

# NEW ALGORITHM FOR EVALUATING CARDIO RESPIRATORY SYNCHRONIZATION UNDER ZEN MEDITATION AND VARIOUS MENTAL-STRESS STATES

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## ABSTRACT

### Background

This paper presents new graphical algorithms for illustrating the efficiency of cardio respiratory interactions at different levels of mental stress.

### Methods

Seven, Zen-meditation practitioners (experimental group) and fifteen normal controls at different levels of mental stress were studied. Synchrogram analysis based on the relationship between R-peak phase and respiratory cycle can access the performance of cardio respiratory interactions. Ranked R-peak phase alignment (RRPA) and R-peak linearization (RPL) synchrogram proposed in this study provide a long-term overview of the quality and performance of cardio respiratory functioning and respiratory sinus arrhythmia (RSA) performance. RRPA characterizes the global behavior of R-peak phases of the synchrogram by linear regression of ranked R-peak phases. RPL synchrogram provides another overview of the RSA behavior. RPL synchrogram is composed of piecewise linear lines formed by linear regression of the normalized R-peak phases in one respiratory cycle. Time-domain HRV (heart rate variability) and RSA are evaluated as the referenced indicators.

### Results

HRV and RSA analysis shows breathing regulation at 8 breaths per minute effectively relieves the mental stress. The effect of breathing regulation is better than the normal relaxation rest. Zen-meditation practitioners exhibit prominently better performance on cardio respiratory synchronization and RSA behavior. Zen meditation induces a better regulation scheme for stabilizing the cardio respiratory functioning

### Conclusions

RRPA portrait makes the cardio respiratory synchronization behavior more visible than conventional synchrogram. The deviation of the first and the last R-peak phases in different respiratory cycles allow us to track the regularity and stability of cardio respiratory interactions.

**KEYWORDS:** Zen Meditation; Cardio respiratory Interaction; Heart Rate Variability; Respiratory Sinus Arrhythmia; Electrocardiograph; Synchrogram