football science. The model attempts to illustrate the important steps involved in completing football-related research projects. The emphasis here is on the early investigation of important practical issues such as barriers to uptake and the completion of effectiveness research studies.

theoretical understanding of concepts) it may unnecessarily compartmentalise the research process into fundamental and applied work. This will result in an extension of the timescale associated with the production of research projects that are practically focussed. Bishop's views on the requirement for efficacy studies, in the truest sense, may be especially problematic as the completion of this type of research will clearly take substantial time and produce output that may not significantly impact in either of the applied environment.

Figure 1 represents an attempt to revise Bishop's original model. The overarching aim of this amendment is to attempt to refine the broad concepts included in the earlier model to enable a more direct and streamlined approach to "real world" research to be made. These refinements centre on an earlier focus on examining barriers to uptake and a withdrawal of the emphasis on efficacy, as opposed to effectiveness projects. The model is also underpinned by the importance of the implementation of reporting structures such as the Consort statement or REAIM wherever possible in research studies. The inclusion of the additional information on the design and procedures associated with the data collection suggested in these documents can only improve the understanding and interpretation of an investigation's outcomes. Such additions will not only be important in "the now" as mediators of the results of research projects but also as a crucial influence in the design and development of future applied projects.

## Conclusions

The development of the scientific understanding of football has progressed substantially in the last 30–40 years. This can be clearly evidenced by both the increase in scientific outputs related to the sport as well as the development of scientifically orientated

positions within elite football organisations. Despite these developments, it can be suggested that the influence of the scientific information that is available has a relatively small influence on the day-to-day activities within the “real world” of football. This limited influence is probably a consequence of a range of factors that relate to the inherent differences between both scientists and practitioners and the variables that drive their actions. The later sections of this article have attempted to present some ideas as to how the influence of scientific research can be promoted within the “real world”, especially elite football. While this content is clearly based around the informed opinion of a very small number of individuals, there is no direct evidence that such measures, even if implemented, would actually improve the ability of science to influence practice within sport. If it is accepted that current approaches are largely ineffective then it would seem to be logical to follow Bishop’s (2008) suggestion that the individuals working within a research area may as well try something different. This philosophy of innovation reflects that demonstrated by the pioneering fathers of football research. As such, it represents a time-honoured strategy in developing the field of science and football that will serve the discipline well in the future.

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