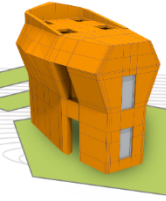


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# Breathing-related stability among 10-meter air pistol shooters

**S. Hybois**, D. Chadeaux, L. Valdes-Tamayo, Y. Lespert, R. Moreno Flores, M. Coursimault, C. Sauret, V. Attali and P. Thoreux



# Introduction



Céline Goberville, © Sebastien Botella / Maxppp

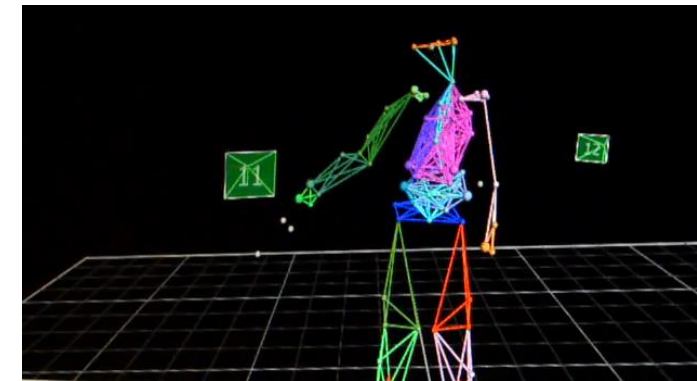
## Pistol shooting: Olympic activity



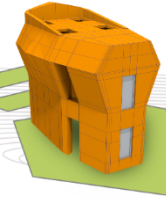
- Popular sport all over the world
- 25 m air pistol shooting (W/M « rapid fire »)
- 10 m air pistol shooting (W/M/mixed team)  
qualifying: 75min – 60 shots
- standing position
- pistol: weight  $\leq 1,5$  kg

For 10 m air pistol shooting, 2 distinct phases:

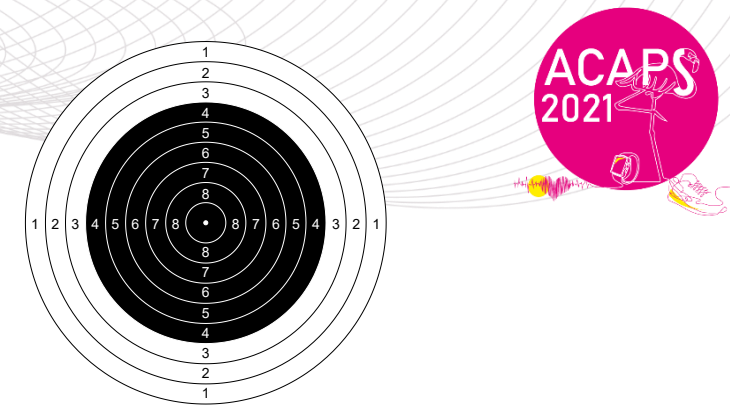
- « **distance-covering** » : raising the arm & pistol to an approximate position
- « **homing-in** » on target : adjusting sight and pistol alignment on target



## Synchronisation



# Introduction

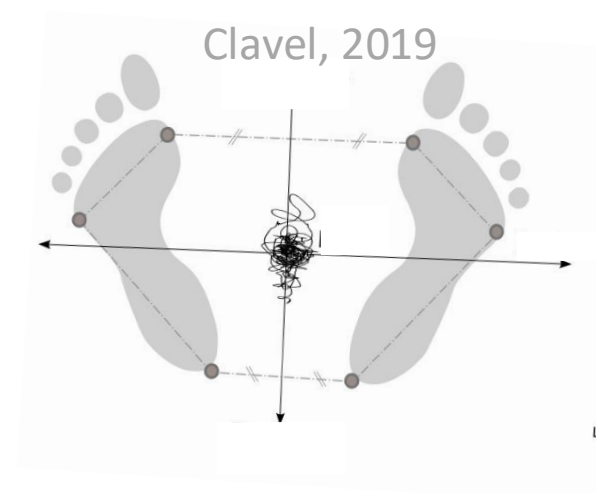


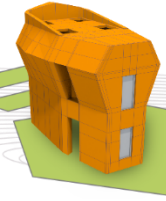
## Aiming phase – role of postural stability

- Maintaining a low displacement of the center of pressure (CoP) → performance [Ko et al., 2017]
- Stability strategies and shooter expertise : lowest CoP displacement during shooting for elite athletes vs. untrained controls [Chadefaux et al., 2020]

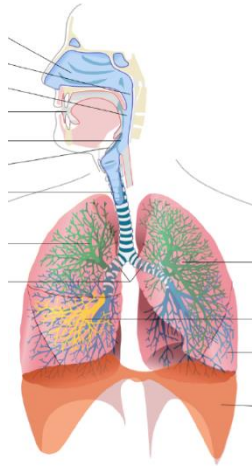
## Postural stability and breathing strategy

- Coupling between locomotion, postural and breathing functions [Perry et al., 2006]
- Respiratory movements affect balance (diaphragm involvement, CoP oscillations) [Kantor et al., 2001]





# Introduction



*Apnea during aiming*

**Breathing strategy**



**Stability**

**Aim:** evaluate the breathing-related stability parameters for various athletes expertise

**Hypothesis:** elite shooters able to better synchronize breathing and posture

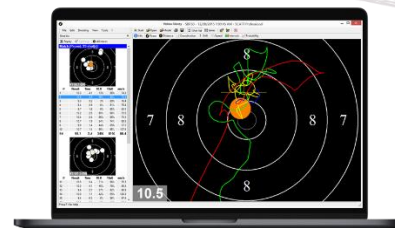
# Materials and Methods



10 m pistol shooters  
various levels




Biomechanical / Postural analysis  
of shooting under various breathing conditions

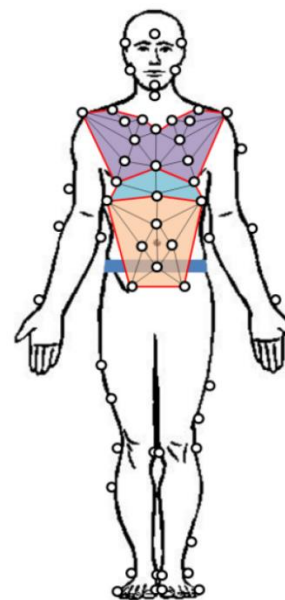
Individual breathing/stability profile



## Population

20 participants

Elite 	Intermediate 	Novice 
N = 4 (3H/1F)	N = 6 (4H/2F)	N = 10 (6H/4F)



## Stabilometric trial

natural standing position during 1 minute, with  
eyes open and a natural breath

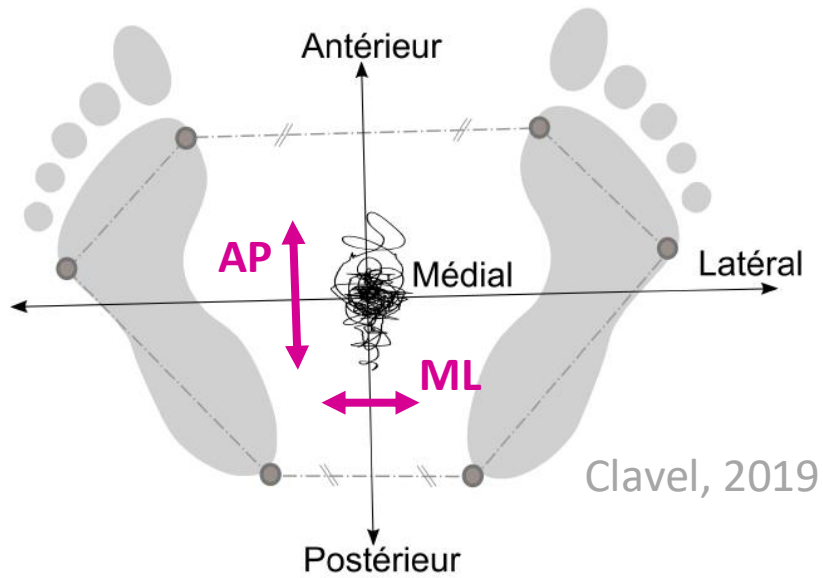
### Optoelectronic cameras

(Vicon® System, ©Oxford Metrics Inc., UK, 100 Hz)  
Kinematics

### Forceplates

(AMTI, USA, 1000 Hz)  
Ground Reaction Forces → CoP

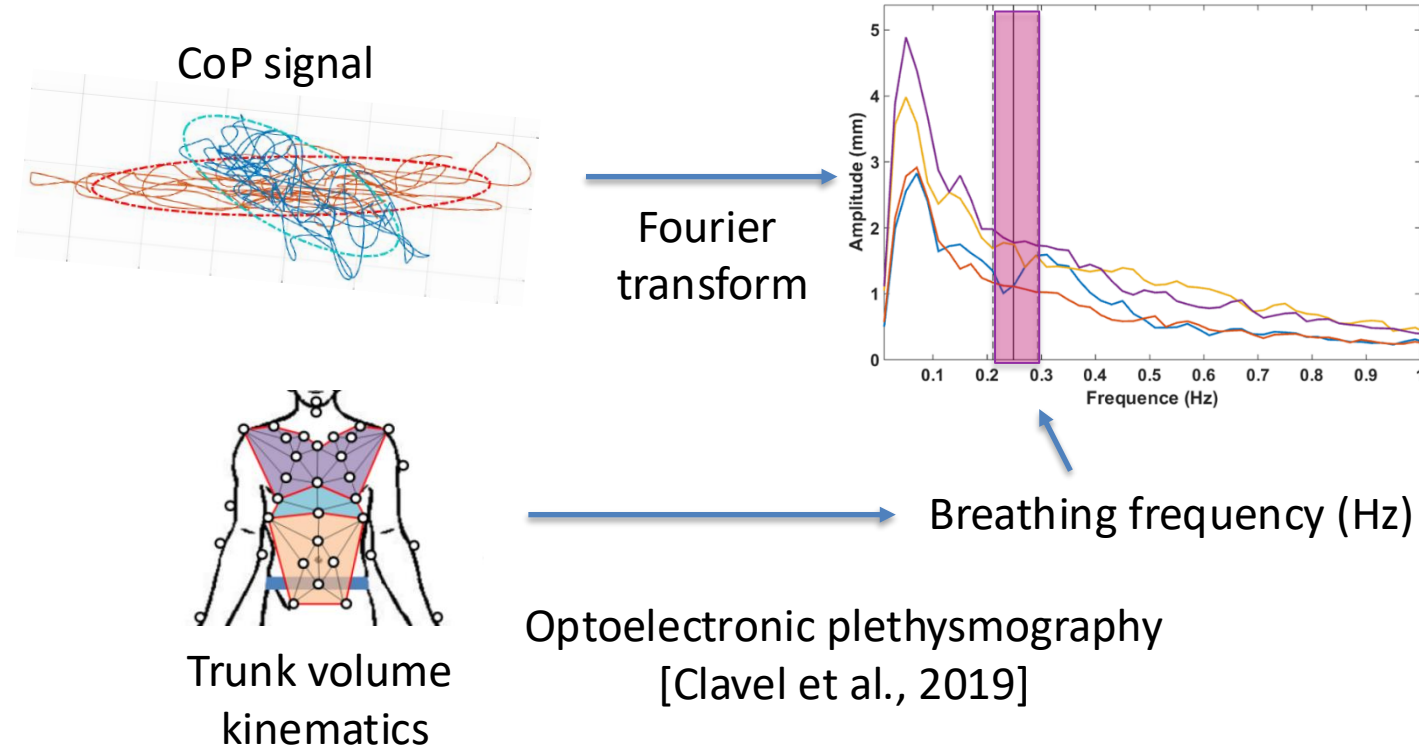
## Stabilometric profile

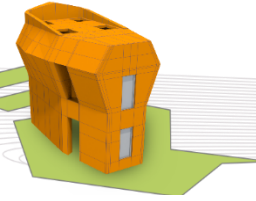


CoP **anterior-posterior (AP)**  
and **mediolateral (ML)** displacement

**Respiratory emergence** parameter (Rem) :  
portion of the CoP displacement explained by ventilation

[Hamaoui et al., 2010]





# Results and Discussion

Fig 1. CoP displacement during natural breathing

Fig 1a. Mediolateral (ML) component

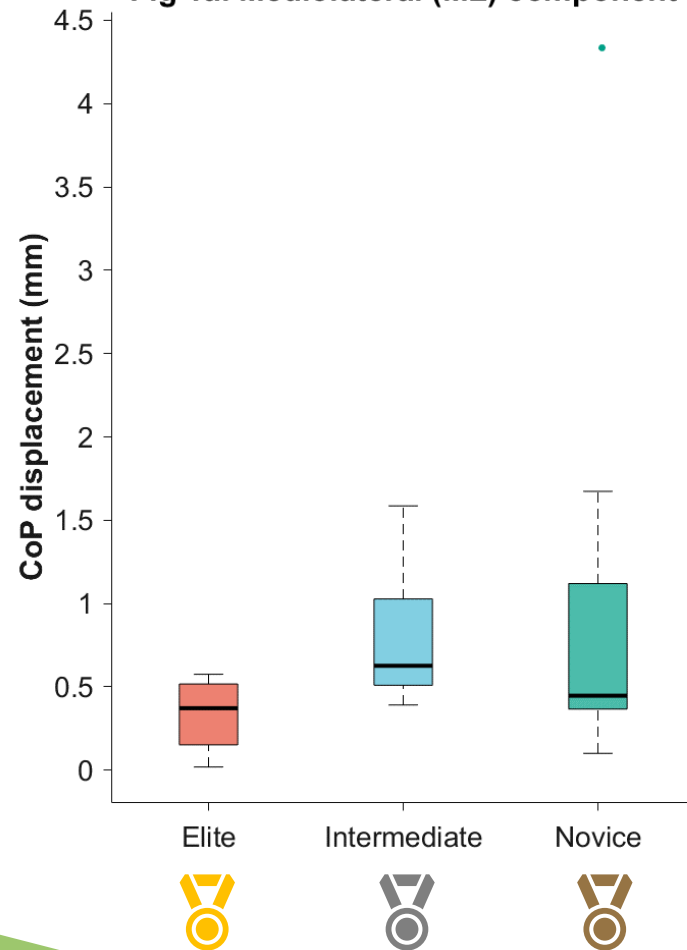
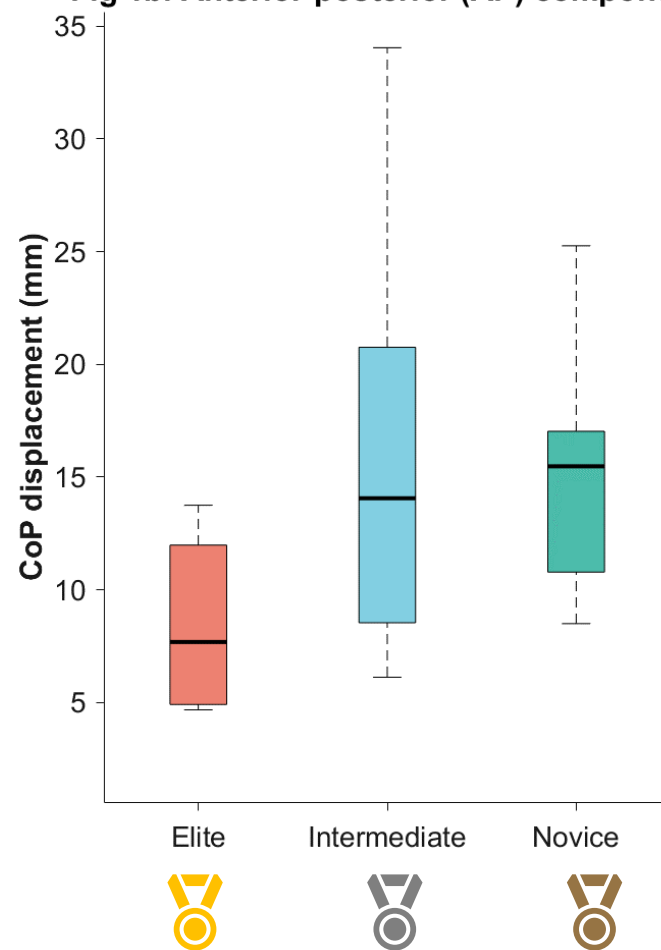
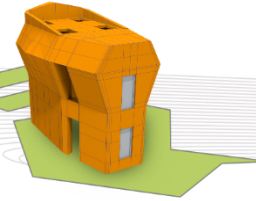


Fig 1b. Anterior-posterior (AP) component

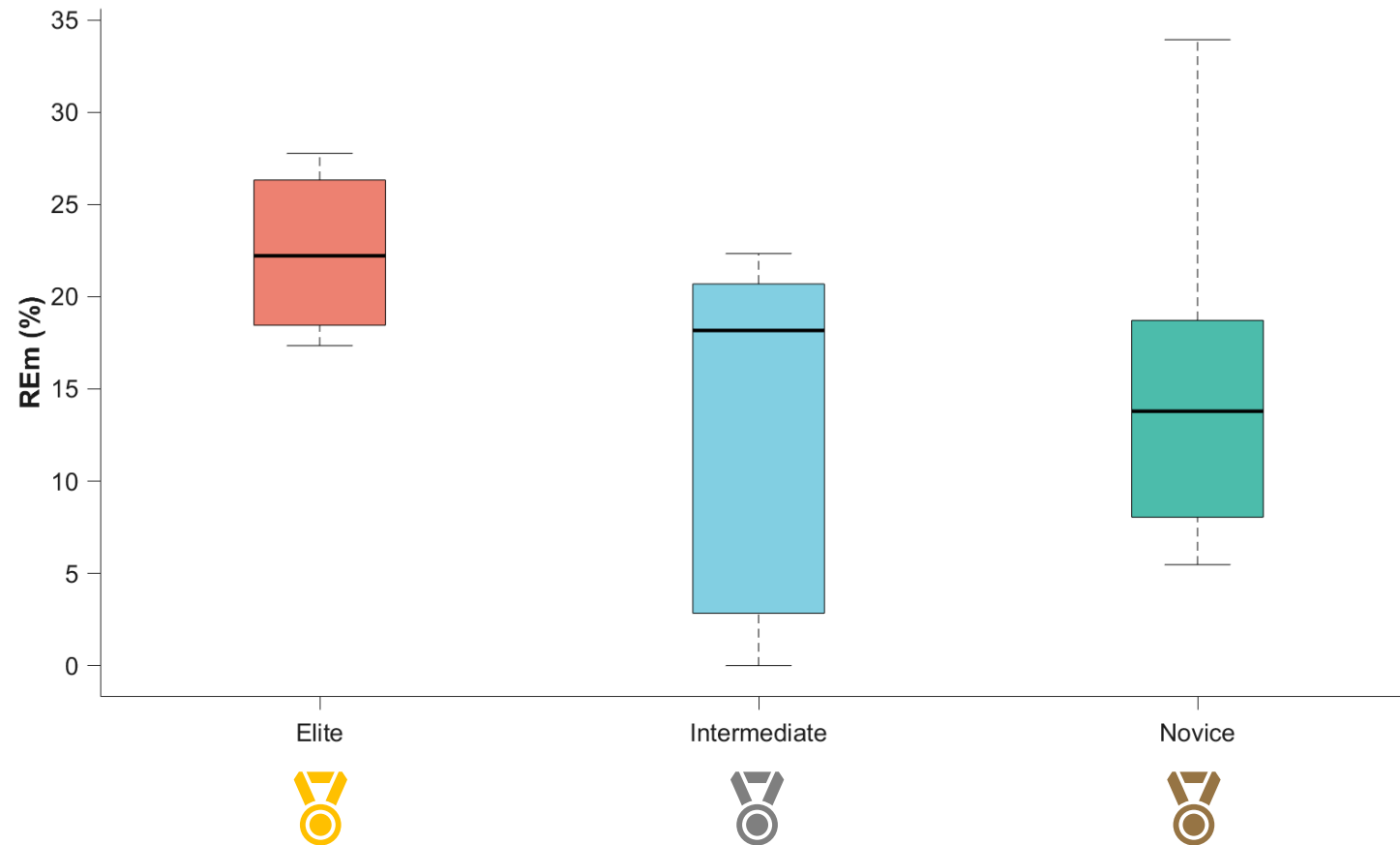


- Balance stability = higher among elite shooters (lowest CoP displacements)
- In line with previous studies on rifle shooters [Era et al., 1999]
- « Natural » stability: even for a non-shooting posture

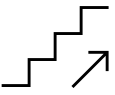


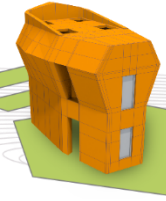
# Results and Discussion

Fig 2. Respiratory emergence parameter for the AP component of the CoP



- Portion of CoP displacement explained by breathing = higher among Elite shooters
- Posture / Breathing synchro
- Similar to findings in the context of people practicing Tai Chi [Holmes et al., 2016]
- Benefit in 10 m pistol: reduce a larger portion of CoP displacement during apnea in aiming





# Conclusion

## Elite 10 m pistol athletes:

- increased **postural stability** in natural conditions ;
- increased **posturo-ventilatory synchronisation** ;
- advantage for the aiming phase in competition conditions

→ Suggests some **improvement tracks** for National level athletes who do not display the same trend



## Limitations:



- Include more athletes (Covid-19 + Olympics preparation...)
- Individual strategies within groups ;
- Correlation but not causality ;

## To go further:

- Whole-body coordination strategy and perturbation absorption  
[Attali et al., in preparation]
- Effect of breathing conditions on shooting kinematics/performance : optimal pattern?
- Link between postural stability and target aiming stability



# Thanks for your kind attention

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## List of references

- Ko, J. H. et al. (2017). Skill level constrains the coordination of posture and upper-limb movement in a pistol-aiming task. *Human Movement Science*, 55, 255-263
- Chadeaux, D et al. (2020). A preliminary study of stability in elite and novice 10 meter air pistol shooters. *Computer Methods in Biomechanics and Biomedical Engineering*
- Hamaoui, A. et al. (2010). Respiratory disturbance to posture varies according to the respiratory mode. *Neuroscience Letters*, 475, 141-4.
- Perry, S. F et al. (2006). The coupled evolution of breathing and locomotion as a game of leapfrog. *Physiological and biochemical zoology : PBZ*, 79(6) :997–9
- Kantor, E. et al.(2001). Does body stability depend on postural chain mobility or stability area ? *Neuroscience Letters*, 308(2) :128–132.
- Era, P. et al. (1996). Postural stability and skilled performance—A study on top-level and naive rifle shooters. *Journal of Biomechanics*, 29(3), 301-306
- Holmes, M. L. et al. (2016). Tai Chi training reduced coupling between respiration and postural control. *Neuroscience Letters*, 610 :60–65.