



THE IMPACT OF THE VISUAL SYSTEM ON DYNAMIC STABILITY WHILE WEARING FIRE-SPECIFIC EQUIPMENT AND GEAR

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INTRODUCTION

Slips, trips, falls, and jumps were the second leading cause of injuries at the fireground. Arguably, these injuries can be attributed in part to issues related to dynamic postural stability. Donned loads and diminished visibility has the potential to impact a firefighter's dynamic postural stability while navigating dark or smoke-filled structures.

PURPOSE

To explore the effect vision had on dynamic postural stability during a single-leg landing and stabilization (SLLS) task.

METHODS

24 fire cadets participated in the study (25.97 ± 4.90 yrs, 180.76 ± 9.15 cm, and 80.64 ± 22.68 kg). Participants performed three SLLS trials under three different conditions: 1) without equipment and gear (EQG), 2) with EQG, and 3) with EQG and a tented BASHield (EQG-S). All conditions requiring EQG included a self-contained breathing apparatus, turnout coat, pants, boots, hood, gloves, and helmet (mass, 24.5 kg). The SLLS task required the participant to drop onto their dominant leg from a 30 cm box placed 10% of their height away from a 40 cm x 60 cm force plate. Upon landing, participants had to remain motionless for 10 seconds. The first, 3 seconds of the vertical ground reaction forces (VGRF) after initial ground contact (IGC) were used to calculate the DPSI.

IGC was defined as the instant the VGRF exceeded 5% body weight. A higher DPSI value represents worse dynamic postural stability. A repeated measures ANOVA was conducted to determine the effects of vision on DPSI while donning EQG. Alpha level was set a priori at .05.

RESULTS

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, $\chi^2(2) = 14.798, p < .001$. Epsilon (ϵ) was 0.671, calculated according to Greenhouse and Geisser (1959), and was used to correct the one-way repeated measures ANOVA. DPSI was statistically significantly different across conditions, $F(1.343, 30.880) = 134.448, p < .001, \eta^2 = .854$. DPSI increased from 0.375 ± 0.054 without EQG to 0.528 ± 0.079 with EQG and to 0.562 ± 0.086 with EQG-S. Post hoc analysis with a Bonferroni adjustment revealed that DPSI was statistically significantly higher going from without EQG to with EQG [-0.153 (95% CI, -0.187 to -0.119), $p < .001$], and from without EQG to with EQG-S [-0.187 (95% CI, -0.225 to -0.149), $p < .001$], and from with EQG to with EQG-S [-0.034 (95% CI, -0.052 to -0.016), $p < .001$].

CONCLUSION

The findings of this study suggest that diminished sensor inputs from the visual system alter postural stability while donning EQG.

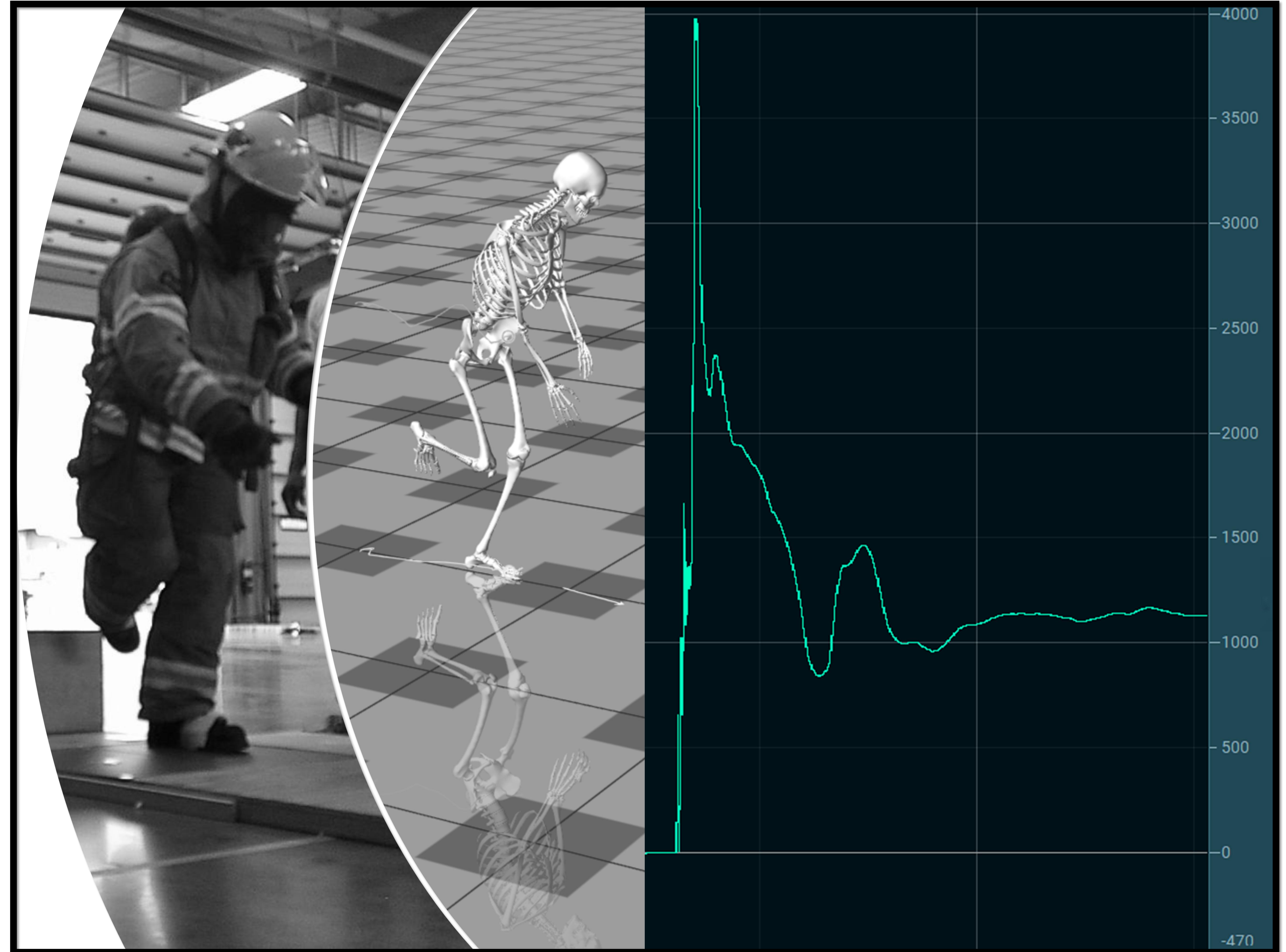


Figure 1. Single Leg Landing and Stabilization Task

PRACTICAL APPLICATION

Firefighter strength and conditioning programs should incorporate balanced training activities that require donning of EQG. Balance training should also be performed within scenarios that diminish visual inputs. Low-visibility balance training activities would require firefighters to rely more heavily on the somatosensory and vestibular systems to maintain stability.

REFERENCES

Campbell R, Hall, S. United States Firefighter Injuries in 2021. Quincy, MA: National Fire Protection Association Research, 2022

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