Paced to perfection: Exploring the potential impact of WaveLight Technology in athletics

Dr. Jonathan Taylor, Prof. Greg Atkinson and Dr. Russ Best explore the ergogenic effects of WaveLight technology on pacing and performance in long-distance track events.

Introduction and background

Athletics is in the midst of a technological revolution, which has had a major impact on endurance running performance. Since 2016, most men's and women's world records, from the 5000 m to the Marathon have been broken, while the all-time list of fastest performances has been recalibrated. While much emphasis has been placed on the introduction of the so-called 'super-shoe' technology, other innovations may have contributed to these improvements. For instance, when Eliud Kipchoge completed the marathon in under 2-hours in 2019, his race-kit and the course were carefully designed (i.e., long-straight sections and minimal undulations/curves), but a lesser appreciated innovation was the pacing device that was used. The use of pacing lights represented a key factor in Kipchoge's performance, and this approach to pacing was translated to international track athletics during 2020. This translation of technology coincided with world record performances in the Men's 5000 m and 10000 m, and the Women's 5000 m.

record, based on the literature, an even-paced approach would seem most appropriate for optimal performance.

A tool that has traditionally been used to assist with even-paced running during record attempts is the use of a 'pacemaker'. A pacemaker in an athletic sense is a designated athlete(s) whose purpose is to run part of a race at a given running speed, whilst shielding other athletes from the elements, through drafting. While this has been a universal approach in athletics, there are limitations with respect to the optimisation of performance, namely that athletes intending to complete the race at a given pace are reliant on the intuition of the pacemaker, and undesirable fluctuations in running speed may still occur. Furthermore, once the pacemaker steps off the track (often around half-way through the full distance), athletes are required to maintain the target pace unaided. The introduction of WaveLight pacing technology however, has to some extent alleviated these issues.

> **It appears that WaveLight technology has an ergogenic effect on performance in long-distance track events by allowing athletes to more closely achieve an even pace.**

Pacing in middle and long-distance running

Pacing the distribution of power, energy expenditure and/or speed during an event is fundamental to endurance running performance. Various strategies to pace the profile of running speed have been identified including: positive, all-out, negative, parabolic shaped, even and variable pacing (Abbiss & Laursen, 2008). The pacing strategies employed by elite runners depend on various factors, most notably whether the race is a championship or time-trial race (Filipas *et al.,* 2018). Other environmental factors including ambient temperature and windspeed, may also influence pacing. While championship 5000 m and 10000 m racing usually result in variable or negative pacing strategies (Filipas *et al.,* 2018), an even paced approach is proposed to be optimal for time-trial performance in long-distance track events (Abbiss & Laursen, 2008). Minimizing fluctuations in running speed is more economical and may decrease physiological disturbances, both of which are critical to performance (Abbiss & Laursen, 2008). Variable speeds in events held in the relatively consistent environmental conditions of track racing could also be sub-optimal for non-physiological reasons (Atkinson, Peacock & Passfield, 2007).

In an analysis of the men's world records over 5000 m and 10000 m between 1921and 2004, a parabolic shaped pacing strategy was adopted whereby the first and last kilometres were associated with the fastest splits (Tucker *et al.,* 2006). The concept of the 'end-spurt' has been considered with respect to the 'reserve' that an athlete possesses at the end of a race, and this was used to explain the fast final kilometre (Tucker *et al.,* 2006). More recently, a change in the pacing strategy in men's 5000 m running was identified. Thiel *et al.* (2014) reported a decreasing coefficient of variation (CV) in kilometre-to-kilometre (km-km) split times in World record performances from 3.4%, 2.8% and 2.1% in the time periods 1912-1937, 1938-1962 and 1963-1987, respectively. Between 1988-2012, however, the km-km split CV was 1.4%, and Thiel *et al.* (2014) suggested that an even paced strategy and a km-km split CV of ≤1.0% may lead to further improvements. While the same type of analysis has not been completed for the women's 5000 m world

WaveLight technology is an electronic pacing tool that comprises 400 LED lights installed on the drainage covers of an athletic track and uses fluid motion to flash at an assigned pace. At a relatively modest cost of ~€25,000-50,000, the number of athletics facilities that have had this technology installed is increasing exponentially. The technology was formally introduced to the international athletics' Grand Prix circuit (including World Athletics' flagship series, the 'Diamond League') in 2020, where it was used during world record runs over 5000 m (men's and women's) and 10,000 m (men's). While some people have questioned the ethics of using WaveLight, it is likely to be used in future international, none-championship, athletics meetings. Here, we explore the pacing strategies that were assisted by WaveLight technology during the recent men's 5000 m and 10000 m and women's 5000 m world records.

Observational analysis

To describe the pacing strategies assisted by WaveLight technology during the World record performances achieved in 2020, we obtained intermediate split-times to compare the km-km variability in running speed during the 10 most recent world record performances in each event. We calculated the km-km standard deviation in time and speed, as well as the respective CVs to describe how 'even' the pacing was. Mean time (s) per kilometre and km-km standard deviation are presented for the men's 5000 m (Figure 1), men's 10000 m (Figure 2) and women's 5000 m (Figure 3). Table 1 displays the CV% in running speed (km.hr-1) for the 10 most recent 5000 m men's, 10000 m men's and 5000 m women's world-records, respectively.

The km-km variability in running speeds during the men's 10000 m and women's 5000 m was lower than that of the previous 9 world record performances, while only 1 of the previous 9 world record performances in the men's 5000 m exhibited lower km-km variability than the record performance in 2020. These observations are indicative of a more even paced approach during the 2020 world records, than in previous record performances.

Table 1. World record performance kilometre-kilometre running speed Coefficient of variation.
Records during which WaveLight was used are highlighted in green.

Men's 5000 m		Men's 10000 m		Women's 5000 m	
Athlete (Year)	**CV (%)**	**Athlete (Year)**	**CV (%)**	**Athlete (Year)**	**CV (%)**
Cheptegei (2020)	0.7	Cheptegei (2020)	0.7	Gidey (2020)	1.2
Bekele (2004)	1.0	Bekele (2005)	1.6	Dibaba (2008)	3.2
Gebrselassie (1998)	1.8	Bekele (2004)	1.8	Defar (2007)	1.9
Komen (1997)	0.5	Gebrselassie (1998)	1.8	Defar (2006)	2.6
Gebrselassie (1997)	1.5	Tergat (1997)	1.1	Abeylegesse (2004)	1.9
Gebrselassie (1995)	1.3	Gebrselassie (1997)	0.9	Bo (1997)	2.5
Kiptanui (1995)	1.2	Hissou (1995)	1.7	Yanmei (1997)	4.0
Gebrselassie (1994)	2.6	Gebrselassie (1995)	1.9	Ribeiro (1995)	1.9
Aouita (1987)	1.9	Sigei (1994)	1.9	Kristiansen (1986)	1.4
Aouita (1985)	3.2	Ondieki (1993)	1.2	Budd (1985)	2.1

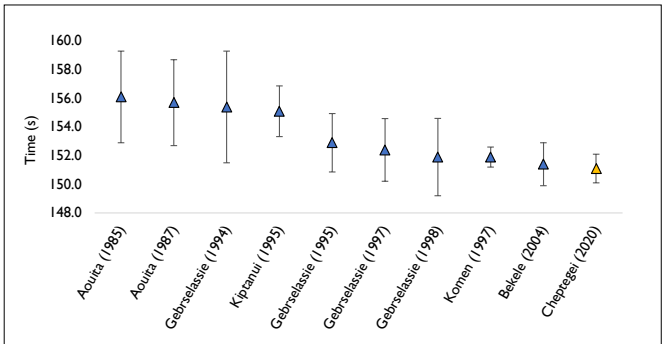

Figure 1. Men's 5000 m WR - Time (s) Per Kilometre (Mean ± SD)

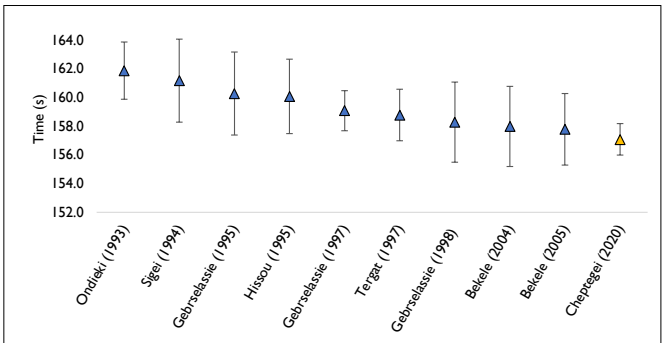

Figure 2. Men's 10000 m WR - Time (s) per Kilometre (Mean ± SD)

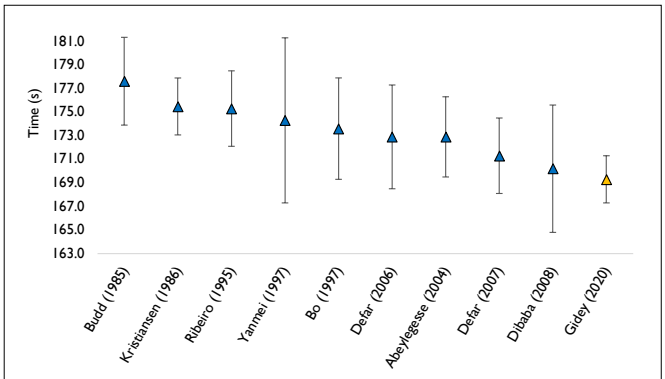

Figure 3. Women's 5000 m WR - Time per Kilometre (Mean ± SD)

Summary

The pacing strategy used by an athlete has major implications for optimum time-trial performance (Atkinson *et al*., 2007). While an even-paced strategy seems optimal for longer duration events, this has not always been the approach taken during world record performances. It appears that WaveLight technology has an ergogenic effect on performance in long-distance track events by allowing athletes to more closely achieve an even pace. Given the relatively subdued athletics racing schedule in 2020, the full extent to which the recent innovations (i.e., footwear and pacing) affect distance running performance are yet to be seen. Therefore, in the near future there appears to be greater potential for world records to be attained in distance running events on the track. The pacing strategies adopted in middle-distance events i.e., 800m and 1500m may present an area of interest given differing pacing positive approach taken in these races which have traditionally included negative and parabolic pacing, respectively. In summary, the use of pacemakers (for drafting) in conjunction with WaveLight technology, appears to have moved athletics a step closer to 'perfect' pacing with further records and personal bests in sight. ■

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