



Diversity of scoring, ingenuity of striking, art of flying — conceptual and systematical identification of soccer scoring techniques

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Abstract

The terms of soccer scoring techniques (SSTs) used in practice and research have been remaining confusing; even dramatic, we still do not know how many SSTs available for the game. This scenario hinders not only the scientific studies on some unique SSTs but also the development of novel coaching methods for learning these SSTs. The current paper aims to bridge the gap by establishing a SST terminology system. The system is built based on goal repeatability, selected anatomical & biomechanical parameters, and analyses of 579 attractive goals from international professional tournaments. The results have revealed that there are 43 SSTs existed in current soccer practice. Some SSTs can be identified by preliminary parameters (i.e. anatomical parameters, the ball vertical position at the shot and the hit-point on the ball), but most of them need additional biomechanical examination on the movement control in frontal & transverse planes, jumping control, and trunk orientation at shots in order to identify uniquely. Further, the new SST terminology has disclosed that soccer attractiveness is linked to the diversity, ingenuity and artistry of shots. The most attractive type of scoring awaited by millions of spectators is aerial shots. Lastly, the most important contribution of the new SST terminology system is to help researchers and practitioners launch target-orientated studies that would provide a practical and convincing scientific coach-method, clear definitions, and means to reevaluate and improve SSTs in practice.

Keyword: scientific-based training system, biomechanics, anatomy, goal repeatability, aerial shots.

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INTRODUCTION

Soccer is without question the world's most popular sport and, globally, is played and watched by more people than any other sports [1, 2]. The simple objective of soccer games is to score goals, but goals are difficult to achieve. In average there are less than 3 goals per game in FIFA world cups since 1960's, many ended with zero goal [3]. Due to the rarity, soccer goals are extremely fascinating for millions of fans. Hence, the various means for gaining goals can be thought of as an improvised drama, where emotional tension is built over long periods only to be fully released when a goal is achieved [2]. This characteristic could be the unique and great attraction of the most popular sport in the world. Since various soccer scoring techniques (SSTs) are the last destination determining the outcome of every "emotional drama", the relevance of mastering various SSTs is obviously an essential core of soccer coaching and training; of course, it is also a focus of scientific research on soccer [4-6].

To establish a science-based training system needs first to know how many SSTs available. Unfortunately, no one currently knows the answer. As such, the names/descriptions of SSTs used in practice and research have been remaining confusing [7-9]. Various documentations and reports employ some impressive words, e.g. "acrobatic", "epic" and "cheeky", to describe the unnamed and/or unclearly-identified SSTs, which have creatively performed by elite and/or talented athletes. For example, the jumping side volley has been repeatedly misreported as a bicycle kick [7-9], however, the former is a side-kick technique and the latter is an overhead-kick skill. For avoiding such a confusing description, some professional soccer leagues, e.g. La liga (Spain), Bundesliga (Germany) and Premier League (England), indistinctly label the both kicking techniques as an acrobatic skill [7-9]. Additionally, some breathtaking goals achieved by applying these two techniques have been selected as epic volleys or cheeky goals of the last decade in Premier League [10, 11]. This vague scenario hinders not only the scientific studies on some unique characteristics of SSTs but also the development of novel coaching methods for learning these SSTs.

Comparison to the popularity of soccer, the scientific understanding of SSTs lags far behind its practice [12, 13], with most participants acquiring skills through individual experience rather than research-based instruction [2]. The lack of science-based SSTs' training in the present soccer practice is multifactorial. It is no doubt that there is no concept structure for a systematical identification of SSTs is the main hindrance. A SST terminology system is definitely required to help the research and analysis of SSTs for the purpose of documenting and promoting consistent usage in both research and coaching practice. It is clear that, to avoid variation and/or confusion between research and coaching, SSTs have to be clearly defined, i.e. a structured set of concepts and their designations in the SST research and application.

Consequently, the current paper aims to bridge the gap and to promote scientific SST research & training through accomplishing the following objectives:

- to structure a terminology system, in which a proper and unique term will be linked to a SST with clear identifications of the influence factors of the SST. This point is essential if the quality of a SST is to be achieved, especially to bridge the gap between research and coaching practice.
- to enable the established system for creating new terms, as required. This point is relevant for the sustainability of SST research & training. It should be noted that, in practice, SST collections may well contain not only standardized terms and concepts, but also innovative, vague and unstructured conceptual and linguistic information.
- to formulate bi-linguistic terms for both researchers and practitioners. Terms of SSTs are inextricably linked with motor-control knowledge and hence with special body-control languages for purposes of effective motor-learning.

In short, the establishment of the thesaurus-type SST terminology serves not only for current and future SSTs' identification but also for research and innovative development of coaching and training systems.

MATERIAL AND METHODS

Concepts in SSTs' identification

It is wise to begin a framework by examining the fundamental elements existing in soccer practice, especially in the professional soccer leagues. The first concept came from FIFA (Fédération Internationale de Football Association) Puskás Award [14]. The award was created in 2009, to honor the "goal of the year" (i.e. the "most beautiful goal" of the year). This would encourage and promote aesthetically significant goals, as such it would spark the creativity of athletes to perform various SSTs in soccer games. Based on FIFA award criteria ("The goal should not be the result of luck or mistakes by the other team" [14]), every goal (i.e. a SST applied) is clearly repeatable (i.e. entrainable). Therefore, the 1st concept in the establishment of SST terminology is repeatable/entrainable.

It is well known that any part of the body can be used to score a goal except for the arm or hand. Usually, players use foot or head for scoring. But, theoretically, goals could be obtained by all allowed segments. Identification of SSTs should consider all possibilities. Further, previous studies have revealed that accuracy and power are two basic elements of shooting quality [3, 15] and the segmental contact-point with the ball at a shot affects the accuracy considerably [2, 4]. Hence, both segment and its contact should be considered in definition of SST terms, i.e. the 2nd concept is anatomical parameters.

Soccer shots, like many complicated human movements, are trained motor skills. Studies have demonstrated that systematic & scientific inquiry into the biomechanics of human motor skills has a great potential to demystify complicated human motor skills for learning [16-18] and to provide means that maximize performance success and minimize the risk of injury during training [19-25]. Accordingly, analysis of biomechanical parameters that influence the soccer shot control would supply evidences to distinguish one SST from the other. Ergo, the 3rd concept is to select biomechanical parameters for identification of SSTs.

There are two levels in soccer world: amateur and professional [26]. The two levels are dependent on each other. On one side, amateur soccer focuses on fundamental skills training as a leisure activity. On the other side, elite program provides advanced/high-level training for professionals, attracting and inspiring young players. It should also be mentioned that the move from amateur status to elite may happen at different ages. However, from the point of motor-learning view, the control elements involved and the degree of difficulty are remarkably different at the two level training, and learning of some highly complex motor skills requires talent [27]. In order to make a feasible SST terms for training both grassroots and elites, the identification is also done at two levels: preliminary (covering basic parameters for shot control) and advanced (covering parameters for complicated 3D movement control). Thence, preliminary-vs-advanced is the 4th concept. The last concept is, for some one-time-identified SSTs, to perform further exploration (i.e. case-identification) in order to make sure that the identified rare SSTs are repeatable/entrainable (Table 1).

Selection of data sources and data

The data source is the public big-data bank YouTube, which contains millions of soccer-game videos. In order to obtain an authorized, reliable and representative samples for analysis, the following criterions were applied in the data selection:

- Only high-quality videos with movement details were within the scope of sample selection.
- Soccer's flagship tournaments, such as the FIFA, UEFA (Union of European Football Associations), and professional national soccer leagues with international reputation (i.e. La Liga/Italy, Premier League/England, Bundesliga/Germany), were considered.
- At international level, nominated-goals for awards and top goals of seasons available were chosen.
- At national level, either the top-last-decade goals were opted or keyword-search was applied for the selection. The keywords' selection were commonly found in media reports, such as acrobatic goal, volley goals, epic goals, cheeky goals, stunning goals and outrageous goals.

Table 1. The professional data sources and the collected elite soccer goals.

Search	Data Source		Goals
1 st selection	FIFA [33]	Nominees of Puskás 2009-2019	110
	UEFA [34]	Top 10 season goals of Champions League, 2014/15 – 2018/19	50
		Top 10 season goals of Europa League, 2014/15 – 2018/19	50
	La Liga [35]	Top 20 volley goals of the last decade	20
		Top 20 acrobatic goals of the last decade	20
		Top 20 lob goals of the last decade	20
		Top 20 headers of the last decade	20
		Top 20 solo goals of the last decade	20
		Top 20 long-distance goals of the last decade	20
		Top 20 free kick goals of the last decade	20
		La Liga Skills – Rabonas	2
	Premier League [36]	Outrageous outside of the boot & trivela goals	18
		Stunning acrobatic, overhead & bicycle kick goals	28
		Epic volleys	25
		Cheeky Goals	20
		20 great team goals	20
	Bundesliga [37]	Top 10 best acrobatic goals of the last decade	10
		Top 10 best volley goals of the last decade	10
		Top 10 most cheeky goals of the last decade	10
		Top 10 no-look goals since 2000	10
Top 10 best free kicks of the last decade		10	
Top 10 headers of all time		10	
Top 10 best long-range goals of the last decade		10	
Top 10 best team goals of the last decade		10	
Additional selection	Chest [31]	11 chest goals that make you satisfied	11
	Taekwondo [38]	TOP 25 Greatest Goals of Ibrahimovic	25
Total			579

Table 1 includes the sample data collected by applying the search criterions. There were only three cases appeared once: a chest goal and two taekwondo-style goals [28-30]. For verifying if these 3 goals could be repeatable, additional searches focusing on the three type goals archived by elite soccer stars were performed. For the first case, keywords “chest goals” was applied for an additional search. It did turn out that elite players like Messi has achieved chest goals in professional competitions [31], but the goals could not identified by the selection criterions listed above. For the other two cases, a targeted search was performed, focusing on soccer star Ibrahimovic. Ibrahimovic is few players who have also trained in taekwondo [32]. After the additional search, all types of goals have confirmed their repeatability.

Motion analysis and parameters' selection

The collected data were biomechanically analyzed (i.e. multi-segment model [39, 40]). The commonly-applied reference system in sport practice (Figure 1) was used for the motion analysis. As mentioned in concepts' section, the video-based motion analysis focused on anatomical parameters (i.e. ball segments and their contact-points with the ball at shots) as well as biomechanical parameters (i.e. ball dynamic position, segmental controls and their coordination). In combination with results of previous biomechanical studies on various soccer shots [2, 4-6, 18, 41, 42], the dominant control-parameters that would characterize various SSTs would recorded for further distinguishing one SST from the other. These selected anatomical and biomechanical parameters were also applied for defining terms of SSTs.

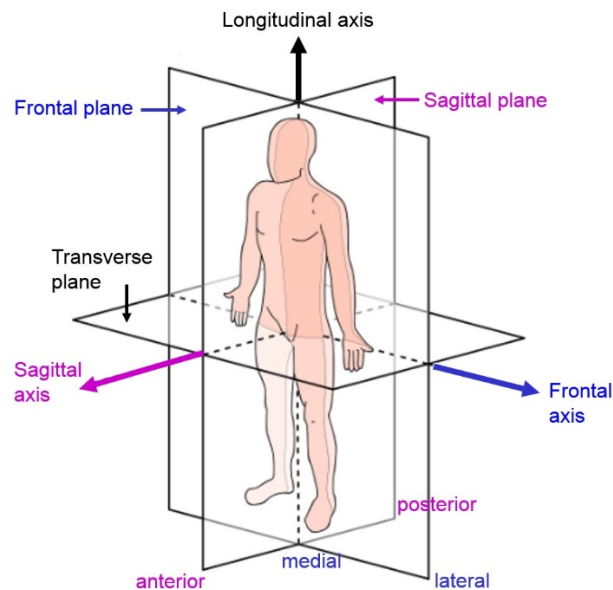


Figure 1. The reference system for data analysis and SSTs' identification.

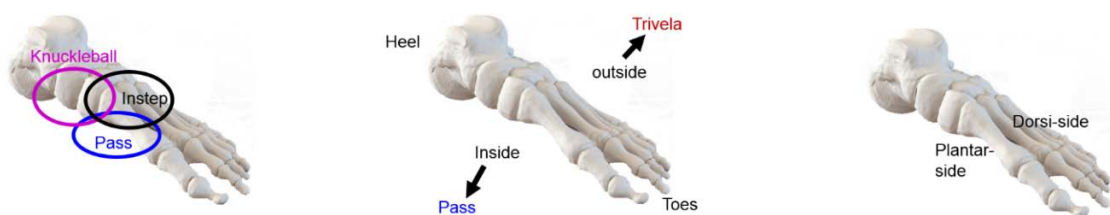


Figure 2. Foot anatomical landmarks that can be applied for kicks and exemplars of popular terms linked to some of the landmarks. Please note that there are overlaps among instep kick, pass kick and knuckleball kick. The last one is performed by few players, such as Cristiano Ronaldo and Gareth Bale [44]. This SST is famous for creating an unpredictable flying trajectory, known as a zigzag trajectory [45].

Identification of SSTs

SST terms is the main vehicle by which learning/training activities and research results/knowledge are represented and conveyed. It is well known there is gap between researches and coaching practice. In order to bridge the gap and establish unambiguous terms, the current study would introduce clear rules that would be easily used by both groups. These rules come from both movement science studies [2, 4-6, 41] and coaching practice [26, 43].

First, the default uses (i.e. no clarification word is applied in term definition):

- Soccer shooting mainly happens in sagittal plane with kick-leg forward-swing. Hence, the leg movement in sagittal plane is a default use in term definition.
- Upright position (i.e. vertical) and forward spin of the trunk during kicks are commonly seen, hereafter defined as default uses in term definition.
- Non-jumping shots are defined as default use.
- Non-head twist/turning is the default use in headers' definition.

Second, the general rules applied for the term definition:

- Preliminary parameters: These parameters are fundamental elements in term definition and, are inevitably used in every term definition. Through motion analyses of the selected data the following parameters are selected: ball-contact segment and contact point on

segment (i.e. anatomical parameters) as well as the ball vertical position at the shot and the hit point on the ball (i.e. biomechanical parameters related to soccer ball). There are two situations for the ball vertical position – ground or airborne, and three for hit-ball point – center hit, off-center hit & bottom hit.

- Advanced parameters: These parameters are only involved in performing complicated SSTs. In addition to control the preliminary parameters, players have to integrate more parameters into their motor control. Some of the advanced parameters, even a single one, are very difficult to be integrated into the preliminary control. Through motion analyses of the selected data, three advanced controls are identified: movement control in frontal plane & transverse plane, jumping control, and trunk orientation at shots. For movement control in frontal plane & transverse plane, there are five recognizable movements – the kick-leg crossing in front of the non-kick-leg, the kick-leg crossing behind the non-kick-leg, trunk twist, head twist, and foot eversion. Two types of jumping control – vertical jump and long jump – are recorded. Regarding the trunk orientation at shots, identified controls are tilted toward anterior (facing down), tilted toward posterior (facing up) and tilted laterally.
- The term definition should be inextricably linked with special/commonly-used vocabulary in practice, hence those special words widely-accepted in the practice are applied for the SSTs' definitions in the current article, e.g. inside-foot kick is defined as pass kick while outside-foot kick as trivela kick [36] (Figure 2). Pass and trivela are widely used in practice and media report. Another example is the airborne-ball kicks is defined as volley (regardless with or without rebounded). Further examples are bicycle, scorpion, chip/lob, diving, tap-in, knuckleball and rabona [35-37] Please refer to results for the parameters involved in these definitions.

Based on the above rules, some of controls and their contrary ones could be practically and clearly defined for a distinction. For example, If we apply rabona for “kick-leg crossing behind the non-kick-leg” (currently, the popular term for the control [35]), the opposite control element “the kick-leg crossing in front of the non-kick-leg” can easily defined as inward. A further example is the taekwondo-style kick (trunk twists backwards). Since the forward-twisting is default in term definition, the widely-recognized taekwondo term “turning kick” can be easily applied in the term definition.

RESULTS

Applying the introduced terminology system, we have identified 43 SSTs from the data collected. Table 2 contains both preliminary (uncolored) and advanced parameters (highlighted in green) that are linked to each SST definition/identification. Three segments (i.e. foot, head and trunk) have been found to be used for scoring. Actually, the ball control training in youth soccer covers practices using all the three segments [26]. The most variation used in shots is the foot. There are eight style shots that can be performed by the kick foot (column 2 in Table 2). Some SSTs are only influenced by preliminary parameters and are usually find in the training of young players [26]. Normally these SSTs belong to fundamental training. The poplar ones are max instep kick, pass kick, chip/lob kick, curl kick and header. The rarely trained ones are trivela kick and knuckleball kick. In total, there are 14 SSTs (names in black, column 8 in Table 2) can be trained by just focusing on the preliminary parameters.

Table 2. The SSTs identified in the collected elite soccer goals by using the selected anatomical and biomechanical parameters.

Anatom param		Biomechanical parameters					SSTs	
Seg	Seg part	BVP	HBP	MC in FP / TP	Jump	Trunk tilt		
Foot	Instep	G	C				(Max) instep kick	
				KL fore-crossing NKL			<i>Inward instep kick</i>	
				KL rear-crossing NKL			<i>Rabona kick</i>	
					m-l	<i>Tackle kick</i>		
		OC				<i>Curl kick</i>		
		B					<i>Chip/lob kick</i>	
			KL fore-crossing NKL				<i>Inward chip/lob kick</i>	
			KL fore-crossing NKL	V-jump			<i>Jumping inward volley</i>	
		A	C	Trunk twist				<i>Side volley</i>
				Trunk twist	V-jump	m-l		<i>Jumping side volley</i>
				V-jump	posterior		<i>Bicycle/overhead kick</i>	
							<i>Front volley</i>	
	Dorsi-side	A	B		L-jump		<i>Jumping front volley</i>	
					V-jump		<i>Jumping lob kick</i>	
	Inside	G	C				<i>Pass kick</i>	
		A	C		V-jump		<i>Jumping pass kick</i>	
	Inside-instep	G	C				<i>Knuckleball kick</i>	
	Outside	G	OC				<i>Trivela kick</i>	
			C	Foot eversion			<i>Foot flick</i>	
		A	OC				<i>Trivela volley</i>	
							<i>Trivela rebound</i>	
					V-jump		<i>Jumping trivela bound</i>	
			Trunk twist				<i>Turning kick</i>	
	Trunk twist	V-jump			<i>Jumping turning kick</i>			
	Toes	G	C				<i>Tap-in Kick</i>	
	Heel	G	C				<i>Heel kick</i>	
							<i>Heel rebound</i>	
A		C		V-jump		<i>Jumping heel rebound</i>		
			KL m-l swing			<i>Scorpion kick</i>		
Plantar-side	G	C		L-jump	anterior	<i>Diving scorpion kick</i>		
	A	C		V-jump	posterior	<i>Sliding kick</i>		
Head	Front	A	C				<i>Header</i>	
				Head twist				<i>Turning header</i>
					V-jump			<i>Jumping header</i>
				Head twist	V-jump			<i>Jumping turning header</i>
					L-jump			<i>L-jump header</i>
				Head twist	L-jump			<i>L-jump turning header</i>
					L-jump	anterior		<i>Diving header</i>
				Head twist	L-jump	anterior		<i>Diving turning header</i>
Trunk	Chest	A	C				<i>Chest</i>	
				Trunk twist				<i>Turning chest</i>
					L-jump	anterior		<i>Diving chest</i>

Anatom param: Anatomical parameters; Seg: Segment; BVP: Ball vertical position; G: Ground; A: Airborne; HBP: Hit-ball point; C: Center; OC: Off-center; B: Bottom; Mov in FP / TP: Movement in frontal plane and/or transverse plane; KL: Kick leg; NKL: Non-kick leg; V-jump: Vertical jump; L-jump: Long jump; m-l: medial-lateral

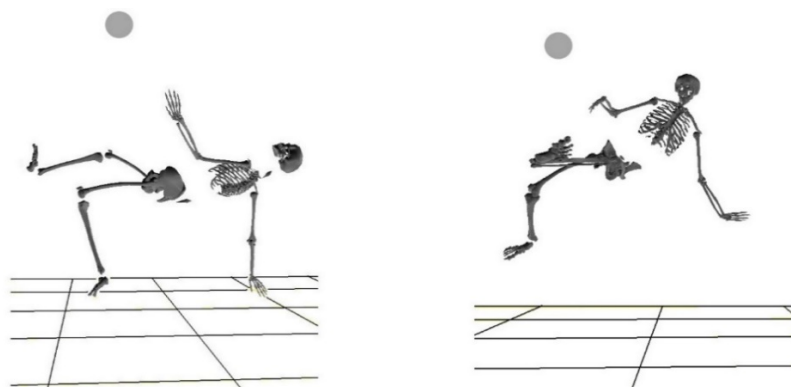


Figure 3. Three-dimensional motion analysis of bicycle kick (left) [18] and jumping side volley (right) [41].



Figure 4. The further breathtaking SSTs innovatively applied by elite athletes: jumping heel rebound (top, from La liga [35]), rabona kick (middle, from UEFA Europa League [34]) and jumping turning kick (bottom, from FIFA Puskás Award [33]).

Table 3. The number of goals achieved by each identified SST in the collected elite database

Level	Category	SSTs	Number of goals	Top 10 SSTs	
Preliminary (anatom para, BVP, Ball-hit, and movement control mainly in sagittal plane)	Ground-attack	Curl kick	39	#5	
		(Max) instep kick	37	#6	
		Knuckleball kick	27	#9	
		Trivela kick	19		
		Heel kick	9		
	Air-attack	Front volley	21		
		Trivela volley	6		
		Chest	4		
		Header	2		
	Both ground- & air-attack	Pass kick	32	#7	
		Chip/lob kick	26	#10	
		Heel rebound	7		
		Tap-in Kick	3		
		Trivela rebound	3		
	Advanced (complicated 3D movement control)	Ground-attack	Inward instep kick	43	#3
Turning chest			4		
Rabona kick			3		
Foot flick			3		
Air-attack		Bicycle/overhead kick	60	#1	
		Side volley	56	#2	
		Jumping side volley	41	#4	
		Jumping front volley	16		
		Jumping inward volley	13		
		Jumping turning header	13		
		Diving turning header	6		
		Long-jump turning header	6		
		Jumping turning kick	5		
		Scorpion kick	4		
		Jumping trivela rebound	4		
		Jumping heel rebound	4		
		Diving chest	4		
		Diving scorpion kick	3		
		Turning kick	3		
		Turning header	3		
		Jumping header	3		
		Jumping lob kick	2		
		Jumping pass kick	2		
		Jumping breaking kick	2		
		Long-jump header	2		
		Diving header	2		
		Both ground- & air-attack	Inward Lob kick	30	#8
			Sliding kick	4	
			Tackle kick	3	
		Total			579

Regarding the advanced SSTs, there are different number of influencing parameters involved. Some only integrate one advanced control into the preliminary control (e.g. inward instep kick and rabona kick), while others can incorporate 2 (e.g. bicycle kick and jumping turning kick) or 3 advanced control (e.g. jumping side volley and diving turning header) into the preliminary control (column 5-7 in Table 2). In total, there are 29 SSTs (names in blue, column 8 in Table 2) belong to advanced skills. Obviously, each of these skills has its uniqueness.

In order to get a better understanding of the new SST terminology system as well as its results, we have exemplarily chosen five unusual SSTs and their signature postures (Figure 3 and 4) for a visual illustration of the results and how the advanced elements are used in the terms definitions (Table 2).

Table 3 displays the grouping of SSTs (based on level and category), the number of goals achieved by each SST and the top 10 SSTs applied in the selected database. The results indicate that advanced air-attack includes the most SSTs, 22 out of 43. Among the top 10, half come from preliminary group and the other half from advanced group. Four SSTs out of the top 10 can be applied for both ground- and air-attack, three are for ground-attack only, and the other three can only make air-attacks. Bicycle/overhead kick and jumping side volley (Figure 3) are the top 2 most favorite/attractive SSTs from the view of both soccer experts and fans [33-37].

Further, Table 4 demonstrates the desire and expectation on the type of goals that soccer spectators are looking for. Generally speaking, goals achieved by air-attacks are the most exciting moments for them; and advanced SSTs bring more wonderful and memorable moments for them than the preliminary SSTs.

Lastly, regarding the anatomical parameters, the results reveal that foot is the most applied segment for goals, followed by head and trunk (Table 5). Instep is the most anatomical landmark used for shots. Based on the ranking in Table 5, forehead is the 4th dominant body part used by players for scoring.

Table 4. The contrast of the attractiveness among scoring types revealed by the collected elite soccer goals

Category	preliminary	Advanced	Sum
Ground-attack	22.6%	9.2%	31.8%
Air-attack	5.7%	43.9%	49.6%
Both ground- & air-attack	12.3%	6.4%	18.7%
Total	40.6%	59.4%	100.0%

Table 5. The ascendancy of segmental parts applied for scoring revealed by the collected elite soccer goals

Segment	Segment part	Goal %	Top 5	Sum
Foot	Instep	50.3%	#1	91.5%
	Dorsi-side	17.1%	#2	
	Inside	5.9%	#5	
	Inside-instep	4.7%		
	Outside	7.4%	#3	
	Toe	0.5%		
	Heel	4.7%		
	Plantar-side	1.0%		
Head	Front	6.4%	#4	6.4%
Trunk	Chest	2.1%		2.1%
Total		100.0%		100.0%

DISCUSSION

Terminology is the main vehicle by which facts, methods and knowledge are represented and conveyed. A logically-constructed terminology system reduces ambiguity and increases clarity in knowledge transfer, in other words, the quality of specialist communication depends to a large extent on the quality of the terminology employed. Unfortunately, there is no such a terminology system existed for identifying SSTs in both research and practice. The main aim of the current study is to bridge the gap by structuring a terminology system for identifications of various SSTs in practice. Such a new system is required for promoting scientific researches in soccer as well as for developing innovative coaching methods for practitioners. The primary results have supplied rich food of thinking on future SST researches and coaching-method developments. The following points highlight some fresh aspects.

Diversity, ingenuity, artistry: the determinants of soccer attraction

Why soccer is so popular and attractive? The superficial answer is goal [1, 2]. However, the results of this paper may unveil some hidden reasons. Understanding the hidden arguments would promote novel soccer studies, develop innovative coaching methods, and henceforth, make soccer even more attractive.

First, SSTs are more diverse than we previously thought. The established system, for the first time, has determined that there are 43 SSTs; but, the current practice covers about 10 SSTs [26, 43] and scientific studies have investigated less than 10 SSTs [13, 18]. This may suggest that both current coaching methods and scientific studies would lag far behind the practice. Since soccer shot is the last destination determining the outcome of a team effort, the relevance of mastering various SSTs is obviously an essential core of soccer coaching and training; of course, it should also be a focus of scientific studies. With the established SST terminology system, coaches and researchers should know where they could go in the future.

Second, to performing SSTs effectively needs a player's ingenuity. The results have revealed that soccer stars have creative ability to select a SST depending on the instant dynamic playing situation. Such a selection would surprise the defense player/goal keeper to delay their reactions for achieving a clever goal. Examples are all inward kicks (i.e. inward instep kick, inward chip/lob kick, and jumping inward volley, Table 2) – running in one-direction and kicking in the other direction (normally, both directions are perpendicular to each other). The most difficult one is jumping inward volley; the trickiest one is inward chip kick. The other excellent examples are all back-facing kicks, e.g. heel kick, heel rebound and jumping heel rebound (Table 2 and Figure 4). The characteristic of back-facing kicks is time efficiency. Time is of the essence when preparing to shoot the ball. Even if in possession of a "free ball", a player will likely not be free for long; defenders will attempt to thwart the shot. Setting the ball and then shooting will give defenders/goal keepers more time for preparing a defense. One-touch-shot is the most successful strategy. Coaches and researchers need to think how to improve players' ingenuity.

Third, some SSTs are aesthetically beautiful. They can be precisely considered as artistic performances. The typical examples are the flying techniques, such as bicycle kick, jumping side volley (Figure 3), diving header and diving scorpion kick. These SSTs are considered as high risk because of the evitable falling to the ground, i.e. a realistic fear of injury to players/learners. Relying on talent of athletes to improvise on the fly can hardly be considered a viable learning strategy [42]. How to develop a safe learning program is one more item that researchers and coaches need to ponder seriously.

Playing aerial shots: the most attractive type of scoring awaited by soccer fans

Hitting an airborne ball is far riskier, as such more fascinating, than shooting a ground ball because of the following reasons: 1) the motion of a ground ball is two dimensional while the motion of an aerial ball is three dimensional, therefore, the dynamic position of ground ball is easier to predicted by the players; 2) aerially shooting ball at different heights requires obviously various body segments and/or techniques, that is why there are more air-attack SSTs existed in soccer practice than ground-attack SSTs (Table 3); and 3) for an air-attack, athletes have no control over the speed and

flight of the ball and it's all down to their technique selected, full-body coordination and timing, hence, an air-attack increases the hit-and-miss nature of the game, i.e. higher risk, higher reward.

The increased variation in ball dynamics, diversity in SST selection, and difficulty in coordination & timing may contribute to increasing the emotional tension further, leading to even crazier release when a goal is achieved. Ergo, playing aerial shots is the most attractive type of scoring awaited by soccer fans. Unfortunately, both the scientific research on aerial shots and their training in practice are mostly uncultivated. Obviously, more studies on aerial shots are desired for training-method development in this area. This newly developed SST terminology system would let researchers and coaches know where they could go.

The SSTs' learning and training strategy: at popular or at elite level

From a social and cultural point of view, one cannot underestimate the importance of soccer because it allows youth and hobby players to participate in a group setting for health and leisure. Due to this characteristic, the SST training at popular level should focus on easy-to-learn and low-risk techniques. Based on training parameters selected by coaches, the established SST terminology system would help them choose proper SSTs for making their training plans.

From an elite sport point of view, special/unique training methods are definitely needed to enable talented young children moving from beginners to professional players. Such a path consists of multiple developing steps: from fun playing, initial-coordination building, specialized-techniques developing to individual-creativity establishing [26]. Currently, there is no guide frame of how to select proper SSTs as well as how to make an effective training program for learning the proper SSTs in each steps [2, 18, 42]. The initiation of this SST terminology system would help researchers and practitioners comprehend influencing factors involved, make right selection of SSTs for talented young players as well as structure their concepts for investigations and novel training-method developments for these youths.

The scientific quantification of SSTs: a foundation for developing novel system of effective training

The desirability of acquiring SSTs efficiently and effectively while simultaneously avoiding injury would seem self-evident. However, the use of biomechanics to analyze various SSTs and validate the effects of training are still uncommon. Most participants acquiring skills through individual experience rather than research-based instruction [2]. For young players aiming at professional league, consequences of uninformed pedagogy can range from a frustrating lack of progress to debilitating, dream-ending injury [19]. Unfortunately, the number of studies examining the biomechanics of various SSTs, the effects of different coaching approaches on biomechanical efficiency, and the injury risks occurring during learning/training of various SSTs remains small [18, 42]

Previous studies have shown that the potential benefits of biomechanical research are considerable, not only in relation to maximizing performance and reducing or eliminating risk of injury, but also for fostering new attitudes and methods in complicated motor skills' learning & training [19, 29]. Until now, SST research could be considered as directionless, because we do not know exactly how many SSTs existed in practice. With the established SST terminology system, quantitative studies could be planned to demystify every SST for a safe and effective learning/training. The launch of such studies would provide a practical and convincing scientific coach-method, clear definitions, and means to reevaluate and improve SSTs in practice.

CONCLUSION

Terminology plays a key role in the production and dissemination of training documents, as well as offers concepts and methodologies for high-quality, effective knowledge representation and transfer. Through the established SST terminology system, we have learnt that there are 43 SSTs existed in current soccer practice. Some SSTs can be identified by preliminary parameters (i.e. anatomical parameters, the ball vertical position at the shot and the hit-point on the ball), but most of them need additional biomechanical examination on the movement control in frontal plane & transverse plane, jumping control, and trunk orientation at shots for a clear identification. Further, the new SST terminology has revealed that soccer attractiveness is linked to the diversity, ingenuity and

artistry of shots. The most attractive type of scoring awaited by millions of spectators is aerial shots. These aesthetically impressive goals illustrate the beauty that blossoms from the joy of soccer games. Lastly, the most important contribution of the new SST terminology system is to help researchers and practitioners launch more-and-more target-orientated studies that would provide a practical and convincing scientific coach-method, clear definitions, and means to reevaluate and improve SSTs in practice.

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