

Influence of local thermal stimulation on afferent-induced modulation in the hand motor area: a transcranial magnetic stimulation study

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Introduction

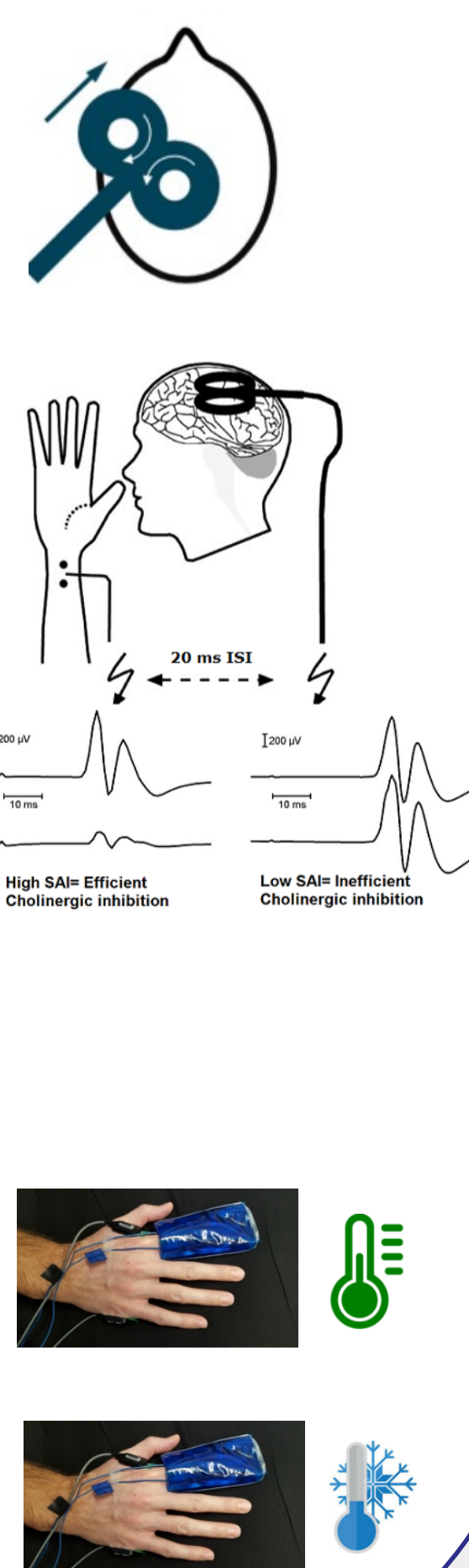
- Thermal stimulation, in the form of either skin cooling or warming, has been proposed as a method to facilitate motor responses in neurologic populations, such as stroke patients.
- In this study, we are investigating the effect of efferent skin cooling on cortical excitability, using markers of sensorimotor integration derived from transcranial magnetic stimulation (TMS).
- By comparing the magnitude of afferent-induced inhibition (SAI) and facilitation (SAF) of pre-cooling and post-cooling in our participants, we will attempt to determine whether thermal stimulation induced by local skin cooling can modulate intra-cortical excitability and influence circuits involved in sensorimotor integration in the human motor cortex.

Methods

Participants (Young healthy Adults)	Gender	Handedness	Age (Mean ± SD)
N=15	11♀, 4♂	2 L, 13 R	24.6 ± 5.0 y

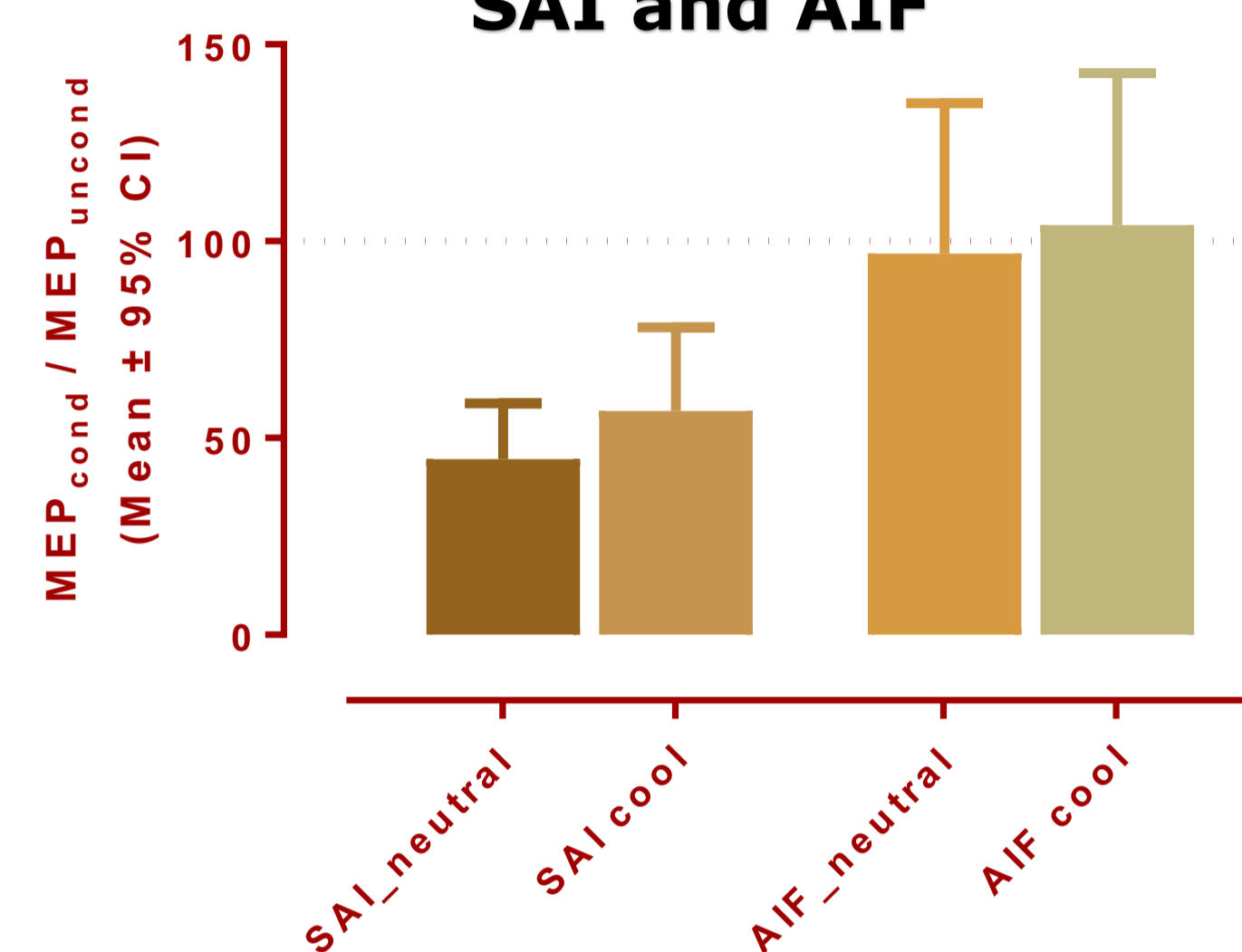
Procedure

- TMS produced using a Magstim 200 (Dyfed, UK) connected to a focal coil (70-mm inner loop).
- Motor evoked potentials (MEPs) amplitude recorded from the 1st dorsal interosseous (FDI) muscle.
- Afferent conditioning produced by prior median nerve stimulation at the wrist (200 μs, electrical pulse at motor threshold)
- Testing protocol involved 3 blocks of trials under 2 conditions (Neutral and Cooled):
 - Unconditioned (baseline) MEPs (n=15, 120 %rMT)
 - Short-latency afferent inhibition (SAI) at 20 ms ISI (n=15)
 - Afferent-induced facilitation (AIF) at 50-60 ms ISI (n=15)



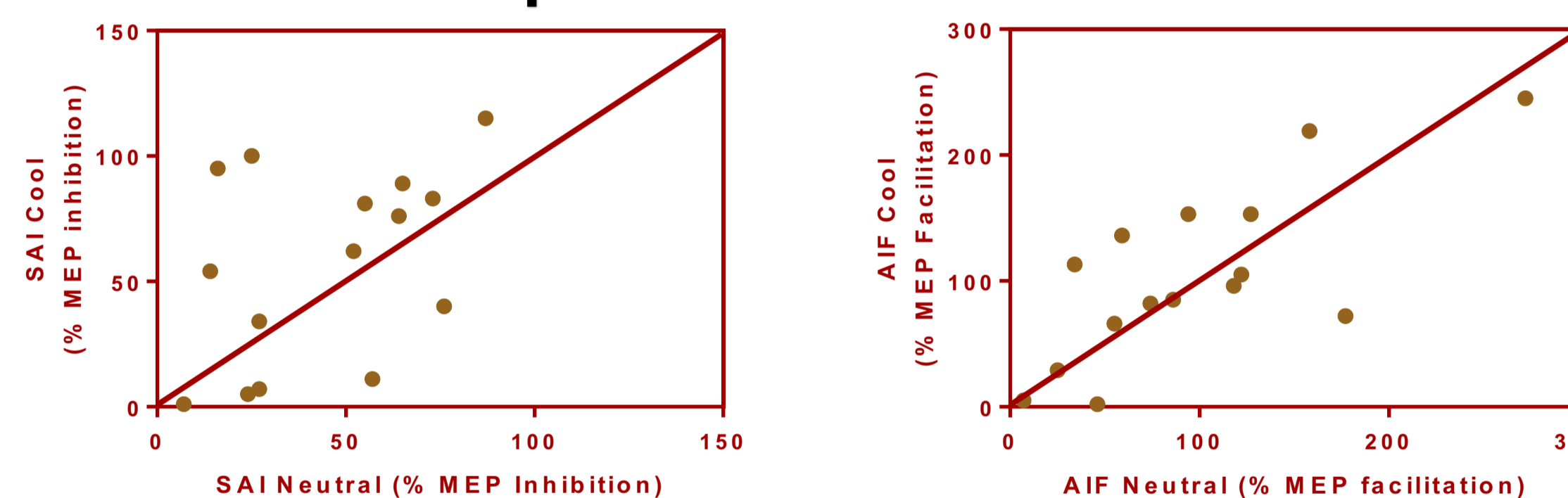
Results

1. Mean comparison of neutral vs cooling temperatures on SAI and AIF



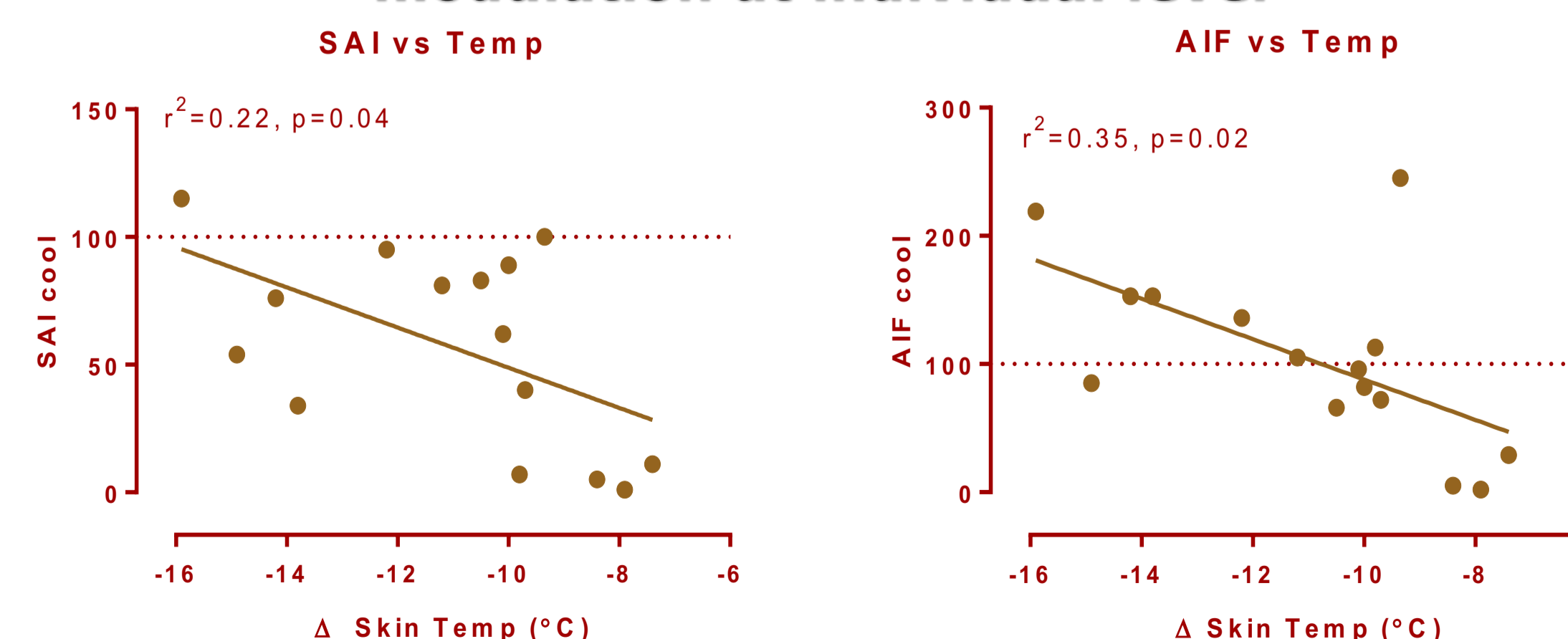
- SAI, on average, decreased with cooling but a t-test comparison revealed no significant difference with BL ($t=1.22, p=0.20$). AIF exhibited little change with cooling.

2. Individual comparison of neutral vs cooling temperatures on SAI and AIF



- When comparing individual modulations, it can be seen that many participants exhibited less afferent-inhibition (SAI) and higher afferent-induced facilitation (AIF) in response to cooling.

3. Relationship between skin cooling and MEP modulation at individual level



- Correlative analysis between individual changes in skin temperature and markers of sensorimotor integration revealed significant inverse associations. Greater reductions in temperature were associated with lesser SAI and larger AIF.

Summary of results

- Cooling was effective in reducing skin temperature (One-way ANOVA, $F=170.6, p<0.0001$). Post-hoc comparisons with Dunnett's post-test confirm that skin temp for both SAI (mean $18.4^\circ \pm 3.4$) and AIF ($18.4^\circ \pm 3.5$) were significantly lower than that at baseline ($29.4^\circ \pm 2.4$).
- Although SAI, on average, tended to be decreased with cooling (i.e., less MEP inhibition), a comparison using a paired t-test revealed no significant difference between BL ($t=1.22, p=0.20$). Likewise, no difference was found when comparing AIF cooled with AIF at BL. Thus, **overall**, neither SAI nor AIF were significantly changed in response to cooling when examining pooled data.
- However, at the **individual** level, we found significant inverse associations between individual reductions in skin temperature and SAI_AIF, so that individuals showing larger reduction in temperature also showed lesser inhibition and larger facilitation.

Discussion

- These results, although still preliminary, indicate that thermal stimulation induced by distal focal cooling can influence measures of sensorimotor integration derived from TMS.
- While no effects were detected when pooling data across all participants, a finer analysis at the individual level revealed an association between greater reductions in skin temperature and decreased SAI, i.e. the larger the reduction the lesser the inhibition.
- The same logic applies to AIF, with greater reductions in skin temperature leading to larger MEP facilitation in the presence of cooling.
- These observations suggest that activation of thermal cold afferents in the digital skin tends to release inhibition at the cortical level leading to enhanced sensorimotor transmission.
- These effects, however, appears to be dependant on the degree of skin cooling and likely reflect the recruitment of larger cold fiber populations as temperature decreases.

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