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 subgroups of measures selected for analysis according to criteria described in the background information available online (see URL/QR code).

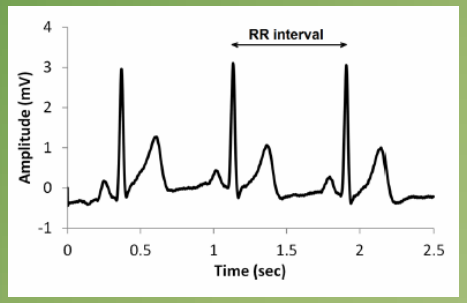
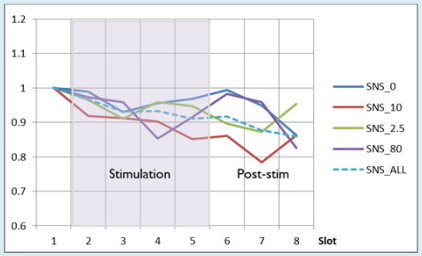


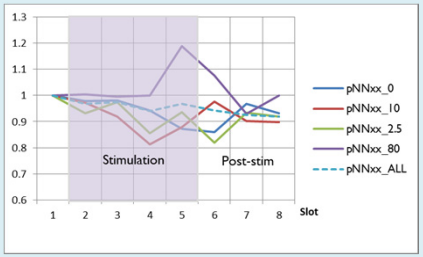
Fig 1. Left: ECG electrodes on R arm; PPG on finger. Right: Resulting ECG trace, showing 'RR interval', the basis for all HRV measures.

Fig 2. Numbers of significant differences between measures for all stimulation frequencies (by 'slot')

Slot	1	2	3	4	5	6	7	8	Sum
	Baseline	Stim1	Stim2	Stim3	Stim4	Post1	Post2	Post3	
N signif	11	26	31	30	24	10	6	6	192

Fig 3 (Left). SNS index over time (medians).
Fig 4 (Right). pNNxx (percentage of ectopic beats?) over time (medians).





Conclusion

LI4 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.

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 ($|rho| \geq 0.5$) 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 than 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 3**].
- 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.

Overall, stimulation at both 2.5 and 80 pps appeared to increase rather than decrease the stress response, sham to increase it slightly, and 10 pps to decrease it slightly.

- Thus, taking part in a study like this may not always be a stress-free experience!

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

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