Thinking while falling forward:
an EEG study on reactive postural control in older adults

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BACKGROUND

- Fall incidence is a major **public health burden** globally (James et al., 2017). Old adults are more prone to fall, such as while walking on **a slope** or **staircase**. **Forward trip** or stumble is the second most common cause of falls, accounting for about 20% of the cases (Robinovitch et al., 2013).
- We can **observe** if someone stumbles or takes a recovery step, through e.g. motion capture systems = final *outcome* of the balance response. However, **behaviour outcome always happens late** after the brain has already processed the perturbation = so, EEG allows you to **access early internal** processing (before physical reaction).

OBJECTIVE

- This study aims to **examine neural signatures** of reactive postural control to a forward trip on a slope in older adults, while performing a **secondary cognitive task**.

MATERIALS & METHODS



32-ch wireless EEG (Brain Products GmbH)



16-ch wireless EMG (Cometa Systems)

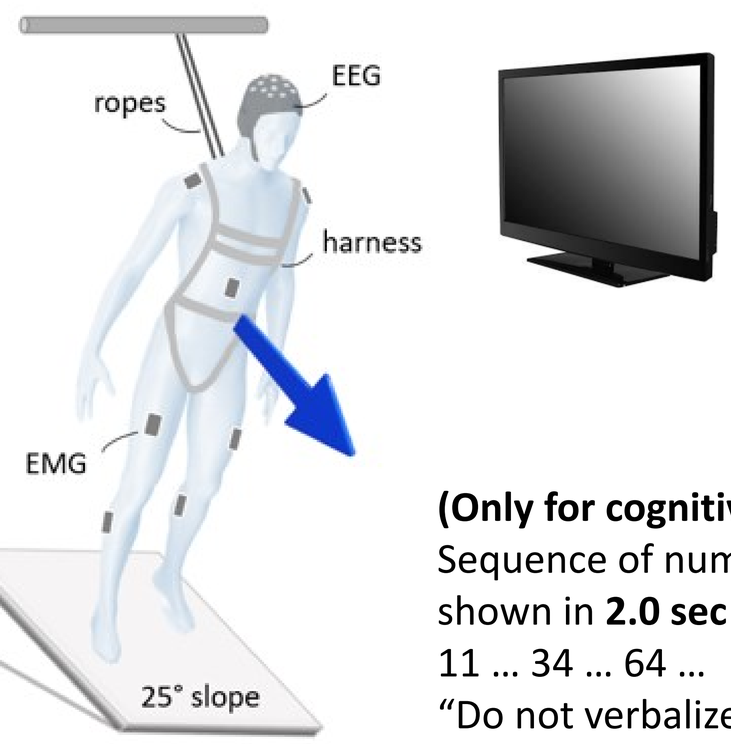
N = 10 older adults (65 years old and above) participated in the trials.

Each participant performed 3 blocks, in randomized manner:

(1) Passive: "Stay relaxed as you experience forward fall, harness will catch you!"

(2) Active: "Once we release you, do a corrective step forward to gain back your stability!"

(3) Cognitive: same as Active, but added "Try to remember as many numbers as possible"



(Only for cognitive)
Sequence of numbers shown in **2.0 sec** each:
11 … 34 … 64 …
"Do not verbalize!"

At least 25 trials per condition

Random release onset 3 to 10 sec

EEG: Visually check of eye blinking and jaw clenching

Analysis per subject and condition

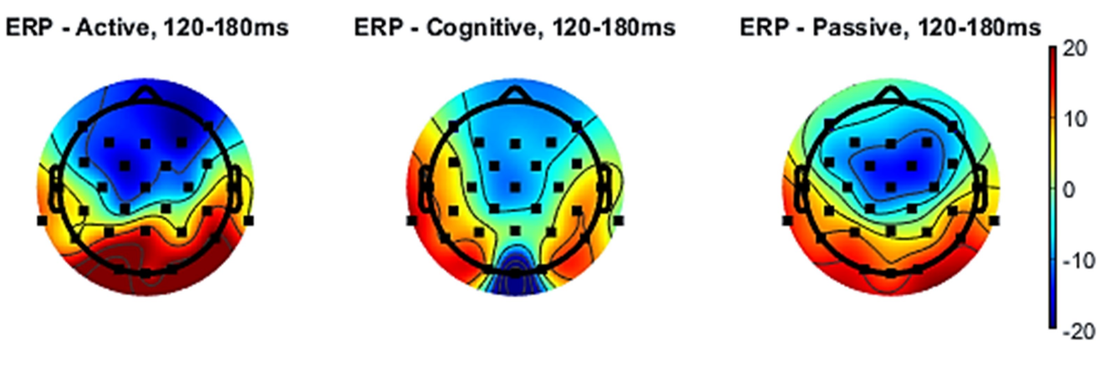
Filtering (1-30Hz) → Baseline correction → Epoch → ICA denoising → Re-reference

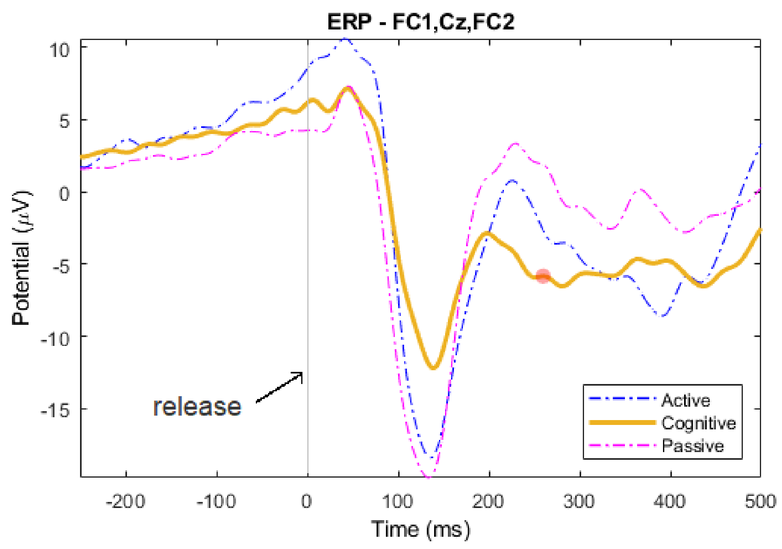
EEGLAB



RESULTS

Group analysis produced a **topographical map** showing the distribution of negative potential (N100) around the cortical midline.





A significant effect of task conditions [$F(2,18) = 3.88$, $p = 0.03$, $h_p^2 = 0.30$; passive = -21.63 ± 2.60 μV, active = -21.61 ± 3.77 μV, and cognitive = -13.48 ± 2.52 μV] with reliable difference from the cognitive vs passive ($p = 0.03$, with Tukey adjustment).

DISCUSSION

- The experiment resulted in brain evoked potentials with consistent **N100**, peaking around the **central midline** (Varghese JP et al., 2017).
- **N100 amplitude** along the midline was **smaller** compared to the passive condition, but no differences in the latency. This suggests that N100 was modulated by a secondary cognitive task.
- This informs age-related neural patterns that are affected by a secondary cognitive task, potentially introducing **higher risk of falls** in older adults.

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