

Dissociating perception and attention in a human experimental model of pain: thermal grill conditioning facilitates late but not early somatosensory evoked potentials

Francisco Sacadura, Soony Brookes, Brianna Beck, Francesca Fardo, Patrick Haggard
Institute of Cognitive Neuroscience, University College London, London, United Kingdom



Summary

- The TGI is an important experimental model for studying tonic/chronic pain in humans
- Temperature matching quantifies TGI intensity
- Only late SEP components are affected by TGI
- TGI enhanced N140 subadditivity, suggesting a selective saliency/attentional effect

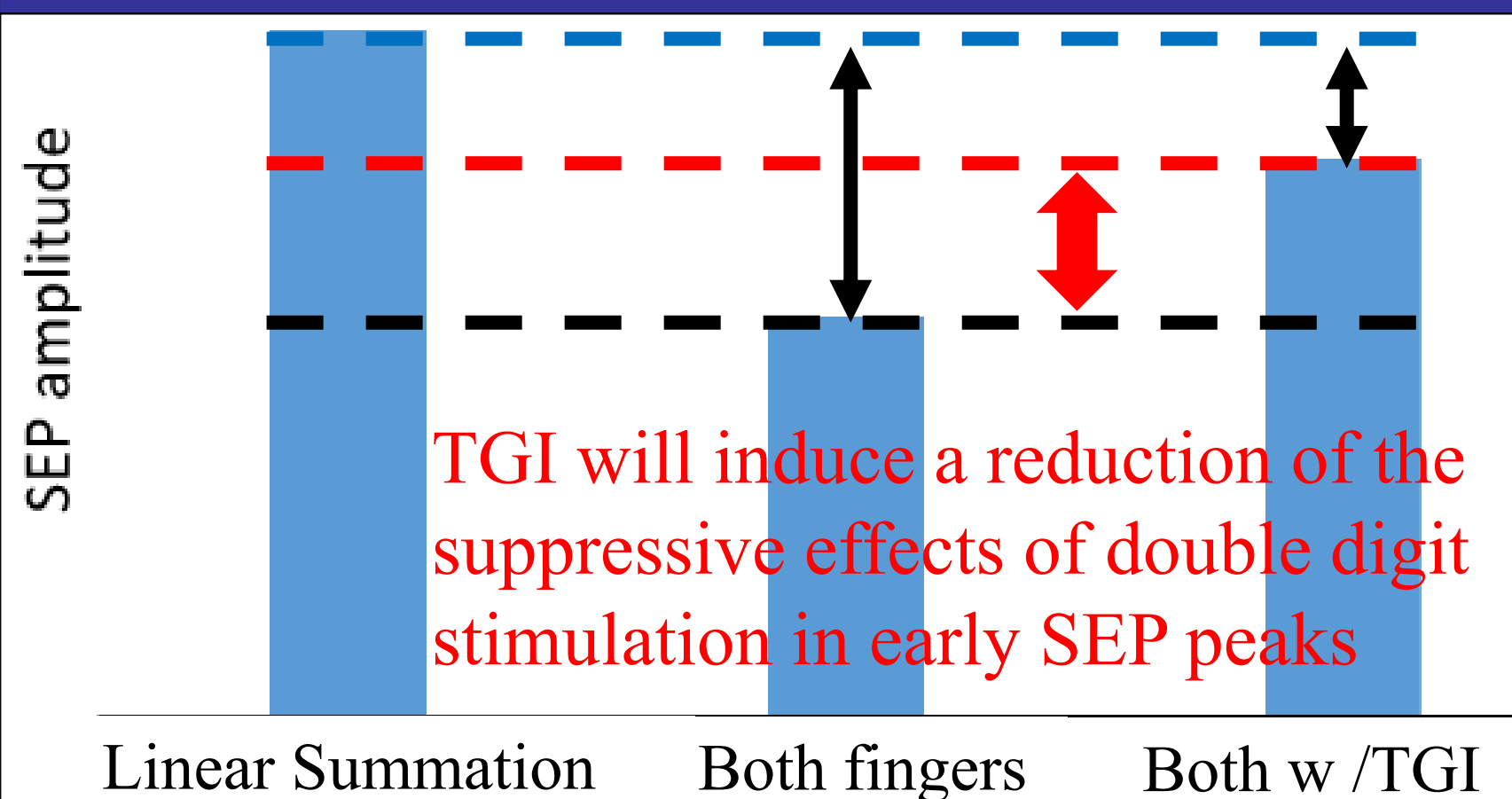
Introduction

- Thermal Grill Illusion (TGI) is the paradoxical burning sensation evoked by alternating non-noxious warm and cold temperatures [1]
- The TGI is suggested to be the only human experimental model of chronic/tonic pain [2]
- Patients with chronic pain have shown reduced temporal intracortical inhibition in SI [3] and this somatosensory disinhibition has been suggested to play a causal role in tonic pain [4]
- How spatial intracortical inhibition in SI is affected by TGI conditioning is still unknown

Objective

- TGI was combined with double-digit electrical stimulation to probe whether TGI conditioning reduces spatial intracortical inhibition in SI
- We measured subadditivity of somatosensory-evoked potentials (SEPs) when both fingers were stimulated together relative to the linear summation of SEPs when single fingers were stimulated as a correlate of lateral inhibition

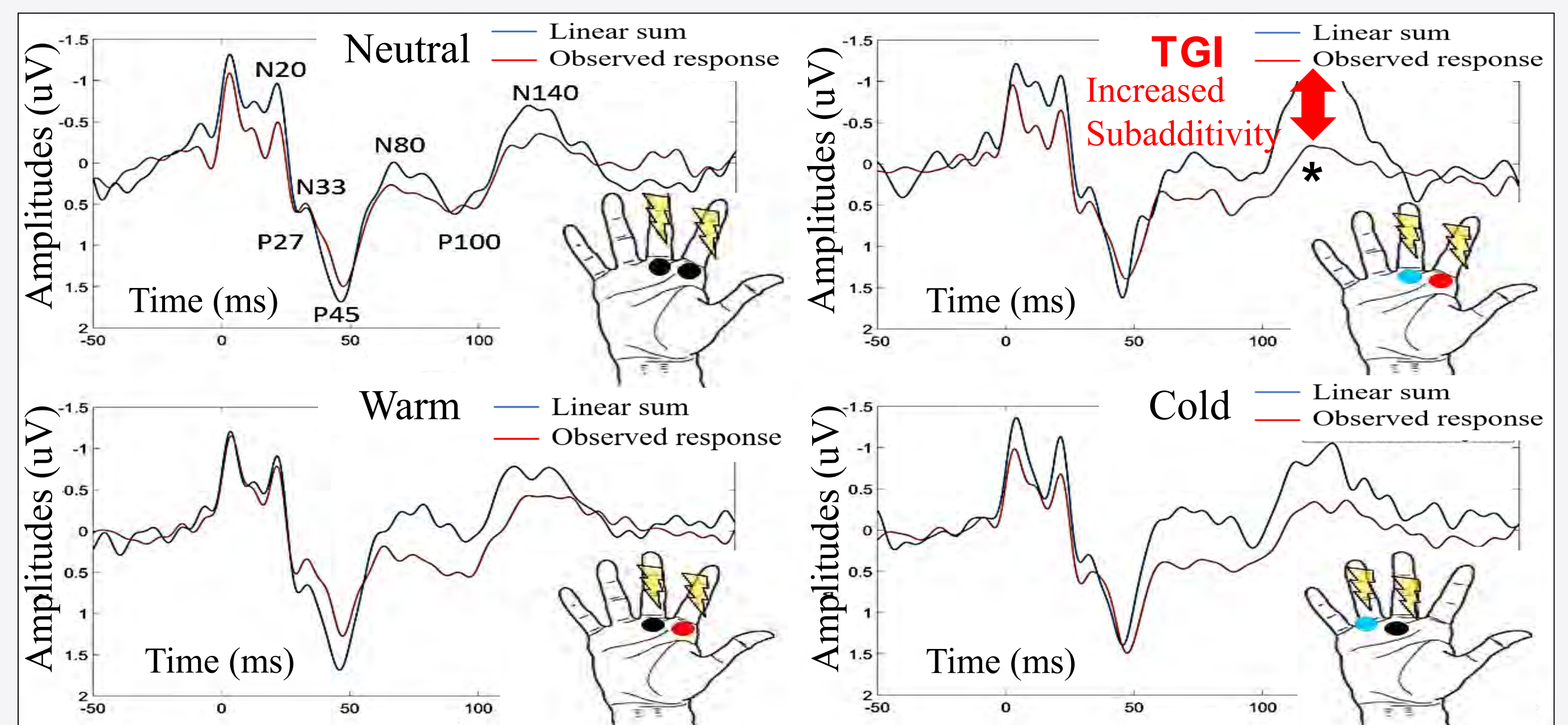
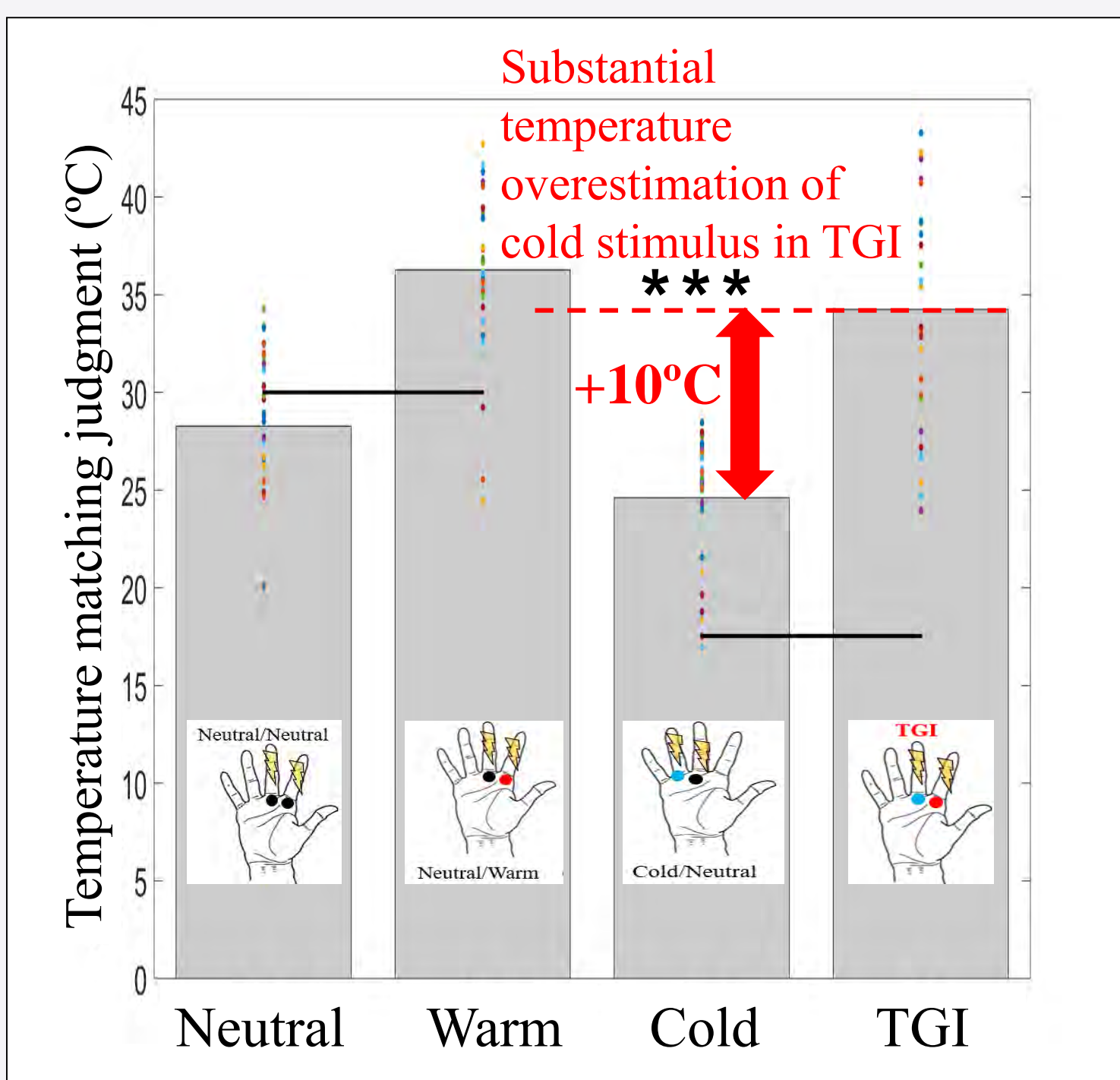
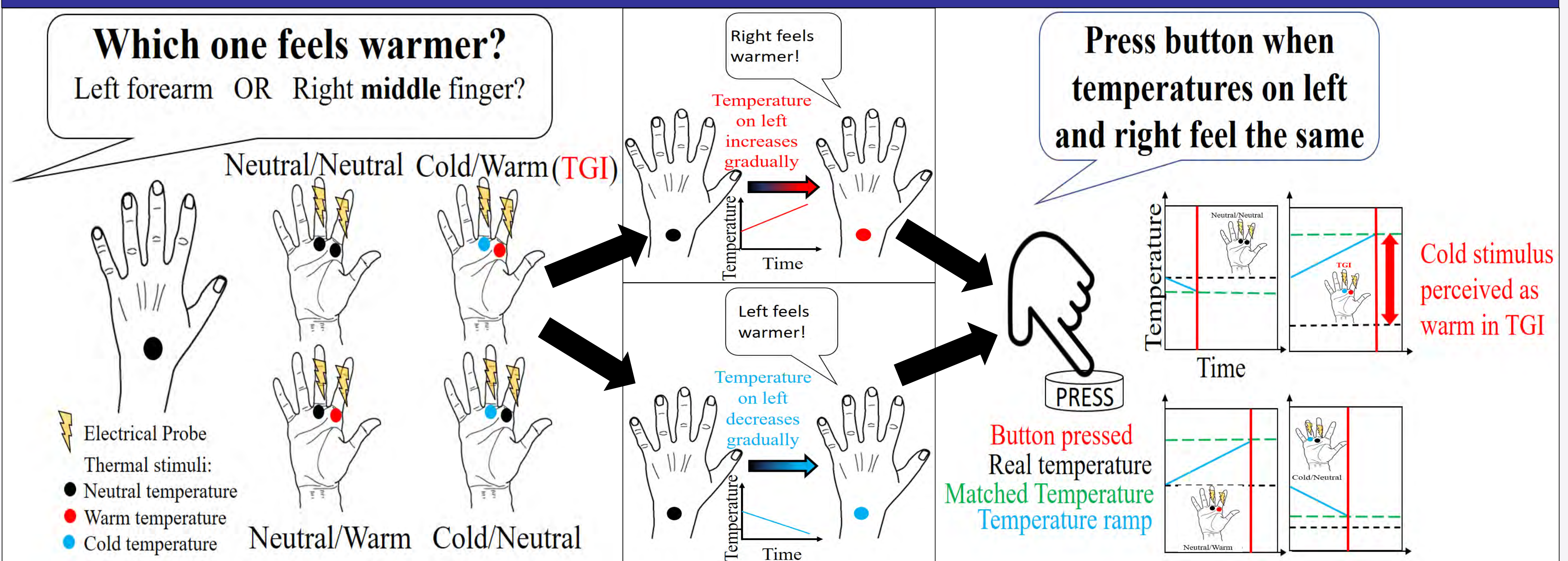
Predictions



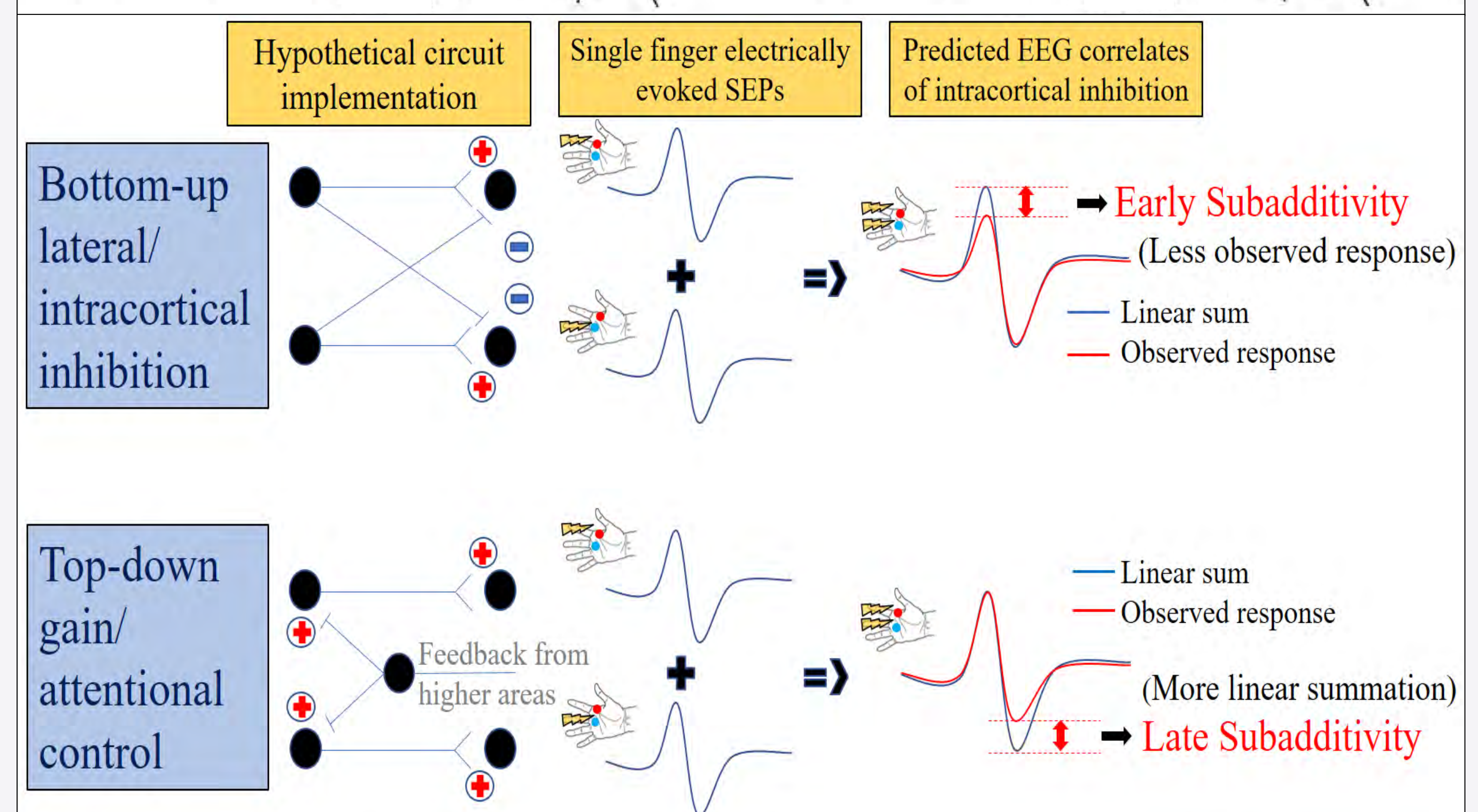
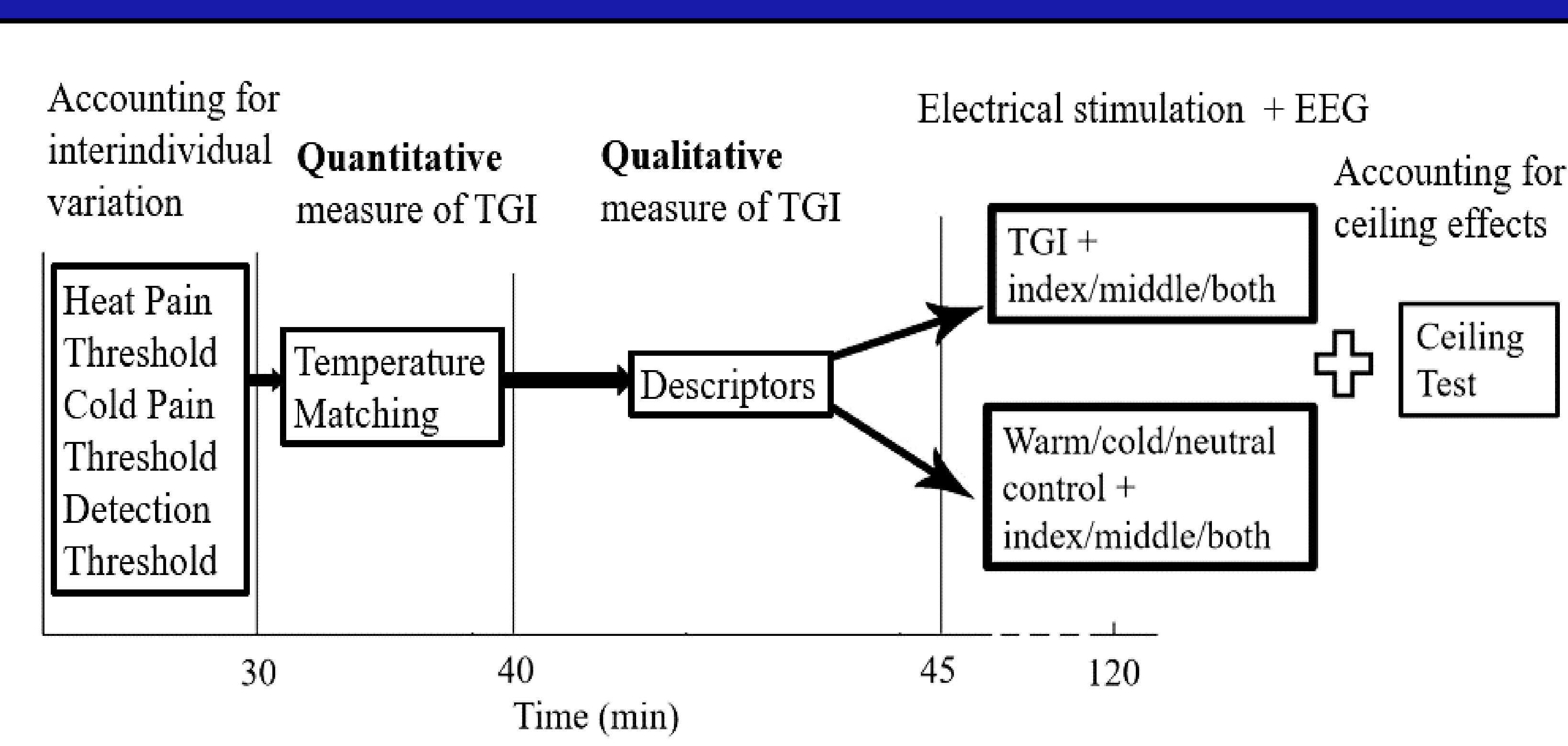
Results

- Substantial temperature overestimation for the cold stimulus (10°C) and unpleasant burning sensation in the TGI condition, confirming successful induction of the TGI (paradoxical heat)
- No significant effect of thermal stimulation on early SEP components (N20, P27, N33, P45, N80), classically linked to early sensory processing (perception)
- Thermal stimulation did affect later cognitive SEP components (P100, N140):
 - Warm and cold stimulation reduced subadditivity in the centro-parietal P100 by decreasing the evoked responses to individual finger stimulation (i.e., by decreasing the summed response)
 - TGI enhanced subadditivity in the centro-parietal N140 by increasing the evoked responses to individual finger stimulation (i.e., by increasing the summed response)

Temperature Matching: quantifying TGI thermal intensity



Task Structure Overview



Conclusions

- Thermal stimulation had no effect on early intracortical inhibition in SI
- However, TGI conditioning enhanced sub-additivity in N140, classically associated with top-down attentional modulation of somatosensory inputs, by increasing the saliency of individual finger stimulation with much less modulation of double-digit input
- Our results suggest the TGI has minimal effects on early somatosensory processing, but rather increases the gain of later, non-specific attentional components of evoked cortical activity
- This experimental pain model altered attentional processing of a body area, but left early sensory processing of stimuli from that area unaffected [4]

References

Thunberg T (1896) Förmimmselna vid till samma ställe lokaliserad, samtidigt pågående köld-och värmeretning. Uppsala Läkfören Förh 2: 489-495

Sumracki, N., Buisman-Pijlman, F., Hutchinson, M., Gentgall, M. and Rolan, P. (2014). Reduced Response to the Thermal Grill Illusion in Chronic Pain Patients. *Pain Medicine*, 15(4), pp.647-660

Lenz, M., Hofken, O., Stude, P., Lissek, S., Schwenkreis, P., Reinersmann, A., Frettlow, J., Richter, H., Tegenthoff, M. and Maier, C. (2011). Bilateral somatosensory cortex disinhibition in complex regional pain syndrome type I. *Neurology*, 77(11), pp.1096-1101

Haggard, P., Iannetti, G. and Longo, M. (2013). Spatial Sensory Organization and Body Representation in Pain Perception. *Current Biology*, 23(4), pp.R164-R176

Jutzeler C, Warner F, Wanek, J, Curt, A and Kramer, J (2017). Thermal grill conditioning: Effect on contact heat evoked potentials. *Scientific Reports*, 7, p.40007.