Cognitive and motor contributions to the control of balance during stepping in young and older adults – a fNIRS study

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BACKGROUND

The literature suggests that older people rely on cognitive-motor control resources in order to maintain their balance.

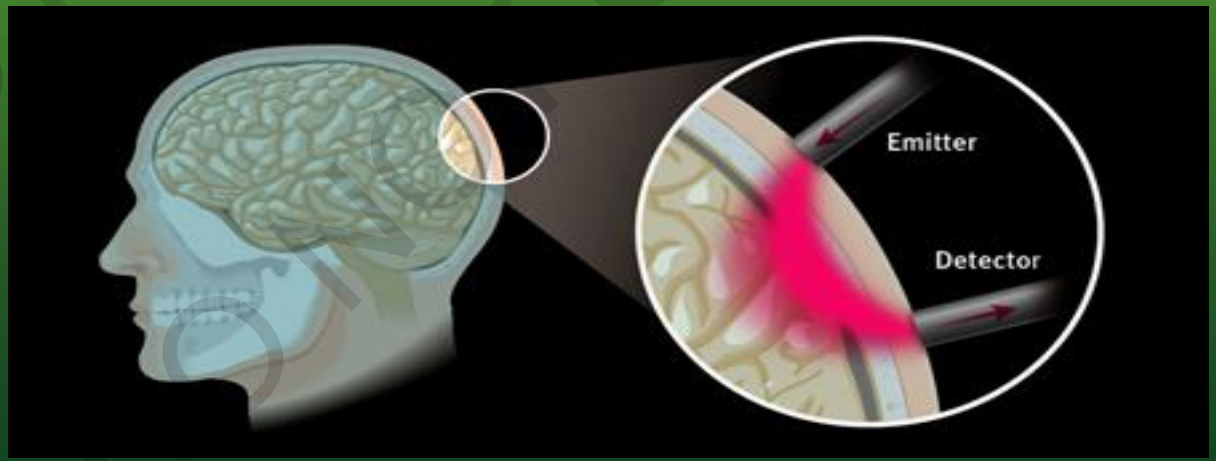
Standing balance tasks require cortical input, but whether this relates to balance control per se or simply the undertaking of a motor task (i.e. stepping task) has not been investigated.

If balance is a “special” motor activity that requires a lot of attention, Prefrontal Cortex (PFC) activity should increase when undertaking a dual task unsupported (i.e. free standing) as opposed to supported (i.e. resting arms on a support).

BACKGROUND

Functional near-infrared Spectroscopy (fNIRS) is an optical neuroimaging technique for investigating cortical brain area activation while participants move freely (i.e. stepping tasks).

fNIRS is particularly useful for monitoring haemodynamic changes in brain activation before and after a stimulus.



BACKGROUND

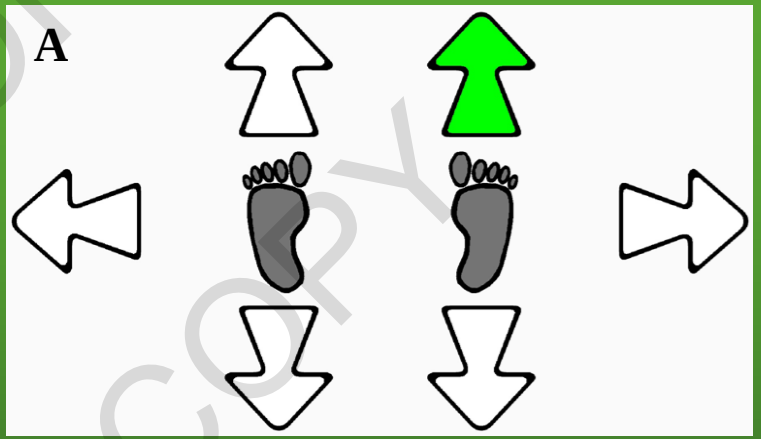
Aim of the study: to investigate prefrontal and motor cortices activation during stepping tasks using fNIRS.

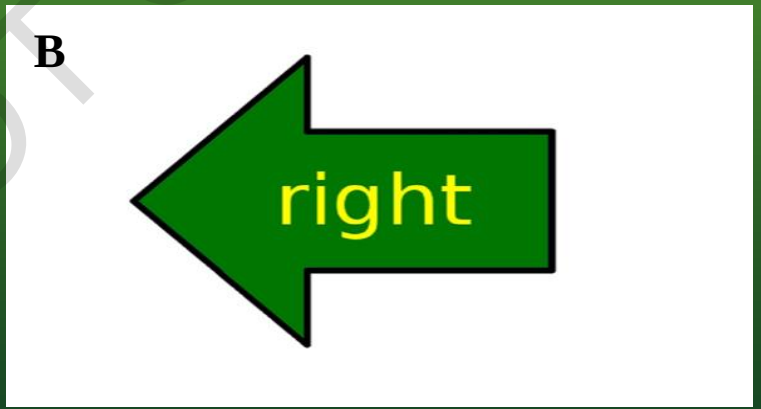
Hypothesis: Unsupported stepping would require increased cortical activity, and this would be more so for older people.

Participants: 48 older adults and 20 young adults.

METHODS

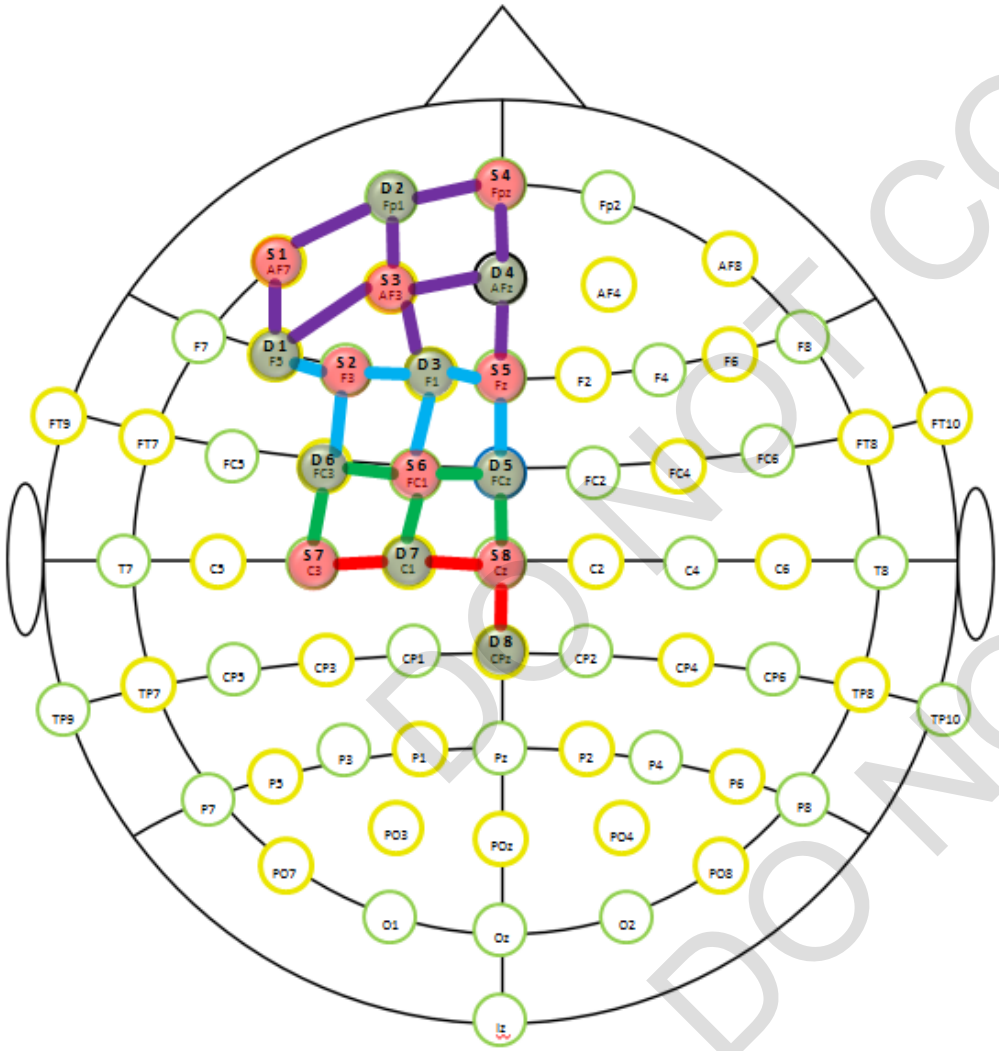
Choice-stepping Reaction Time (CSRT)





Stroop Stepping Test (SST)

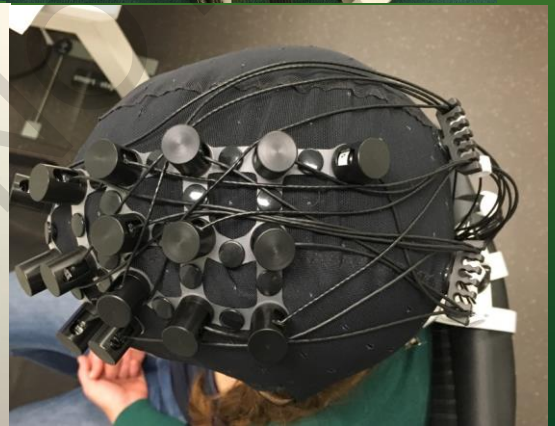
METHODS



Regions of interest (ROI)

- Prefrontal Cortex (area 9, Brodmann cortical areas)
- Supplementary Motor Area (SMA – area 8, Brodmann cortical areas)
- Premotor Cortex (PMC – area 6, Brodmann cortical areas)
- Primary Motor Cortex (M1 - area 4, Brodmann cortical areas)

METHODS



RESULTS

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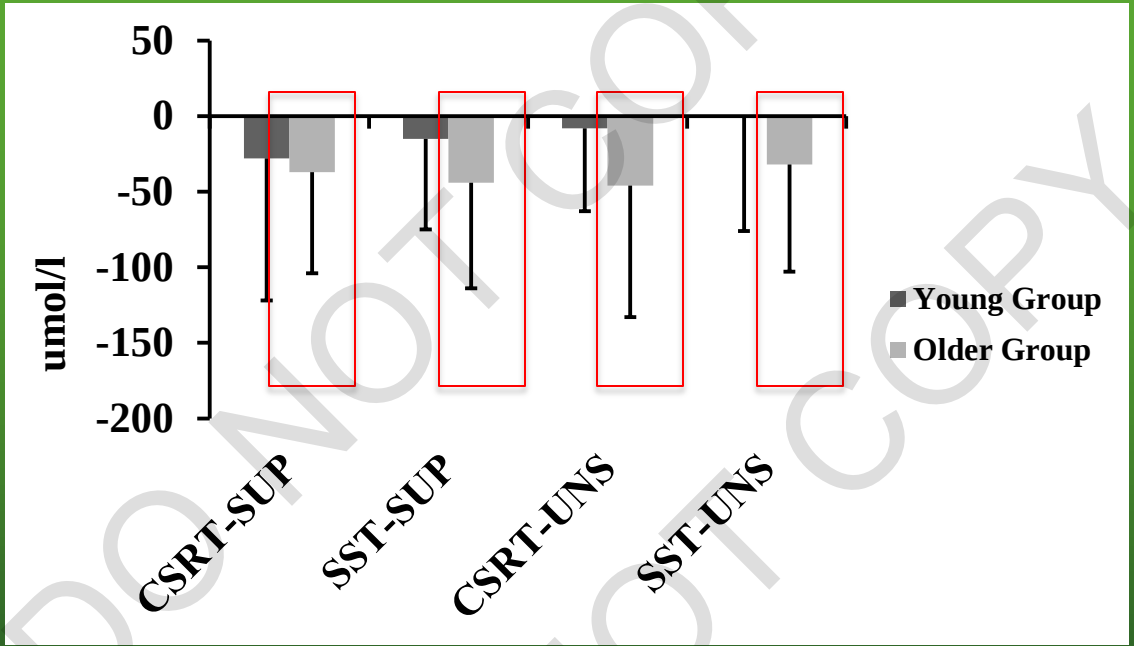
Table 1. Stepping response performance.

		Supported	Unsupported	Group main effect	Condition main effect	Interaction
CSRT	**Young group**	802 (105)	871 (87)	**<0.001**	**<0.001**	0.687
	Older group	983 (139)	1059 (148)			
SST	**Young group**	741 (109)	838 (149)	**<0.001**	**<0.001**	0.601
	Older group	1021 (212)	1096 (179)			

RESULTS

Figure 1. Deoxy-Haemoglobin changes in PFC (mean±SD).

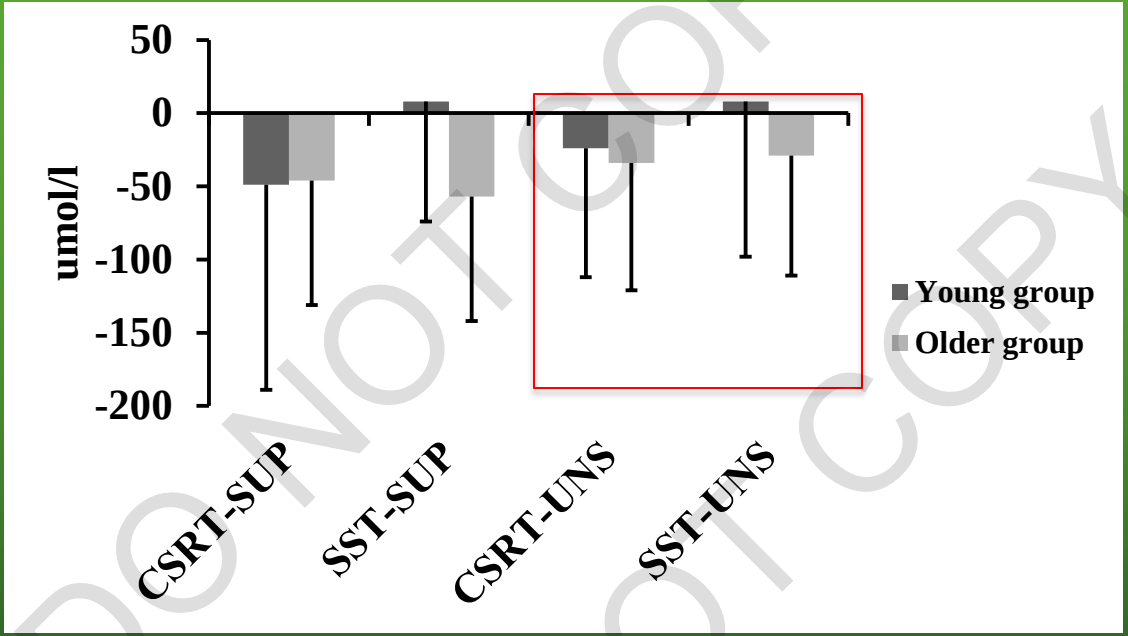


Main group effect: Older group > Young group (p=0.003)

Increased PFC activity seems to be necessary for older people to successfully perform stepping tasks.

RESULTS

Figure 2. Deoxy-Haemoglobin changes in M1 (mean±SD).



Unsupported condition: Older group > Young group (p=0.015)

Increased M1 activity seems to be necessary for older people to successfully perform stepping tasks.

CONCLUSION

Hypothesis: Unsupported stepping would require increased cortical activity, and this would be more so for older people.

Partially confirmed!

Older people rely on cognitive-motor control resources in order to maintain their balance.

PFC and M1 activity

Stepping performance

FUTURE APPROACHES

- These findings might be used to understand ageing processes and sensorimotor impairments in older people;

- Studies need to be done to confirm the cortical involvement on balance in frail and clinical populations at high risk of falling;

- Haemodynamic changes can be used as an outcome to investigate the effectiveness of a balance training intervention.

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CAPES