

Original Research

# Effects of Verbal and Tactile Cues on Gluteal Force Production and Broad Jump Distance

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### Background

Verbal and tactile cues can increase muscle activity, force production, and kinematics. Several studies demonstrate the effects of verbal and tactile cues on upper extremity muscles, while relatively few examined lower extremity muscles, specifically the gluteals. Studies that observed changes in gluteal function from verbal and tactile cues examined muscle activity via electromyography rather than force production or functional activities such as jumping.

### Purpose

The purpose of this study was to measure the effects of verbal and tactile cues on gluteal force production and broad jump distance.

### Study Design

Cross-Sectional cohort

### Methods

Gluteus maximus force production and broad jump distance were tested in forty-two healthy male and female university students at baseline and after verbal and tactile cues given in random order. Gluteus maximus force was measured using handheld dynamometry and reported in kilograms. Verbal cues included “push, push, push” before both tests. The examiner provided tactile cues to the gluteus maximus before force production testing, and the participant provided tactile cues to both gluteus maximus muscles before performing the broad jump. Performance on the broad jump was measured in centimeters. Descriptive statistics and test-retest reliability via Pearson correlation coefficients were calculated, differences in performance between sexes were analyzed with an independent t-test, and changes in force production and jump distance from baseline were analyzed using a one-way ANOVA.

### Results

Mean gluteus maximus force production following verbal cues significantly increased ( $p = 0.000$ ) by 13.48% (3.83 kg) compared to the control condition, while gluteal force production following the tactile cues was not significantly different. Broad jump distance following the verbal cues significantly increased ( $p = 0.000$ ) 3.99% (7.71 cm) compared to the control condition and significantly increased ( $p = 0.000$ ) by 2.95% (5.71 cm) following the tactile cues. There were no significant differences in performances between males and females. The test-retest reliability of all measurements was 0.97-0.99.

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## Conclusion

Verbal cues significantly increased gluteus maximus force production and broad jump distance. Tactile cues significantly increased broad jump distance but had no significant effect on gluteus maximus force. These results have implications for clinical testing and athletic performance when gluteus maximus force and jump distance are concerned.

## Level of Evidence

3

## INTRODUCTION

Verbal and tactile cues can influence muscle activity, muscle force, and kinematics. Verbal cues, also known as auditory cues, can take the form of internal cueing (e.g. singing) or external cueing (e.g. listening to music). Tactile cues such as tapping, sustained pressure, or the application of adhesive tape, for example, are considered external cueing. Multiple authors have demonstrated increased muscle activation using verbal cues, including triceps and pectoralis major activity during the bench press,<sup>1,2</sup> and gluteus maximus activity during prone hip extension<sup>3</sup> and bridging.<sup>4</sup> Increased force production appears to increase with verbal cues but has primarily been studied in the upper extremity.<sup>5-7</sup> Moreover, muscle force production appears to increase with increases in verbal cue volume, but few studies report the volume of the verbal cues used.<sup>5</sup>

Tactile cues also demonstrate the ability to affect muscle activity and kinematics. In combination with verbal cues, tactile cues in one study increased gluteus maximus activation during bridging from 16.8% to 33.0% of maximal voluntary contraction (MVC).<sup>4</sup> Similar research has been conducted on the effect of verbal and tactile cues during shoulder exercises.<sup>8</sup> Tactile cues alone, such as manual pressure to trunk muscles, can decrease thoracic kyphosis and scapular winging.<sup>9</sup> Manual pressure to hip muscles was also shown to alter cadence and other gait parameters.<sup>10</sup>

Although authors have demonstrated the ability of verbal and tactile cues to affect muscle activity, force production, and kinematics, no research exists on the ability of such cues to affect gluteus maximus force production or broad jump distance. This information could benefit clinicians when deciding how to cue a patient to achieve desired outcomes related to force and power. Therefore, the purpose of this study was to measure the effects of verbal and tactile cues on gluteal force production and broad jump distance. It was hypothesized that tactile and verbal cues would increase gluteus maximus force production and broad jump distance compared to a condition without cueing.

## METHODS

Healthy subjects were recruited from a local university for this cross-sectional study. Participants completed a survey to confirm their eligibility before participation. Participants completed an informed consent form and health questionnaire approved by the study institution's Internal Review Board (IRB) before testing. Participants were excluded if

they had lower extremity surgery within the prior year; had knee, hip, back, ankle, or foot pain; or were pregnant or trying to get pregnant. A single tester performed each intervention while blinded to the measurements of each outcome.

Before data collection, participants were familiarized with the testing procedures, and performed a stationary bicycle warm-up for three minutes near 60 rotations per minute at 60 Watts as a warm-up. Participants were randomized to perform prone hip extension dynamometry testing or standing broad jump testing first, underwent one familiarization trial for each test, and performed each activity with no cue, followed by a randomized verbal or tactile cue. Participants then repeated each test with the alternate cue.

Participants were shown how to perform the standing broad jump before their practice jumps. The standing broad jump test was measured with a tape measure stabilized to the floor with tape and a carpenter's square. A solid line of tape was placed perpendicular to the start of the tape measure to indicate the starting line for jumping. Participants were instructed to stand and jump as far forward as possible without stumbling or deviating from their landing position. Participants were instructed to swing their arms at the beginning of the jump to propel themselves forward. Measurements were taken from the starting line position to the heel landing point closest to the starting line and measured with the carpenter's square perpendicular to the tape measure. Measurements were not used if an additional step was taken upon landing, toes extended beyond the starting line before jumping, or hands contacted the floor to brace from falling. Participants performed another trial if one of those conditions was met.

Measurements included two trials each of no cue, verbal cue, and tactile cue for a total of six trials. After every measurement, the participant was given a 30-second rest before their next attempt. Attempt scores were recorded and averaged for each testing condition. The verbal cue was provided as the participants began each jumping motion. The tactile cue involved participants striking each gluteus maximus with ipsilateral palms at moderate intensity as demonstrated by a researcher and determined by the participant three times before the start of the broad jump. The intensity of striking was meant to be strong enough to be audible (although this was not intended as an auditory cue) and potentially increase blood flow without causing discomfort. The cues used are described in [Table 1](#).

The prone hip extension test measured hip extension force production with a handheld dynamometer (FEI Lafayette Manual Muscle Tester) for two trials for each cue

**Table 1. Cues for Standing Broad Jump Test**

No Cue:	"Start standing with your toes behind the line. Begin by raising your arms overhead at the shoulder, then quickly hinge at the hips, extend the arms at the shoulder, and jump forward by extending your hips as fast as you can."
Verbal Cue:	"Start standing with your toes behind the line. Begin by raising your arms overhead at the shoulder, then quickly hinge at the hips, extend the arms at the shoulder, and jump forward by extending your hips as fast as you can. This round I will shout "Push, push, push" once your arms extend prior to your jump."
Tactile Cue:	"Start standing with your toes behind the line. Begin by raising your arms overhead at the shoulder, then quickly hinge at the hips, extend the arms at the shoulder, and jump forward by extending your hips as fast as you can. This round I will have you slap your gluteals three times with your hands with moderate intensity before you start your jump (demonstrated by researcher)."

**Table 2. Cues for Prone Hip Extension Test**

No Cue:	"Keeping the knee bent to 90 degrees, slowly start lifting your leg and then lift as hard as you can, trying to break the blue strap."
Verbal Cue:	"Keeping the knee bent to 90 degrees, slowly start lifting your leg and then lift as hard as you can, trying to break the blue strap. For this trial, once you start lifting your leg, I will shout "Push, push, push." This will be loud, and I want you to push as hard as you can."
Tactile Cue:	"Keeping the knee bent to 90 degrees, slowly start lifting your leg and then lift as hard as you can, trying to break the blue strap. For this trial, I will tap your gluteal muscles prior to testing them. I want you to use these muscles to lift your leg."

condition listed in [Table 2](#). After every measurement, the participant was given a 30-second rest before their next attempt, allowing a 1:5 work-to-rest ratio which was deemed adequate based on similar research.<sup>11</sup> Attempt scores were recorded and then averaged for each testing condition to enhance objectivity of the data as is the practice in some studies.<sup>12</sup> Participants were positioned prone on the testing surface with the dominant knee flexed to 90 degrees with the handheld dynamometer placed over the distal femur ([Figure 1](#)). A strap was placed over the dynamometer to assist placement. The participant was instructed to start by extending the hip slowly and then as strongly as possible towards the ceiling. These instructions were given before every trial with no cues, verbal cues, or tactile cues. The no-cue trial was conducted first for each participant with one trial attempt before they completed their two trials under each condition. The verbal cue was "push, push, push" at a decibel level near 0.90 decibels once the participant initiated hip extension. The tactile cue was applied by the index, middle, and ring fingers pushing on the dominant side gluteus maximus over clothing three times, asking the participant to use that muscle to extend the hip as strong as possible.

Statistical analysis was performed using a one-way ANOVA to compare group means, an independent t-test to examine sex differences, and Pearson correlation coefficients for test-retest reliability of measurements. Data were examined for normality and the Scheffe test was used for post hoc analysis.

## RESULTS

Forty-two healthy subjects (20 female, 22 male) between 18 and 35 years of age (mean age = 23.07 ± 1.40 yrs; height = 173.81 ± 8.83 cm; weight = 75.67 ± 14.54 kg) participated.

**Figure 1. Prone Hip Extension Test Position and setup**

[Table 3](#) shows participant demographics. [Table 4](#) shows the mean results of two trials for no cue, verbal cue, and tactile cue conditions for all assessments. There was a statistically significant increase ( $p = 0.000$ ) of 13.5% for verbal cues during prone hip extension compared to the no cue control condition, but no significant difference existed for tactile cues during prone hip extension. A statistically significant increase ( $p = 0.000$ ) also existed among broad jump testing for verbal cues (4.0%) and tactile cues (3.0%) compared to the control condition, but not between verbal and tactile cue conditions. The significant differences in mean scores were not significantly different between males and females. The test-retest reliability for all measurements was 0.97-0.99.

**Table 3. Participant Demographics**

	Mean ± SD (females and males; n=42)	Mean ± SD (females; n=20)	Mean ± SD (males; n=22)
Age (years)	23.07 ± 1.40	22.85 ± 0.99	23.27 ± 1.70
Height (cm)	173.81 ± 8.83	167.80 ± 7.79	179.27 ± 5.65
Weight (kg)	75.67 ± 14.54	64.75 ± 9.03	85.60 ± 11.06

cm = centimeters; kg = kilograms; SD = standard deviation

**Table 4. Prone Hip Extension Strength and Broad Jump Distance with Verbal and Tactile Cues**

	Mean ± SD (females and males; n=42)	Mean ± SD (females; n=20)	Mean ± SD (males; n=22)
Gluteal Strength No Cue (kg)	28.41 ± 23.67	21.19 ± 11.67	34.97 ± 22.58
Gluteal Strength Verbal Cue (kg)	32.24 ± 22.22*	25.27 ± 15.58*	38.59 ± 17.72*
Gluteal Strength Tactile Cue (kg)	28.43 ± 22.61	21.69 ± 16.98	34.55 ± 18.32
Broad Jump No Cue (cm)	193.29 ± 16.22	161.18 ± 9.96	222.48 ± 11.54
Broad Jump Verbal Cue (cm)	201.00 ± 15.90*	168.23 ± 9.04*	230.79 ± 10.83*
Broad Jump Tactile Cue (cm)	199.00 ± 15.72*	167.01 ± 9.13*	228.09 ± 10.89*

cm = centimeters; kg = kilograms; SD = standard deviation; \* = significantly different from the no cue condition at the  $p < 0.000$  level

## DISCUSSION

The primary purpose of this study was to determine if gluteus maximus force production and broad jump distance can be altered with verbal or tactile cueing. While authors have demonstrated the ability of verbal and tactile cues to alter muscle activity, force production, and kinematics effectively, no studies have examined the effect of such cues on gluteus maximus force production and broad jump distance.<sup>1-10</sup> This study's results show that verbal and tactile cues can have statistically significant improvements on performance. Performance, in this study, was defined by prone hip extension force production measurements and the distance of standing broad jumps. The magnitude of prone hip extension force increase seen following verbal cues (13.5%) appears both statistically and clinically relevant. However, the clinical relevance of the 3-4% increase in broad jump distance is arguably low. Such an increase may be relevant to elite athletes, but that magnitude may only slightly extend beyond measurement error among recreational athletes or healthy adults. The intention was to examine common strength and power functions of the gluteus maximus. Females and males both significantly benefited from verbal cues during prone hip extension and the standing broad jump. Tactile cues significantly increased broad jump distance but did not significantly affect gluteus maximus strength. These results have implications for clinical testing of gluteus maximus force production and jump distance performance.

Multiple studies have demonstrated increased muscle activation using verbal cues, including gluteus maximus activity during prone hip extension and bridging. Lewis and Sahrman<sup>3</sup> concluded that cueing can alter muscle activation in healthy women during prone hip extension. Their

results demonstrated that muscle timing, activation amplitude, and movement can be affected by verbal cues. The same research suggests that using specific verbal cues to contract the gluteals or hamstrings can alter their firing pattern and improve biomechanical function. Hollman et al.<sup>4</sup> found that gluteus maximus electromyography activity also significantly increased following verbal and tactile cueing for the supine bridge exercise. The current study focused on hip extension force production and contributions to power (as measured via the broad jump) as primary outcome measures. This measurement approach allowed the authors to examine the immediate relationship between verbal and tactile cues and the ability to generate force during hip extension and broad jump distance.

This information could benefit clinicians when deciding how to cue a patient to achieve desired outcomes related to force and power during testing or performance. Multiple studies demonstrate increased muscle activation using verbal cues, including triceps and pectoralis major activity during the bench press.<sup>13,14</sup> In combination with verbal cues, tactile cues in one study increased gluteus maximus activation during bridging from 16.8% to 33.0% of MVC.<sup>4</sup> The difference between muscle activation as measured in these studies, and force production as measured in the current study, is notable. An increase in muscle activation may or may not lead to a corresponding increase in force production.

Several interventions demonstrate the ability to increase broad jump distance in addition to verbal cues. Clinicians can use evidence-supported strategies from this study as well as previous research to impact an individual's performance. The inclusion of arm motion, modification of take-off angle, starting position of the feet, and holding light weights all appear to impact broad jump distance.<sup>15</sup> Com-

pared to an average standing broad jump of 222.48 cm in the present study, another study consisting of 773 first-year police officers of similar ages demonstrated average values of 210 cm, suggesting this study's sample may have had more jumping ability than others with the potential for a ceiling effect of the intervention.<sup>16</sup>

When looking at clinical and athletic populations, proper cueing to elicit the desired response of an athlete, patient, or client is an effective intervention to increase performance. Practical application of these cues can be used in everyday settings by providing tactile or verbal cues to increase performance or other outcomes. Improved performance followed by specific verbal instructions can be further explained by the "constrained action hypothesis."<sup>17</sup> The theory states that when an internal cue is used, it increases muscle activity. In contrast, using an external cue increases neuromuscular coordination with decreased electromyographic activity. Therefore, appropriate cueing is important and dependent on the task. The use of tactile and external verbal cues proved effective for increasing performance in the present study. An internal cue may be more suitable to increase specific muscle activity, while an external cue may be more appropriate when looking at task-oriented performance.

Fatigue was the main limitation seen in this research. Though rest periods were implemented to allow adequate recovery during testing, some participants showed signs of fatigue with testing, most notably following failed broad jump attempts. Further limitations include that only college-aged individuals were tested, the volume or exact decibel of the verbal cues was not identical during trials as they would be with the use of a recording (although re-

searchers attempted to maintain similar volume over trials), and the intensity of tactile cues was not measured and thus may have varied between trials and participants. Also, the study was designed only to analyze immediate effects of cueing; therefore, the lasting impact of such cues is unknown and may warrant future study.

## CONCLUSION

The results of this study indicate that verbal and tactile cueing can improve gluteus maximus force production and broad jump distance compared to no cueing. Practitioners may be more effective in administering performance tests or delivering targeted interventions in the fields of sports medicine and physical therapy with the use of these cues. Further research into the effects of verbal and tactile cueing should include a broader population, additional outcome measures, and examining the effect on actual sports performance.

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## CONFLICT OF INTEREST

There are no potential conflicts of interests, including financial arrangements, organizational affiliations, or other relationships that may constitute a conflict of interest regarding the submitted work.

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