Acute effects of verbal feedback on upper-body performance in elite athletes

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ABSTRACT

Improved training quality has the potential to enhance training adaptations. Previous research suggests that receiving feedback improves single-effort maximal strength and power tasks, but whether quality of a training session with repeated efforts can be improved remains unclear. The purpose of this investigation was to determine the effects of verbal feedback on upper-body performance in a resistance training session consisting of multiple sets and repetitions in well-trained athletes. Nine elite rugby union athletes were assessed using the bench throw exercise on four separate occasions each separated by seven days. Each athlete completed two sessions consisting of three sets of four repetitions of the bench throw with feedback provided following each repetition; and two identical sessions where no-feedback was provided after each repetition. When feedback was received there was a small increase of 1.8% (90% confidence limits, ±2.7%) and 1.3% (±0.7%) in mean peak power and velocity when averaged over the three sets. When individual sets were compared, there was a tendency towards the improvements in mean peak power being greater in the second and third sets. These results indicate that providing verbal feedback produced acute improvements in upper-body power output of well trained athletes. The benefits of feedback may be greatest in the latter sets of training and could improve training quality and result in greater long-term adaptation. **KEY WORDS:** Bench throw, power, velocity, rugby union

INTRODUCTION

To be successful in a chosen sport, athletes need to develop a variety of specific skills and physical attributes. In many sports, such as rugby union, athletes have limited time to train and develop each physical attribute before optimal recovery is compromised or injury risk is increased. It has been suggested that athletes may sometimes train with insufficient motivation or intensity to maximise their training time (23), and their training quality may suffer. Therefore, improving the quality of each training session (without extending the duration or increasing the volume) is a common goal for many athletes. Quality of training is vital to the success of the conditioning programme and relates to the exercise stimulus required to make specific improvement (14). For example, attempting to maximise jump height or velocity during vertical jump training may lead to greater training quality and adaptation when compared to performing the same quantity of jumps performed with sub-maximal intent.

Psychological strategies may be a potential method for improving training quality and have been previously reported to improve performance of strength, power and skill based tasks (10, 12, 17, 25). Psychological techniques can be classified as either intrinsic (e.g. self talk, ‘psyching up’) or extrinsic (e.g. visual and verbal feedback [knowledge of results or performance], encouragement) and although the exact mechanisms for improvement are unclear, improvements may be due to a combination of enhanced neuromuscular activation, intent, focus of attention, levels of arousal, and improved skill performance and learning (10, 12, 16, 17, 25, 31). ‘Psyching up’ has been shown to increase isokinetic bench press strength by 11.8% when compared to a mental distraction control (25). Additionally, Jung and Hallbeck (10) reported an increase in peak handgrip strength of approximately 5% when visual feedback or verbal encouragement were given. It should be noted that the strength improvements in the aforementioned investigations were assessed in testing sessions consisting of a single repetition or set, an approach that is atypical in resistance training where multiple sets and repetitions are performed consecutively (excluding one repetition maximum lifting) (20). Therefore, the effect of psychological strategies on resistance training performance still requires investigation.

Training quality can be affected by accumulated fatigue that occurs throughout a training session and may cause a reduction in exercise movement velocity (15). As such, the rate of work done (i.e. power) in the final sets may not be as high as the initial sets, resulting in reduced training quality. Using psychological techniques Tod and colleagues (26) reported a significant increase (~4.7%) in knee angular velocity during a vertical jump when athletes performed self-talk such as “I can jump high” prior to jumping. Verbal feedback is another psychological technique that might influence movement velocity when delivered to athletes throughout training sessions, although to date, such a possibility has yet to be explored. The finding that verbal feedback increases movement velocity during resistance training, thus allowing training quality to be maintained or improved, may yield practical implications for coaches and athletes.

While strength is important and often assessed in practice, research indicates that power may be a better predictor of athletic performance (18). Numerous authors have reported increases in lower body power when psychological strategies were implemented (26, 28, 29). To date, only one study has investigated the acute effects of psychological methods on upper-body power (7). It was reported that the use of self talk (labelled motivational self talk) increased distance of an over head throw of a water polo ball (7.2%) in untrained swim class students compared to a no-talk (control) condition (7). It is however unknown whether verbal feedback can improve performance in upper-body power exercises in well trained athletes. Therefore, the purpose of this investigation was to determine the effects of verbal feedback on upper-body power in a resistance training session consisting of multiple sets and repetitions in well trained rugby athletes. We hypothesized that receiving feedback throughout a training session will improve training quality, observed as enhanced power output and velocity of each exercise set.

METHODS

Experimental Approach to the Problem

To assess the effects of verbal feedback on mean peak power and mean peak velocity; nine elite rugby union athletes were assessed using the bench throw exercise on four separate occasions each separated by seven days. All testing sessions were conducted at 0900 hours on the same day of the week. Additionally, all subjects had been instructed to maintain a high level of hydration in the 24 hours leading up to each testing occasion. While nutrition was not controlled prior to each testing; the subjects recruited in this experiment were all professional athletes who had a sound understanding of appropriate nutrition for training and also had a team nutritionist who regularly monitored their nutritional habits. Each athlete completed two sessions consisting of three sets of four repetitions of the bench throw with feedback provided following each repetition; and two identical sessions where no-feedback was provided after each repetition. Each set was separated by two minutes rest. Athletes were randomly split into two groups which differed only in the order they received feedback or no-feedback over the four testing occasions (Figure 1). Power and velocity were assessed using the bench throw exercise due to its common usage in power training programs and research studies and its ability to represent upper-body power (1, 2). Multiple repetitions and sets were performed to be more representative of a typical training session. Peak power and velocity were selected as the dependent measures as they have been reported to have the greatest association with athletic performance (6).

Insert Figure 1 here

Subjects

Nine elite rugby union athletes from a Super 14 professional rugby team volunteered to take part in this study during the start of the competitive phase of their season (testing was performed in the month of March) (mean ± SD; age, 22.1 ± 2.1 years; height, 184.2 ± 7.7 cm; mass, 107.3 ± 13.2 kg; maximal bench press strength, 135.9 ± 22.6 kg). Each athlete had undergone at least two years of intensive and regular resistance training. All athletes were informed of the experimental risks and benefits of the study and signed a consent document prior to the study commencing. The investigation was approved by an Institutional Review Board for use of Human participants (Auckland University of Technology Ethics Committee).

Procedures

Feedback

Peak velocity ($m.s^{-1}$) was obtained by a GymAware® optical encoder (50 Hz sample period with no data smoothing or filtering; Kinetic Performance Technology, Canberra, Australia) and the numerical value (e.g. 2.38 $m.s^{-1}$) was verbally provided to each participant following the completion of each repetition. Verbal feedback was provided at a volume slightly greater than normal conversation volume due to the additional noise created within the gymnasium. No other feedback or motivation (e.g "come on" or "you can do it") was provided. The no-feedback condition had only the repetitions counted aloud (i.e. "1, 2, 3, 4") at the same volume as the feedback condition. The same encoder was also used to record the peak velocity and peak power of each repetition for later analysis (5). Briefly, GymAware® consists of a spring-powered retractable cord that passes around a pulley mechanically coupled to an optical encoder. The retractable cord is then attached to the barbell and velocity and distance are calculated from the spinning movement of the pulley upon movement of the barbell. The encoder gave one pulse approximately every three millimeters of load displacement, with each displacement value time stamped with a one-millisecond resolution. The mass of the bar (as entered into a personal digital assistant), the entire displacement (mm) of the barbell, and time (ms) for the movement are used to calculate mean values for power (5).

Bench-throws

A standardised warm up consisting of two sets of ten body-weight press ups followed by one set of five explosive press ups with a clap was completed. Athletes then completed three sets of four repetitions of bench throw at a load of 40kg within a Smith machine that was equivalent to 30% (± 5%) of the group's mean maximal bench press. Athletes used a self selected hand position and lowered the bar to a self selected depth (1). Athletes then threw the bar vertically and explosively as possible, trying to propel the bar for maximal velocity (19). Each repetition began with an eccentric phase followed immediately by a concentric phase with no pause between the two phases. In both conditions a one second pause occurred following the completion of each repetition (at the end of the concentric phase) so that verbal feedback or no-feedback could be provided (obtained via GymAware®). Athletes rested for two minutes between all warm up and training sets. Athletes were asked to rate their effort after each set; all reported maximal effort.

Statistical Analyses

The first repetition from each set was excluded from analysis, as feedback could not be provided until after the completion of the first repetition. The repetitions for each set from the two feedback sessions were combined and averaged prior to analysis, as were the no-feedback repetitions. Mean peak power and mean peak velocity data of all nine repetitions, as well as the mean for each set of three repetitions (set one, two or three) were used for analysis.

All data were log-transformed to reduce non-uniformity of error, and the effects were derived by back transformation as percent changes (9). Standardised changes in the mean of each measure were used to assess magnitudes of effects by dividing the changes by the appropriate between-participant standard deviation. Standardised changes of <0.2, <0.6, <1.2, <2.0 and >2.0 were interpreted as trivial, small, moderate, large, and very large effects (8). An effect size of 0.2 was interpreted as the smallest worthwhile change. To make inferences about the true (large-sample) value of an effect, the uncertainty in the effect was expressed as 90% confidence limits. The effect was deemed unclear if its confidence interval overlapped the thresholds for small positive and negative effects (4). Intraclass correlations (r) and coefficient of variation (CV%) for the bench throw was assessed on 11 recreationally trained males and were r=0.949 and 5.2%, and r=0.957 and 3.1% for peak power and peak velocity, respectively.

RESULTS

A small increase of 1.8% (90% confidence limits; ±2.7%) in mean peak power of all repetitions was observed when feedback was received. When each set was compared individually there was no difference in mean peak power between the first set in either condition. The mean peak power in the second set was 2.4% (±4.7%) greater when feedback was received when compared to the second set of the no-feedback condition and represented a small effect. There was also a small increase of 3.1% (±3.3%) in mean peak power of the third set in the feedback condition compared with no-feedback (Figure 2).

Insert Figure 2 here

Mean peak velocity of all repetitions was 1.3% (±0.7%) greater when feedback was provided and this represented a small effect. When each set was compared, a small improvement in mean peak velocity was observed in all three sets in the feedback condition compared to no-feedback. Increases in mean peak velocity were 1.3% (±1.1%), 1.1% (±1.1%) and 1.6% (±1.0%) for set one, two and three, respectively (Figure 3).

Insert Figure 3 here

There were no clear differences between the change in power or velocity from set to set between either condition. However, the change in mean peak power from set one to set two in the feedback condition was nearing a clear difference compared to the no-feedback condition (2.5 ±5.6%; effect size, 0.37 ±0.83). Figure 4 illustrates the individual response in mean peak velocity and power to feedback and no-feedback conditions.

Insert Figure 4 here

DISCUSSION

The purpose of this investigation was to determine the acute effects of verbal feedback on upper-body power in a resistance training session consisting of multiple sets and repetitions in well trained athletes. Small improvements in bench throw mean peak power and mean peak velocity were observed when verbal feedback was received immediately after each repetition. These results contribute to the current body of knowledge in several ways. Firstly, to our knowledge, only one other investigation has examined the effects of psychological strategies on upper-body power (7). Indeed, the previous investigation examined the effects of feedback on a relatively complex skill based task (overhead water polo throw), whereas the current investigation examined the effects on a simpler task (bench throw). Secondly, this was the first investigation to examine the effects of feedback in well-trained athletes using assessment procedures typical of a traditional resistance training session i.e. consisting of multiple sets and repetitions. As such, the current investigation addresses a deficit in the strength and conditioning literature.

Receiving verbal feedback improved mean peak power and velocity of the training session by 1.8% and 1.3%, respectively. The greatest benefit when receiving feedback appears to be in the latter sets of training. Indeed, when each set was analysed separately, improvements were greatest in the final set (3.1% mean peak power; 1.6% mean peak velocity). These findings suggest that receiving feedback improved the rate of work done and the therefore the overall quality of the training session, especially as the training session progresses. If these improvements can be made during one training session, the long-term effects of repeating these "higher quality" sessions may result in enhanced training adaptations and potentially better performance (11, 18, 30). Although the benefits gained may appear small, it should be noted that previous literature has reported 5% improvements in upper-body power in elite rugby league athletes over a four year period (3). As such improvements of ~3.1% in a single session are a positive and worthwhile finding.

Performance improvements were smaller than previously reported in studies investigating the effects of psychological strategies in muscular force (10, 12, 17, 25, 26, 28). Differences may be due to the level of participants and musculature recruited. It is commonly accepted that well trained individuals routinely recruit a greater percent of muscle than their untrained counterparts (13, 21, 27). Therefore in untrained individuals, there may be greater potential for feedback and other psychological strategies to enhance muscular activation which may lead to greater performance improvements. The smaller improvements in the current study may also be due to the muscle group involved (i.e. upper vs. lower body, whereby the larger muscle mass of the lower body may have greater scope for improvement.

The mechanisms for improvements as a result of feedback were not assessed in the current investigation. Previously, authors have speculated that improvements from psychological interventions such as feedback may be due to a combination of enhanced neuromuscular activation, intent, focus of attention, levels of arousal, and improved skill performance and learning (10, 12, 16, 17, 25, 31). Further research should attempt to identify the mechanisms that lead to performance improvements with specific feedback as this may allow the nature of the feedback to be altered to further augment the acute response.

Interestingly there appeared to be a small increase in mean peak power and velocity from set one to set two in both conditions (Figure 2, Figure 3). It is possible that either the warm-up prior to the first set was not adequate to prepare the athletes for maximal effort, or although not measured in the current investigation, there may have been potentiating effects provided from the first training set. Postactivation potentiation is the phenomenon in which acute muscle force output is enhanced as a result of contractile history and typically is evident following maximal or near maximal lifting (22). However it is possible that the lighter load performed with maximal intent may have provided some potentiating effects. Indeed, Thompsen and colleagues (24) reported increased standing long jump distance after performing a dynamic warm up wearing a weighted vest of only 10% bodyweight when compared to performing the same warm up without additional weight. Although in the current study both groups tended to produce greater mean peak power on set two than set one, we observed a small but unclear difference (effect size = 0.37 ±0.83) in mean peak power between the conditions, suggesting the possibility that the increase in mean peak power across the first two sets was greater in the feedback than no-feedback condition (Figure 2). It may therefore be suggested that in addition to postactivation potentiation, the greater improvements in power for the feedback group may have been in part due to potentiating effects of receiving feedback.

The use of verbal feedback resulted in acute increases in upper-body mean peak power and velocity. However it is unknown whether providing acute feedback to athletes across multiple training sessions will provide continuous acute adaptations in performance over a longer training phase, or if adaptation will diminish with repeated use. Future research should investigate the chronic training effects of receiving feedback to determine any long term use benefits.

PRACTICAL APPLICATIONS

Providing feedback during a typical power training exercise improves the rate of work done (i.e. power output) and hence the quality of training of well trained athletes, in which even small improvements in power are often difficult to achieve. Providing feedback may be particularly useful in periods where training volume is higher as the results of this investigation indicate that the benefit of feedback was greatest in the latter sets of training. Based on our findings, conditioning coaches should consider providing athletes with specific feedback (i.e. velocity) during a resistance training session in an attempt to maximise training quality.

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FIGURE LEGENDS

Figure 1. Outline of testing order to assess difference in bench throw performance when feedback or no-feedback is recieved. Group A, n=4; Group B, n=5.

Figure 2. Mean peak power and standard deviations (error bars) obtained during three sets of three repetitions of 40-kg bench throw. Peak velocity feedback was provided in a verbal manner at the completion of each repetition for the feedback condition. * denotes a small difference between conditions.

Figure 3. Mean peak velocity and standard deviations (error bars) obtained during three sets of three repetitions of 40-kg bench throw. Peak velocity feedback was provided in a verbal manner

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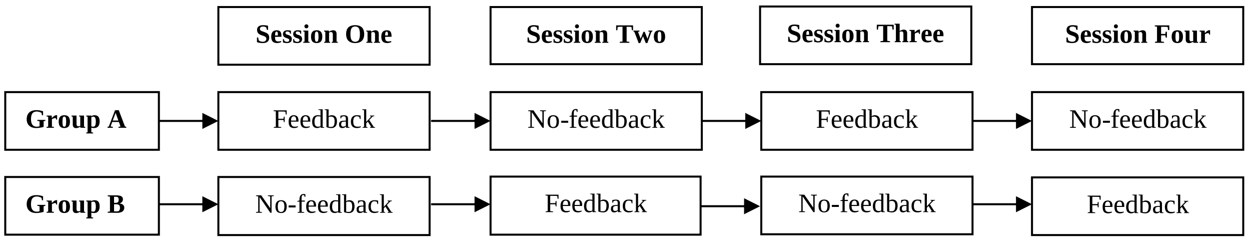
Figure 4. Subject variation mean peak velocity and mean peak power in three sets of three repetitions of 40-kg bench throw performed with or without verbal feedback.



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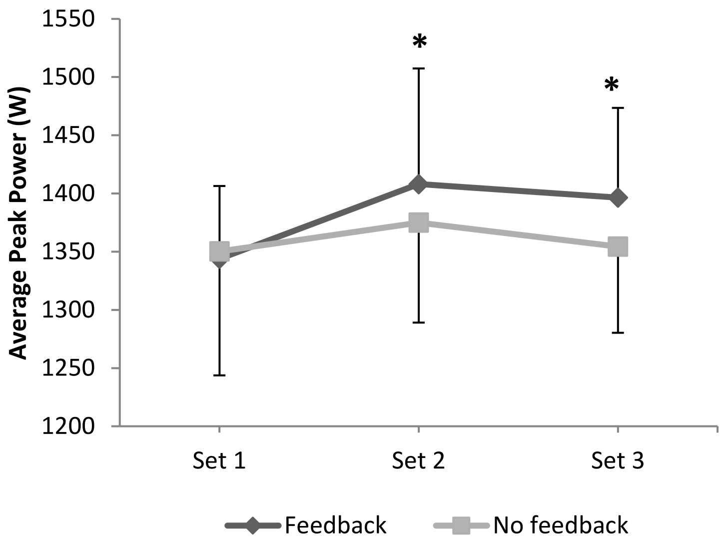
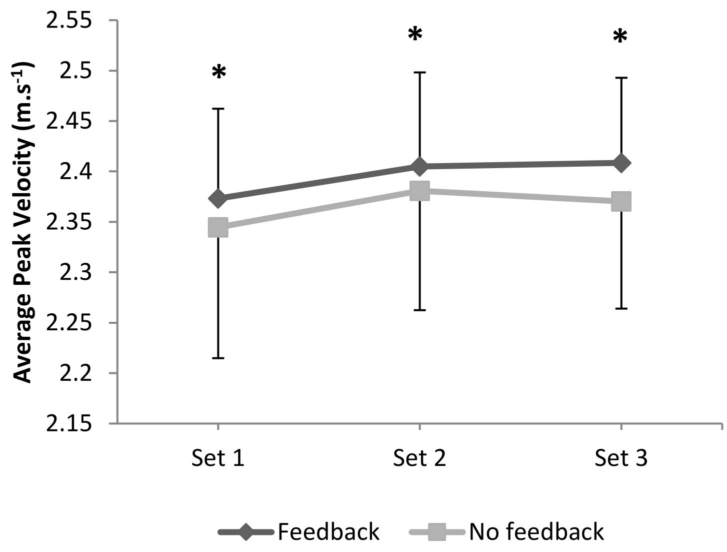


Figure 2. Mean peak power and standard deviations (error bars) obtained during three sets of three repetitions of 40-kg bench throw. Peak velocity feedback was provided in a verbal manner at the completion of each repetition for the feedback condition. * denotes a small difference between conditions.



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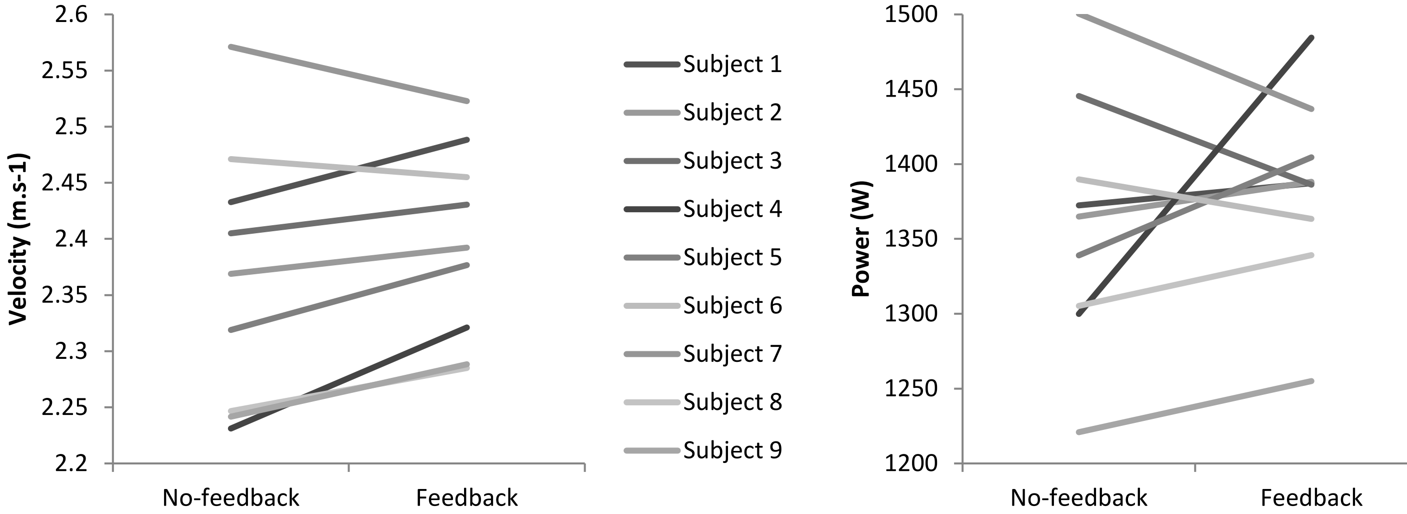

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