2. MOVEMENT ANALYSIS

O-007 Deceleration movements performed during FA Premier League soccer matches

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OBJECTIVE Deceleration (DCL) of high intensity movements in soccer has been related to cause of muscle damage (Reilly, 1990), which may be related to injury. Time-motion analysis can identify a breakdown of match time between different locomotive movements (LM). However, previous studies have not included deceleration as a movement classification and as a result such information has not been reported. The purpose of the current investigation was to characterise the nature of DCLs performed during elite soccer competition.

METHODS The on-field activity of 55 FA Premier League soccer players was recorded from Sky Television's PlayerCam facility for approximately 15 minutes each. The purposeful movement within these observations (about 5 minutes per player) was analysed using the Bloomfield Movement Classification (Bloomfield et al., 2004) allowing LM, direction and intensity of movement to be recorded.

RESULTS A total of 26,613 movements were recorded and 514 of these were DCL events. The analysis indicates that a player will perform a mean of 9.3 DCLs per 15mins. Table 1 shows the LM performed immediately before and after each DCL. There were 76.9% of the DCLs performed after sprinting and 41.6% of activity performed after all DCLs were classed as high intensity.

Table 1. Frequency of locomotive movements performed immediately before and after decelerations during 13 hours and 45 minutes of soccer match play.

Before Dec.	After Deceleration											Total
	Skip Low	Skip Med	Shuf. Low	Shuf. Med	Shuf. High	Shuf. VHI	Run Med	Run HI	Sprint HI	Sprint VHI	Other	
Run HI	12	19	1	23	29	0	14	8	3	1	9	119
Sprint HI	41	43	11	37	97	3	31	12	12	5	14	306
Sprint VHI	9	8	2	6	30	7	13	4	2	1	7	89
Total	62	70	14	66	156	10	58	24	17	7	30	514

Shuf = shuffle.

DISCUSSION The mean duration of all DCLs was 0.82s, however, there were 72.2% of all DCLs less than 1s and 95.5% less than 2s. The current results provide useful knowledge for strength and conditioning and injury prevention and rehabilitation exercises specifically for elite soccer players.

REFERENCES
Bloomfield et al. (2004) *Int J PerformAnalysis Sport* **4,** 20-31.
Reilly (1990) Football. In: *Physiology of Sports.* Eds: Reilly, T. et al.). London: Chapman & Hall. 371-424.

KEY WORDS Deceleration, injury prevention, strength, conditioning

O-008 A technical analysis of elite male soccer players by position and success

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OBJECTIVE If an analysis of the technical attributes of each player position was defined, results would influence selections and coaching. Notational analysis literature has few examples of technical analysis, in particular skill analysis involving soccer. This study developed analysis systems concerned with the technical requirements of each position in soccer, by using qualitative data within a quantitative system. The aim of this study was to analyse the technical ability

of every individual that competed in the 2004 European Football Championships. The measurements were based on a subjectively drawn continuum that analyses a player's technical execution of actions in the game. It was investigated whether technical differences occurred between player positions and successful and unsuccessful teams.

METHODS Data were gathered from matches within the 2004 European Championships (n = 31). A specifically designed notation system was tested for reliability by % error and the Chi-Squared test of independence. P value of 0.99 indicated strong inter-observer reliability between action observations, and 5.32% error was accepted as being acceptable given the subjective and qualitative nature of the data.

RESULTS The technically best team did not win the tournament; Greece was joint 10th in the overall technique-ranking table. Portugal and the Czech Republic had the highest average technique scores. The successful teams during the early rounds had higher technique scores in all positions but in the semi finals and finals the losing teams had the higher technique scores (Table 1).

Table 1. Technical Score summations for selected team's skill rating.

	Portugal	**Greece**	**Spain**	**Russia**	**France**	**England**	**Croatia**	**Switzerland**
Pass	1035	418	881	551	594	562	449	336
Receive	792	356	667	491	119	143	81	66
Shot	33	14	8	10	-1	21	14	12
RB	86	52	39	53	148	119	120	94
Dribble	251	71	139	95	162	60	136	53
Header	152	140	72	99	122	181	145	96
Cross	83	35	80	33	47	58	41	37
Tackle	14	94	31	57	113	115	160	138
Total Rating Frequency	2446	1180	1917	1389	1304	1259	1146	832
Mean	305.7	147.5	239.6	173.6	163	157.3	143.2	104

DISCUSSION A regression was made between the team's final position and their technique ratings at different skills. It gave insight into the relative strengths and weaknesses of these Performance Indicators. 'Heading' and 'running-with-ball' were ranked at the top, whilst fine skills, 'passing' and 'dribbling', were rated at the lowest. Perhaps this reflected the surprise result of the tournament.

KEY WORDS Technical analysis, elite male soccer, player position, success.

O-009 Method comparison of linear distance and velocity measurements with global positioning satellite (GPS) and the timing gate techniques.

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OBJECTIVE Objective quantification of training volume and intensity in football has proved a complex task. Timing gates permit the quantification of speed over pre-planned distances but are not suitable for general training drills, which are random and multidirectional. Recent developments in GPS technology offer potential to overcome logistical issues and restrictions of the timing gate method. Currently, there is a limited understanding of the measurement properties of commercially available GPS units in football training environments. Therefore, the aim of this investigation was to perform a method comparison of linear distance and velocity measurements with commercially available GPS units and the timing gate technique.

METHODS Three Doppler shift 1 Hz GPS units were used to estimate distance (m) and velocity (km/h) in a linear running protocol at varying velocities and were compared against timing gates over 10 trials. For GPS-estimated distance, mean % error was calculated. For velocity a log-transformed linear regression was conducted. The standard error of the estimate for each unit was expressed as % CV.

RESULTS The error for GPS distance measurements varied by the velocity of the trial. The mean % error was highest during running at 22.5km/h (5.64%; 2.82m). The lowest % error (0.71%; 0.36m) was at the slowest velocity of 6.45 km/h. At the highest velocity (27 km/h) the mean % error was -1.51% (-0.76m). The % CV for the GPS-estimated velocity was 1% for each of the three units (95% CI 0.8% to 1.2%).

DISCUSSION GPS and timing gates produced comparable speed and distance data. One Hz seems appropriate for predicting distance at low velocity, but may be insufficient for higher velocity. Some error reported may be due to timing gate measurement issues and not the GPS technology. Doppler shift appears to improve the variability of the GPS speed data.

CONCLUSION To quantify football related movements' future work should consider comparison of GPS and image-based video analysis technology on non-linear courses.

KEY WORDS Technology, displacement, speed.

O-010 Analysis of technical-tactical parameters in young soccer players

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OBJECTIVE A soccer player's achievement depends on variables such as psychology, physical condition, coordination and cognition. Although researchers have focused on all variables, investigation in how the tactic influences achievement is yet unknown (McMorris, 1997; Rulence-Pâques et al, 2005). No experimental evidence exists about relation between technical and tactical actions. The principal aim of the study was to analyze the technical and tactical actions of passing, looking and opening space, and shooting the ball towards a goal in a football match.

METHODS Four groups of twelve football players participated in this study. They belonged to two age categories (8-12 years). Three technical-tactical tests were used to measure the variables (passes, looking opening space and shoots to the goal). In order to carry out the subsequent analysis, two video cameras (Panasonic AG-DVX 100AE) were used for filming.

RESULTS The descriptions of all the measured variables are shown in Table 1. No significant differences were obtained in any of the variables analyzed in relation to category, position and/or dominance of subjects. A positive correlation was found between the number of correct, looking opening space, and the number of goals scored ($r = 0.765$, $p < 0.001$. $n = 48$).

Table 1. Descriptions of the variables measured

TESTS	VARIABLE	CATEGORY	MEAN(SD)	MAX	MIN
Shoots to goal	**Goals**	**8-9 years**	1.54 (1.64)	6	0
		10-12 years	1.75 (1.29)	4	0
	Saves	**8-9 years**	0.58 (0.72)	2	0
		10-12 years	0.92 (1.25)	5	0
	Kick-Out	**8-9 years**	1.04 (0.95)	3	0
		10-12 years	0.75 (0.85)	2	0
Passes	**Correct**	**8-9 years**	2.29 (1.27)	5	0
		10-12 years	1.88 (1.23)	4	0
	Incorrect	**8-9 years**	1.38 (1.13)	4	0
		10-12 years	1.25 (1.64)	3	0
Looking opening spaces	**Correct**	**8-9 years**	2.13 (2.38)	7	0
		10-12 years	2.00 (1.67)	7	0
	Correct with goal	**8-9 years**	0.92 (1.18)	4	0
		10-12 years	0.79 (0.88)	3	0

Units are expressed as points, representing the highest scores of the highest number of action made.

DISCUSSION The present study showed no significant difference among the means of independent variables analyzed. Nonetheless, significant relations were found among the technical and tactical variables studied. It would be interesting to prolong observation times in future investigations to increase the likelihood of finding significant differences among the independent variables analyzed.

REFERENCES
McMorris (1997) *Percept Mot Skills* **85,** 467-476.
Rulence-Pâques et al. (2005) *Revue Eur Psych Apliquée* **55,** 131-136.

KEY WORDS Soccer, technique, tactic.

O-011 Automatic analysis of football games using GPS on real time

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OBJECTIVE Global Positioning System (GPS) is a localization system designed by the United States Department of Defence in 1978 that allows knowing latitude, longitude and altitude. To a certain extent, soccer action implies using space in an intelligent way that can be tracked by describing players' positions on the pitch. This technology has been used in human movement studies as well for the study of human locomotion and cross-country skiing for instance. The main objective of this investigation was to test and ad hoc designed and developed application for real time recording of cinematic and physiological variables of team sports.

METHODS The participants were 6 professional football players of 2nd B division El Ejido FC who played a 60'game (30'+30') practice game. Each of the participants wore a FRWD F 500 GPS set consisting of a recording unit, a tape and a heart rate (HR) transmitter band. All data produced during play action (velocity, distance, HR and position) were taken every second and stored constantly on the recording unit.

RESULTS According to collected data we found significant differences in distance travelled in four of the six players whereas HR was different for all players monitored. As far as velocity was concerned, differences were only found for three participants (Table 1).

Table 1. Inter-subject analysis of the variables (Heart Rate, Speed and Distance p < 0.005).

	Right defender			Mid-R defender			Left defender		
	HR	S	D	HR	S	D	HR	S	D
Right defender	,000	**,074**	,000						
Left defender	,000	,000	,000	,000	,000	**,248**			
Left midfielder	,000	,001	,000	,000	**,024**	**,147**	,000	**,717**	,004

CONCLUSION GPS technology can be taken one step forward for coaching control if it is implemented with appropriate software like the one designed by us. By these means, we found significant differences between playing positions as referred in bibliography.

KEY WORDS Soccer, software, heart rate.

O-012 Turning movements performed during FA Premier League soccer matches

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OBJECTIVES Time-motion analysis studies have provided a breakdown of match time between different locomotive movements. However, such information does not indicate the agility demands of the given sport as turning during movement or the transition between movements have not been reported. Therefore, the purpose of the current investigation was to characterise the nature of turning performed during elite soccer competitions and investigate the transition of locomotive movements (LM).

METHODS The on-field activity of 55 FA Premier League soccer players was recorded from Sky Television's PlayerCam facility for approximately 15 minutes each. The purposeful movement within these observations (about 5 minutes per player) was analysed using the Bloomfield Movement Classification (Bloomfield et al., 2004) allowing LM, direction and intensity of movement to be recorded.

RESULTS A total of 26,613 movements were recorded and 5,115 of these were turning events. Table 1 shows the LM performed immediately before (BF) and after (AF) each turn. There were 21% of turns performed within the same LM and 79% during a transition. Chi square tests of independence were applied to the angle ($\leq 90°$ or $>90°$), direction (left or right) and movement BF and AF each turn.

DISCUSSION The frequency profile of movements performed BF ($X2,24=185.0$, P < 0.001) and AF ($X2,24=69.6$, P < 0.001) turns were significantly influenced by angle with more turns of $\leq 90°$ BF or AF jogging and shuffling and more

turns of >90° during skipping, stopping and slowing. The current results provide knowledge for development of speed and agility training exercises specifically for elite soccer players.

Table 1. Frequency of locomotive movements performed immediately before and after turning movements during 13 hours and 45 minutes of soccer match play.

Before turn	After turn									
	jog	**Run**	**shuffle**	**skip**	**Slow down**	**Sprint**	**stand**	**stop**	**walk**	**Total**
jog	391	107	140	307	0	45	49	10	170	1219
run	81	75	61	57	18	36	3	8	8	347
shuffle	176	128	178	173	1	113	62	30	102	963
skip	322	91	82	263	0	44	39	5	231	1077
slow down	35	11	33	31	0	7	7	2	28	154
sprint	3	8	15	1	33	21	0	2	0	83
stand still	79	32	45	42	0	17	0	1	147	363
stop	20	15	28	22	1	21	7	1	13	128
walk	241	59	76	178	0	23	51	3	150	781
Total	1348	526	658	1074	53	327	218	62	849	5115

REFERENCES
Bloomfield et al. (2004) *J Perform Analysis Sport* **4,** 20-31.

KEY WORDS Agility, turning, transition

O-013 Analysis of high intensity activity in soccer highest level competition

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OBJECTIVES The analysis of the physical activity during competition is a basic referent when establishing the means and loads of training. Bibliography determines volume and intensity of the player's activity during the match as essential parameters in the rating of effort, and the activity that the player performs at a high intensity as a key to distinguish the player's strain level. The objective of this research was to describe and compare the high intensity physical performance of the players during European professional leagues' competition, taking into account their playing position.

METHODS The AMISCO® system has been used to register player's performance. From the record of 194 matches in the highest competitive level in the 2003-04 season, we have considered a sample of 6112 entries: Wide Fullback (N=1326), Centre fullback (N=1388), Pivot (N=1187), Centre midfield (N=215), Wide Midfield (N=1032), Centre forward (N=275), Striker (N=689). An ANOVA test on one Factor has been done.

RESULTS The descriptive analysis of the results showed the obtained values (average and standard deviation) for each of the defined position in each half. The average of the total distance run over by the players has been 5,598Km, with a standard deviation of 0.481Km. The confidence interval of 95% for the average has been between 5,586 and 5,610Km. The results for each position are shown in table 1. Significant differences were found between plating positions ($p < 0.05$).

Table 1. Reference values of different playing positions.

	Total distance	Distance 14-21 km/h	Distance 21> km/h	Distance 14> km/h
Wide Full-back	5.557 (0.375)	0.958 (0.198)	0.341 (0.126)	1.299 (0.271)
Centre Fullback	5.205 (0.325)	0.736 (0.166)	0.196 (0.082)	0.932 (0.207)
Pivot	5.929 (0.366)	1.193 (0.255)	0.238 (0.099)	1.431 (0.299)
Centre Midfield	5.925 (0.465)	1.175 (0.304)	0.287 (0.104)	1.463 (0.344)
Wide Midfield	5.835 (0.417)	1.112 (0.245)	0.402 (0.135)	1.514 (0.302)
Centre Forward	5.750 (0.426)	1.080 (0.239)	0.339 (0.128)	1.420 (0.313)
Striker	5.383 (0.516)	0.859 (0.222)	0.353 (0.135)	1.213 (0.302)
TOTAL	5.598 (0.481)	0.981 (0.279)	0.298 (0.137)	1.279 (0.348)

CONCLUSION In conclusion, we have shown that the playing position of player determines his activity on the field. The originality, accuracy and reliability of our method, and the size and characteristics of this updated sample, makes this piece of research hard to be compared to the similar ones found in bibliography.

KEY WORDS Match analysis, team position, high intensity activity, computer analysis, video analysis.