"Falling Behind", "Letting Go", and Being "Outsprinted" as Distinct Features of Pacing in Distance Running

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Running Header: Falling Behind vs Letting Go in Running

Abstract

Introduction: In distance running, pacing is characterized by changes in speed, leading to runners dropping off the leader's pace until a few remain to contest victory with a final sprint. Pacing behavior has been well-studied over the last 30 years, but much remains unknown. It might be related to finishing position, finishing time, and dependent on critical speed (CS), a surrogate of physiologic capacity. We hypothesized a relationship between CS and the distance at which runners "fell behind", and "let go" from the leader, or were "outsprinted" as contributors to performance. **Methods**: 100-m split times were obtained for athletes in the men's 10,000-m at the 2008 Olympics (N = 35). Split times were individually compared to the winner at the point of "falling behind" (successive split times progressively slower than the winner), "letting go" (large increase in time for distance compared to winner), or "outsprinted" (falling behind despite active acceleration) despite being with the leader with 400 m remaining. **Results**: Race times ranged between 26:55-29:23 (world record = 26:17). There were 3 groups who fell behind at ~1000 m (n = 11), ~6000 (n = 16) and ~9000 m (n = 2), let go at ~4000 m (n = 10), ~7000 m, (n = 14) and ~9500 m (n = 5) or were outkicked (n = 6). There was a moderate correlation between CS and finishing position (r =.82), individual mean pace (r =.79), "fell behind" distance (r =.77), and "let go" distance (r =.79). D′ balance was correlated with last 400 m performance. **Conclusions**: Athletes displayed distinct patterns of falling behind and letting go. CS serves as a moderate predictor of performance and final placing. Final placing during the sprint is related to preservation of D′ balance.

Index terms: Olympics, losing contact, action crisis

Introduction

The distance versus time behind the leader in competitive distance running is typically stochastic, with runners progressively "falling behind" the leaders until a relatively small number remain to contest victory over the last ~10% of the race distance.[1-3] In most cases, in "head to head" races the pace is slower and more variable than when athletes attempt world record (WR) or personal best performances.[3] Recent evidence suggests that the overall pace is related to the critical speed (CS), with less successful runners running at a higher percentage of CS (%CS) and more successful runners running at a lower %CS early in the race. Less successful athletes then slow to a lower %CS later in the race, whereas higher finishing athletes accelerate to a higher %CS later in the race.[2-3] This strategy acts to preserve non-oxidative energetic resources, known as the D′ balance, until late in the race amongst those contesting victory with a final sprint.[2-3] This results in a two-step process where lesser runners first "fall behind" (dropping slightly, but progressively, behind the leaders) and later "letting go" (abrupt progressive decreases behind the pace of the leading runners and not running in the same pace pattern as the leaders). Although this pattern is evident to anyone watching a championship race, and may represent an "emotional crisis" and likely represents a negative affective event in goal-striving for the athlete involved,[4] it has not been well-studied in terms of whether it occurs sequentially in every athlete and whether it occurs in relation to the CS + D′ model of energy use.[5] Also, it is not clear whether this pattern of pacing occurs only in the non-competitive runners who drop off early, or also amongst those runners contesting victory late in the race.

Venhorst et al.[6] have shown that athletes "falling behind" performance-matched competitors perceived this situation as a highly negative and stressful event, which leads to the development of an "action crisis", defined as a conflict between further goal-pursuit and goal-disengagement, and eventually to "letting go" of the initially aspired/desired performance goal." They have further shown that at this unique and decisive point in a competition the opposite perceptions and psychophysiological responses occur in athletes "pulling away". However, we would argue that the action verb should be consistent and from the perspective of the trailing runners "letting go" seems most appropriate." Critically, this pacing pattern has shown a clear relationship with the accumulated gap to the leader, the affective state, and cortisol accumulation. Clearly, this is a unique point in the ecology of the competition. We would argue that the action verb of the runners should be consistent and that if "falling behind" is correct, then "letting go" is more consistent than "pulling away" as both are from the perspective of the trailing runners. These patterns have clear relationships to the accumulated gap to the leader,[6] the feeling scale (or affect)[7,8] and cortisol accumulation.[6] Other studies suggest that the process of letting go is associated with changes in blood pH and bicarbonate concentration.[9] Early studies by Karlsson and Saltin[10] demonstrated that muscle lactate accumulated to a near common concentration during cycling rides of 2, 6 and 16 minutes, implying a constant homeostatic disturbance at the finish of severe exercise that is related to acid-base disbalance and phosphocreatine depletion, but with only minimal depletion of adenosine triphosphate. Subsequently, Jones et al.[11] have demonstrated, using magnetic resonance spectroscopy, a decrease in phosphocreatine concentration and a progressive acid-base disbalance when exercise intensity is greater than the critical power (e.g. CS), the mean speed during 10,000 m running, the speed at a lactate concentration of ~4 $mmol \cdot L^{-1}$, the second ventilatory threshold or the maximal lactate steady state.[3,5,12] Thus, it is reasonable to suggest that progressive physiological disturbances during competition underpin the pacing behavior where some athletes fall behind and let go as the athletes work through the decision-making process of continued goal-striving or goal disengagement.[6,13,14] This report was intended to evaluate the individual pattern of falling behind and letting go in elite male distance runners, competing in the 2008 Olympic 10,000 m final. This was evaluated using individual time behind the leader versus distance completed plots vs the leader. Second, it was designed to compare the distances where falling behind and letting go occurred relative to CS and D′ balance. Third, it was designed to compare the pattern of falling behind and letting go in both competitive (in contention with 400 m remaining) and non-competitive runners. Our hypothesis was that falling behind and letting go would be directly related to competitive outcome and to estimates of physiological disturbance. An additional hypothesis was that success in the final sprint would be related to the D′ balance with 400 m remaining as suggested by Kirby et al.[2]

Method

Individual plots were constructed of both speed and time behind the leader versus distance completed for each of the 35 finishers in the 2008 men's Olympic 10,000 m race, and interpreted against the speed and time versus distance plot of the winner. The plots were based on data collected when a chip in the runners' bib passed successive 100 m positions on the track surface.[1]

The winner of the race was always closely within the top 7 competitors, and the reporting of the results is based on his split times, which was easier to compare, than to the changing momentary leader. The data were converted based on a time updated every 100 m, and the individual time when falling behind and letting go occurred were identified based on the first and second change in slope of the distance versus time relationship, respectively, and in the last 400 m for the outsprinted athletes (Figures 1 and 2). Comparisons of time behind the winner versus distance completed were compared amongst the authors, with evidence of good reproducibility of the method (Figure 3). The winner had an even speed-distance profile, with a large endspurt during the last 400 m (Figure 1a). Every athlete who fell behind or let go before 400 m remaining could be identified as having a distinct point for both falling behind and letting go (Figure 1b), although a very few athletes had the same value for both falling behind and letting go. For illustration, the comparative time behind the leader versus distance curves of the winner and 12th place are presented in Figure 1b and 2b. Identification of falling behind or letting go was similar graphically to plots in gas exchange data equivalent to the first and second ventilatory thresholds of VCO_2 versus VO_2 and V_E versus VCO_2.

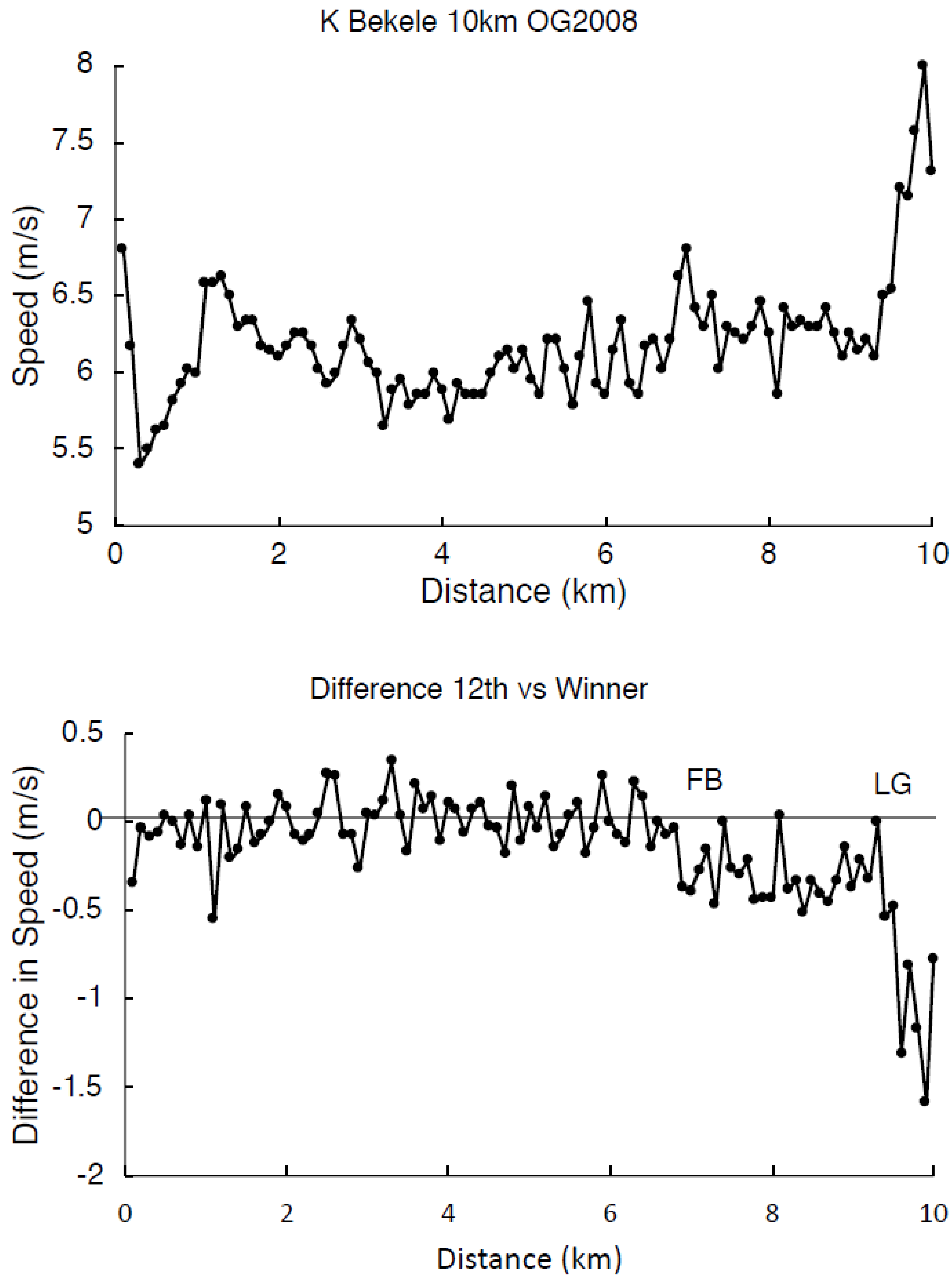

Figure 1: *Top:* Running pace in the winner of the 2008 men's Olympic 10,000-m race (Kenenisa Bekele) demonstrating the stochastic nature of the pace. There are distinct increases in pace (surges) at 1000, 6000 and 7000 m that caused some runners to either FB or LG of the pace, and during the last 700 m. Times are measured every 100 m. *Bottom:* Difference in running pace between the winner and the 12th place finisher, presented as an example of when he fell behind (6800 m) or LG (9200 m) of the pace. FB indicates fall behind; LG, let go.

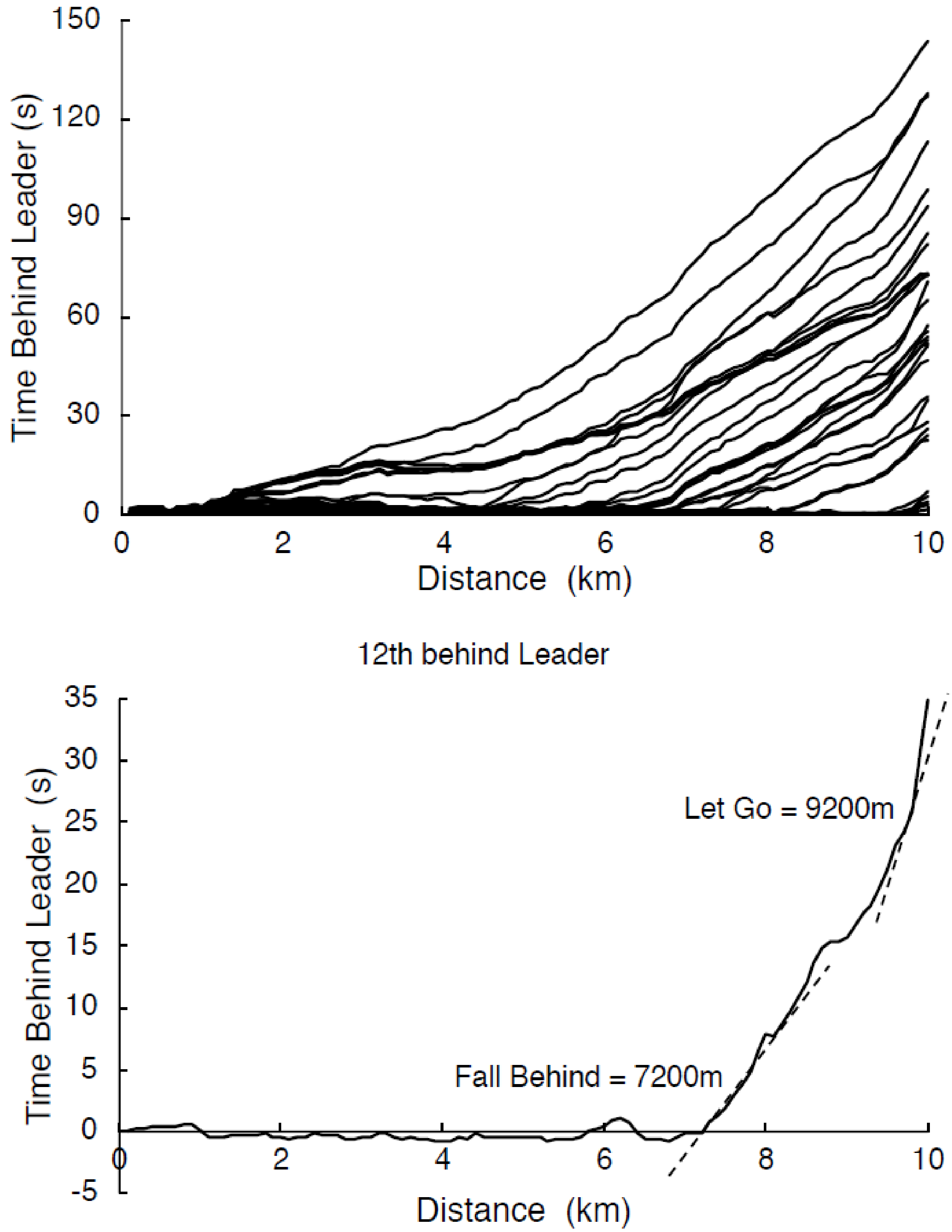

Figure 2: *Top:* Time behind the winner versus distance completed in the entire field. The progressive pattern of both falling behind and letting go of the pace is well illustrated. *Bottom:* Schematic of the time behind the leader versus distance in the 12th place finisher, demonstrating the 2 increases in slope of the relationship that correspond to falling behind and letting go.

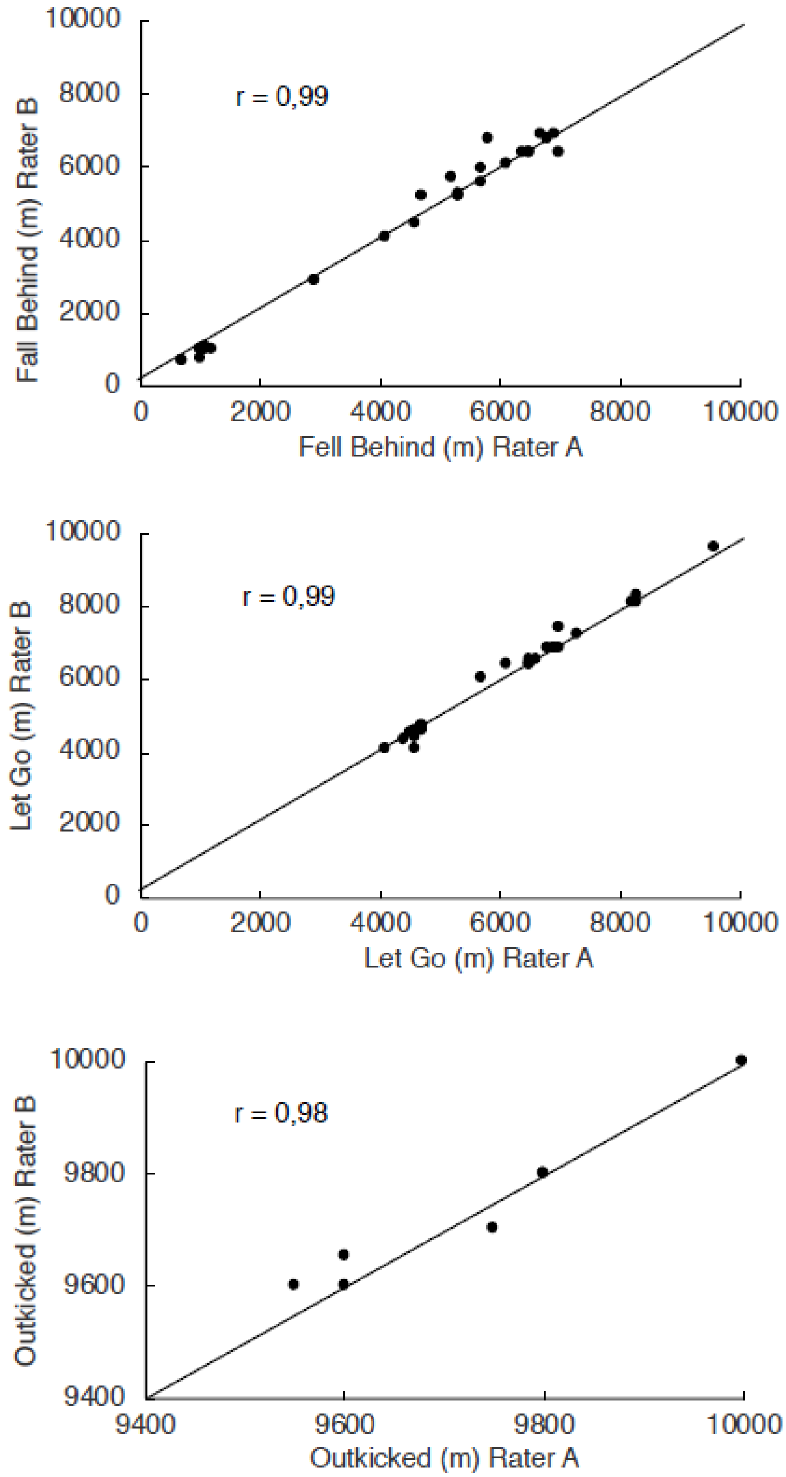

Figure 3: Example of the reproducibility of the method for identifying the results of 2 different raters on identifying the distance at which runners either fell behind, let go, or were outkicked.

We retrieved individual performances over the 9 months preceding the 2008 Olympic race from online sources. Individual estimates of CS and D′ balance were computed using data from at least 3 distances using linear regression from performances belonging to flat events over 1500 m to 10,000 m. While acknowledging that CS is normally computed over 2 to 20 minutes (e.g., 800 m-5000 m),[15] given high degree of linearity of the speed vs distance relationship and the fact that all runners had a prior time over 10,000 m as part of Olympic qualification, we chose to include the 10,000 m time in the computation of CS.

Individual time versus distance curves were computed for each runner from the official race protocol. The curves were superimposed with the same curve for the winner, and the position of falling behind and letting go was individually identified by subtraction (Figure 2b). The point at which falling behind occurred was based on the distance within the race where a runner first began to run progressively slower than the winner. The point at which letting go occurred was based on the distance within the race where a runner had a large increase in split time, and no longer changed pace in response to the actions of the winner.

The CS was compared using linear regression with the finishing position, mean running speed and to the distance at falling behind and letting go (Figure 4). The D′ balance, normalized to the individual maximal value, was compared between the successful (those with the leader at 400 m remaining, n=7) (Figure 5) and unsuccessful runners (who had let go before 400 m remaining, n=28) according to Skiba.[16] The pattern of the normalized D′ balance is depicted for the 1st, 10th, 20th, and 30th finishers to demonstrate the pattern of preservation of D′ balance during the race in the runners (Figure 6).

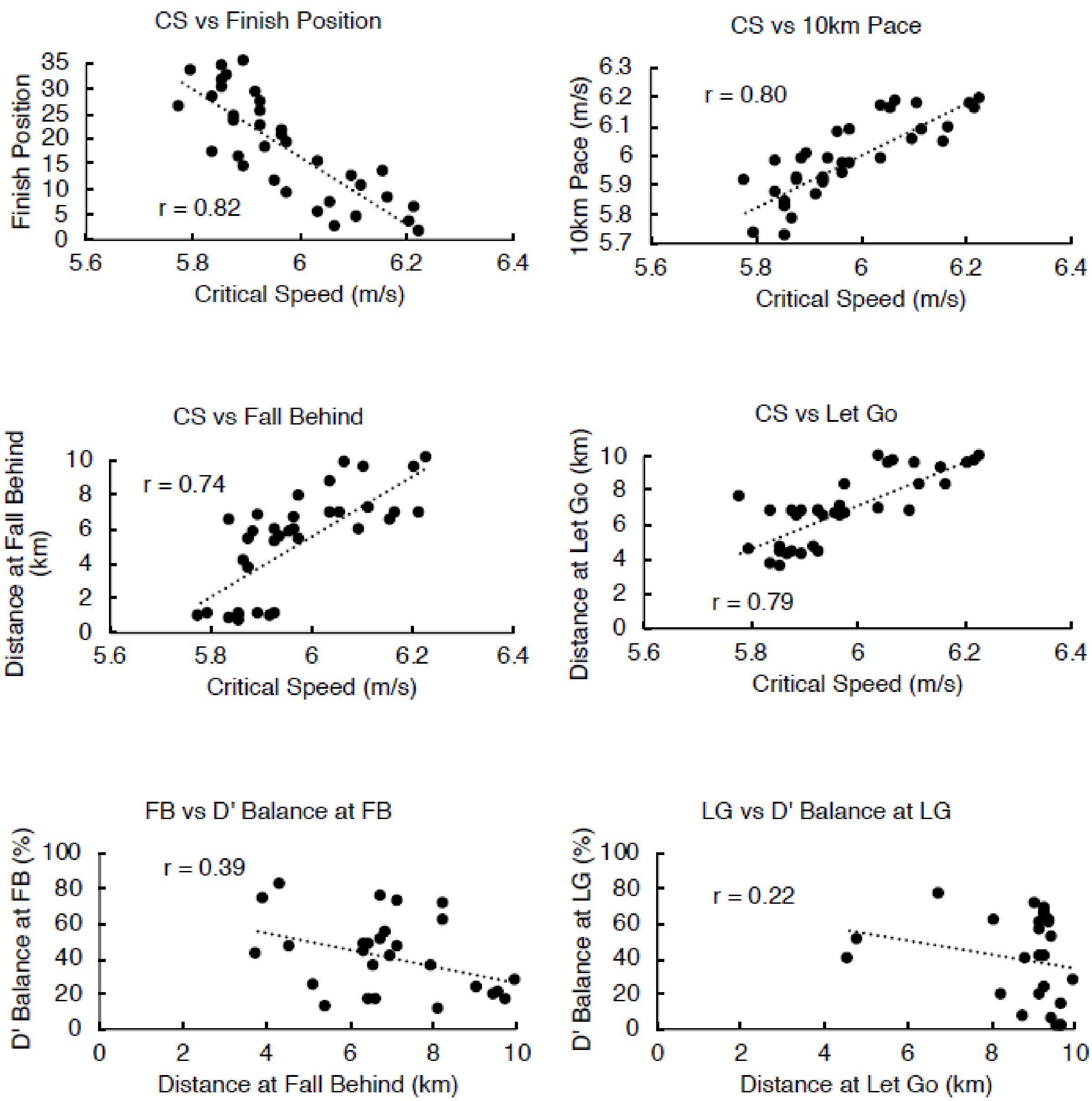

Figure 4: *Top left*: Relationship between CS and finishing position. *Top right*: Relationship between CS and mean 10,000-m speed. *Middle left*: Relationship between CS and the distance completed before falling behind. *Middle right*: Relationship between CS and distance completed before letting go. *Bottom left*: Relationship between D′ balance and the distance at falling behind. *Bottom right*: Relationship between D′ balance and the distance at letting go. All of these relationships demonstrate that CS estimated from previous running performances, is a strong predictor of performance. CS indicates critical speed.

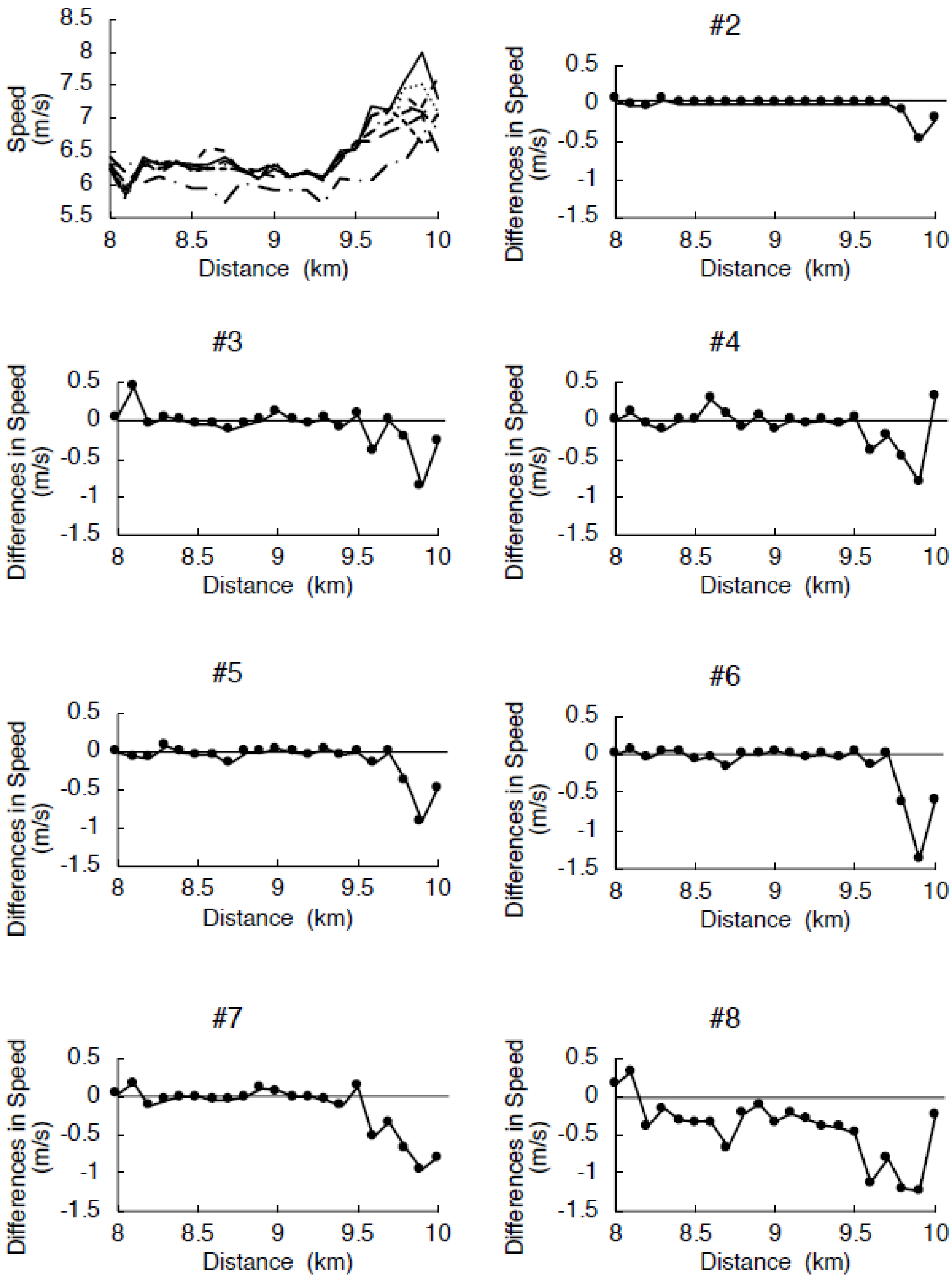

Figure 5: Speed versus distance completed profiles during the last 2000 m of the first 8 runners. In all but the first figure, the speed is normalized to that of the winner. It is evident that the better-placed runners let go later than the less successful runners. The last runner had already been dropped before the last 400 m.

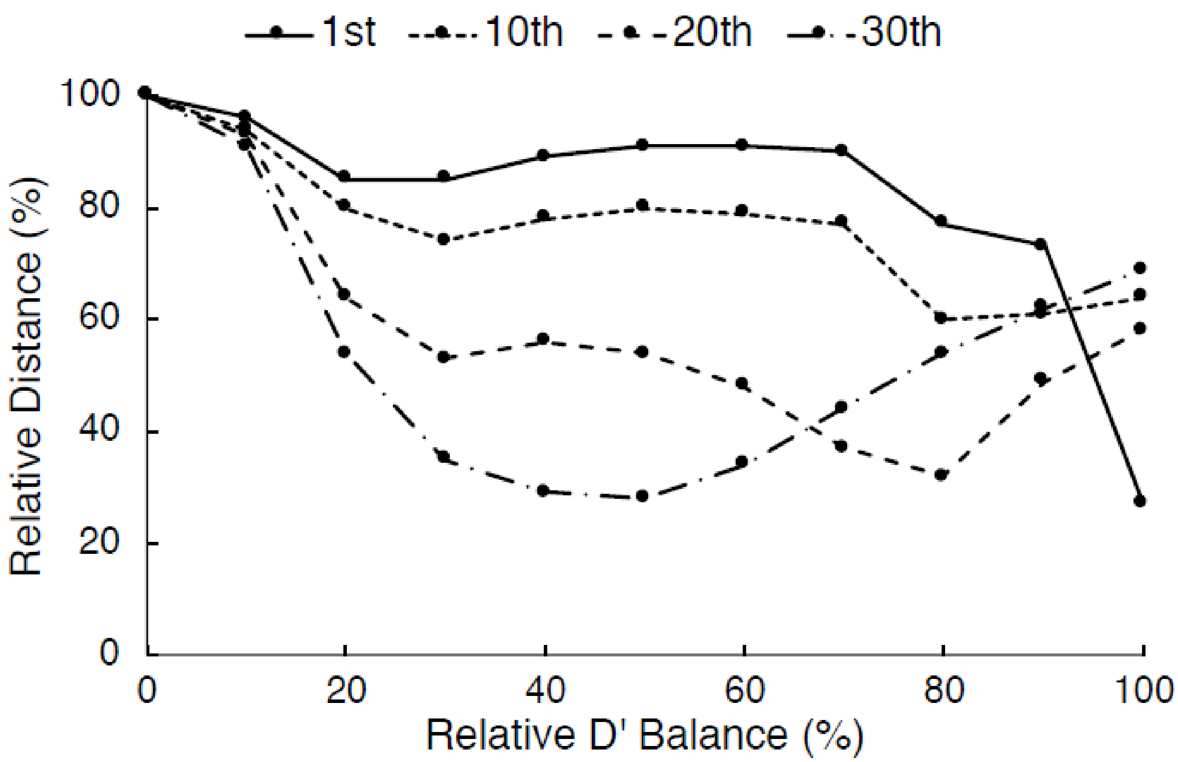

Figure 6: Schematic of the D′ balance, normalized to the maximal value for the 1st, 10th, 20th and 30th finishers. The results demonstrate that better-placed runners preserve D′ balance until late in the race, and that less successful runners use D′ balance early in the race, until reaching the point of letting go, at which time their pace decreases so much that D′ balance is reconstituted.

Results

The race was completed in finishing times between 26:55 and 29:23, with 35 finishers. The contemporary WR was 26:17. The winner was Kenenisa Bekele from Ethiopia, whose pacing behavior is presented in Figure 1. The pace was fundamentally constant until 9400 m, but there were minor increases in pace (e.g., surges) at 1000 m and 7000 m. There were 3 distinct groups of runners who fell behind at ~1000 m (n = 5), ~6000 m (n = 10) and ~9000 m (n = 5), and 3 groups who let go at ~4000 m (n = 10), ~7000 m (n = 16), and ~9500 m (n = 11) (Figure 2). The incidence of falling behind or letting go was related to both the mid-race surges by the winner and independent slowing by the falling behind/letting go runners

The relationships between mean CS (5.98 ± 0.13 m·s^{-1}) and finishing position ($r = 0.82$), mean speed for the 10,000 m ($r = 0.80$), falling behind distance ($r = 0.74$) and letting go distance ($r = 0.79$) were strong (Figure 4). There was a weak relationship between final placing and falling behind distance ($r = 0.39$) and letting go distance ($r = 0.22$), respectively.

The distance completed versus falling behind, letting go or being outsprinted, as judged by different authors, is present in Figure 3. In general, these points were well correlated, suggesting that the method is robust.

During the last lap, the top 7 runners succeeded by increasing their running pace, in contrast to a reduction in pace by runners who fell behind or let go; these lower-finishing runners decreased their relatively constant pace during the early-mid portions of the race, and often fell behind or let go immediately in response to surges by the leader. The speed profile of the athletes contesting victory during the last 2000 m is presented in Figure 5 (including for reference runner #8 who fell behind at 800 m and let go at 9500 m.

Plots of D′ balance in runners finishing 1st, 10th, 20th and 30th are presented in Figure 6. The high finishing runners preserved D′ balance until near the end of the race, whereas low finishing runners depleted D′ balance early, slowed and then often reconstituted D′ in the later part of the race, after reaching the letting go phase of the run.

The plot of distance completed versus D′ balance in the 7 runners still together with 400 m remaining is presented in Figure 7. As with the larger pattern evident in Figure 6, the better placed runners (medalists) preserved D′ balance until the later stages of the race. Runer #6 (Gebrselassie) preserved D′ balance until the finish, reputedly secondary to an injury that prevented him from sprinting properly. The correlation between D′ balance and finishing speed over the last 1 km was strongly related (without finisher #6, $r = 0.87$), but only moderately related ($r = 0.42$) with finisher #6, who had an injury that prevented sprinting but not running at a fast pace.

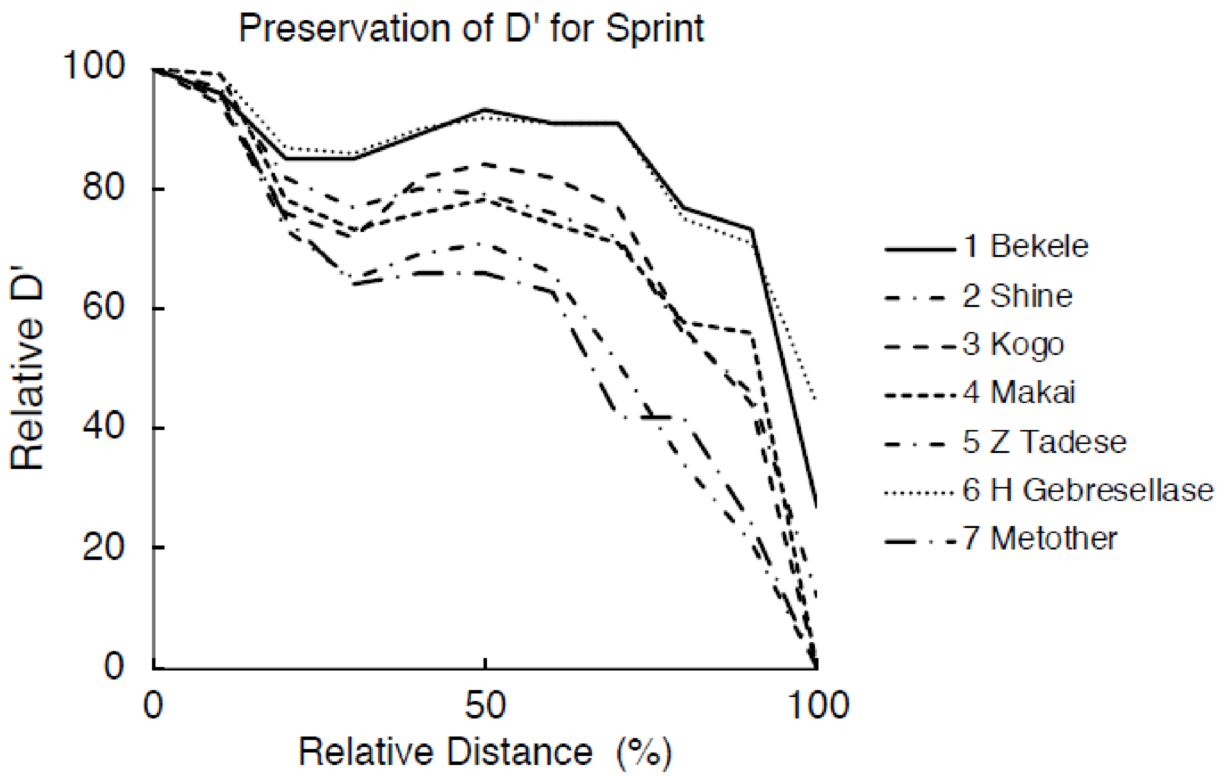

Figure 7: Schematic of the D′ balance in the top 7 runners (together with 400 m to go). The top 2 runners preserved D′ very well until the last 3000 m and then expended D′ during the finishing effort. The other runners used a larger proportion of D′ earlier in the race, leaving them with less reserve for the terminal part of the race.

Discussion

This study was intended to determine whether there were distinct phases in championship races where some athletes fell behind and/or let go, or were outsprinted. A secondary purpose was to compare performance and the positions of falling behind, letting go, or being outsprinted in relation to physiological capacity represented by the CS + D′ model.[2,3,5.15] A tertiary purpose was to determine whether runners competing for victory late in the race had the same process of falling behind and letting go during the final 2000 m.

The main finding of this study was that elite runners, at the very highest standard of competition (Olympic Games), showed "falling behind" and "letting go" behavior of the speed versus distance relationship. This behavior occurred in 3 basic groups, leaving 7 (of 35) finishers to contest for the victory during the last 400 m (4% of race distance). There was a strong relationship between final placing ($r = 0.82$) , mean pace ($r = 0.80$), distance at falling behind ($r = 0.74$) and distance at letting go ($r = 0.79$) with CS, which would be expected as CS is widely recognized as a strong marker of endurance performance.[5,15]

The magnitude of the relationship between CS and markers of running performance is similar to other physiologic markers such as VO_2 max, lactate threshold, OBLA, maximal lactate steady state (MLSS), and running performance.[5,12,15] It is also in concert with the findings of Venhorst et al.[6] who found that the decrease in speed was preceded by a decline in affective valence and subsequent increase in conflict between further goal-pursuit and goal-disengagement (the latter termed an action crisis) which is clearly a stressful event goal striving (as indicated by increased blood cortisol levels despite reduced performance) in competitive athletes and is suggested to explain the decision-making processes underpinning observed pacing behavior more comprehensively. Rather than being a completely responsive process on the part of athletes at the falling behind and letting go phases of the race, the process appeared to be driven both by surges in pace from the leaders, including the endspurt, and by decreases in pace by the trailing runners. The same general pattern was evident in the runners competing for victory, although it was more of a “letting go” pattern. We analyzed whether this distance, shown by a sudden difference in the speed profile vs difference in the speed profile of the eventual winner (our constant reference) and the runners who fell behind or let go, was attributable to an unmatched acceleration by the eventual winner, or to an independent decrease in pace by the trailing runner. Amongst the falling behind runners, 26/28 slowed their own pace, 19/28 failed to match an acceleration by the winner, and 17/28 both slowed their pace and failed to match an acceleration. Amongst the letting go runners, 19/28 slowed their own pace, 24/28 failed to match an acceleration and 13/28 both slowed and failed to match an acceleration by the winner. Outside of the runners contesting for the victory, the process of letting go was more related to a decrease in running speed by the trailing runners. Amongst the 7 leading runners, even letting go was primarily related to failure to increase pace by as much as the leader (last lap in 53 s) rather than by a large deceleration.

The top 10 finishers maintained appreciable D′ balance through the early part of the race because the cost of running could be accounted for mainly through oxidative energy sources, reflected by their high CS. They only depleted D′ balance during the last 2000 m of the race. The winner still preserved D′ balance late in the race, demonstrating his competitive superiority (last 1000 m). Runners finishing outside the top 10 depleted D′ balance early in the race, reached the point of letting go and, in many cases, reconstituted D′ balance through much of the remainder of the race. This is consistent with the findings of Kirby et al.[2] who observed that high finishing runners maintained D′ balance until the last 400 m, and of Foster et al.,[3] who observed near zero values for D′ balance only at the end of WR 1 mile races. It further fits the predictions by Skiba et al.[16] relative to the depletion and reconstitution of D′ balance. It can be argued that, once the letting go stage of the race has been reached, an athlete is no longer fully competing in the event but continues to the finish on the chance that they could still achieve a personal best time or for the satisfaction of having completed the race. By the same token, runners who reach either the falling behind or letting go stage of the race might be anticipating the behavior of those runners who continue with the leaders, but who often have a subsequent competitive crisis, and that they may overtake these runners and achieve a better placing by moderating their pace earlier in the race. This is congruent with the idea that runners are continuously evaluating their momentary capabilities and are making active decisions about pacing on a moment-to-moment basis, based both on pre-race expectations and on homeostatic disturbances.[3,9,10,14,17-25]

The process of falling behind is probably an unconscious part of decision making, in that the runner cannot keep with the pace, either through a subtly unacceptable rate of RPE growth or affective decline. In a race as important as the Olympics, most runners are likely to start at the pace of the eventual leaders/winner, but gradually fall behind as their body realizes, even before their mind, that the pace is unrealistic for them. The process of letting go is probably more intentional and strategic. Athletes who have fallen behind almost certainly come to realize that they have fallen behind by so much that they cannot recover to the lead, and make an active decision to reduce to the best pace that they can tolerate, part of a conscious decision making process. In many cases, because of the "risk it all" mind set engendered by a race of this important, this may involve having to radically reduce the pace of running, to the point where D´ balance can be reconstituted. In runners who let go early in the race, it seems likely that they realized that the leaders pace was impossible for them, and they made an early decision. Runners who let go later in the race, may have persisted in a belief that they might have a "good day" and succeed at the finish, so the decision to let go was more dramatic.

An unanticipated finding from this study is that the CS is attained at approximately the speed required for competing over 10,000 m in elite runners. However, this fits well with evidence provided by Lourenço[9] that 10,000 m pace is dependent on the ability to buffer acid-base disturbances, and evidence from Karlsson and Saltin[10] that events of 2, 6 and 16 minutes end with approximately the same muscle lactate (e.g., acid-base disturbance), and Jones et al.[11] who observed that phosphocreatine and pH both change dramatically at intensities greater than Critical Power/Speed.

Practical Applications

It is important to understand where and when runners will fall behind and let go during a race, during even the most elite races. Falling behind and letting go appear to occur in groups and, in a field of 35, there could be as many as 3 groups who fall behind and who more or less quit competing (e.g., let go) before the final sprint. This appears to be related to homeostatic disturbances (early loss of D′ balance), but could also represent a tactic to maintain the best possible position, even in the case where winning or medaling, is perceived as impossible. Clearly, the point at which a runner falls behind or lets go is part of the decision-making process designed to optimize performance. The same process appears to occur even amongst the runners near the front of the pack who are contesting for the victory.

Conclusions

In elite head-to-head long distance (10,000-m) races, non-successful runners successively drop off the leading pack. This occurs in a two-phase process: falling behind, where they are no longer closely linked to the leading group but running at only a slightly slower pace than the leader; and letting go, where they decrease their pace dramatically and run independently of the leaders. The process is at least potentially dependent on individual responses to surges by the leaders, although on the whole it is more related to decelerations by the trailing runners. The pace and position at falling behind and letting go are highly related to the CS estimated from recent performances. For the runners contesting victory, the race is not a "gun to tape" full effort. They simply have to run fast enough so that approximately 75% of the field either falls behind or loses contact or lets go before the last 10% of the race. In the last 400 m, the pattern is more one of letting go, although it occurs in the context of runners who are accelerating rather than decelerating. Management of D′ balance appears to be an important factor in racing, with better runners preserving D′ until the end, and less good runners depleting D′ balance early, decreasing their pace, and often reconstituting D′ balance. However, it is important to note that for as much as the results depend on aerobic capacity (e.g., CS), achieving victory depends upon sprint ability during the closing stages (e.g., D′ balance or anaerobic speed reserve).[2,26]

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