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Increasing of the orthosympathetic and parasympathetic system activity during a cognitive flexibility

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Introduction

Performing a cognitive task with different levels of:

- **Difficulty** (working memory load)
- **Executive involvement**



Elicits different levels of:

- **Mental effort**
- **Executive control**

Cardiac reactivity as an autonomic marker of such mental activities



Sympathetic activity: cardiac pre-ejection period (PEP)

Parasympathetic activity: vagally-controlled heart rate variability (HRV)

Wright & Gendolla (2012);
Richter et al. (2008)

Sherwood et al. (1990);
Thayer & Lane (2009)

Objective: To examine whether cardiac reactivity is related to task difficulty or to executive control using a within-subject experimental design.

Method

Participants

35 healthy students (26 females); 18-26 years.
 Body Mass Index: 16.5-27.4 (m = 21.5)
 Syst. Blood Pressure: 84.5-134 (m = 107)
 Diast. Blood Pressure: 50-75.5 (m = 60)

The Switching paradigm: Letter/Digit tasks



adapted from Rogers & Monsell (1995)

- **Simple block:** Letter (consonant/vowel) or Digit (odd/event)

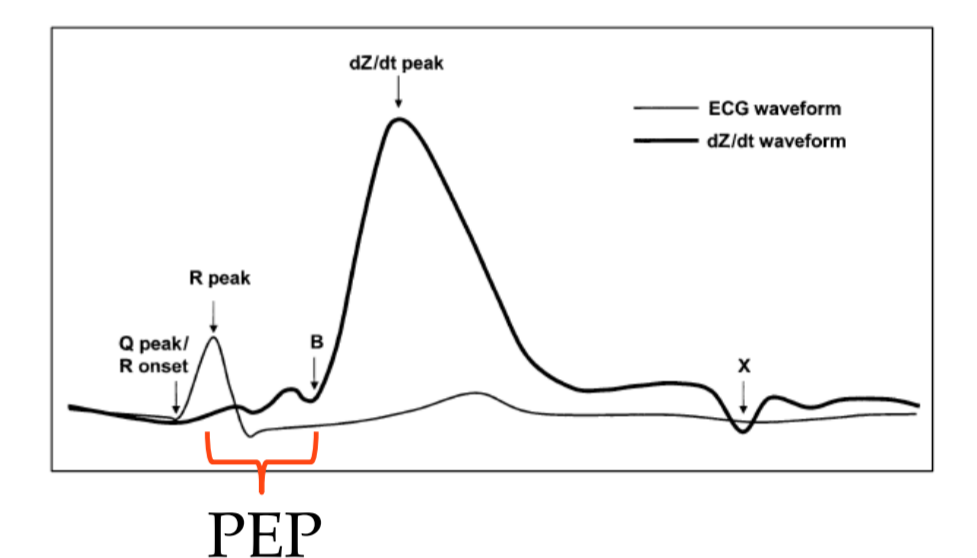
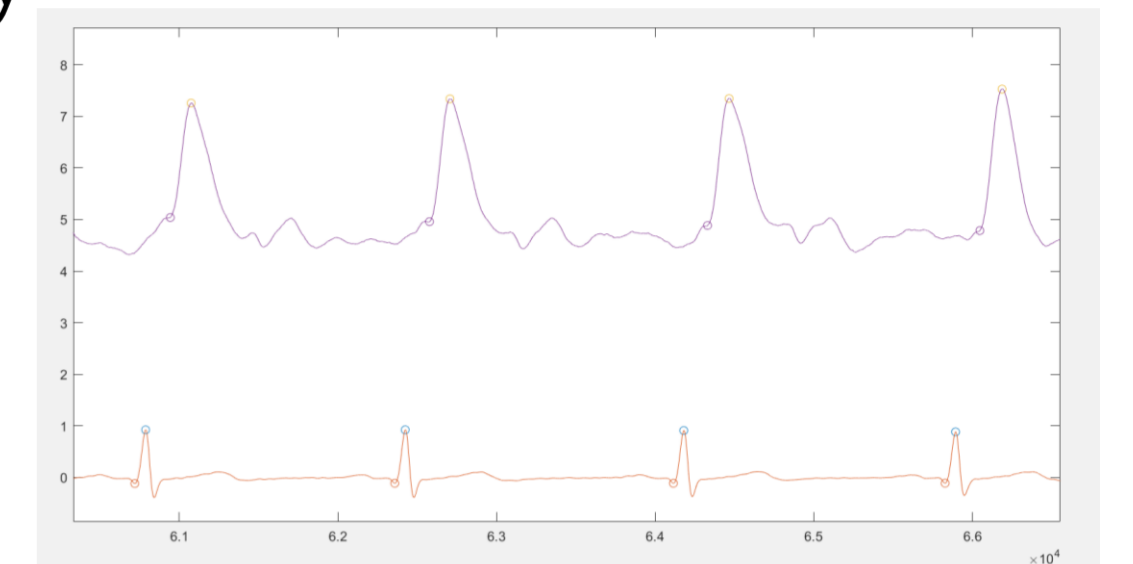
- **Mixed block:** Clockwise alternation

3 levels of difficulty: Easy – Medium- Difficult

Cardiac activity/reactivity

ECG / ICG at rest and during **cognitive activity**

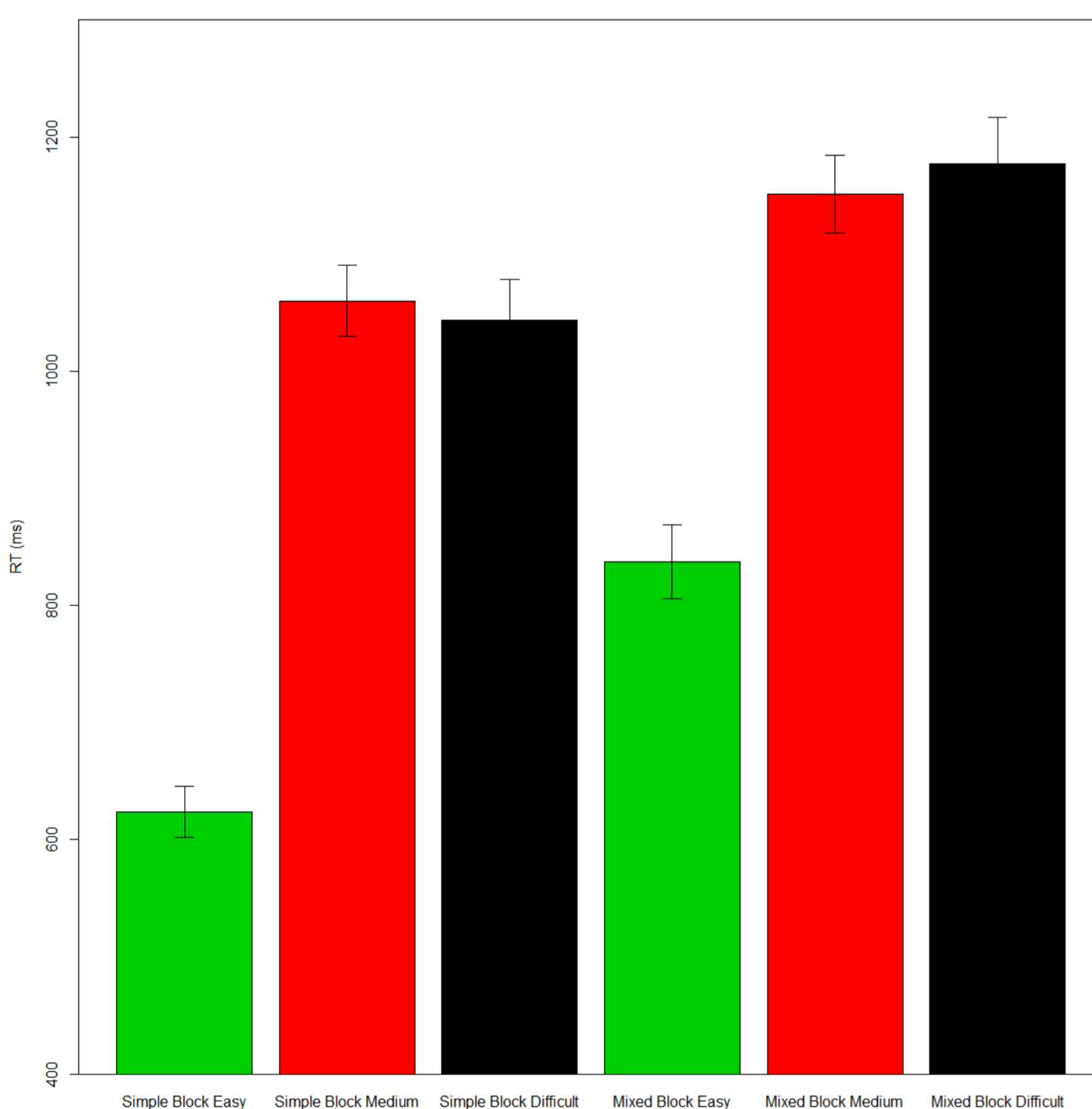
- **HRV:** parasympathetic activity = HF power and RMSSD of R-R intervals
- **PEP:** sympathetic activity



Results

Behavioral data

Reaction Time - Conditions



Significant effect of Difficulty ($p < .0001$):

Easy < Medium = Difficult.

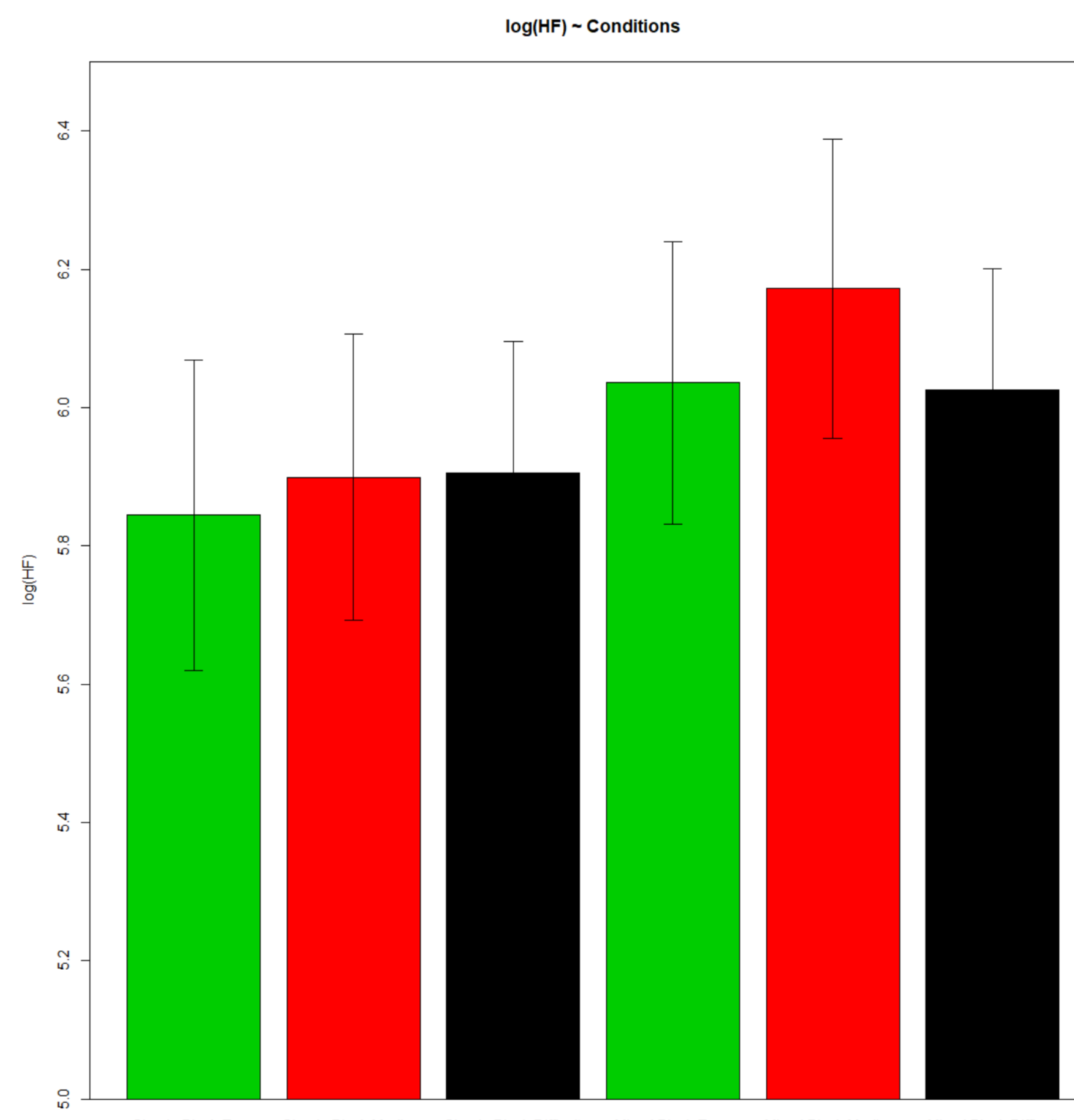
Significant effect of Block ($p < .0001$):

Simple block < Mixed block.

Significant Difficulty X Block interaction ($p < .0001$)

The percentage of correct responses was high (> 90%) and overall higher for the Easy condition than the two other conditions.

Parasympathetic activity : HF power



Significant effect of Block ($p < .005$):

Simple block < Mixed block.

No effect of Difficulty.

No interaction.

Cardiac reactivity

Significant effect of Block ($p < .005$):

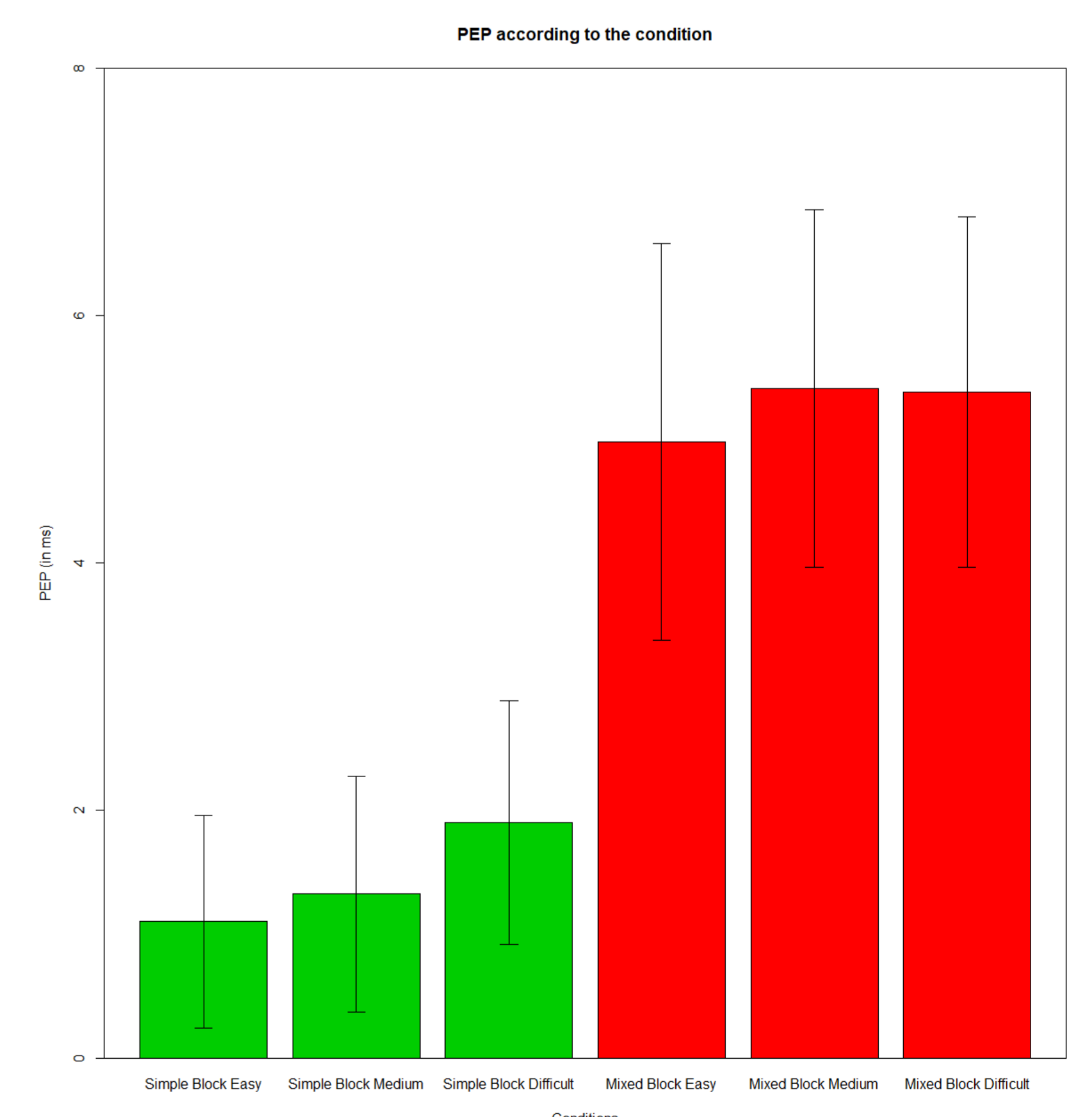
Simple block < Mixed block.

No effect of Difficulty.

No interaction.

Results virtually identical for RMSSD.

Sympathetic activity : PEP



Discussion

Participants' behavioral performance was affected by both task difficulty and the involvement of executive control (flexibility). Moreover, the increasing of task difficulty tended to reduce the switch cost on RT, a result sometimes reported in the literature.

Both sympathetic (PEP) and parasympathetic (HF power, RMSSD) activities increased during the executive task (flexibility) but were not affected by task difficulty. To the best of our knowledge, it is the first report of such a pattern of results using a within-subject design. This design may help to better understand the discrepant results in the literature. These results may suggest that cardiac reactivity might reflect more executive control than higher effort per se. Future studies must replicate these findings and control baseline resting cardiac activity as well as time on task effects to ascertain this conclusion.

References