

The relation between central processing and muscle torque development speed, and balance recovery during standing

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Falls are a global health problem

World population of 655 million people over 65, of whom:

- 1 in 3 will fall at least once
- 50% will fall recurrently

15% of falls results in injury, making falls responsible for:

- 3 in 4 hospitalized injuries in older Australians
- \$648.2 million of direct health costs in Australia

(Bradley 2012)

The importance of balance recovery

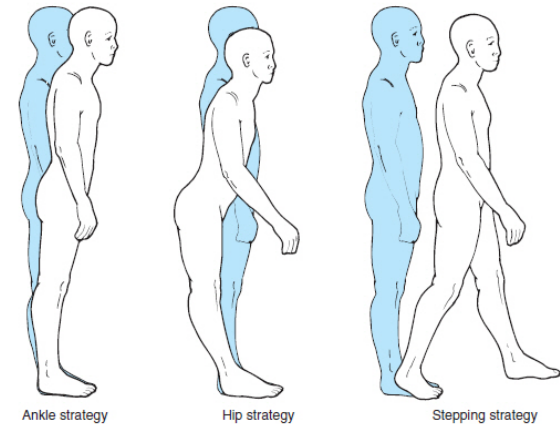
- May require fast central processing of sensory information, followed by rapid execution of appropriate motor actions; all of which decline with ageing

(e.g. Albinet et al. 2012, Spirduso et al. 2005)

- These processes act in a loop, suggesting that compensation might take place

- Magnitude of the perturbation someone can withstand without having to take a step is reduced in older people and is associated with falls

(e.g. Sturnieks et al 2012; 2013)



Aims

- To test the hypothesis that stepping thresholds are associated with central processing speed and rate of muscle torque development
- To test the hypothesis that the effect of combined reductions in central processing and muscle torque development speed is greater than their sum (interaction)

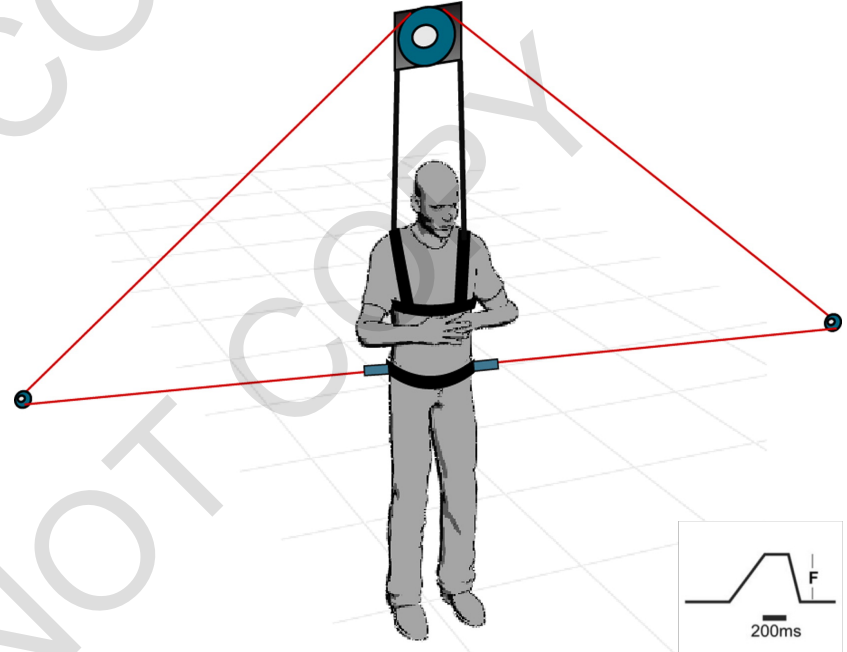
Methods

240 participants

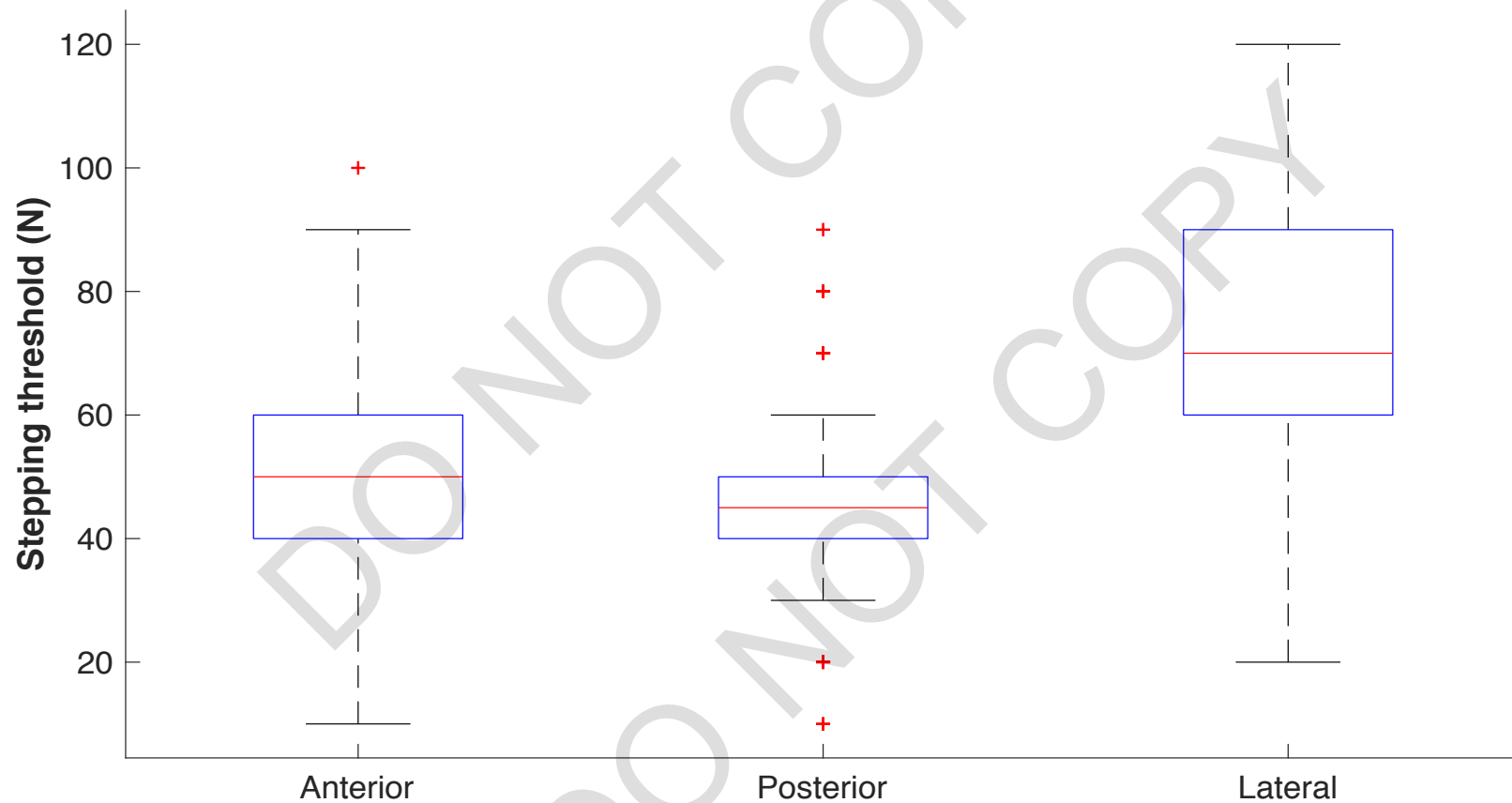
80 \pm 4 yrs; 110 ♀

Balance recovery during standing

Waist-pull perturbations of increasing forces to assess stepping thresholds

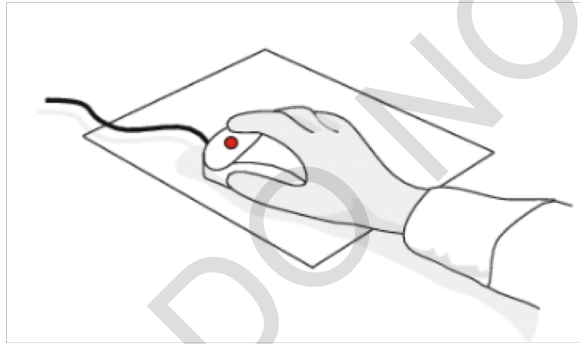


Stepping thresholds

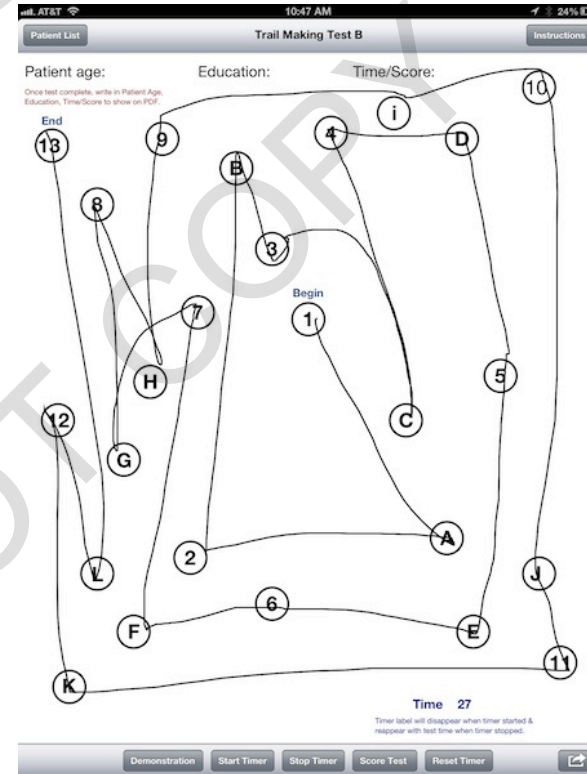


Processing speed and executive function

Simple reaction time

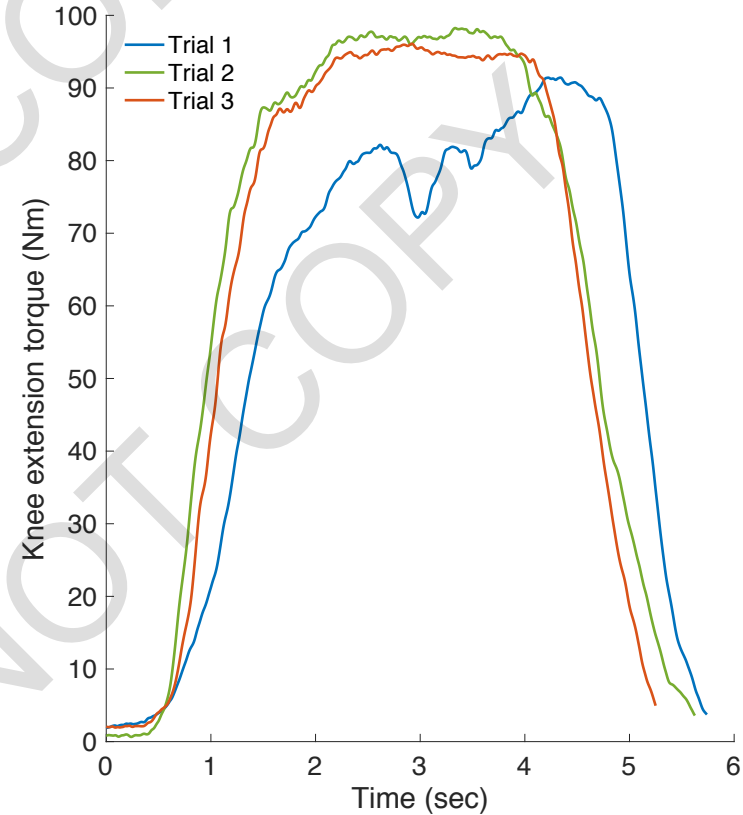


Trail making test



Isometric peak and rate of torque development

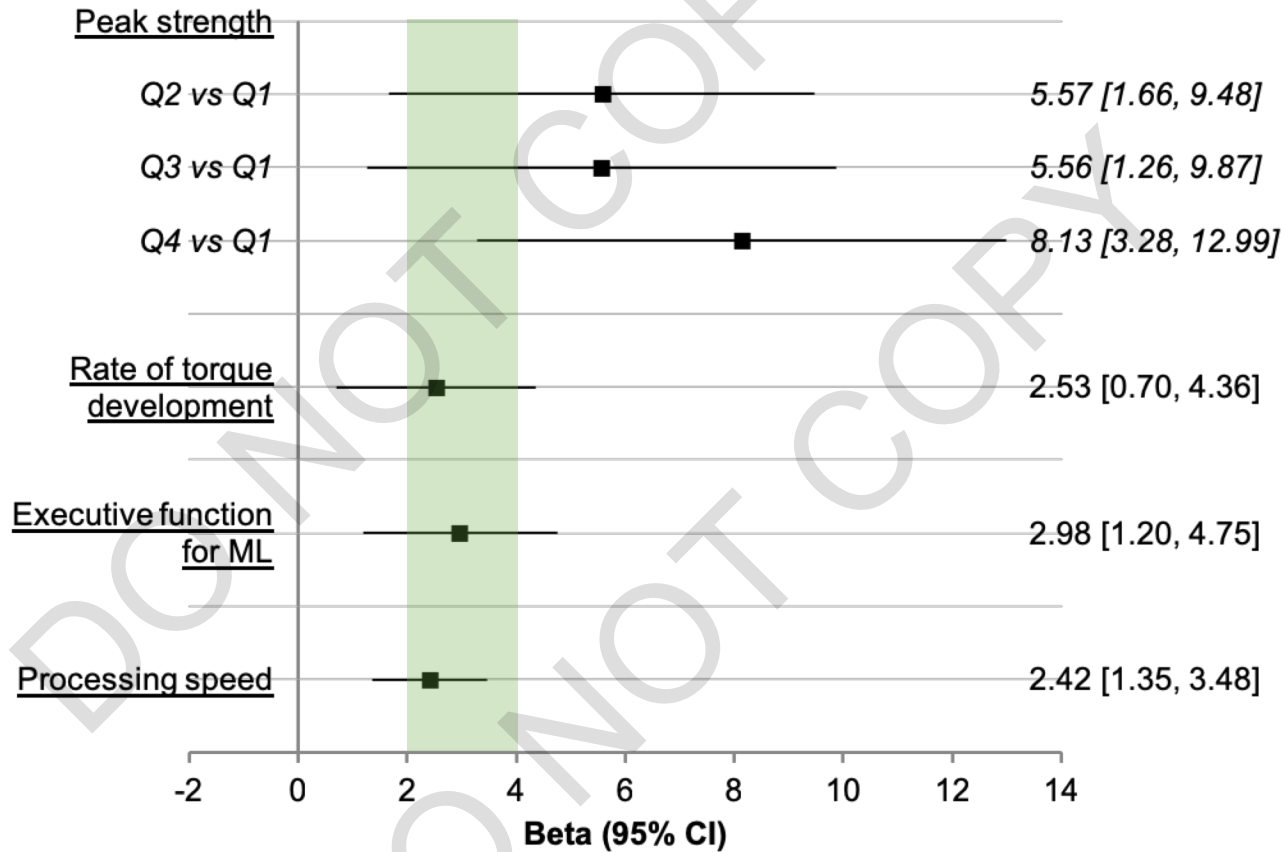
- Knee, hip flexors and extensors and hip abduction of the dominant leg
- 2 trials “as hard as you can”, last trial “as fast and hard as you can”
- Determined peak torque & rate of torque development over 50 ms



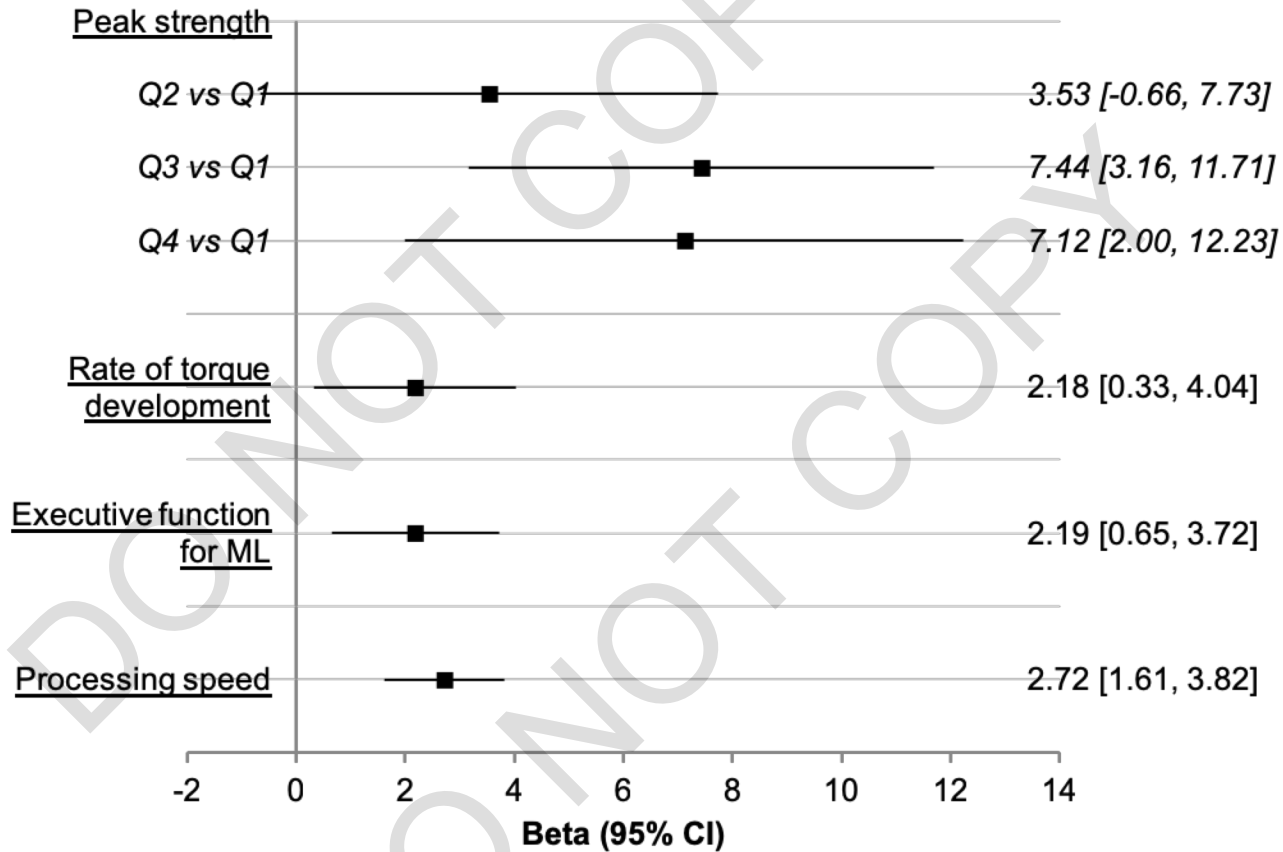
Dimension reduction: principal components

	1 <i>Peak strength</i>	2 <i>Rate of torque development</i>	3 <i>Executive function</i>	4 <i>Processing speed</i>
Peak knee extension	.672			
Rate of knee extension		.818		
Peak knee flexion	.671			
Rate of knee flexion		.824		
Peak hip flexion	.856			
Rate of hip flexion	.417	.732		
Peak hip extension	.807			
Rate of hip extension	.367	.643		
Peak hip abduction	.780			
Rate of hip abduction	.554	.468		
Simple reaction time				.783
Trail making test B-A			.932	
Trail making test A			.301	.742
Trail making test B			.880	.394

Univariable association with stepping thresholds



Multivariable association with stepping thresholds



No interaction between processing speed and rate of torque development

Discussion

- Peak muscle strength showed a threshold effect (Buchner & de Lateur 1991)
- Executive functions seem particularly important for mediolateral balance recovery
- Central processing and rate of muscle torque development affect balance recovery independently and may be important age-related motor impairment targets for preventing falls in older people

Limitations

- Disregarded contributions of individual muscles
- Findings might not generalise to more dynamic movements, during which most falls occur

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