**Effect of Verbal Cueing on Sagittal Plane Drop Jump Landing Kinematics and Ground Reaction Forces.**

**Denn-Thiele T, Lin H, Outar R, Shnider L,**

**Background:**

The prevalence of lower extremity injuries among the athletic population account for nearly 50% of injuries.[1] Football has the highest incidence rate for male athletes, and conversely, soccer has the highest incidence rate among female athletes. The leading pathologies are ligament sprains (50%), muscle strains (17%), contusions (12%), and fractures (5%).[2] The ankle was the most affected joint found in younger patients (206 per 100,000; 95% confidence interval, 181-230) followed by the knee and then the hip. Given the low acuity of sprains and strains and their increased frequency in emergency room visits it places a significant strain on healthcare resources. Methods of injury reduction should be implemented to help reduce the incidence of emergency room visits that are low acuity in nature.[3] Modifying landing mechanics through conservative and preventative treatment is a viable method to reduce the incidence of lower extremity injuries.[4] This research study focuses on the use of verbal cueing to alter kinematics and ground reaction forces to reduce lower extremity injuries.

**Methods:**

In order to evaluate the effect of verbal cueing on drop jump landing kinematics, two participants were recruited for the study. Both participants were instructed under three conditions to perform drop jump landings and were given three trials per condition. Warm-up exercises were performed before attempting the first jumps, which included a 3 minute walk at a self-selected speed, walking lunges with rotation, and lateral squats for a total of 5 minutes. The independent variable for this experiment was the verbal cueing provided: loud, soft, and self-selected. The dependent variables included vertical ground reaction force (force with which the participants contact the ground), sagittal plane kinematics at the hip, knee, and ankle joints (angles of each respective joint as the participants land and recover from the landing), and axial loading rates (how quickly is the force distributed after the landing). Data was collected via marker models on Vicon® 8-camera Motion Capture System and Kistler® force plates. Markers were placed as per the Plugin gait model[5].

**Results:**

The cueing implemented had an effect on all of our dependent variables as shown in figures 1-3. With the soft landing condition, participants landed in a more flexed position across all joints, forces on the body were decreased 14% (self-selected: 21N/Kg, soft: 18 N/Kg) and applied at a 30% slower rate (self-selected: 338.85 N/s, soft: 227.27 N/s). In the loud landing condition, subjects landed in a more rigid landing position which was correlated with a 47% increase in the vertical force acting on the body self-selected: 21N/Kg, loud: 31 N/Kg) and more than a 100% increase in the rate at which this force was applied (self-selected: 338.85 N/s, loud: 793.51 N/s). Larger differences were observed between the 'loud' and self-selected conditions than the 'soft' and self-selected

---

1

2

3

4

5

conditions, likely due to the fact that the subjects in this study were individuals with backgrounds in athletics and proper landing mechanics. Kinematic data are shown below in Table 1.

| Overall Sagittal Peak ROM | Self-Selected | Soft Average | Loud Average |
|---|---|---|---|
| RKnee | 110.42 ± 5.51 | 119.29 ± 7.92 | 108.28 ± 13.54 |
| RHip | 84.85 ± 11.91 | 87.90 ± 12.90 | 79.87 ± 17.57 |
| RAnkle | 33.36 ± 6.16 | 35.36 ± 4.89 | 33.86 ± 6.92 |
| LKnee | 112.00 ± 5.05 | 122.21 ± 6.42 | 111.68 ± 12.93 |
| LHip | 85.45 ± 9.13 | 88.611 ± 9.43 | 80.78 ± 15.24 |
| LAnkle | 33.57 ± 6.43 | 36.27 ± 5.89 | 35.19 ± 7.86 |

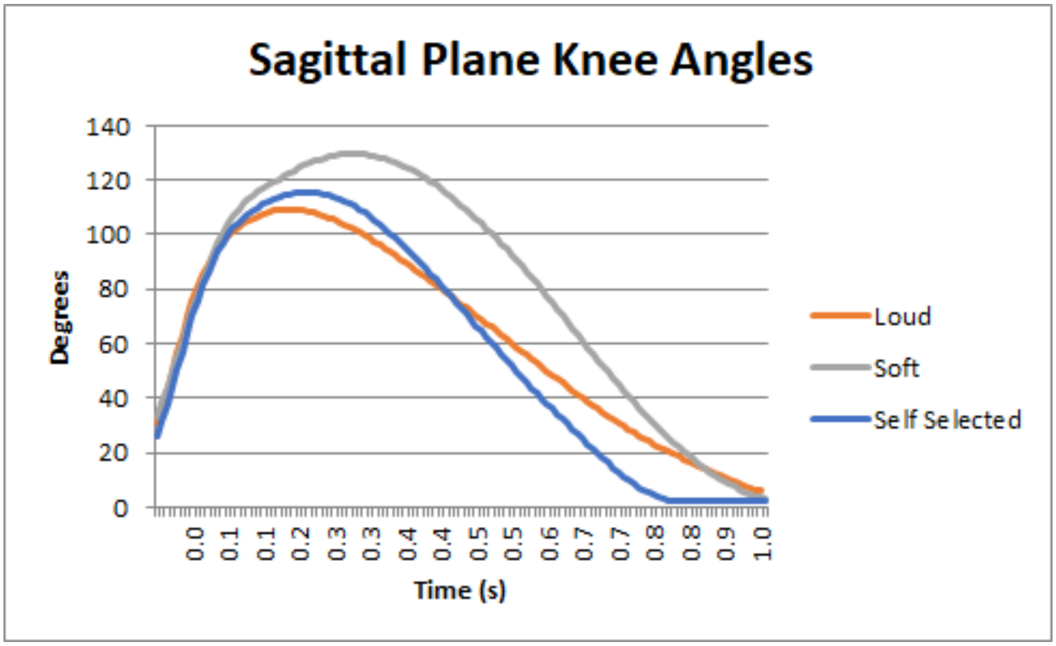
Table 1. Total Sagittal Plane ROM

**Discussion:** This study shows that our auditory biofeedback can make a difference in changing the landing mechanics of athletes. All of the findings indicate that the cues of 'soft landing' may help to decrease injury risk. By improving landing mechanics in this manner, we can help to decrease injury risk for large amounts of athletes with simple cues. Specifically, it has been noted in previous literature that the changes we observed in the 'soft' landing condition compared to the 'loud' and self-selected are associated with decreased risk of ACL injury, decrease in knee pain of symptomatic athletes, and reduced tendon load throughout the lower extremities.

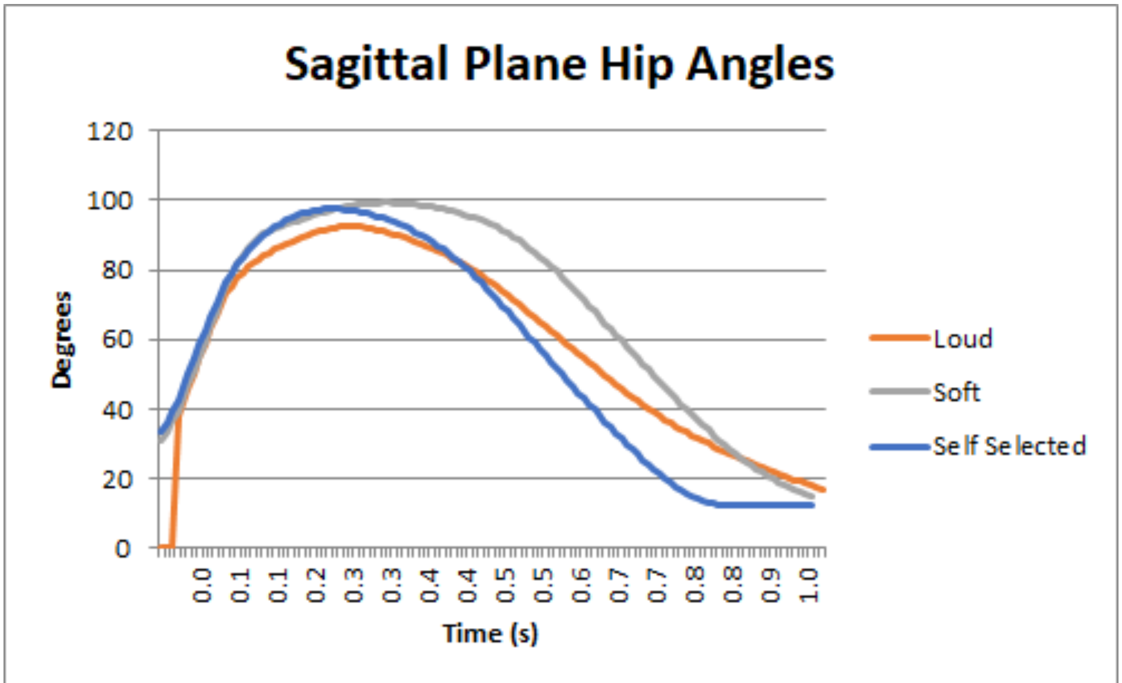
**Citations:**


1. Rosa, B. B., Asperti, A. M., Helito, C. P., Demange, M. K., Fernandes, T. L., & Hernandez, A. J. (2014). Epidemiology of sports injuries on collegiate athletes at a single center. *Acta Ortopedica Brasileira*, *22*(6), 321–324.
2. Fernandez, W. G., Yard, E. E., & Comstock, R. D. (2007). Epidemiology of Lower Extremity Injuries among U.S. High School Athletes. *Academic Emergency Medicine*, 14(7), 641–645.
3. Lambers, K., Ootes, D., & Ring, D. (2012). Incidence of Patients with Lower Extremity Injuries Presenting to US Emergency Departments by Anatomic Region, Disease Category, and Age. *Clinical Orthopaedics and Related Research*, *470*(1), 284–290.
4. Monajati, A., Larumbe-Zabala, E., Goss-Sampson, M., & Naclerio, F. (2016). The Effectiveness of Injury Prevention Programs to Modify Risk Factors for Non-Contact Anterior Cruciate Ligament and Hamstring Injuries in Uninjured Team Sports Athletes: A Systematic Review. *PLoS ONE*, *11*(5), e0155272.
5. Guide VP-iGP. Foundation Notes Revision 2.0 March 2010. *For Use with Plug-in Gait Version.* 2010;2.


.



Sagittal Plane Knee Angles
140
120
100
80
60
40
20
0
Degrees
0.0
0.1
0.1
0.2
0.3
0.3
0.4
0.4
0.5
0.5
0.6
0.7
0.7
0.8
0.8
0.9
1.0
Time (s)
Loud
Soft
Self Selected



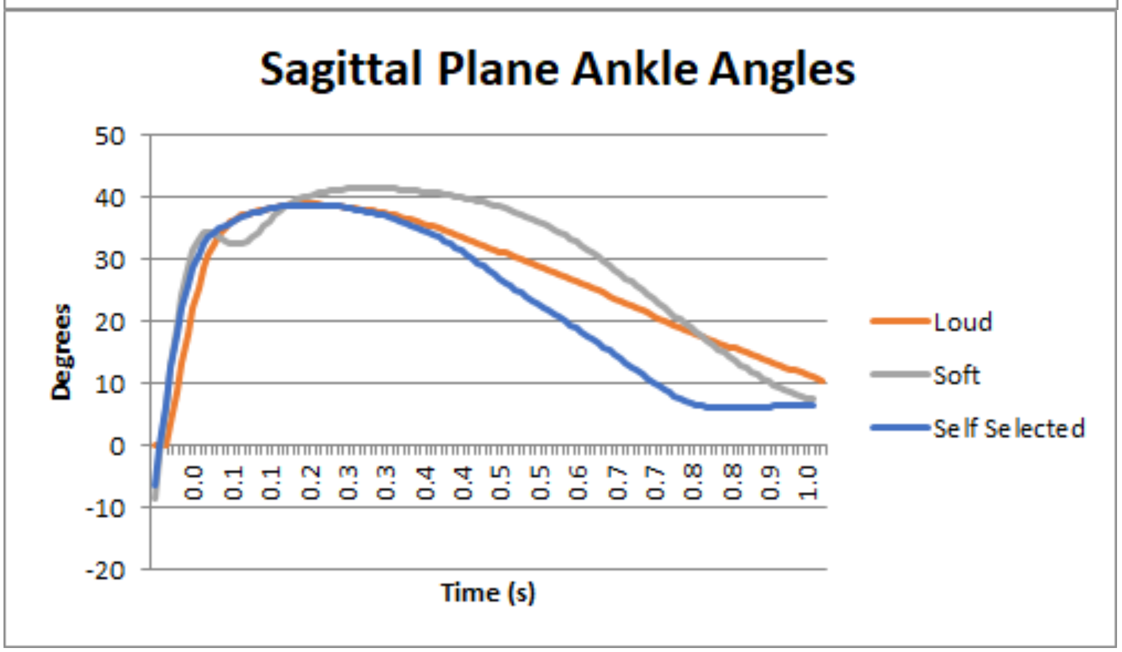




**Figure 1 A-C. Sagittal Plane angles at the hip, knee and ankle respectively.**

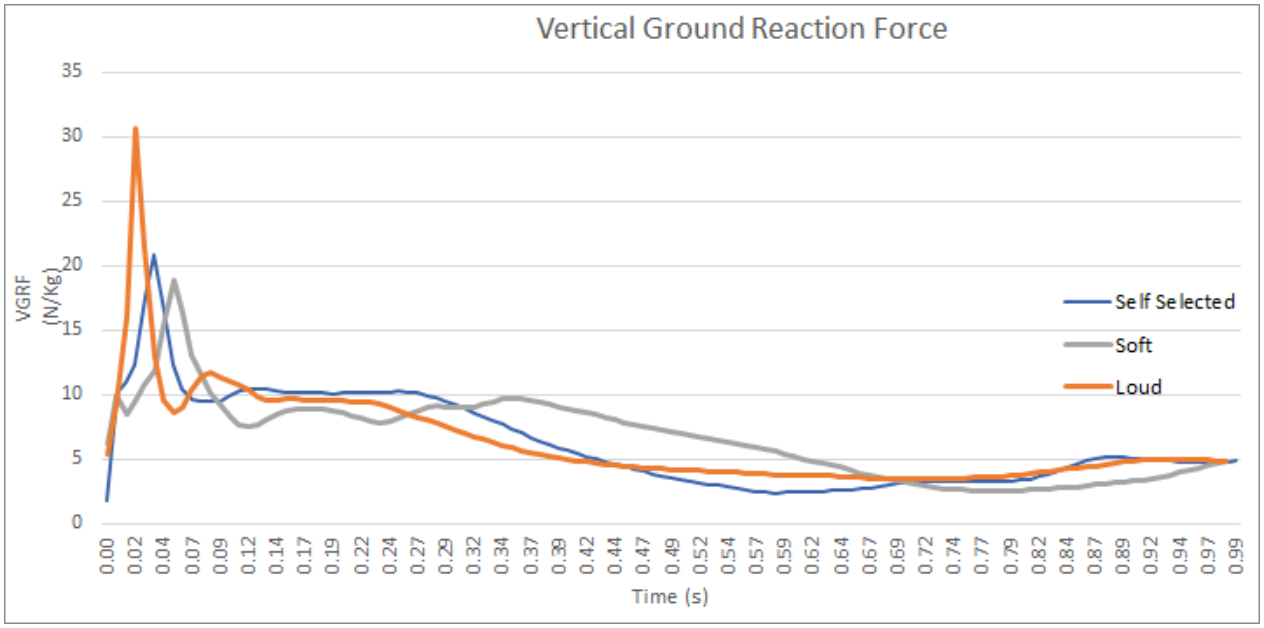



**Figure 2. Vertical Ground reaction forces**

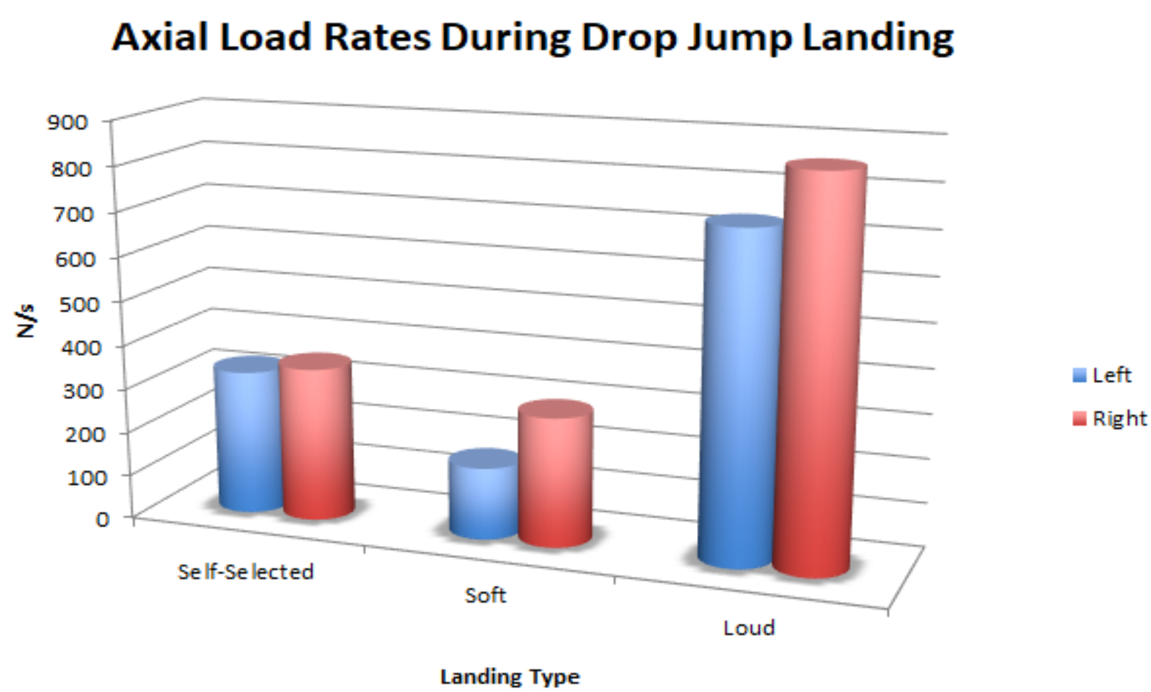



**Figure 3. Axial Loading Rates.**