Pacing Strategies of Inexperienced Children During Repeated 800 m Individual Time-Trials and Simulated Competition

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Prior experience of fatiguing tasks is considered essential to establishing an optimal pacing strategy. This study examined the pacing behavior of inexperienced children during self-paced, 800 m running, both individually and within a competitive environment. Thirteen children (aged 9–11 y) completed a graded-exercise test to volitional exhaustion on a treadmill (laboratory trial), followed by three self-paced, individual 800 m time-trials (Trials 1–3) and one self-paced, competitive 800 m time-trial (Trial 4) on an outdoor athletics track. Ratings of perceived exertion (RPE) and heart rate (HR) were measured throughout all trials. Overall performance time improved from Trial 1–3 (250.1 ± 50.4 s & 242.4 ± 51.5 s, respectively, \( p < .017 \)). The difference in overall performance time between Trials 3 and 4 (260.5 ± 54.2 s) was approaching significance (\( p = .06 \)). The pacing strategy employed from the outset was consistent across all trials. These findings dispute the notion that an optimal pacing strategy is learned with exercise experience or training.

During competitive endurance exercise, the rate of energy expenditure is regulated to ensure successful completion of the event in the fastest possible time (21,22,37). This intensity regulation is termed a pacing strategy. For events lasting more than a few seconds, a pacing strategy is particularly important (22). Pacing strategies have been shown to be influenced by a number of situational factors, such as...
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as course topography, distance, duration, environmental conditions, mode of exercise, degree of competition, motivation, knowledge and experience (1,7,21,22,37).

It is generally believed that pacing is consciously controlled by the individual via the integration of internal cues that arise from numerous physiological systems during exercise, in conjunction with the conscious perception of exertion, to delay the onset or development of fatigue (3,30,39). Several theoretical models have been proposed to elucidate the mechanisms associated with the development of an appropriate pacing strategy. It is postulated that a ‘central programmer’ within the brain subconsciously regulates exercise performance through central calculations, to preserve whole body homeostasis, while concurrently reducing the risk of premature fatigue (41). Following the setting of a predetermined initial power output, which is based upon the known distance or duration of the event, the brain mediates a complex system of efferent (feedforward) and afferent (feedback) commands to ensure that the power output is appropriate within the context of the exercise bout. The central governor model (CGM) extends this theory and infers that the brain modulates motor unit recruitment (pacing strategy) throughout an event via refined subconscious calculations that integrate current metabolic demand with the individual’s level of metabolic fuel reserve, their experience in completing fatiguing tasks, external environmental conditions and knowledge of an endpoint (35,38,39).

Recent research suggests that pacing schemas, which are created from prior bouts of analogous exercise and stored for reference in the long-term memory, may impact upon a current pacing strategy (39). In this respect, it is proposed that an internal clock exists to monitor distance covered and the time taken to complete an exercise bout at a specific pace, to refine changes in power output (37). Importantly, the ratings of perceived exertion (RPE) have been proposed as a mediating factor in this model, on the basis that exercise will terminate when the RPE reaches a level which is intolerable or uncomfortable for an athlete (39). In this regard, Tucker (39) suggests that a conscious RPE is compared with an expected level of exertion during exercise to ensure that the conscious RPE does not exceed acceptable limits.

Prior experience of fatiguing tasks that are similar in distance and/or duration is considered essential to establish an optimal pacing strategy for a specific exercise bout (21). How then, is an initial pacing strategy adopted or developed in the first instance? In addition, how does this pacing strategy evolve during subsequent bouts of exercise as new pacing schemas are created? In this regard, the pacing behavior of children, who are unfamiliar with a given exercise task, is of particular interest. Only one study (29) has assessed the pacing behavior of young schoolchildren of differing age and level of cognitive development, during a single running event. In accordance with Piaget’s proposed stages of intellectual development (34), as a child progresses through the concrete operational period (8–12 years), they develop logical thought and the ability to form temporal-spatial representations. As demonstrated by Micklewright et al. (29), this ability is crucial for anticipating the demands of an exercise task and for regulating effort accordingly. However, studies have yet to assess the pacing behavior of children during repeated bouts of exercise or indeed during a competitive bout of exercise. In fact, the influence of competition on pacing strategy has only recently been examined in adults (9). Although their study assessed pacing behavior during a 2000 m cycling time-trial, head-to-head competition was shown to provoke systematic alterations to the adopted pacing strategy and resulted in improved performance times.
The purpose of this study was therefore to assess the pacing behavior of children who have no prior experience of endurance running (> 80 m; 11) during i) a series of individual 800 m timed trials and ii) a race situation in the presence of other competitors. It is important to note that although 800 m is considered to be a middle-distance running event for adults, the general pacing strategy employed by elite adult runners more closely reflects that of a short-distance event (i.e., ‘positive’ pacing strategy; 23). A positive pacing strategy generally denotes a decline in an athlete’s speed over the course of the event (1). This is in contrast to the ‘variable’ pacing strategy, which is often characterized by a ‘sprint start’, modulated midportion and an ‘end spurt’, typically employed in longer distance events in adults and recently demonstrated with children (aged 11 y) when running a distance of 750 m (29). The pacing strategy employed by children during repeated 800 m running is yet to be explored. By implementing repeated trials, we could examine the extent to which prior experience and the presence of other competitors influenced the initially-adopted pacing strategy. We hypothesized that performance time would improve across three individual time trials as the children became familiarized with the demands of the exercise task and that, in line with the CGM of pacing, this would coincide with alterations in pacing strategy to elicit the best performance. We also hypothesized that the RPE would increase during the course of each of the 800 m runs until a maximal value was obtained and that performance times would improve during a competitive bout of analogous exercise.

Method

Participants

Thirteen healthy children (n = 8 boys; age: 10.3 ± 0.7 y; height: 1.43 ± 0.10 m; body mass: 34.0 ± 7.5 kg; n = 5 girls; age: 10.6 ± 0.5 y; height: 1.44 ± 0.03 m; body mass: 34.8 ± 5.7 kg) volunteered for the study. Participants were recruited from two local schools in the East Devon area, England. All children were asymptomatic of illness or disease and free from injury, as assessed by a standardized health questionnaire which was completed by parents / guardians. Written informed consent and assent were obtained from parents / guardians and children, respectively, before the start of the study. All participants were generally active (play-type activities) but none were specifically trained in middle- or long distance running (i.e., continuous running ≥ 800 m), according to self-reports and parental-reports of activity status. The teachers of each school also confirmed that at the time of data collection, children had not participated in any structured endurance running events (> 80 m; 11) as part of their school curriculum. This study was conducted in accordance with the ethical guidelines of the University of Exeter’s ethics committee.

Procedures

The children participated in five sessions. The initial session was laboratory-based comprising basic anthropometric measurements, including height and body mass (stadiometer & scales; SECA, Hamburg, Germany), and a graded-exercise test (GXT) to volitional termination at the point of exhaustion. This was completed on a motorized treadmill (Woodway GmbH PPS 55Med-I, Weil am Rhein, Germany)
and served to habituate the participants to the use of the Eston-Parfitt (E-P) scale (15) and equipment (heart rate [HR] monitor & watch) which would be used in following sessions. A pediatric wireless chest strap telemetry system (Wearlink+, Polar Electro Oy, Kempele, Finland) was used to record HR throughout all trials. Physiological data were masked from participants at all times. The four subsequent exercise sessions were field-based and took place on an outdoor grass athletics pitch. Average air temperature (18.5 ± 2.9 °C) and relative humidity (67 ± 6%) were calculated for all field-based exercise sessions within the period of data collection and anecdotally, wind conditions were observed as being nonexistent to light.

**Rating of Perceived Exertion**

Children can accurately gauge their level of exertion using appropriate perceived exertion rating scales (4,12,26), particularly after they become familiarized with the exercise task (17,33). In this study, the E-P scale (27) was used to assess perceived exertion during the laboratory-based GXT and each of the field-based trials. During the final few seconds of each exercise stage during the GXT, the E-P scale was placed directly in front of each participant and the question ‘how hard does the exercise feel to you?’ was asked by the investigator. Children pointed to- or verbalized a number or phrase that best described their level of exertion, before the next exercise intensity being implemented. During the field-based exercise trials, enlarged versions of the E-P scale (size A0) were positioned at 200 m, 400 m, 600 m and 800 m around the track. As children ran past each scale, they verbally reported an RPE to the investigator who was holding the scale. Standardized instructions as to the use of the E-P scale were provided before the laboratory-based GXT, and were repeated before each exercise test thereafter.

**800 m Trials**

Participants were required to run 800 m on a marked, grass athletics track, once on four separate days. During the first three of these four exercise sessions, participants ran the 800 m distance individually. They were encouraged at the start of each trial to ‘run the distance in the fastest possible time’; although no verbal encouragement was provided during the trials. Colored ‘marker’ cones and enlarged versions of the E-P scale were positioned and clearly visible at each 200 m point (of the 800 m distance) around the track, and at both the start and finish lines. As the athletic track had a total distance of 300 m, this meant that children were to run 2 and 2/3 laps to complete the full 800 m distance. The total time taken for participants to complete the 800 m distance, in addition to the split time for each 200 m, were recorded during each test. Each participant wore a HR monitor and corresponding watch which continuously measured and recorded HR in 5 s averages, for the duration of the test.

Procedures during the competition trial were identical to the three previous individual trials, with the exception that the children ran the 800 m distance in randomized groups of either 4 or 5. Children were again instructed to run the distance in the fastest possible time. As in the previous three trials, RPE were reported every 200 m. No feedback as to completion times or any physiological data were provided to the participants until the completion of all tests.
Data Analysis

A one-factor, repeated measures Analyses of Variance (ANOVA) was used to assess overall performance time (800 m) between trials 1–3. A series of two factor (Distance x Trial), repeated-measures ANOVA were also used to assess the split times, HR and RPE across each 200 m distance, during trials 1–3. To assess the influence of competition, similar analyses were performed between the third individual trial (trial 3) and the fourth group trial (trial 4). A paired-samples t test was used to compare overall performance time (800 m) between trials 3 and 4. A further series of two factor (Distance x Trial) ANOVA were used to compare the split times, HR and RPE across each 200 m distance, between trials 3 and 4. If assumptions of sphericity were violated according to the Mauchley’s test, a Greenhouse-Geisser correction factor was applied to correct the degrees of freedom of the F ratio. Post hoc paired-samples t tests were employed where statistical differences were observed, with Bonferroni adjustment applied to increase the stringency of the analysis and protect against type one error. Significance was determined according to a < .05 or (following adjustment) either < 0.017 or < 0.008, where appropriate.

Results

Performance Times

Overall Performance Time (800 m) for All Trials  Overall performance time was significantly different ($F_{(2, 24)} = 5.541, p < .01$) across Trials 1–3. Post hoc analyses revealed that the total time to complete trials 2 ($243.5 \pm 51.2$ s; $t_{(12)} = 2.813$) and 3 ($242.4 \pm 51.5$ s; $t_{(12)} = 2.745$) were faster than trial 1 ($250.1 \pm 50.4$ s; both $p < .017$).

The difference in overall performance time between trials 3 and 4 ($260.5 \pm 54.2$ s) was approaching significance ($t_{(12)} = 2.033, p = .06$; Figure 1).

Figure 1 — Overall 800 m performance time (s) for field-based exercise trials (Trials 1–4). Values are reported as mean ± SEM * Trials 2 and 3 were significantly faster than Trial 1 ($p < .017$)
Split Times Across Split Distances of 200 m for Trials 1–3  There was a significant difference in Distance ($F_{(3,36)} = 33.689, p < .001$) and a significant difference between Trials ($F_{(2,24)} = 5.360, p < .05$), but no Distance by Trial interaction was observed for split times across trials 1–3 ($p > .05$). Post hoc analyses revealed that the average split time to complete the first 200 m of the event ($53.1 \pm 12.2$ s) was significantly faster than the average split time for 400 m ($65.3 \pm 13.3$ s; $t_{(38)} = -11.679$), 600 m ($65.1 \pm 14.8$ s; $t_{(38)} = -11.151$), and 800 m ($61.9 \pm 11.8$ s; $t_{(38)} = -7.311$, all $p < .008$). The average split time was also faster between 400 m and 800 m ($t_{(38)} = 3.327, p < .008$) and 600 m and 800 m ($t_{(38)} = 3.344, p < .008$), but there were no differences in split times between 400 m and 600 m across trials 1–3 ($p > .05$). Further post hoc analyses revealed that the average split times for trial 3 ($60.6 \pm 13.9$ s) were significantly faster than for trial 1 ($62.5 \pm 13.9$ s; $t_{(51)} = -2.620, p < .017$).

Split Times Across Split Distances of 200 m for Trials 3–4  When comparing split times between trials 3 and 4, a significant difference in both Distance ($F_{(1.5, 18.2)} = 18.374, p < .001$) and Trials was observed ($F_{(1.12)} = 15.822, p < .01$), but there was no Distance by Trial interaction ($p > .05$). Post hoc tests revealed that the average split time for 200 m ($55.0 \pm 12.7$ s) was significantly faster than for 400 m ($67.3 \pm 14.2$ s; $t_{(25)} = -7.657$), 600 m ($63.9 \pm 14.0$ s; $t_{(25)} = -8.328$) and 800 m ($61.5 \pm 12.5$ s; $t_{(25)} = -3.711$), and that 800 m was faster than 400 m ($t_{(25)} = 6.809$, all $p < .001$). Moreover, trial 3 was significantly faster than trial 4 ($60.6 \pm 13.6$ s cf. $63.3 \pm 14.3$ s, respectively; $t_{(51)} = -2.672, p < .01$; Figure 2).

Heart rate

Heart Rate Across Split Distances of 200 m for Trials 1–3  There was a significant main effect for Distance ($F_{(1.8, 22.1)} = 19.022, p < .001$), but no main effect for Trial and no Distance by Trial interaction was observed for HR (both $p > .05$). Differences in HR (all $p < .001$) were noted only between the first 200 m ($162 \pm 13$ b·min$^{-1}$) and each succeeding distance, including 400 m ($187 \pm 14$ b·min$^{-1}$; $t_{(38)} = -7.969$), 600 m ($186 \pm 23$ b·min$^{-1}$; $t_{(38)} = -5.484$) and 800 m ($190 \pm 19$ b·min$^{-1}$; $t_{(38)} = -7.074$), across all three trials.

Heart Rate Across Split Distances of 200 m for Trials 3–4  There was a significant difference in HR across Distance ($F_{(2.0, 24.6)} = 41.480, p < .001$), but there was no difference across Trials and no Distance by Trial interaction between trials 3 and 4 (both $p > .05$). Post hoc tests demonstrated significant increases in HR from 200 m ($161 \pm 12$ b·min$^{-1}$) to 400 m ($186 \pm 9$ b·min$^{-1}$; $t_{(25)} = -10.422$), 600 m ($188 \pm 19$ b·min$^{-1}$; $t_{(25)} = -5.852$) and 800 m ($191 \pm 19$ b·min$^{-1}$; $t_{(25)} = -7.296$; all $p < .001$; Figure 3).

Perceived Exertion

Ratings of Perceived Exertion Across Split Distances of 200 m for Trials 1–3  There was a significant main effect for Distance ($F_{(1.5, 17.9)} = 90.674, p < .001$), but no main effect for Trial and no Distance by Trial interaction for RPE (both $p > .05$). Post hoc analyses revealed a significant increase in RPE between 200 m ($2.2 \pm 1$) and 400 m ($4.0 \pm 1.2$; $t_{(38)} = -12.851$), 200 m and 600 m ($5.4 \pm 1.8$; $t_{(38)} = -14.401$), and 200 m and 800 m ($6.5 \pm 2.0$; $t_{(38)} = -17.786$), as well as a difference between 400 m and 600 m ($t_{(38)} = -9.269$), 400 m and 800 m ($t_{(38)} = -12.065$) and 600 m and 800 m ($t_{(38)} = -9.626$, all $p < .001$), across all three trials.
There was a significant difference in RPE across Distance ($F_{(1.4, 16.3)} = 75.676, p < .001$), but there was no difference across Trials and no Distance by Trial interaction between trials 3 and 4 (both $p > 0.05$). Post hoc analysis revealed highly significant increases in RPE as distance progressed from 200 m (2.3 ± 1.0) to 400 m (4.0 ± 1.2; $t_{(25)} = -13.844$), 600 m (5.3 ± 1.7; $t_{(25)} = -12.104$) and 800 m (6.3 ± 2.1; $t_{(25)} = -13.008$), as well as between 400 m and 600 m ($t_{(25)} = -5.801$), 400 m and 800 m ($t_{(25)} = -8.041$), and 600 m and 800 m ($t_{(25)} = -6.845$, all $p < .001$; Figure 4).

**Discussion**

This is the first study to assess i) whether young children, who have no prior experience in 800 m running use pacing strategies to improve performance across repeated bouts of exercise and ii) whether the presence of other competitors influences pacing behavior. The main findings of this study demonstrated that children can successfully regulate their pacing behavior over the course of an 800 m distance and that familiarization to the exercise task improved performance times across the three
individual trials. However, it was clear that the presence of other competitors had detrimental influence on individual performance, resulting in increased duration to complete the 800 m event (overall performance time approached statistical significance \( p = .06 \); split times were statistically slower during the competitive trial).

It is commonly accepted that prior experience of a specific exercise task is essential for adults to establish an optimal pacing strategy (21). The findings of the current study provide novel evidence which demonstrates that children are able to adopt a successful pacing strategy for a given running event (800 m), despite having no prior experience of the task. The criteria for successfully adopting a pacing strategy were met by all children as they were able to complete the initial exercise task without stopping. In addition, the pacing strategy that the children employed during Trial 1 did not differ during subsequent exercise trials, although a performance improvement was observed. Overall, children ran the second and third 800 m bouts of exercise ~6.6 s and ~7.7 s faster than Trial 1, respectively, which represents an absolute improvement in performance of 2.6–3.1%.

A recent study investigating the pacing strategies of young children in different stages of cognitive development (29), according to Piaget’s classifications (34), has revealed similar findings to our current study. Micklewright et al. (29) demonstrated that when children, who were in the ‘late concrete operational’ stage of cognitive

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**Figure 3** — Heart rate (b·min\(^{-1}\)) during each 200 m distance, across field-based exercise trials (Trials 1–4). Values are reported as mean ± SEM * Average heart rate for 200 m was significantly lower than for succeeding distances (400-, 600-, & 800 m), for Trials 1–3 (all \( p < .001 \)). # Average heart rate for 200 m was significantly lower than for succeeding distances (400-, 600-, & 800 m), for Trials 3 and 4 (all \( p < .001 \)).
development (aged 11.8 ± 0.4 y), were asked to run a distance of 750 m (comparable to the current study) they used a parabolic U-shaped pacing strategy. In the current study, an identical strategy was noted with split times markedly faster for the initial- (0–200 m) and final- (600–800 m) 200 m distances, demonstrating the statistical occurrence of both a ‘sprint start’ and an ‘end spurt’, respectively. The findings of these two studies demonstrate that young children (~10–11 y) attempt to regulate and conserve their energy throughout a running event to ensure that they complete the distance successfully within their own physiological limits. Furthermore, these studies offer convincing evidence that pacing behavior occurs early in childhood and that the stage of intellectual development (i.e., concrete operational period) is associated with the level of anticipatory regulation of power output that can be achieved in these young children.

In adults, it has been suggested that performance templates are laid down early in an athlete’s development (19). During repeated performances in adults, these templates have been shown to be fairly resistant to change, despite improvements in performance often being observed (20). The current study demonstrates

Figure 4 — Rating of perceived exertion (RPE; E-P scale) during each 200 m distance, across field-based exercise trials (Trials 1–4). Values are reported as mean ± SEM * Average RPE for 200 m was significantly lower than for succeeding distances (400-, 600-, & 800 m), average RPE for 400 m was significantly lower than 600 m and 800 m, and average RPE for 600 m was significantly lower than 800 m, for Trials 1–3 (all \( p < .008 \)). # Average RPE for 200 m was significantly lower than for succeeding distances (400-, 600-, & 800 m), average RPE for 400 m was significantly lower than 600 m and 800 m, and average RPE for 600 m was significantly lower than 800 m, for Trials 3–4 (all \( p < .001 \))
that children can also produce a performance template from a single, initial bout of unfamiliar exercise and that performance can improve across repeated trials, despite the lack of change in the pattern of pacing. In this regard, the employment of this specific performance template (i.e., the ‘variable’ strategy) is quite remarkable when considering the relative distance of the event. In adults, although 800 m may be considered middle-distance, the typical ‘positive’ pacing response reflects that of a sprint event, whereby power output is seen to decrease over the course of the event once the initial peak power output has been achieved (1). However, an 800 m distance for children of this age is generally classified as an endurance event (11) and as such, the presentation of a ‘variable’ strategy is actually comparable to that observed with adults for a relatively equivalent endurance-based distance. Interestingly, research with adults has frequently documented that an optimal pacing strategy is ‘learned’ as a result of task familiarization, such as during exercise training (21), and that athletic performance over longer-distances is optimized with the employment of an end-spurt (25,28,37). Yet, despite the children in this study having never experienced running a continuous 800 m distance before the initial trial, they were able to i) demonstrate an appropriate pacing strategy for the given relative distance and ii) regulate their pace to employ an end-spurt to optimize performance, without prior training or familiarization to the exercise task. Further research is necessary to elucidate the factors that contribute to the development of an appropriate performance template for a given distance / duration in young children, in addition to the influence age-, cognitive developmental level and exercise experience on a child’s pacing behavior.

It is well established that the pressure associated with a competitive exercise task may influence the performance outcome, whether negatively or positively (8). Pressure is largely attributed to an increased level of anxiety as a result of various situational incentives such as social comparison, presence of an evaluative audience or rewards offered for success (6). Although studies have assessed the various pacing strategies adopted during differing athletic events in relation to simulated competition (i.e., time trial performance), there is a paucity of research on the influence of the presence of competitors on pacing behavior in children. In the current study, a competitive 800 m running event significantly impacted upon individual performance, despite improvements in overall completion time having occurred during previous trials (1–3). Simply, the children ran slower during the competitive trial than when completing the task individually (i.e., Trial 3). The decrement in performance time is in contrast to that of Bath et al. (5) who reported that a ‘second runner’ had no effect on an athlete’s performance time during a 5 km time trial. However, an important distinction between these two studies relates to the age of the participants, as Bath and colleagues used 11 club level male athletes, aged 33 ± 8 y. Familiarity with competition most likely accounts for the decrease in performance variability often associated with increasing age (24). Moreover, attitude to competition has been suggested as a probable determinant of performance variability among athletes, as slower runners may feel less motivated to compete in the knowledge that they have little chance of ‘winning’ (24). Although the aim of the competitive trial in the current study was not to ‘win’ but to complete the trial in the ‘fastest possible time’ in the presence of other runners, it is plausible that motivational levels differed among the children which may have impacted upon their individual performance. Thus, the age of the participants in this study
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and relative inexperience of participating within a competitive environment are likely factors that contributed to the overall decrement in performance during the fourth competitive trial. As such, it would be of interest to examine the effect of repeated-bouts of competition on performance capability in children of this age and athletic experience.

Although theoretically driven, the mechanistic models of fatigue and energy regulation (i.e., CGM, pacing schemas) offer potential insight into the formation of an appropriate pacing strategy. It is feasible to consider that children may possess some form of protective limiting control mechanism which acts specifically to prevent any harmful physiological disturbance to normal homeostatic function. According to Noakes (31), such a control mechanism (central governor) may well have evolved over millions of years to prevent us from catastrophic physiological failure in one or more of our body systems during conditions of extreme stress. In the context of exercise, and when considering that a child’s muscle tissue is in the process of growth and development, such a control mechanism is certainly plausible as excessive exercise may impose more damage on their immature musculoskeletal and cardiopulmonary systems than would a comparative overexertion in adults (36).

Accordingly, predictions of the CGM suggest that the initial formation of a pacing strategy occurs in an anticipatory manner, implementing feed-forward control of skeletal muscle recruitment to ensure that homeostasis will be maintained for the ‘calculated’ duration of the exercise task (32,37). The important question that remains then is how these children regulated their energy throughout the 800 m to ensure that they completed the distance successfully, particularly when they had no prior-experience on which to base any ‘calculations’ of skeletal muscle recruitment or energy expenditure for such a specific distance? On the basis that the children in this study were specifically inexperienced with regards to 800 m running and analogous bouts of exercise, our findings suggest that such an ability may be inherent in young children and not largely dependent upon situational factors or prior reference.

Limited scientific evidence currently exists to infer that these mechanistic models may be relevant to the exercising child. However, the data presented in this study appears to offer some tentative support to the theory of the CGM. Indeed, when considering the hypotheses of the CGM, it is plausible that the observed pacing strategy, such that the children ran the first 200 m faster and then moderated their pace for the subsequent 400 m before employing an ‘end spurt’ in the final 200 m, were a direct result of changes in skeletal muscle recruitment (38). Furthermore, such changes feasibly occurred as a result of the brain integrating the numerous cues from peripheral body systems including the muscles, joints, body temperature and cardiorespiratory system (31), and which presented as a measurable construct in the children’s conscious perception of exertion. According to Joseph et al. (25), these refined alterations in power output may have occurred to ensure that the rate of accumulation of fatigue was appropriate for each segment of the exercise trial.

Recently, de Koning and colleagues (10) have provided evidence that velocity changes (pacing strategy) during competition are dependent upon both the momentary RPE and the percentage of the exercise event that remains to be completed. It has been suggested that during exercise a conscious RPE is compared with an expected level of exertion to ensure that it does not exceed acceptable limits, and that once an intolerable level is reached, exercise will be terminated (39). In this regard, the RPE is proposed to possess scalar-time properties, in that it rises as a
function of the amount of work done or of how much of the exercise bout remains (13,18). Thus, it is reasonable to assume that RPE will achieve maximum levels at completion of an exercise bout, be it at the end of a self-paced time-trial performance (2,3,25) or as a result of volitional fatigue (13,14,16). Interestingly, although RPE rose linearly over time (exercise duration) in the current study, theoretical maximal RPE (in accordance with the E-P scale) was not achieved during any of the exercise tests (field trials or GXT). Yet, the fact that the RPE was shown to rise linearly, despite participants demonstrating a ‘variable’ pace response, suggests that the RPE is disassociated from the on-going changes in power output (3,40). Accordingly, the precise role, or at least the sensitivity of the RPE within such a mechanism remains ambiguous with young children.

**Conclusion**

It is evident that young children, who are inexperienced at endurance running, can successfully employ a pacing strategy during an 800 m event despite no prior experience of an analogous bout of exercise. This may reflect an inherent ability that children possess to regulate their energy expenditure. Nevertheless, familiarization to the exercise task resulted in improvements in performance. Conversely, a single bout of competitive exercise was detrimental to performance and should be considered a pertinent area for future research. In addition, the influence of age-, cognitive development and exercise experience on the natural development of an individual’s pacing strategy is worthy of further exploration.

**References**


