EFFECT OF PERFORMANCE FEEDBACK DURING 6 WEEKS OF VELOCITY BASED SQUAT JUMP TRAINING

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This study investigated the effect of instantaneous performance feedback (peak velocity) provided after each repetition of squat jump exercises in 13 professional rugby players. Players were randomly assigned to a feedback or non feedback group and completed three training sessions per week for six weeks. The relative magnitude (effect size) of the training effects for all performance tests were found to be small, except for 30m sprint which was moderate. The use of feedback was found to be possibly beneficial to increasing vertical jump, 10m and 20m sprint, likely to be beneficial to increasing horizontal jump and almost certainly beneficial to increasing 30m sprint. It is suggested that the provision of instantaneous feedback on movement velocity during resistance training sessions provides a greater potential for adaptation and larger training effects.

KEYWORDS: Monitor, resistance training, squat jumps, sprint.

INTRODUCTION: Although the monitoring of training load and or training intensity may provide useful information as to what has been completed in training, its value in affecting positive changes within a session or to quantify and evaluate each session is limited. It is fairly conclusive from motor learning theory that instantaneous feedback in terms of knowledge of performance and knowledge of results can have a substantial effect on athletic performance and the acquisition of motor skills (Bilodeau, 1966; Kilduski and Rice, 2003). Of particular interest is the literature citing improvements in strength and the acute production of force and power (6-12 %) when the subjects were given visual feedback (Figoni and Morris, 1984; Graves and James, 1990; Kellis and Baltzopoulos, 1996). However, the effects of this type of feedback over an entire resistance training cycle are unexplored and provide exciting possibilities for improved athletic performance.

One area in which this feedback might be most useful is in how the load is actually moved. Maximum power output is the product of optimum force and shortening velocity (Fleck and Kraemer, 2004; Zink *et al.*, 2006), therefore when training for power development it would seem intuitive to ensure movement velocity, force and/or power output is maximized for each repetition of an exercise session. Consequently, it would seem logical to monitor and provide feedback for these variables. The purpose of the present study was to investigate the effect of instantaneous performance feedback (peak velocity) provided after each repetition of squat jump exercises over a six week training block on sport specific jumping and sprinting performance tests.

METHOD: Thirteen professional rugby players were randomly assigned to one of two groups, feedback (n = 7, age = 25.7 ± 3.6 years, height = 188.5 ± 8.2 cm, mass = 104.3 ± 10.0 kg, training age = 3.7 ± 1.0 years, 1RM squat = 176.0 ± 35.6 kg) and non feedback (n = 6, age = 24.2 ± 2.5 years, height = 184.7 ± 7.2 cm, mass = 102.9 ± 14.3 kg, training age = 3.2 ± 1.2 years, 1RM squat = 185.4 ± 28.8 kg). All subjects had a minimum of two years resistance training experience and were currently in the pre-season phase of their training.

Each group completed a testing sessions at least 48 hours prior to the commencement of the training study and 48 hours after the completion of training. The testing sessions consisted of bilateral countermovement vertical and horizontal jumps, and 30m timed sprints with split times also taken at 10m and 20m. Three resistances sessions per week were prescribed and all participants completed the same exercises and number of repetitions and sets. All other conditioning sessions (energetic and skills focus) were similar for both groups of players.

Three sets of three concentric squat jumps were performed in two of the three sessions each week with a 40kg barbell. The depth of the squat was set at a knee angle of 90^{o}, controlled via an adjustable rack that the barbell rested upon prior to each repetition. Participants were

instructed to perform the movement as fast / explosively as possible with a pause between repetitions to distinguish each movement. The subjects in group one (feedback) were given real-time feedback (visual onto a screen) on peak velocity at the completion of each repetition, whilst those in group two (non feedback) did not receive any feedback. Peak velocity during the concentric phase for each repetition was recorded using a position transducer (Celesco PT5A-150; Chatsworth, CA) with a velocity repeatability of better than ± 0.10% of output, and customized data acquisition and analysis software (Labview, National Instruments, Austin TX). Velocity was calculated by differentiating the displacement time data which was sampled at 500 Hz and low-pass filtered at 10 Hz.
Intraclass correlation coefficients (ICC) were used to determine the consistency of effort (i.e. consistency of session average peak velocity) for both groups over the entire training study. A spreadsheet for analysis of a straight forward controlled trial (Hopkins, 2003) was used to determine the percent change between pre and post training study for each of the performance tests. Cohen effect sizes (ES) were used to determine the relative magnitude of the training effects. (ES < 0.41 represented a small ES, 0.41 to 0.70 a moderate ES, and > 0.70 a large ES (Cohen, 1988). The chances (% and qualitative) that the true value of the statistic (percent change in variable of interest) was practically or mechanistically positive, trivial, or negative was also calculated using the spreadsheet. An alpha level of 0.05 was also used for statistical significance.

RESULTS: The change in 30m sprint time was the only statistically significant difference between training groups (p = 0.0008). The mean (± SD) results and percent change of the performance test for the feedback and non feedback conditions can be observed in Table 1. These show that for all tests the feedback condition produced larger percent changes in means (0.9 to 4.6% vs. -0.3 to 2.8%).

Table 1 Mean, standard deviation (SD), and percent change in mean of vertical jump (m), horizontal jump (m), and 10/20/30 m sprints (s) pre and post six week squat jump training.

		Feedback	Non-Feedback
Vertical Jump	Pre	0.61 (0.06)	0.66 (0.06)
	Post	0.64 (0.07)	0.67 (0.01)
	Percent Change	4.6	2.8
Horizontal Jump	Pre	2.50 (0.16	2.58 (0.20)
	Post	2.56 (0.15)	2.59 (0.20)
	Percent Change	2.6	0.5
10 m Sprint	Pre	1.74 (0.04)	1.79 (0.10)
	Post	1.73 (0.05)	1.79 (0.09)
	Percent Change	-1.3	-0.1
20 m Sprint	Pre	3.03 (0.06)	3.06 (0.16)
	Post	3.00 (0.06)	3.06 (0.15)
	Percent Change	-0.9	-0.1
30 m Sprint	Pre	4.20 (0.11)	4.25 (0.21)
	Post	4.14 (0.11)	4.26 (0.19)
	Percent Change	-1.4	+0.3

With regards to practical significance, the chance that these changes were practically beneficial or trivial as well as the effect sizes are reported in Table 2. The use of feedback during squat jump training was reported to be possibly (45-65%) beneficial to increasing vertical jump, 10 m and 20 m sprint performance, likely (83%) to be beneficial to increasing horizontal jump performance and almost certainly (99%) beneficial to increasing 30 m performance. The relative magnitude (ES) of the training effects for all performance tests was small (0.18 to 0.28), except for the 30 m sprint performance which was moderate (0.46).
The ICC was used as a measure of consistency of effort between days. The ICCs for the feedback condition (0.81 to 0.95) were superior to the non-feedback condition (-0.52 to 0.14)

suggesting that those in the feedback group maintained effort/rank (i.e. average system velocity) to better effect than the non-feedback group.

Table 2 Effect sizes and chances (% and qualitative) that the benefit of feedback during jumps squats is practically positive or trivial for vertical jump, horizontal jump, and 10/20/30 m sprints following six weeks of training.

	Vertical Jump	Horizontal Jump	10 m Sprint	20 m Sprint	30 m Sprint
Effect Size	0.18 Small	0.28 Small	-0.28 Small	-0.20 Small	-0.46 Moderate
Positive	45 Possibly	83 Likely	65 Possibly	49 Possibly	99 Almost Certainly
Trivial	51	17	33	49	1

DISCUSSION: Results indicated an increase in vertical jump over the 6 weeks for both the feedback (4.6%) and non feedback (2.8%) groups. Although a greater improvement was seen with feedback there was a 51% chance this was trivial and 45% chance of being positive. This suggests there is some evidence for the use of feedback during training to enhance vertical jump performance. Given this performance test was very similar to the movement used in training (squat jump) it suggests that improvements were seen as a result of repetition of the movement regardless of the feedback conditions.

A larger increase in performance with the use of feedback was also observed in the horizontal jump (2.6% vs. 0.5%). As suggested previously it is thought that movements requiring a powerful thrust from hips and thighs can be improved through the prescription of a biomechanically similar movement during training (Adams et al., 1992). It would seem that this has occurred here where the use of squat jumps during training resulted in improvements in horizontal jump performance. Again there appears justification for the use of feedback within training to optimise performance improvements, as the use of feedback was reported as being likely to be beneficial to increasing horizontal jump performance (83% chance of a positive effect) and a small training effect noted (ES = 0.28).

Improvements in sprinting speed for the feedback group were observed over 10 m (1.3%), 20 m (0.9%) and 30 m (1.4%) distances. Again these were larger than those observed from the non-feedback group (0.1%, 0.1% and -0.3% respectively). This meant that feedback was possibly beneficial to increasing 10 m and 20 m sprint performance, with small training effects (ES = -0.28 and -0.20 respectively) and almost certainly beneficial to increasing 30 m performance, with a moderate training effect (ES =0.46). The results from the non-feedback group are in agreement with previous research using jumps without feedback, whereby loads of 70%1RM (Hoffman et al., 2005) and 30% (Wilson *et al.*, 1993) did not produce any significant increases in sprinting speed.

With regards to the motivational aspects of feedback it seems that the feedback resulted in a greater consistency of effort/performance throughout the programme as highlighted by the reported ICC values. The feedback group's ICCs ranged from 0.81 to 0.95 whereas the non-feedback condition ICs ranged from -0.52 to 0.14. Given the ICCs relate to the reproducibility of the rank order of subjects on a subsequent training session, it appears that the use of feedback during training enabled a greater consistency in the peak velocity achieved during the squat jumps. As it has been suggested that the actual velocity of training is a vital component of producing high velocities in other sporting movements (McBride et al., 2002), such a result appears of considerable importance. In addition peak velocity during traditional squats has been shown to be significantly correlated to sprint time ($r = 0.40$, $P = 0.029$) (Sleivert and Taingahue, 2004). Similarly it has also been suggested that exercises with greater rate of force development (RFD) lead to greater improvements in sprinting (Tricoli *et al.*, 2005), and whilst RFD was not measured in the present study consistently higher peak bar velocities were seen with feedback. Therefore it would appear that optimising the training session through the use of feedback leads to increases in sprint performance that may not have been realised using traditional training strategies.

CONCLUSION: Results of this study indicated that the provision of feedback on a single exercise (squat jump) during a resistance strength training programme resulted in an improvement in the performance of movement and sport specific tests. Given athletes were also able to produce more consistent training performances through the entire six week training programme, it would seem intuitive to constantly monitor multiple exercises of each training session and provide feedback, which should provide greater potential for adaptation and larger training effects. The use of such monitoring and feedback technologies may be further utilised through the ability to set training performance targets, such as maximum velocity and number of repetitions and/or sets completed above a pre determined performance threshold. This may prove to be very motivational when fatigue sets in, as well as creating competition between athletes in the training environment.

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