



Voluntary Thermoregulation Can Only Be Achieved via Skeletal Muscle Activation



Vlada Aslanov¹, Noelani Luckas¹, Lukas Gerhards¹, Vlada Caraman⁴, Hein Daanen², Tomas Knapen¹, Simon van Gaal³, Johannes J. Fahrenfort^{1,3}

¹ Department of Applied and Experimental Psychology, VU; ² Department Human Movement Sciences, VU; ³ Department of Psychology, UvA

Context

Thermoregulation is generally considered beyond conscious control, as peripheral temperature is regulated by **autonomic changes in blood flow**.

However, previous research suggests individuals can learn to **voluntarily** modulate peripheral skin temperature.

For example, participants have been shown to create **temperature differences** between the hands (warming one hand while cooling the other) using **mental strategies**, **hypnosis**, or **biofeedback** (e.g., Maslach et al., 1972; Roberts et al., 1973, 1975; Lynch et al., 1976; McGuirk et al., 1998; Cooper et al., 2014).

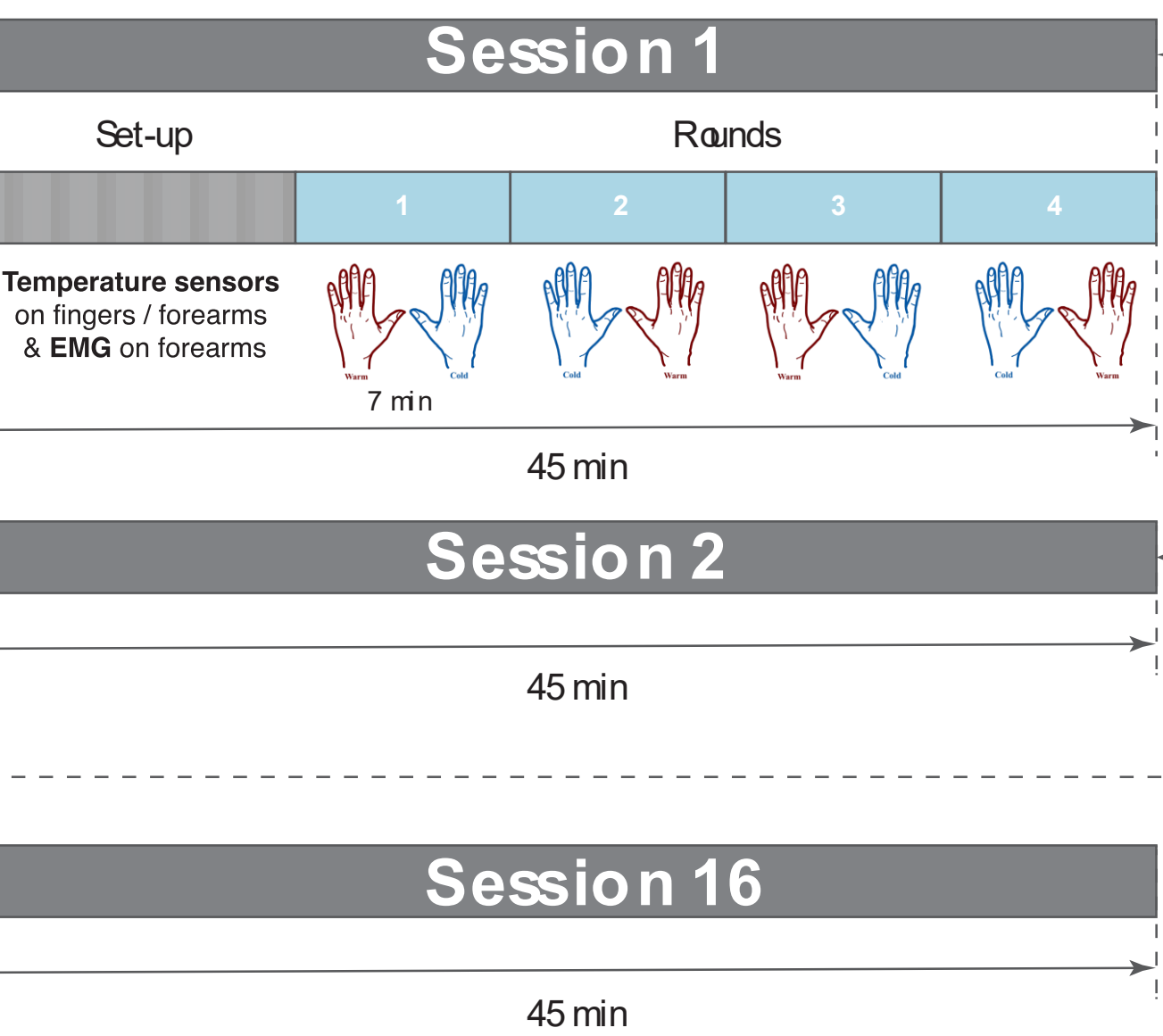
Voluntary temperature control may benefit performance in extreme environments and aid conditions involving impaired temperature regulation.

Research Question

Can people learn to create a temperature difference between their hands by warming one hand while cooling the other using using personal mental imagery and biofeedback?

Methodology

Adapted from Roberts et al. (1975)



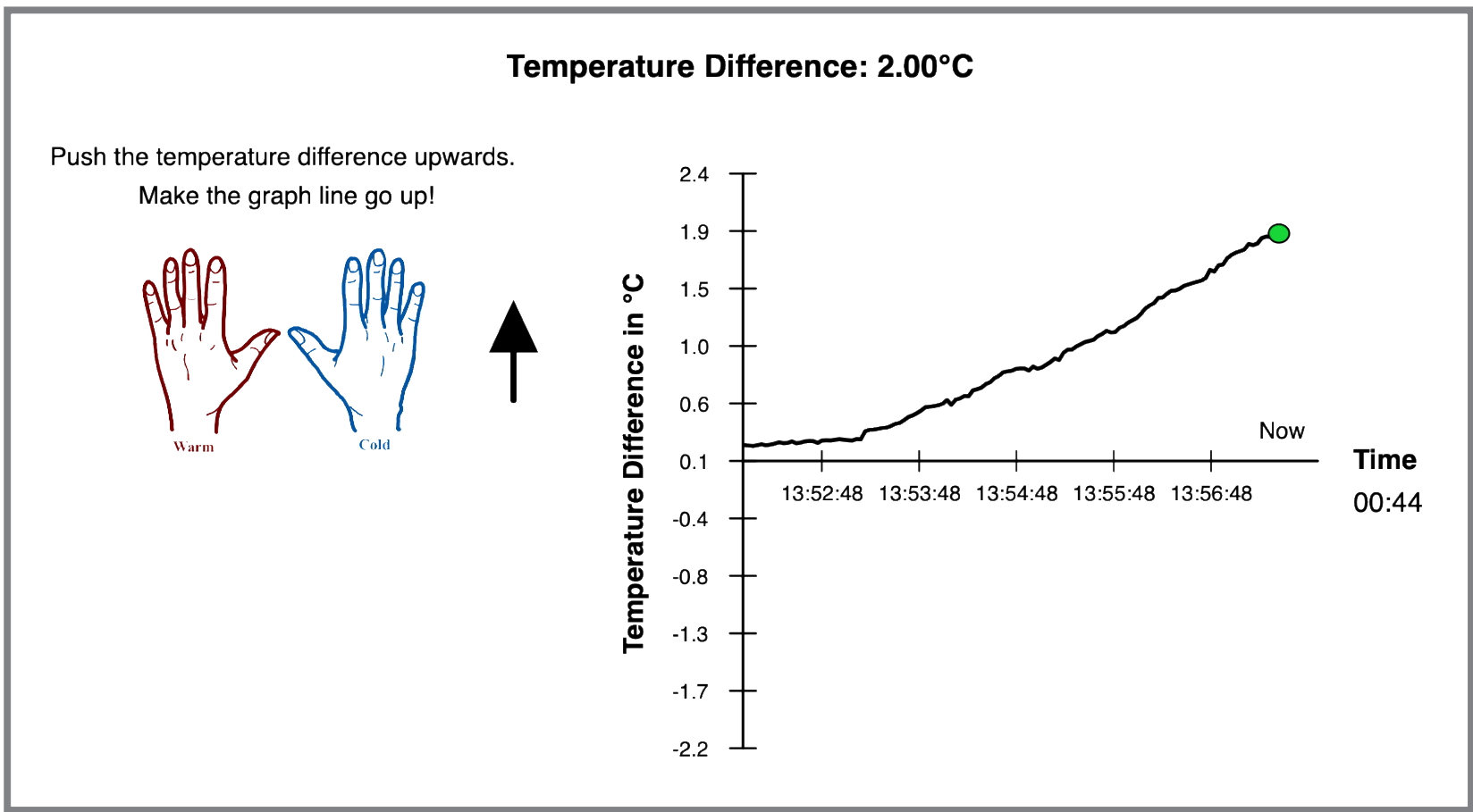
Task: Create a temperature difference between the hands by warming one hand while simultaneously cooling the other using personal mental strategies.

Measurements:

- Temperature:** Sensors attached to the palmar surface of the middle fingertips of both hands.
- EMG:** Electrodes placed on the inner forearm muscles of both arms to verify that temperature changes were not driven by muscle activation.

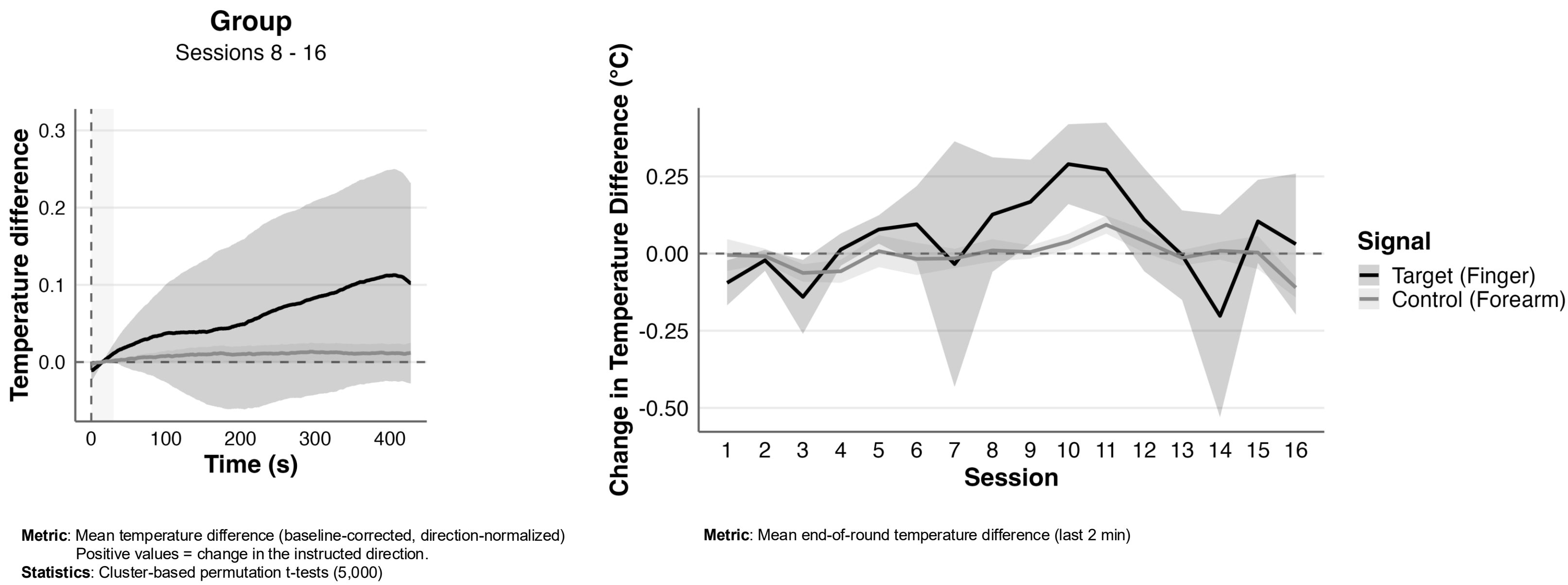
Visual biofeedback presented during a round:

Custom interface displaying the temperature difference between the hands in real time.

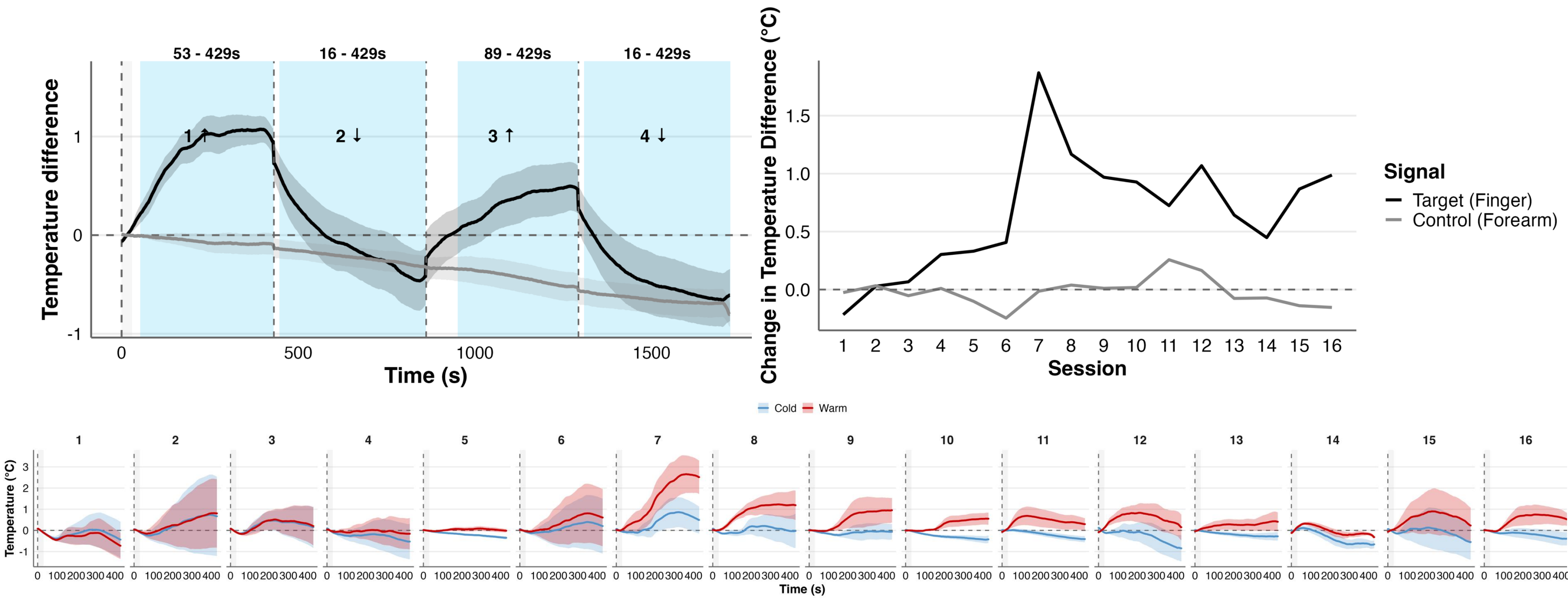


Results

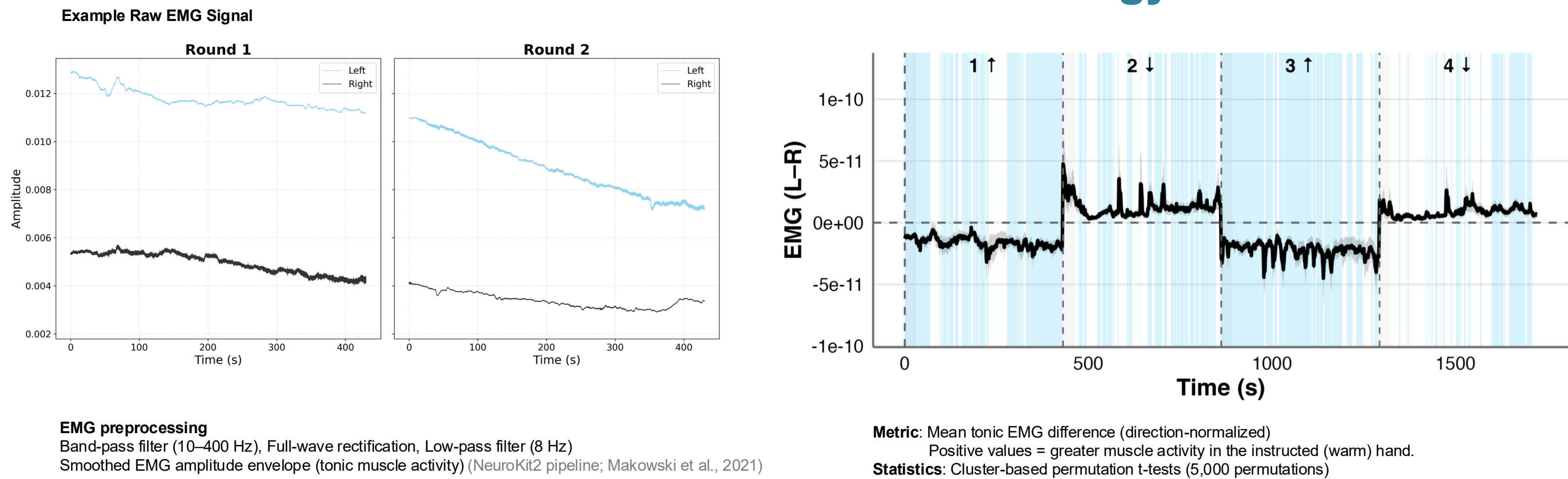
N = 7



Participant Showing Successful Temperature Regulation



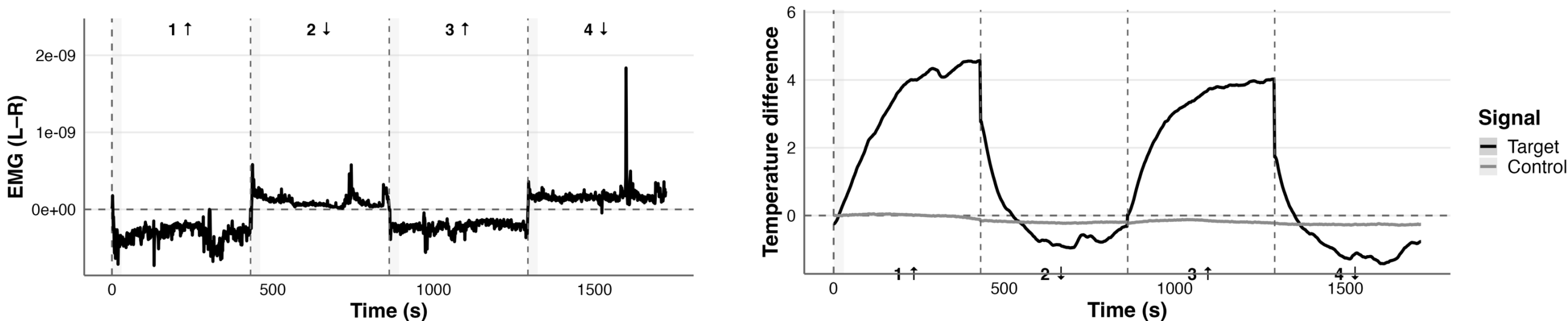
Evidence for a Muscular Strategy



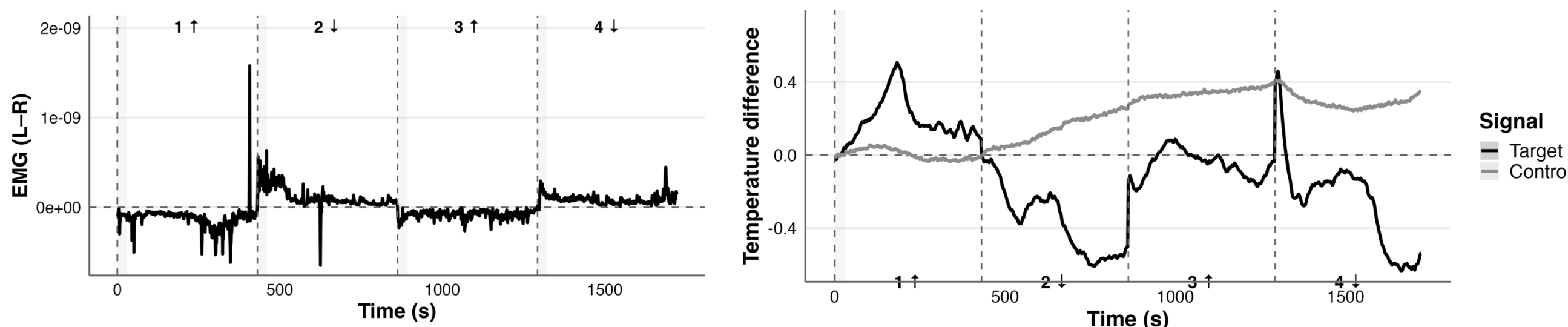
Exploratory

Is the temperature difference achieved by reducing blood flow through fingertip pressure or by tensing the muscles of the hand instructed to cool?

Fingertip Pressure



Muscle Tension



- In contrast to previous studies, only one participant reliably created temperature differences in the instructed direction.
- However, this effect was accompanied by greater tonic activation of the cooled hand, suggesting a **muscular rather than a mental strategy**.
- The strategy likely involved **fingertip pressure** in the cooled hand, reducing local blood flow and thereby lowering temperature.

- These findings suggest that **direct voluntary control of peripheral skin temperature is not achievable**, even with extensive training.
- Previous reports of voluntary temperature regulation may reflect **unmeasured muscular strategies**.