Confirmation that Rhythmical Skeletal Muscle Tension (RSMT) Can Increase Heart Rate Variability

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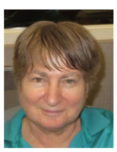
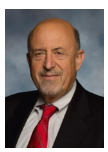
Gratitude

We are grateful to Evgeny Vaschillo, Bronya Vaschillo, and Paul Lehrer for their inspiration, encouragement, and support for this study.

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Gratitude

We are also deeply grateful to the Foundation for Education and Research in Biofeedback and Related Sciences for student travel support, which has made our participation possible.

Foundation for Education and Research in Biofeedback and Related Sciences

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Introduction

Evgeny Vaschillo, Bronya Vaschillo, and Paul Lehrer have demonstrated that rhythmical stimulation, by displaying pictures and *rhythmical skeletal muscle tension (RSMT)*, can stimulate the baroreceptor reflex like resonance frequency breathing and increase frequency-domain measures of heart rate variability (HRV).

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Introduction

In their RSMT study, 16 participants placed in a semi-recumbent position rhythmically contracted their hands and feet 3, 6, and 12 times per min. RSMT only produced high-amplitude oscillations in blood pressure, heart rate, and vascular tone at the 6-contractions-per-min (cpm) rate, which corresponds to 0.1 Hz.

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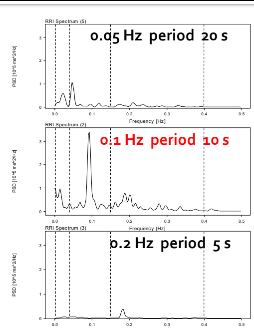
Introduction



High amplitude HR oscillation was elicited by rhythmical muscle tension only at 0.1 Hz (graphic used by permission by E. Vaschillo)

6

Introduction

The present study investigated the effect of RSMT on selected HRV time-domain, frequency-domain, and nonlinear metrics with a larger sample of healthy university students.

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Method

Participants
Forty undergraduates (25 women and 15 men), 18 to 28 years of age, participated in this study.

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Method

Apparatus
A Thought Technology ProComp Infiniti ™ system monitored ECG, HRV, EMG, and respiration.

Active ECG electrodes were located on the upper torso. A respirometer was positioned over the navel to measure excursion and respiration rate.

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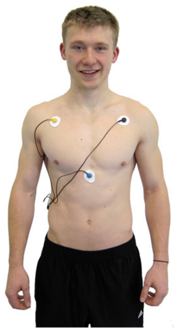
Method



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Method

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Method

Active EMG electrodes were centered over the flexor carpi ulnaris for a manipulation check of rhythmic skeletal muscle contraction.

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Method

Procedure

Participants were randomly assigned to one of six different orders of 5-min trials of 3, 6, and 12 muscle contractions per min (cpm), separated by 3-min buffer periods.

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Method

Participants received verbal prompts to perform simultaneous hand and foot contractions for 3 s, but did not receive feedback.

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Method

Data were manually artifacted within CardioPro and then detrended in Kubios 3.1 using a smoothness priors procedure. Frequency domain analysis utilized Welch's periodogram (FFT) procedure.

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Method

Data were transformed using a natural log (Ln) transformation and analyzed using a General Linear Model Repeated Measures ANOVA.

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Results

Participants contracted their hands and feet at the prescribed frequencies.

Flexor carpi ulnaris EMG increased in a stepwise fashion with contraction frequency, $F(2,66) = 7.26$, $p = .001$, $\eta^2 = 0.18$, $d = 0.94$).

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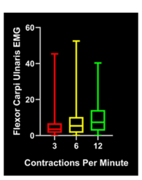
Results

LnEMG was greater at 12 cpm than at 3 cpm, $F(1,33) = 16.51$, $p = .000$, partial $\eta^2 = 0.33$, $d = 1.40$ and 6 cpm, $F(1,33) = 5.10$, $p = .03$, partial $\eta^2 = 0.13$, $d = 0.77$.



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Results

We found no significant contrast for LnEMG between 3 and 6 cpm.

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Results

Respiration rate was constant across all rhythmical skeletal muscle tension conditions, $F(2,68) = 1.83$, $p = 0.168$.

Since respiration rate was equivalent across all three conditions, effects on HRV were not mediated by breathing.

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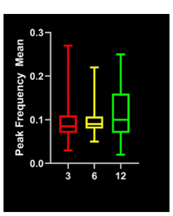
Results

The 6-cpm condition produced a mean peak frequency of ~ 0.1 Hz compared with 0.09 at 3 cpm and 0.11 at 12 cpm.



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Results

Rhythmic muscle contraction significantly affected LnLF power, $F(2,68) = 50.64$, $p = .000$, partial $\eta^2 = 0.60$, $d = 2.45$.

Muscle Contraction Frequency	FFT LF Power in original units
3 contractions per min	1927.17 (1603.21)
6 contractions per min	2267.39 (1891.07)
12 contractions per min	807.17 (774.62)

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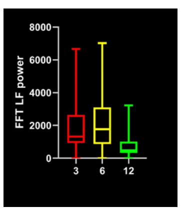
Results

The 6-cpm condition produced greater LnLF power than the 12-cpm condition, $F(1,34) = 44.82$, $p = .000$, partial $\eta^2 = 0.67$, $d = 2.85$.



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Results

Rhythmic muscle contraction significantly affected LnSDNN, $F(2,68) = 42.89$, $p = .000$, partial $\eta^2 = 0.56$, $d = 2.26$.

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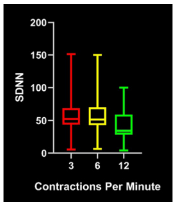
Results

The 6-cpm condition produced greater LnSDNN values than the 12-cpm condition, $F(1,34) = 60.10$, $p = .000$, partial $\eta^2 = 0.64$, $d = 2.67$.



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Results

Rhythmic muscle contraction significantly affected LnRMSSD, $F(2,68) = 17.24$, $p = .000$, partial $\eta^2 = 0.34$, $d = 1.44$.

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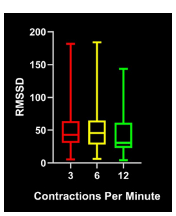
Results

The 6-cpm condition produced greater LnRMSSD values than the 12-cpm condition, $F(1, 34) = 25.48$, $p = .000$, partial $\eta^2 = 0.43$, $d = 1.74$.



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Results

Rhythmic muscle contraction significantly affected the nonlinear metric LnSD1, which measures short-term heart rate variability, $F(2,68) = 9.44$, $p = .000$, partial $\eta^2 = 0.22$, $d = 1.06$.

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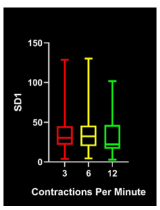
Results

The 6-cpm condition produced greater LnSD1 values than the 12-cpm condition, $F(1, 34) = 12.26$, $p = .001$, partial $\eta^2 = 0.27$, $d = 1.22$.



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Results

Rhythmic muscle contraction significantly affected the nonlinear metric LnSD2, which measures long-term heart rate variability, $F(2,68) = 50.61$, $p = .000$, partial $\eta^2 = 0.60$, $d = 2.45$.

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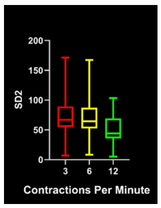
Results

The 6-cpm condition produced greater LnSD2 values than the 12-cpm condition, $F(1, 34) = 71.36$, $p = .000$, partial $\eta^2 = 0.68$, $d = 2.92$.



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Discussion

The present study replicated the Vaschillo et al. (2011) finding that rhythmic skeletal muscle contraction at 6 cpm can produce a mean peak frequency of ~ 0.10 Hz like 6-bpm resonance frequency breathing.

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Discussion

This study contained validity checks on *EMG* (the independent variable) and *respiration rate* (a potential confounding variable).

The stepwise increase in carpi ulnaris EMG confirmed that subjects followed instructions to contract their hands at the specified rates.

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Discussion

Further, identical respiration rates across all three cpm conditions ensured that this variable did not account for HRV changes.

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Discussion

This experiment has shown that rhythmic skeletal muscle contraction can modulate LnLF power, LnSDNN, LnRMSSD, LnSD1, and LnSD2, and that a rate of 6 cpm produces greater values than 12 cpm.

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Discussion

We didn't observe a significant difference between 3 and 6 cpm on these five variables.

A possible explanation is that 3 cpm (0.05 Hz) and 6 cpm (0.10 Hz) fall too close to each other within the low-frequency range (0.04-0.15 Hz) to produce significantly different HRV values.

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Discussion

Collectively, these findings suggest that rhythmic skeletal muscle contraction can "exercise" the baroreceptor reflex like resonance frequency breathing and provide clients with an alternative exercise for increasing heart rate variability.

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Discussion

We encourage researchers to replicate our findings with an older and more diverse sample.

Future research could evaluate the comparative effectiveness of alternative RSMT maneuvers like Kegel exercises or a combination of hand, foot, and pelvic floor contraction.

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Discussion

Investigators might also explore the difference between 1 (0.02 Hz) and 6 cpm (0.10 Hz), which might produce significant contrasts on the five variables examined in this study.

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Discussion

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References

Vaschillo, E. G., Vaschillo, B., Pandina, R. J., & Bates, M. E. (2011). Resonances in the cardiovascular system caused by rhythmical muscle tension. *Psychophysiology, 48*, 927-936.

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