

# Wearable Physiological Sensors Reflect Mental Stress State in Office-Like Situations

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## Background

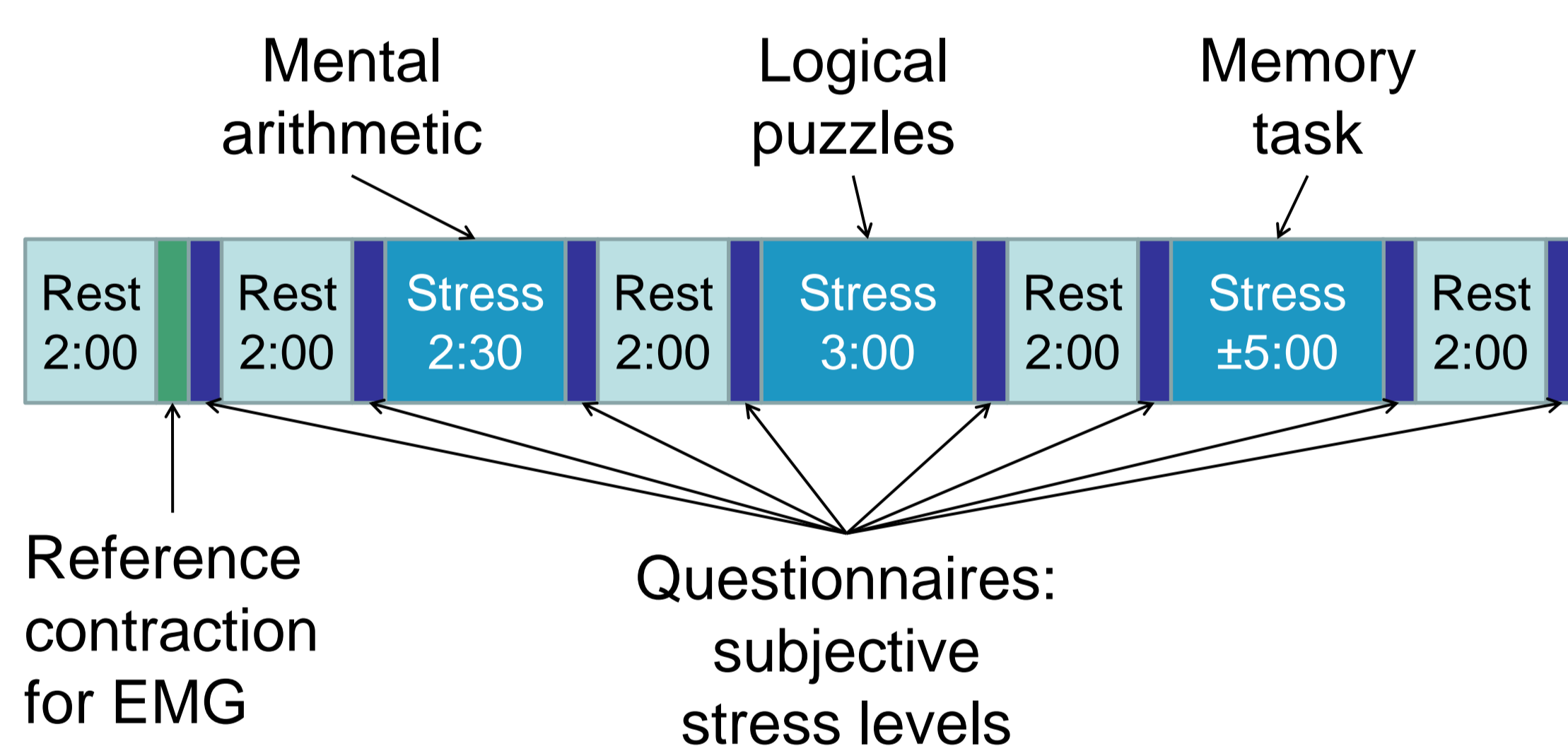
- Stress is a major and increasing problem in today's society
- Chronic mental stress can cause health problems like high blood pressure and cardiovascular diseases
- People are not always aware of stress
- Timely stress detection can prevent stress-related health problems
- Vision is to enable long-term, real-time continuous stress monitoring on an individual basis for personalized stress management

## Goal

- Measure physiological signals in artificial stressful conditions
- Identify physiological features that show distinct reactions to mental stress
- Classify rest and stress conditions based on these features

## Methods

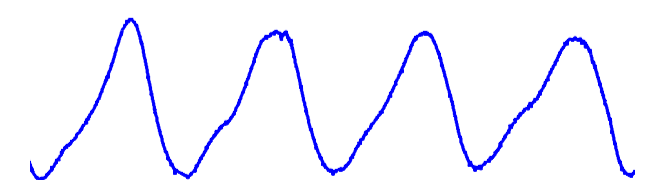
- A protocol was implemented on the PC
- Three stressful tasks
- Stress was increased by time pressure and distracting news fragments through headphones
- 30 subjects



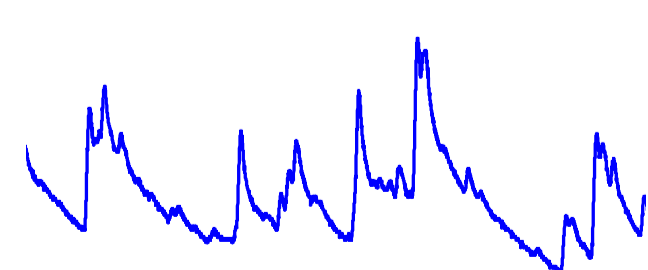
Electrocardiogram (ECG)



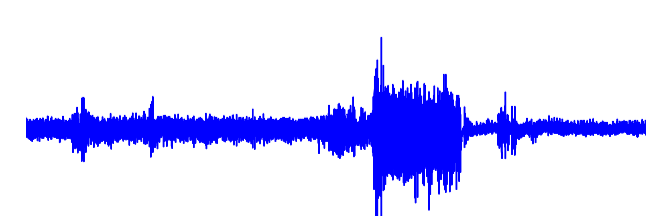
Respiration (RSP)



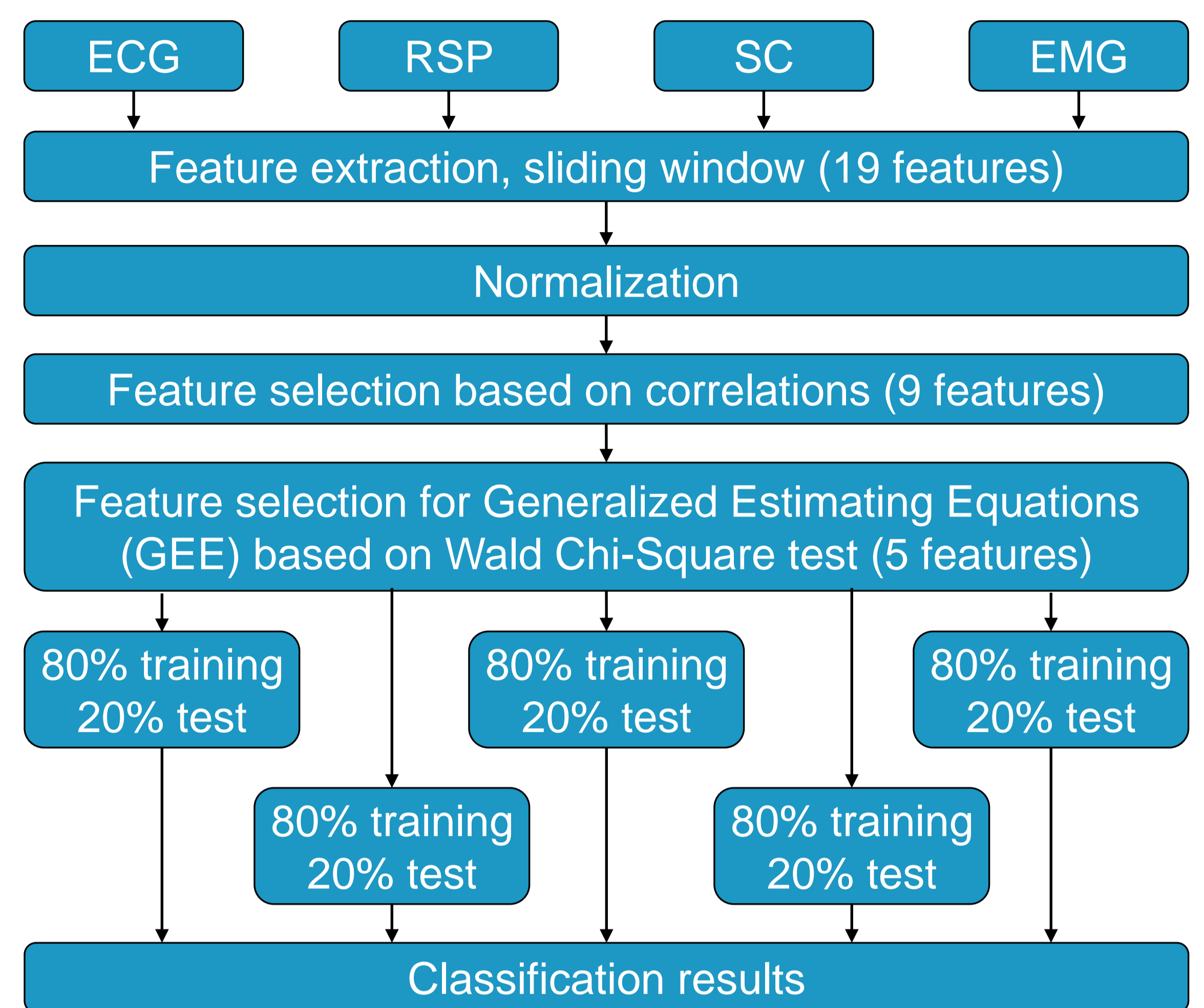
Skin conductance (SC)



Electromyogram (EMG)  
Trapezius muscles



## Analysis



## Results

- Selected features for Generalized Estimating Equations
  - Heart rate
  - Skin conductance level
  - Signal power in second difference of skin conductance
  - Respiration frequency
  - Relative time with EMG gaps (drop of muscle activity during short period, negatively related to stress)
- Classification results in % for the five different test sets

	Set 1	Set 2	Set 3	Set 4	Set 5	Average
Rest	100.0	81.8	63.6	63.6	90.9	80.0
Stress	63.6	81.8	63.6	63.6	72.7	69.1
Overall	81.8	81.8	63.6	63.6	81.8	74.5

## Conclusions and Future Work

- Average classification rate of 74.5% for rest and stress conditions
- Features of all four signals selected, so all signals contribute to identification of stress in a robust manner
- Points of attention for the future
  - Physiological differences among users, both for baseline and stress response
  - Context awareness
- Future work towards
  - Stress measurement in uncontrolled environments
  - Stress measurement in real-life conditions
  - Adequate feedback to the user
  - Continuous stress measurement

Example of continuous stress level estimation

