

# Motor skill performance in violin bowing: Evidence for constrained action effects on acoustical, physiological, and physical outcomes

## Background

- **Constrained Action Hypothesis (CAH):** focusing on action execution (**internal** focus) compared to focusing on action effects (**external** focus) impairs motor performance in sport (i.e. “paralysis by analysis”, Wulf, McNevin & Shea, 2001).
- **Distance effect:** the more distal the focus from the body, the better the performance (Singh & Wulf, 2020).
- **Internal focus** also causes **increased EMG** muscle activity (i.e. reduced efficiency, Neumann & Brown, 2013)
- Few studies have extended these findings to music performance, and none to string playing.
- **Somatic awareness** (i.e. focusing on body *sensations*) is theoretically important in motor skill performance (Shusterman, 2009) and instrumental music making (Stambaugh, 2019).
- In violin bowing, bow **motion parameters**, **acoustic features**, and **EMG muscle activity** of sound may reveal behavioural changes in performance.

## Aims

1. Investigate effects of focus of attention (FOA) during a violin bowing task on acoustic features of sound produced, motion parameters, and EMG muscle activity during performance, while considering expertise effects.
2. Compare effects of internal and external foci with a novel “somatic” focus on tactile sensory feedback through the bow (also serving as a **proximal external** focus).

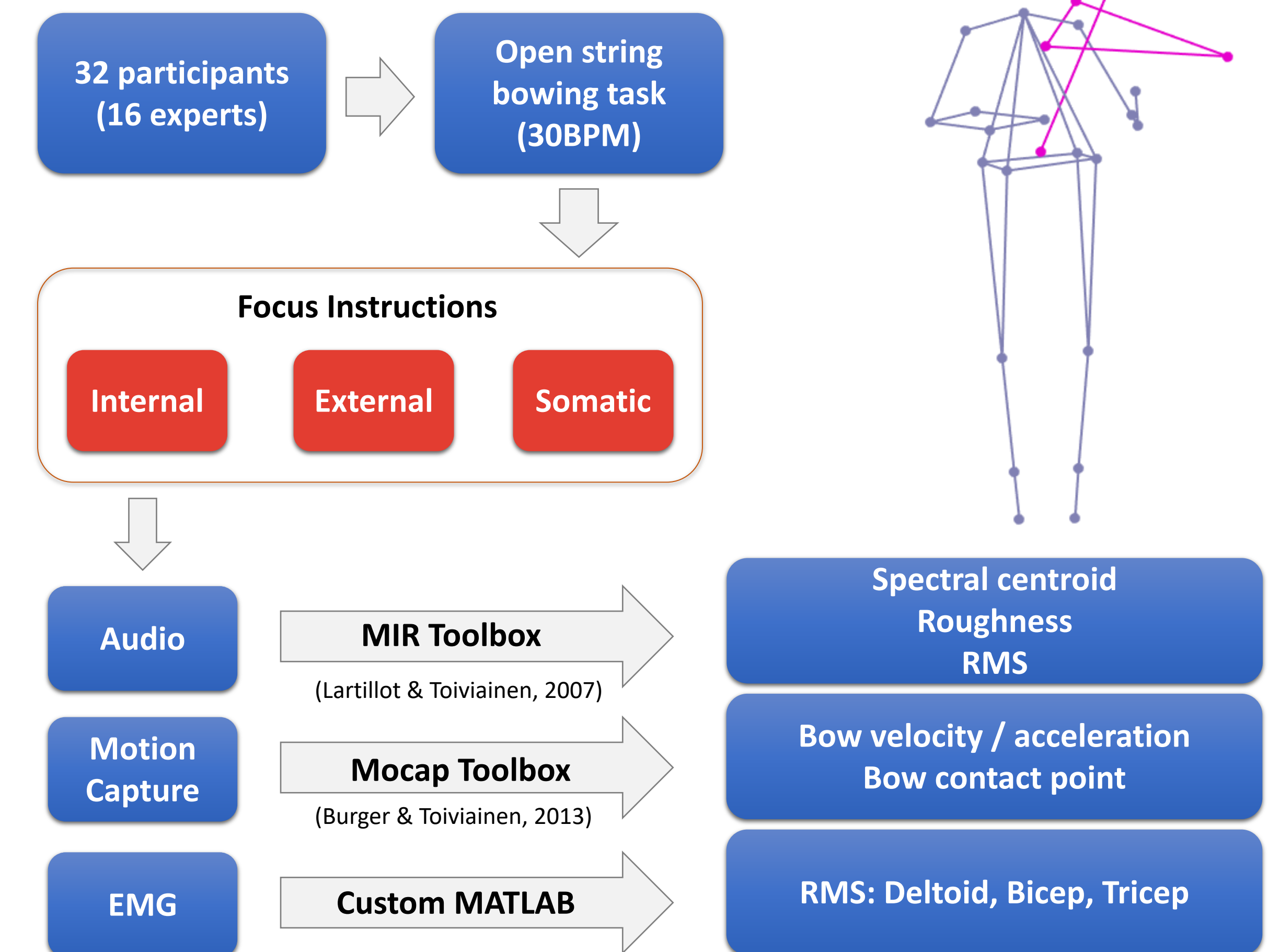
**H1:** External and somatic foci will benefit motor performance relative to internal.

**H2:** Expertise will mediate FOA effects.

### Focus Instructions

**Internal:** focus your attention on the movements in your right arm  
**External:** focus your attention on the sound you produce  
**Somatic:** focus your attention on the resistance of the bow against the string

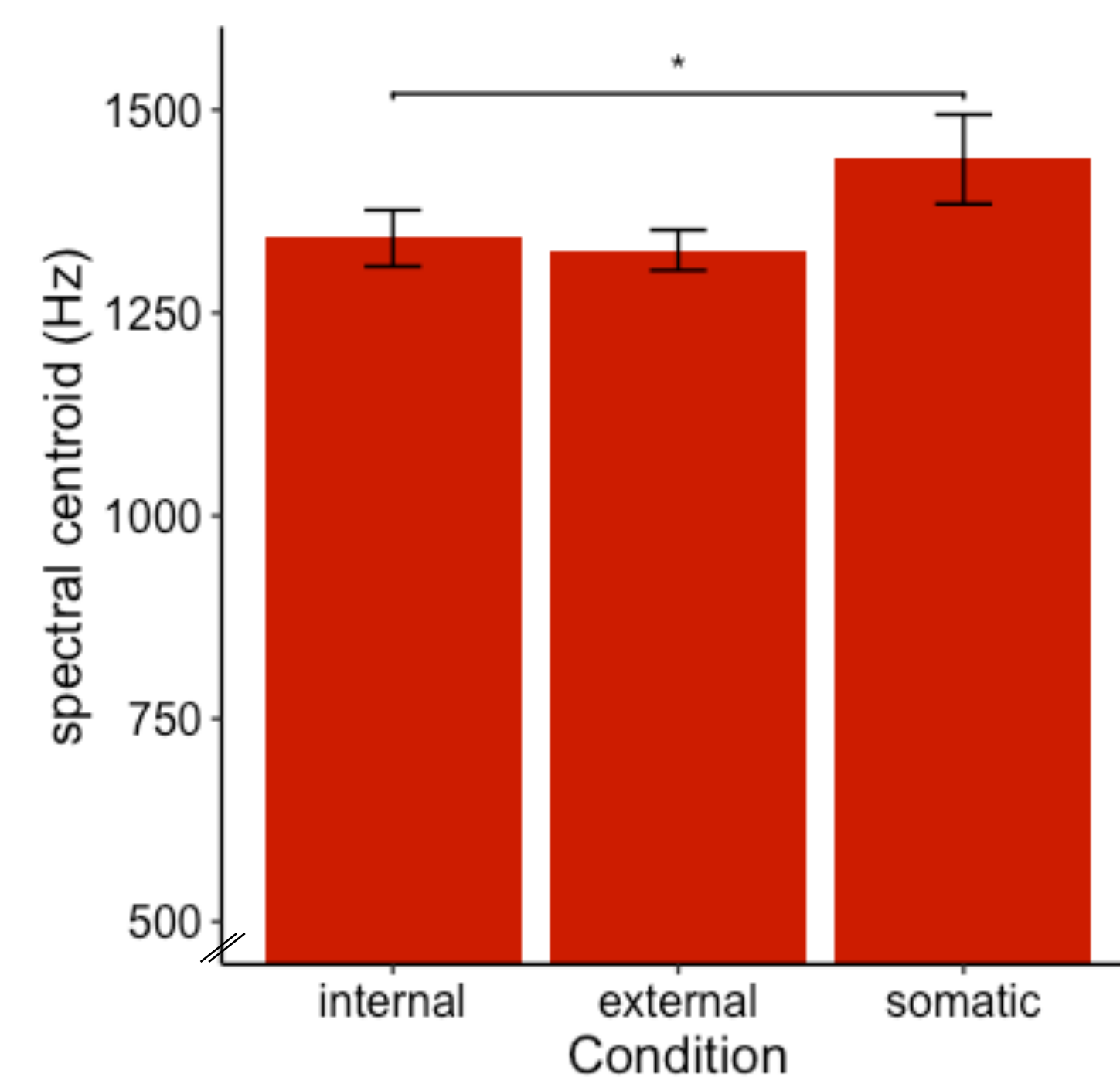
## Method



## Results

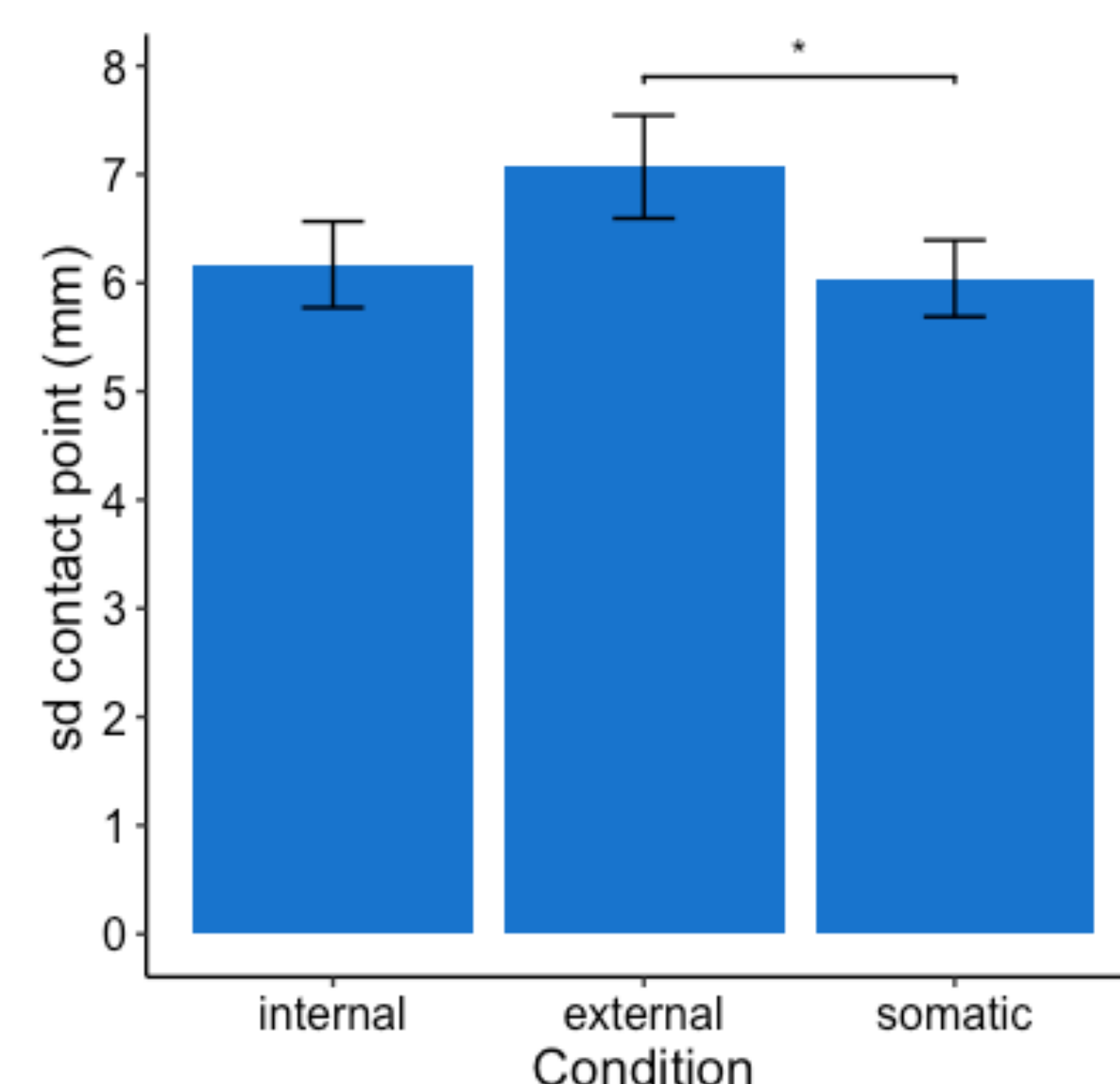
Mixed ANOVAs: focus condition (3) X expertise (2)

### Main FOA effect on Spectral Centroid



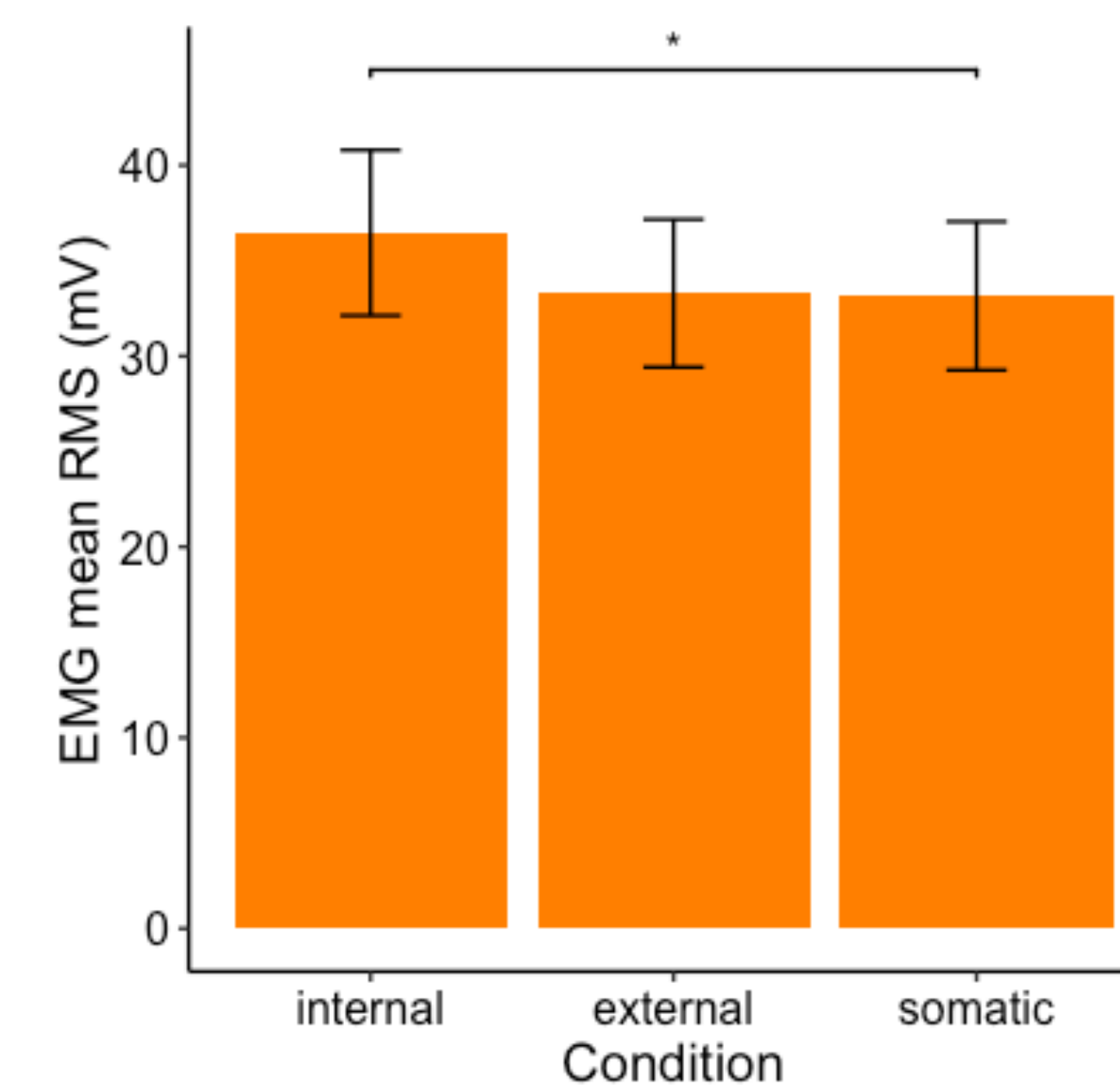
Significantly higher spectral centroid (tone brightness) in somatic focus compared to internal ( $F(1.52, 38) = 3.65, p = .047, \eta^2_p = .13$ )

### Main FOA effect on bow contact point SD



Significantly higher bow contact point SD (lower consistency) in external focus compared to somatic ( $F(1.60, 48.12) = 4.98, p = .016, \eta^2_p = .14$ )

### Main FOA effect on deltoid EMG activity



Significantly higher EMG deltoid activity in internal focus compared to somatic ( $F(1.35, 40.50) = 6.34, p = .010, \eta^2_p = .17$ ).

- No effects of FOA on roughness, RMS, bow velocity or bow acceleration.
- No effects of FOA on bicep or tricep EMG activity

- No expertise interaction effects

## Conclusions

- Results **partly support the CAH**: somatic focus (proximal external) caused performance improvement compared to internal, in terms of spectral centroid and reduced EMG activity.
- **The distance effect was not supported**: There were no significant differences between internal and distal external (sound) foci. In fact, there was an improvement in bow contact point consistency for proximal external (somatic) over distal external (sound).
- **Expertise did not influence focus effects** for this relatively novel task.
- We suggest the somatic condition acted as a superior external focus to the sound condition, supporting the theoretical **importance of attending to tactile sensory feedback** during musical motor tasks.
- Violin performers and educators should carefully consider how **verbal FOA instructions can affect performance**.

## References

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