The Use of a 10-Point Effort Perception Scale in Adults: A Preliminary Study

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The purpose of the present preliminary study was to investigate whether a Chinese 10-point effort perception scale, which is a tool for monitoring exercise intensity in children, could be validly and reliably applied to adults. To evaluate this scale, 14 adults (aged 20 to 39 years) completed two identical continuous incremental cycling trials on a Monark stationary cycle ergometer during a period of 1 week. For each trial, the exercise intensity started at 30 W and increased by 30 W every 3 minutes until an intensity level of 180 W was completed. The pedal rate was maintained at 60 rpm throughout the test. The same test experimenter conducted the test at the same clock hour on the same subject for both trials. The effort perception ratings and heart rate responses were recorded at the end of each 3-minute incremental exercise stage. Results revealed significant main effects for exercise intensity \( (p < 0.01) \) and non-significant effects for trial \( (p > 0.05) \). The Pearson validity correlations between effort perception and heart rate responses were significant \( (p < 0.05) \). The test–retest intraclass reliability coefficients ranged from 0.46 to 0.79 across different exercise intensity levels. In conclusion, the results suggest that the repeatability of this 10-point effort perception scale appears to be a concern for use in adults. Children and adults might have different cognitive and perceptual processes during exercise; hence, this scale should be used with caution in adults.

Keywords: cycle ergometry, effort perception, translation

Introduction

The concept of perceived exertion was first introduced in the 1960s (Borg & Linderholm 1967; Borg 1962, 1961). Borg (1970) stated that “Since man reacts to the world as he perceives it and not as it ‘really is’, it is important to know more about the relation between objective and subjective measurements of physical stress” (p. 92). The concept of perceived exertion is simply a measure of exercise intensity but the perception of exertion could be a complex issue (Borg 1998, 1985). Borg (1985) described perceived exertion as “This is a complex perception, which integrates many different signals from the body, among other things sensations from the working muscles and joints, from the respiratory and circulatory system etc.” (pp. 6–8). Robertson (2001) further described that “The perception of physical exertion is a psychological construct that includes feelings of effort, strain, discomfort, and/or fatigue experienced during both aerobic and resistance exercise” (p. 191). Over the last 30–40 years, research extended from Borg’s original concept of perceived exertion has been abundant. Extensive research has investigated the perception of effort during different types of physical stresses and under different conditions. Positive linear correlations between subjective (perceived exertion) and objective (heart rate, power output, oxygen consumption) measures of exercise intensity were evident.
in previous perceived exertion studies (Borg & Kajser 2006; Robertson et al. 1996; Borg et al. 1987; Skinner et al. 1975; Bar-Or et al. 1972).

Recently, attempts have been made to translate the perceived exertion scales into other languages. Japanese researchers noted the existence of a significant association between subjective and objective measures of exercise intensity in adults when Borg’s rating of perceived exertion scale was translated into Japanese (Ueda & Kurokawa 1991; Miyashita et al. 1986; Onodera & Miyashita 1976). Other researchers developed Chinese versions of the 15-point perceived exertion scale and the 10-point effort perception scale (R. Leung et al. 2004; M. Leung et al. 2002). Both translated scales were found to be valid and reliable instruments for measuring exercise intensity with comparable correlations between subjective and objective indicators of exercise intensity as those reported in the Japanese studies. Furthermore, M. Leung et al. (2002) suggested that the 10-point effort perception scale with verbal expressions accompanying each number was better than the 15-point perceived exertion scale for children’s use. Nevertheless, the applicability of the 10-point scale in adults has not been examined. A recent trend in perceived exertion is the shift from using the traditional 15-point scale to different simpler 10-point scales in the field of physical education and exercise science (Barkley & Roemmich 2008; Robertson et al. 2006; Roemmich et al. 2006; Utter et al. 2006; Yelling et al. 2002; Eston et al. 2000).

It was speculated that the Chinese 10-point effort perception scale might be applicable to adults. Therefore, the question was would this 10-point scale be suitable for and applicable to adults? As a result, the objective of this preliminary study was to examine the applicability of the Chinese 10-point effort perception scale in adults by evaluating its validity and reliability.

**Methods**

**Subjects**

In the present study, the subjects were a convenience sample of 14 male adults (age, 27.3 ± 7.1 years; height, 1.68 ± 0.04 m; body mass, 61.0 ± 5.9 kg) who could read and speak Chinese, and they took part in this study on a volunteer basis. The subjects were not overweight as indicated by the body mass index (21.6 ± 3.8 kg/m²). Physiologic measures at rest were normal (heart rate, 67.1 ± 13.9 bpm; systolic blood pressure, 124.2 ± 10.3 mmHg; diastolic blood pressure, 78.6 ± 6.8 mmHg). Prior to any testing, the nature of the study and the procedures to be employed were explained to the subjects. All subjects gave informed consent in accordance with the requirement of the Institutional Review Board. All subjects were asked to complete the Physical Activity Readiness Questionnaire (Canadian Society for Exercise Physiology 1994). Subjects indicating any contraindication to exercise were excluded from the study. All subjects engaged in some type of recreational physical activity (e.g., soccer, basketball, tennis) while none specialized in any particular sport.

**Testing designs and protocols**

The translation process of the effort perception scale was based on Brislin (1980, 1970) and has been described in previous studies (R. Leung et al. 2004; M. Leung et al. 2002). In brief, the original scale was first translated into Chinese, and additional efforts were made to back-translate the Chinese version into English to ensure comprehension of wording and concepts of the scale. The back-translation process was repeated until the wording in both the English and Chinese versions were consistent. This translated effort perception scale is displayed in the Figure.

Each subject performed the continuous incremental progressive cycling tests on two occasions (trial 1 and trial 2) separated by 1 week. The two trials were performed at the same time of day to avoid any circadian state-dependent effects of physiological responses to exercise (Halberg et al. 2001; Halberg 1994; Levine et al. 1977). The same experimenter administered the test to the same subject for both trials. Prior to any testing, the body mass (to the nearest 0.1 kg) and height (to the nearest 0.01 m) of each subject were measured on a manually adjusted scale with an attached stadiometer (Detecto Scales, Inc., Webb City, MO, USA). Subjects removed their shoes and wore light clothing during the measurements. Pre-exercise resting blood pressure and heart rate were also measured to establish reference

1. Very, very easy
2. Very easy
3. Easy
4. Just feeling a strain
5. Starting to get hard
6. Getting quite hard
7. Hard
8. Very hard
9. Very, very hard
10. So hard I am going to stop

![Fig.](image-url) The 10-point effort perception scale. The original scale by Williams et al. (1994) on the left and the translated scale by M. Leung et al. (2002) on the right.
data. Resting blood pressure was measured with the subject seated using a standard stethoscope and sphygmomanometer, whereas resting heart rate was measured by manual palpitation of the radial artery.

During trial 1, each participant performed continuous incremental cycling exercise on a Monark stationary mechanically braked cycle ergometer beginning at an intensity that elicited a heart rate of above 100 bpm for 3 minutes as warm up. After warm up, the first exercise intensity level was set at a power output of 30 W. Thereafter, the power output was increased by 30 W every 3 minutes in each exercise intensity stage until the subjects reached a power output of 180 W. Pedal rate was held constant at 60 rpm. During the last 15 seconds of each exercise stage, the effort perception rating and heart rate value for that stage were recorded. Exercising heart rates were measured using a Polar heart rate monitor. The effort perception scale was in view only at the time in which it was used. At the end of the testing, each subject was monitored until blood pressure and heart rate returned to pre-exercise values.

All subjects were given standardized instructions for the use of the effort perception scale (adapted from Borg 1985). Verbal explanations of how the scale should be interpreted in numerical form were given. Both the scale numbers and the corresponding word explanations were carefully reviewed with the subjects. Special attention was paid to instruct subjects on how to correctly perceive exertion; in particular, the experimenter emphasized that the rating was the overall whole-body perception of exertion, not just the fatigue coming from the legs, chest or breathing. Borg (1985) stated that “by perceived exertion, we mean all your sensations and feelings of physical stress, effort, and fatigue in your whole body, coming from your legs, your chest, and your breathing etc” (p. 23). Following the verbal explanation, subjects were encouraged to ask any questions regarding the scale and were given 5 minutes to study the scale prior to the test.

**Statistical analysis**

Data were analyzed with two-way repeated measures analysis of variance (exercise intensity and trial) to evaluate the variability of effort perception and heart rate responses across exercise intensities and trials. Post hoc comparisons of different factor levels (exercise intensity and trial) were analyzed with Tukey’s HSD (Honesty Significantly Different) test. Pearson’s interclass correlations (rs) were computed to evaluate the validity of the effort perception ratings against the heart rate data. Pearson’s rs were computed from the simultaneous analysis of all subjects’ data to give the correlation coefficients for trial 1 and trial 2. The test–retest reliabilities across the two trials across different exercise intensity levels were evaluated using the intraclass correlations (Rs), obtained from a two-way analysis of variance model. Statistical significance was accepted at a confidence level of \( p < 0.05 \) for all analyses and the results are expressed as mean ± standard deviation.

**Results**

All subjects completed six 3-minute 30-W incremental exercise stages, and their data were utilized for analysis. Analysis of variance of effort perception data revealed significant main effects for exercise intensity \( (F = 662.6, p < 0.01) \) and non-significant main effects for trial \( (F = 0.2, p > 0.05) \). The mean and standard deviation values of effort perception ratings at each exercise intensity level across the two trials are presented in Table 1. In addition, analysis of variance of heart rate data showed significant main effects for exercise intensity \( (F = 168.9, p < 0.01) \) and non-significant main effects \( (F = 1.5, p > 0.05) \) between trials. The heart rate data at different exercise stages across the two trials are presented in Table 2. For both effort perception and heart rate data, no significant \( (p > 0.05) \) interactions (exercise intensity x trial) were evident.

Validity interclass correlations, as indicated by Pearson’s rs, between effort perception and heart rate data were significant \( (p < 0.05) \) in trial 1 \( (r = 0.67) \) and trial 2 \( (r = 0.69) \). With respect to reliability when the results were analyzed at different exercise levels, the test–retest intraclass Rs ranged between 0.46 and 0.79. Relatively lower reliability was observed in the first two levels and last two levels of exercise intensity \( (Rs = 0.46–0.52) \) than for the intermediate workloads.

**Table 1. Effort perception ratings at each stage of exercise intensity across the two trials**

<table>
<thead>
<tr>
<th>Exercise intensity (W)</th>
<th>Effort perception rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
</tr>
<tr>
<td>30</td>
<td>1.7 ±0.5</td>
</tr>
<tr>
<td>60</td>
<td>2.2 ±0.4</td>
</tr>
<tr>
<td>90</td>
<td>3.3 ±0.6</td>
</tr>
<tr>
<td>120</td>
<td>5.7 ±0.5</td>
</tr>
<tr>
<td>150</td>
<td>7.0 ±0.6</td>
</tr>
<tr>
<td>180</td>
<td>7.9 ±0.9</td>
</tr>
</tbody>
</table>

*Data are presented as mean ± standard deviation.*
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The results of Pearson’s validity correlation and test–retest reliability are presented in Table 3.

Table 2. Mean heart rate at each stage of exercise intensity across the two trials*

<table>
<thead>
<tr>
<th>Exercise intensity (W)</th>
<th>Heart rate (bpm)</th>
<th>Trial 1</th>
<th>Trial 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>94.7 ± 12.0</td>
<td>93.7 ± 10.5</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>105.9 ± 12.7</td>
<td>107.7 ± 10.7</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>123.0 ± 13.8</td>
<td>128.1 ± 12.7</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>140.8 ± 14.9</td>
<td>143.5 ± 13.6</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>159.1 ± 15.1</td>
<td>162.3 ± 14.4</td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>175.4 ± 13.2</td>
<td>177.9 ± 11.0</td>
<td></td>
</tr>
</tbody>
</table>

*Data are presented as mean ± standard deviation.

Table 3. Validity and reliability analyses of the effort perception scale

Validity: Pearson’s rs between effort perception and heart rate

<table>
<thead>
<tr>
<th>Trial</th>
<th>rs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td>0.67</td>
</tr>
<tr>
<td>Trial 2</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Reliability: intraclass Rs between trials across different intensity levels

<table>
<thead>
<tr>
<th>Intensity level (W)</th>
<th>Rs</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.46</td>
</tr>
<tr>
<td>60</td>
<td>0.50</td>
</tr>
<tr>
<td>90</td>
<td>0.74</td>
</tr>
<tr>
<td>120</td>
<td>0.79</td>
</tr>
<tr>
<td>150</td>
<td>0.52</td>
</tr>
<tr>
<td>180</td>
<td>0.47</td>
</tr>
</tbody>
</table>

(Rs = 0.74–0.79). The results of Pearson’s validity correlation and test–retest reliability are presented in Table 3.

Discussion

The purpose of the present study was to examine the applicability of the Chinese version of the 10-point effort perception scale in adults. Specifically, this preliminary study aimed to investigate if the Chinese-translated 10-point scale, which was previously found to be a valid and reliable measure of exercise intensity in children, could also be suitable for use in adults. Analysis of variance findings indicated that both the effort perception and heart rate responses increased across exercise intensity levels and did not differ between trials. A positive relationship between effort perception and heart rate was observed. However, the low reliability of the effort perception data revealed that the reproducibility of the scale might be a concern for use in adults.

Research in effort perception is generally classified into two categories: estimation and production modes (Diafas et al. 2007; Buckley et al. 2003; Yelling et al. 2002; Lamb & Eston 1997). Estimation-mode research refers to studies that required subjects to choose an effort perception rating appropriate to a given exercise intensity to examine the subjective–objective effort relationship. Specifically, in estimation-mode studies, subjects were asked to use effort perception to estimate exercise intensity. Subjects’ subjective effort perception responses during estimation mode were validated against objective measures of exercise intensity such as heart rate, power output, and/or oxygen consumption. Production-mode research refers to studies that required subjects to adjust the exercise intensity to match certain experimenter-specified effort perception ratings. Specifically, studies in production mode examined the ability of subjects to produce work outputs corresponding to different effort perception levels. The experimenter or the subject varied and adjusted the exercise intensity as appropriate to achieve different specified effort perception levels, and the objective indicators of effort were recorded at each effort perception level. In effect, it dealt with the ability of the subjects to use their perception of effort to regulate exercise intensity (Diafas et al. 2007; Buckley et al. 2003; Yelling et al. 2002; Lamb & Eston 1997). The present study was based on an estimation-mode design to examine the applicability of an effort perception scale for use in adults.

The significant main effects for exercise intensity with respect to effort perception and heart rate responses demonstrated that this effort perception scale was sensitive to differences in workloads during a continuous incremental cycling test. Careful evaluation of the effort perception data showed that the subjects tended to choose low effort perception ratings (≤5) even though the exercising heart rates were above 50% of the subjects’ estimated heart rate maximum. When compared with Pearson’s correlations (rs = 0.76–0.99) between subjective and objective measures of exercise intensity using the Japanese perceived exertion scale (Ueda & Kurokawa 1991; Miyashita et al. 1986; Onodera & Miyashita 1976), the validity correlations of the present study were slightly lower (rs = 0.69 in trial 2). In addition, the current correlations when the scale was used by adults were lower than the correlations (rs = 0.84–0.92) found in a previous study when the same effort perception scale was tested in children (M. Leung et al. 2002). The relatively low rs in the current study might imply that this 10-point scale, which was found to be valid in children, might not share a high degree of validity for use in adults.
Although non-significant main effects for trial were observed with respect to effort perception and heart rate responses, the test–retest reliability intraclass \( R_s \) of the effort ratings analyzed at each level of exercise intensity appeared to be worth noticing. The \( R_s \) was calculated from repeated measures analysis of variance and was the type that accounted for the change in the mean trial-to-trial variabilities and the order of individual responses (intraclass \( R = [\text{MSs} - \text{MSw}] / \text{MSs} \), where \( \text{MSw} = [\text{SS}_\text{trial} + \text{SS}_\text{interaction}] / [\text{df}_\text{trial} + \text{df}_\text{interaction}] \)). The \( R_s \) at different exercise intensity stages appeared to be moderately low (0.46 ≤ \( R_s \) ≤ 0.79). In particular, \( R_s \) were low at the low end (50 W and 60 W) and high end (150 W and 180 W) of exercise intensity levels. The low reproducibility of the effort perception data might indicate that the comprehensive level of the subjects did not match well with the cognitive level of the scale that was initially designed for children. In this case, the verbal expression next to each number might be too confining for adults to discriminate their perception of exercise intensity. In a comprehensive review concerning the influence of age and cognitive development on effort perception, Groslambert and Mahon (2006) reported that the use of different rating scales could influence perceptual responsiveness differently between children and adults. Another possible reason might be that the subjects in the current study had prior experience of using a 15-point perceived exertion scale for exercise prescription in other circumstances. According to the subjects, some found it difficult to adjust their cognitive knowledge of using the 15-point scale to the 10-point scale being tested. It is not clear the extent to which prior experience of using different scales would influence the accuracy of effort perception and this issue deserves further investigation. Moreover, some subjects indicated that the verbal descriptor next to each number on the 10-point scale not only did not help them distinguish between the exercise intensities but distracted them from accurately perceiving effort. The above factors might explain the low reproducibility of the scale in this sample of adults. Based on the current findings, \( R_s \) were relatively higher at the intermediate exercise stages (90 W and 120 W) than at the low- and high-intensity stages, showing that the reliability of the scale was acceptable only during moderate-intensity work.

In this preliminary study, several factors might limit the generalizability of the current findings. First, heart rate at a given submaximal exercise intensity level was used as the criterion measure to validate an effort perception scale. Researchers have suggested that relative oxygen consumption is a better criterion measure than heart rate because effort perception and relative oxygen consumption has a strong linear positive association across a wide range of exercise intensity levels in different modes of exercises (Utter et al. 2002; Dishman 1994; Robertson et al. 1990). Therefore, using heart rate as the criterion measure could impose a limitation in the current findings. Also, researchers have suggested that the criterion measure be relative to an individual’s actual or predicted maximum intensity of effort (e.g. percent maximum oxygen consumption and/or percent maximum heart rate) rather than the absolute level, to make interpretation and generalization of findings justifiable (Utter et al. 2002; Dishman 1994; Robertson et al. 1990; Robertson 1982; Bar-Or 1977). Second, the fitness level of the subjects might affect their individual perception of effort across different levels of exercise intensities. It was difficult to determine whether the relatively low effort perception ratings given by the subjects in the early stages of the test were due to their varying fitness levels or to other factors. Therefore, an examination of the subjects’ aerobic capacity would be crucial to understand the fitness levels of the subjects and help interpret the findings. Third, all subjects in this preliminary study were males. The gender difference in perception of effort is always an issue of concern (Robertson et al. 2000; Winborn et al. 1988). Using females as subjects in this type of culturally-related perceptual study is warranted. Thus, future studies that control for and/or which look further into the abovementioned variables are suggested.

In conclusion, the results of this preliminary study suggest that the reproducibility of effort perception appears to be a concern when this 10-point effort perception scale is used by adults. The effort perception responses underestimated the heart rate responses although a positive relationship between effort perception and heart rate was observed. Adults may have cognitive and perceptual processes that are different from children’s during exercise. Hence, the Chinese 10-point effort perception scale that is suitable for use in children should be used with caution in adults.

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