

Effects of two types of hyperventilation on standing balance

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INTRODUCTION

The present study sought to establish links between **hyperventilation** and **postural stability**.

Insofar as hyperventilation can be performed **voluntary** or by the mean of **metabolic** changes, we hypothesized by modifying the system of ventilatory control (metabolic vs voluntary) that characteristics of postural perturbations and mechanisms of postural adjustments may also be different.

MATERIALS AND METHODS

* Forceplate data :

- ground reaction forces (Fx, Fy and Fz)
- centre of pressure (COPx and COPy)
- ⇒ **characterising postural disturbances**

* Ventilatory measurements :

- CO₂ fraction of exhaled gas (F_{ECO₂})
- breathing frequency (BF)
- ⇒ **characterising ventilatory perturbations**

* Myoelectric activities (EMG) :

- Soleus (SO)
- Tibialis anterior (TA)
- ⇒ **reflecting postural control**

Participants

8 healthy university students



Ventilatory perturbations :

applied randomly with a 5 min-rest period between them

👉 **Metabolic Hyperventilation (MH) :**
5-min of CO₂ rebreathing using Douglas bag

👉 **Voluntary Hyperventilation (VH) :**
3-min imposed by a metronome set at 25-min⁻¹

Data collected over 20-s periods

Postural tests (maintenance of bipedal stance with eyes open) made before and during the ventilatory perturbations

RESULTS AND DISCUSSION

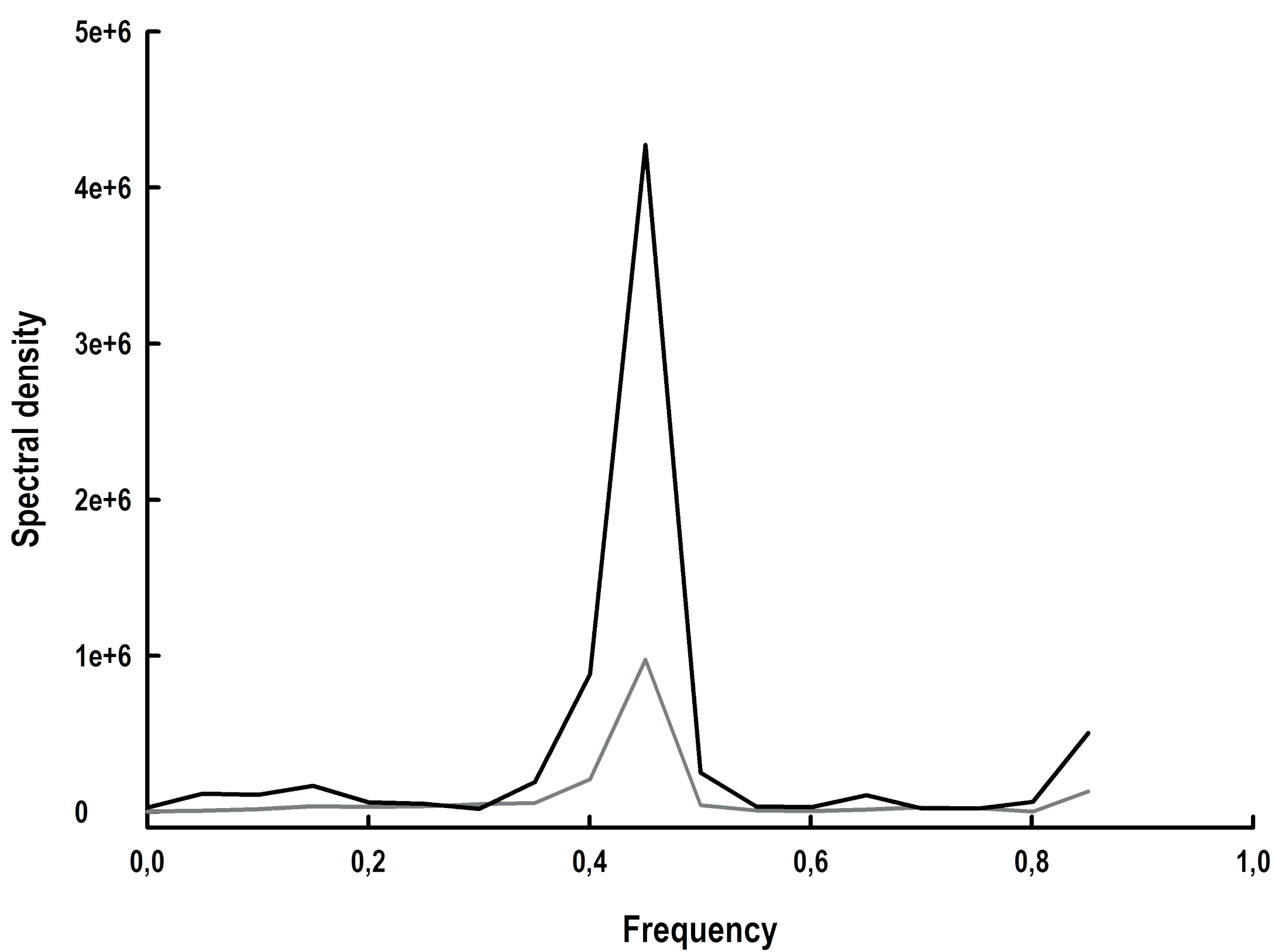
Ventilatory (F_{ECO₂}, f_R, Δacc) and postural sway (ΔFz, ΔFx, SPx, Δx, Δy) parameters measured in postural tests before (RT) and during the ventilatory perturbations (MH and VH) (Mean ± SD) * P<0.05, ** P<0.01, ‡ P<0.05

	F _{ECO₂} (%)	Δacc	f _R (Hz)	ΔFz (mm)	ΔFx (mm)	SPx (mm)	Δx (mm)	Δy (mm)
RT	5.3 ± 0.7	0.04 ± 0.02	0.33 ± 0.03	1.33 ± 0.22	0.77 ± 0.10	90.7 ± 9.8	2.81 ± 0.45	2.91 ± 0.78
MH	7.6 ± 0.6**	0.12 ± 0.07*	0.36 ± 0.08	1.70 ± 0.4**	1.01 ± 0.31	133.6 ± 51.7*	3.75 ± 1.59	3.60 ± 1.86
VH	2.8 ± 0.4**‡	0.10 ± 0.05*	0.44 ± 0.02**	3.56 ± 1.66**‡	1.90 ± 0.56**‡	172.8 ± 49.4**	5.08 ± 1.26**	4.19 ± 1.48*

Characteristics of postural perturbations differ as MH and VH

- Close relationship between breathing and ΔFz during VH (coh = 0.8 ± 0.14)

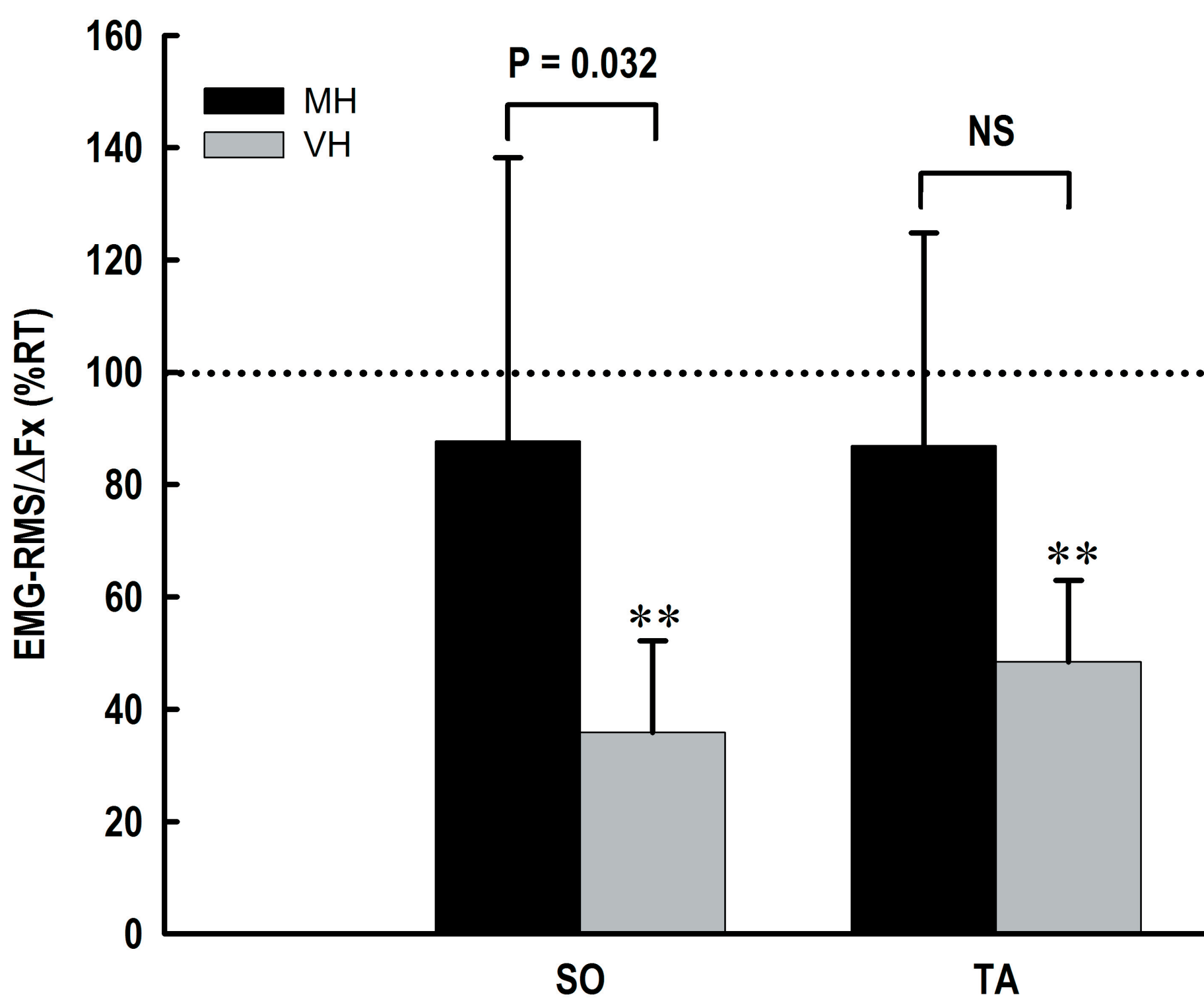
Suggests a ventilatory origin of these postural disturbances



Example of spectral analysis applied on both breathing and Fz signals during VH for one subject. The frequency distribution of the two signals - ■ for the ventilation and ▨ for Fz- revealed a synchronization in spectral densities around 0.4 Hz.

- Significant decrease in RMS SO/ΔFx and RMS TA/ΔFx ratios during VH (P<0.01)
- Significant difference in RMS SO/ΔFx ratios between MH and VH (P=0.032)

Hypothesis : leg muscle strategies directly linked to ventilatory control modes ?



Soleus and tibialis anterior EMG activities measured in postural tests during MH ■ and VH ▨. EMGs were quantified in terms of the RMS, normalized with respect to ΔFx and expressed as percentages of the baseline values obtained in the reference test. **P<0.01

CONCLUSIONS

- Our results indicate that characteristics of postural perturbations and mechanisms of postural adjustments markedly differ as the type of hyperventilation (metabolic or voluntary).
- More experiments are needed to better understand how those mechanisms imply some links between ventilatory drive and postural control.