Does electrical stimulation to the hands (transcutaneous electroacupuncture stimulation, TEAS) have frequency-specific effects on heart rate variability (HRV)?

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Background and Aim
Heart rate variability (HRV) [Fig 1] is increasingly used in clinical and experimental research as an indicator of autonomic health, i.e. balance between Parasympathetic and Sympathetic nervous systems (PNS, SNS) in favour of the former. Our aim was to ascertain if transcutaneous electroacupuncture stimulation (TEAS) has frequency-specific effects on HRV. With 66 healthy participants attending for four sessions each, to our knowledge this is the largest study published to date that investigates our research question.

Objectives
To determine:
Q1. Which HRV measures in the volunteers in this study might reflect a better state of health
Q2. Which measures most strongly reflect differences between TEAS frequencies
Q3. Which measures most strongly reflect changes over time
Q4. Whether there is a different selection of measures that reflects changes during and after stimulation
Q5. What conclusions may be drawn on frequency-specific effects of TEAS.

Methods
- Ethics approval was granted by the University of Hertfordshire and participants recruited from staff and students, local complementary health practitioners and other contacts.
- Following a 5-min baseline ECG recording, TEAS was applied for 20 mins to each hand between acupuncture point LI4 (hegu) and the ulnar border. In each session, stimulation was at a different frequency – 2.5, 10 or 80 pps (pulses per second) at a ‘strong but comfortable’ amplitude, or as ‘sham’ at 160 pps and zero amplitude. After stimulation, recording was continued for 15 minutes to assess post-stimulation changes (8 x 5-min ‘slot’ recordings per session [Fig 2]). Statistical analysis (non-parametric) was conducted in Excel and SPSS.
- Fifty-six different HRV measures were considered as indices of parasympathetic or sympathetic functioning and subgroupings of measures selected for analysis according to criteria described in the background information available online (see URL/QR code).

Salient results
- After accounting for missing data, 55 complete participant datasets remained (1988 5-minute ‘slot’ recordings in all).
- (Q1) From literature review and correlations with PNS and SNS indices (|r| ≥ 0.5) in our data, 18 other HRV measures could be allocated as representing ‘better’ or ‘worse’ autonomic functioning in our volunteers (for details of these and other HRV measures, see our online information).
- (Q2, Q3) Of these 20 measures, seven consistently demonstrated larger numbers of significant differences between frequencies and significant changes over time (using the Wilcoxon signed-ranks test): PNS, SNS, RR, RMSSD, NNxx, pNNxx and SD2/SD1, along with multiscale entropy at three scales.
- (Q4) There were markedly more significant differences between the effects of the different stimulation frequencies during after stimulation, with RMSSD, SD2 and DFA alpha1 figuring prominently [Fig 2].
- (Q5) SNS index values suggest that 10 pps stimulation was experienced as less stressful during and after stimulation than the other TEAS frequencies [Fig 1].
- In addition, HF_abs and LF/HF, as well as RR, suggest that there was greatest reduction in stress following 10 pps stimulation.
- In keeping with these findings, towards the end of the sessions, pNNxx was lowest for stimulation at 10 pps, whereas the percentage of ectopic beats (?) found during and immediately after stimulation was highest for 80 pps [Fig 4].
- MSE findings are more difficult to interpret, but again appear to indicate a difference between the effects of 10 pps and the other stimulation frequencies.

Conclusion
L4 TEAS at 10 pps may be less stressful than at 2.5 or 80 pps.

Where next?
Further analysis is now planned to clarify questions raised by the current study, including on the effects of stimulation amplitude, participant preference for stimulation at particular frequencies, measures at baseline, and pulse rate variability (PRV) in addition to HRV.

More details are available at www.qeeg.co.uk/electroacupuncture/hrv2, also accessible through the QR code at the head of this poster.