

# **Score-line effect on work-rate in English FA Premier League soccer**

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## **Abstract**

This paper investigates the effect of score-line on work-rate in English FA Premier League soccer. Player movement data from 110 matches where a goal was scored between 15 minutes and the end of the first half were captured by the Prozone™ player tracking system. The number of V-cut path changes performed per minute declined more after the first goal in matches that were won by one of the sides than in drawn matches ( $p < 0.017$ ). V-cut path changes involve players changing direction more than  $135^\circ$  to the left or the right. There was also a significant interaction of match type (won, drawn or lost by the team scoring first), period of the match (before and after the first goal), venue and the relative quality of the teams on the total number of path changes performed ( $p < 0.05$ ). Players from the scoring and conceding teams spent significantly less time in the middle third of the pitch after the first goal than before ( $p < 0.017$ ). This suggests that variability in work-rate is influenced by a combination of factors. The results suggest that the first goal has an influence on teams' tactics and work-rate. However, the study did not find any differences in work-rate between teams achieving different outcomes having scored first.

**Key words:** situational variables, high speed running, sprinting.

## **1. Introduction**

Situational variables, including venue, quality of opposition, period within the game, score-line and the type of competition, influence sports performance (Taylor et al., 2008; Gómez et al., 2013). In soccer, score-line has been found to influence tactics (James et al., 2002; Bloomfield et al., 2004; Lago-Peñas and Martin, 2007; Lago, 2009; Taylor et al., 2008) and the quality of execution of match events (Taylor et al., 2008). Soccer players have been found to spend a greater percentage of match time performing high intensity activity when the score is level than when their teams are winning or losing (Clark and O'Donoghue, 2011). However, this might be explained by fatigue as many studies have shown a decrement in the percentage of time spent performing high intensity activity (Bangsbo et al., 1991), distance covered (Mohr et al., 2005; Reinzi et al., 2000; Burgess et al., 2006; Barros et al., 2007), high intensity running distance and sprint

distance (Di Salvo et al., 2009; Bradley et al., 2009; 2010) from the first half to the second half.

Matches commence with the score level and one team may take and hold the lead during the latter stages of matches. Redwood-Brown et al. (2012) determined a normal pattern of fatigue in soccer matches containing no goals and used this to determine score-line effects on work-rate that are on and above what would be expected if there were no goals. In order to avoid score-line effects being explained by the qualities of the teams that were winning and losing matches, Redwood-Brown et al. (2012) deliberately analysed matches where both teams were level, ahead and behind for at least 15 minutes. They found an interaction between positional role and score-line with forwards tending to increase their work-rate when their team was ahead, while defenders tended to increase their work-rate when their team was behind. An explanation for this is that performance accomplishments (such as scoring goals) are the most powerful source of efficacy expectation and encourage task-related effort (Bandura, 1977). Thus forwards may be encouraged to maintain effort to create further scoring opportunities having already scored. The effort of the defenders within Redwood-Brown et al.'s (2012) study was directly related to the effort of the opposing forwards; thus when the opposing forwards were leading and maintaining a high effort, the defenders, whose teams were losing, had to maintain a matching effort. The main criticism of Redwood-Brown et al.'s (2012) study is that the 90 players all came from a small set of 5 matches. Similarly, the 79 players' data used to determine a fatigue pattern in matches where there were no goals came from a small sample of five 0-0 drawn matches.

Previous research into score-line effects (Redwood-Brown et al., 2009; Clark and O'Donoghue, 2011) is limited in that the studies describe work-rate of teams experiencing score-lines without considering final match outcome. Therefore, the purpose of the current investigation is to compare performances where teams taking the lead went on to win, draw and lose the matches. The change in performance before and after the first goal is studied addressing the relative qualities of the teams within matches and the venue of the team scoring the first goal.

## 2. Methods

### 2.1. Hypotheses

Outcome of matches with respect to the team that took a 1-0 lead is included as a factor; match type. Match type is included as an independent variable because we hypothesise that teams achieving different outcomes have done so with differing work-rates. Hence match type is a group variable determined in an *ex post facto* manner. There are five independent variable of interest within the current study:

- Match type – matches where the team that took a 1-0 lead went on to win, draw or lose the match.
- Team – the team that took a 1-0 lead and the team that conceded the first goal.
- Period of the match – before the first goal and after the first goal.
- Venue – whether the team scoring the first goal was playing at home or away.

- Relative quality – whether the team scoring the first goal was of a higher, similar or lower quality than the team that conceded the first goal.

Thus there are 5 main effects and 26 interaction effects that could be tested. Some of these effects are not of importance to the purpose of the study and so the study focussed on the factors and combinations of factors that involve score-line and match type. These are listed as null hypotheses below.

- Null Hypothesis 1. The interaction of team, match type and period of the match has no significant effect on any work-rate variable. If this hypothesis is rejected it means that the two teams were influenced in different ways by the first goal and that this also differed between matches of differing outcomes.
- Null Hypothesis 2. The interaction of team and period of the match has no significant effect on any work-rate variable. If this hypothesis is rejected it means that the two teams were influenced in different ways by the first goal but this did not differ between matches of differing outcomes.
- Null Hypothesis 3. The interaction of match type and period of the match has no significant effect on any work-rate variable. If this hypothesis is rejected it means that the first goal has influenced the match in a similar way for each team but that matches of different outcomes were influenced in different ways.

A significant influence of an interaction of venue or relative quality within the 3 hypotheses listed above is also of interest.

## **2.2. Matches**

The 380 English FA Premier League matches of the 2013-14 season were considered for the current investigation. There were 135 matches that satisfied the criteria for inclusion that the first goal was scored between the 15<sup>th</sup> minute and the end of the first half. There were 78 matches excluded because the first goal was scored in the second half, 27 matches excluded because they were scoreless, 41 matches where players were dismissed were excluded and a further 99 matches were excluded because the first goal was scored before the 15<sup>th</sup> minute. The remaining 135 matches were reduced to a set of 110 matches to ensure each team was involved in at least 9 matches but in no more than 14 matches. Using a large number of matches reduces the impact of inherent match-to-match variability in soccer work-rate on the results of studies (Gregson et al., 2010). The 110 matches included in the study were classified according to venue and relative quality of the teams and match type as shown in Table 1. Relative quality was represented by the number of points the teams had at the end of the 2013-14 season. The team that took a 1-0 lead within the match was classified as higher quality than the opposition if their points total was 6 or more greater than that of the opponents, similar quality if their points total differed by no more than 5 to the opponent's points, and lower quality if their points total was 6 or more fewer than that of the opponents.

**Table 1.** Matches included in the study.

Team taking a 1-0 lead		Outcome for team taking a 1-0 lead			
Venue	Quality relative to opposition	Won	Drawn	Lost	Total
Home	Higher	33	4	1	38
	Similar	7	2	0	9
	Lower	8	3	3	14
	Total	48	9	4	61
Away	Higher	22	5	1	28
	Similar	6	2	2	10
	Lower	4	2	5	11
	Total	32	9	8	49
All	Total	80	18	12	110

The trajectory data for the player performances in the 110 matches included in the current study were provided by Prozone™. The data recorded by the Prozone™ system have been validated against data recorded by electronic timing gates (Di Salvo et al., 2006). Di Salvo et al. (2009) went on to find that inter-operator agreement between independent quality control staff was high enough for the data to be used for coaching purposes or scientific research.

### 2.3. Variables

The study uses accurate player movement data gathered during English FA Premier League soccer matches using the Prozone3™ player tracking system. The reliability of the system together with the large volume of data ensures that the study is rigorous. The work-rate variables used in recent studies of professional soccer include distance covered using high speed running, sprint distance, frequency of sprints of different distances and the percentage of sprints that are leading sprints and explosive sprints (Di Salvo et al., 2009; Gregson et al., 2010). The data gathered by player tracking systems could be utilised further to reflect other aspects of work-rate. Changing direction at speed is important in creating chances in soccer as well as defending (Gréhaigne et al., 1997). Therefore, the current investigation includes the number of path changes to the left, right and V-cut path changes as well as the total number of path changes to estimate the demands due to direction changes and performing cutting movements. A V-cut path change is where a player changes direction of movement by more than 135°. Differences in work-rate might be explained by tactical choices of teams and, therefore, the proportion of time players spent in three different areas of the pitch is also reported.

The work-rate of the players was represented by a set of 15 dependent variables that were expressed per minute to allow comparisons between match periods of different lengths before and after the first goal was scored:

- Distance covered ( $\text{m} \cdot \text{min}^{-1}$ ).
- High speed running (HSR) distance covered ( $\text{m} \cdot \text{min}^{-1}$ ).
- Sprinting distance ( $\text{m} \cdot \text{min}^{-1}$ ).

- The percentage of sprints that are explosive (as opposed to leading) sprints.
- Number of sprints performed per minute.
- Number of sprints of 0m to less than 10m per minute.
- Number of sprints of 10m to less than 20m per minute.
- Number of sprints of 20m or further per minute.
- Number of sharp path changes to the left per minute.
- Number of sharp path changes to the right per minute.
- Number of V-cut path changes per minute.
- Total number of path changes per minute.
- Percentage time spent in the defending third.
- Percentage time spent in the middle third.
- Percentage time spent in the attacking third.

High speed running distance includes all movement at speeds of  $5.5 \text{ m.s}^{-1}$  ( $19.8 \text{ km.hour}^{-1}$ ) or faster and sprint distance includes all movement at speeds of  $7 \text{ m.s}^{-1}$  ( $25.2 \text{ km.hour}^{-1}$ ) or faster. Sprints counted in the current investigation had a duration of 0.5s or longer (Di Salvo et al., 2009). An explosive sprint is one where the acceleration to sprinting speed ( $7 \text{ m.s}^{-1}$  ( $25.2 \text{ km.hour}^{-1}$ ))) from a speed of less than  $4 \text{ m.s}^{-1}$  ( $14.4 \text{ km.hour}^{-1}$ ) was achieved in less than 0.5s prior to the sprint (Di Salvo et al., 2009). All other sprints were classified as leading sprints.

The path changes counted in the current study included some movement at a speed of  $4 \text{ m.s}^{-1}$  ( $14.4 \text{ km.hour}^{-1}$ ) or faster during each path change (Robinson et al., 2011). The three types of path change are illustrated in Figure 1. All path changes involved straight line movement during the periods from 1.0s to 0.3s prior to the point of path change and 0.3s to 1.0s after the point of path change. Movement was considered to be sufficiently straight line movement if the direction of movement in each 0.1s section deviated from the average direction during the period of interest by  $15^\circ$  or less. Sharp path changes to the left (right) were recorded when the average direction of movement after the path change was  $45^\circ$  to  $135^\circ$  to the left (right) of the average direction of movement before the path change. V-cut path changes were recorded when the average direction of movement after the path change was  $135^\circ$  to  $180^\circ$  to the left or right of the average direction of movement before the path change.

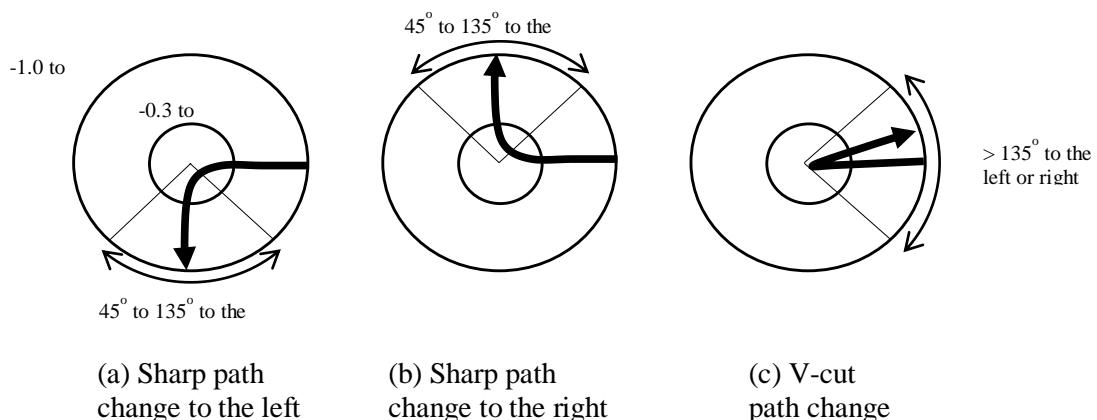


Figure 1. Classification of path changes.

The English FA Premier League aim to standardise pitch size to 105m x 68m (<http://www.theguardian.com/football/blog/2014/oct/29/pochettino-pitch-size-does-matter>, accessed 8/10/15). Therefore, the middle third of the pitch was considered to be the middle 35m of the pitch. The percentage of time spent in each third of the field was determined for the average outfield player on each team.

#### **2.4. Data Analysis**

The player trajectory data for the 3024 players involved in the 110 matches was processed in order to produce the 15 dependent variables. This was done by a system that was developed in Matlab versio 8.5.0 (Mathworks Inc., Natick, MA). Goalkeepers were removed from the data set leaving 2804 outfield players. The mean for each distance and frequency variable before and after the first goal was determined for the average player in each team within the 110 matches. This reduced the data to 220 team performances. The variables were then standardised to be distances and frequencies per minute to account for the different times before and after the first goal within the matches. Statistical analysis was then done using SPSS version 22. A preliminary ANOVA test was conducted including team and match period (before or after the first goal) as repeated measures and venue, match type and relative quality of the teams as between subjects effects. The residual values of the 15 dependent variables were saved during the preliminary ANOVA test so that their normality could be tested using a series of Kolmogorov Smirnov tests for the 2 x 2 repeated measures of interest. There were 38 of these 60 tests where the variables were deemed to be sufficiently normal ( $p > 0.05$ ). Therefore, the ANOVA test including 2 repeated measures and 3 between subjects' effects was justified. The team within the match was included as a repeated measure of 2 values (the team that went 1-0 up and the team that conceded the first goal). Match period was an additional repeated measure of 2 values (the periods before and after the first goal). The venue of the team that took the lead was classified as 'home' or 'away' and included as a between subjects effect. The quality of the team that took a 1-0 lead relative to the opposing team was included as a between subjects effect measured at 3 levels ('higher', 'similar' or 'lower'). Match type was a third grouping variable that classified matches according to outcome with respect to the team that took a 1-0 lead. This was measured at 3 levels ('won', 'drawn' or 'lost'). The p value used to indicate statistical significance was 0.05 for each dependent variable except the three 3 lengths of sprint ( $p < 0.017$ ), the 3 types of path change ( $p < 0.017$ ) and the percentage time spent in each third of the pitch ( $p < 0.017$ ). Partial eta squared ( $\eta^2$ ) values were used to measure effect sizes and these were reported for any significant results.

The mean ( $\pm SD$ ) time at which the first goal was scored was  $28 \pm 9$  mins in the 80 matches where the scoring team went on to win,  $29 \pm 12$  mins in the 18 matches that were drawn and  $28 \pm 10$  mins in the 12 matches where the team that scored first went on to lose. A one-way ANOVA revealed no significant difference in the time of the first goal between these three types of match ( $p = 0.805$ ). Therefore, the time of the first goal was not included as a covariate.

### 3. Results

Table 2 shows the performance of the teams scoring and conceding the first goal in the 110 matches before and after the first goal. Players of both teams covered a significantly greater distance per minute before the first goal than afterwards ( $F(1,93) = 54.6$ ,  $p < 0.001$ ,  $\eta^2 = 0.57$ ). Players of both teams also performed a significantly greater number of sharp path changes to the left ( $F(1,93) = 15.9$ ,  $p < 0.001$ ,  $\eta^2 = 0.15$ ), sharp path changes to the right ( $F(1,93) = 20.5$ ,  $p < 0.001$ ,  $\eta^2 = 0.18$ ), V-cut path changes ( $F(1,93) = 13.7$ ,  $p < 0.001$ ,  $\eta^2 = 0.13$ ) and path changes in total ( $F(1,93) = 22.7$ ,  $p < 0.001$ ,  $\eta^2 = 0.20$ ) before the first goal than afterwards. None of team, venue or match type had a significant influence on any of the 12 variables shown in Table 2 ( $p > 0.05$ ).

Table 2. Performance of teams before and after the first goal.

Performance Variable	Scoring team		Conceding team	
	Pre-goal	Post-goal	Pre-goal	Post-goal
Distance (m.min <sup>-1</sup> )	119.9±6.2	112.4±4.9	119.9±6.6	112.9±4.8
HSR Distance (m.min <sup>-1</sup> )	10.8±2.1	10.5±1.6	11.0±2.0	10.4±1.4
Sprint Distance (m.min <sup>-1</sup> )	2.7±0.9	2.7±0.7	2.8±0.8	2.8±0.6
Sprint.min <sup>-1</sup>	0.38±0.14	0.39±0.12	0.4±0.13	0.39±0.11
%Explosive sprints	58.8±10.9	60.5±7.7	60.1±10.3	59.7±8.1
Sprints of 0 to less than 10m.min <sup>-1</sup>	0.33±0.14	0.34±0.11	0.34±0.12	0.34±0.10
Sprints of 10 to less than 20m.min <sup>-1</sup>	0.05±0.02	0.04±0.01	0.05±0.02	0.04±0.01
Sprints of 20m or further.min <sup>-1</sup>	0.01±0.01	0.01±0.00	0.01±0.01	0.01±0.01
Sharp path changes to left.min <sup>-1</sup>	0.91±0.23	0.79±0.16	0.89±0.19	0.81±0.17
Sharp path changes to right.min <sup>-1</sup>	0.86±0.21	0.77±0.16	0.87±0.18	0.77±0.16
V-cut path changes to right.min <sup>-1</sup>	0.30±0.09	0.25±0.08	0.29±0.08	0.26±0.07
Total path changes to right.min <sup>-1</sup>	2.06±0.50	1.81±0.39	2.05±0.40	1.83±0.38

There were some significant interactions between team, period of the match and the three between subjects effects on a small number of variables. There was a significant interaction between match type and period influencing the number of V-cut path changes performed per minute ( $F(2,93) = 4.9$ ,  $p = 0.009$ ,  $\eta^2 = 0.10$ ). Figure 2 shows that both teams had greater reductions in V-cut path changes after the first goal in matches that were won by either side than during drawn matches.

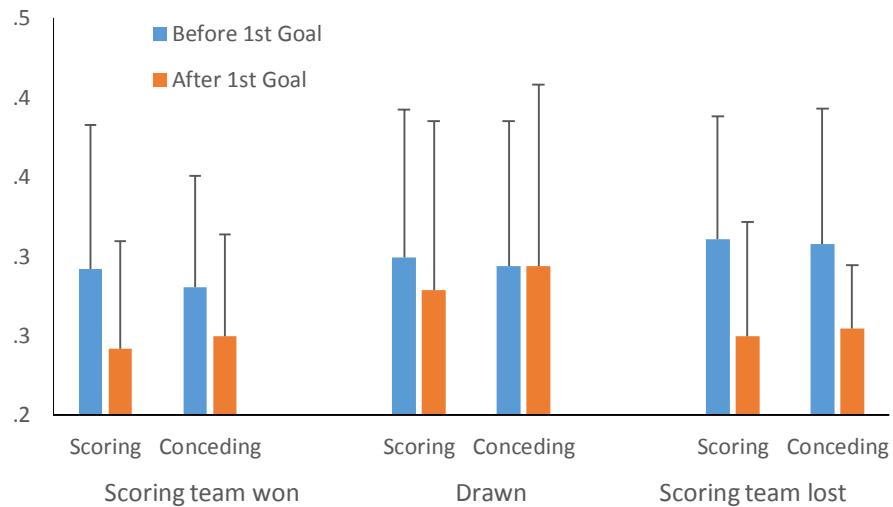


Figure 2. V-cut path changes performed per minute in different types of match by the teams scoring and conceding the first goal.

There was a significant interaction of match type, period of the match, venue and relative quality of the teams on the total number of path changes performed ( $F(3,93) = 2.8$ ,  $p = 0.045$ ,  $\eta^2 = 0.08$ ). Table 3 pools data for the teams that scored and conceded the first goal together because there was no significant team effect on the total number of path changes. The declines in the number of path changes performed after the first goal was scored were more consistent in matches where the home team scored first than when the away team scored first. There were no other significant interactions between any of the five factors ( $p > 0.05$ ).

Figure 3 shows the percentage of time players spent in each third of the pitch before and after the first goal was scored. Figure 3 combines the values for the two teams within matches because there was no significant interaction of team and match type or period. Period of the match had a significant influence on the percentage of time spent in all three zones ( $F(1,93) \geq 7.8$ ,  $p \leq 0.006$ ,  $\eta^2 = 0.08$ ) with the percentage of time spent in the middle third decreasing after the first goal was scored while the percentage of time in the attacking and defending thirds increased. There was no significant interaction of match period and any other factor on the percentage of time spent in any third of the pitch ( $p > 0.05$ ).

Table 3. Path changes performed per minute in different matches.

<u>Venue</u> and Relative quality of the team that scored first	Won by the team that scored first			Drawn			Lost by the team that scored first		
	Matches	Before goal	After goal	Matches	Before goal	After goal	Matches	Before goal	After goal
<u>Home</u>									
Higher	33	1.99 $\pm$ 0.36	1.77 $\pm$ 0.23	4	2.02 $\pm$ 0.43	1.97 $\pm$ 0.40	1	1.91	1.82
Similar	7	1.93 $\pm$ 0.22	1.71 $\pm$ 0.25	2	2.32 $\pm$ 1.01	2.07 $\pm$ 0.89	0		
Lower	8	2.06 $\pm$ 0.27	1.71 $\pm$ 0.19	3	2.49 $\pm$ 0.66	2.37 $\pm$ 0.73	3	2.10 $\pm$ 0.41	1.84 $\pm$ 0.37
<u>Away</u>									
Higher	22	2.13 $\pm$ 0.50	1.92 $\pm$ 0.48	5	2.09 $\pm$ 0.18	1.67 $\pm$ 0.22	1	2.25	1.86
Similar	6	1.93 $\pm$ 0.46	1.57 $\pm$ 0.21	2	2.08 $\pm$ 0.15	2.47 $\pm$ 0.35	2	2.39 $\pm$ 0.13	2.06 $\pm$ 0.31
Lower	4	2.02 $\pm$ 0.56	1.69 $\pm$ 0.21	2	1.64 $\pm$ 0.06	1.58 $\pm$ 0.00	5	2.16 $\pm$ 0.46	1.79 $\pm$ 0.29

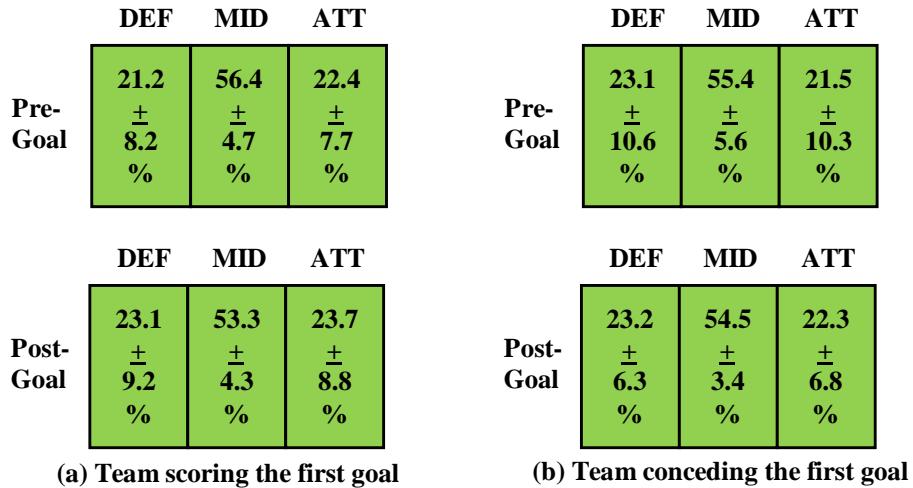


Figure 3. The percentage of time players from the teams scoring and conceding the first goal spent in different thirds of the pitch before and after the first goal (mean $\pm$ SD).

## 5. Discussion

There was a significant interaction of match type and period within the match on the number of V-cut path changes performed per minute. Figure 2 shows that the number of V-cut path changes decreased in matches won by one side or the other more than in drawn matches. This shows the importance of using a more expanded set of work-rate related variables as traditional measures of high speed running distance and sprint distance were not significantly influenced by the interaction of match type and period of the match. The interactive effect on V-cut path changes may be explained by teams being motivated to maintain work-rate in matches where the outcome is still to be determined. It can be argued that until a match has completed, the outcome of any match is unknown. However, the probability of certain outcomes is higher where one team has the lead and increases with the size of the lead and as the match approaches full time. Several studies have found that subjectively classified work-rate is higher when the score is level than when one or other team is leading (O'Donoghue and Tenga, 2001; Shaw and O'Donoghue, 2004; Clark and O'Donoghue, 2013). Score-line may have an influence on efficacy expectation. Groups develop "collective efficacy" or shared beliefs about the group's (or team's) ability to achieve the desired outcome (Bandura, 1982; 1986). Previous research has shown that collective efficacy influences the amount of task related effort and persistence (Feltz, 1992; Greenlees et al., 1999; Hodges and Carron, 1992; Lirgg et al., 1994; Weldon and Weingart, 1993). The current investigation agrees with this general theory. However, in the specific case of the influence of score-line on task related effort in soccer, the current investigation suggests that task related effort declines as the outcome becomes more obvious (no matter whether winning or losing). An alternative explanation for the reduction in V-cut path changes comes from causal attribution theory (Weiner, 1985; Biddle, 1993). Soccer players may attribute score-line, and hence the chance of winning the match, to factors outside their control. For example, score-line may be attributed to the quality of opposition, the quality of team mates or decision making by officials. If such perceptions lead players to believe the outcome of the match is obvious and outside their own control, their work-rate may reduce. The only work-rate variable influenced by this interaction of match type and match period was the number of V-cut path changes performed. This is an important variable with such path changes performed within soccer specific training drills (Pearson, 2001, p.75-76; Schreiner,

2000, p. 100). Direction changes have an important role in helping players evade opponents and find space which in turn may help to create scoring opportunities. For example, dribbling the ball towards an opponent and then changing direction before passing can create space for team mates (Bangsbo and Peitersen, 2004, pp. 31-33). Therefore, maintaining the number of V-cut path changes may help teams come back and draw matches having been a goal down. When teams maintain the number of V-cut path changes performed after they have conceded the first goal, the team who scored the first goal may also need to maintain the number of V-cut path changes to track opponents. The current investigation found that teams scoring the first goal did not maintain the number of V-cut path changes as well as the conceding team. This may have played a role in the trailing team coming back to draw the match.

Table 2 shows that distance covered per minute and path changes of all types performed per minute declined for both teams after the first goal is scored. This agrees with previous research that has found a decline in various work rate variables as matches progress. English FA Premier League players show a decline in high speed running distance (Di Salvo et al., 2009), sprint distance (Di Salvo et al., 2009) and subjectively classified high intensity activity (Bangsbo et al., 1991) from the first half to the second half of matches. Redwood-Brown et al. (2012) found that English FA Premier League players spent a greater percentage of match time moving at  $4 \text{ m.s}^{-1}$  ( $14.4 \text{ km.hour}^{-1}$ ) or faster in the first 15 minutes of 0-0 drawn matches than any other 15 minute period. This is also consistent with the current finding that both teams show work-rate decrements after the first goal is scored than before.

Table 3 shows that the four way interaction between match type, venue, relative quality of the teams and period of the match influenced the number of path changes made in a small minority of matches; most noticeably matches where the away team scored the first goal. While this interaction effect did not influence the high speed activities covered in Gregson et al.'s (2010) study of match-to-match variability, it does raise the possibility that venue, score-line and quality of opposition may explain some of the variability found by Gregson et al. (2010). Most variability in the current investigation was in matches when the away team scored the first goal. The largest decline in path changes was when the higher quality team was away from home, scored first and the match was drawn. These higher quality teams may have preserved their lead if they had maintained the rate of path changes exhibited before scoring the first goal. There was also a relatively large decline in path changes after the first goal in matches where the teams were of similar quality, the away team scored first and went on to win. The home team may have a greater chance of equalising if they maintain the number of path changes after conceding the first goal. There was also a relatively large decline in path changes after the first goal in matches where the away team was of a lower quality than the opponents, scored the first goal and went on to lose. This suggests that actions other than maintaining path changes are used by higher ranked teams to come back and win matches where they have conceded the first goal. The quality of the players in their squads explains their ability to do this against lower ranked opposition. Team was not included in any significant interaction. This may be explained by previous research that found that scoring or conceding the first goal in a match does not have a significant impact on the chance of scoring subsequent goals within the match (Tenga, 2013).

The current investigation does have some limitations. The data used do not distinguish between forwards, backwards and sideways movement performed by players. Some backwards and sideways activity may be performed at a higher intensity than some forwards movement performed at higher speeds. On-the-ball movement is not distinguished from off-the-ball movement. Movement with the ball may be more taxing than movement performed without

the ball performed at the same speed. Stoppage time is not accounted for and may vary between matches as well as within matches, possibly impacting on the volume of high intensity running and sprinting performed by players before or after the first goal is scored.

## 6. Conclusions

There was a significant interaction effect of match type and period of the match on the number of V-cut path changes performed per minute. These reduced for both teams more in matches that were won by one team or other than in matches that were drawn. The total number of path changes was significantly influenced by the interaction of venue, relative quality of the teams, type of match and period within the match. Score-line combined with venue and team quality are sources of variability in player work-rate in English FA Premier League soccer. The study shows the importance of including path changes within work-rate studies as well as traditionally used high speed running distance and sprint distance variables.

## 7. Acknowledgement

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