The Perceptual Response to Treadmill Exercise Using the Eston-Parfitt Scale and Marble Dropping Task, in Children Age 7 to 8 Years

Danielle M. Lambrick, Ann V. Rowlands and Roger G. Eston
University of Exeter

This study assessed the nature of the perceived exertion response to treadmill running in 14 healthy 7–8 year-old children, using the Eston-Parfitt (E-P) Ratings of Perceived Exertion (RPE) scale and a marble dropping task. For the E-P scale and the marble dropping task, the relationships between the RPE and work rate were best described as linear ($R^2 = .96$) and curvilinear ($R^2 = .94$), respectively. This study further suggests that individual respiratory-metabolic cues (oxygen uptake: $O_2$, heart rate: HR, ventilation: $V_e$) may significantly influence the overall RPE to varying degrees in young children. The E-P scale provides an intuitively meaningful and valid means of quantifying the overall perception of exertion in young, healthy children during treadmill running. The marble dropping task is a useful secondary measure of perceived exertion, which provides further insight into the nature of the perceived exertion response to exercise in young children.

A number of ratings of perceived exertion (RPE) scales exist to assess perceived exertion during various modes of exercise in children (for review, see 7,12,16). The combination of numerical, verbal and pictorial descriptors which make up the scales are purported to be ‘developmentally-appropriate’ for the age and cognitive development level of children. With regards to most of the pictorial scales, the rationale to depict a figure at varying stages of exertion on either a horizontal line or a linear gradient is founded on a strong, linear relationship between the RPE and oxygen uptake ($VO_2$), heart rate (HR) and power output during exercise. However, there is some emerging evidence to suggest that the RPE in young children may rise according to a positively accelerating function, or ‘curvilinearly’, in relation to such variables as power output or heart rate (1,15,23). In a recent study (23), boys and girls (age 9–10 years) performed a progressive exercise test on a cycle ergometer to exhaustion, and estimated their RPE every minute using the CALER and OMNI ratings of perceived exertion scales. During the final stage of the exercise test, children indicated RPE scores that were 75 (± 20) % and 74
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(± 19) % of the total numerical range for CALER and OMNI, respectively, which were proportionally less \( p \leq .001 \) than the corresponding HR response of 94.5% of the age-predicted maximal HR. The authors speculated that if children were to indicate a maximal score on the RPE scale at predicted maximum HR or VO\(_2\), then the rise in RPE would have to occur at a faster rate than had occurred at the lower workloads. Indeed, this finding has been observed previously during progressive submaximal treadmill exercise \( (1) \), wherein children (10–12 years) indicated an RPE of only 52% of the maximum value on the RPE scale, despite exercising at a HR and VO\(_2\) of 82% and 70% of their predicted maximum values, respectively.

In a prior study, Lamb \( (15) \) observed a nonlinear relationship between RPE and HR, and RPE and power output, in 9–10 year-old children when using the Children’s Effort Rating Table (CERT; 10, 28) during passive estimation procedures. They observed significantly higher correlations when a curvilinear model was applied to the data. It is important to note that these previous observations are based on data collated from ‘linear’ pediatric rating scales, and thus an RPE scale that depicts a curvilinear relationship may be more applicable for use with young children.

Recently, a pictorial curvilinear scale (Eston-Parfitt; E-P scale) has been devised to assess RPE in young children \( (11,12, \text{Figure 1}) \). Using verbal anchors abridged from the CERT, the E-P scale depicts an ambulatory figure at various stages of exertion on a concave slope with a progressively increasing gradient at the higher intensities. For the initial development of the E-P scale, 20 children aged 8–11 years, were requested to place a sitting figure and four ambulatory figures on a progressively increasing gradient. The figures were stylised to represent different

![Eston-Parfitt (E-P) Ratings of Perceived Exertion scale](11).

**Figure 1** — Eston-Parfitt (E-P) Ratings of Perceived Exertion scale (11).
stages of exertion and the children located them on the scale according to where they perceived they should be. The area under the gradient is also filled by progressively darker shades of red. The numerical range (0–10) reflects the disproportionate increase in the line’s gradient, as evidenced by a reduction in the distance between each numbered increment on the horizontal axis in relation to its antecedent. The scale instructions also encourage ratings which fall between whole numbers on the horizontal axis. In essence, the E-P scale is a category scale with ratio properties that allows interindividual comparisons of perceptual responses to be made.

In the design of the E-P scale, it was postulated that young children would find the scale intuitively meaningful and readily conceive that \textit{the steeper the hill, the harder it is to ascend} (16). Moreover, in consideration that ventilation (\(V_E\)) may be a mediating factor in the respiratory-metabolic signals of exertion in children, such as in adults (19), and \(V_E\) is known to rise in a positively accelerating function above work rates of \(~60\%\ VO_2\text{max}\) (20,25), it is plausible that concurrent increases in RPE may be observed at the higher exercise intensities.

Eston and colleagues (11) confirmed the validity of the E-P scale for cycling in children aged 7–8 years using a discontinuous, incremental exercise test to volitional exhaustion. Although their preliminary findings showed a strong relationship between \(V_E\) and RPE, as measured by the E-P scale (\(R^2 > .90\)), this was not statistically stronger than HR.

The study by Eston et al. (11) also explored the use of a novel psycho-physical marble dropping task. The marble dropping task was employed as a secondary measure to the E-P scale and was intended to provide a completely alternative and novel means of assessing perceived exertion. This method allowed the child to physically grasp a quantity of marbles, without being constrained by numerical, pictorial or verbal descriptors (such as those on the E-P scale) which could restrict the perceived exertion response. In this way, it was assumed that the potential for revealing a curvilinear relationship would be enhanced. Specifically, the marble dropping task required the participant to select marbles from one container and drop them into another to indicate the RPE for a given work rate (WR). The marble task uses interval scaling and was anchored so that the maximum number (50) equated to the same relative level of exertion as the maximum number on the E-P scale (10; i.e., ‘so hard I am going to stop’). However, values between 0–50 were not specifically anchored in any way to the numerical range or verbal descriptors of the E-P scale (i.e., 25 marbles did not equate to 5 or ‘somewhat hard’ on the E-P scale). The marble task was therefore designed and employed alongside the E-P scale under the assertion that children would freely allocate a number- or amount of marbles (between 0 & 50) to their perceived level of exertion. Accordingly, it was postulated that if children tended to perceive their level of exertion in a linear fashion to equal increments in WR, then the number of marbles selected would increase proportionally throughout the exercise test. Conversely, if the number of marbles selected by the children increased positively and disproportionally with equal increments in WR, then it would suggest that children rate their perception of exertion in a curvilinear fashion. The employment of this measure was deemed important to gain a further insight into the nature of perceptual responses in young children. Indeed, both methods employed by Eston et al. (11) indicated that the relationship between effort perception and exercise intensity in young children aged 7–8 years may often be curvilinear in nature.
The purpose of this study was to extend the findings of Eston et al. (11) by examining the nature of the perceptual response to treadmill exercise in healthy children age 7–8 years, using the E-P scale and marble task. As the marble dropping task was shown to be useful in identifying both linear and curvilinear growth functions in the RPE in the aforementioned cycle ergometry study (11), we were interested in comparing the results from the same method during a graded treadmill exercise test, particularly as the E-P scale depicts a character who is walking and running up a progressively increasing gradient.

It was also of interest to establish whether one particular physiological cue (VO₂, HR, Vₑ) has a stronger relationship with the perceptual response over another during treadmill exercise in young children, and to ascertain whether exercise mode may influence the nature of the perceptual response. We hypothesized that the relationships between the RPE, WR and physiological parameters (VO₂, HR, Vₑ) would be similar to those observed previously during cycle ergometry (11), and that both linear and curvilinear growth rates in the RPE (i.e., an exponent of 1 or > 1, respectively) would be detected in relation to equal increases in work rate. Furthermore, on the basis of prior research (11), we hypothesized that the relationship between the RPE and work rate, as measured by the marble task, would be best described as positively curvilinear in nature.

Method

Participants

Fourteen healthy children (eight boys; age: 7.9 ± 0.4 y; height: 1.31 ± 0.05 m; body mass: 27.2 ± 3.5 kg, and six girls; age: 8.0 ± 0.0 y; height: 1.30 ± 0.04 m; body mass: 27.9 ± 4.1 kg) volunteered for the study. Participants and their parents / guardians provided written informed assent and consent, respectively, before the commencement of the study. Institutional ethical approval was granted for this study.

Procedures

Following measurements of height and body mass, children were habituated to the treadmill speeds (5 km·h⁻¹ and 8 km·h⁻¹; Woodway GmbH PPS 55Med-I, Weil am Rhein, Germany) to be used in the graded exercise test (GXT). Children elected to walk or jog at these speeds until completely comfortable with the equipment. For all participants, the habituation period did not exceed 5-min. Treadmill speed was then halted and standardized instructions were provided detailing how to use the E-P scale and marble task during the GXT. No active familiarization with the E-P scale or marble task was given. The instructions used for both the E-P scale and the marble task, which were modified from Eston et al. (11), were as follows: “Whilst you are exercising on the treadmill, we would like you to think about how your body feels. When the exercise is halted, we would like you to use this scale [E-P scale] to tell us how you felt. We would like you to point to a number, or in between like [point between two numbers], that is most like how you feel, and you can use the pictures and words to help you to decide. Please look at the person on the left [point to the left pictorial]. If you feel like this person while you are exercising, it will feel very, very easy to you. Please look at the person on the right [point to
If you feel like this person while you are exercising, then you will feel that the exercise is so hard that you want to stop. If you feel somewhere in between ‘very, very easy’ (0) and ‘so hard I am going to stop’ (10), then point to a number between 0 and 10 that best describes how you feel.

“We would also like you to use these marbles to tell us how you feel when exercising. The harder the exercise feels to you, the more marbles you take from this container [point to the container of 50 marbles] and place into this empty container. If you feel that the exercise is very, very easy to you, then you should take a few marbles and place them into the empty container. If you feel that the exercise was so hard that you were going to stop, then you may place lots, or all of the marbles into the empty container. If you feel somewhere in between ‘very, very easy’ and ‘so hard I am going to stop’ then you may choose any number of marbles to place into the empty container. We would like you to really think about how your whole body feels when you are exercising; how your legs feel and how your breathing (chest) feels. Try to answer as honestly as possible. There are no right or wrong answers.” Participants were also guided through memory-recall anchoring techniques using maximal values of the E-P scale and marbles task (10 & 50, respectively) as upper reference points for perceptual responses.

All information screens were masked from the participant during the GXT. Breath-by-breath sampling of respiratory gases (VO₂, VE, RER; Cortex Metalyzer II, Biophysik, Leipzig, Germany) and heart rate measurement (Wearlink+, Polar Electro Oy, Kempele, Finland) occurred continuously. The gas analysis system was calibrated before each test following the manufacturers guidelines. A large pediatric facemask (Hans Rudolph Inc., Kansas City, USA) was used to collect expired air.

Criteria for terminating the exercise test included exhaustion, in association with a HR approximating 200 b·min⁻¹; respiratory exchange ratio (RER) ≥ 1.00; an evident plateau or peak in VO₂, or < 2.1 ml·kg⁻¹·min⁻¹ increase inVO₂ in the final stage of exercise (24).

**Graded Exercise Test (GXT) to VO₂Peak**

Although a direct comparison between exercise protocols on perceived exertion responses in young children is yet to be conducted, limited evidence suggests that a discontinuous protocol may yield more consistent findings, and may be considered ‘preferable’ for young children in comparison with a continuous exercise protocol (12,17). We believed that a discontinuous protocol would facilitate safe measurement of RPE using the two methods while the treadmill belt was halted. Consequently, participants performed a single, discontinuous GXT to volitional exhaustion. The protocol comprised a series of 1-min ‘active’ bouts that successively increased in speed and/or gradient, and were separated by a series of 1-min ‘recovery’ bouts, whereby the participant stood still to report their RPE.

The initial speed and incline of treadmill was set at 5 km·h⁻¹ and 0%, respectively (i.e., first ‘active’ bout). Thereafter, a speed of 8 km·h⁻¹ was used for each ‘active’ bout, initially at 0% gradient (i.e., s ‘active’ bout), and increasing by 2% for each subsequent ‘active’ bout until exhaustion. Speed and gradient of the treadmill were manually manipulated to ensure that the interim stages between each active bout and recovery were as swift as possible (< 10-s).

Within the first few seconds of each recovery period, the E-P scale was placed directly in front of the participant to obtain an RPE (from the previous active bout),
and then it was removed from sight. Children pointed to a number or corresponding site on the slope of the E-P scale. In the latter case, a perpendicular line was drawn down from this point to obtain a corresponding numerical value. Participants also selected any number of marbles (out of a possible 50) and placed these into a separate container to provide an RPE. The harder the exercise felt to the participant, the more marbles they selected, and vice versa. Once the selected number of marbles had been recorded, marbles were returned to the original container and all components were removed from sight. All of the marbles used in this task were identical in size, color and mass. The question “how hard did the exercise feel to you?” was asked before each method being implemented. The order of each method was randomized between participants but remained consistent during each test.

**Data Analysis**

**Physiological Responses to Increasing Work.** Individual regression analyses were employed to assess the nature of the relationship between physiological responses (VO₂, HR, Vₑ; dependent variable; DV) and increasing WR (independent variable; IV) across the full duration of the exercise test. To approximate the normality of the sampling distribution (27), individual coefficients of determination ($R^2$) were calculated using Fisher’s $Z_r$ transformation across relative maximal work rates, and to obtain an average $R^2$ for the whole participant sample.

**Characteristics of the RPE.** Individual regression analyses were also employed to assess the nature of the relationship between the perceived exertion responses (E-P scale, marbles; DV) and increasing WR (exercise stages; IV). Linear and curvilinear models of ‘best-fit’ were applied to the data, and coefficients of determination ($R^2$) were calculated using Fisher’s $Z_r$ transformation across relative maximal work rates for each participant. A paired $t$ test was subsequently employed to assess whether the relationship between RPE (E-P scale; marbles) and WR was significantly more linear or curvilinear in nature.

Independent one-sample $t$ tests were also conducted to assess whether the average terminal RPE responses of the participants in this study were significantly different to the theoretical maximal RPE values of each ratings method (E-P scale: 10; marble task: 50). A further independent $t$ test was also used to assess the influence of the order in which each ratings method was employed (E-P scale or marble task first) on the RPE responses of the two randomly allocated groups of participants.

**Comparison of Physiological Variables in Relation to the RPE.** Individual regression analyses (using both linear and curvilinear models of ‘best-fit’) were conducted to assess the strength of the relationships between the physiological (VO₂, HR, Vₑ) and RPE criteria (E-P scale and marbles). Paired $t$ tests, with Bonferroni adjustment ($α = 0.008$), were subsequently performed for each physiological variable in relation to the E-P scale and in relation to the marble task to obtain the six ‘best-fit’ relationships (e.g., whether a linear or curvilinear model best described the relationship between VO₂ and RPE).

**Hierarchical Regression Analysis.** Hierarchical regression analysis was also applied to assess the additive contribution of VO₂, HR or Vₑ (IV) to account for the variance in the RPE response using both the E-P scale (DV) and marble task (DV), throughout the treadmill exercise. By alternating the order in which each
IV was inserted into the regression analysis, we were able to determine which variable (VO₂, HR or VE) accounted for the greatest variance in the RPE response. The resultant $R^2$ values expressed as a percentage represents the percentage of the variation in the DV that is explained by the IV. While the sample size used in this study is small, and therefore inferences to the general population are limited, we felt that the inclusion of a hierarchical regression analysis was worthy to show the general relationships between the physiological variables in question and the RPE response from the two methods employed in this study.

**RPE Exponents Using the E-P Scale and Marble Dropping Task.** The natural logarithmic values of the individual relationships between the RPE (E-P scale; marbles) and WR were calculated for each participant in this study, and these were subsequently averaged to obtain a single exponent reflecting the nature of the relationship between these two variables.

Alpha was set at 0.05, and adjusted accordingly. All analyses were performed using the statistical package SPSS for Windows, version 15.0.

**Results**

Maximal physiological and perceptual responses recorded at termination of the exercise test were: (mean ± SD) VO₂: 50.1 ± 8.3 ml·kg⁻¹·min⁻¹; HR: 198 ± 8.9 b·min⁻¹; VE: 55.1 ± 11.0 L·min⁻¹; RER: 1.12 ± 0.05; RPE: 9.7 ± 0.6; Marbles: 49.0 ± 2.9. On an individual level, these data confirmed that each participant had reached exhaustion during the treadmill GXT. The mean data are also comparable to a previous study (11), which used a similarly aged participant sample.

**Physiological and Perceptual Responses to Increasing Work Rate**

All children readily interpreted and used the E-P scale and marble task to assess their level of exertion across relative exercise stages, as demonstrated by the corresponding increases in physiological (VO₂: $R^2 = .85 ± 0.05$, HR: $R^2 = .90 ± 0.02$, & VE: $R^2 = .87 ± 0.04$) and perceptual (E-P scale and marbles) data with increasing WR. A paired *t* test across the complete range of exercise intensity revealed that the relationship between the RPE (E-P scale) and WR was significantly more linear than curvilinear ($R^2 = .96 ± 0.35$ & $R^2 = .89 ± 0.31$, respectively; $t_{(13)} = 4.304, p < .01$). For the marble task, the relationship between marbles and WR was significantly ($p < .05$) more curvilinear than linear ($R^2 = .94 ± 0.48$ & $R^2 = .88 ± 0.67$, respectively; $t_{(13)} = -2.319$).

Independent *t* tests confirmed that there were no significant differences ($p > .05$) between terminal RPE responses and theoretical maximal RPE for both ratings methods (9.7 ± 0.6 cf. RPE 10, & 49.0 ± 2.9 cf. 50 marbles, for E-P scale and marble task, respectively). An independent *t* test confirmed no significant differences ($p > .05$) in RPE response between children who rated using the E-P scale first, or those who rated using the marble task first ($R^2 = .95 ± 0.03$ & $R^2 = .95 ± 0.05$, respectively).
Comparison of Physiological Variables in Relation to the RPE

The coefficients of determination for the relationships (linear; curvilinear) between RPE (E-P scale; marbles) and various physiological variables (VO₂, HR; Vₑ) throughout the GXT are shown in Table 1. It is notable that the only significant differences were observed for VO₂ (t_(13) = -3.416; p < .008) and HR (t_(13) = -10.057; p < .008) with the marble response.

Table 1  Coefficients of Determination for the Relationships (Linear; Curvilinear) Between RPE (E-P Scale; Marbles) and Physiological Variables (VO₂, HR; Vₑ) Throughout the Graded-Exercise Test

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*Significantly (P < .008) stronger than the corresponding relationship (linear; curvilinear), for the same variable.

Hierarchical Regression Analysis

All results of the hierarchical regression analyses are shown in Table 2. When the E-P scale was used to assess the RPE, HR (as the main IV) explained the largest proportion (63.7%; p < .001) of the overall variance (66%), with VO₂ and Vₑ independently accounting for 48% (p < .001) and 46.7% (p < .001) of total variance, respectively. However, when RPE from the marble task was used as the DV, Vₑ accounted for the largest proportion (43.6%) of the total variance (47%) in RPE response (p < .001), with HR and VO₂ accounting for 39.1% (p < .001) and 36.9% (p < .001), respectively.

RPE Exponents

Average exponents of the relationship between RPE and WR were 2.22 (range: 1.10–3.75) and 3.14 (range: 1.79–4.62) for the E-P scale and marble task, respectively.

Discussion

This study assessed the nature of the perceptual response of 7- to 8-year-old children during incremental, discontinuous treadmill exercise using two scaling methods; the E-P scale and a marble dropping task. The utility of both the E-P scale and marble task was confirmed for treadmill exercise, on the basis that corresponding increases in physiological (VO₂, HR and Vₑ) and perceptual (E-P scale and marbles) data were observed with increasing work rate. The RPE increased linearly with work rate (R² = .96) when assessed using the E-P scale, in contrast to
a similar investigation (11). However, the high curvilinear $R^2$ values demonstrate the robustness of the E-P scale in allowing both linear and curvilinear growth functions in the RPE to be detected, which is in keeping with previous research (11).

When the RPE was assessed by the marble dropping task, it is notable that the model which best described the change in perceived exertion with work rate was curvilinear ($R^2 = .94$). This concurs with observations from our previous study (11). The employment of the marble task alongside the E-P scale in this study was not intended to validate the E-P scale, but to provide a differing means (i.e., interval scaling cf. category-ratio scaling) of identifying the nature of perceptual responses in young children. In this regard, the findings of the marble task strengthen the notion that perceived exertion in young children (7–8 years) does not consistently increase in a linear fashion with increasing work, as is commonly presumed and documented in the literature.

The supposition that ventilatory drive acts as the predominant mediator to the respiratory-metabolic signals of perceived exertion in young children, as in adults, provided the conceptual underpinning for the design of the E-P scale (12,16). In adults, moderately high correlations ($r = .63–.86$) have been reported between the RPE and $V_E$ (5,6). Although limited data exist on the relationship between the

<table>
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<th>HR Variance (%)</th>
<th>$V_E$ Variance (%)</th>
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*Significant additive contribution to the RPE response ($P < .05$)
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RPE and $V_E$ in young children, Marinov et al. (18) observed correlations of $r = .51–0.59$ and $r = .62–0.64$ between the RPE and $V_E$ when using the Borg CR-10 scale (3) and the Pictorial CERT (29), respectively, across three trials of a continuous, incremental treadmill protocol, with children aged 10.4 (± 0.5) and 13.4 (± 0.5) years. In a previous study, a high average coefficient of determination ($R^2 = .90$) was reported for RPE (using the E-P scale) and $V_E$ during discontinuous cycle ergometry exercise in an independent group of young children (11). The results from the current treadmill study are directly comparable to those from the latter study ($R^2 = .90$ & $R^2 = .88$ for E-P scale and marble task, respectively).

Interestingly, subsequent investigation into the relative contribution of $\text{VO}_2$, HR or $V_E$ to the perceptual response (E-P scale) revealed that the greatest proportion of the total variability in the RPE (66%) was explained by HR and $\text{VO}_2$ combined, not $V_E$ as the underlying rationale to the E-P scale would suggest. In the marble task, however, $V_E$ and HR accounted for the majority of the variance in the total RPE response (47%). Such findings may suggest that no one specific physiological variable is a predominant mediator of perceptual responses during treadmill exercise with young children. Indeed, in relation to the findings of Eston et al. (11) during cycle ergometry exercise, the current study indicates that respiratory-metabolic cues emanating from all three of the main physiological processes investigated ($\text{VO}_2$, HR, $V_E$), may significantly influence the overall RPE to varying degrees in young children, across differing exercise modalities. However, it is noteworthy that the employment of the hierarchical regression analysis model in the current study was intended merely to illustrate general trends in the relationship between physiological responses and perceived exertion. The authors recognize that a greater participant sample would be required to validate these assumptions.

The E-P scale is a category scale with ratio properties. However, unlike other category-ratio scales (CR-10; 3), free magnitude estimation above maximum (RPE 10) is not permitted. In this regard, the stage of cognitive development is important when applying the concept of perceived exertion in children (8). The majority of perceived exertion research to-date has focused on children aged 8–12 years, yet less attention has been paid to understanding the developmental steps in children aged 7-years (14). As in the study by Eston et al. (11), the children in the current study are within the ‘concrete operations’ period of cognitive development (classified as 7–11 years; 22). Although children are capable of ‘measuring’ by 7–8 years of age (22), they find understanding fractions (ratios) difficult (13). Moreover, at this stage children are unable to comprehend abstract concepts or hypothetical tasks, i.e., applying a number (particularly one obtained from a ratio construct) to a perceived level of exertion at an intensity which is higher than that ever ‘concretely’ experienced before. Thus, although a fixed-endpoint may provoke a ‘ceiling effect’ with adults, we believe it is necessary for children of this age (7–11 years).

As the exponent for a straight line (representing a positive linear relationship between two variables) equates to a value of 1, any increase in an exponent will result in the line of ‘best fit’ between two variables increasing disproportionately and becoming curvilinear in appearance. In this regard, natural logarithmic values calculated between individual relationships of perceptual response and increasing work revealed average exponents of 2.22 and 3.14 for the E-P scale and marble task, respectively. This is in keeping with previous investigations that have yielded an exponent of 3 (in adults) for perceived exertion during
treadmill walking / running (2,3). Exponents of 1.03 (± 0.68) and 1.30 (± 0.83) for the E-P scale and marble task, respectively, have been observed previously during cycling exercise (11), which were similar to the average exponent (of 1.6) often associated with short-term perceived exertion during cycle ergometry exercise (3,4). Differences in psychophysical functions (3 cf. 1.6 for treadmill & cycle ergometry, respectively) may represent fundamental differences in sensory processes and physiological demands between the different modes of exercise (3). Furthermore, the findings of this study, combined with those of Eston et al. (11) indicate that the rate of change in the RPE of young children occurs in relation to the mode of exercise, rather than as a function of the exercise mode which is depicted in the E-P scale (ambulatory figure). This infers that specifically-designed pictorial ratings scales may not be necessary for differing exercise tasks, in accordance with previous observations (11,21).

It is notable that the average terminal RPE at exhaustion was 9.7 when using the E-P scale and 49.0 when using the marble task. These were not statistically different to the theoretical maximal values of both ratings methods (E-P: 10; Marbles: 50). Conversely, previous studies involving children have reported terminal RPE values that were lower than the theoretical maximum at point of exhaustion (1,11), although the difference between the terminal RPE in the latter study (9.4 ± 1.1) and the current study is negligible.

A discontinuous exercise protocol was employed in the current study, unlike the majority of research on perceived exertion in children (16). Tentative evidence suggests that an intermittent (or discontinuous) protocol may be more suitable for use with young children (12). In a study by Eston & Parfitt (12), involving only one 8 year-old boy, perceived exertion responses were higher for a given HR during a continuous, than an intermittent treadmill protocol. Furthermore, exercise was voluntarily terminated at a submaximal intensity (~150 b·min⁻¹) during the continuous protocol cf. intermittent (~190 b·min⁻¹), with the boy expressing that the intermittent protocol was ‘preferable’. Lamb and colleagues (17) also reported a stronger relationship between RPE (CERT) and HR during an intermittent protocol ($r = .66$) compared with a continuous protocol ($r = .46$), during perceptually-regulated cycle ergometry with children aged 9–10 years. These observations are pertinent as young children’s activity patterns are typically intermittent in nature (9,12,26).

**Conclusion**

The E-P scale is robust in its ability to detect both linear and curvilinear growth functions in the RPE during treadmill running. Similar perceptual growth functions were observed using a distinct interval scaling method (marble dropping task), strengthening the notion that perceived exertion in young children (7–8 years) does not consistently increase in a linear fashion with increasing work. The significance of this finding may be particularly relevant to the exercise practitioner or physical education instructor, when assessing perceived exertion during exercise with young children. Exercise during a progressive maximal test is frequently brought to an abrupt halt with children with little advanced warning, and presumably this is commensurate with a sudden rapid rise in RPE (8). Assessment of the RPE using methods which are more intuitive to young children, and which may therefore
provide a better indication of exercise intensity and the point at which a child’s RPE begins to rise disproportionately, may allow for the point of termination to be estimated more accurately. Further research using such methods of assessing the perceived exertion response in young children is recommended.

References