



REVIEW PAPER

**IMPLEMENTATIONS OF TACTO SOFTWARE FOR
ANALYSING ATHLETIC EFFECTS OF PARKOUR ON
YOUTH FOOTBALL PLAYERS' PERFORMANCE**

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Abstract

Improving Social Interactions, learning skills, health and confidence can be achieved through sport and motor development. Young athletes can adapt to new situations and learn various skills quicker than older athletes. The aim of the present study was to investigate the effect of parkour on youth football players' performance using Tacto software. Tacto software can evaluate players' motor skills in sporting environments. To conduct this study, 10 youth players of 8-10 years of age from the professional football club of Sheffield United Academy were selected. The players were asked to take part in 6 sessions of parkour practice. Their football performance was recorded using a 2D camera in indoor 5-a-side football matches prior to and during parkour sessions, and after the last parkour practice session. Tacto software was used to extract the players' performance parameters included velocity, displacement and acceleration from the recorded tapes. The performance parameters were analysed using SPSS and Excel. The results of paired t-test show significant differences in velocity, acceleration and displacement between football matches before parkour practice and after 6 sessions of parkour. Overall, football players' performance improved after they became familiar with parkour and it is anticipated that spending more time practicing parkour will result in the players' greater improvement and will ensure successful outcomes.

Key words: *Parkour, Tacto, Paired t-test, Youth athletes, Sports, Dyadic system*

Introduction

The results of the study by Biddiss and Irwin (2010) have suggested that recently a high percentage of children prefer to spend their free time on sedentary activities, and a child of 8-10 years of age typically spends more than one hour per day playing video games. These habits could be the cause of obesity and reduced physical activities in children. Sports are one of the best ways to improve children's social interaction, learning skills, health and confidence and they are highly beneficial for motor development. Moreover, youth athletes can adapt to new situations and learn various skills quicker than older athletes (Tustin, 2018). A coach's responsibility is to develop athletes' mentality, techniques related to desired sport and decision making skills. Coaches must be cautious not to put youth athletes under more than necessary pressure, and they have to improve their training designs and analyse athletes accurately. A valuable and effective behaviour to control stage along with players' displacement coordination of players learning is exploratory practices (Araujo et al., 2015).

For example, in football, all of the positions require special coordination and body awareness skills, and parkour is advantageous because it engages both body muscles and the brain (Smyth & Anderson, 2001).

Parkour is beneficial for athletes that challenged to negotiate obstacles of various natures during practice to improve their athleticism. Moreover, parkour is advantageous to the improvement of athletes' creativity during physical activities because in this sport athletes are continuously faced with surfaces of various textures, angle and sizes in different environments and combine movements to the key informational sources (Miller & Demoiny, 2008). Parkour influences initial velocity, improves the athletes' agility and teaches athletes to decide quickly in different or new situations. Another effect of parkour on athletes is existing to space to perform the exercise. This means that after practicing parkour, athletes do not need to take some steps back in order to jump further (Atkinson, 2009). Therefore, it is an effective method to design training sessions based on this sport to improve players' initial speed of mobility and movement in football, especially to catch the ball in 1v1 competition. In addition, players can improve their ability to prevent injuries from pushing or tackle by opponent during physical activities or matches. To study the effect of parkour on football players' performances, Sheffield United FC (a professional club in England) youth football players were selected as participants in this project.

Tacto is a software that analysis athletic performance, analyse the development of players on some skills such as team relevant velocity, total

displacement, average velocity and acceleration of each team, body awareness, interpersonal displacement and compare values between the players or teams ((Edgecomb & Norton, 2006) & (Serrano & Fernandes, 2011)).

The aim of this study was to investigate the effect of parkour on the performance analyse the individual skills of the youth football players from Sheffield United Academy. The players' performance was recorded by a 2D camera during friendly 5-a-side matches and all the parameters were extracted using Tacto software. It was expected that parkour be highly beneficial in the improvement of athletes' agility, high-speed actions and creativity in different conditions, and thus, rapid decide making. Tacto software was applied to extract the performance parameters and analyse the results.

Material and methods

The participants consisted of 10 experienced football players (age: 9 ± 1 years) from Sheffield United Academy. The benefits and positive effects of parkour skills were explained to the Academy coaches by a professional. In addition, Tacto software was demonstrated to the coaches and the method of value measurement by Tacto was described to them. After they accepted to use and teach parkour skills to their players, the Academy prepared a form to explain the procedure to players' parents and obtain their permission for this task. All players' parents signed an informed consent attesting the teaching of parkour to their children and recording of their matches for the study. Players were divided into two teams of 5 players that were called Right-team and Left-team throughout this study. They asked to play 4 minutes' football match in 20 x 15 meters football field. The warm up with parkour was performed in 6 individual sessions each lasting 30 minutes. The warm up was incorporated into their weekly training sessions. Practice football matches on artificial field were played before teaching parkour (beginning of the process), after 3 sessions of parkour (the middle of the process) and after the final parkour session (end of this process). The players' motion was captured using a digital video camera. In the process of calibration, 6 cones (as signs) were placed inside the pitch by following an imaginary square. Then, 2 participants were requested to have a 1v1 competition to check the coordination on the x and y axis before the match. The dimension and order of each cone for calibration is shown in figure 1. Tacto digitising action was 25Hz for extract data on player displacement coordinates.

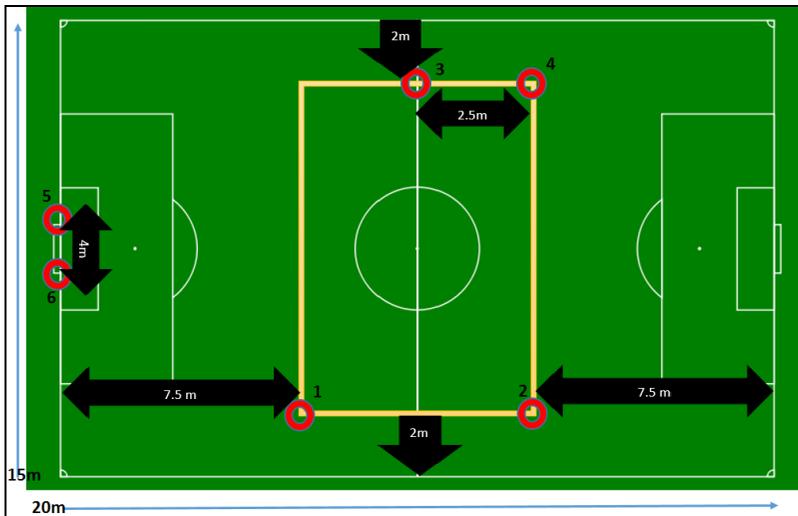


Figure 1. Dimension and place of the cones in the pitch
(Each cone would be a control point to calibrate the pitch in Tacto. The numbers show the order of selection of the calibration points)

After placing the cones as signs to calibrate the camera, the players' movement trajectories were captured by a digital speed 2D camera. The camera was placed on an elevated plane with 6 meters' height, forming an angle of 45° with the linear (y) axis of the selected area (Duarte et al., 2012). In the next step, the computer mouse arrow was placed between each player's feet and the players' movements were manually followed. Tacto was used for image treatment and digitisation of the videos at 25 frames per second (Fernandes & Malta, 2007). The study by Duarte et al. (2012) showed that the cameras with this amount of Hz are suitable for analysis in Tacto software.

Subsequently, data on the velocity, acceleration, displacement and position of each player in all trails were computed with Excel. The process of calculating the variables is presented in the 'Data Processing' section. The average values of all participants were used to measure their performance enhancement. The data of displacement trajectories of youth players was manually digitised with Tacto, and bi-dimensional pixel coordinates were obtained (Fernandes et al., 2010). The x and y direction of players in a period of time was measured by Tacto.

The formula for the Pythagoras theorem was used to measure the total displacement in each period of time. The equations used to measure displacement, velocity and acceleration are presented below:

$$\text{Displacement} = \sqrt{x^2 + y^2}$$

Equation 1. Pythagorean equation (This equation is equal to the sum of the squares of the other two sides; in this study the two other sides are the two axes in x and y direction).

$$V = \Delta x / \Delta t$$

Equation 2. An object's average velocity over a period of time (In this equation, V is the average velocity, **Error! Reference source not found.** is the change in displacement and **Error! Reference source not found.** is the duration of time).

$$a = \Delta V / \Delta t$$

Equation 3. An object's average acceleration over a period of time (In this equation, a is acceleration, **Error! Reference source not found.** is the change in velocity and Δt is the duration of time).

By correlational running of football players, it was possible to measure two types of coordination tendencies: (i) The coordination of each player during matches and the interpersonal interaction of a defender head-on an attacker; and (ii) The average relative velocity, displacement and acceleration of all players as a team during three different matches. The second type was used to analyse the players' performance enhancement.

The study of the interpersonal interactions of 1v1 competition (attacker-defender) dyads for the football players was based on the study by Passos et al. (2013). In this sub-phase, an attacker tries to dribble the defender and defender tries to block the ball. The variable of relative angle illustrates whether the attacker was successful or not when their distance is less than 4 meters (Duarte et al., 2010). Relative angle is an imaginary angle between attacker, defender and the centre of the goal target and calculated by using equation 4.

$$\theta(t) = \arcsin \left(\frac{(Y_{attacker} - Y_{defender})}{\sqrt{(X_{attacker} - X_{defender})^2 + (Y_{attacker} - Y_{defender})^2}} \right)$$

Equation 4. Calculating relative angle between attacker, defender and centre of the goal target.

The angles close to 90° signified that the attacker was on a hypothetical perpendicular line with the defender. Decrease in the angle value shows that the attacker tried to dribbled the defender. However, after the attacker passed the defender, there were two possible occurrences. The first possibility was that the attacker passed the defender without any contact that means the attacker was successful in dribbling the defender. In this situation, the angle values continuously decreased up to around -90° and the attacker moved toward the try line. The second possibility was a contact between defender and attacker. In this situation, there were fluctuations in angle values and the cessation of fluctuation meant that either the defender had tackled and blocked the attacker, or the attacker had avoided a contact

with the defender (for example, had passed the ball to another teammate). If the relative angle never decreases up to 0° , it means the attacker could not pass or dribble the defender or the defender did not allow the attacker to pass him.

Another variable that was analysed in this study was the fluctuation rate of relative angle position between the attacker and the defender. This variable showed which of the 3 situations was the appropriate outcome of the attacker-defender encounter: (i) the attacker successfully tackled and blocked the defender; (ii) the defender was unsuccessful in tackling the attacker; and (iii) the attacker destabilized the dyad. The fluctuation rate of relative angle was measured by central finite differences approximation of derivatives for a given time that already measured in Tacto.

$$\left(\frac{d\theta(t)}{dt} = \frac{\theta(t1 + \Delta t) - \theta(t2 + \Delta t)}{(2 \cdot \Delta t)}\right)$$

Equation 5. The formula for the calculation of the fluctuation rate of relative angle position between the attacker and the defender.

Phase space graphs are drawn to identify the existence of chaotic attractor in time (Brown & Henkel, 1995). In These graphs, the x and y axes, respectively, represented the defender-attacker vector values and the players' first derivative. These nonlinear tools helped the analysers to recognise the variability and complexity analysis for each coordination pattern.

The statistical analyses were conducted in SPSS software (Version 22.00, IBM Corporation, Armonk, NY, USA). Using Kolmogorov-Smirnov test, the normality of the data was assessed before any further data analyses (Field, 2013). The normally distributed data were analysed through parametric methods. Paired t-test was used to compare the youth players' mean values of displacement, velocity and acceleration between: (i) before teaching parkour and after 3 sessions of parkour (middle of process); (ii) before teaching parkour and after the final session of parkour; and (iii) after 3 sessions of parkour and after the final session of parkour.

Results

The variables were collected for each practice session and compared by using paired t-test in SPSS software. In the statistical analyses, each parameter value for each session was compared with that for other match sessions. Tables 1 to 3 show the differences in mean, standard deviation, standard error of the mean, confidential interval, t-test value, degree of freedom and level of significance for the velocity, acceleration and displacement of all players. In the level of significance column, values of less than 0.05 illustrate that the differences between the two compared sessions in the related variable were statistically significant (Tables 1 to 3).

Table 1

Paired t-test statistical analyses of all of the players' velocity improvement as one team during three practice match sessions

		Paired Differences					t	df	Sig. (2-tailed)
		Mean difference	SD	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre_test - Mid_test	-0.265	0.049	0.035	-0.709	0.179	-7.571	1	0.084
Pair 2	Pre_test - Transfer test	-0.755	0.077	0.055	-1.453	-0.056	-13.727	1	0.046
Pair 3	Mid_test - Transfer test	-0.490	0.127	0.090	-1.633	0.653	-5.444	1	0.116

(Each session was compared individually with another session and only the variables with a significance level of less than 0.05 (2-tailed) had differed significantly).

Table 2

Paired t-test statistical analyses of all of the players' acceleration improvement as one team during three practice match sessions

		Paired Differences					t	df	Sig. (2-tailed)
		Mean difference	SD	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre_test - Mid_test	-0.0030	0.0002	0.0002	-0.0055	-0.0004	-15.00	1	0.042
Pair 2	Pre_test - Transfer test	-0.0035	0.0002	0.0002	-0.0060	-0.0009	-17.50	1	0.036
Pair 3	Mid_test - Transfer test	-0.0005	0.0005	0.0004	-0.0055	0.0045	-1.250	1	0.430

(Each session was individually compared with another session and only the variables with a significance level of less than 0.05 (2-tailed) had significantly differed).

Table 3

Paired t-test statistical analyses of all of the players' displacement (total distance that they had ran) improvement as one team during three practice match sessions

		Paired Differences					t	df	Sig. (2-tailed)
		Mean difference	SD	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre_test - Mid_test	-168.6	24.3	17.2	-387.6	50.4	-9.7	1	0.065
Pair 2	Pre_test - Transfer test	-211.1	19.8	14.1	-389.7	-32.5	-15.0	1	0.042
Pair 3	Mid_test - Transfer test	-42.6	44.2	31.2	-440.2	355.1	-1.3	1	0.403

(Each session was individually compared with another session and only the variables with a significance level of less than 0.05 (2-tailed) had differed significantly).

Figure 2 shows the patterns of interpersonal dynamics in 1v1 defender-attacker dyads in football. The left side of figure 2 illustrates the situation in which the defender tackled the ball and successfully stopped the

attacker and the right side of figure 2 illustrates the situation in which the attacker was successful and dribbled the defender. In figure 2, the A and D sections represent the collective variable against time, sections B and E represent the plot of first derivatives against time, and C and F represent the phase space illustrating collective variable as x axis and first derivative as y axis. As can be seen in figure 2, in cases in which the defender was successful, the collective variable had a positive value and the first derivative had a negative value. The opposite was true when the attacker was successful.

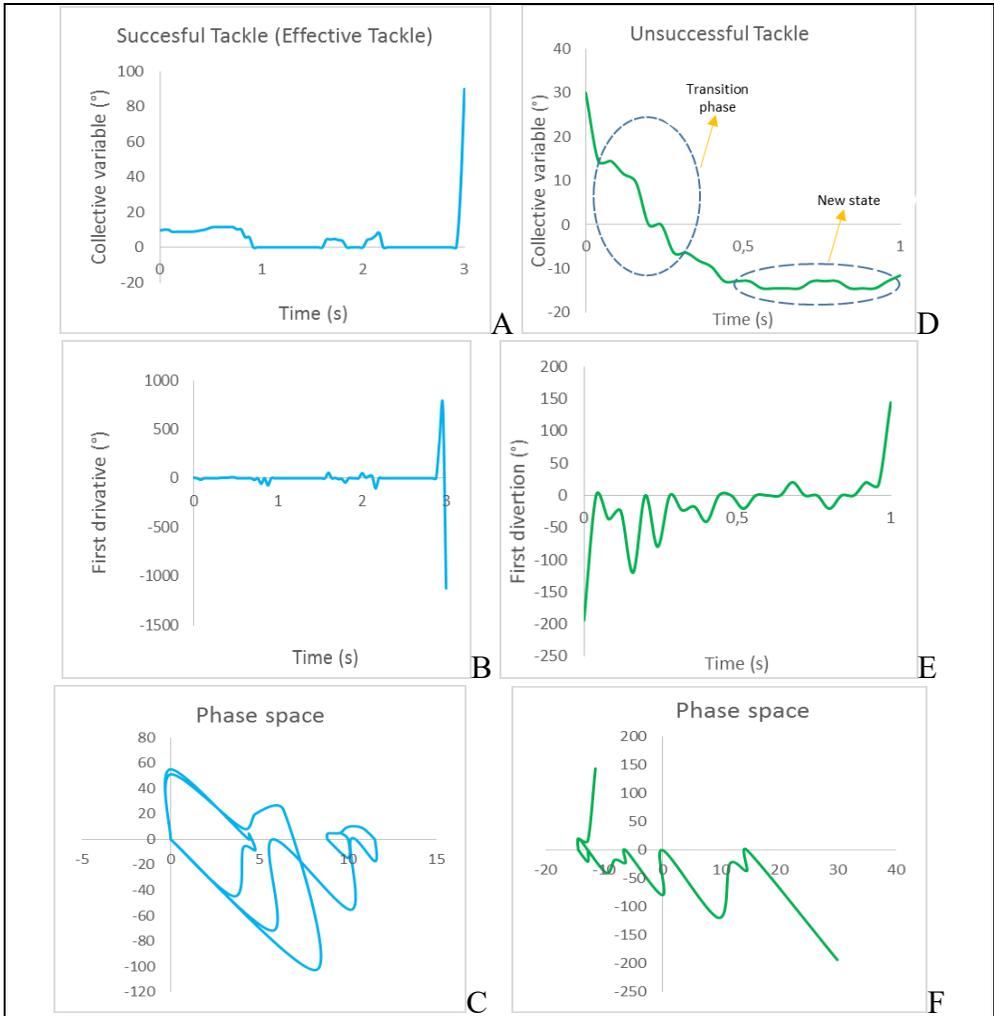


Figure 2. The left side of the figure shows a successful defender and the right side a successful attacker. Sections A and D show the collective variables against time, B and E show first derivatives against time, and C and F show phase space.

The last graph (Figure 3) is an example of the comparison of the teams' total displacements and average velocity during the mid-test session. From this graph, the performance of the teams can be understood during a whole 4-minutes match and at each second of the match, what team was more covered the pitch.

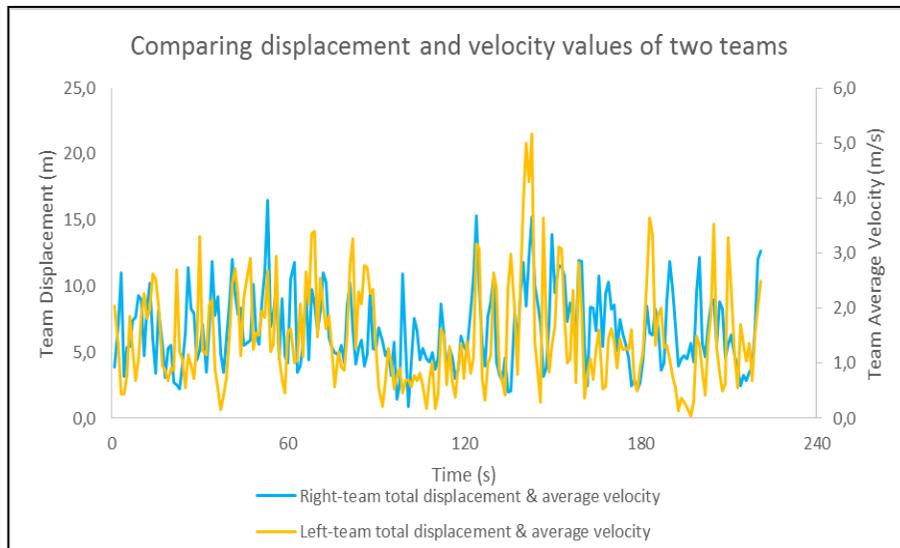


Figure 3. The displacement and the velocity during the whole 4 minutes' match in the mid-test session for the two teams. The yellow lines were for left team and blue line for right team.

Discussion

After data collection and analysis using SPSS software, data shows that the significant values of average velocity, acceleration and displacement for all players between the pre-test and transfer-test were reliable (0.046, 0.036 and 0.042). In addition, the difference in acceleration between pre-test and mid-test was also significant (0.042). These results showed that all the players' performance enhanced significantly by learning parkour skills. In all 3 parameters of velocity, acceleration and displacement, the differences were significant between before and after parkour introduction. This could be due to learning new parkour skills; the players' body awareness helped them to have more open minded during the match, and thus, they tried to cover more parts of the pitch in order to block the opponent.

Conclusion

Tacto is a performance analysis system that makes the comparison of 2 teams or 2 players possible. Tacto is an accurate method and many variables can be measured and analysed with it. After collecting players'

movements in x and y axis by using Tacto, with mathematical skills and engineering knowledge it is possible to achieve the data requested by the analyser or the coach.

The overall results showed that by introducing parkour skills to the warm up session of youth football players, their performance were enhanced. Young athletes can have more parkour training sessions to achieve more success and run longer distances and faster, improve their body awareness and prevent injury. Furthermore, coaches can use Tacto software to analyse variables such as interpersonal interaction in order to design further training sessions and become familiar with the weaknesses or strengths of their players and how to arrange the players for the matches or different training systems. In addition, the coach can evaluate the players' performance individually, and for example, if one player runs much more than his teammates, the coach can divide their roles in a way to maintain balance in the team if needed.

Practical Implication

- Parkour is an effective method to enhance athletes' performance.
- Tacto is a method to analyse athletes' performance.
- Matlab or Excel are the assistant software to analyse the collected data in Tacto.

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