UNIVERSITY OF WISCONSIN-LA CROSSE

Graduate Studies

TEMPORAL ROBUSTNESS OF SESSION RPE

A Manuscript Style Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Clinical Exercise Physiology

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College of Science and Health
Clinical Exercise Physiology

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TEMPORAL ROBUSTNESS OF SESSION RPE

By Bo Orton

We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the degree of Master of Science in Clinical Exercise Physiology.

The candidate has completed the oral defense of the thesis.

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ABSTRACT

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Session Rating of Perceived Exertion (sRPE) has been used to monitor training as an alternative to traditional measures such as heart rate, blood lactate and VO2. The goal of this study was to analyze the effects of time post-exercise on temporal robustness of Session of Rating of Perceived Exertion (sRPE) as well as the difference between coach-intended RPE and athlete-reported sRPE. 15 collegiate swimmers (NCAA Division III) completed five training sessions at different intended RPE as prescribed by the swim coach. The subjects reported sRPE within 30 minutes post-exercise and then five more times in the subsequent two weeks for each training session. Athletes reported similar sRPE over all times post-exercise for all workouts, suggesting that sRPE is a viable method of monitoring training up to 14 days post-exercise. The sRPE reported by the athletes were significantly lower than coach's when the intended RPE was high (9.0), and sRPE was significantly higher than coach's when intended RPE Was lower (4.0 and 5.0). This suggests that there is a mismatch between coach and athlete when it comes to prescribing exercise intensity.

ACKNOWLEDGEMENTS

I would like to thank Carl Foster for his guidance in helping me design this study, and for serving as a resource of knowledge throughout the semester. I thank Richard Pein for allowing me to use his swim team as subjects for this study, as well as for serving on my thesis committee. I thank Richard Mikat for aiding me with the statistical analyses of my thesis and for serving on my thesis committee. Finally, I would like to thank the CEP class of 2018-2019 and the LEHP participants for the support and the relationships we have built over the past year.o

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INTRODUCTION

Training monitoring is important in an exercise program to guide appropriate changes in training load in an efficient manner, and ultimately to elicit the most benefits with minimal adverse side-effects (Borensen and Lambrecht, 2008). To track intensity, many internal measures such as heart rate (HR), oxygen consumption (%VO2max), and blood lactate concentration (BLa) have been used. Although these measurements allow for individualized training, they require substantial equipment for data collection, and may require maximal exercise tests to produce reference points for computation of the training load.

The Session Rating of Perceived exertion (sRPE) has been used for many years as an internal measure to quantify the intensity of an entire workout (Foster et al., 2001 and Foster et al., 1995). This method requires no equipment, and data collection is very easy which makes sRPE a practical tool for tracking exercise intensity. sRPE has been shown to be well-related to objective measures of the internal training load. (Borresen & Lambert, 2008, Herman et al., 2006, Foster et al., 1998, and Foster et al., 1995), and is appropriate for describing intensity of aerobic (Foster et al., 2001, Foster, 1997, Foster et al., 1996, and Foster et al., 1995), non-steady state (McGuigan & Foster, 2004 and Foster et al., 2001), and resistance training (Day et al., 2004 and Sweet et al., 2004). Because of sRPE's strong relationship with these internal markers of exercise training intensity, sRPE has been substituted in Banister's scheme of training impulse (TRIMP) (Morton et al., 1990 and Fitz-Clarke et al., 1991) which is a single factor that integrates the intensity and duration of training. TRIMP along with training monotony, calculated by dividing mean load over one week by the standard deviation of load in that same period, was used to monitor fatigue in athletes (Foster, 1998, Foster et al., 1997, Foster et al., 1996, and Rodriguez-Marroyo et al., 2017.) This may assists athletes in avoiding injuries, illness, and decreases in performance due to inappropriate training.

Prolonged heavy exercise is to immune dysfunction (Pedersen et al., 2003 and Walsh et al., 2011). Increases in volume, but not intensity, may lead to decreases in performance (Lehman et al., 1992). By tracking training load and training monotony, Foster (1998) was able to account for 84% of illnesses following increases in training load specific to each subject. Factors that can be monitored with the use of sRPE that have a specific effect on performance include training monotony (Foster, 1998, Hansen et al., 2005, and Orie et al., 2014), training load, and training intensity (Esteve-Lanao et al., 2007 and Seiler, 2010). Practically, coaches can use sRPE to monitor these factors relatively easily and make decisions regarding the training program. For example, asking an athlete for their sRPE after a warmup session along with the coach's knowledge of recent training load, may potentially determine what adjustments need to be made for the upcoming workout (Rodriquez-Marroya et al., 2017).

Although the use of sRPE is convenient, there is evidence to suggest that coaches may need to be educated on how to use sRPE and training load properly (Comyns & Hannon, 2018). Correct use of sRPE requires the ability of the athlete to execute an exercise program based on coach intended levels of intensity. When compared to the RPE intended by the coach, athletes' true RPE have been found to be significantly higher when exercising at low intensities, and is lower than intended RPE at high intensity exercise (Brink et al., 2017, Brink et al., 2014, and Foster et al., 2001). This may be improved by proper communication and depends on an athlete's ability to recall previous workouts and accurately remember sRPE of those sessions to use as reference points for future exercise. It has been found that recall of sRPE immediately after exercise is not different than 5 minutes post-exercise which indicates that the last set or repetition in a workout session does not strongly bias the athlete's sRPE (Singh et al., 2007 and Uchida et al., 2014). Christen et al. (2016) observed that sRPE recall up to 24 hours post-exercise was not significantly different than sRPE measured 30 minutes post-exercise. More recently, Scantlebury et al. (2018) found a nearly perfect correlation ($r = 0.98$) between sRPE measured 30 minutes and 24 hours post-exercise. This same study found a strong correlation ($r = 0.72$) between sRPE values at 30 minutes and 72 hours, but a larger error was associated with this timeframe. Further research into the temporal robustness of sRPE may be valuable in further developing this simple method of evaluating exercise training. If temporal robustness can be documented to a week and beyond, sRPE may be an even more attractive tool for monitoring training. Classically, sRPE is rated 30 minutes following the completion of an exercise bout, so that terminal elements of a training session would not unduly influence the reported sRPE (Foster et al., 1995). The purpose of this study was to determine the effect of post-exercise time on session RPE, and to investigate the possible mismatch between athlete and coach.

METHODS

The subjects were seven male and eight female competitive swimmers from the University of Wisconsin – La Crosse. Each subject provided written informed consent and the protocol was approved by the university's Institutional Review Board for the Protection of Human Subjects committee and conforms to the Declaration of Helsinki. Characteristics of the subjects are presented in Table 1.

Table 1. Subject Characteristics

Sex	n	Age (yrs)	Height (cm)	Weight (kg)	Experience (yrs)	200yd Time (s)
M	7	20±1.5	182±3.8	79.4±4.87	11±3.3	112.2±3.07
F	8	19±1.3	161±5.8	56.4±5.96	9±3.3	128.3±6.48

Values represent mean ± standard deviation.

Each subject was monitored during and after five training sessions, as part of their in-season training. Before the first session of data collection, the subjects were familiarized with Rating of Perceived Exertion (RPE) scales such as the Category-Ratio (CR) 10 scale (Borg, 1998), and the global Rating of Perceived Exertion (sRPE) (Foster et al., 1995). The subjects were also shown how to use a visual analog scale (VAS), which in this study was a digital image of a line with the left border representing, and labeled as, "rest" and the right border labeled as "maximal effort". Subjects were instructed how to mark their RPE during the training sessions on the line and submit their sRPE using mobile smartphones. The mark's location on the line was scaled to a 10cm line and used as the value for sRPE. This was done to avoid inaccurate data collection attributed to the subjects remembering the verbal anchor of the CR-10 scale they last recorded instead of the actual exertion that they recall experiencing (Christen et al, 2016).

The five different training sessions were chosen by the swim coach, and represented different levels of intended intensities. The coach-intended RPE for the sessions were 6.5, 6.5, 9.0, 5.0, and 4.0 on the CR-10 scale. Each of the five training sessions was recalled by each subject six times. After completion of the training bout sRPE was collected within 30 minutes post-exercise, representing the standard method for sRPE (Foster et al., 1995). The following five additional measures of sRPE recall occurred at 1 day, 3 days, 7 days, 10 days, and 14 days post-exercise. Subjects were not aware of the next date of sRPE recall for any session except for the 30-minute post-exercise recording. Athletes' sRPE recall scores were compared with their 30-minute post-exercise scores to analyze the effects of post-exercise time on the temporal robustness of sRPE. The coach also produced a rating of intended sRPE for each training session prior to the execution of that session.

Statistical Analyses

Differences between mean sRPE values reported by the athletes for each workout over time were compared to the coach intended RPE using one sample t-tests.

Differences between sRPE within workouts over time were compared to sRPE at IPE using one-way analysis of variance (ANOVA) with repeated measures. When a significant F value was found, Tukey's HSD test was applied to identify significant differences between the means. Values of $p \leq 0.05$ were considered statistically significant.

RESULTS

Mean sRPE as reported immediately post-exercise (IPE) for each workout and mean sRPE over time for each separate workout is displayed in Figure 1. Results of the one-sample t-tests comparing athlete experienced sRPE to coach intended RPE are displayed in Table 2. Significant differences were found between sRPE and intended RPE at IPE and at 1 day post-exercise for Workout 1, but the subsequent times of sRPE recall were not significantly different than intended RPE. For Workout 2, all reported sRPE values were not significantly different than coach intended RPE. At each time of recall for Workout 3, athletes reported significantly lower sRPE values than the coach intended RPE. Contrarily, athletes reported sRPE values that were significantly higher than coach intended RPE at each time of recall for Workout 4. For Workout 5, no reported sRPE value was not different than coach intended RPE.

Differences between sRPE and intended RPE over time for all workouts combined, followed by each workout individually are displayed in Figure 2. Results of the one-way ANOVA with repeated measures are displayed in Table 3. Differences between sRPE and intended RPE were not significant over time in Workouts 1, 2, 4, and 5. A significant F value was observed when examining Workout 3. Tukey's HSD test revealed that the difference between sRPE and coach intended RPE was significantly higher at 10 days post-exercise compared to the IPE score for sRPE.

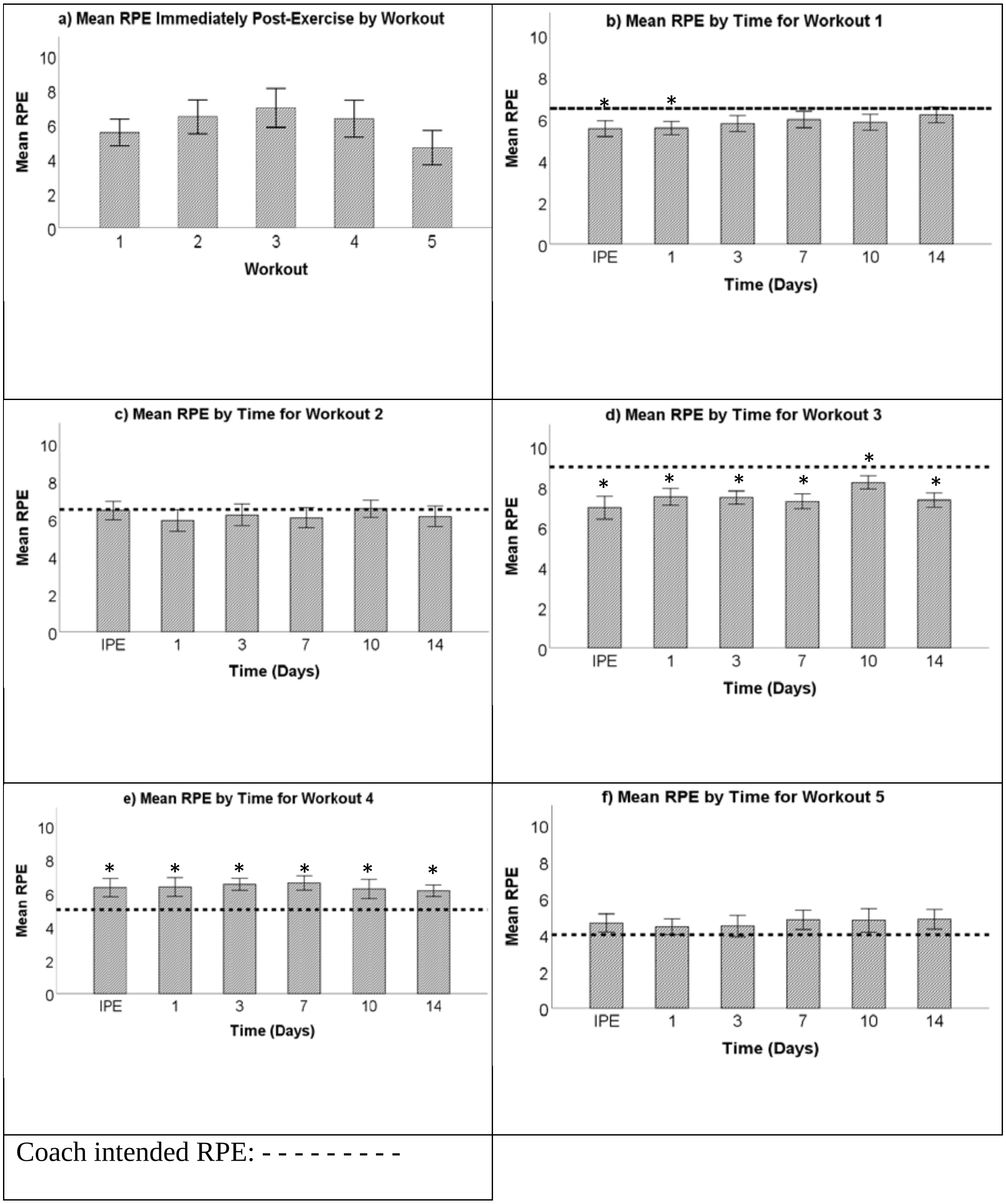

Figure 1. Mean sRPE at IPE for all workouts and sRPE over time for each workout. Significant difference in coach intended vs athlete experienced sRPE are indicated by an*.

Table 2. Results of One Sample t-Test between Mean sRPE Values and Coach intended RPE.

Workout 1	Time	Mean sRPE	SD	p-value
	IPE	5.5*	1.50	.026
	1 day	5.6*	1.27	.012
	3 days	5.8	1.48	.081
	7 days	6.0	1.52	.202
	10 days	5.8	1.47	.108
	14 days	6.2	1.46	.440
Workout 2	Time	Mean sRPE	SD	p-value
	IPE	6.5	1.91	.926
	1 day	5.9	2.19	.323
	3 days	6.2	2.26	.639
	7 days	6.1	2.09	.436
	10 days	6.6	1.78	.909
	14 days	6.1	2.14	.525
Workout 3	Time	Mean sRPE	SD	p-value
	IPE	7.0*	2.20	.003
	1 day	7.5*	1.60	.003
	3 days	7.5*	1.25	.000
	7 days	7.3*	1.46	.000
	10 days	8.2*	1.29	.036
	14 days	7.3*	1.41	.000
Workout 4	Time	Mean sRPE	SD	p-value
	IPE	6.3*	2.10	.027
	1 day	6.4*	2.14	.026
	3 days	6.5*	1.38	.001
	7 days	6.6*	1.64	.002
	10 days	6.3*	2.20	.043
	14 days	6.2*	1.32	.004
Workout 5	Time	Mean sRPE	SD	p-value
	IPE	4.7	1.93	.212
	1 day	4.4	1.67	.325
	3 day	4.5	2.29	.424
	7 day	4.8	2.05	.144
	10 day	2.8	2.50	.240
	14 day	4.9	2.09	.135

*Significantly different than Coach intended RPE ($p < 0.05$).

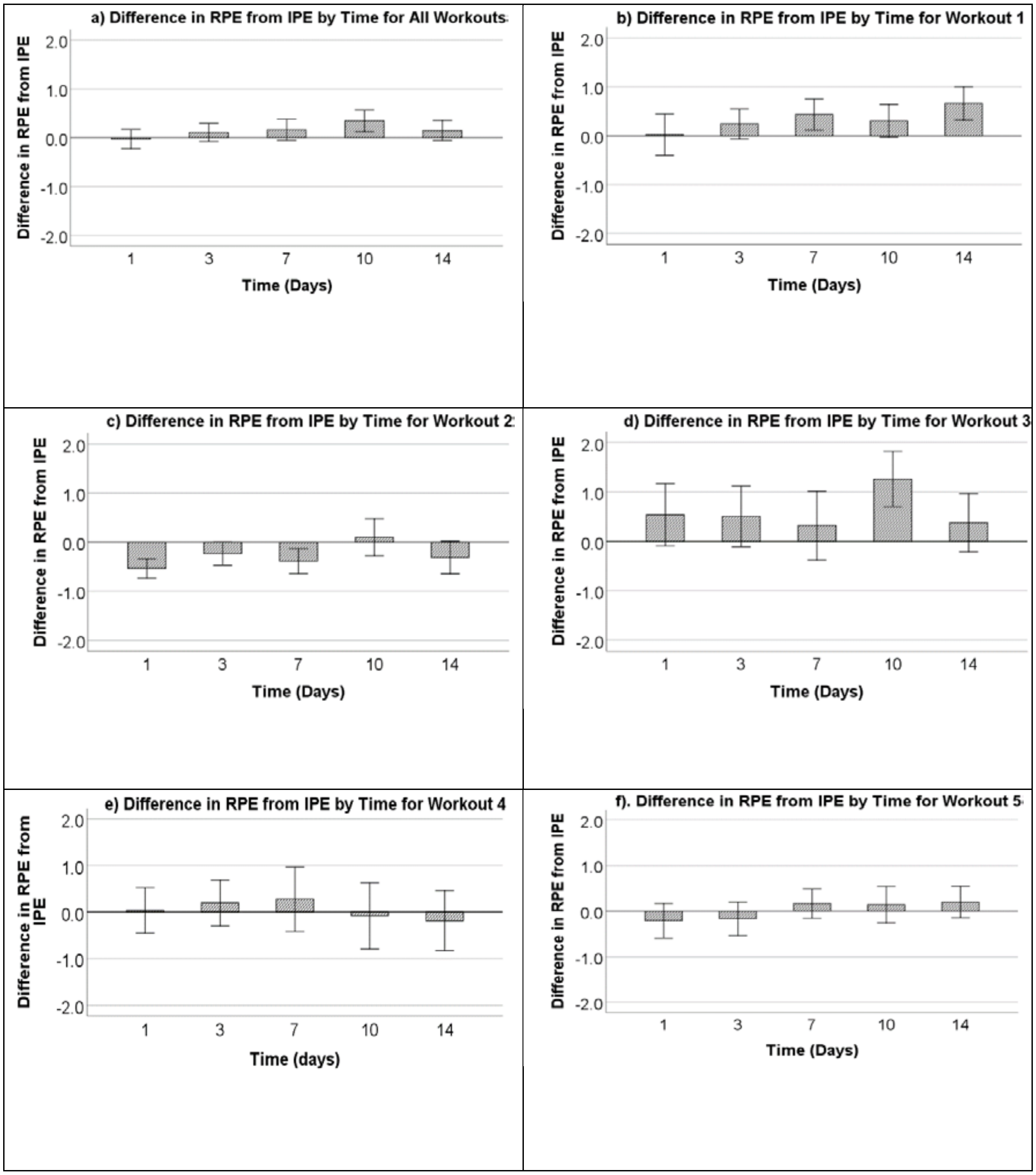

Figure 2. Difference in sRPE from IPE for all workouts combined and separate. Significant differences represented with *

Table 3. Differences in sRPE from IPE.

Workout 1	Time	Mean Difference	SD
	1 day	0.0	1.63
	3 days	0.2	1.19
	7 days	0.4	1.22
	10 days	0.3	1.30
	14 days	0.7	1.32
ANOVA	F = .995	p = .396	
Workout 2	Time	Mean Difference	SD
	1 day	-0.5	0.76
	3 days	-0.2	0.92
	7 days	-0.4	0.99
	10 days	0.1	1.48
	14 days	-0.3	1.29
ANOVA	F = .954	p = .440	
Workout 3	Time	Mean Difference	SD
	1 day	0.5	2.44
	3 days	0.5	2.39
	7 days	0.3	2.70
	10 days	1.3*	2.17
	14 days	0.4	2.28
ANOVA	F =3.417	p = .014	
Workout 4	Time	Mean Difference	SD
	1 day	0.0	1.88
	3 days	0.2	1.91
	7 days	0.3	2.67
	10 days	-0.1	2.75
	14 days	-0.2	2.50
ANOVA	F = .271	p = .788	
Workout 5	Time	Mean Difference	SD
	1 day	-0.2	1.47
	3 days	-0.2	1.42
	7 days	0.2	1.25
	10 days	0.1	1.55
	14 days	0.2	1.33
ANOVA	F = .536	p = .710	

*Significantly greater than other mean differences (p<0.05).

DISCUSSION

The purpose of this study was to determine the temporal robustness of sRPE up to two weeks post-exercise. The results suggest that sRPE can be accurately recorded for up to two weeks after performing a training session. The only point in time in which sRPE was significantly different than sRPE at IPE was at 10 days after workout 4. This finding adds to previous knowledge and suggests that sRPE is reliable up to 14 days post-exercise (Christen et al., 2016 and Scantlebury et al., 2018). Although Scantlebury et al. found a large correlation between sRPE at 30 minutes and sRPE at 72 hours, a large error suggested that this timeframe to be unsuitable for recording sRPE. The findings of the present study suggest that sRPE is quite robust, at least out to two weeks following a training bout.

The second goal of this study was to investigate the difference between coach intended RPE and athlete experienced sRPE. Based on the results of the one-sample t-test, it appears that there is a significant mismatch between coach and athlete for two of the five workouts at every time point after exercise. For these two workouts, coach intended RPE was 9.0 for workout 3 and 5.0 for workout 4. These findings support previous findings by Brink et al. (2017), Brink et al. (2014), and Foster et al. (2001) that athletes perform at significantly lower intensities when the coach intended RPE is high and athletes perform at significantly higher intensities when the coach intended RPE is low. Perhaps athletes have a hard time limiting their exercise intensity when intended RPE is lower, and thus, they are not as rested when it comes time to perform at very high intensities. This would cause them to report sRPE values that are much lower than intended RPE. The mismatch between coach and athlete may also be due to unfamiliarity with the use of sRPE by the coach, although the coach in this study had extensive experience with sRPE. Comyns & Hannon (2018) found that coaches may need time to learn how to evaluate the status of their athletes when prescribing exercise. Perhaps, both athlete and coach need to use sRPE for a period of time to get used to this method of prescribing exercise and reporting exertion.

For practical use, it appears that sRPE is suitable for recording exertion during exercise for up to two weeks following a training session. This, in combination with the ease in which sRPE can be measured, makes sRPE an attractive tool for monitoring training, especially in situations with many exercisers such as group classes or athletic teams.

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APPENDIX A

INFORMED CONSENT

Informed Consent

Project: Examining the Temporal Robustness of Session RPE

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Purpose and Procedures

- The purpose of this study is to investigate the effect of post-exercise rating time on session RPE up to 2 weeks post-exercise.
- My participation will include reporting session RPE for 5 different workouts 6 times within a 2 week period post-exercise.
- I will be using a visual analog scale as instructed by the investigators to report session RPE via mobile device.
- Workouts will be chosen for data collection by the cross-country coaching staff.
- Total time requirement for this study will be between 60 and 90 minutes over the course of the season.

Potential Risks

- There are minimal risks in this study due to its survey-based nature.

Rights and Confidentiality

- My participation is voluntary, and I can withdraw or refuse to answer any question without consequences at any time.
- I can withdraw from the study at any time for any reason without penalty.
- The results of this study may be shared in scientific literature or presented at professional conferences.
- All data and information will kept confidential through the use of number codes.
- By completing the survey tools provided, I am constituting informed consent.

Informed Consent

Benefits of this Study

- I may gain a better understanding of the use of session RPE and its future applications in exercise prescription.

Questions regarding study procedures may be directed to Bo Orton (715-684-9500), the principal investigator, or the faculty advisor Carl Foster, PhD., Department of Exercise and Sport Science, UW-L (608-785-8687). Questions regarding the protection of human subjects may be addressed to the UW-La Informed Consent Crosse Institutional Review Board for the Protection of Human Subjects at irb@uwlax.edu.)

Participant________________________________ Date_________________
Researcher_______________________________ Date_________________

APPENDIX B

BORG CR-10 RPE SCALE

Borg CR10 Scale® (2010)[20]

0	Nothing at all	
0.3		
0.5	Extremely weak	Just noticeable
0.7		
1	Very weak	
1.5		
2	Weak	Light
2.5		
3	Moderate	
4		
5	Strong	Heavy
6		
7	Very strong	
8		
9		
10	Extremely strong	"Maximal"
11		
∫		
•	Absolute maximum	Highest possible

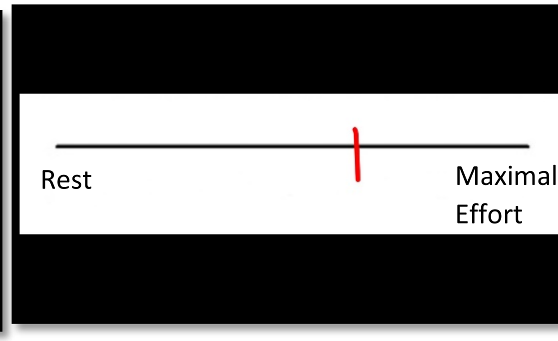
APPENDIX C

VISUAL ANALOG SCALE

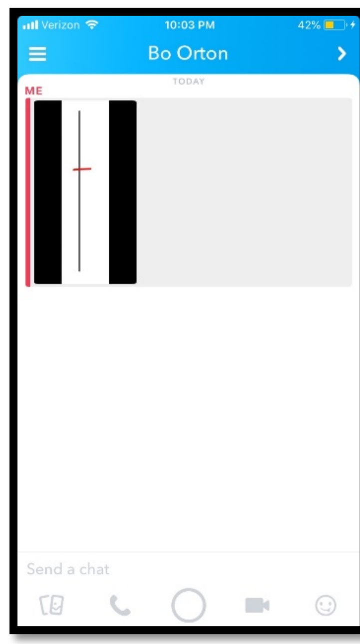
VISUAL ANALOG SCALE

1) Image that subjects received.

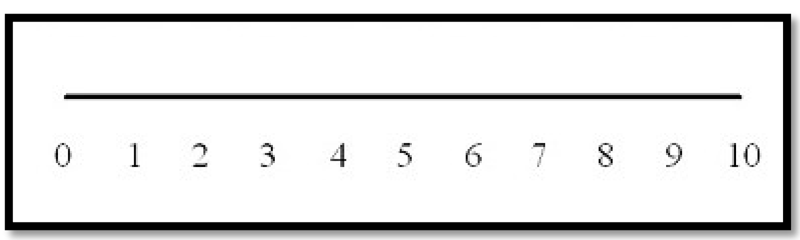
2) Image with subject's sRPE.



3) Image that is received by researcher.



4) Image of line scaled to 10cm used for data collection.



APPENDIX D

LITERATURE REVIEW

Exercise Prescription and Training Monitoring

In any exercise program, from athletes to cardiac rehabilitation patients, the ability to monitor training is important. Training monitoring requires efficient communication between exerciser and prescriber, and timely adjustments to the exercise prescription to elicit maximal benefits and minimal adverse effects. A typical exercise program uses four variables outlined by the American College of Sports Medicine (ACSM); frequency, intensity, time, and type (*ACSM Guidelines for Exercise Testing and Prescription* 10^{th} edition). Of these four, frequency, time, and type of exercise are easy to explain to a layperson. Intensity may be more difficult due to its nature, and requires effective methods of measurement.

Intensity of Exercise

A typical understanding of intensity may be "how hard one is working". This is not incorrect, it is simply a verbalization of the physiological events happening within one's body during exercise. A simple and primitive method of determining intensity with little equipment is timing lap paces in repeated repetitions. As the exerciser improves, an even faster pace can be set, a shorter rest period tolerated, or the number of repetitions within a given time increased. This is the basis of interval training which became popular within the last several decades. This type of training requires less volume, but much higher intensities than steady-state training. Anecdotally, many athletes have expressed a preference for lower volume to maintain a high level of performance, and reduce the incidence of injuries and illness. This suggestion has been backed by a study carried out by Lehman, Baumgartl, & Wisenack (1992) in which higher volumes, not higher intensities, of training produced a decrease in performance. From this, it is evident that alternating high and low intensities during exercise may be beneficial. This idea applied to an entire training program instead of just the singular session led to the development of periodization training.

The goal of periodization is to plan very intense, physically demanding training sessions that elicit a physical and/or physiological adaptation around sessions of lower intensity to allow for the management of fatigue (Fleck, 1999, and Rowbottom, 2000). Although this type of training program has been favored by some, it still requires a method of measuring exercise intensity for it to be an effective tool. In a common steady-state aerobic exercise such as running, miles per week has traditionally been used to track training load (Foster, Daniels, and Yarbrough, 1977 and Foster & Lehman, 1997). Theoretically, it would make sense that the amount of work done within a specific time period should indicate intensity, but distance alone does not give a great deal of insight to the effort being put forth by the exercising body.

Internal Measurements of Intensity

Once advances in technology allowed for cheaper methods of measuring internal physiological factors such as heart rate (HR), blood lactate (BLa) levels, and oxygen consumption (VO2), it allowed for more precise training and exercise prescription. Although these methods required the use of equipment, it allowed for greater individualized training than before. VO2 and BLa were studied in regards to their similar responses to exercise (Wasserman & Whipp, 1962) and HR has been improved upon by the likes of Matti Karvonen and his development of heart rate reserve (HRR) as an individualized method of measurement (Karvonen, Kentala, & Mustala, 2007).

TRIMP

These internal factors were now useful in tracking training load, and in 1975 the concept of training impulse (TRIMP) was developed to quantify intensity based on %HRR and duration (in minutes) of exercise (Bannister, Clavert, Savage, & Bach, 1975). TRIMP was calculated by simply multiplying the two factors along with a coefficient. The coefficient served as a weighting factor according to the usual increase in blood lactate in an exercising body. This prevented extremely low intensity exercise at very long durations from producing an inflated TRIMP value that did not accurately represent the stress on the exerciser. The units are arbitrary, and the numerical value for TRIMP simply serves as a reference point to plan exercise. Although it became popular to use in periodization exercise programs, it was not as useful for resistance, high-intensity interval, or plyometric training due to difficulty to collect HR and duration within each set (Fitz-Clarke, Morton, & Banister, 1991 and Morton, Fitz-Clarke, & Banister, 1990). They kicked off a trend in which zones of exercise intensity were being recommended based most commonly on HR. These methods of measurement were individualized indeed. However, the need for equipment, and the time necessary to look at the training session data is not always practical.

External Measurements

Gunnar Borg eventually developed a non-invasive, and relatively quick method of measurement for exercise intensity called rating of perceived exertion (RPE). Although his interests began in the 1950s, Borg's work in the field of psychophysiology will long be remembered for his RPE scale. In 1982, Borg's 6-20 RPE scale was introduced, and is still regularly used today (Borg, 1982). With both numeric and verbal cues, RPE is a practical use for describing exercise intensity without excessive equipment, or time needed to collect data. The original reason for the scale being 6-20 was the notion that each number on the scale represented about one tenth of the exercise HR. It is common knowledge that everybody's HR is specific to them, and can be influenced by a number of factors. Also, physiological factors such as BLa, also used to determine intensity of exercise, does not increase in a linear fashion with increases in exercise intensity. For this reason, Borg revised his scale to what is known as the CR-10 scale. This iteration of the RPE scale includes decimals and is meant to represent, for example, 6 on the RPE scale to be nearly twice as hard as 3, which was not the case in Borg's original scale. Another difference is that the scale includes ratings beyond the maximal limit to account for the possibility of the exerciser "finding another gear" within them that had not previously been reached. In all, the CR-10 scale was found to fit well with the original 6-20 scale, and is easily communicated with athletes (Noble, Borg, Jacobs, Ceci, & Kaiser, 1983 and Noble & Robertson, 1996). RPE is an accurate measure of exercise intensity and has been shown to fit well with HR and BLa while also being effective in both aerobic and resistance training (Scherr et al, 2013 and Gearhardt et al, 2002 and Borg, 1998).

Session RPE

While RPE is useful in describing exercise intensity, it is generally meant to quantify a single instant during exercise. This may be useful in determining how much longer an individual could last on an exercise test, for example. The idea to use RPE to describe an entire workout, and use this external, instead of internal, measurement to describe load led to the use of what is now known as "session RPE" (sRPE). The measurement of sRPE has been used in aerobic (Foster, Florhaug, & Franklin, 2001 and

Foster, 1997 and Foster & Lehmann, 1997) and resistance training exercise (Day, McGuigan, Brice, & Foster, 2004 and McGuigan & Foster, 2004). sRPE, although quite simple, is related closely to internal physiological markers and accurately describes training intensity (Borresen & Lambert, 2008 and Herman, Foster, Maher, Mikat, & Porcari, 2006 and Foster et al, 2001 and Foster, 1998, and Foster, Hector, Welsh, Schrager, Green, & Snyder, 1995). Because of the ease in which sRPE can be measured, and its close relationship with other factors of exercise intensity, it can replace %HRR in the TRIMP equation, eliminate the need for a weighting factor, and make the measurement even more practical.

Combining sRPE and TRIMP

In previous research, training load has been described as sRPE multiplied by duration of exercise in minutes, similar to the Bannister's TRIMP equation (Foster, 1998). To account for variability of training load in a fashion similar to periodization, the term training monotony has been calculated as the mean training load divided by the standard deviation of load in a one week period (Foster, 1997). These two variables are used just the same as previously used measurements in periodization training, but with simple, external measurements of intensity. Training monotony is used to describe the level of variability within a program. Higher variability means that there is a proportionate quantity of low-intensity workouts allowing for rest to prepare for the high-intensity workouts.

A benefit of using sRPE instead of prescribed paces or %HRmax is that it is related to TRIMP of previous training sessions which indicates that it is connected to the athlete's level of fatigue immediately before a workout (Roos, Wolfgang, Tuch, Frei, &

Wyss, 2018). It may seem to be self-evident that a reduced night of sleep, poor dietary choices, or physical fatigue would impact a subsequent training session, but if a pace for a runner is set by their coach the previous day, the exertion of the athlete may not match the intensity originally intended. By using sRPE in exercise prescription, even a fatigued athlete may be able to achieve the intended intensity level by managing their pace and rest periods accordingly. For instance, a cross-country runner can describe their sRPE after a warm-up period, and based on this response, the coach may make appropriate changes to the planned workout. sRPE may be practically used in other settings such as group exercise (Comyns & Flanagan, 2013), or even in competition (Rodriguez-Marroyo, Villa, Garcia-Lopez, & Foster, 2017), and make further examination into its properties more attractive.

Overtraining and sRPE Usage

While there are no universally accepted criteria for diagnosing overtraining syndrome in athletes, the general description of it involves reduced performance due to progressive fatigue. Poor performance may be caused by a deficit in recovery (Foster, Daines, Hector, Snyder, & Welsh, 1996), or an immunological dysfunction caused by prolonged, vigorous exercise (Walsh et al, 2011 and Pedersen et al, 2003). It has actually been found that a great deal of illnesses may be predictable when an individual exceeds certain thresholds of exercise if properly monitored (Foster, 1998). This means that overtraining syndrome is preventable if the athlete or coach is aware of the stressors on the athlete’s body. Three factors that have an effect on a person, and determine whether or not they may experience overtraining syndrome are training load, training intensity (Seiler, 2010 and Esteve-Lanao, Foster, Seiler, & Lucia, 2007), and training monotony

(Orie, Hofman, de Koning, & Foster, 2014, Hansen, Fischer, Plomgaard, Andersen, Saltin, & Pedersen, 2005 and Foster, 1998). Aware of these factors, a coach may then make alterations to a training program by using sRPE as an indicator of athlete fatigue during the program or even the warm-up phase of a workout. However, there is evidence that coaches may need to be educated on how to use the variables of sRPE and training load to properly evaluate the status of their athletes (Comyns & Hannon, 2018). It has been found that there is a mismatch in terms of the coaches' intended RPE for a workout, and the RPE reported by athletes post-exercise (Brink, Kersten, & Frencken, 2017 and Brink, Frencken, Jordet, & Lemmink, 2014). In both studies by Brink et al, it was observed that athletes typically exercised at higher sRPE's than intended when the prescribed intensities were low, and they exercised at lower sRPE's than intended when the prescribed intensities were high.

This may be the competitive nature of the athletes coming out when they feel that a workout was easy, but it causes true training monotony to increase. Because they exercised at higher than intended intensities, they may not have been recovered enough to reach the intensities the coach had intended on the high-intensity workout days.

Remaining Questions

It is clear that sRPE can be used to accurately describe exercise intensity, and it has already been used in exercise prescription. To further simplify training monitoring, it would be interesting to study the temporal robustness of sRPE for an athlete beyond 24 hours post-exercise that has already been studied by Christen, Foster, Porcari, & Mikat in 2017. Christen et al found that sRPE recollection up to 24 hours post-exercise was accurate. Being able to properly recall sRPE ratings and corresponding intensity levels of exercise even longer would allow coaches to communicate with athletes in terms of RPE. In all, sRPE may lead to greater simplification in training monitoring and exercise prescription, and increase the efficiency and rate at which physical performance is able to progress.

APPENDIX E

LITERATURE REVIEW REFERENCES

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