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Original research article

Influence of different verbal cue types on countermovement jump performance in youth female athletes

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ABSTRACT

[GQ2] [GQ4] [GQ5] Although external (EXT) verbal cues have been shown to improve jump performance, limited research has been conducted in youth athletes. Therefore, the purpose of this study was to investigate how different EXT verbal cue types influenced countermovement jump (CMJ) performance in youth athletes. Ten young trained female athletes (16.80 ± 0.60 years) performed the CMJ using four different EXT verbal cues including external-distal (DIST), external-proximal (PROX), analogy (ANA) and holistic (HOL) as well as a neutral cue (CON). Jump height, reactive strength index modified (RSI_{MOD}), countermovement depth, jump time and force-time measures from eccentric and concentric CMJ subphases were measured. No significant differences between cue types were found for RSI_{MOD} . ANA resulted in significantly higher jump height compared to CON ($g = 0.37$). PROX significantly increased jump time ($g = 0.60$), concentric time ($g = 0.47$) and braking time ($g = 0.52$), as well as significantly decreasing eccentric braking mean force ($g = 0.43$) and eccentric braking rate of force development ($g = 0.59$) compared to CON. Countermovement depth significantly increased when using PROX ($g = 0.60$), HOL ($g = 0.46$) and ANA ($g = 0.51$) compared to CON. These results suggest that compared to a neutral cue, EXT verbal cues result in similar CMJ performance in trained youth athletes. However, PROX verbal cues appear to result in reduced performance in many CMJ force-time measures.

KEYWORDS

- Youth
- attentional focus
- jumping
- force-time
- verbal cues
- female athlete

Introduction

Verbal cues are a common approach that coaches use to aid the skill development of athletes.¹ Indeed, the ability to prescribe verbal cues to improve technique is a competency that coaches must possess when working with athletes.^{2,3} To this end, coaches can use verbal cues to direct an athlete's attentional focus to pertinent aspects of skill execution.³ For example, should an athlete display sub-optimal technique when performing an exercise, then verbal cues can be provided to improve subsequent efforts.⁴ Typically, verbal cues are prescribed with the aim of directing an athlete's attention focus either internally or externally.⁵ An external (EXT) focus directs the athlete's attention on the intended movement or goal, whilst the internal (INT) focus directs their attention on movement of the body.⁶ An EXT focus is suggested to result in superior motor performance as it promotes greater automaticity in movement control.⁷ In support of this, a number of meta-analyses have reported the benefits of using an EXT compared to an INT focus for strength and power performance.^{8,9} Thus, verbal cues that encourage a focus on the movement goal are considered a beneficial strategy for coaches to use.

Numerous methods exist for how verbal cues can be delivered to encourage an EXT focus. For instance, a distal (DIST) or proximal (PROX) focus ('jump as close or as far past to the cone as possible') can be given to manipulate the spatial distance between the movement goal and action.¹⁰ An EXT focus can also be achieved via the use of analogies in which task-relevant rules are provided as a verbal single biomechanical metaphor ('jump as if the ground is suddenly hot and you have to get off it as quick as possible') to direct attention to external features of the movement or to its result.¹¹ Also, the use of a holistic (HOL) cue that directs attention to the general feeling or sensations associated with the movement ('focus on feeling explosive') has been suggested to be an effective method to avoid conscious control of movement.¹² Although a HOL focus could be considered an extension of an EXT focus, it may direct attention to some aspects of the body.³ Nevertheless, since a HOL focus does not focus specifically on generating or controlling body movement like an INT cue, a HOL focus can be considered as an alternative to an EXT focus.² Overall, it appears that a range of verbal cue types exist which can be used to avoid conscious control of a movement during a task.

Despite the proposed benefits of promoting an EXT focus during a task, few studies have compared the effects of EXT

verbal cue types on performance in youth athletes. In young male soccer players, EXT verbal cues were found to influence the corresponding kinetic response during the drop jump (DJ) exercise (e.g. 'focus on getting as close to the ceiling as possible' increased jump height).¹⁴ Additionally, in young male academy soccer players, EXT verbal cues which emphasised velocity ('get off the ground as fast as you can') rather than force ('try and touch the ceiling with your head') resulted in greater countermovement jump (CMJ) performance.¹⁵ However, the aforementioned studies did not specifically include a directional focus or make comparisons with other EXT verbal cue types. To address this gap in the literature, an internal meta-analytical approach was used to analyse CMJ height in young male athletes by using a range of EXT cue types.⁶ However, minimal differences were found when using either neutral, INT, proximal, distal or analogy cues. The authors highlighted that despite the minimal differences between verbal cue types, they did not necessarily impede CMJ performance. Consequently, further research is required to determine the efficacy of different verbal cue types in youth athletes.

The ability to perform jumping based tasks is considered a key athletic movement skill competency (AMSC) that youth athletes must develop.¹⁷ As a result, tests such as the CMJ are a popular method used to assess athletic performance in children and adolescents.¹⁸ This is because the CMJ enables physical qualities such as lowerbody power to be assessed via measuring outcome variables such as jump height.¹⁹ However, to enable a more detailed understanding of an athletes' lower-body explosiveness capabilities it is suggested that both outcome (e.g. jump height) and strategy (e.g. force-time characteristics) variables are collected.²⁰ Further, measurements of force-velocity variables taken from specific phases of the CMJ (e.g. eccentric, concentric) enable a more comprehensive analysis of an athlete's jumping ability.²¹ This is useful for adolescent athletes as CMJ outcome and force-time metrics are associated with jumping,²² sprinting,²³ and change of direction.²⁴ Moreover, CMJ training itself has been shown to improve speed and power performance in youth athletes.²⁵ Therefore, identifying training methods that can optimise CMJ performance in youth athletes may offer further insights as to how physical qualities for this population can be developed.

To the authors' knowledge, only one study to date has investigated the effects of different EXT verbal cue types on jump performance in youth athletes. However, the study in question only measured CMJ jump height.¹⁶ Further, how a HOL cue influences jump performance in youth athletes is unknown. As a result, little is known regarding how different EXT verbal cue type influence force-time metrics during important AMSC tasks such as jumping in youth athletes. This knowledge and practical gap are important to address in youth as verbal feedback needs to consider both cognitive and motor capabilities which accelerate during adolescence.²⁶ Subsequently, increasing knowledge within this area as to how different EXT verbal cues types influence CMJ performance and force-time measures in youth athletes may provide further insights into coaching strategies and training methods for this specific population. Accordingly, the aim of this study was to investigate the influence of different EXT verbal cues on CMJ performance and force-time measures in youth athletes.

Methods

Experimental design

A within-group, randomised, repeated-measures design was used to examine the effects of different EXT verbal cue types on CMJ performance in young, trained female athletes. Participants performed two CMJs for each of the five verbal cue conditions which included neutral (CON), external-distal (DIST), external-proximal (PROX), analogy (ANA) and holistic (HOL). Considering the proposed benefits of using EXT verbal cues and the suggestion that single-cue training protocols are not representative of so-called 'real-world' sport coaching practice,²⁷ this study design was used to determine if different EXT cues were more effective for CMJ performance compared with a more general instruction.

Participants

A priori power analysis (G*Power; University of Düsseldorf, Dusseldorf, Germany) was used to determine a minimum sample size for this study. Based upon a repeated-measures analysis of variance (ANOVA) study design including one group and five conditions, a desired power of $(1-\beta)$ 0.90, an alpha error of 0.05 and an effect size (ES) of 0.51 based upon a previous eight-week training study which investigated the effects of using an EXT verbal cue compared to an internal on neutral cue on jump performance,²⁸ a minimum of eight participants were required. Subsequently, a total of ten 16–18-year-old young female athletes (age: 16.80 ± 0.60 years; stature: 173.86 ± 7.83 cm; body mass: 68.31 ± 9.96 kg) volunteered to participate who were part of the soccer and netball teams of an educational institution's sports academy, **that who** competed regularly at local and national level. Participants performed sport specific training two to three times per week (~90 min **per session**) and resistance training twice per week (~60 min **per session**). Additionally, participants had experience of performing the CMJ through training and/or testing procedures. As such, participants were classified as 'Trained/Developmental' athletes.²⁹

Participants were required to be free of any lower-body injuries for a minimum period of six months. Before testing, participants were informed about the details of the study and written informed consent from both participants and their parent/guardian was obtained. The design of the present study was carried out in accordance with the Declaration of Helsinki and was approved by the University ethics committee (ETHICS2022-130).

Procedures

Participants were required to attend two testing sessions which took place at the University's human performance laboratory and gym facilities. Prior to the testing sessions, the participants were asked to refrain from performing intense exercise 24 h prior to the session and to not consume caffeinated drinks beforehand. Although participants had previous experience of CMJ training and testing, the first testing session was intended to familiarise the participants with the CMJs on the dual force plates and advise them on the verbal cues types they could receive during the experimental session. Prior to performing the CMJs, participants standing stature (cm) and body mass (kg) were recorded before completing a warm up. The warm up consisted of 5-min cycling on low resistance at ~60 rpm, followed by a series of lower-body dynamic stretches including squats, lunges, glute bridges, single-leg Romanian deadlift and three CMJs with increasing intensity. Following the warm up, participants were given a 5-min passive recovery period before performing their maximal CMJs on a dual force plate. For the second testing session, where the verbal cues were provided, a random number generator (<https://www.random.org/>) was used to randomly allocate each participant to their 'jump order' for the 10 jumps (2 jumps for each cue) with the following numbers used; 1 = Neutral, 2 = Proximal, 3 = Distal, 4 = Analogy and 5 = Holistic. The same investigator provided the verbal cues for all participants. The verbal cues used for the experimental sessions can be seen in Table 1.

Table 1. Countermovement jump (CMJ) verbal cues.

Cue type	Verbal cue
Control	Jump as high and fast as possible at your preferred depth.
External-Proximal	Focus on jumping as far above the ground as possible.
External-Distal	Focus on jumping as close to the ceiling as possible.
Analogy	Focus on jumping to beat an opponent to the ball.
Holistic	Focus on feeling as explosive as possible during the jump.

Prior to stepping onto the force plates for each CMJ, the participants were instructed that the goal of CMJ was to 'jump as high and as fast as possible at your preferred depth'. This instruction was provided as a neutral cue since it had been shown to improve explosive CMJ performance.³⁰ Once participants stepped onto the force plates, they were asked to obtain their 'ready' position which involved standing in a tall position, hands placed on their hips, each foot placed on one of the dual platforms, and to remain motionless for a minimum of 1 s. This was done to ensure a stable baseline of force at bodyweight was obtained which was measured as the average vertical ground reaction force (GRF) during this period. Participants were then provided their randomly selected verbal cue and were advised to begin the jump when they were ready to do so. No specific verbal cues were used for the landing phase, but participants were instructed to land back onto the force plates before returning to their initial 'ready' position. A minimum rest period of 60 s between CMJ trials was provided to the participants. If the participants ascended before initiating downward movement, paused between the ascent and descent phases or flexed their hips or knees during the flight phase, the trial was nullified and repeated. To assist with the aforementioned, the lead author visually inspected each participant's raw force-time trace from the force plate software.

Data processing

All CMJs were collected on a dual force plate (NMP ForceDecks FD4000-Vald Performance, Brisbane, Australia) with proprietary software (ForceDecks Software 2.0.8587) used for data analysis. The intrasession reliability of the ForceDecks system to measure CMJ in athletes has previously been reported.³¹ All data were recorded at a sampling frequency of 1000 Hz. To improve the accuracy of identifying the onset of movement, the ForceDecks software was set to 5 standard deviations (SD) of body weight that was measured during the ~1 s weighing phase.³² Additionally, prior to every CMJ the force plates were zeroed, and body weight of the participants retaken to ensure any subtle changes in system weight

between trials could be accounted for in the ForceDecks software.³³

Force-time variables selected for analysis were based upon proposed CMJ subphases³⁴ These subphases included the eccentric braking phase (defined as from peak negative centre of mass (COM) velocity until $0.\text{ms}^{-1}$) and concentric phase (defined as the moment when vertical COM velocity was greater than $0.\text{ms}^{-1}$ until take off when vertical GRF reduced below 20 N). The modified reactive strength index (RSI_{MOD}) was calculated (jump height / jump time) as a measure of explosiveness during the CMJ.³⁵ Jump height was calculated via the impulse-momentum method as per force plate recommendations.³⁶ Countermovement depth (lowest COM displacement achieved prior to take-off) was calculated as a percentage of standing COM height.³⁷ Rate of force development (RFD) was calculated as the change of vertical GRF divided by the change in time. However, concentric RFD was not included for data analysis due to poor reliability ($\text{CV} > 70\%$ for all cues), which is in accordance with previous research of this CMJ measure.³¹ Force and RFD values were normalised to bodyweight for each participant. The average of the two jumps from each verbal cue was used for statistical analysis.

Statistical analysis

Absolute reliability for all CMJ variables for each condition was calculated as a coefficient of variation percentage (CV%) via the root square method with upper and lower 95% confidence intervals (CIs) reported.³⁸ Based upon the upper 95% CI, a CV of $\leq 10\%$ and $\leq 5\%$ was considered to represent good and excellent reliability, respectively.³⁹ Normality of data was assessed using the Shapiro–Wilk test. Sphericity was examined using Mauchly's test and, where violated, a Greenhouse-Geisser adjustment was applied. Data was analysed using a 1 (group) \times 5 (conditions) repeated-measures ANOVA to examine the effects of the different verbal cues on CMJ performance. For those CMJ variables nonnormally distributed then the Friedman Test was used. Where significant main effects were observed, post-hoc analysis was conducted using Bonferroni post-hoc pairwise comparisons for normally distributed data and the Conovers post-hoc test for non-normally distributed data. An alpha level of $p \leq 0.05$ was used to determine statistical significance with analysis completed using JASP (v 0.17.1, University of Amsterdam, Netherlands). Given that statistical significance and practical importance are different outcomes, the ES were calculated to describe the magnitude of differences between conditions. ES are presented alongside their 95% CI. ES were calculated in Microsoft Excel using Hedges g and were interpreted as < 0.20 = trivial, 0.20 – 0.59 = small, 0.60 – 1.19 = moderate, 1.20 – 1.99 = large and ≥ 2.00 = very large.⁴⁰

Results

Results for all variables are shown in Table 2. The within-subject reliability for all CMJ measures was deemed good ($\text{CV}\% = 0.57\%$ – 10.06%) except for braking RFD in the PROX, DIST and ANA conditions ($\text{CV}\% = 16.24\%$ – 19.30%). For RSI_{MOD} , no significant differences between cues were observed ($F = 1.742, p = 0.162$). For jump height, a significant difference between cues was observed ($F = 3.590, p = 0.015$) with an increase in ANA compared to CON ($p = 0.009, g = 0.37, \text{CI} = -0.35$ to 1.13). For jump time, a significant difference between cues was observed ($\chi^2 = 10.960, p = 0.027$) with an increase in PROX compared to the CON ($p = 0.043, g = 0.60, \text{CI} = -0.12$ to 1.38). For countermovement depth, a significant difference was observed between cues ($F = 4.628, p = 0.039$) with increases found in PROX ($p = 0.006, g = 0.60, \text{CI} = -0.13$ to 1.38), HOL ($p = 0.040, g = 0.46, \text{CI} = -0.26$ to 1.23) and ANA ($p = 0.031, g = 0.51, \text{CI} = -0.21$ to 1.28) compared to CON.

Table 2. Countermovement jump metrics for the different verbal cue types.

Variable	Control	Proximal	Distal	Holistic	Analogy
RSI_{MOD}	0.37 ± 0.06 (2.41%–5.16%)	0.34 ± 0.05 (2.67%–5.35%)	0.35 ± 0.06 (2.56%–6.00%)	0.36 ± 0.06 (2.18%–5.13%)	0.36 ± 0.07 (2.16%–5.01%)
Jump height (cm)	25.47 ± 2.62 (1.54%–3.45%)	26.13 ± 2.93 (1.88%–5.88%)	25.79 ± 2.89 (1.53%–3.95%)	26.06 ± 2.81 (1.65%–3.37%)	26.67 ± 3.51 (1.29%–2.31%)
Jump time (ms)	706 ± 84 (2.27%–4.38%)	768 ± 111 (2.27%–4.24%)	751 ± 115 (1.40%–3.64%)	736 ± 107 (1.75%–3.87%)	748 ± 104 (2.17%–4.79%)
Countermovement depth (% Height)	-13.76 ± 2.06 (1.48%–3.44%)	-15.34 ± 2.91 (1.72%–3.51%)	-14.50 ± 2.11 (1.84%–4.23%)	-15.01 ± 3.01 (1.98%–4.09%)	-15.08 ± 2.80 (2.51%–5.09%)

Concentric time (ms)	246 ± 34 (1.41%–3.50%)	264 ± 39 (2.11%–4.62%)	255 ± 32 (2.71%–4.92%)	259 ± 40 (1.90%–2.73%)	258 ± 34 (1.77%–3.45%)
Concentric mean force (xBW)	1.93 ± 0.13 (0.60%–1.43%)	1.88 ± 0.12 (1.11%–2.24%)	1.91 ± 0.13 (1.49%–2.70%)	1.90 ± 0.13 (0.97%–1.81%)	1.91 ± 0.13 (0.80%–1.88%)
Concentric peak velocity (m·s ⁻¹)	2.38 ± 0.12 (0.57%–1.40%)	2.40 ± 0.13 (0.73%–2.15%)	2.39 ± 0.13 (0.61%–1.57%)	2.40 ± 0.12 (0.80%–1.60%)	2.42 ± 0.15 (0.57%–1.18%)
Braking time (ms)	146 ± 24 (1.59%–3.33%)	162 ± 34 (3.49%–10.06%)	153 ± 29 (3.34%–6.92%)	155 ± 29 (2.93%–6.06%)	152 ± 25 (3.21%–8.21%)
Braking RFD (BW/s)	9.62 ± 2.59 (2.97%–5.48%)	8.12 ± 2.31 (5.69%–16.24%)	8.77 ± 2.66 (7.88%–18.53%)	8.93 ± 2.60 (4.76%–9.41%)	9.02 ± 2.54 (6.40%–19.30%)
Braking mean force (xBW)	1.84 ± 0.18 (0.99%–2.14%)	1.76 ± 0.18 (2.03%–4.46%)	1.78 ± 0.21 (1.33%–2.92%)	1.82 ± 0.22 (1.89%–3.33%)	1.83 ± 0.21 (1.27%–3.71%)
Eccentric peak velocity (m·s ⁻¹)	-1.19 ± 0.18 (0.99%–2.37%)	-1.16 ± 0.18 (1.86%–4.39%)	-1.13 ± 0.20 (2.43%–5.65%)	-1.20 ± 0.22 (2.52%–4.39%)	-1.19 ± 0.21 (1.82%–4.08%)

Results are shown as mean ± SD with lower and upper 95% confidence interval bounds reported for the coefficient of variation in brackets.

*RSI_{MOD}: reactive strength index modified; BW: relative to body weight; RFD: rate of force development.

In the concentric phase, a significant difference was observed between cues for concentric time ($F = 2.871, p = 0.037$) with an increase in PROX compared to CON ($p = 0.025, g = 0.47, CI = -0.25$ to 1.24). For concentric peak velocity, a significant difference was observed between cues ($F = 4.654, p = 0.004$) with an increase in ANA compared to CON ($p = 0.002, g = 0.28, CI = -0.44$ to 1.03). No significant differences between cues were found for concentric mean force ($F = 1.675, p = 0.177$).

In the eccentric braking phase, a significant difference between cues was found for braking time ($\chi^2 = 10.046, p = 0.040$) with an increase in PROX compared to CON ($p = 0.006, g = 0.52, CI = -0.20$ to 1.29) and ANA ($p = 0.037, g = 0.32, CI = -0.41$ to 1.08). For braking RFD, a significant difference between cues was observed ($F = 4.126, p = 0.007$) with a decrease in PROX compared to CON ($p = 0.003, g = 0.59, CI = -0.14$ to 1.36). For braking mean force, a significant difference was observed between cues ($F = 3.286, p = 0.021$) with a decrease in PROX compared to CON ($p = 0.039, g = 0.43, CI = -0.30$ to 1.19). No significant differences between cues were observed for eccentric peak velocity ($F = 1.771, p = 0.156$).

Discussion

The aim of this study was to examine if executing the CMJ in youth athletes was influenced using different EXT verbal cue types. To the authors' knowledge, this was the first study to directly compare the effects of multiple different EXT verbal cue types on both CMJ performance and force-time measures in youth athletes. Overall, minimal differences were found between verbal cue types for CMJ performance and force-time measures. Specifically, statistically significant findings were only to a small-moderate magnitude of effect. These effects primarily related to PROX which compared to CON resulting in increases in jump time, concentric time and eccentric braking time, as well as lower eccentric braking RFD and eccentric braking mean forces. Further, countermovement depth was influenced by verbal cue type with increases reported for PROX, HOL and ANA compared to CON.

Our findings are like those previously reported in trained youth male athletes in which CMJ performance was similar when using either neutral, INT, EXT, PROX analogy and DIST analogy verbal cues⁶. In the current study, force-time characteristics of the CMJ were also found to be similar when using either neutral or EXT verbal cues. Contrastingly, although previous research in trained youth athletes did not include ANA and HOL conditions, EXT verbal cues influenced force-time characteristics during the DJ¹⁴ and CMJ¹⁵ compared to neutral cues. Other populations, including recreational active individuals⁴¹ and elite athletes,¹⁰ have also increased jump performance when using an EXT verbal cue compared to a neutral cue. Therefore, it is possible that the participants used in this study were simply not receptive to the EXT verbal cues provided. A similar finding was also shown in recreationally active adults in which no significant differences in jump performance were observed when performing the CMJ with either a neutral cue of 'jump to the best of your ability' or four different EXT verbal cues which had a PROX or DIST emphasis⁴². Since attentional focus is dependent on the interaction of several variables such as cue type, skill level, preference and personality dimension,⁴³ it is likely that our verbal cues did not

take into account such factors for the current population to find the EXT verbal cue types effective.

A further potential explanation for the similar responses to the verbal cue types provided in the current is whether the novelty of the EXT verbal cue types impacted their effectiveness. Although the participants were familiar with the CMJ, they were not familiar with the specific EXT verbal cues provided. Previously, in expert jump rope performers, verbal cues were found to have little to no effect on jump rope performance.⁴⁴ The authors reported that a relatively low number of the performers (13–53%) were familiar with each cue and suggested the novelty of the verbal cues might have disrupted immediate performance. Indeed, reduced cue familiarity has previously been shown to degrade skill performance in athletes.⁴⁵ Thus, it is possible that the neutral cue of 'jump as high and as fast as you can' was sufficient to elicit maximal CMJ performance in this group of participants. Furthermore, indeed, it has been argued that regardless of where an athlete's attention is directed, the primary concern is to ensure relevant information is provided which guides the athlete to the most important aspects of the task.⁴⁶ As such, for the CMJ, a task which is completed over a short period of time (e.g. 700 ms), providing information that simply focuses on the objective of the task (i.e. height and speed) may be all that is needed for some athletes who are already familiar with the task.

Despite minimal differences between verbal cues being observed for most force-time metrics, the PROX cue resulted in significant increases in jump time, concentric time and braking time as well as decreases in braking RFD and braking mean force. Such characteristics are not desirable to optimise CMJ performance.^{21,47} A PROX focus has also been reported to result in lower performance in other jumping tasks. For example, during horizontal jumping tasks a PROX focus resulted in shorter jump distances than a DIST cue.^{10,48} Previous research has shown that skill-level influences the effects of DIST and PROX cues with more skilled participants benefitting from a DIST focus whereas a PROX focus was more beneficial for less-skilled participants.⁴⁹ This has been suggested to occur because skilled performances have greater automaticity of movement control and therefore a PROX focus may direct attention to movement effects closer to the body rather than the overall task goal.⁵⁰ As a result, a focus of attention which distracts from the task goal may disrupt the fluidity of movement.⁴⁹ Evidence for this suggestion has been recently provided in skilled volleyball players in which greater accuracy and functional variability occurred during overhead volleyball serves when using a DIST versus PROX cue.⁵¹ Therefore, due to the trained status of the participants in the current study and their familiarity with performing the CMJ, this may help explain why a PROX focus was detrimental to their CMJ performance.

Interestingly, ANA and HOL cues significantly increased countermovement depth compared to CON but with no negative impact on CMJ performance or force-time measures. Although a relatively 'shallower' countermovement has been shown to result in higher RSI_{MOD} via achieving a faster jump time,³⁷ it is worth considering if in some instances athletes may benefit from verbal cues which result in a relatively deeper countermovement strategy during the CMJ. This is because an insufficient lowering of one's COM during a vertical jump, whether it be too deep or too shallow, may lead to reduced jump performance. For example, whilst a progressively deeper countermovement increases jump time which subsequently lowers RSI_{MOD} ,⁵² too shallow a countermovement shortens jump time which consequently reduces concentric and eccentric impulses, thus lowering jump velocity and jump height.⁵³ For female athletes, countermovement depth may be an important factor to consider since this is typically shallower compared to males.^{54–57} Indeed, the countermovement depth for all verbal cue types in the current study was between 13% and 15% of standing height whilst adolescent male athletes have been reported to be between ~17% and 19%.^{58,59} Therefore, if a shallow countermovement depth strategy is deemed to be limiting explosive jump performance via impacting jump height and/or jump time, verbal cues such as those used in the current study may be of use.

Limitations

Despite the novelty of the findings from the current study, limitations exist that could be improved in future studies. Firstly, to better understand the effectiveness of the verbal cues provided and whether our participants were receptive to these, reporting of their preferences and adherence to the cues could have been undertaken as per those used in other studies.^{13,44} Secondly, whilst the current study included measures of force-time metrics from specific phases of the CMJ, kinematic analysis of the lower-limb joints was not performed. Since verbal feedback has been shown to influence joint positions⁶⁰ and coordination variability⁶¹ in females during jumping tasks, such analysis would enable a further understanding as to how verbal cues can be used to modify performance within this population. This may be particularly helpful in youth athletes since growth and maturation can influence motor control.⁶² Additionally, verbal cues have been found to influence motor unit recruitment during dynamic tasks in athletes.⁶³ Thus, electromyographic measurements during the task may have provided further insights as to how the different verbal cues influence muscle activation which may in turn help inform exercise selection for performance and injury prevention purposes.⁶⁴

Practical applications

Our findings suggest the use of EXT verbal cues results in similar CMJ performance and force-time responses compared to a neutral cue in trained youth female athletes. Therefore, in some populations, the instruction of 'jump as high and as fast as you can' may already contain the relevant information to optimise their CMJ. However, whilst the DIST, ANA and HOL verbal cues overall did not appear to positively enhance CMJ performance compared to that of a neutral cue, it is important to note that they did not appear to impede CMJ performance either. Therefore, depending on the force, time or outcome metric being targeted for an individual during the CMJ, the use of these verbal cues may be effective. Nevertheless, the use of a PROX verbal cue during the CMJ may not be preferable should the goal be to reduce jump time or increase eccentric braking forces.

Declaration of conflicting interests

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