Effect of cognitive tasks on forward lunge performance: A biomechanical analysis

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Introduction

The Forward Lunge (Fig 1)

- Increases the strength of the ankle, knee and hip joint[1], as well as the muscles of the lower body (gluteus maximus, iliopsoas, quadriceps, hamstrings, soleus and gastrocnemius)[2].
- Requires balance to maintain stability[3].
- Is commonly used in rehabilitation programmes[1,4] and in training for athletes[4].

Dual Tasking

- Dual tasking is performing two tasks at the same time, for example, doing a motor task and a cognitive task simultaneously[5].
- Decreases performance in one or both of the tasks[5].
- The addition of a cognitive task has a negative impact on balance[6].

Figure 1: Forward Lunge.

Aims

- To determine if performing a cognitive task while lunging affects an individuals lunge performance.

Purpose

- Practicing dual tasking has been shown to increase the ability to dual task[6].
- There is limited research on the effect of dual tasking on the forward lunge exercise.
- Understanding the effects of dual tasking on the forward lunge exercise could support the use of cognitive tasks along with the forward lunge exercise to increase the difficulty of training and rehabilitation programmes.

Methodology

- 6 able-bodied young individuals (3 male, 3 female, age:23.5±3.5 years) participated in the study.
- 16 reflective markers were attached using the Plug-in Gait model in Vicon Nexus (Fig 2)

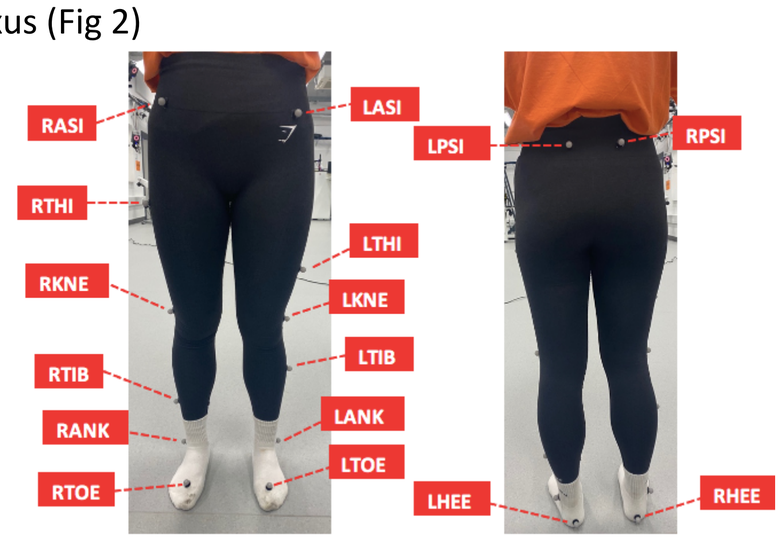

Figure 2: Marker placement using the Plug-in-Gait model.

Tasks

- Each task was completed for 5 reps on each leg.

Table 1: Description of different tasks completed by each participant.

Task	Description
Normal lunges	Perform forward lunges.
Lunges with Stroop Test	Perform forward lunges whilst completing a Stroop test displayed on screen.
Lunges with Arithmetic Task	Perform forward lunges whilst counting down in 3s from 100.
Lunges with On-screen Arithmetic Task	Perform forward lunges whilst subtracting numbers that appear on screen from 100.

Motion Capture

- 12 Vicon Nexus motion capture camera's were used to collect kinematic data.
- The camera's were calibrated prior to each use.

Data Processing

- Small gaps in the data were filled using either the cubic spline or cyclic function.
- Data was filtered using a Woltring filter.
- Peak hip, knee and ankle flexion were found using MATLAB.

Statistical Analysis

- Data was analysed using multiple univariate ANOVAs with a Tukey post hoc test.

Results

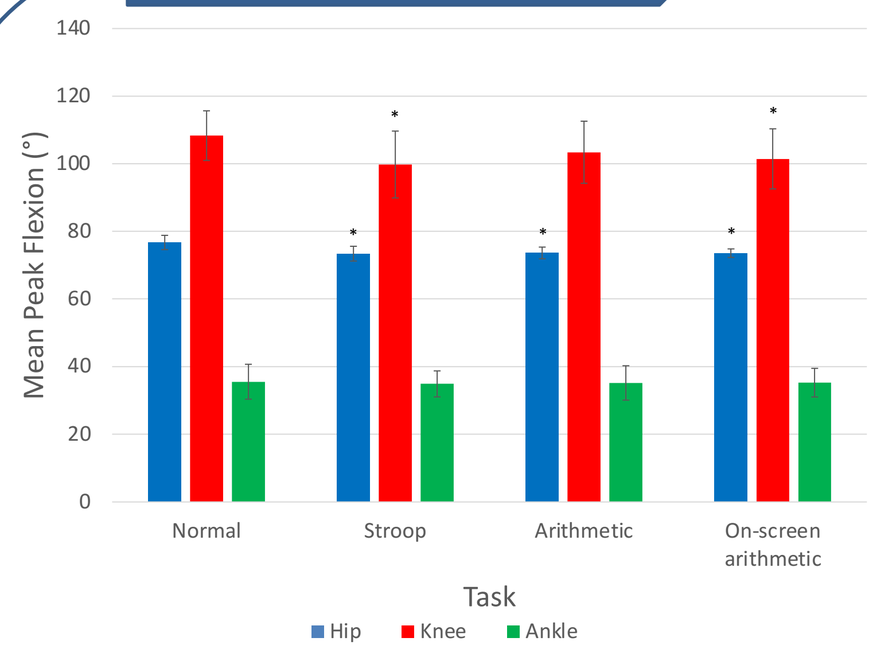

Figure 3: Comparison of peak flexion joint angle for each task. * Indicates significantly lower ($p<0.05$) than normal lunging (control).

Peak hip flexion was significantly lower in the Stroop, arithmetic and on-screen arithmetic tasks compared to normal lunging.
Peak knee flexion was was significantly lower in the Stroop and on-screen arithmetic tasks compared to normal lunging.

Mean lunge step distance was most affected in the Stroop task, and showed the greatest inter-subject variability for the arithmetic task, but neither reached significance ($p>0.05$)

There were no significant differences in mean peak lower limb abduction when a secondary task was added ($p<0.05$)

Conclusions

- Motor-cognitive dual-tasking appears to impact lunge performance.
- Adding cognitive tasks has an effect on hip and knee flexion.
- These results could be utilized to improve training programmes and enhance rehabilitative practice.
- The tasks using the screen may be able to better identify those at risk of injury, and create more challenging rehabilitation programmes due to the greater unpredictability of these tasks.

Future Work

- Further exploration of the effect of different cognitive tasks on lunging is required.

References: [1] Park et al.(2021) Comparative Study of the Biomechanical Factors in Range of Motion, Muscle Activity, and Vertical Ground Reaction Force between a Forward Lunge and Backward Lunge. *Phys Ther Rehabil Sci.*10:98-105. [2] Graham, J.F. (2007) Dumbell Forward Lunge. *Natl Strength Cond Assoc J.* 29:36-37.[3] Bloomfield, L. (2009) Effects of Forward Lunge Training on Balance Control in Eldery Women. *University of Windsor.*[4] Marchetti et al.(2018) Balance and Lower Lumb Muscle Activation between In-Line and Traditional Lunge Exercises. *J Hum Kinet*. 62:15-22.[5] Wollesen et al. (2016) Influence of a visual-verbal Stroop test on standing and walking performance of older adults. *Neuroscience.* 318:166-177.[6] Beurskens et al.(2021) Cognitive and motor task performance under single- and dual-task conditions: effects of consecutive versus concurrent practice. *Exp Brain Res.* 239:2529-2535. [7] Moreira, P.E.D. et al. (2021) The Acute and Chronic Effects of Dual-Task on the Motor and Cognitive Performances in Athletes: A Systematic Review. *Int J Environ Res Public Health.* 18:1732.