5-7-2011

Augmented Verbal Feedback and Its Effect on Power Output During a Counter-movement Vertical Jump Protocol with Division 1 Collegiate Athletes

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Joseph N. Staub

B.S. University of Connecticut, 2009

A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of Master of Arts

at the

University of Connecticut

2011

APPROVAL PAGE

Master of Arts Thesis

Augmented verbal feedback and its effect on power output during a counter-movement vertical jump protocol with Division 1 collegiate athletes.

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2011

Acknowledgments

I would like to thank Dr. Kraemer, the other members of my committee, Dr. Maresh and Dr. Volek, and all those in the Kinesiology and Strength & Conditioning departments at UCONN for providing me with the opportunity to learn and grow, as a student, as a person and as a professional. The opportunity to develop the skills and knowledge necessary both in the classroom and in the athletic world is one that I will remember forever and feel honored to have experienced. Thank you for allowing me to be here.

To Moe, thanks for everything you have done, and will do for me. There is no better boss, colleague and friend a person could ask for. Thanks for keeping me sane and making me insane.

To my family and friends for helping see me through this process, for without you I would not have been able to be here. The love, support (emotionally and financially =)) and friendship you have given me is beyond anything I can repay. You are too many to list and I am indebted to you all.

Lastly, to my better half, you are the Peanut Butter to my Jelly. Without you, I wouldn't be nearly as good as when I am with you…Can I get a Mongo *now?!* =P

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CHAPTER ONE

INTRODUCTION

Among all levels of sport, coaches seek to help their athletes improve their skills and abilities by providing feedback during training sessions. This is important both in a competitive setting, at the collegiate or professional level were improved skill and performance allows for greater opportunity to win, but in all levels of sport, as athletes try to learn the technical and tactical skills necessary to play. It is known that giving feedback for the performance of a task isn't necessary for successful completion of the task, especially when the task is easy. However, even when feedback may not be needed, providing feedback can greatly improve the learning process and the ability to do the task (4, 9, 13, 15, 16, 20, 22, 36, 42). It could potentially take years, if not decades, for an athlete to truly master the technical skills for their sport, so it is very important that they practice with a high level of efficiency and reinforce the skills they seek to obtain correctly. Using feedback is one way to create a high level of efficiency in training as it is recognized as a key factor in assisting motor skill acquisition in practice environments (5, 17). Thus it is of great importance to coaches to understand what type of feedback is the most effective in eliciting improvement in performance.

The two broadest types of feedback are defined as either intrinsic or extrinsic. Intrinsic feedback has to do with the individual processing their own sensory information and being able to internalize and understand the necessary adjustments that need to be made (17, 28, 34, 35). Extrinsic feedback on the other hand is when the individual relies on input from an external source, such as a person or video recording, to understand where adjustments need to be made (28). There are two distinct types of extrinsic or augmented feedback, knowledge of performance and knowledge of results.

In the past, feedback came as dialogue between the coach and the athlete, discussing what the Coach saw the athlete do. This allowed the Coach to provide instruction to the athlete for the next time the task was to be attempted. This is called knowledge of results feedback. Knowledge of results feedback pertains to feedback given in relation to the goal the task set out to accomplish and deals with the entire task and set a specific part of the task (28, 25, 40). Research was predominantly focused on the content and context of this type of feedback and how it helped in the efficiency of learning the task.

With advancements in technology, such devices as linear transducers (e.g., Tendo, Myotest) and computer software (e.g., Dartfish, MotionPro!) began to emerge and allowed the possibility of both real-time and recorded video feedback. This allowed athletes to not only have real-time feedback but to be able to see themselves doing the task and the coach the ability to review the task multiple times to see something they may have missed initially. Because of this, research shifted away from knowledge of results to focusing more on knowledge of performance, another type of augmented feedback. Knowledge of performance focuses on a direct and measureable aspect of the task rather than the outcome of the task. Having this new technology helped revolutionize the training environment because coaches and athletes were now able to have highly detailed information on both kinematic and kinetic factors such as force, velocity and joint angles.

Recently, with improved technology and more condensed technology, it has been popularized by Strength and conditioning coaches, especially at the collegiate and professional level, to use some type of technology based feedback with their athletes during training sessions. Being able to track kinematic variables, such as velocity and power, has allowed the Strength & Conditioning coach to better train and develop the individual athlete based off of their specific quantitative measures in training rather than the qualitative measures usually used.

STATEMENT OF THE PROBLEM

It is hypothesized that when compared to not giving feedback, there will be a significantly improved power output, meaning a higher level of training efficiency and effectiveness, in a counter movement vertical jump protocol. This is significant to the Strength & Conditioning coach, as a positive finding will show that giving knowledge of performance feedback with a kinetic variable compared to no feedback can help improve power output over a training session. This would result in a better quality training session, and the potential for improved power development over time.

It is the purpose of this study to determine how augmented verbal feedback, specifically knowledge of performance feedback, during a counter movement vertical jump protocol will affect acute power output.

CHAPTER TWO

LITERATURE REVIEW

It has become a common occurrence at all levels of sport to provide some kind of feedback, verbal or visual in order to elicit a more specific and refined action for improvement in sport. Feedback is now a term used to represent some kind of sensory information, either categorized as intrinsic or extrinsic, given in relation to some type of action (15). There are very specific types and methods of providing feedback within each of these two broader categories. Using feedback is recognized as a key factor in assisting motor skill acquisition in practice environments (1, 7, 14, 17, 21).

As the scope of this paper only falls within the realm of extrinsic feedback, intrinsic feedback will only be touched on to provide a better understanding of the differences before delving into specific types of extrinsic feedback.

INTRINSIC FEEDBACK

Intrinsic feedback or sensory feedback is the information inherent to a person during and after competition of a task (7, 15, 16). This information is generally used by the individual to adjust performance of the task based on experience with the task and self-observation of performing the task. For example, if a basketball player during a practice session was given the task of performing 10 foul shots, the individual would be exposed to both sensory information relating to prior experience in doing the same task, taking foul shots, as well as the observational information as they performed each shot, if it was successful or not. The individual would thus be able to modify their actions based on not only seeing if the ball went into the hoop or not, but also with the kinesthetic and proprioceptive information acquired and internalized when taking each shot.

EXTRINSIC FEEDBACK

Extrinsic feedback, or augmented feedback as it is more often called, is retrospective in nature. It provides information from an external source, visually and/or verbally, that allows an individual to change their next action or task based off of the previous action or task (7). Using the same example of the basketball player shooting free-throws, from when intrinsic feedback was described, if a coach was present and provided further verbal instruction about shooting technique, the player would also be receiving extrinsic, or augmented, verbal feedback.

VERBAL FEEDBACK

Verbal feedback may have a direct impact on neurological pathways, as described by P.J. McNair et al. (8): “To generate maximum force in a muscle, an individual must recruit all of the muscle's fibers at their maximum firing rate…pathways have been identified between the components of the auditory system and the motor system (for example, the startle reflex)”. It therefore appears that such pathways could serve as a mechanism for improved performance.

A 1995 study by P.J. McNair et al. (8), titled *"*verbal encouragement effects of maximum effort voluntary muscle action" showed that mean peak force increased 5% (P<0.05) when verbal encouragement was given during a 5second maximum effort isometric elbow flexion at 90degrees. Twenty untrained subjects in a crossover design had their peak forces measured on dynamometer with each subject completing the protocol, two sets of three reps, with verbal encouragement and the same protocol again without verbal encouragement. When verbal encouragement was provided, the words spoken were "come on you can do it". This study would seem to indicate that, when words of encouragement, even those not specific to the task, are given, it can lead to small but significant increases in strength in a single session.

VISUAL FEEDBACK

In regards to visual feedback, there has been research showing a correlation between visual augmented feedback and improvement in isometric and isokinetic outputs in both upper and lower body extremities (4-6). Randell et al. in a 2010 article about optimizing training sessions provides a very detailed summary of the three studies previously mentioned (12),

"Kellis and Baltzopoulos examined the effects of visual feedback on maximum moment measurements of the knee extensors and flexors during isokinetic eccentric activations. At angular velocities of 30 and 150m/s, the maximal moments produced during the feedback trials were found to be 7.2 and 6.4% higher for knee extension and 8.7 and 9.0% higher for knee flexion. These results are similar to those reported by Figoni and Morris who examined the effects of visual feedback during isokinetic knee extension and

flexion at 15m/s. Mean peak torque values of knee extension under feedback and nonfeedback conditions were 156.7 +/- 42.5 and 139.8 +/- 42.3 ft-lb, respectively, whereas for knee flexion, the values were 104.1 +/- 24.0 and 92.4 +/- 21.5 ft-lb, respectively. The use of visual feedback equated to an increase of approximately 12% in mean peak torque values for both muscle actions. Graves and James evaluated the effect of concurrent visual feedback on isometric force output during isometric abduction of the fifth digit. Feedback was provided on alternate contractions, and it was reported that peak output was greater during contractions under feedback conditions (4.4 +/- 0.29 and 4.1 +/- 0.26 kg, respectively)."

KNOWLEDGE OF RESULTS

Augmented feedback, regardless of it being visually or verbally provided, can further be broken down into two distinct types, knowledge of performance and knowledge of results (7, 16). Knowledge of results, is feedback given by an external source which describes the outcome of the action in relation to its desired goal. A coach telling their athlete, "you did not make the basket", would be an example of giving the individual verbal knowledge of results feedback on their performance in shooting a basketball.

A 2000 study by Wise et al. (20) titled "Verbal messages strengthen bench press efficacy", looked at comparing subjects confidence in bench pressing progressively heavier weights when given knowledge of results feedback specific to their performance or given a general statement about their ability. Thirty-two, untrained, female subjects (mean age 21.3±1.5) were assigned to one of two experimental groups. Each subject then completed 10 repetitions of bench press on a machine and immediately upon completion took the bench press efficacy measure, a 14 item scale which asked subjects to rate their confidence in their ability in regards to bench press. This was followed by one of two verbal messages, both having similar content, being told to the subjects. The messages started the same but differed in that one had subject specific information in it (the amount of weight they had lifted) compared to the second, which was a positive statement about the lifters ability to bench press. After being given the verbal message, subjects again completed the bench press efficacy measure. It was found that both the general message and a specific message significantly improved bench press efficacy, P=.001 for both trials.

KNOWLEDGE OF PERFORMANCE

Knowledge of performance however, deals with information directly related to the action that led to the outcome concerned. In the resistance training setting, this type of feedback is given using specific kinematic or kinetic variables during the action (7, 10, 15, 16, 18, 22). For example, a person bench pressing with the bar connected to a linear transducer will be able to see the exact velocity which they moved the bar, giving them visual knowledge of performance. Most studies use a mix of verbal and visual feedback in regards to the kinematics of the movement providing the subjects with cues to specific desired movement changes. Most studies using knowledge of performance feedback have focused on how kinematic information given verbally or visually affects performance.

One study that used knowledge of performance feedback and showed performance improvements within a single trial was a 2008 study by Cronin et al. (3). They found that with one session there was a reduction in vertical ground reaction forces by 23.6% (P=0.01) amongst a sample of 15 NCAA Division 1 female volleyball athletes. Subjects were required to land on a force plate after spiking a volleyball from a four step approach. Visual and verbal feedback for correct jumping and landing technique was given before and after jump attempts. Feedback before testing was given as a two-minute demonstration by volleyball coach who demonstrated correct landing technique. Feedback while testing consisted of phrases such as "on your toes" and "over your knees" to help correct landing technique during trials.

While the study showed an immediate decrease in vertical ground reaction force but no decrease in medial-lateral or anterior-posterior ground reaction forces, it is important to note that a single session of augmented feedback in regards to kinematics allowed NCAA Division I volleyball athletes to decrease ground reaction forces thus possibly reducing the potential for injury.

Other studies, such as the 2005 study by Mononen et al. (9) showed performance improvement over multiple sessions as well as looking at a combination of knowledge of performance and knowledge of results. They examined the effects of both visual and verbal kinematic feedback on postural balance and amplitude of sway and rifle shooting performance. Thirty subjects, who were non-elite shooters, were randomly assigned to three groups and over a four-week period took 440 shots in 11 sessions. One group was given knowledge results feedback after each trial and also supplemented with knowledge of performance feedback. The second group received only knowledge results feedback and the third group was a control receiving no feedback at all. Knowledge results feedback was available from a PC screen which showed location of the hit point on the target along with the numerical value associated with that hit. Kinematic knowledge of performance consisted of the aiming trajectory of the rifle barrel during the shot displayed on another PC screen. The maximum amplitude of sway was significantly smaller in the group that received knowledge of results and knowledge of performance compared to the group that received knowledge of results alone.

A study done by Rucci and Tomporowski (13), looked at three different types of kinematic feedback and the execution of the hang power clean exercise. Twenty six, NCAA Division I athletes (mean age 20±1) who all had previous training with the hang power clean were divided into three groups, one group received video feedback only, the second group received video + cues feedback and the third group received only verbal feedback. After being tested for their 1-RM and watching a video of an expert lifter demonstrate the hang power clean, subjects completed 8 training sessions with the hang power clean over a 4 week period, with 2 sessions per week. Subjects completed four sets of four reps at 75% of their 1-RM (4x4 75%-1RM) each testing session and upon completion of each set (4 reps) went to their assigned feedback station, which lasted for all groups approximately 45 seconds.

For the video only group, each participant was immediately shown video images of themselves lifting and able to watch all 4 repetitions. Participants in the video+cues group were also shown video of their performance with the addition of relevant cues added to the video as well as verbal feedback from the investigator in regards to movement kinematics. Subjects in the verbal only group received feedback typical of that given by a trained specialist. Verbal feedback was directed towards aspects of the movement most in need of correction for the subject and once the subject demonstrated competence in the area, a different area was then addressed.

Statistically significant interactions were found for numerous kinematic movement indices, such as bar position relative to toe. It was of interest that the video only condition failed to improve performance and video + cues did not yield a greater performance than the verbal only condition.

Another study which looked at a complex total body movement was done by Winchester, Porter and McBride, in 2009 (19). They investigated changes in bar path kinematics and kinetics through use of summary feedback in power snatch training. Twenty-four NCAA Division I football athletes (21.72+ -1.94 years old), who had at least 18 months training with the power snatch exercise, were separated into two groups, one group which was given feedback and one group that was not given feedback. Both groups trained three days a week for four weeks. The three training days consisted of one low intensity day (5x5 at 50%1RM), one high-intensity day (3x1 at

90%1RM) and a moderate intensity day (4x3 at 70%1RM). After each set of lifts those in the feedback group received verbal and visual feedback by means of summary knowledge of performance in regards to the kinematics of bar path. Visual feedback was provided on a computer showing the bar path during each power snatch and verbal feedback addressed how to make appropriate changes to the bar path. Investigators did not tell participants the kinetic values for peak power or peak force when feedback was given. It was shown that there was improvement in peak force and peak power as well as kinematic variables, such as catch position, at all three loads when feedback was used.

This suggests that the combination of verbal and visual feedback can improve kinematic and kinetic variables associated with the power snatch. While Winchester and Rucci's studies both showed improvements in kinematics of a complex movement (Olympic lift variations) when knowledge of performance was given, they did not give specific kinetic measures to their subjects as feedback but instead relied on cues for the particular movement changes they desired.

To date, there have been only a few studies that have looked at giving only a kinetic variable, such as velocity, as feedback. One such study was conducted by Brown et al. (2), in 1984 and investigated visual knowledge of performance feedback on an isometric leg extension routine. Subjects completed a maximum effort 30 second leg extension using a rope friction exerciser, once a day, five days a week, for five weeks. The feedback group was able to see their force output (lbs) on a digital force meter whereas the non-feedback group was not able to see their force output. It was found that subjects who were given visual feedback improve their leg extension strength 98% from pre (697lbs ± 212) to post test (1394lbs ± 192) compared to only a 28.7% improvement for when no feedback was given.

Another study which gave subjects specifically kinetic knowledge of performance feedback was a study done by Randell et al. in 2011 (11). It examined the effects of knowledge of performance feedback on multiple performance tests after a 6-week resistance training program. Visual feedback of bar velocity was provided during weighted squat jumps for subjects in their resistance training protocol and not provided for others subjects. The investigators found a 99% chance of feedback having a positive effect on 30-m sprint improvement in the feedback group as compared to the non-feedback group, with a moderate training effect (ES=.046) (11). This would seem to say that the improvements in power because of feedback also helped cause an improvement in performance in other areas. While the authors acknowledged the limitations in their study, in both sample size, duration of intervention and that there was no statistical significant difference between groups, the fact that there was a high probability that feedback was beneficial led the authors to value the use of feedback because of the possibility of it helping improve performance.

Amongst all the aforementioned studies there is one constant theme, verbal or visual augmented feedback, either knowledge of performance or knowledge of results, provided an increase or improvement in the desired measures. Also, while visual or verbal feedback alone each caused positive results, it seems that visual feedback in combination with verbal feedback provides the most dramatic effects especially if the feedback is knowledge of performance based compared to knowledge of results based. However, few studies have examined how beneficial kinetic knowledge of performance is compared to kinematic knowledge of performance, especially when looking at complex multi-joint movements, such as a counter movement vertical jump.

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CHAPTER 3

METHODS

EXPERIMENTAL APPROACH TO PROBLEM

Each subject completed the Counter Movement Vertical Jump (CMVJ) protocol twice, in a balanced, randomized order, one trial with feedback (WFB) and one without feedback (WOFB). At least 48-hours were given between sessions to allow for adequate rest and recovery. Student-athletes were used because of their trained state as well as their familiarity with receiving and processing some type of feedback regularly during training sessions.

SUBJECTS

Fourteen NCAA Division 1 collegiate athletes (5 female and 9 male), age 18-26 were recruited to participate in this research study looking at the effects of feedback during a countermovement vertical jump protocol. Each subject was well-informed of the risks and benefits of the study and signed an informed consent form in accordance with the guidelines of the University of Connecticut's Institutional Review Board.

All subjects were current student-athletes, medically fit to participate and had significant experience in collegiate athletics, all having been previous varsity letter winners. All subjects also regularly resistance trained and did plyometric drills in addition to their sport specific training. All subjects were in the preseason training phase for their respective sport. Table 3.1 consists of the demographics of the subjects used in this study.

Table 3.1 **Subject Characteristics**

	n =	**Age (yr)**	**Weight (kg)**	**Height (cm)**
Men	9	21.5 ± .6	91.4 ± 15.5	181.8 ± 5.4
Women	5	21.1 ± 1.2	80.3 ± 11.8	175.8 ± 5.8
All Subjects	14	21.4 ± .8	87.5 ± 14.8	179.6 ± 6.1

WARM-UP

There has been a great deal of research on warm-ups and their ability to enhance performance in the vertical jump (2, 3, 11, 12, 21, 26, 30, 33, 37). In 2005, Burkett et al. (7), showed the most beneficial type of warm-up before vertical jump is performing a weighted resistance specific warm-up. However, dynamic stretching or sub-maximal jumps, which do not require outside equipment, while not as beneficial as weighted jumps did improve performance compared to doing no warm-up at all (7). Thus, before each testing session began subjects completed a 10-minute warm-up routine consisting of the combination of dynamic stretching and sub-maximal jumps. The same warm-up process was used for all subjects before all testing sessions. The warm-up consisted of the following,

- Cardio acceleration
    - 5 minute stationary bike at 65-75RPMS
- Dynamic warm-up
    - Knee hugs (2x5ea)
    - Quad Pulls (2x5ea)

- Forward lunges (2x3ea)
- Lateral lunges (2x3ea)
- Jumping Jacks (2x15)

- 3x CMVJ at 50% effort with a subject selected rest period no more than 1 minute between jumps
- 1x CMVJ at 80% effort followed by a 1minute rest period before beginning the protocol

COUNTER MOVEMENT VERTICAL JUMP

After completion of the warm-up, the subjects then began the CMVJ protocol. The CMVJ protocol consisted of 3 sets of 5 jumps (repetitions) on a calibrated force plate set to read at 200 Hz (Accupower; Athletic Republic, Fargo, ND, USA). Subjects were reminded at the beginning of the protocol to give maximal effort on every jump. Before each jump, the subject was told the jump number (i.e. – “jump number four”) as well as given a “Ready, Set, Go” before the initiation of each jump. Subjects had been instructed not to jump before the “Go” command.

A countermovement vertical jump consists of standing with your feet approximately shoulder width apart and your hands on your hips. A rapid eccentric action, at the hip and knee lowers the body to approximately 90° of flexion about the hip and knee at which point the body is decelerated and then rapidly re-accelerated with a concentrated action, in a countermovement fashion, into a vertical position, causing full extension at the hip knee and ankle joints with the feet leaving contact with the ground for maximum displacement. The hands remained on the hips at all times to negate any potential influence of arm action during the jump.

The set and repetition scheme was used to mimic the practice of training with multiple sets and repetitions. It has been shown that with a greater the training age, doing only one set of an exercise becomes less effective in eliciting improvement compared to doing multiple sets (27, 29). The rest interval between sets plays a large role in the physiological response from the training and the body's ability to recover (10, 14). It has been shown that with a greater training age, a shorter rest period can be used to maintain force output compared to a longer rest period for relatively less trained individuals (18, 31). Most studies have looked at using 1-, 3- and 5-minute rest periods and the ability to maintain force output (18, 19, 31, 38, 39).

Upon completion of the jump, the investigator started a 20-second countdown on a digital stopwatch (Fisher Scientific Electronic Timer Model S90861) which acted as a rest period between jump repetitions. Subjects remained on the force plate during the 20-second rest period. This was repeated for each of the 5 jumps per set, and a 3-minute rest period was given between sets.

Abdessemed et al. (1), examined the effect of recovery period on muscular during a maximal effort bench press protocol in untrained subjects. Using a 1-minute rest period between sets resulted in a significant decrease in mean power as well as a significant elevation in blood lactate, suggesting that there was insufficient recovery of the ATP-PC system (1). However this effect was not seen nor did power significantly vary using 3- or 5-minute rest period, thus being able to draw the conclusion that for a trained individual, a rest period between 2-4 minutes may allow for maintenance of power production over multiple sets and repetitions of maximum effort countermovement vertical jump.

FEEDBACK

During each of the feedback trials, knowledge of performance verbal feedback was given to the subjects by the investigator upon the completion of each jump, within the 20-second rest period, but before the next jump. Verbal knowledge of performance feedback consisted of the kinetic measure of the peak power output in watts (W) of the last completed jump. The numeral value for peak power output was given to the subjects in full numerical format (i.e. "four thousand six hundred seventy seven watts"). The investigator repeated the value for each jump twice and the subjects were instructed to ask for the value to be repeated a third time if they did not hear it initially.

Conversation between the investigator and subject was kept to a minimum during the entire protocol. Other than reminders to maintain appropriate CMVJ form ("keep your hands on your hips") or to maintain safety ("center your stance on the force plate") the only communication was the jump number, start commands, and feedback, only if in a feedback session.

STATISTICAL ANALYSES

All values are presented as mean ± standard error (SE). The data sets met the assumptions for linear statistics. A priori power analysis determined an n=14 would be adequate to defend the alpha level of $P<0.05$ with a Cohen probability of 0.8 for vertical jump power. A two way (group * time) analysis of variance ANOVA with repeated measures was used to analyze this data. Gender did not act as a significant covariant in the model and thus it was excluded from analysis. When appropriate a Fishers LSD post-hoc was used to determine pairwise differences between the means. Significance of this study was set at $P<0.05$. All statistics were calculated with SPSS 17 statistical software.

CHAPTER 4

RESULTS

FEEDBACK TO NO FEEDBACK

There was a significant difference between mean power outputs (4335w ± 366 to 4108w ± 345, P=0.003) as well as the peak power outputs (4567w ± 381 to 4319w ± 371, P=0.018) when comparing feedback to no feedback respectively. Figure 4.1A and 4.1B represent these findings for mean and peak power outputs respectively.

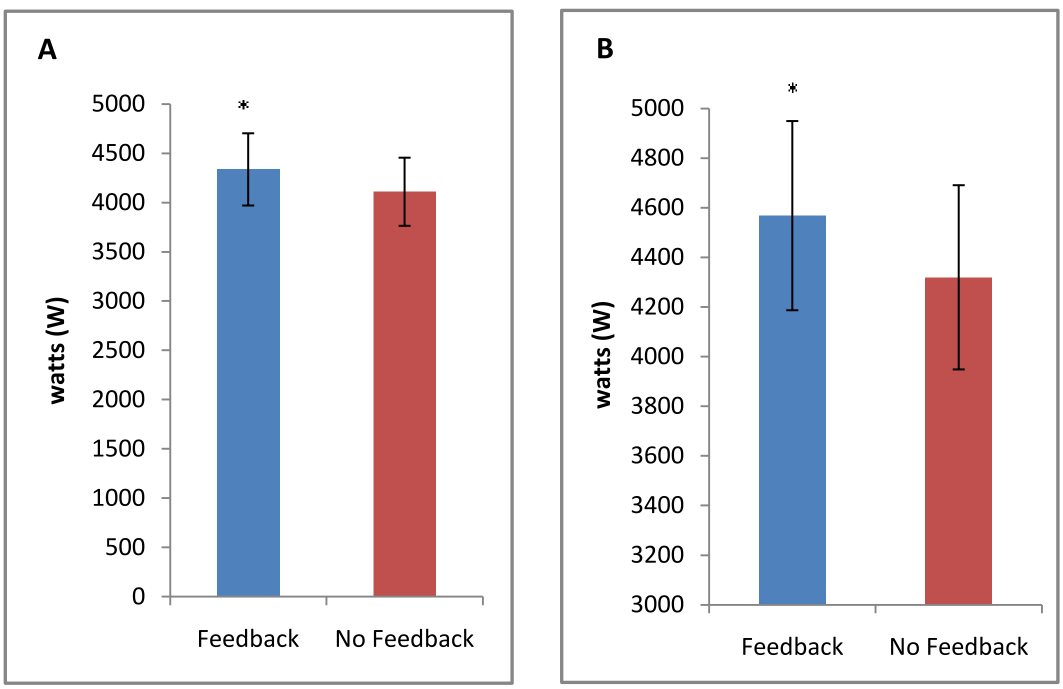

Figure 4.1 - Feedback v.s. No Feedback. A) Mean Power Output per trial B) Peak Power Output per trial. *Significant difference between Feedback and No Feedback trials when p≤0.05

FEEDBACK TO NO FEEDBACK * SETS

There was significant difference in Peak Power output between the feedback and no feedback trials during Set 2 (mean difference 361w ± 161, P=0.043) and Set 3 (mean difference 283w ± 109, P= 0.022). Also, there was significant difference in mean power output between feedback and no feedback trials during Set 2 (mean difference 240w ± 66, P=0.003) and Set 3 (mean difference 299w ± 93, P=0.007). In both Peak and Mean power outputs (see Figure 4.2 A & B), Set 2 and Set 3, the feedback trial produced a higher peak power output then the non-feedback trial.

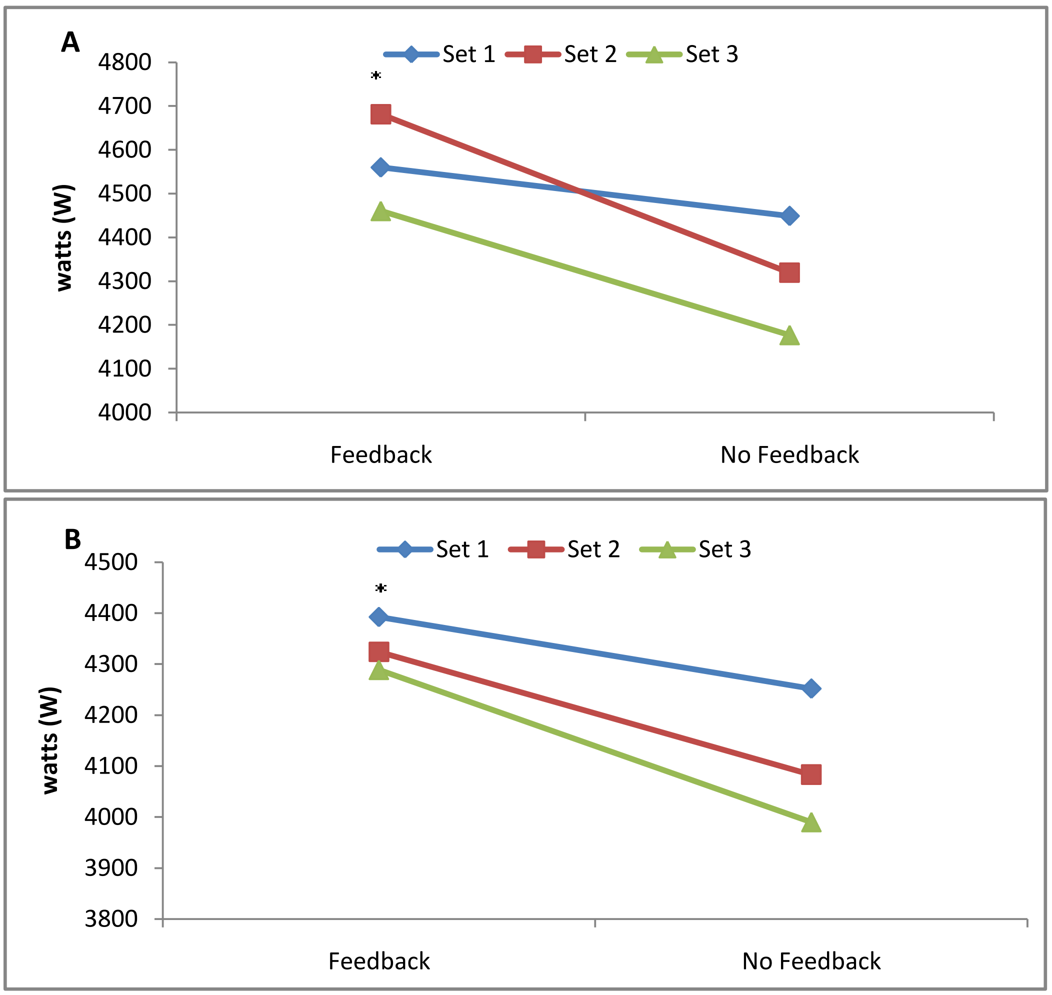

Figure 4.2 – Feedback vs No Feedback per set. A) Peak Power Output per set B) Mean Power Output per set. *Significant difference between Feedback and No Feedback trials when p≤0.05

Feedback to No Feedback * Sets * Reps

There was a significant difference in the last six jumps (Set 2 Rep 5 to Set 3 Rep 5) between feedback and no feedback trials (Figure 4.3). See Table 4.1 for mean difference ± SE and P values associated with mean power output.

Table 4.1 Mean Difference Feedback vs. No Feedback

		Mean difference (W) ± SE	**P=**
Set 1	Rep 1	42 ± 95	0.668
	Rep 2	216 ± 108	0.067
	Rep 3	197 ± 115	0.112
	Rep 4	241 ± 118	0.062
	Rep 5	92 ± 90	0.327
Set 2	Rep 1	101 ± 82	0.244
	Rep 2	374 ± 182	0.06
	Rep 3	260 ± 157	0.122
	Rep 4	152 ± 138	0.293
	Rep 5	317 ± 102	**0.008**
Set 3	Rep 1	336 ± 98	**0.005**
	Rep 2	248 ± 91	**0.017**
	Rep 3	292 ± 129	**0.041**
	Rep 4	337 ± 111	**0.01**
	Rep 5	281 ± 94	**0.011**

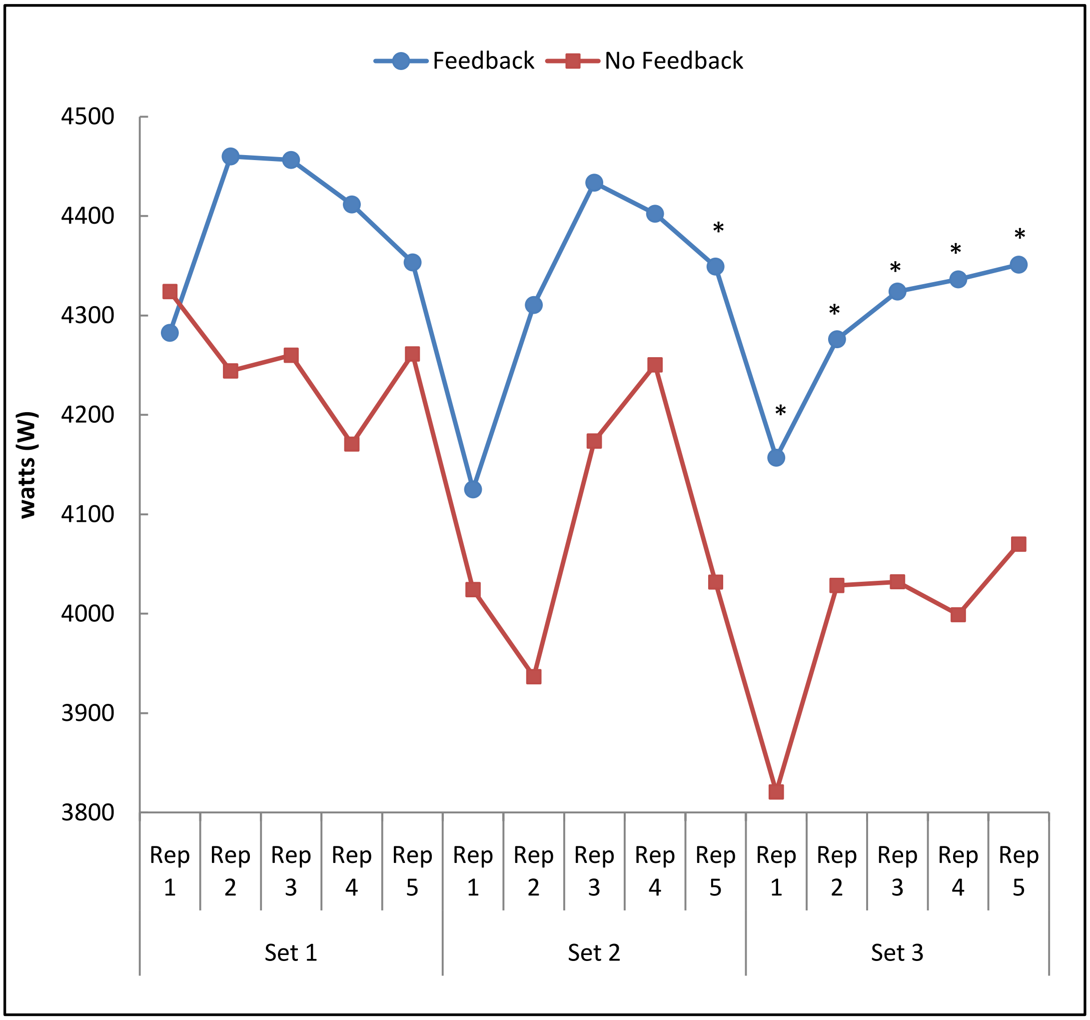

Figure 4.3 – Mean Power Outputs for all Sets & Reps Feedback vs. No Feedback.
*Significant difference between Feedback and No Feedback trials when p≤0.05

CHAPTER 5

DISCUSSION

The goal of this study was to examine how a very specific type of feedback, knowledge of performance, verbally given as the kinetic measure of power output, to trained Division 1 athletes, acutely affected power output during a counter movement vertical jump protocol. There was a significant difference between mean power outputs (4335w ± 366 to 4108w ± 345, P=0.003) as well as the peak power outputs (4567w ± 381 to 4319w ± 371, P=0.018) when comparing feedback to no feedback respectively over the entire protocol. Both the mean and peak power outputs had significant differences between Set 2 and Set 3 (Feedback Set 2 mean difference 361w ± 161, P=0.043; Feedback Set 3 mean difference 283w ± 109, P= 0.022; No Feedback Set 2 mean difference 240w ± 66, P=0.003; No feedback Set 3mean difference 299w ± 93, P=0.007). There was a noticeable spike in performance from set 2 to set 3 with feedback as compared to a gradual decline in performance from set 2 to set 3 without feedback in both cases. When looking at the interaction between feedback and sets and reps there was a significant difference between mean power outputs during the feedback trial compared to the no feedback trial from the 9^{th} rep to the 15^{th} rep (Set 2 Rep 5 to Set 3 Rep 5).

With both peak power output and mean power output showing an improvement with feedback compared to when no feedback was given, as well as there being a significant increase in performance at the end of the protocol with feedback, the hypothesis for this study has been confirmed. Augmented verbal feedback comprised of a specific kinetic measure helped improve the overall training session by acutely improving power-output over the jump protocol. This enhancement in performance agrees with previous findings that verbal messages can improve force production and efficacy in doing a task (8, 23, 32,40, 41) and coincides with the findings from Brown et al. that knowledge of performance feedback given as a specific kinetic measure can improve performance (6). Feedback was able to not only elicit a higher overall training session, but also caused improvement during the middle of the training session starting specifically at set two and carrying over to set 3.

The investigator acknowledges the limitations in this study, as there was no retention testing to see if this specific type of knowledge of performance feedback had any lasting effect. However, as the aim of this study was to see if power output could be acutely improved only using a kinetic measure, it is therefore considered a success as the end result was an improved performance when feedback was given compared to when it was not.

In recent years as technology has advanced and become cost effective, it has been popularized by Strength and conditioning coaches, especially at the collegiate and professional level, to use some type of technology based feedback with their athletes during training sessions. Being able to track kinematic variables, such as velocity and power, has allowed the Strength & Conditioning coach to better train and develop the individual athlete based off of their specific quantitative measures in training rather than the qualitative measures usually used. In summary, it was found that providing verbal knowledge of performance feedback, as a kinetic measurement, improved power output, specifically in the latter stages of multiple set multiple rep counter movement vertical jump protocol, compared to when no feedback was given among a sample of 14 NCAA Division 1 athletes.

PRACTICAL APPLICATIONS

These findings are important to the Strength and Conditioning coach, because acute power output can be significantly improved when only a kinetic variable (i.e. peak power) is given to the athlete being worked with. Also of note is that these improvements did not require extensive or uncommon technology, nor was providing this type of feedback overly time consuming. Too often research is not transferable to the practical setting due to these two key limitations, however in this instance, it will be possible to easily transfer this method of improving performance to the practical setting. This creates the possibility for more efficient and effective training sessions, allowing the athlete to work at or close to their maximal power output throughout that session.

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APPENDIX A

University of Connecticut

Consent Form for Participation in a Research Study

Principal Investigator: William J Kraemer, Ph.D

Study Title: #H10-257 Augmented verbal feedback and its effect on power output during a counter-movement vertical jump protocol with Division 1 collegiate athletes.

Introduction

You are invited to participate in a research study examining the effects of oral feedback on performance during a counter-movement vertical jump (CMVJ) protocol.

This consent form will give you the information you will need to understand why this study is being done and why you are being invited to participate. It will also describe what you will need to do to participate and any known risks, inconveniences or discomforts that you may have while participating.

We encourage you to take some time to think this over and to discuss it with your family, friends and doctor. We also encourage you to ask questions now and at any time. If you decide to participate, you will be asked to sign this form and it will be a record of your agreement to participate. You will be given a copy of this form.

Why is this study being done?

The purpose of this study is to investigate the effects of verbal feedback on a CMVJ protocol to see if feedback can increase the performance of the participant during the workout. If performance is improved when feedback is given between repetitions, it has serious implications for anyone wishing to improve quality and efficiency of a similar training session by use of feedback.

What are the study procedures? What will I be asked to do?

Eligibility

If you agree to take part in this study, you will be asked to complete a medical history questionnaire. These forms will help us determine if you are eligible to participate in the study.

In order to participate in this study the following criteria must be met:

1. Healthy individual between the ages of 18-26 years.

2. UConn Varsity Athlete.
3. No previous bone or muscle problems or previous injuries that would prevent free movement about the shoulder, hip, knee or ankle, or increase the risk of discomfort or injury during exercise. No ongoing back problems.

What Will the Study Involve?

If you are eligible for the study and consent to participate, you will be asked to attend a familiarization session (described later in this document). After that familiarization session, you will be asked to come to our laboratory for two visits (T1, T2) consisting of two similar but slightly different CMVJ protocols.

One protocol includes verbal feedback during the protocol given as the force output in Newtons achieved during that jump (i.e. – “Jump 1 – 1200Newtons”, “Jump 2 -1333 Newtons”) and the second protocol does not include oral feedback (“Jump 1” ,”Jump 2”).

The order that you will perform the protocols is random.

The time requirement of this study is about 3 hours.

- Total Time in laboratory per visit: Approx 60 minutes (180 total minutes)
- Total Time commitment after consent meeting: Approx 3 Hours.
- Please note that all time are approximates and total commitment may be less than 3 hours.

Please see the table below for more information on the time commitment:

Commitment Table	Visit 1	Visit 2	Visit 3	Time for Each	Total time
Warm up	X	X	X	15 min	45 Min
CMVJ Technique and familiarization	X			30 min	30 min
CMVJ Protocol		X	X	45 min	90 Min

What is the Testing Like at Each Visit?

The first visit, which is a familiarization session, will include a warm-up and a technique review of what the CMVJ protocol entails as well as anthropometric measurements which include height (cm) and mass (kg).

Both testing protocols are exactly the same but differ in whether feedback is given or not. Each visit will contain a warm-up and the CMVJ protocol.

Warm-up:

Before the CMVJ protocol starts, you will pedal against a light resistance for five minutes on a stationary cycle, followed by a dynamic warm-up.

The warm-up routine is the same for all visits.

CMVJ Protocol:

The vertical jump test measures muscle functions and power capabilities. You will keep your hands on your waist during all jumps. From the standing position, you will bend your knees, lowering your center of mass and then explosively jump as high as you can while on a force plate.

You will complete 3 sets of 5 jumps. You will be given 20 seconds between each of the jump repetitions and 3 minutes between the sets of jumps.

What are the risks or inconveniences of the study?

This study will require a time commitment

You will be asked to attend a familiarization session (~45minutes). You will be asked to attend 2 testing visits to the laboratory (~1 hour each). We estimate that the total time commitment for this study is approximately 3 hours total.

This study involves exercise, which poses certain risks

- *Soreness*: With the performance of the CMVJ protocol (maximal effort jumps) you may experience muscle soreness (especially in the thighs) for 1-3 days following testing. This soreness is normal, and such symptoms should disappear completely within a few days and are thought to have no lasting effects.

- *Injury*: Risks of injury due to strained or torn muscles, ligaments, or tendons, while rare, are possible with physical exercise. We will employ safety precautions to reduce such risks during all phases of the protocol. We ask you to perform a warm-up (which will be monitored by trained research assistants) for each exercise. We carefully monitor your exercise form and technique during each test.

- *Heart attack*: With exercise, there is a minimal increase in the risk of a heart attack. Personnel trained in CPR and AED (Automatic External Defibrilator) use will be present at all sessions. The AED is onsite and we have documented emergency procedures.

What are the benefits of the study?

In this study, you will learn how powerful you are in a repeated vertical jump test. This study is aimed at providing an insight into how feedback acutely affects training performance in a lower body exercise of multiple sets and reps.

Will I receive payment for participation? Are there costs to participate?

There is no financial compensation for participating.

How will my personal information be protected?

You're Identity

Your data will remain confidential. For research purposes, your name will be number-coded. In data entry, and statistical evaluation, you will not be identified by name (except on a need-to-know basis). At the conclusion of this study, the researchers may publish their findings. Information will be presented in summary format and you will not be identified in any publications or presentations. You will not be referred to by name in any publication without your written consent. Data that shared with others will be coded (as described above) to help protect your identity.

Security of your personal information

Your data, medical, and other information will be kept in locked cabinets. A master key that links names and codes will be maintained in a separate and secure location. This master key will be destroyed in one year. All electronic files (e.g., database, spreadsheet, etc.) related to this study will be password protected. Any computer hosting such files will also have password protection to prevent access by unauthorized users. Only investigators and research assistants directly involved with this study (and approved by the university for this study) will have access to the data and/or passwords.

The IRB and ORC

You should also know that the UConn Institutional Review Board (IRB) and the Office of Research Compliance may inspect study records as part of its auditing program, but these reviews will only focus on the researchers and not on your responses or involvement. The IRB is a group of people who review research studies to protect the rights and welfare of research participants.

What happens if I am injured or sick because I took part in the study?

If you become sick or injured as a result of the study, you should immediately notify the Principal Investigator of the study, Dr. William Kraemer at (860) 486-6892 or the physician covering the study (Dr. Jeff Anderson, 860-486-0404 ext.0). In the event that a serious medical condition arises, Dr. Anderson will evaluate the condition and, if indicated, direct you to seek care at a hospital.

If you have a medical emergency, the local emergency medical services will be called immediately. On-site medical care is limited to emergency stabilization pending evacuation to a hospital. If you require medical care for this type of sickness or injury, your care will be billed to you or to your insurance company in the same manner as your other medical needs are addressed.

However, if you believe that your illness or injury directly resulted from the research procedures of this study, you may be eligible to file a claim with the State of Connecticut Office of Claims Commissioner. For a description of this process, contact the Office of Research Compliance at the University of Connecticut at 860-486-8802

Can I stop being in the study and what are my rights?

You do not have to be in this study if you do not want to. If you agree to be in the study, but later change your mind, you may drop out at any time. There are no penalties or consequences of any kind if you decide that you do not want to participate.

Who do I contact if I have questions about the study?

Take as long as you like before you make a decision. We will be happy to answer any question you have about this study. If you have further questions about this study or if you have a research-related problem, you may contact the principal investigator, William Kraemer at 860-486-6892 or a student researcher.

If you have any questions concerning your rights as a research participant, you may contact the University of Connecticut Institutional Review Board (IRB) at 860-486-8802.

Documentation of Consent:

I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement and possible risks and inconveniences have been explained to my satisfaction. I understand that I can withdraw at any time. My signature also indicates that I have received a copy of this consent form.

______________________	______________________	___________
Participant Signature:	Print Name:	Date:
______________________	______________________	___________
Signature of Person Obtaining Consent	Print Name:	Date: