Strategic and Tactical Decision-Making in Middle- and Long-Distance Running Races

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Highlights

- Regulation of pace is a decision-making process that is influenced by knowledge of how far an athlete has left to run combined with an awareness of the internal physiological environment that governs the athlete's state of fatigue.
- The ~~optimal~~ most frequently used pacing strategy to achieve a fast time in the 800 m event involves a positive split approach, characterised by a fast initial 200 m followed by a progressive deceleration over the remainder of the race.
- In track middle-distance events (800 m and 1500 m), remaining close to the leader and avoiding running wide on bends ~~appears~~ is important for gaining qualification for subsequent rounds or winning a medal.
- In events longer than 800 m, an even pace throughout is recommended to achieve the fastest possible time and finish in a high position.
- Marathon runners are advised to start conservatively (based on their present fitness and target time) to avoid slowing in the second half of the race.
- Running behind a pacemaker or in a pack of runners provides a large advantage by reducing the energetic cost of running and the cognitive burden associated with ~~pace~~ pace-related ~~decision~~ decision-making.

Introduction

Middle- and long-distance runners spend many hours preparing for competitive events in an attempt to improve their race outcomes, be that faster finishing times or higher finishing positions in races. However, although this training ~~may~~ might improve performance potential, there is no guarantee that it will result in enhanced performance itself. ~~In order t~~To realise performance potential, it is imperative that athletes deploy their physiological resources appropriately over the duration of a race. If they are unable to do this then they risk premature fatigue and underperformance. The way effort is distributed over the course of a bout of exercise is termed 'pacing'. This chapter reviews the theory that explains how pacing is achieved, describes observations of pacing behaviour that have been published, and ends with some practical recommendations for coaches and runners aiming to improve their pacing ability.

Regulation of pace

Although various models have been proposed to explain the regulation of pace during exercise, a common theme is that the process requires central regulation by the brain and nervous system (Renfree et al, 2013b). A key component of this regulatory process also appears to be knowledge of the endpoint of exercise (Ulmer, 1996). Indeed, this is intuitively obvious; if you were challenged to a race the first question you would ask would almost certainly be 'how far?'. Knowledge of how much of the race remains is combined with knowledge regarding the condition of the internal physiological environment, gained via feedback from various receptors throughout the body, ~~in order~~ to decide how quickly to run at any given ~~point in~~ time (St Clair Gibson et al, 2006). In effect, pace regulation is a decision-making process. Before even starting exercise, the athlete is required to identify an overall strategic approach that will be taken, ~~whilst~~ whereas during exercise the athlete ~~may~~ might be required to continually adjust exercise intensity. The athlete must decide ~~if~~ whether the current pace is sustainable until the end of exercise without risking catastrophic physiological failure, or ~~if~~ whether they are able to run faster. If the change in pace is considered necessary, ~~then~~ they must also decide how large this change must be, and they are able to select from all possible paces between zero (i.e., they stop running) and the maximum speed they are able to generate at that point.

There is some controversy as to exactly how the athlete regulates pace during exercise and to what extent this is an ~~subconscious~~ unconscious or conscious process. However, regardless of the precise mechanisms, observations of athletes' strategies are remarkably consistent. In situations where the goal is to complete a given distance in the fastest possible time, an even-paced, or negative pace strategy (where the second half of the event is completed more quickly than the first) is generally associated with superior performances (Abbiss and Laursen, 2008). In an analysis of 32 previous world records over the mile run, Noakes, Lambert and Hauman (2009) found that the first and last laps were significantly quicker than the second and third laps, which were generally completed at similar speeds. Likewise, in a similar analysis of world record runs over 5000 m and 10,000 m, a consistent pattern was identified whereby the first and final kilometres were run at higher speeds than the middle sections of the races. Furthermore, in a historical analysis of world records over the marathon, it was found that the overall trend was for the performances to become more evenly paced as they became faster in recent years (Díaz, Fernández-Ozcorta and Santos-Concejero, 2018). It is noteworthy that in the recent successful ~~sub~~ sub-two-hour performance by Eliud Kipchoge in Vienna, it was decided to ~~utilise~~ adopt an even paced strategy with the speed being controlled by a pace car. Indeed, it could even be argued that the use of the car in this way made Kipchoge's task somewhat easier because it reduced the need for self-regulation through decision-making, thereby reducing the cognitive load on the athlete.

The remainder of this chapter aims to discuss methods that both elite and recreational runners can use to improve the quality of their strategic and tactical decision-making relating to pacing, and the ability to maintain these strategies during competition itself. We differentiate between events where the goals ~~may be~~are either ‘best possible time’ or ‘highest possible finishing position’, and address these aims in three broad sections: middle-distance (800 m-1500 m) events, long-distance (5000 m-10,000 m) events, and road and cross-country races.

Middle-distance events

Although the middle-distance running events include the 800 m, 1500 m and 1 mile distances, the optimal pacing strategy for achieving the fastest possible time appear to differ between events. Analysis of pacing displayed by elite male and female 800 m runners during their season’s best performances indicates that, in contrast to longer events, these are achieved with a ‘positive’ strategy characterised by a first-half of the race that is faster than the second (Filipas et al, 2018). However, differences have been found between ~~males and females~~men and women. In both sexes, the first 200 m was the fastest of the race, but whereas ~~males~~ men demonstrated a further slowing with each subsequent 200 m split, ~~females~~ women displayed an almost constant pace for the remainder of the race. Similar findings were reported in an analysis of 26 world-record performances over 800 m (Tucker, Lambert and Noakes, 2006) whereby the average speed in the second lap was significantly lower than in the first in only two individual performances. This finding ~~may~~ supports the suggestion that performance in faster events is optimised through a strategy characterised by a fast start, and that the ability to increase speed in the second lap is limited. The precise reasons for this are unclear, although one possible explanation ~~may be~~is related to the faster start accelerating oxygen uptake kinetics at the onset of exercise, thereby increasing the aerobic contribution to energy expenditure and sparing anaerobic capacity (Jones et al, 2008).

With regards to the 1500 m and mile events, a study of 32 previous male world records over the mile was described earlier in the chapter (Noakes, Lambert and Hauman, 2009). In these 32 performances, on only two occasions was the final lap of the race the slowest, an observation that was proposed to provide evidence that pacing strategies are regulated in anticipation of exercise duration, rather than simply reflecting the onset of peripheral muscular fatigue. Regardless of these observations regarding the optimal pacing strategies associated with achieving the fastest possible time, it is evident that athletes do not always prioritise running as ~~fast~~ quickly as possible as highly as they do achieving the highest possible finishing position, especially in major international championship events. The range of winning times in recent men’s 1500 m races at global championships, from 3:27.6 by Hicham El Guerrouj in the 1999 IAAF World Championships~~,~~ to 3:50.0 by Matt Centrowitz in the 2016 Olympic Games, illustrates the range of ways in which races can unfold. ~~In order t~~To best understand how athletes can adopt strategies that maximise their chances of achieving a high overall finishing position in events where time achieved is of secondary importance, it is necessary to study the relationship between tactical behaviours throughout the race, and eventual race outcome.

An analysis of the men's 800 m event at the 2000 Sydney Olympics provides a striking example of the importance of tactical decision-making, especially in races where all competitors are likely to be closely matched in terms of ability. The gold medal was won by Nils Schumann of Germany in a time of 1:45.08, ahead of world record holder Wilson Kipketer of Denmark who gained the silver medal in a time of 1:45.14. However, video analysis of the race revealed that Schumann ran closer to the inside lane throughout most of the race and covered a total distance of 802 m compares to 813 m by Kipketer (Jones and Whipp, 2002). Through calculation of the average speeds maintained over distances covered, it becomes evident that Schumann ran 800 m in 1:44.82 compared with Kipketer's 1:43.46.

The above example may seem obvious in that, clearly, athletes who run further than necessary put themselves at a significant disadvantage. However, in reality, the situation is likely to be more complex. By simply attempting to run the shortest distance possible, athletes risk putting themselves in a 'box' whereby they may be prevented from following changes of pace initiated by other runners. Furthermore, falling behind other competitors means an athlete needs to run faster over the remainder of the race just to draw level with them. This may be possible if the leading athletes are slowing, but in many championship races (especially 1500 m), the last lap is the fastest of the race, meaning athletes who are in trailing positions need to run faster than competitors who are themselves already running very fast. With these issues in mind, several studies have analysed the relationship between intermediate positioning and race outcome in middle-distance running events at international championships (Casado and Renfree, 2018; Mytton et al., 2014; Renfree et al, 2014a).

An analysis of the heats and semi-finals of the 800 m and 1500 m events at the 2012 Olympic Games calculated the probability of automatic qualification to the next round of competition for athletes in each available position at various intermediate stages of races (Renfree et al, 2014a). Unsurprisingly, athletes with superior seasonal best performances over the distance were more likely to qualify than slower athletes. However, in the 800 m races there was a striking relationship between intermediate position and likelihood of qualification. By the midway point of the race, athletes already in one of the leading three positions had a 61% probability of qualification. By the 600 m point this had increased to 84%. In the 1500 m there were more changes in position as races progressed. However, athletes outside one of the automatic qualifying positions by the 1000 m point had less than 50% chance of qualification to next round. Similar results were found in a subsequent analysis of the middle-distance events at the 2017 IAAF World Championships (Casado and Renfree, 2018). This study also rank-ordered the athletes in terms of absolute speeds over each intermediate race section and found that an even bigger predictor of eventual race outcome was the ability to produce a fast final lap. Therefore, even though intermediate positioning is extremely important throughout races, there ~~may~~ could be some opportunity to 'salvage' a bad situation if the athlete develops the ability to finish quickly. This observation is in agreement with earlier work by Mytton et al (2014), which found medallists in middle-distance swimming and running events at major championships displayed greater variation in pace compared ~~to~~ with non-medallists, and that this variation was the result of a greater acceleration in the final stages.

Improving strategic and tactical decision-making in middle-distance events

Based on the research described so far, it is possible to make some practical recommendations to athletes that may maximise their chances of ~~them~~ achieving their physiological potential in middle-distance races. The most obvious strategy is to train appropriately ~~in order~~ to maximise physiological capacities. Doing so will increase the range of behavioural options available to an athlete at any point in race due to maintenance of a greater physiological reserve capacity. It is not as though an athlete can simply consciously 'decide' to run faster than they are able ~~to in order~~ to keep up with an opponent! Additionally, athletes need to ensure they make appropriate strategic and tactical decisions.

Strategic decision-making sets the overall approach to the race and is performed in advance of the starting gun being fired. If the goal is simply to achieve the fastest time possible, then analysis of elite performers suggests running the first 200 m of an 800 m race slightly faster than the goal time followed by an even pace or slight deceleration for the remainder is the optimal strategy. In 1500 m races, faster times are associated with a more even pace, or even an acceleration in the final lap. Although seemingly relatively simple to implement, these strategies require accurate assessment of current abilities to set appropriate performance goals. Inappropriately ambitious goals will almost certainly result in premature fatigue and underperformance.

One further issue which has not been discussed thus far relates to the use of other athletes who act as 'pacemakers' by setting the pace in the initial stages of races and are a common sight on the Grand Prix circuit. It is thought that pacemakers serve to benefit athletes by reducing the air resistance encountered, and thereby the energetic cost of running at a given speed. Pugh (1971) demonstrated that overcoming air resistance accounted for 7.5% of energy expenditure when running at 'middle-distance' speed, but that running one metre behind another athlete reduced this by 6.5%. Theoretically, following another athlete during the early and middle stages of a race may conserve physiological reserve capacity until further into the race.

An additional potential benefit of following a pacemaker is that it may reduce the level of cognitive fatigue induced through the requirement for continual pace related decision-making (Renfree et al, 2015). Rather than need to interpret various environmental and perceptual cues in order to assess and adjust running speed throughout a race, it is likely to be less cognitively demanding to simply do what everyone else does. This so-called ‘herd behaviour’ (Banerjee, 1992) has been observed in a wide range of human environments and may be a ‘hardwired’ characteristic that confers some form of advantage. However, it must be emphasised that the consequences can also be negative if an athlete attempts to follow others with superior physiological abilities, and the result is likely to be underperformance.

5000 m and 10,000 m events

The 5000 and 10,000 m races are the longest track races at major championships, although competitions over these distances are also held on roads. To the casual observer, races over these longer track distances are run with a fairly constant pace, with athletes who cannot keep up gradually fading, and the winner usually being the athlete who possesses best sprint finish. It is certainly true that the endspurt can be crucial in deciding the medal places; for example, Dieter Baumann overtook three rivals to win the men’s Olympic 5000 m final in 1992 with a last 100 m in 11.39 s (8.78 $m.s^{-1}$) (Reiss, Ernest and Gohlitz, 1993). However, to get into a position where winning is a possibility, the pacing tactics used beforehand can make a difference in structuring the race to provide an athlete with an advantage over their rivals (Martin and Coe, 1997).

With regard to recent major championship racing, Hettinga, Edwards and Hanley (2019) found that 5000 m finalists in major championships ran with negative splits (including medallists and those finishing at the back of the field), although variations in pace were quite considerable (coefficients of variation of 8.5% and 6.9% in men and women, respectively). Thus, pacing profiles in 5000 m racing show an overall even pace for the first 4000 m (Filipas, La Torre and Hanley, 2018) but with microvariations in running speed injected into the race that are often adopted by the leading athletes to try to shake off rivals (Thompson, 2007). Using data from the 2008 Olympic Games, Thiel et al (2012) found that both men and women in the 5000 m finals had variable pacing profiles (running speed dropped very quickly from 7 $m.s^{-1}$ at 100 m to 5 $m.s^{-1}$ at 400 m in the men’s race), and thus the authors recommended variable pace training for athletes who aim to perform well in championship races. Aragón et al (2015) found that these changes in 5000 m race pace mainly took place on the bends, in contrast to the 1500 m where they occurred on the straights, even though this tactic in the 5000 m would seem to be counterproductive given the extra distance that must be run away from the inside kerb.

Although physiologically similar (Duffield and Dawson, 2003), performances over 10,000 m are of course run at a slightly slower pace compared ~~to~~ with the 5000 m, but also have ~~less~~ fewer variations in pace (Filipas, La Torre and Hanley, 2018). For example, Thiel et al (2012) showed that 10,000 m finalists at the 2008 Olympics had relatively variable pacing profiles (mean pace per lap varied by 3.6% for men and 3.4% for women) and, like in the 5000 m, this was more variable than contemporary world record performances. Hettinga, Edwards and Hanley (2019) found that the winners’ paces increased noticeably over the last 1000 m (to a maximum of approximately 7.5 $m.s^{-1}$ in the men’s race, and 6.25

m.s^{-1} in the women's), having been relatively even paced over the first 9000 m. For example, when Kenenisa Bekele won the 2007 IAAF World Championship 10,000 m, it was the increase in speed during the final 400 m that separated him from the silver and bronze medallists (the gap between 1st and 3rd was only 0.42 s at the bell, but 5.52 s at the finish); he completed the last lap in 55.51 s, equivalent to a mean speed of 7.21 m.s^{-1} (Enomoto et al, 2008). Thus, although even pacing is often considered the best approach for maximising endurance performance, the small physiological differences between world-class athletes mean that strategic pacing is crucial when competing in championship races.

In both the 5000 m and 10,000 m, world record performances are more evenly paced than in championship racing. For example, Thiel et al (2012) showed that 5000 m world record pacing profiles had very small variations in pace for both men (1.7%) and women (2.5%) and require a different training approach from that needed for the more tactical racing used in major ~~Championship~~ championship finals. Although championship athletes might vary pace because of tactical reasons, it is of course more usual for those outside the world's best to have varied pacing profiles because of how much they slow in the later stages of fast-run races (Filipas, La Torre and Hanley, 2018). The tactic of running an even pace throughout a long-distance race is thus recommended for competitive club runners who, like world record holders, aim to achieve their fastest possible time, and in most road races is also the most effective tactic for finishing in a high position.

Marathon and half-marathon events

The marathon differs from shorter distance races because the unique physiological challenges posed by the duration of the event mean that maintaining speed is a considerable challenge. These changes arise because of glycogen depletion and a subsequent reliance on lipids as a key energy source (O'Brien et al, 1993). In addition, hyperthermia can occur in warm weather (as is frequently the case during Olympic and World Championship marathons) often resulting in a reduction in pace, or drop-out (March et al, 2011). By contrast, cooler weather conditions (5 – 10°C), which are more common in big city marathons in spring and autumn, are associated with smaller reductions in running speed, particularly in faster runners (Ely et al, 2008). Because of these factors, pacing the marathon well, usually by achieving an even pace or a negative split, is associated with better performances to a greater extent than shorter distances events (Hettinga, Edwards and Hanley, 2019). However, even world-record performances could have been improved with a greater appreciation of the effects of weather and gradient (Angus, 2014). World records in the marathon are generally obtained on relatively flat courses with favourable weather conditions (Díaz et al, 2019), but the effect of pacemakers must also be taken into account. As noted previously, although using pacemakers is often considered advantageous because they potentially provide a drafting benefit, their value might lie more in the way in which they reduce the psychological load on the lead runners who otherwise would have to focus intently on the pace throughout the race. As a result, recent marathon world records (those since 1988) have been run at very even speeds dictated by pacemakers, and many include a last 5 km that was the fastest part of the race; by contrast, older world records (those set between 1967 and 1988) were achieved through a very fast start but with large drops in speed in the latter part of the race (Díaz, Fernández-Ozcorta and Santos-Concejero, 2018). Of course, running an even pace is achievable for physically fit and well-prepared club runners, particularly in big city marathons where the volume of runners can provide unintentional pacemaking opportunities.

Although even pacing is usually the most appropriate approach to take, the reality in World and Olympic marathons is that 95% of men and 87% of women have been found to run slower in the second half of the race (Hanley, 2016); women are generally better at achieving even pacing than men, a finding that has been observed across running abilities (Deaner et al, 2015). However, Santos-Lozano et al (2014) reported that athlete ability was a better predictor of significant slowing in the second half of the marathon than any sex-based difference. Indeed, World and Olympic marathon medallists of both sexes are more likely to maintain their pace from 10 km onwards (men ~ 5.4 $m.s^{-1}$; women ~ 4.8 $m.s^{-1}$) and achieve negative splits. Renfree and St Clair Gibson (2013) analysed the pacing profiles of women marathon runners competing in the 2009 World Championships and found that those who started faster than personal best pace had greater decreases in speed than those who started slower than their previous best pace. Marathon runners are therefore advised to start conservatively (based on present fitness and realistic goals) to avoid considerable slowing in the latter stages of the race, and coaches who know their athletes are likely to take risks in terms of starting too fast are encouraged to develop a conservative approach to pacing in training (Deaner, Addona and Hanley, 2019).

In contrast with the marathon, very little research has been conducted on the half-marathon, despite its considerable popularity with recreational runners. This might be because it is not a standard championship distance, although it is held as a biennial World Championship event. An analysis of six of these World Championship half-marathons showed that athletes generally started quickly over the first 5 km with a gradual slowing until 20 km, after which they increased speed substantially until the finish (Hanley, 2015). What was more interesting from this analysis of pacing was the way in which the athletes formed packs – these varied between those who ran the whole race together, which included teammates and sets of twins, to those who moved between groups ('nomadic pacing'), and those who ran the entire race alone. The results showed that those who ran together for the whole race had the most even paces, with nomadic pacing also working well in this regard. However, those who ran the race alone or quickly dropped off a group were more likely to suffer decreases in running speed between the opening 5 km and the rest of the race. Another interesting aspect of racing that arose from this analysis was the way in which packs of runners tended to slow to the exact same extent between 15 and 20 km, and showed that slowing down is not necessarily an outcome arising from fatigue but can also be a tactic employed to use other athletes as external references for pacing (Renfree et al, 2014b). The fast final 1.1 km confirmed clearly that these athletes were not slowing because of extreme fatigue but because they believed it placed them into a strong position to beat their nearest rivals (Hanley, 2015). An analysis of packing in major championship marathon running showed that whereas the tactic of running in a pack with athletes of similar ability and ambition throughout was beneficial for runners of both sexes (Hanley, 2016), nomadic pacing was less successful compared to world-class half-marathon racing. This is likely due to the greater fatigue that occurs in the second half of the marathon.

Cross-country running and 3000 m steeplechase

Cross-country running has unique pacing characteristics because variations in terrain can affect the running style used, not only making it different from track and road running but often from one course to another, or even within the same course (Canova, 1998). Achieving anything close to a constant speed is difficult in cross-country because the World Athletics rules state that natural obstacles such as hills or logs should be incorporated to create a challenging course. Furthermore, steady pacing is a challenge even for accomplished runners given that no accurate distance markers are used. Laps can also alter in length (often including ‘small’ and ‘large’ laps) and time elapsed is not an indication of being close to the finish; for example, the winning time in the men’s 12 km race in 2004 was 35:52, compared with 32:45 in 2013 (Hanley, 2014). The lack of a reliable source of pacing information means that the most popular tactic in the senior men’s World Cross Country Championships from 2002 to 2013 (over 12 km) was for all athletes to start quickly and try to keep up for as long as possible with the leaders. This approach is perhaps understandable given the slightly unstructured nature of the event and the team competition that makes every finishing position important. However, this pacing approach inevitably means that the high number of athletes who start too quickly end up dropping behind the lead pack after only a few laps and continue to slow throughout the race (Esteve-Lanao et al, 2014).

The current equalised men’s and women’s race distances of 10 km at the World Cross Country Championships were adopted for the first time in Kampala in 2017, and pacing analyses of those championships showed that men ran with a more even pace than over the previously contested 12 km distance (Hanley, 2018). Instead, they had either an even pace or an increase in speed during the last 2 km, although it should be noted that their pace had still slowed from the initial lap, regardless of finishing position. Hanley (2018) was also the first to analyse women’s pacing at World Cross Country Championships, and the increase in race distance led to pacing profiles that were very similar to men. Runners of both sexes should therefore remember that the distance of cross-country races and the terrain involved mean that fast starts are not always necessary, and that the same self-discipline of pacing required in track or road running also applies to off-road racing.

Although it is held on the track, the 3000 m steeplechase resembles cross country running in that maintaining a constant running speed is hindered by the negotiation of 28 barriers and seven water jumps. Unsurprisingly, the quickest section found in Olympic steeplechase finals was the first half-lap that features no barriers, although better athletes were also quicker over the last lap than any of the preceding ones, leading to an overall U-shaped pacing profile (Hanley and Williams, 2020). In terms of differences within laps, the water jump section tends to be more disruptive of pace in women’s racing, which is also characterised by a relatively quicker opening than the men’s races (Hanley and Williams, 2020). This might be related to the fact that even world-class women steeplechasers have greater difficulty in negotiating the water jump because they land nearer the barrier on exit, and therefore into deeper water (Hanley, Bissas and Merlino, 2020).

Summary and practical recommendations

This chapter has addressed the mechanisms underpinning the regulation of pacing strategy, as well as some of the commonly observed behaviours during athletic races. Although we have examined a wide range of differing events, there are some obvious similarities. The most obvious is that, in all events longer than 800 m, when the goal is to run as fast a time as possible, an even paced strategy is most likely to result in realisation of physiological potential. In the 800 m, fast times are typically associated with a positive pacing strategy characterised by a quick initial 200 m followed by a progressive deceleration over the remainder of the race. Therefore, for most events, the recommended strategy may be to determine the goal time and required intermediate splits, and to stay as close as possible to this schedule throughout the race. Although this may seem simple, such a strategy is only likely to be effective if appropriate performance goals are used to inform strategic planning of races. When attempting to run quickly, it is also likely to be beneficial to ~~utilise~~ use ~~‘~~pacemakers~~’~~, if possible. These ~~may~~ can have the effect of reducing the energetic cost of running ~~due to~~because of the reduction in air resistance encountered and ~~may~~ can also reduce the cognitive demands of racing by decreasing the need for pace related decision-making. Even if there are no designated pacemakers for a runner’s desired speed, it is still likely to be beneficial to run in packs with other competitors of similar ability~~ level~~.

Athletes ambitious enough to realistically challenge for medals at major championships need to develop an additional skillset, as the ability to run fast times alone is insufficient. Rather, athletes must develop the ability to run at a variable pace and accelerate over the final stages. Given the small time gaps covering athletes at the end of championship races, tactical positioning throughout is of paramount importance. Particularly in the middle-distance events, it is important to be close to the leading positions as the race enters its final stages, and to minimise distance covered by avoiding running wide on the bends. However, there is a risk associated with this approach in that maintaining a position close to the inside line ~~may~~could leave an athlete ‘boxed in’ if they get trapped behind slower athletes during a break made by other competitors. In this sense, tactical training is an important aspect of distance running to complement the physical preparation required to do well in competition.

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