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Effort distribution analysis for the 800 m race: IAAF World Athletics Championships, London 2017 and Birmingham 2018

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Abstract

Study aim: To analyse the distribution of effort in the 800 m event at the IAAF World Athletics Championships in London 2017 (outdoor, 44 men, 45 women) and in Birmingham 2018 (indoor, 9 men, 14 women).
Material and methods: A total of 187 individual performances during heats, semi-finals, and finals were analysed. The official split times of each athlete every 100 m were taken as reference for the analysis of: times; percentages of times in regard to the final time; speed; changes in position during the races; percentage deviations in terms of the average time per race per section of 100, 200 and 400 m.
Results: There are different strategies used in the elite 800m race that are related to sex differences, the management of energy consumption and the differences and similarities between indoor and outdoor races.
Conclusions: Although diverse pacing strategies exist, more balanced strategies, after a fast start, have better results.

Key words: Elite athletics – Track & Field – Pacing strategies – Effort distribution – Pace analysis

Introduction

The 800m event is the shortest middle-distance race in the Olympic Games and World Championships and the first event where the balance of the energy systems during the race is controlled mainly by the aerobic system [5]. The distribution of work during the race, known as the pacing strategy [7] influences the final outcome [1] because of metabolic saturation or depletion of energy reserves. A significant correlation exists between the positions at the 400m mark and the qualification for the next round indicating that the racing strategy plays a key role in race outcome [10]. The exercise intensity is regulated via the pace of the race to ensure positive results [13]. Athletes consciously ensure an optimum pace by following the internal signs from their physiological state, their perception of effort throughout the race and their interaction with other athletes, with the brain processing different efferent (feed forward) and afferent (feedback) stimuli.

Multiple ways of planning for a race exist, and significant differences between Olympic medals, world records (WRs) and personal bests (PB) can be found [12], although there are exceptions, such as the current men's outdoor WR obtained by David Rudisha in the 2012 Olympic final. It is therefore important to understand the differences between the diverse strategies of effort management. Previous experience, training, and tactical knowledge are important factors that influence a faster or slower pace [14]. Moreover, during championship qualifying series, athletes that run the last races have the results of the previous ones as reference, allowing them to calculate the required qualifying time, if they cannot do so by position.

In the IAAF (known as World Athletics since 2019) World Championships, the 800m race has two different settings: an 8-lane outdoor 400 m track, measured along the inside of lane 1, or a 6-lane indoor 200 m track. Moreover, there are two types of 800 m races: those in championships, (more tactical with athletes aiming for the best possible rankings), and those in meetings (normally counted as pacemakers and known as 'racing the clock' or 'head-to-head' competitions [1]), which aim for excellent finish times. Nonetheless, there are examples of competition races without pacemakers that have finished

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with WR times, e.g. the current men 800m WR of David Rudisha, achieved in the final of the 2012 Olympic Games (1’40”91).

Observational methodology has been successfully used in a wide range of studies in the area of sport [2] due to its immense potential in the study of human behaviour [3]. An observational analysis of the result in athletics competitions does not explain how this has been achieved. It is therefore important to know which quantitative and qualitative variables influence performance to control them in the least invasive way for the athlete. The analysis of the split times of the athletes every 100 m in the 800 m events of the IAAF World Athletics Championships London 2017 (outdoor) and Birmingham 2018 (indoor), leads to a comparison of the distribution of effort as well as the analysis of the tactical approaches and physiological and strategic aspects of each race. Performance profiles can be established both for men and women, in heats, semi-finals and finals, and in different settings (indoor and outdoor). The present work analyses the rhythmic structures used by each athlete, aiming to identify optimal pacing strategies.

Materials and methods

Ethical approval

The present research complies with the Declaration of Helsinki. An approval for this project was obtained from Ethics Committee for Clinical Research of the Catalan Sports Council (reference number: 14/CE/CGC/2020).

Data analysis

Data of all participants of the 800m event at the IAAF World Athletics Championships London 2017 (44 men, 45 women) and the IAAF World Indoor Athletics Championships Birmingham 2018 (9 men, 14 women) were analyzed. Since 7 men and 9 women participated in both championships, the total sample size was n = 96 (46 men, 50 women).

Twenty-seven races were analysed (20 London, 7 Birmingham13 men and 14 women),as well as the individual performances of 90 men (75 London, 15 Birmingham) and 97 women (77 London, 20 Birmingham). In London, there were 6 heats, 3 semi-finals and 1 final in each category, men and women; in Birmingham, 2 men’s and 3 women’s semi-finals, and 1 men’s and 1 women’s final. Thus, for each sex, five race groups were analysed (London heats, semi-finals and final, and Birmingham semi-finals and final).

Of the total sample, 21 men (45.7%) participated in only one race, 11 (23.9%) participated in two races, 10 (21.7%) participated in three races, and 4 participated in 4 or 5 races (8.7%). 22 women (44%) participated in only one race, 17 (34%) participated in two races, and 11 (22%) participated in between 3 and 5 races.

The official split times used in this analysis were published by the IAAF (https://www.worldathletics.org/) as measured with a Seiko Holdings Corporation (Japan) four-transponder antennae under the 400 m track at 0 m, 100 m, 200 m and 300 m, and ID chips on the inside of each athlete’s front bib. When the athletes passed over the transponder, their ID is read from the chip and their time is registered to the nearest hundredth of a second.

Statistical analysis

Average and standard deviations were calculated as descriptive indices for the inferential analysis of the data. An ANOVA analysis of variance for repeated measures was applied to determine the influence of the independent variables of sex (men, women), race (heat, semi-final, and final), championship (London 2017, Birmingham 2018), and the sex interactions per championship and sex per race, over the dependent variables of time and percentage of time used (measured at 100, 200, and 400 m intervals), speed (measured at 100 m intervals), and split times (measured at 100, 200, and 400 m intervals). The Mauchly test was applied to check the sphericity, the adjustment of Bonferroni at the contrasts, and the correction of Greenhouse–Geisser applied when the sphericity was violated, given that on all occasions $\varepsilon < 0.75$, except in the comparison of the 400 m, where checking the sphericity was not viable. To quantify the magnitude of the effect exposed in the partial eta square index, assuming $\eta^2_p < 0.01$ *trivial effect*, $0.01 < \eta^2_p < 0.06$ *small effect*, $0.06 < \eta^2_p < 0.14$ *medium effect*, $\eta^2_p > 0.14$ *important effect*. The statistical analysis was carried out using JASP, version 0.10.2 (Department of Psychological Methods, University of Amsterdam, Netherlands).

Results

Comparing the average finishing times between men (107.19 ± 3.16 s) and women (121.82 ± 3.39 s), significant statistical differences were found ($F_{1;177} = 1054.79$; $p < 0.001$; IC95% from 12.88 to 15.16 s.; $\eta^2_p = 0.843$). Significant statistical differences were also found regarding the average times achieved outdoors (London, 114.47 ± 7.97 s) and indoors (Birmingham, 116.14 ± 8.27 s) ($F_{1;177} = 35.549$; $p < 0.001$; IC95% from 0.098 to 2.58 s; $\eta^2_p = 0.134$).

100 m split times

Significant statistical differences were found regarding all 100 m split times ($F_{1;1253} = 94468.106$; $p < 0.001$; $\eta^2_{partial} = 0.998$), as well as the 100 m split times between men and women($F_{1;1253} = 403.55$; $p < 0.001$; $\eta^2_{partial} = 0.693$). The comparison between groups (between subjects) revealed significant statistical differences between sex (Sex)

($F_{1;178}$ = 959.316; $p < 0.001$; $\eta^2_{partial}$ = 0.843), between championship ($F_{1;178}$ = 24.799; $p < 0.001$; $\eta^2_{partial}$ = 0.134) and between round ($F_{1;178}$ = 18.720; $p < 0.001$; $\eta^2_{partial}$ = 0.173), with important effect sizes ($\eta^2 > 0.14$).

In the percentage distribution of the time taken to run the different 100 m sections of the race (see Table 1), significant statistical differences were observed ($F_{1;1253}$ = 46.401; $p < 0.001$; $\eta^2_{partial}$ = 0.206); this is also the case if the total percentage distribution is compared (between subjects) between the two sexes, ($F_{1;178}$ = 402.786; $p < 0.001$; $\eta^2_{partial}$=0.692).

Average speed values, obtained from the average time of each 100 m section (see Table 2) showed statistically significant differences ($F_{1;1253}$ = 107.648; $p < 0.001$; η^2_{split} = 0.376);this is also the case when comparing the total speed (inter-subjects) in relation to sex ($F_{1;178}$ = 883.055; $p < 0.001$; η^2_{split} = 0.831) and in relation to round ($F_{2;178}$ = 18.128; $p < 0.001$; η^2_{split} = 0.168) with significant impact ($\eta^2 > 0.14$).

Significant statistical differences were also observed ($F_{1;1253}$ = 93.684; $p < 0.001$; η^2_{split} = 0.344) regarding the average time per 100 m section (s) and the percentage difference in relation to the average time per 100 m section.

Table 3 presents the average position changes of the athletes every 100 m, as calculated from the data.

200 m split times

In all the 200 m split times, statistically significant differences were observed ($F_{1;537}$ = 101.730; $p < 0.001$; η^2_{split} = 0.362).

In the percentage differences in relation to the average time per 200m, obtained during the different 200 m sections of the race, significant statistical differences were also observed ($F_{1;537}$ = 111.169; $p < 0.001$; η^2_{split} = 0.383).

400 m split times

In the percentage distribution of the times taken to cover the different 400 m sections of the race, statistically significant differences were observed ($F_{1;178}$ = 27.012; $p < 0.001$; $\eta^2_{parcial}$ = 0.131).

In the split times of all the 400 m sections, statistically significant differences were also observed ($F_{1;178}$ = 24.924; $p < 0.001$; η^2_{split} = 0.122) with a moderate impact, and this was also the case if the split times were considered jointly (inter-subjects) and related to sex ($F_{1;178}$ = 587.122; $p < 0.001$; η^2_{split} = 0.766).

The rest of the comparisons of the split times in general (inter subjects) and per 100 m, 200 m, or 400 m sections (intra subjects), did not show important effects ($\eta^2 > 0.14$), even though some presented significant statistical differences ($p < 0.05$).

Table 1. Time percentage of each 100m section with regard to the athletes' final race time (%)

Distances	0_100m	100_200m	200_300m	300_400m	400_500m	500_600m	600_700m	700_800m
Men	11.79 ± 0.4	11.84 ± 0.5	12.66 ± 0.5	12.82 ± 0.4	12.85 ± 0.3	12.59 ± 0.4	12.54 ± 0.5	12.89 ± 0.7
London 2017								
Heats	11.81 ± 0.4	11.87 ± 0.4	12.52 ± 0.4	12.69 ± 0.3	12.74 ± 0.3	12.68 ± 0.5	12.70 ± 0.4	12.99 ± 0.8
Semi-final	11.67 ± 0.2	11.56 ± 0.2	12.91 ± 0.4	12.99 ± 0.4	13.11 ± 0.3	12.54 ± 0.2	12.49 ± 0.5	12.71 ± 0.4
Final	11.55 ± 0.3	11.59 ± 0.2	12.53 ± 0.2	12.81 ± 0.1	13.01 ± 0.1	12.42 ± 0.2	12.71 ± 0.2	13.38 ± 0.6
Birmingham 2018								
Semi-final	12.02 ± 0.4	12.06 ± 0.5	12.32 ± 0.4	12.62 ± 0.4	12.74 ± 0.1	12.74 ± 0.2	12.44 ± 0.5	13.06 ± 0.8
Final	12.24 ± 0.2	12.73 ± 0.1	13.36 ± 0.1	13.41 ± 0.1	12.50 ± 0.2	12.28 ± 0.2	11.43 ± 0.1	12.05 ± 0.3
Women	11.90 ± 0.4	12.91 ± 0.4	12.98 ± 0.4	12.86 ± 0.3	12.86 ± 0.3	12.51 ± 0.3	12.53 ± 0.4	12.74 ± 0.6
London 2017								
Heats	11.81 ± 0.4	13.13 ± 0.4	13.08 ± 0.4	12.80 ± 0.3	12.80 ± 0.3	12.40 ± 0.4	12.63 ± 0.4	12.76 ± 0.6
Semi-final	12.03 ± 0.2	12.90 ± 0.3	13.04 ± 0.3	13.00 ± 0.1	13.00 ± 0.1	12.68 ± 0.2	12.43 ± 0.3	12.55 ± 0.4
Final	11.86 ± 0.2	13.26 ± 0.2	13.14 ± 0.2	12.93 ± 0.1	12.93 ± 0.1	12.17 ± 0.2	12.51 ± 0.2	12.60 ± 0.4
Birmingham 2018								
Semi-final	12.03 ± 0.5	12.49 ± 0.5	12.89 ± 0.2	12.95 ± 0.2	12.95 ± 0.2	12.84 ± 0.2	12.49 ± 0.5	12.84 ± 0.8
Final	12.57 ± 0.3	13.06 ± 0.2	12.09 ± 0.3	12.53 ± 0.2	12.53 ± 0.2	12.40 ± 0.1	12.31 ± 0.3	13.28 ± 0.6

Percentage mean (SD) of each 100 m section (%).

Table 2. Average speed in each 100m section (m/s) and average race speed (m/s)

Distances	0_100m	100_200m	200_300m	300_400m	400_500m	500_600m	600_700m	700_800m	MVrace_m/s
Men	7.91 ± 0.2	7.89 ± 0.3	7.38 ± 0.2	7.29 ± 0.2	7.33 ± 0.1	7.42 ± 0.3	7.46 ± .4	7.27 ± 0.5	7.47 ± 0.2
London 2017	8.04 ± 0.2	8.04 ± 0.2	7.42 ± 0.2	7.32 ± 0.2	7.25 ± 0.3	7.49 ± 0.3	7.44 ± 0.4	7.23 ± 0.5	7.51 ± 0.2
Heats	7.86 ± 0.2	7.82 ± 0.2	7.42 ± 0.2	7.31 ± 0.2	7.29 ± 0.3	7.34 ± 0.4	7.32 ± 0.4	7.18 ± 0.6	7.43 ± 0.3
Semi-final	8.06 ± 0.1	8.14 ± 0.2	7.29 ± 0.2	7.25 ± 0.2	7.18 ± 0.2	7.50 ± 0.1	7.54 ± 0.3	7.41 ± 0.2	7.53 ± 0.1
Final	8.20 ± 0.2	8.17 ± 0.1	7.55 ± 0.1	7.39 ± 0.1	7.28 ± 0.1	7.62 ± 0.2	7.45 ± 0.2	7.09 ± 0.3	7.57 ± 0.1
Birmingham 2018	7.68 ± 0.2	7.52 ± 0.4	7.26 ± 0.4	7.16 ± 0.3	7.37 ± 0.1	7.44 ± 0.2	7.81 ± 0.4	7.43 ± 0.5	7.44 ± 0.1
Semi-final	7.79 ± 0.2	7.77 ± 0.4	7.60 ± 0.2	7.42 ± 0.2	7.34 ± 0.1	7.34 ± 0.2	7.53 ± 0.3	7.19 ± 0.5	7.48 ± 0.1
Final	7.56 ± 0.1	7.27 ± 0.1	6.92 ± 0.1	6.89 ± 0.1	7.40 ± 0.1	7.53 ± 0.1	8.09 ± 0.1	7.67 ± 0.2	7.40 ± 0.1
Total	7.89 ± 0.2	7.83 ± 0.3	7.36 ± 0.2	7.25 ± 0.2	7.30 ± 0.3	7.47 ± 0.3	7.59 ± 0.4	7.31 ± 0.5	7.48 ± 0.2
Women	7.18 ± 0.2	6.88 ± 0.2	6.33 ± 0.2	6.79 ± 0.5	6.39 ± 0.2	6.57 ± 0.3	6.56 ± 0.3	6.47 ± 0.4	6.57 ± 0.2
London 2017	7.27 ± 0.2	6.99 ± 0.2	6.35 ± 0.2	6.36 ± 0.2	6.45 ± 0.2	6.71 ± 0.3	6.65 ± 0.3	6.59 ± 0.4	6.66 ± 0.2
Heats	7.15 ± 0.2	6.90 ± 0.2	6.21 ± 0.2	6.23 ± 0.2	6.37 ± 0.2	6.58 ± 0.3	6.46 ± 0.3	6.40 ± 0.4	6.52 ± 0.2
Semi-final	7.00 ± 0.2	6.70 ± 0.2	6.50 ± 0.3	6.30 ± 0.2	6.30 ± 0.3	6.3 ± 0.3	6.50 ± 0.4	6.30 ± 0.4	6.50 ± 0.2
Final	7.39 ± 0.2	7.18 ± 0.1	6.42 ± 0.1	6.48 ± 0.1	6.59 ± 0.1	7.00 ± 0.2	6.82 ± 0.2	6.77 ± 0.3	6.82 ± 0.1
Birmingham 2018	7.06 ± 0.2	6.67 ± 0.2	6.43 ± 0.3	6.58 ± 0.3	6.45 ± 0.3	6.50 ± 0.3	6.63 ± 0.4	6.30 ± 0.4	6.56 ± 0.2
Semi-final	7.05 ± 0.2	6.73 ± 0.2	6.49 ± 0.3	6.28 ± 0.2	6.26 ± 0.3	6.31 ± 0.3	6.50 ± 0.4	6.33 ± 0.4	6.48 ± 0.2
Final	7.07 ± 0.1	6.61 ± 0.1	6.36 ± 0.1	6.87 ± 0.1	6.63 ± 0.1	6.69 ± 0.1	6.75 ± 0.2	6.26 ± 0.4	6.64 ± 0.1
Total	7.19 ± 0.2	6.86 ± 0.2	6.38 ± 0.2	6.44 ± 0.2	6.45 ± 0.2	6.62 ± 0.3	6.64 ± 0.3	6.47 ± 0.4	6.62 ± 0.2

Average speed (SD) (m/s).

Table 3. Average position changes of the athletes every 100m

	Men London 2017	Men Birmingham 2018	Women London 2017	Women Birmingham 2018
Heats	3.0	–	3.2	–
Semi-finals	2.9	2.7	3.9	1.9
Final	4.1	3.8	3.9	2.8

Discussion

Due to the bioenergetic and tactical characteristics of the 800m event, it is essential to analyse how the athletes distribute their effort during the race, in order design optimal pacing strategies and thus improve performance. In this paper we analyzed the split times of each athlete every 100 m, thus achieving far more detailed, accurate and significant results than the limited results that provides the classic division of the race into two 400 m sections.

By demonstrating and analysing the rhythmic profiles performed by elite-level athletes in competition, both outdoor and indoor, and in the male and female categories, the final result of each athlete is explained to a large extent, and the different effort distribution strategies are linked with their competitive outcome. This will serve as a great help to all 800 m coaches, even at a much lower competitive level, as they can this way implement better pacing strategies, better adapted to their athletes.

First and second 400 m

Since the outdoor Athletics WRs were officialised in 1912, only two men WR holders ran the second lap been faster than the first [14]. This shows that when an athlete runs around their PB, it is very difficult to run the second lap faster than the first, from a physiological point of view. But it is not impossible, and there are isolated cases in which this circumstance occurs.

The present study showed that 84.4% of men and 72.2% of women of the total sample ran the first 400 m faster than the second. In all races, the last 400 m were ran slower in a statistically significant manner, except in the men's final in Birmingham.

In the 800 m event, two different types of the distribution of effort can be found. The positive split strategy, which is clearly identified when the speed during the event gradually decreases [1, 4, 6, 7, 11, 12] and the negative split strategy, whereby an increase in the speed throughout the race can be observed, and normally a final sprint. This strategy is normally used in qualifying races, where the global time is not relevant [7]. The intention is to manage fatigue and to use all the available energy of the different energy systems in the final phase of the race [13]. In this study, the clear use of this strategy was only found in the men's final in Birmingham.

For Gajer *et al*. [8], the gap in % compared to the average time of the race per lap (Total time/2) is 2% for the best male athletes (1'48'' or better mark) and about 1.5% for male athletes of lower level (more than 1'50'').In the two analysed championships, both for men and women, and in the different race groups, it was observed that these proposed percentages were not met, as there are a great variety of models. The reason for this is that the situation being analysed was a championship, which is very different to a race where the goal is to obtain a PB.

Therefore, no statistically significant correlations were found between the gap of the average time per lap and the final time at the finish line. In the London men's category, the percentage was higher in the final (3.04%), which was faster, than in previous races (2.05%), which were slower. However, in the women's category this is not true: although semi-finals were faster than the heats, and the final was faster than the semi-finals, the percentage increase in the previous races was (1.20%) compared to the final (0.40%).

In Birmingham, a significant correlation was not found either. The analysis showed a tactical and slow final where the second half was run faster than the first. This shows a gap in the percentage, in reference to the average time of the race per lap, of 1.96% in the semi-finals (which were faster) and – 3.47% in the final (which was slower). On the other hand, in the women's category, it varied from – 2.21% in the semi-finals (which were slower) to 1.06% in the final (which was faster).

Therefore, it is not possible to establish an ideal percentage in this variable in a championship, where there is a great variety of paces and strategies. Instead, there are cases of athletes who have run in championships at the pace of their PB. In 800 m races there are only a few, but there is always an athlete that can exceptionally achieve this. That is why all races have been analysed using the PB of the sample. In the men's category, six athletes attained a PB, three in London and three in Birmingham. Since the PBs of these athletes are under 1'48'' and applying the Gajer *et al*. [8], criteria of about 2% of optimal difference, it was observed that the average of these six athletes is 2.50%. Considering the low sample size ($n = 6$) it is difficult to establish a comparison even though the values approximate each other.

In the women's category, there are eight cases of athletes that obtained their PB, five in London and three in Birmingham, of which four were medallists. In this case however, the results are very different with an average in reference to the average time per lap of 0.93%. Therefore, although the sample is very small ($n = 8$) it can still be sensed that in the case of the female participants at a PB pace, where races are slower than in the male ones, the optimal percentage difference in reference to the average time per lap has to be lower and should be under 1%.

Analysis every 200 m

In 800 m races run at a PB pace, the same profile of work distribution is always found: the first 200 m are around 5% faster than the average time of each 200 m. Next, there is a steady speed plateau with a slight decrease in the third section (400 m to 600 m) and a time 1–2% greater than the average time per 200 m. The last 200 m section is the slowest, with a time between 2 and 4% greater than the average time per 200 m [8]. The differences in the planning of the race between the fastest and slowest athletes are mainly that the faster ones stay longer and at a higher speed in the intermediate plateau, while the slower ones have a much more accentuated loss of speed in the last 200 m. In competition this profile changes and various profiles are used, having in common only the first fast 200 m. Out of the whole participant sample (187 participants), only one athlete, the winner of the men's final in Birmingham ran the first 200 m slightly slower (1.16%) than his average 200 m time, which is the usual way for this athlete to plan his races.

Significant correlations were found ($p < 0.01$) among those athletes that present a greater negative deviation in the first 200 m section (consequently much faster), against the average time per 200 m, occupying the last positions at the end of every series. This occurs both for men and women, not only during heats (where it would be more logical since it is where there are the biggest differences in levels between athletes), but also in semi-finals and finals.

Differences were found between the best and worst PBs. Thus, out of 10 male and female PBs from the whole sample, they do follow the proposed profile for a race of a PB with a timing of 5% less in the first 200 m than in the middle 200 m (men: – 5.34%; women: – 5.67%). However, if the worst PBs of each gender are analysed, the deviation is much larger and diverges from the proposed profile (men: – 7.91%; women: – 9.56%).

This also is related to the evolving maximum consumption of oxygen (VO_2max) in an 800 m race. A maximum increase occurs around 300m into the race and stabilizes at around 500 m, approximately, and when the race is beginning to be decided, the consumption of oxygen decreases [9]. Lower level athletes rapidly enter into predominant anaerobiosis. Therefore, a good 800 m athlete has to be capable of controlling a fast first 200 m, but without altering either their race energy distribution or the ideal stride length.

When the pronounced drop of the VO_2max begins (especially around 600–700 m into the race), the demand from the anaerobic system is large and there is a clear reduction of the speed in the race. But this is not always the case in championships where fast 200 m finals can be found. For example, the first men's semi-final in London, the second men's semi-final and men's final in Birmingham, the third women's semi-final in London, and the first women's semi-final in Birmingham.

As can be observed in figures 1 and 2, when the average velocity of each 200 m is analysed, the effort distribution and strategy in the male and female finals in Birmingham are completely different. This does not mean that those differences between men and women actually exist, as Birmingham's final is an isolated event.

Analysis every 100 m

As observed, the first 100m are clearly the fastest (46.7% of males and 91.8% of females). In outdoor races this corresponds with the first bend, in which each athlete runs in their own lane, without being conditioned by the interaction with other participants. The second fastest segment is the one between 100 and 200 metres (43.3% of males and 8.2% of females). This is the section where athletes, in outdoor races, have a free lane, share the space, and try to occupy a good position they can keep during the race. In indoor races the free lane is taken at the end of the first 50 m.

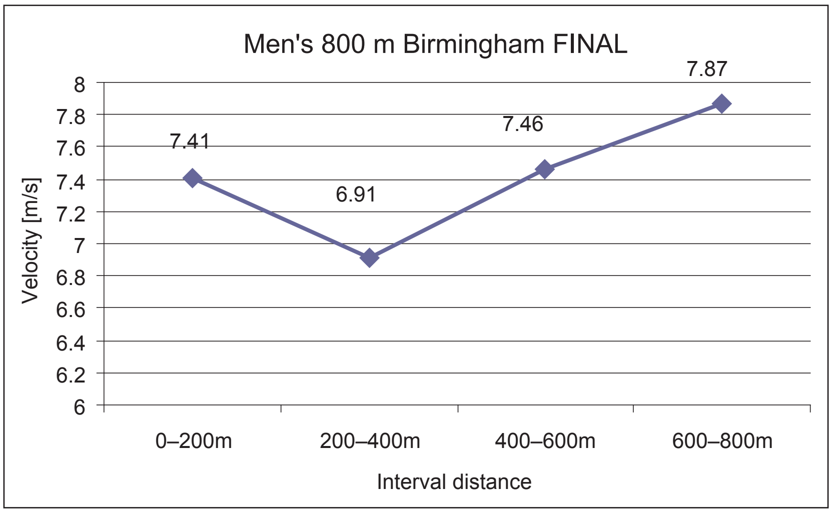

Figure 1. Average velocity every 200 m (Men's 800 m Birmingham Final)

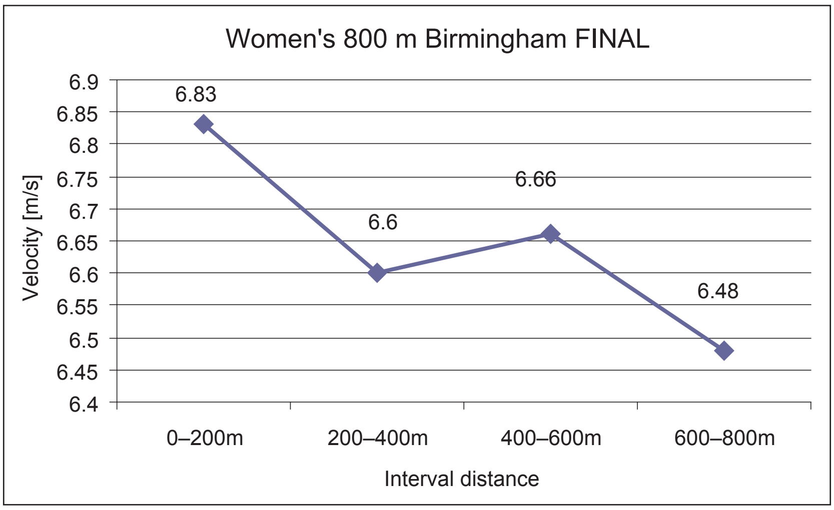

Figure 2. Average velocity every 200 m (Women's 800 m Birmingham Final)

However, in men's races, there is a greater balance between the first two 100 m splits, while in women's races it is much more common that the highest speed is achieved during the first 100 m. This is because male athletes can continue to maintain a high speed during the second section. According to Gajer *et al*. [8], the first 100 m are run in a time which is 2–3% lower than the average 100 m time, while the second 100 m segment is performed in the average 100 m time minus 6–9%. As shown in Table 3, these percentages are not the same during competition. In outdoor racing, male athletes make a better use of the first straight section, which is logical as they are running in a straight line.

However, as previously stated, there is one exception in all the races analysed: Birmingham men's final. This is a typical tactical championship race, in which all athletes are capable of running faster between the 600 m and 700 m. For the first four classified (of 6 participants) the last section was the second fastest. A considerable slowdown was also observed during the second lap (200–400 m). This effort distribution would not be possible in a race planned towards improving a PB.

The third 100 m segment should be an extension of the two previous ones, without too much slow-down when running outdoors aiming for a PB. But this was not the case in London, where there was a considerable slowdown.

During the 4th and 5th 100 m sections, the paces the athletes use are of maintenance of the plateau. This is the slowest 200 m portion of the race. Although these are very strategic sections in competitions, and in the average of all the races studied, an increase of speed can be observed, they are treated by the athletes in a neutral way.

Regarding the slowest segment of the race, differences comparing to the fastest segment can be observed. If it were a 400 m race (mainly anaerobic lactic), it would be clear that the last 100 m segment would be the slowest one. In the 800 m event, this is not always the case. In the total sample, only 28.8% run slower at the end. The most common slowest parts of the race are between 300 m and 500 m, adding a total of 37.8%. In the female category the variety is even greater. The slowest segment is the fourth (300 to 400 m), with 33.0% of the cases, followed by the third (200 to 300 m), with 23.3%, and the last segment (21.3%). It is therefore possible to accelerate in the last segment, particularly in outdoor qualifying races (17 men achieved this in London, 18.9%, and 19 women, 19.6%, in heats; while 33.3% of women, 8 athletes, also run faster in the last segment). This final acceleration was seen even in two finalist women in London: one of them the winner. On the other hand, this situation is much less common in indoor races.

Analysing the 32 men and 22 women that performed their slowest race split time in the last 100 m, it was observed that it is very advisable to keep the effort distribution as balanced as possible. Of the 32 men that have their worst split at the end of the race, 15 (46.9%) occupy one of the two last positions in each race; meanwhile of the 22 women in the same situation, also 15 (68.2%) end up in one of the last two positions.

In contrast, of the 14 women's races and 13 men's races analysed, only one winning woman and 4 winning men have their slowest split at the end. In conclusion, during competition, the worst athletes end up at their slowest speed in the last 100 m of the race, while the majority of the best athletes are capable of keeping a good competitive ability in this final section, which is usually decisive for the final ranking.

Another way of studying the effort distribution every 100m is to analyse what percentage of the total final time represents the split time of every 100 m for each athlete. In this study, the general distribution pattern of the percentage of time used in running each 100 m section has statistically significant differences ($F_7 = 56.066$; $p < 0.0005$; $\eta^2_{partial} = 0.241$). When comparing male and female runners, statistically significant differences were also observed ($F_{7;177} = 16.467$; $p < 0.0005$; $\eta^2_{partial} = 0.085$) (Table 1).

Changes in the athletes' position during the race every 100 m

It is logical to change position during straight stretches rather than bends, in order not to run more than the official distance. Overtaking is also harder in indoor races as the bends are sharper and the straight stretches shorter. This study confirms this, as on average more positional changes took place every 100 m in the outdoor races, with significant differences both in the men's and women's races ($p < 0.05$).

A greater percentage of positional changes in the four finals was also observed. This is justified because in qualifying races, athletes are aware that a fixed number will advance to the final, either by position or by time, and they apply more conservative strategies, following the leader's pace. Finals are faster races, in which all athletes try to place themselves in a good permanent position to achieve s medal and not get left behind by a sudden change of pace of the leader.

No significant differences were found regarding the number of positional changes performed and the final place at the finish line. In other words, making more or less positional changes does not imply a better final result.

General conclusions

By analysing the data of two championships, it was demonstrated that achieving the first position when breaking for any lane and up to the first quarter of the race is not a good strategy, neither for men nor for women, and the sudden accelerations from the mark of the beginning of the free lane until the end of the first straight stretch are especially detrimental. Of the 13 men's races studied, only two athletes that were in the first position when going through the 100 m, and three that were leading the race at 200 m, ended up winning the race. In the women's category, in the 14 races studied, the results are similar: only three athletes who were leading the race at 100 m, and 5 who were leading when going through the 200 m went on to win the race.

On the other hand, in more than half of the races studied, both in the male and female categories, the winner was in first position when entering the 600 m. Therefore, this straight stretch, between the 500 and 600 m, is crucial.

There are several different strategies of effort distribution in an 800 m race in high-level competitions. Although the analysis of the split times of 100 m intervals showed no uniformity, it is also true that more balanced models, after a fast start, have better results. This consistency, at a fast pace, should be maintained during the plateau from 200 to 600 m, and the greatest resistance to slowing down during the last 200 m (in contrast to other middle-distance races) is determinant for the outcome of the race.

Future longitudinal studies that include data from more World Championships, both outdoor and indoor, will serve to identify and confirm the optimal rhythmic profiles in the 800m event, as well as the evolution of the pacing strategies of each individual athlete throughout their career in elite performance.

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