EFFECTS OF FEEDBACK TYPE ON TRAP BAR DEADLIFT PERFORMANCE IN FEMALE ROTC CADETS

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ABSTRACT

Velocity Based Training (VBT) such as Perch Technology (PT) has been utilized to increase performance in velocity and power through motor learning feedback concepts of Knowledge of Results (KR) and Knowledge of Performance (KP). It is unknown which type of feedback mechanism is ideal for optimal performance. In tactical athletes, disparities between male and female performance on velocity and power in the trap bar deadlift event (TBDL) of the Army Combat Fitness Test (ACFT) have been identified in career soldiers and ROTC cadets. **PURPOSE:** To determine and quantify what effect feedback type may elicit on TBDL velocity and power in female ROTC cadets. **METHODS:** Participants (n=13) were randomly assigned to 1 of 4 groups: control group (CG) receiving no feedback and 3 feedback groups (KR, KP, KR+KP). Following an initial ACFT, 85lb TBDL was conducted for 5reps/3sets/2d/wk. All participants were instructed to lift as fast as possible. Velocity and power were measured utilizing PT. Following 6 weeks a final 3rep max TBDL was assessed. **RESULTS:** KR and CG significantly increased participants' velocity (KR 6.6%, CG 5.6%, p = 0.03) and power (KR 6.6%, CG 5.4%, p = 0.04) in TBDL after 6 weeks of VBT.
CONCLUSION: VBT results in participants increasing TBDL velocity and power, while feedback overload may adversely impact performance results.

DEDICATION

I would like to dedicate this thesis to both of my parents and my little brother Alex. Without your support I would not be completing my Master's thesis. I would also like to dedicate this thesis to the female ROTC cadets. All of you continue to compete and succeed day in and day out, and hopefully this study will enlighten you on something that you may have not known before, and may potentially help you reach your utmost highest potentials as a cadet and as an officer.

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DEFINITION OF TERMS

The following definitions are used within the context of this study:

Knowledge of Results and Knowledge of Performance

There are two types of augmented feedback and they are known as knowledge of performance and knowledge of results. Knowledge of results (KR) can be described as the information related to the performance outcome, whereas knowledge of performance (KP) is related to specific movement component characteristics (Sharma et al., 2016)

Velocity

Velocity is the rate at which a body's position changes in a certain direction. The 2 velocity variables most used in practice and scientific research are mean velocity (MV), the average velocity across the entire concentric phase and peak velocity (PV), the maximum instantaneous velocity reached during the concentric phase (Weakley et al., 2021).

Power

The strict mechanical definition of power is the rate at which mechanical work is done. Power can be calculated utilizing the formula Power(W)=Force(N) X Velocity(m/s). Perch technology utilizes collected velocity data to give a power output value (Noffal et al., 2012).

Velocity Based Training

Velocity based training is defined as a novel and practical resistance training method proposed to rapidly monitor and prescribe relative loads. It has been demonstrated that the velocity attained during the concentric phase can be used to precisely determine the RT intensity because of the close relationships observed between %1RM and mean propulsive velocity (MPV) in multiple exercises (Riscart-López, 2021).

ARMY ACFT Test

The original version of the ACFT was a six-event physical fitness test designed to be sex and age neutral that assesses whether soldiers are able to perform physical tasks required for combat, like casualty evacuation, movement under fire, construct a fighting position. The test includes in this order, a 3-rep max trap bar deadlift, standing power throw, hand-release push-ups, sprint-drag-carry, leg tuck/plank hold, and the 2-mile run (Smith et al. 2023).

INTRODUCTION

Previous research on competitive athletes has suggested that utilizing feedback strategies can enhance motivation and competitiveness, consequently improving resistance training performance in areas of velocity, power, and force (Weakley et al., 2019). Current monitoring practices can provide retrospective quantification of a resistance training session. The information collected summarizes a completed session and is therefore used to modify a subsequent session. It is accepted from previous motor learning theory literature, however, that instantaneous and summary feedback in terms of Knowledge of Results (KR) and Knowledge of Performance (KP) can have a substantial effect on athletic performance (Randell et al. 2005, Weakley et al., 2019, Weakley et al.,2020, Wilson et al., 2020, Weakley et al., 2023). Instantaneous feedback refers to feedback given immediately following the completion of a repetition of exercise, before the next repetition is completed while summary refers to similar concepts, but after every set (Randell et al., 2011). More recently, the role of velocity within a resistance training program has received increased attention and has become easier with the increase in portable technology systems used in velocity based training (VBT) programs. This type of technology allows for variables such as max velocity, average velocity, max power, and average power to be observed during and following an exercise set or repetition. The speed of the bar under specific loads can display increases in strength and power, or increases in fatigue, throughout the workout (Weakley at al., 2023). If an athlete is lifting the same load at an increased velocity, it can be observed that they are displaying increases in power output.

More recently, the need for improved performance and physiological measures spans outside of the normal athlete spectrum. The tactical athlete may benefit from the use of feedback and VBT technology in order to improve scores on combat fitness tests and combat related job duties, as well as potentially bridge the gap between male and female test scores. Specifically, in the Army, Withrow et al., identified that the Army Combat Fitness Test (ACFT) events where sex had the largest impact were tests in which strength and power were a major factor (sprint-drag-carry, standing power throw, 3RM deadlift, leg tuck) (Withrow et al. 2023). The performance gap between male and female tactical athletes may result in decreased job or leadership opportunities for females, and could result in dangerous combat situations if not properly addressed. Training plans where feedback and VBT are used on female tactical athletes is limited.

PURPOSE

The purpose of this study was to examine the effects of different feedback types on trap bar deadlift velocity and power in college-aged female ROTC cadets completing 6 weeks of velocity-based training using the trap bar deadlift. A randomized research design was used.

HYPOTHESES

The following hypotheses were tested within the context of this research study:

1. The KR+KP group would result in faster mean velocity and increased power on the Army ACFT trap bar deadlift event.
2. The groups utilizing Perch technology feedback would see greater improvements compared to the control group.

REVIEW OF THE LITERATURE

Increases in performance measures may be attenuated directly to visual feedback mechanisms, but could also be from increases in competitiveness and motivation and may vary with exercise selection, length of velocity-based programming, type and frequency of feedback and technology measures used. The aim of this review was to examine the evidence from control trials to determine the efficacy of feedback on performance tasks, effort, and motivation.

Technology and Feedback

The use of linear position transducer technology has become a useful way to track and understand bar movement and alter future repetitions of exercise based off previous performance. In a study done by Anderson et al., this same concept was investigated but with a unique type of technology. The aim of the 2005 study was to determine if real-time visual ipsative (comparison with oneself) feedback of instantaneous kinematic consistency improved overall kinematic consistency in rowing. The study involved 13 rowers who were observed using an in-lab technology system (LabVIEW software and a DAQCard-AI-i6E-4 data acquisition card) and were asked to row 2000m on three separate occasions, each time receiving either no feedback, detailed feedback, or summary feedback, which displayed their rowing movements and allowed them to make corrections to their form based on which type of feedback they were receiving. The results indicated significantly increased performance consistency for detailed feedback when compared to no feedback ($p<0.01$) and summary feedback ($p<0.05$). The detailed feedback resulted in rowers making immediate mid-stroke alterations to their kinematics, promoting consistency throughout their trials (Anderson et al., 2005). The authors explain that it is important to observe how much instantaneous feedback is being given to the athlete, as too much feedback may overload the system, but not enough feedback can result in similar findings as if they had no feedback at all. Overloading the system, or providing too many feedback instructions at one time, can be as detrimental to the session as having no feedback at all. This is important to note that feedback within a certain range is most beneficial to the athlete.

Although the study done by Anderson et al. does not utilize LPT, the mechanism in which the participant receives feedback and therefore changes their next action to be more consistent or correct can be shown to improve overall performance, in this case; for rowers. This can also be seen in a study done by Kim and Kramer, where the use of LPTs was not known. The purpose of the study was to compare knee extensor peak torques during visual feedback and no feedback conditions on three test occasions completed over a 2-week period, using a computer monitor and a computerized dynamometer. During the study, 6 repetitions of knee extension were completed; 3 focusing on the concentric action and 3 focusing on the eccentric action. The visual feedback group was able to see their results on a computer screen in the form of a beam of light, where the larger the beam, the better. This study also found enhanced knee extension torques with visual feedback. The increase ranged from 14%-19% higher than no feedback groups (Kim and Kramer, 1997). This study poses an interesting point in comparison with other studies in this area, where no value is associated with the performance (i.e., velocity in m/s), but an increase in performance is still seen. This may be because the visual feedback, even without set values causes an increase in motivation for most trained individuals, up until to a certain point. It is, however, important to note that the effectiveness of visual feedback decreased over time, particularly during eccentric muscle actions. This may display that at some point, regardless of motivation, fatigue takes over the muscle action.

Program Type

Early studies such as Kim and Kramer in 1997, led to more recent studies where the use of LPTs and their effect on performance measures can be seen. Randell et al., investigated the effect of performance feedback after squat jumps in a 6-week training block on performance specific tests. The feedback was observed as a value of peak velocity. The 13 trained rugby players completed 6 weeks of training, either with or without feedback and performed squat jumps 2 times per week using an absolute load of 40kg. Pre- and post-testing were also included, as performance tests, which included vertical jump, horizontal jump and 10-/20-/30-m timed sprints. The effect size for all training effects was found to be small (0.18-0.28) except in the 30m sprint performance where the effect size was moderate (0.46). The use of Celesco PT5A-150 as the LPT was also new to this area of research and was shown to be reliable. What is of significance in this study are the increases in overall speed of the athlete observed using feedback during training. Feedback was reported to have a 65% and 49% chance of having a positive effect on 10-and20-m sprint performance, respectively, with small training effects. In addition, feedback was reported to have a 99% chance of having a positive effect on 30-m performance, with a moderate training effect. This may be because the use of feedback during training enables a greater consistency in the peak velocity achieved during the squat jumps (Randall et al. 2011). This study displays the effects of utilizing visual feedback over a long period of time (6 weeks), not just in an acute bout of exercise or between repetitions. It is important to note that multiple acute bouts of visual feedback resulted in overall improvement in sport-specific tests.

Velocity Based Training and Feedback

During these studies, specifically Randall et al. 2011, that observed the use of feedback over long periods of time, we see the implementation of velocity based training in the form of strength and exercise programs. VBT is gaining popularity in strength and conditioning due to multiple practical advantages for auto-regulating and individualizing training volume and load on a day-to-day basis over a set number of weeks. It is important to note that there is a different load-velocity relationship with each major lifting exercise where the most improvements in peak power (PP) and peak force (PF) can be seen. Morán-Navarro et al., observed that the load that maximized overall power output was 60% of the 1 RM for the deadlift exercise, which can be useful in the study looking to be conducted (Morán-Navarro et al., 2021).

With the validity and reliability of load-velocity relationships confirmed for maximal improvements in PP and PF, it is also important to assess the velocity in which that specific load should be moved in order to see these maximal increases in performance. In 2021, Hirsch and Frost observed that creating a target velocity is more effective for the athlete than instructing them to “move the bar fast”. In the study, the knowledge of results (KR) theory is utilized. The observation of a numerical value upon finishing a repetition or a set of exercises can allow for an athlete to create goals in a training session. It can also be speculated that setting and achieving specific, measurable, goals can increase performance and motivation throughout the set compared to instructing an individual to “do their best.” This type of feedback gives no room for measurements of KR or KP. The study investigated 13 male power lifters who performed 4 sets of 5 repetitions with 45% 1RM while being instructed to either attain a target velocity of 1.0 m/s or to move as fast as possible. After these 4 sets of 5 repetitions, the number of repetitions performed during an RM test with 75% 1RM was compared as well. Participants moved faster when they received the target velocity instruction of 1.0 m/s, than when they received the “move as fast as possible” instruction ($p < 0.001$). The results concluded that an instruction to attain a specific velocity target may be a more effective strategy to use when attempting to elicit maximum barbell velocities during training relative to the traditional instruction to move as fast as possible (Hirsch and Frost 2021).

VBT is most utilized in a program where improvements in speed and power are being observed, as well as to keep fatigue levels under control. Banyard et al., described the changes in strength, jump, sprint, and change-of-direction performance in both VBT and maximum percentage-based training (PBT). The study included 24 trained males who conducted 6 weeks of full-depth free-weighted back squats, 3 times per week. The PBT group lifted throughout 6 weeks, with fixed relative loads (59%-85% 1RM). The VBT group lifted to reach a target velocity that was individualized to their own load-velocity profiles. This included the real time velocity feedback, that would dictate VBT set by set load adjustments. The results displayed that the VBT group maintained faster training repetitions throughout than PBT as well as improvements in change-of-directions, 5-m sprint, 10-m sprint, 20-m sprint, 1 RM and the countermovement jump. PBT had very small differences in the 1 RM improvement over 6 weeks, but still notable

(Banyard et al., 2021). It can be concluded from this study that improvements in 1 RM can be seen from both PBT and VBT groups, but in terms of improvement in velocity or power movements (CMJ, sprint, COD), VBT proved to be most beneficial.

Feedback Type and Frequency

As observed in the previous studies, monitoring lifting velocity during resistance and plyometric training can result in increases in lifting velocity and power output and therefore improve overall performance. For the purpose of this study, only Visual Feedback mechanisms were observed, but some studies involve the comparison of augmented feedback (knowledge of results vs. knowledge of performance) versus visual feedback and make observations about the timing of feedback (immediate vs. waited or average feedback). In 2020 Nagata et al., defined augmented feedback as presenting an external source of information to athletes (i.e., velocity) during a bout of exercise. This study is the most recent study that compared immediate feedback, average feedback, visual feedback, and no feedback. The immediate and average feedback groups received general augmented feedback (bar speed) after either each set (ImFb) or the average of a lifting session once it is completed (AvFb). The visual feedback group (ViFb) will be observing video data on a screen in front of them (Nagata et al., 2020). This study utilized a 4 week, 2x per week VBT program and then observed performance on the loaded jump squat. This study showed greater improvements in loaded squat jump in the ImFb group compared to all other groups. This group also displayed the best retention of improvements, but small improvements were seen in the ViFb and AvFb as well.

Similar to the results from Randell et al. in 2011, feedback increases performance, however, it is questioned whether the increase in performance could be due to enhanced consistency of the loaded jump squat and therefor an increase in mood and motivation during the following exercise sessions. In Keller et al., the timing and frequency of feedback is observed as well. This study looked to decipher the short- and long-term effects of varying augmented feedback frequencies on drop jump performance. The jump training took place 3 times per week over 4 weeks, which is again consistent with the VBT programs we see in studies included in this review. Random groups received vary levels of augmented feedback (aF). The 100% group received aF after every jump, the 50% group received feedback after every jump during the first half of each series (jumps one to six), and the 0% group served as the control group that trained without aF. The short-term results show that aF instantly increased the drop jump height. The long-term results highlight that aF can enhance the efficiency of drop jump training resulting in higher rebound heights. A high frequency of aF (100%) was superior to lower frequency (50%) or no aF (0%) (Keller et al., 2014).

The studies previously discussed looked mostly at the augmented feedback that displays knowledge of results. This means that the feedback only give context to the exercise rep itself, where knowledge of performance feedback will give individual feedback on the movement characteristics of the practiced task (Lai, 1999). In 2009, Winchester et al., looked to observe changes in bar path movement through summary knowledge of performance feedback (KP) in the power snatch lift. In this study, it was observed that in some cases, a high frequency of feedback may be overwhelming to the system and the learning process and in turn decrease retention of that skill done correctly. This study provided summary feedback (after each set of trials vs. each set) in an attempt to increase skill acquisition. For KP the individuals in the study were given information on their movements during the snatch; these included, rearward movement of the bar during the first pull, a catch position no more than 20 cm behind the most forward bar position, the amount of looping, which should have been less than the net rearward horizontal displacement. Previous research showed that poor bar path movement resulted in less successful lifts and less power created during the exercise itself. In a 4-week training session, individuals were divided into a control group and a feedback group (FG). The FG was given small amounts of verbal feedback but was given visual feedback cues through 2-D videography to observe technique and form after each set of the exercise. Upon completion of each set of lift, the FG would watch themselves and their bar path specifically, and then a coach would verbally asses' corrections to make in the next set of lifts. The results of this study showed that at all levels of increasing load (50%,70%, 90%), there was an increase in PP and PF during the feedback group compared to the control group when there was an improvement in kinematic variables of bar path. It also showed the effectiveness of summary feedback on athletes performing weightlifting movements (Winchester et al., 2009).

SUMMARY OF THE LITERATURE

Technology and feedback have shown to illicit increases in velocity and power performance for male and female athletes (Weakley et al., 2019). In both acute exercise sessions, and chronic exercise interventions, summary feedback (KP) and Immediate Feedback (KR) result in varying levels of performance increases. In addition, VBT over longer periods of time shows direct improvements in speed related tasks outside of the exercise being trained (Randell et al., 2011).

What is unknown from the literature are which type of feedback and feedback frequency would result in the greatest responses in velocity and power on the trap bar deadlift exercise. The literature also lacks female-related VBT studies where trained female athletes complete chronic exercise interventions to observe similar performance changes, and studies involving tactical female athletes is unknown to this author.

METHODS

A randomized group design was used to examine the effects of different feedback types on trap bar deadlift performance in college-aged female ROTC cadets. Differences in velocity and power, the dependent variables, were assessed between feedback type, the independent variable, during each exercise session. Velocity was measured utilizing Perch velocity based training technology, and power was calculated with Perch utilizing the velocity values for each repetition the participants performed.

Participants

Participants were college-aged (18-21) females from the Temple University ROTC program. A total of (*n=13*) participants completed the entire protocol. Males and any collegiate female athletes were excluded from participating in the study. Participants were all enrolled in ROTC for at least one semester prior and had all completed at least one Army ACFT test before beginning the study. Descriptive statistics of the participants can be found in Table 1.

Measurements

Velocity (m/s) was measured and power (W) was calculated during each repetition of the trap bar deadlift and was recorded using Perch technology. Perch is shown to provide both valid and reliable mean and peak concentric velocity outputs across a range of velocities (Weakley et al., 2023).

Procedures

Before subject recruitment and testing procedures began, Temple University IRB approval was obtained. All testing procedures took place in the Exercise and Sports Science Strength and Conditioning laboratory in Pearson Hall room 10C at the Temple University Main Campus located in Philadelphia, Pennsylvania. Participants were recruited in person via informational flyer (Appendix A) at ROTC meetings located on Temple University Main Campus, and by word of mouth across the ROTC program. All recruitment took place in-person on the Temple University Main Campus, and the order of procedures is provided in Figure 1.

Participants were required to participate in 2 sessions a week for the duration of 6 weeks, and then complete a maximum effort session during the final visit of the study after 12 full sessions of velocity based training had been completed.

Upon initial meeting, participants received a brief description of how the sessions would run as well as how Perch technology would be used for the sessions to determine whether they were still interested in participating. Upon agreement, participants completed an informed consent (Appendix B). Participants that were willing and eligible to participate in the study were then instructed to complete the health questionnaire (Appendix C) with questions pertaining to sleep, hydration, supplementation, menstrual cycle, and diet for the 24 hours leading up to that session. The participants then completed the exercise session with a specific feedback type that will be broken down in greater detail in the subsequent section.

Exercise Feedback Sessions

Each group completed a warm up consisting of lifting the trap bar with no extra weight (70 lb.) for 5 reps, 2 times, with 45 seconds in between each set. All participants were instructed to complete all warm up and exercise repetitions with shoes on. After the warm up was completed, the participants completed 3 sets of 5 repetitions with 45 seconds of rest in between at 85 lb., with their specified feedback type. Each subject was instructed to lift as fast as possible, and was corrected on form if needed from the coaching form sheet (Appendix D). Participants were instructed to stop any exercise if any discomfort or pain outside of soreness or fatigue was felt at any time.

Group 1($n=3$), the control group, did not receive any type of feedback from Perch technology at all.

Group 2 ($n=4$), the KR group, participants received feedback in the form of m/s after every repetition, displayed in bar graph form on an iPad in front of them.

Group 3 ($n=3$), the KP group, participants received feedback as a video of their form from the Perch video app, after each set of exercises.

Group 4 ($n=3$), the KR+KP group, received feedback in m/s on the iPad after each repetition, as well as feedback of their form from a video after each set.

Statistical Analysis

The difference in outcome measures was analyzed using a two-way analysis of variance (ANOVA) with repeated measures using SPSS Statistics Version 26 for Windows (IBM, Armonk, New York). If statistical significance existed, a post hoc t-test with Holm-Sidak correction was used to determine the differences. A value of $p < 0.05$

was considered significant. All data are presented as means SEM except descriptive data, which are presented as means ± standard deviations.

RESULTS

Subject Recruitment

Of the 19 females recruited, 2 declined participation prior to beginning any portion of the study, and 5 did not show up during the first week of the exercise sessions. There was 1 female that dropped out after the first session due to illness and 2 females joined after the first week of sessions due to availability. All thirteen participants present after the first session completed 12 velocity based training sessions and 1 maximum effort session to finish the study.

Feedback Type on Velocity

A repeated measures ANOVA was performed to compare the effect of feedback type on velocity (m/s). There was a statistically significant difference in velocity between at least two feedback groups ($F(3,2) = 10.41$, $p= 0.03$). Simple main effects analysis showed that there was a significant effect for the control group in velocity from week 1 to week 6, (M= 0.75 m/s and M= 0.80 m/s) where participants were displaying greater velocity on average. Furthermore, the KR group saw similar significant increases from week 1 to week 6, (M= 0.75 m/s and M= 0.81 m/s). Simple main effects analysis showed that KR+KP did not have a statistically significant effect on velocity $p= 0.57$ (M= 0.79 m/s and M= 0.80 m/s).

Feedback Type on Power

A repeated measures ANOVA was performed to compare the effect of feedback type on power. There was a statistically significant difference in power (W) between at least two feedback groups ($F(3,2) = 10.71$, $p=0.04$). Simple main effects analysis showed that there was a significant effect for the control group in power from week 1 to week 6, ($M=283$ W and $M=298$ W) where participants were displaying greater power on average. Furthermore, the KR group saw similar significant increases from week 1 to week 6, ($M=285$ W and $M=305$ W). Simple main effects analysis showed that KR+KP did not have a statistically significant effect on power $p=0.85$ ($M=299$ W and $M=301$ W).

DISCUSSION

The purpose of this study was to identify what effect feedback type would have on velocity and power during the U.S. Army Combat Fitness Test (ACFT) trap bar deadlift (TBDL) event in female ROTC cadets. The main finding of this study was that velocity and power increased across all groups from week 1 of velocity-based training to week 6 independent of feedback group and the feedback group receiving both KR and KP feedback types may have experienced feedback overload, resulting in increases in velocity and power that were not statistically significant.

Velocity and Power Response to Feedback

The velocity and power changes from different types of feedback in this study does not support the original hypothesis that the KR+KP group would show greater increases in velocity and power compared to other groups. Additionally, the hypothesis that groups receiving feedback versus the control group receiving no feedback would also see greater improvements in velocity and power cannot be supported by the data. In the context of this study, velocity was measured as knowledge of results or instantaneous feedback and video feedback was measured as knowledge of performance or summary feedback. Randell et al. found that in trained males, KR feedback versus non-feedback groups elicited increases in the squat jump as well as 10m,20m, and 30 m sprint times. There were no significant increases in these tests for the non-feedback group (Randell et al., 2011). In 2020, Nagata et al. observed the differences between Immediate feedback (Imf), Average feedback (AvgF), and Visual Feedback (ViF). The study reported that ImF (m/s) given after each repetition elicited the greatest velocity improvements compares to AvgF (m/s) given after each set or ViF (video) given after each set. The retention of velocity-based movements was also that greatest in the ImF group (Nagata et al., 2020). In the current study, we saw significant changes from week 1 to week 6 in the control group receiving no feedback, which does not compare to the studies mentioned. The current study did show that the most significant results from week 1 to week 6 for velocity and power were shown in the KR group receiving ImF, like Nagata et al. in 2020. Banyard et al. compared PBT to VBT and found that the VBT group maintained faster squat repetitions throughout 6 weeks than the PBT group and saw greater improvements in a change of direction test, 5-m, 10-m, 20-m, and 1 RM countermovement jump test (Banyard et al., 2021). The current study saw improvements in velocity and power in all groups utilizing VBT training methods for the trap bar deadlift. In a 2020 study done by Wilson et al., the effect that feedback had on several relevant psychological variables, including task competitiveness, motivation, workload, and mood were investigated. Mean concentric velocity for the feedback group was 0.70

m/s and 0.65m/s for the non-feedback group which was consistent with previous studies discussed. This specific study also displayed changes in frustration and temporal demand, showing that temporal demand went up with feedback but frustration level decreased. Temporal demand on this scale assesses how much time pressure an individual felt due to the pace of the tasks and frustration level assessed how irritated, stressed, or annoyed the individual felt during the tasks (Wilson et al., 2020). The current study only saw significant increases in velocity and power in the control group and in the KR group. Neither group receiving KP (ViF/summary) saw significant differences in either velocity or power from week 1 to week 6. The KR+KP group saw the least significant differences out of all four groups, where feedback frequency was the highest. In 2005, Anderson et al. found that overloading the system, or providing too many feedback instructions at one time, can be as detrimental to the session as having no feedback at all. These findings display that feedback within a certain range is most beneficial to the athlete (Anderson et al., 2005). The temporal demand of the KR+KP group may have been higher compared to the demands of other feedback groups and the control. The increased temporal demand may have resulted in feedback overload, stunting any significant velocity or power increases over 6 weeks.

Implications

In order to create increases in performance on the Army ACFT test and subsequently increase job performance upon commissioning into the United States Army, velocity and power based training techniques should be implemented into Army training protocols with the assistance of motor learning feedback types. When college-aged females completed 6 weeks of velocity based training with differing feedback types, significant changes did not occur within all groups from feedback. However, improvements could be seen over time from week 1 to week 6 from velocity based style training. The results of the current study support the idea that in order to become faster and thus more powerful, velocity based training may have a positive effect. Although results from the current study were not significant, previous research supports the use of ImF or KR versus summary feedback types, and any type of feedback versus a non-feedback exercise session. The benefits of the current study also include a female-focused exercise protocol, which the previous literature lacks. The current study shows the need for further tactical female athlete-based exercise studies.

Limitations

The study contained limitations that were considered when interpreting the results. The limitation with the most significance was sample size. The Temple ROTC program consisted of less than 50 eligible females, and completing the study in the Spring semester versus the Fall semester removed senior cadet (MS4) interest in the study. This left the pool of participants to less than 30 females. The study asked participants to compete 2 more sessions of exercise on top of the Physical Training required by ROTC.

Another limitation of the study was the completion of other bouts of exercise throughout the 6 weeks. The participants could not remove themselves from ROTC training, and therefore completed the exercise sessions in conjunction with other exercise sessions. The ROTC physical training occurred on Monday, Wednesday and Friday, and the participants completed the sessions on either M/W, W/F, or T/Th. Some of the participants would have completed their sessions on days they already trained with ROTC previously versus others who did not.

An additional limitation of the study was that all participants lifted 85 lb., independent of their 3 RM max collected during the US Army administered ACFT. The current study methods were created due to time and lack of researchers to assist in changing bar weight for each participant. The number was based on the VBT scale of % RM and m/s.

Future Research

Future studies should focus on identifying which specific type and frequency of feedback will elicit the greatest increases in velocity and power. Existing work indicates that no feedback results in smaller or no increases in velocity, for velocity based exercises, but excess feedback past an individual's feedback threshold may result in increased temporal overload and therefore decreases or plateaus in performance (Wilson et al., 2017).

Future research should also look to compare males and females utilizing VBT and feedback types as well as the effect of this type of training on task load. In 2019, Weakley et al. was the only study on males that included a follow-up study on females, but the data was never compared to make any further conclusions (Weakley et al., 2019). This gap in the data aligns with the gap in performance that can be seen between male ROTC cadets and female ROTC cadets. The current study did not obtain data observing the direct effects on menstrual cycle on velocity and power and can be explored further to close the performance gap as well.

Another major area that can be explored is deciphering where the increases in performance arise from. Previous studies do not show how the psychological reaction to feedback results in the increases or plateaus in performance seen. It could be the feedback itself, using it to change the next movement, or how the feedback effects mood, temporal load or even exercise enjoyment.

Conclusions

This study aimed to assess the changes in velocity and power during 6 weeks of velocity based training and motor learning feedback intervention on college-aged female ROTC cadets from Temple University. Based on the present findings, VBT programing increased velocity and therefore power in groups independent of feedback type. Feedback overload may occur when knowledge of performance is displayed through average or summary feedback due to increased temporal demand. No significant differences were present in either group receiving KP feedback. There were significant differences in both velocity and power in the control group receiving no feedback. The current study does not allow for any claims to be made about the positive effects of feedback versus no feedback on the trap bar deadlift due to control group changes.

With future research to solidify previous findings, it is the hope that feedback and VBT may be implemented into tactical female athlete training programs to bridge the gap between male and female performance on strength and power based exercises in the Army ACFT, resulting in more leadership and job opportunities for females and eliminated dangerous combat situations.

FIGURES AND TABLES

Group	Mean Age	ROTC MS	Feedback
Control (*n=3*)	21	3	None
KR (*n=4*)	20	3	PT Feedback (m/s)
KP (*n=3*)	20	2	PT Feedback (video)
KR+KP (*n=3*)	19	2	PT Feedback (m/s+ video)

Table 1. Descriptive Statistics of Participants

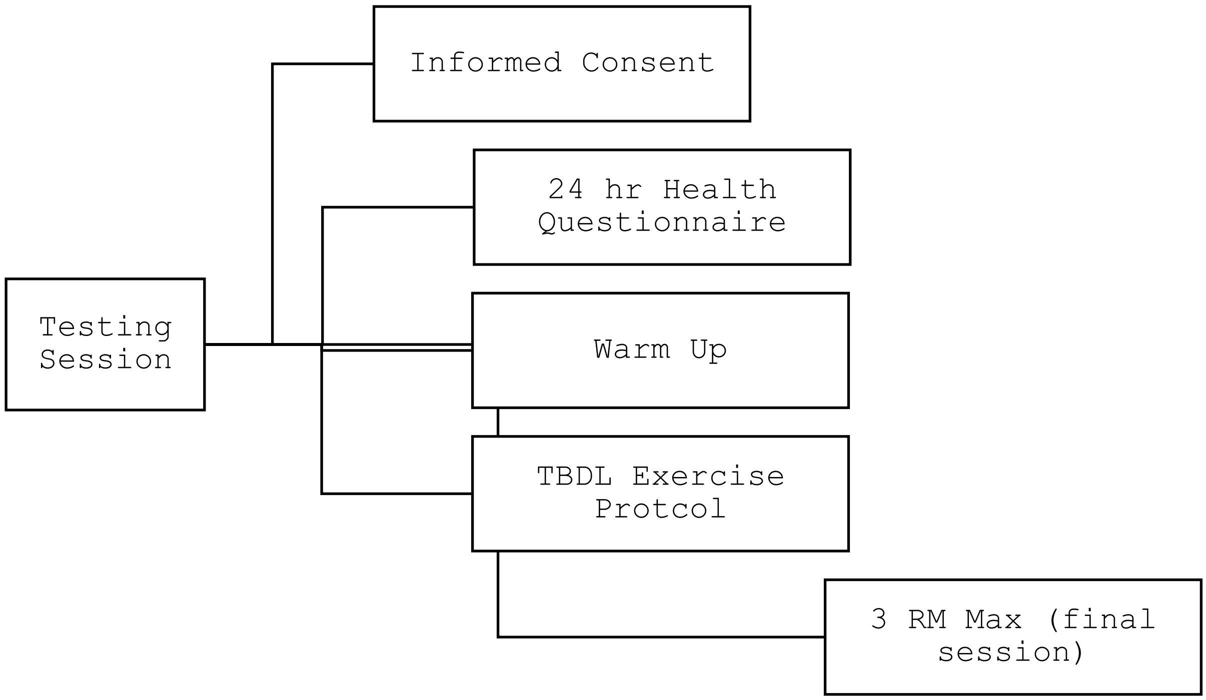

Figure 1. Exercise Session Methods

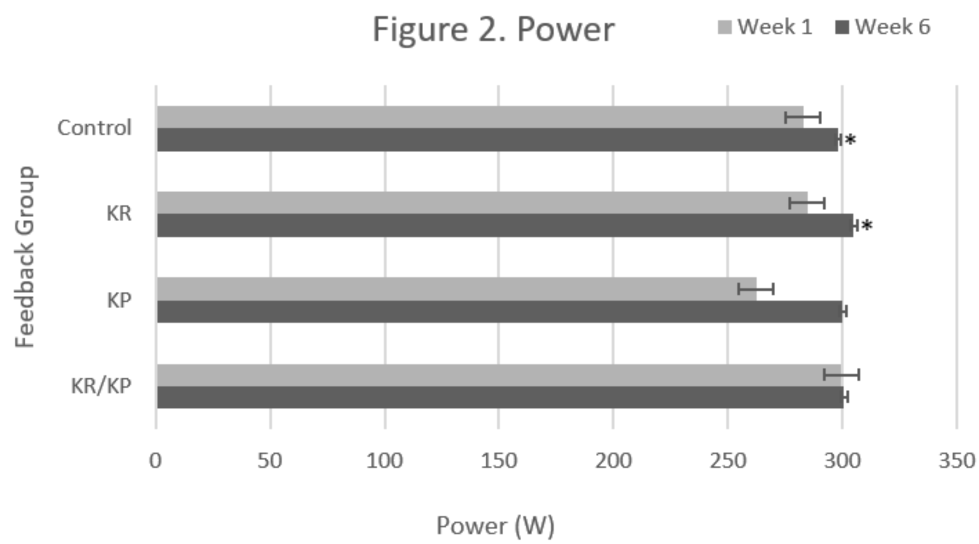

Figure 2. Trap Bar Deadlift Power (W)

Trap bar deadlift power at the beginning and end after receiving feedback. Paired t-tests were performed on values between time points.

Note. Error bars represent standard errors. ***** Week 6 values were significantly different than Week 1 values, $p < 0.05$.

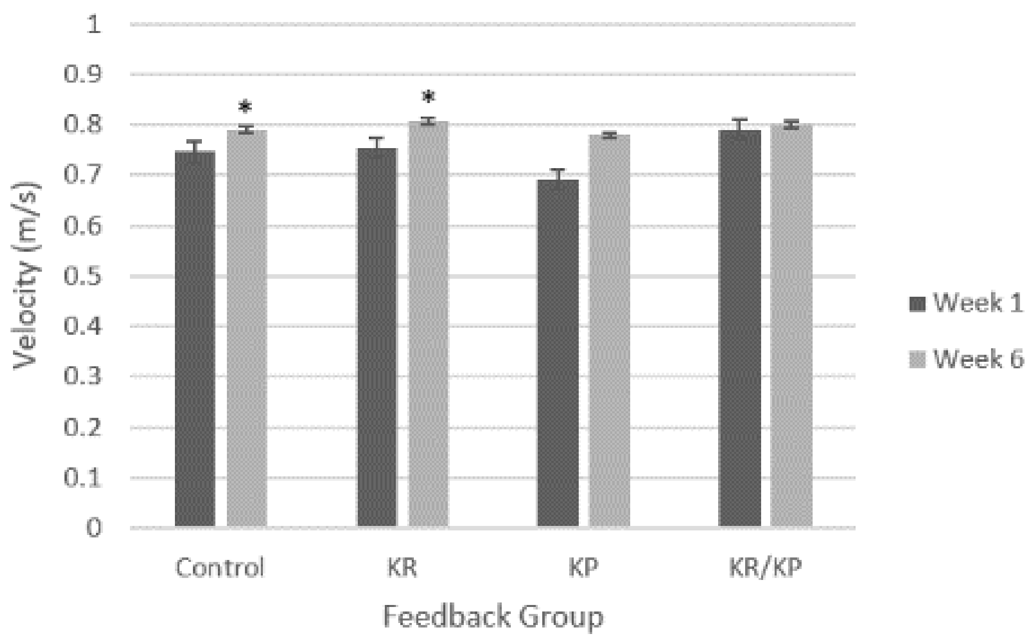

Figure 3. Trap Bar Deadlift Velocity (m/s)

Trap bar deadlift velocity at the beginning and end after receiving feedback. Paired t-tests were performed on values between time points.

Note. Error bars represent standard errors. ***** Week 6 values were significantly different than Week 1 values, $p < 0.05$.

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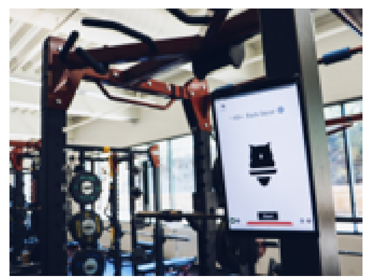
APPENDICES

APPENDIX A
RECRUITMENT FLYER

Volunteers Needed for Exercise Performance Research!

If you are a female in the ROTC program at Temple University you may be eligible to participate in this research study

Effects of Feedback Type on Trap Bar Deadlift Performance in Female ROTC Cadets



The study will include meeting around your regularly scheduled PT to fill out questionnaires and then complete 3 sets of the trap bar deadlift using a velocity-based training method. Different groups in the study will be given two different types of feedback during this time as well to observe performance measures for the trap bar.

Participants will be eligible to be entered into a random drawing of three 100$ Visa gift cards.

Participation is voluntary. Your choice to participate or not participate in the research will not affect your status in Temple's ROTC program.

If you are unsure if you meet the requirements, email a member of the study team:
P.I. Dr. Daniel Rosney
daniel.rosney@temple.edu
Amanda Picozzi
amanda.picozzi@temple.edu

Location

In person meetings in Pearson Hall room 10C (strength lab)
3 times per week for 6 weeks for about 30 minutes.
Starting Fall Semester 2022

Are you eligible?

- Female
- Temple ROTC cadet
- Non-Varsity Athlete at Temple University
- Not participating in any other research study at the same time

APPENDIX B
INFORMED CONSENT

INFORMED CONSENT FORM

CONSENT TO PARTICIPATE

VOLUNTARILY IN A RESEARCH INVESTIGATION

DEPARTMENT OF KINESIOLOGY
TEMPLE UNIVERSITY
PHILADELPHIA, PA

Daniel Rosney — Amanda Picozzi
Responsible Faculty Member — Investigator's Name

____________________ __________________
Subject's Name — Date

PROJECT TITLE: The Effects of Feedback Type on Trap Bar Deadlift Performance in Female ROTC Cadets

You are being invited to take part in a research study. A person who takes part in a research study is called a research subject, or research participant. Before you decide to participate in this study, it is important that you understand why the research is being conducted and what it involves. This form is designed to provide you with information about the research study so you may decide whether or not to be involved in the study. Please take the time to read the information carefully and you are encouraged to reach out to any of the investigators listed on the document with any questions you may have. This process is called "informed consent," and a copy of this form will be provided to you.

Participation is voluntary. Your choice to participate or not participate in the research will not influence your status in Temple's ROTC program.

I. Purpose of the Study

The objective of this study is to observe and identify what effect feedback types (Knowledge of Results vs. Knowledge of Performance) will have on mean velocity, mean power, and score on the ARMY ACFT trap bar deadlift in female ROTC cadets, using Perch. You have been asked to participate in the research because you expressed interest in participating. There is an equal chance that if eligible, you will be allocated to one of the four feedback groups.

II. Procedures

If you decide to take part in this research study, the general procedures include completing questionnaires involving sleep, stress, diet, hydration, supplementation, and menstrual cycle as well as mood and task effort. You will then be asked to do about 15-20 minutes of velocity-based trap bar deadlift movements (fast and lightweight) while Perch technology measures movement velocity from the squat rack above you. There will be 4 groups and assignment to group will be based off a random number generator. You have an equal likelihood of ending up in any of the 4 groups. In each of the 4 groups, you will be receiving a type of feedback about your movements that will be recorded using Perch technology. The type (velocity or form) and frequency (after each set or each repetition) of feedback will differ based on which group you are randomly assigned. We will ask you to meet for this procedure 2 times per week for 6 weeks and one final time for a max rep session until the conclusion of the study in 2023.

III. Risks

The most important risks or discomforts that you may expect from taking part in this research include muscle tightness or muscle strain from completing warm up exercises. Participants may also experience muscle soreness after the completion of the trap bar deadlift exercise repetitions. Further risks include possible physical injury or failure to complete the exercise due to pain. To minimize this risk, coaches will be present during the exercise protocol to read form cues and run warm up exercises correctly.

Non-physical risks associated with the exercise protocol may include boredom from questionnaire repetition. To minimize this risk, we have shortened the questionnaires to only include pertinent information to the proposed study. Stress about performance on the exercise protocol may also be a risk. To minimize this risk, each participant will be completing the set of exercises in the gym lab space alone. The participants will filter in one at a time so they do not feel added pressure from other participants observing.

If you require medical attention from participating within the study, you are encouraged to reach out to any of the investigators listed on this document as soon as you can.

If you are seeking medical assistance due to a physical discomfort, these two resources are available for you:

Temple University Hospital
3401 N. Broad Street Philadelphia, PA 19121 (800) - 836 - 7536

Temple University Student Health Services 1700 N. Broad Street, 4th floor Philadelphia, PA 19121 (215) - 204 - 7500

IV. Benefits

We cannot promise any benefits to you or others from taking part in this search. However, based on previously conducted studies, possible participation in strength exercises utilizing feedback mechanisms may improve velocity and power as well as increase mood and task effort.

V. Confidentiality

The device being utilized to measure velocity, Perch, will capture shadow video data but you cannot be identified by the shadow image. The velocity data collected will be stored, maintained, and can be used by Perch. The research data may be utilized by Perch to support marketing the device itself. The consent form that you sign will be kept in a location separate from the information that will be obtained from you during the study. To safeguard your identity, the researcher will give you a number that the researcher will use on all forms. This code will not appear on the consent forms.

Your identity will not be revealed in any publication of the results of this research. Research data of individual participants and their identity will not be shared with Temple ROTC. The Principal Investigator will not have access to any identifiable information. The individually identifiable results of your participation will be confidential. A copy of your test results and the study results will be made available to you if you request it.

The project's research records may be reviewed by individuals at Temple University responsible for research oversight. The number that links your name to the study data obtained will be deleted after all the study participants have been tested which is expected no later than the end of May 2023. Researchers will not release identifiable results of the study to anyone other than individuals working on the project without your written consent unless required by law if you are injured and need medical attention.

We may publish the results of this research. However, we will keep your name and other identifying information confidential. We protect your information from disclosure to others to the extent required by law. We cannot promise complete secrecy. Data or specimens collected in this research might be de-identified and used for future research or distributed to another investigator for future research without your consent.

If you have questions, concerns, or complaints, or think this research has hurt you or made you sick, talk to the research team at the phone number listed above on the first page.

This research is being overseen by an Institutional Review Board ("IRB"). An IRB is a group of people who perform independent review of research studies. You may talk to them at (215) 707-3390 or irb@temple.edu if:

You have questions, concerns, or complaints that are not being answered by the research team.

You are not getting answers from the research team.

You cannot reach the research team.

You want to talk to someone else about the research.

You have questions about your rights as a research subject.

I CERTIFY THAT I HAVE READ AND FULLY UNDERSTAND THE ABOVE RESEARCH PROJECT. ALL OF MY QUESTIONS HAVE BEEN ANSWERED TO

MY SATISFACTION BY THE RESEARCHER. I WILLINGLY GIVE MY CONSENT TO PARTICIPATE.

______________________ ______________________

SIGNATURE OF WITNESS SIGNATURE OF SUBJECT

APPENDIX C
HEALTH QUESTIONNAIRE

24 HOUR HEALTH QUESTIONNAIRE

ROTC Study Questionnaire Form

Participant ID: _______________

Sleep:

1. About how many hours of sleep did you get last night?
   a. 2-3
   b. 4-5
   c. 6-7
   d. 8
   e. 8>

2. On a scale from 1-10, 1 being tired, 10 being wide awake, how do you feel right now?

Stress:

1. On a scale from 1-10, 1 being extremely relaxed 10 being extremely stressed, how do you feel right now?

2. About how many days per week do you wake up at a level of 5 stress or above?
   a. 0 days
   b. 1-2 days
   c. 3-5 days
   d. Everyday

Hydration:

1. About how much water have you drank in the last 24 hours? (A Poland Spring water bottle is 16 oz)
   a. <16oz
   b. 16oz-32 oz
   c. 32 oz-48 oz
   d. 48 oz-64 oz
   e. 64 oz-128 oz
   f. >128 oz

2. On average, how much water do you drink on a normal PT training day?
   a. <16oz
   b. 16oz-32 oz
   c. 32 oz-48 oz

d. 48 oz-64 oz
e. 64 oz-128 oz
f. >128 oz

3. Have you consumed any caffeinated beverages in the last 12 hours?
a. Yes
b. No
4. If yes, about how many beverages have you consumed?
a. 1
b. 2
c. 3
d. 4
e. 5
f. >5

Supplementation:

1. Have you consumed any vitamins in the last 12 hours?
a. Yes
b. No

2. If yes, which type of vitamins do you consume?
a. Multivitamin
b. Vitamin D
c. Vitamin C
d. Vitamin B12
e. Folate
f. Other: ________

3. Have you consumed any type of supplements other than vitamins or caffeine in the last 12 hours (i.e., BCAA, pre-workout, creatine, greens powder, herbal supplements)?
a. Yes
b. No

4. If yes, which type and about how much? (Dose)

Menstrual Cycle:

NOTE: The following section is applicable to females (as defined by current ROTC policy).

1. When was your last period?
2. Do you have regular periods?
a. Yes
b. No

3. About how many days are there in between each period?
a. No days
b. 7-10
c. 12-14
d. 16-20
e. 24-28
f. >30

4. About how long does each period typically last?
a. 1 Day
b. 2-3 days
c. 3-4 days
d. 5-6 days
e. > 7 days

5. Do you take or have hormonal birth control?
a. Yes
b. No

Diet:

1. Please write down all foods and beverages consumed for a 24-hour time period. Please include anything from 4 am yesterday to the present time.
2. List the approximate time the meal was consumed, place where it was consumed (home, work, name of restaurant, church, etc.), and the type of eating occasion or meal (breakfast, lunch, dinner, snack, or other).
3. List each food/beverage item you consumed. Specify details/ingredients/preparation of each food or beverage consumed.
4. Record the amount of each food or beverage consumed. Portion sizes can be recorded in a variety of ways, please estimate as best as possible if it is not being measured.

Date:

Time	Place	Meal	Food Item	Ingredients/Preparation	Amount

APPENDIX D
COACHING REFERENCE

TRAP BAR DEADLIFT FORM COACHING REFERENCE

The below coaching cues will be used in group 2 and group 4, which are receiving knowledge of performance. The participants will receive any of the below form cues that pertain to them after each set, not each repetition. This means that they will receive coaching feedback 3 times during their session.

Correct performance of Movement:

- From the starting position, slowly perform a hip hinge by flexing at the hip joint and knees to allow the bar and chest to lower toward the ground.
- During the hinge, the weight should be slightly transferred toward the heel, to keep the weight centered over the middle of the foot.
- The trunk should be properly braced to maintain a neutral spine and head position throughout the entire motion.
- The shoulders should remain retracted and depressed.
- The weight should be lowered to either the end functional range of motion (ROM) or to the ground.
- Proper tempo for the eccentric phase should be approximately 3 seconds.
- Once the athlete has reached the bottom position of the movement, contract the gluteal muscles and hamstrings to return to the starting position.
    - Athletes should avoid beginning the concentric phase by attempting to lift the weight from the shoulders, which leads to improper form and changes in spinal alignment.
- As the bar crosses just above the patella, the individual should focus on “pushing the hips through.” Keeping shoulders, arms, and head in the same position.

Common Errors and Corrective Cues:

1. Lack of trunk/postural control:
    - Cue participants to brace and tuck their abdominal muscles (core) to avoid hyper lordosis.
    - Cue pushing the scapula’s together to keep the chest up and tight.
    - Cue participants to keep head and neck in-line “eyes should follow the movement down and then back up, do not stay looking straight ahead”
2. Weight shifting forward (forward flexion):
    - Cue to keep the weight in the heels
3. Knee movement (squat pattern or keeping knees stiff)
    - Cue to keep knees slightly bent if they are stiff
    - Cue a hip hinge motion, “think only pushing your butt back on the way down and then pushing your hips forward on the way up”

Snarr, Ronald L. PhD, CSCS*D, NSCA-CPT; Adams, Kara BS; Cook, Jordan MS, ATC, CSCS Exercise Technique: Hexagonal Bar Romanian Deadlift, Strength and Conditioning Journal: February 2021 - Volume 43 - Issue 1 - p 116-121 doi: 10.1519/SSC.0000000000000571