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DOES RESISTED SPRINT TRAINING ACUTELY ENHANCE SPRINT MECHANICS?

Andrew J. Harrison, Niamh Whelan, Ciaran O'Regan

Biomechanics Research Unit, University of Limerick, Ireland

Resistance sprint training with sledges and harnesses is often used by athletes to induce an acute enhancement in performance during recovery. Such enhancements are similar to post-activation potentiation (PAP) effects found in complex training. The methods used to detect PAP are variable across studies. The aim of this study was to compare the results of the typical error method of analysis with conventional repeated measures ANOVA on data obtained from a resisted sprint training. The results showed that the ANOVA method found many significant differences between pre-test and post-test means but the typical error method showed relatively few incidences of fatigue-potentiation patterns across any subjects. This suggests that the ANOVA may be an inappropriate analysis technique for examining fatigue potentiation effects.

KEY WORDS: Post activation potentiation, biological variability, typical errors.

INTRODUCTION: Resistance sprinting training (RST) employing sledges, parachutes and harnesses is increasingly used by athletes and field games players to improve performance in sprinting. Training studies on RST have consistently shown that repeated exposure to RST is effective in improving initial acceleration (Harrison *et al.,* 2009; Upton *et al.,* 2011), but research is limited on whether RST can induce an acute post activation potentiation effect on sprint performance during recovery within a training session. The majority of PAP studies in the literature have examined the potentiating effect of weighted squats on jump and sprinting performance (Comyns *et al*., 2007; Comyns *et al.,* 2010; Kilduff *et al.,* 2007) but the methods used to determine PAP effects vary across studies and this often results in conflicting findings. The expected pattern of PAP responses is that subjects show an initial decrement in performance immediately after a short duration high intensity muscle contraction and this may be followed by an enhancement of performance at some point during the recovery period. Harrison and Bourke (2009) showed that individual variations in the timelines of fatigue and recovery may confound the analysis of results in PAP studies and recommended that Repeated Measures (RM) ANOVA be used to compare non-fatigued performances with the minimum and maximum performances during recovery irrespective of when those minima or maxima scores occurred. While this approach is useful in accounting for inter-subject variability in the timelines of recovery between subjects, it does not take account of the biological variability in performance which may also confound the detection of significant fatigue or potentiation effects. Hopkins (2000) has recommended the use of typical errors (TE) based the calculation of the within-subject standard deviation to determine smallest worthwhile changes in performance outside the individual range of the biological variability in performance. Crewther *et al*., (2011) suggested that PAP responses may depend on the specificity of the movement pattern in the preload exercise. The squat movement pattern is specific to the movement pattern of some jumping activities such as a countermovement jump or squat jump but it is not similar to the movement pattern of sprinting. RST sledges, parachutes or harnesses provides a bore biomechanically similar form of resistance compared to heavy squatting and therefore probably provides a more suitable for of exercise to induce PAP effects in running. Clearly the methods used to determine acute potentiation or fatigue related effects in RST studies, may have important influences on the interpretation of results. Therefore the aim of this study is to compare the use of TE and RM ANOVA methods to detect acute fatigue and potentiation responses in subjects during recovery from RST using sledge based resistance.

METHODS: Twelve physically active males aged 22.5 ±3.9 year, (mean ±SD); mass 74 ±5.9 kg; height 1.77 ±0.05 m, participated in this study. All participants were injury free and had completed at least three training sessions each week in team or individual sports for three months prior to testing. The study was approved by the local university research ethics committee and written consent was obtained from all participants. All testing took place on an indoor synthetic track over a period of two days. Sprint performance over a 10 m sprint was recorded using an Optojump Next system triggered by a set of dual beam timing gates (Microgate, Botzano, Italy). Participants started each sprint from a standard two point starting position with their front foot placed on a line 70 cm behind the timing gates ensuring that they did not trigger the timing gates before the start of each sprint. For the RST trials a weighted sledge device was used and the total sledge mass for each participant was adjusted to approximately 25% to 30% of body mass (to the nearest 2.5 kg). The sledge was attached the participant with a shoulder harness and rope.

Testing Protocol: All participants completed a pre-test and post-test on separate days. In the pre-test, the participants performed a standard warm up followed by ten maximum effort sprint trials over a distance of 10 m with two minutes recovery between each run. In the post-test, all participants completed the standard warm up followed by three maximum effort sled pulls over 10 m with 90 seconds recovery between runs. One minute after the final sledge pull the participants performed the first non-resisted sprint through the Optojump system and again at 2, 4, 6, 8, and 10 minutes following the last sledge pull. The Optojump system provided ground contact times, flight times for six steps on all non-resisted sprint trials. The reactive strength index for each step was calculated as the ratio of flight time/ground contact time.

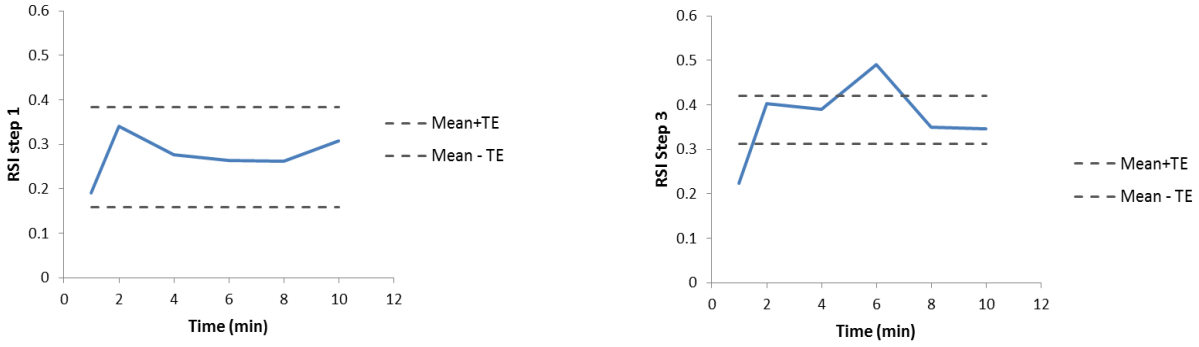
Statistical Analysis: The incidence of fatigue and PAP events was evaluated using an adapted TE method and a Repeated Measures (RM) ANOVA design. In the TE method, the scores of the ten pre-test trials were used to construct a range of biological variability around the mean pre-test performance using the recommendations of Hopkins (2000). A fatigue event was defined as a score during the post-test which was more than $1.5 \times SD_{T10}$ worse in performance terms than the pre-test mean and a PAP event was defined as a score during the post-test which was more than $1.5 \times SD_{T10}$ better than the pre-test mean (where SD_{T10} is defined as the standard deviation of the participant's scores across the 10 pre-test trials) An RM AVOVA was also used to determine whether there were any performance changes between pre and post test results. The RM ANOVA compared group means for the pre-test sprints with group means of minimum and maximum scores during the post-test trials. A group potentiation or fatigue effect was determined as a statistically significant improvement or decrement in post-test performance compared to the pre-test mean ($p < 0.05$).

RESULTS: Exemplar results of the TE error analysis on a selected participant's RSI performance are provided in table 1 and figure 1. The results show that during recovery, the subject exhibited fatigue (reduced RSI) and potentiation (increased RSI) in steps 2 and 3 during the recovery form RST.

Table 1: Typical error analysis of a single subject's post-test RSI over all six steps

Step	RSI Pre-Test Typical Error Range	Post-Test Min	Post–Test Max	Fatigue	Potentiation
1	0.159 to 0.383	0.190	0.341	**X**	**X**
2	0.200 to 0.305	0.167	0.406	✓	✓
3	0.312 to 0.420	0.223	0.490	✓	✓
4	0.308 to 0.537	0.313	0.430	**X**	**X**
5	0.317 to 0.515	0.367	0.506	**X**	**X**
6	0.350 to 0.547	0.435	0.544	**X**	**X**

Figure 1A and 1 B illustrate the TE analysis of RSI for this subject during steps 1 and 3 respectively. In Figure 1A, the RSI scores for step 1 lie within the typical error range but in Figure 1B the RSI for step 3 shows initial fatigue at 1 minute followed by a potentiation effect at 6 minutes after completion of the RST protocol.



A **B**

Figure 1: Exemplar graphs illustrating TE analysis of a single subject RSI performance for step 1 (A) and Step 3 (B).

Table 2: Group analysis of Fatigue and PAP effects for CT, FT and RSI across 6 steps

	Contact Time Step 1-6			Flight TimeStep 1-6			RSIStep 1-6		
	No. of FAT Events	No. of PAPEvents	No FAT-PAP Patterns	No. of FAT Events	No. of PAP Events	No. of FAT-PAP Patterns	No. of FAT Events	No. of PAP Events	No. of FAT-PAP Patterns
Sum	39	28	2	35	65	2	39	62	7
%	9.03	6.48	2.8	8.10	15.05	2.8	9.03	14.35	9.7

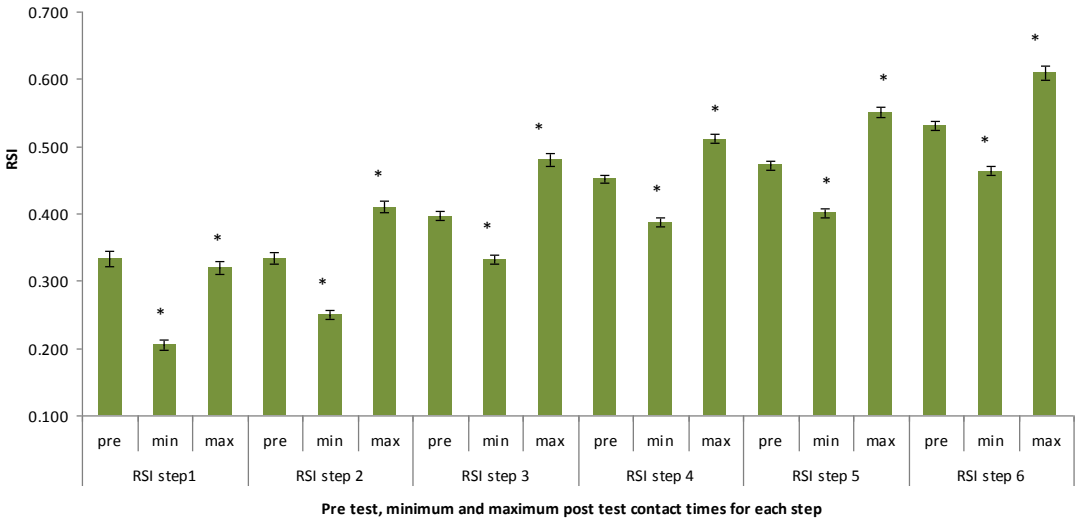


Figure 2: Mean ±95% Confidence Intervals for baseline (pre), minimum and maximum during post-test for RSI over 6 steps *denotes significant difference between pre-test and post-test means ($p \leq 0.05$).

Table 2 provides a group summary of TE error analysis of FT, CT and RSI scores. The results show total number and percentage of Fatigue (FAT) and PAP events across the group and the number of FAT-PAP patterns elicited by participants during the post-test. The data indicated a relatively small number/percentage of FAT and PAP events. Further examination of these data revealed that the FAT and PAP events did not always occur at consistent times or steps for CT, FT or RSI. The results also show very few incidences of fatigue followed by potentiation pattern in all three variables.
Figure 2, illustrates the effect of the RST protocol on mean RSI scores for each of the first 6 steps of the sprints performed during the recovery. The data shows means for the pre-test and the minima and maxima scores during the recovery. The results of the RM ANOVA on these data revealed statistically significant differences between the pre-test and minima and the pre-test and maxima for all steps, suggesting that the RST protocol induced significant FAT-PAP effects on RSI for all 6 steps. Analysis of CT and FT data revealed similar results with statistically significant differences between pre-test *vs* minima and pre-test *vs* maxima throughout most of the first 6 steps of the post-test sprints.

DISCUSSION: The results of the RM ANOVA showed that RST induced a significant PAP effect on CT, FT and RSI on the first six steps of the sprints completed during recovery from the RST protocol. By contrast, the TE results showed relatively few incidences of fatigue PAP across all subjects and in those cases where PAP did occur, it presented in a somewhat random way with no consistency in the timing of PAP effects across variables or subjects. Taken together, the results do not provide strong support for the existence of PAP effects from RST. While the RM ANOVA provided evidence of PAP, the lack of any consistent FAT-PAP patterns within subjects provided very limited evidence of a real phenomenon. Since the classic fatigue PAP pattern occurs rarely across subjects, it is suggested that the ANOVA method is not suitable for analysing these data. The TE method allows the inclusion of biological variability (within subjects SD) within the analysis process and treats this as a real data rather than noise.

CONCLUSION: The typical error approach presents a more appropriate methodology for analysing fatigue-PAP effects compared to analysis with RM ANOVA.

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