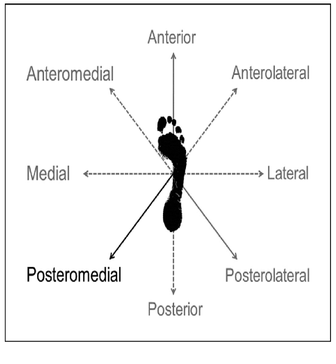
QUICK ON YOUR FEET: REVAMPING THE STAR EXCURSION BALANCE TEST WITH A RESPONSE TIME TASK

Seth Freeny, Abbey McCrory, Sunny Jo Chandler, Daniel Young, Sydni Carter, Savannah-Kate Trigg, Adam Knight & Harish Chander

Neuromechanics Laboratory, Department of Kinesiology, Mississippi State University, MS State, MS 39762

INTRODUCTION

The Star Excursion Balance Test (SEBT) is a common balance assessment used across clinical and research settings to test dynamic balance [1]. The primary outcome measure of this test is maximal reaching distance performed by the non-stance limb to a point along designated lines. Response time (RT) is a critical component of dynamic balance control [2]. Interestingly, RT during dynamic balance disruptions is altered in persons with chronic ankle instability [3]. However, the measure of response time has never been done in conjunction with SEBT. The lack of an RT measure in SEBT allows for critical component of balance to go untested and provides an avenue for possible improving rehabilitation processes. Additionally, balance-related RT and the ability to maintain dynamic balance is compromised by muscular fatigue [3,4], but their interactions are not well understood. The purpose of this study is to examine RT during a SEBT, with a secondary goal to examine the effects of muscular fatigue on RT during SEBT.



Left: Blazepods and SEBT directions. **Right:** Participant performing SEBT with Blazepod™ sensors to measure RT

METHODS

Sixteen healthy young male and female adults (age: 20 ± 1 years; height: 169.48 ± 8.2 cm; weight: 67.93 ± 12.7 kg) participated in this study. Each participant performed the SEBT which consisted of standing on one leg [Left Leg Reach (LLR), Right Leg Reach (RLR)] and reaching as far as possible in 5 directions [Anterior, Anterior-medial, Medial, Lateral, Anterior-lateral], one by one, repeated for three trials for each leg. Reaching distance was recorded in inches based on the tape measure on floor representing the SEBT. Blazepod™ sensors were then placed on the average maximum reaching distances, and the SEBT was performed again for three trials, but required participants to strike the Blazepod™ sensors as soon as they light up (randomly turn on). Posterior, posterior-lateral and posterior-medial directions were not test as participants were unable to see the sensors. The fatigue protocol consisted of three sets of three different lower extremity exercises: Ten unilateral body weight calf raises, 20 standard body weight squats, 20 standard bodyweight lunges. Immediately following this, the participants repeated the SEBT testing procedures mentioned above. RTs was averaged across reach directions to form a mean RT measure for each trial. A 2 × 2 × 3 repeated measures ANOVA was performed to test for differences in mean response time across trials (Trial 1, Trial 2, Trial 3), fatigue states (PRE, POST), and leg reach (RLR, LLR) as within-subjects factors. All statistical analysis was conducted in JASP (v0.15) were a p-value of less than 0.05 was considered statistically significant. Significant main effects were followed up with a Holm post-hoc correction.

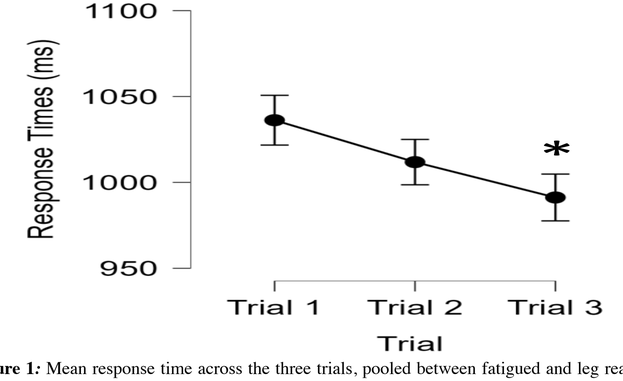


Figure 1*:* Mean response time across the three trials, pooled between fatigued and leg reach conditions. Represented as mean ± standard error. * represents a significant difference from Trial 1 (p<0.05).

RESULTS

Response time significantly decreased over the course of testing regardless of leg reach or fatigue state (p=0.023). Trial 3 demonstrated lower response times compared to Trial 1 (p=0.019, mean difference (MD)=44.984 ms). No significant differences were found between fatigue states (p=0.732, MD=4.635 ms) or leg reach (p=0.274, MD=18.198 ms).

DISCUSSION

These results indicate that response time during an SEBT with RT is a learned skill that can change over time and future incarnations of the RT SEBT should include an extended familiarization period to remove learning effects. RT did not differ between left and right leg reaches, indicating leg dominance does not affect performance of a response time based SEBT, which is comparable to other studies [1,3]. This may open this type of testing to a modified version that only utilizes one limb. Lastly, fatigue did not hinder RT performance, which aligns and contrast with previous studies that examine RT and SEBT performance [3,4,5]. This may be attributed to a deficient intensity of the fatigue protocol, in turn did not change neuromuscular control of the postural muscles as seen in other studies [3,4,5].

CONCLUSION

Response time is a critical postural control characteristic that is involved in athletic competition and activities of daily living. The findings of the current study add a new element to dynamic balance testing that could be utilized as a clinical marker to facilitate rehabilitation. However, based on the findings of this study, several recommendations regarding incorporating RT into dynamic balance assessments can be gleaned. First learning effects should be controlled by allowing performance to plateau prior to testing. Secondly, the performance of this task did not change between fatigue states or between reaching legs. Therefore, the assessment of RT during the SEBT can be administered a different time point of training/rehabilitation and with either lower extremity.

REFERENCES

[1] Plisky et al., 2009. *N AM J Sports Phys Ther*. 4(2): 92-99.
[2] Sierra-Guzman et al. 2018. *Clin Biomech*. 54: 28-33.
[3] Gribble et al., 2007. *Int J Sports Med*. 2007. 28(3): 236-242.
[4] Simoneau et al., 2006. *J Neuroeng Rehab*. 3:22.
[5] Debusk et al., 2018. *Int J Indust Ergo*. 64: 51-58