

Effect of Properly Describing the Borg Rating of Perceived Exertion (RPE) Scale on Heart Rate Response

Original Research

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Abstract

Introduction: The Rating of Perceived Exertion (RPE) scale is often used to guide intensity during exercise. The purpose of this study was to determine if a thorough explanation of the scale is necessary to achieve optimal heart rate during indoor group cycling.

Methods: The study consisted of a familiarization visit and two 60-minute instructor-led group cycling classes. The cycling sessions were identical in procedure; the only difference was that during one session, there was no explanation of the RPE scale (RPE-NE), and in the other, it was fully described in detail (RPE-E). Heart rate (HR) was continuously monitored. Maximal and average HR were calculated for each stage of the class. Repeated-measures ANOVAs (condition x stage) were used to compare the mean HR, HRmax and %HRmax between conditions. Paired-samples t-tests were used to compare session RPE between conditions.

Results: There were no differences between conditions for average HR ($p=.436$), HRmax ($p=.086$), or %HRmax ($p=.084$). There was also no difference between conditions in session RPE (RPE-NE: 15.7 ± 1.4 ; RPE-E: 16.0 ± 1.3 ; $p=.432$)

Conclusions: A detailed explanation of the RPE scale before a group cycling class elicits a HR response similar to simply having a poster of the RPE scale posted and referenced.

Key Words: group exercise, cycling, perception

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Introduction

There is a clear positive dose-response relationship between the amount of physical activity (or exercise) performed and health outcomes; the risk of all-cause mortality, CVD, colon cancer morbidity, and incidence of overweight or obesity decrease with increasing amount of daily cycling ¹. Physical activity is one of the known controllable risk factors for cardiovascular disease ². Cycling is a very popular, low-

impact form of exercise. A systematic review on the health benefits of cycling ¹ showed that sports participation for up to 3.5 hours per week results in a 23% reduction in the risk of coronary heart disease (CHD) and cycling participation greater than or equal to 3.5 hours per week resulted in a further reduction to 34%.

Indoor group cycling, or spinning, is a form of cycling performed on stationary bikes in front of an instructor. Group cycling is offered in most gyms, and allows participants of various ages, and fitness levels to be physically active ³. Battista et al. ⁴ examined various physiologic responses during indoor cycling such as ventilatory threshold (VT), oxygen consumption, heart rate (HR), rating of perceived exertion (RPE), and respiratory compensation threshold. This study employed traditional cycling instruction in which the instructor choreographed a series of hill climbs, sprints, and drills. They found that during a 45-minute group cycling class, 52% of the time was spent at an intensity above

VT, and momentary VO_2 exceeded $\text{VO}_{2\text{max}}$ on multiple occasions, showing that indoor cycling is a form of exercise with a high level of intensity.

The recommended intensity of group cycling exercise is determined by the scheme and the verbal directions of the instructor, which include phrases such as “nice steep hill,” “keep it steady,” and “increase/lower resistance.” Instructors are encouraged to use target HR zones, RPE guidelines, and cadence goals to help participants to assess exercise intensity during group cycling classes ⁵. Many indoor cycling instructors strongly recommend the use of HR monitors. The use of HR monitors is beneficial when participants are aware of their training zones, which can be obtained from having a stress test or by using a standard HR formula ⁶.

RPE is an indicator of the individual’s perception of exertion during physical activity ⁷. The use of the Borg 6-20 scale ⁸ allows exercise intensity to be rated with a “6” indicating a resting condition and “20” representing maximal exertion. The original Borg 6-20 scale was created to simulate increases in HR in response to increases in exercise intensity. High correlation coefficients between RPE and HR indicate the differential value of the scale ⁷. RPE can be used to assess the subjective intensity of exercise or to direct the intensity of exercise (production) ⁹. When RPE is utilized as a production paradigm, the subject is asked to actively self-regulate exercise intensity by producing a pre-determined target RPE. It is expected that the target RPE that is to be produced corresponds to an absolute or relative VO_2 or HR, or to a blood lactate concentration ¹⁰. During a group cycling workout, participants can be instructed to work at a light level (RPE 9-11) during the warmup, cool-down, and downhill segments; a moderate level (RPE 12-13) during seated flats and standing runs; and a vigorous level (RPE 14-17) during climbs, jumps, and power intervals ¹¹. For most individuals, RPE is not a familiar scale and is not commonly used; when it is referenced without explanation, individuals may have issues grasping the concept of what is being represented. A detailed explanation of the RPE scale may increase understanding and allow participants to better describe their perception of exercise intensity.

The purpose of this study, therefore, was to determine if there were any differences in HR response (mean HR, HR_{max} and $\%\text{HR}_{\text{max}}$ overall and within stages) when the Borg 6-20 scale is fully explained versus when it is simply referenced during a group cycling class. A dissimilar HR response would indicate that they interpreted the RPE scale differently when it was fully explained. Another goal of the study was to determine if the overall session RPE would be different between conditions. It was hypothesized that the HR response and overall session RPE would both be greater when RPE was explained versus when RPE was not explained.

Scientific Methods

Participants

Eleven subjects (1 male, 10 female), average age 23.1 ± 4.2 (mean $\pm$ standard deviation, or SD) years, participated in the study. Mean body mass index (BMI) was $24.0 \pm 4.1 \text{ kg} \cdot \text{m}^{-2}$, estimated $\text{VO}_{2\text{max}}$ was $45.6 \pm 3.9 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ and predicted HR_{max} was $191.8 \pm 2.9 \text{ bpm}$. Subjects were primarily recruited from the student body and faculty of the university via email recruitment and flyers. All subjects completed a brief AHA/ACSM Health-Screening questionnaire to screen for cardiovascular risk factors and signed an informed consent document in accordance with the Human Subjects Institutional Review Board at the university.

Protocol

This was a non-randomized experimental study with three visits to the laboratory. The first session served as a familiarization visit, where the informed consent document was read and described in detail. Each subject was familiarized with the cycling studio and the structure of the study. The second and third sessions were 60-minute group cycling classes.

Familiarization Session

During the familiarization visit, the structure of the study and informed consent were explained in detail. If the participant agreed to sign the consent and classified as “low risk” according to the health screening form, they were asked to continue. The subjects’ age, height, and weight were recorded during this session. The participants also completed the Physical Activity Rating (PA-R) ^{12,13} and Perceived Functional Ability (PFA) ¹⁴ scales. The PA-R asks participants to rate their overall level of physical activity for the previous 6 months. The PFA features questions related to participants’ perceived pace for running 1 mile and 3 miles. The instructions for the questionnaires and their purposes were explained to each participant beforehand. Cardiorespiratory fitness was estimated through the George Non-Exercise equation ¹⁴ which utilizes information obtained through the PA-R and PAF scales. This test was developed from a homogenous sample of physically active college males and females ages 18-29 years.

$$\text{VO}_{2\text{max}} (\text{ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}) = 45.513 + (6.564 * \text{gender}) - (0.749 * \text{BMI}) + (0.724 * \text{PFA}) + (0.788 * \text{PA-R})$$

Gender = 1 for male; 0 for female

BMI = body mass index ($\text{kg} \cdot \text{m}^{-2}$)

PA-R = number from PA-R scale

PFA = sum of both PFA scales

Estimated HR_{max} was calculated using the Tanaka et al. equation, $208 - (0.7 \times \text{age})$ ¹⁵. At the conclusion of the familiarization visit, subjects were informed of the policies of the Student Recreation Center and the location of the cycling studio. They were told that they would be participating in two similar group cycling classes. Directions were provided regarding proper attire for cycling exercise. It was emphasized that participants would complete both the second and third sessions alongside other participants in a group exercise setting.

Group Cycling Sessions

The group cycling classes were structured to have the same cycling workout in both classes. Moreover, the ride profile for both classes was controlled; segment, body position, cadence, suggested RPE, music tempo, music selection, and duration were identical (Table 1). The only difference between the two conditions was that in the first session, there was no distinct explanation of the RPE scale (RPE-NE), whereas in the second condition it was fully described in detail (RPE-E). In both conditions, the RPE chart was posted on the front mirrors of the classroom and was viewable to all participants. In the first condition, the instructor pointed to the RPE chart and told the group that “*How hard they should be working should come from this (RPE) chart.*” No further explanation of the scale was given within the first condition. In the second condition, the instructor pointed to the RPE scale and read a script explaining RPE ¹⁶:

“I would like you to cycle under my instruction and under the use of the RPE scale. Please use the numbers on this scale (point to the scale) to reference how your body should be feeling when you are cycling. Please look at the bottom of the scale, it says “6”. If you feel like a “6” this means that you feel like you are performing “no exertion at all”. Now look at the top of the scale, which is 20 (point to the top of the scale), this is “maximal exertion”. Your effort for this class will fall somewhere between **no exertion at all** (6) and **maximal exertion** (20), you will be given a number and a verbal descriptor between 6 and 20. I will ask you to cycle at a number and description that tells you how your body should be feeling while cycling. Please take notice of the scale during this class and adjust your resistance and pacing so that you feel as though your effort matches the scale.”

The instructor-led group cycling classes were both 60 minutes in length. Subjects were asked to arrive approximately 30 minutes early to be equipped with HR monitors. Each participant was fitted with a chest strap and heart rate watch (Garmin Forerunner 110, Garmin, Olathe, Kansas, USA). During both conditions, subjects wore the HR monitor during warmup, cycling exercise, and cool down. Subjects were instructed to press the “Start” upon the signal of the test administrator and to press “Lap” for every song change; they were also assisted with bike setup before class to achieve proper alignment while exercising.

During each condition, subjects were given complete instructions on how to participate in the class and how to pace themselves throughout the class. During the warm-up, the instructor detailed the range of cycle gears (resistance), structure of the ride profile, and how to establish “a flat road”. A “flat road” was defined as the standard riding position established during warmup and is performed with limited resistance. The instructor described the intensity of each segment using the RPE scale along with directions about body position. The instructor encouraged participants to adjust resistance to match the prescribed RPE. After each stage, the participants returned to a flat road before beginning the next stage.

Within both conditions, subjects regulated the workload during the class based on personal safety and perception of exertion. Subjects were observed throughout the entirety of each class to ensure safety. Subjects were allowed to consume water *ad libitum*. HR data was uploaded to the laboratory computer directly following each condition. For each stage, the corresponding average HR, HR_{max} , and percent HR_{max} were recorded. At conclusion of both sessions, the participants were asked to provide an estimation of their session RPE, which was indicated as the perceived exertion for the entire 60-minute class.

Table 1. Ride profile.

Stage	Body Position	Cadence (rpm)	RPE	Music Tempo	Song Selection	Duration (min:sec)
Warm-up	Seated	50		Moderate	Kanye West-Strong	5:11
1. Warm-up	Standing	80-90	11	Moderate	Rihanna-Pon de Replay	4:07
2. Climb	Seated and standing	60	16	Moderate	Gwen Stefani-Wind It Up	3:10
3. Flat road	Seated and standing	90	13	Moderate	Michael Jackson-Don't Stop Till You Get Enough	6:04
4. Jumps	Seated and standing	70-80	17	Moderate	Missy Elliott-Lose Control	3:47
5. Flat road	Seated and Standing	90	13	Moderate	Bruno Mars-24K Magic	3:47
6. Climb	Seated	60	16	Slow	Kayne West-Paranoid	4:38
7. Flat road	Seated and standing	100	13	Moderate	Ciara- Get Up	4:23
8. Sprints	Seated or standing	90- 100	17	Fast	Weeknd-False Alarm	3:50
9. Flat road	Seated and Standing	90	13	Moderate	Big Sean-Bounce Back	3:42
10. Hoovers	Standing	50-60	16	Moderate	KeSha- Your Love is My Drug	3:07
11. Cool-down	Seated	50-60	9	Moderate	Kayne West-Heard 'Em Say	3:24
Stretch	Off the bike			Moderate	Maroon 5-Sunday Morning	4:04

Statistical Analysis

All data was analyzed using SPSS (IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp). Two (condition: RPE explained vs. unexplained) x 11 (stages: 1-11) repeated-measures ANOVAs were used to compare the average HR, HR_{max}, and percent HR_{max} between conditions. Paired-samples t-tests were also used to compare overall session RPE between conditions. Significance level was set at *a priori* at $p < .05$.

Results

There was not a significant difference between conditions in overall session RPE (RPE-NE: 15.7 ± 1.4 ; RPE-E: 16.0 ± 1.3 ; $p = .432$). Average HR across the entire 60-minute cycling class for the RPE-NE was 152.2 ± 22.7 bpm and 153.3 ± 20.8 bpm in RPE-E. The main effect of condition was not significant ($F = .664$, $p = .436$, $\eta_p^2 = .069$). There was a main effect of stage ($F = 26.120$, $p < .001$, $\eta_p^2 = .744$) and no significant interaction ($F = 1.127$, $p = .351$, $\eta_p^2 = .111$). Mean HR for each stage can be seen in Figure 1. Table 2 shows the specific values and comparisons between conditions.

Figure 1

Mean HR for each stage

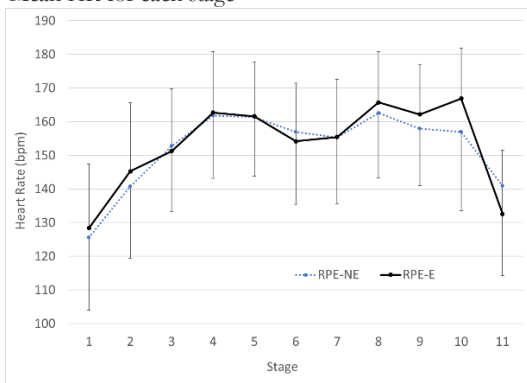
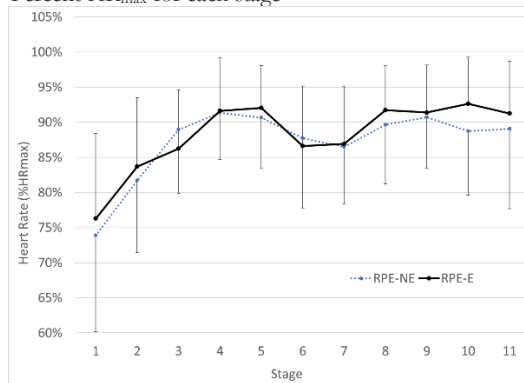


Figure 2

Percent HR_{max} for each stage



** Error bars represent standard deviation from the mean.

For HR_{max}, there was also not a main effect of condition ($F = 3.719$, $p = .086$, $\eta_p^2 = .292$), a significant effect of stage ($F = 24.102$, $p < .001$, $\eta_p^2 = .728$) and no interactions ($F = .466$, $p = .908$, $\eta_p^2 = .049$). HR_{max} averaged for each stage across the entire 60-minute cycling class for the RPE-NE was 167.3 ± 20.6 bpm and 169.4 ± 18.9 bpm in RPE-E.

Lastly, for percentage of HR_{max}, there was no main effect of condition ($F = 3.764$, $p = .084$, $\eta_p^2 = .295$), a significant effect of stage ($F = 24.584$, $p < .001$, $\eta_p^2 = .732$) and no interaction effect ($F = .494$, $p = .890$, $\eta_p^2 = .052$). Percent of HR_{max} averaged for each stage across the entire 60-minute cycling class for RPE-NE was $87.2 \pm 10.2\%$ and for RPE-E was $88.2 \pm 9.1\%$. HR_{max} percentage across the 11 stages of the group cycling classes can be seen in Figure 2.

Table 2. Mean heart rate (BPM).

Stage	Condition			p
	RPE	RPE-NE	RPE-E	
1	11	125.6 $\pm$ 21.6	128.4 $\pm$ 19.1	.722
2	16	140.8 $\pm$ 21.5	145.3 $\pm$ 20.4	.364
3	13	152.8 $\pm$ 19.5	151.3 $\pm$ 18.6	.550
4	17	161.8 $\pm$ 18.6	162.7 $\pm$ 18.1	.540
5	13	161.4 $\pm$ 17.6	161.6 $\pm$ 16.2	.587
6	16	157.0 $\pm$ 21.5	154.2 $\pm$ 17.3	.887
7	13	155.4 $\pm$ 19.7	155.5 $\pm$ 17.0	.641
8	17	162.5 $\pm$ 19.2	165.7 $\pm$ 15.0	.279
9	13	157.9 $\pm$ 17.0	162.2 $\pm$ 14.9	.219
10	16	156.9 $\pm$ 23.4	166.9 $\pm$ 15.0	.121
11	9	140.9 $\pm$ 26.6	132.6 $\pm$ 18.9	.073

Data presented as mean $\pm$ SD

Discussion

The purpose of this study was to determine if a thorough, descriptive explanation of the RPE scale affects the HR response to an indoor group cycling class. It was hypothesized that the HR response and overall session RPE would

both be greater when the RPE scale was explained versus when it was not. The results of this study show that there was no significant difference between conditions; overall session RPE and all HR measurements were similar between conditions. This suggests that a detailed explanation of the RPE scale is not necessary to elicit a greater HR response or overall RPE during a group cycling class.

Overall, session RPE was similar between conditions and subjects exhibited similar heart rates in both conditions. Rodriguez-Marroyo et al.¹⁷ conducted a study with professional cyclists exercising in a Time Trial (TT), Flat (FL), Medium Mountain (MM) and High Mountain (HM) simulated terrain; the experiment had the purpose of monitoring the session RPE (using the 0-10 scale) during different types of stages in professional cycling races. The session RPE was demonstrated to be significantly different; session RPE was greater ($p < 0.05$) in HM (7.3 ± 0.2) and MM (7.0 ± 0.3) versus TT (5.5 ± 0.4) and FL (4.6 ± 0.2). The difference in session RPE was due to the difference in exercise protocol between conditions. There was no significant difference between conditions within the current study, both conditions were identical; the ride scheme, music, and prescribed RPE were the same. Therefore, it would be feasible to infer that session RPE would be similar for conditions with no change in exercise structure. Session RPE could be associated with assessment of environmental change.

A potential explanation for a similar HR response between conditions could be a person's motivation style¹⁸. Irrespective of perceived intensity (i.e., RPE), subjects may have performed at similar intensities during both sessions due to several other intrinsic (i.e., inherent satisfaction, enjoyment) or extrinsic (i.e., recognition, reward) motivational factors¹⁹. Moreover, the RPE-E session did not necessarily lead to producing higher power outputs, and in conjunction, higher heart rates that would correlate to a higher RPE.

A meta-analysis studying the criterion-related validity of the Borg 6–20 RPE scale found an average RPE-HR correlation of 0.65 for cycling ergometry in healthy adults²⁰. This would suggest that increased exposure to the scale increases participant familiarity; subjects are able to mimic the suggested HR for the corresponding RPE. Introducing a learning protocol or teaching subjects about the scale may assist in this, however, subjects had only implemented this training during *one* exercise session. It is possible that the initial implementation of the RPE scale may not be as accurate, and subjects would need to implement additional exercise sessions to accurately depict their perceptions of effort.

Percent maximal heart rate and achieved maximal heart rate were not significantly different yet they were approaching significance. Chen et al. (2002) supported the validity and reliability of the use of the 15-point RPE scale when heart rate is the criterion measure. Moreover, heart rate and the RPE 15-point scale demonstrate a positive correlation ($r^2 = 0.62$), and this correlation is true with cycle ergometry ($r^2 = 0.62$). In the current study, heart rate was the criterion measurement of exercise intensity. Therefore, it could be interpreted that lack of significance could be attributed to the small sample size ($N = 11$) and low observed power, or even participant and measurement error. Heart rate measurement for each prescribed RPE was dependent upon the participants pressing the lap button at the appropriate time. Additionally, in this study, the Garmin Forerunner 210 GPS-Enabled Sports Watch exhibited technical difficulty when monitoring multiple exercisers within close range. Correspondingly, both instances could have attributed to measurement error. Suggestions for future studies would be to have a minimum of 36 participants and to establish distance between participants to eliminate potential technical interference.

There were several limitations to this study that could not be controlled by the researcher and placed restrictions on the methodology and conclusions. This was not a randomized controlled study; participants in the study participated in group exercise sessions. Though the ride scheme and music were identical for both conditions, participant encouragement phrases were not controlled, but an attempt was made to make them as similar as possible. $VO_{2\max}$ and $HR_{\max}$ were estimated, not measured, which introduced some level of error. There were some instances of technical difficulties with the HR monitors. Due to this, two participants' data was excluded from the analysis. Certain confounding factors such as temperature, humidity, seat height, hydration, anxiety levels, and experience with HR tracking could affect the results, and these variables were not measured.

Conclusions

The fact that the HR response, and therefore the intensity level of the subjects was not different between conditions speaks to the ease of use with the RPE 6-20 scale. Within the setting of group cycling exercise, the RPE scale provides participants with a useful reference for gauging intensity. It is suggested that cycling instructors continue to use the scale, even with novice exercisers, to give further information about the recommended level of perceived exertion.

Future research should consider evaluating participant motivation strategies for exercise, and whether these alter perception of effort.

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