

Measuring Behavior 2022

Volume 2

12th International Conference on Methods and Techniques in Behavioral Research, and 6th Seminar on Behavioral Methods

18 – 20 May 2022. Online.

Proceedings



The Effects of Stimulus Duration and Group Size on Wearable Physiological Synchrony

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Abstract

Physiological synchrony refers to the degree to which physiological measures such as heart rate and electrodermal activity (EDA) across multiple individuals uniformly change. Physiological synchrony has shown to be informative of attention among individuals presented with a narrative stimulus: higher physiological synchrony is often related with better attention to the narrative. However, results are strongly dependent on basic factors such as group size and recording length. In the current work we explore what group size and recording length are needed for robust physiological synchrony results.

Introduction

Individuals that share attention to narrative stimuli show synchronized heart rate and electrodermal activity (EDA) signals [1, 2]. The degree to which this synchrony occurs is reflective of attentional engagement; individuals with higher physiological synchrony to others presented with the same stimulus generally also answer more questions about the content of the narrative correctly [1], indicating that synchrony is a marker of attention. Furthermore, physiological synchrony can distinguish between groups of individuals with different selective attentional focus to the same narrative stimulus [3]. This synchrony is more sensitive in distinguishing between individuals with different selective attentional focus than absolute levels of heart rate or EDA [1].

The degree of physiological synchrony is dependent on factors modulating attention, such as attentional instructions, attentional saliency of stimuli and attentional motivation of individuals, but also on more basic factors such as group size and recording length. We explore the amount of data that is required to obtain robust results, where the amount of data is varied by the number of participants and the duration of (audiovisual) stimuli.

Methods

Thirty participants took part in the study. All participants signed an informed consent in accordance with the Declaration of Helsinki. The experiment has been approved by the TNO internal review board (reference: 2020-117). Participants' HR and EDA were recorded with a Tickr chest-strap (Wahoo Fitness, Atlanta, GA, USA) and EdaMove 4 (Movisens GmbH, Karlsruhe, Germany), respectively, while being presented with six movie clips of approximately 10 minute duration (09:48 ± 00:41 minutes). The movie clips were selected from the Dutch YouTube channels NPO3 and KORT! and featured short, moderately emotionally engaging stories. The presentation order was randomized across participants. We assessed physiological synchrony by computing inter-subject correlations following our earlier work. Significance of these inter-subject correlations was assessed by comparing the real values to 500 circular-shuffles. We varied the amount of data included in analysis in two ways, by varying the stimulus duration from 1 to 60 minutes and by varying the group size from 2 to 30 individuals. For each iteration we computed the amount of participants with significant inter-subject correlations.

Results

Figure 1 shows the expected result: increasing the stimulus duration or group size results in a higher percentage of participants with significant inter-subject correlations. Interestingly, the graph shows that while increasing the amount of data increases the fraction of participants with significant inter-subject correlations, it does not matter whether the amount of data is increased by increasing stimulus duration or the number of participants. The next step is to relate the inter-subject correlations to other measures reflective of attentional engagement, such as the number of correctly answered questions about the content of the movie.

Discussion

We here investigated the effect of stimulus duration and group size on wearable physiological synchrony. We focused on the significance of the inter-subject correlations, as this is a first premise for a robust relation between physiological synchrony and attention. We found that it does not matter in which way the total amount of data is reached, either by including more participants or by using longer narrative stimuli. The results here may be a guideline for future research using synchrony in HR and EDA as measure of attention.

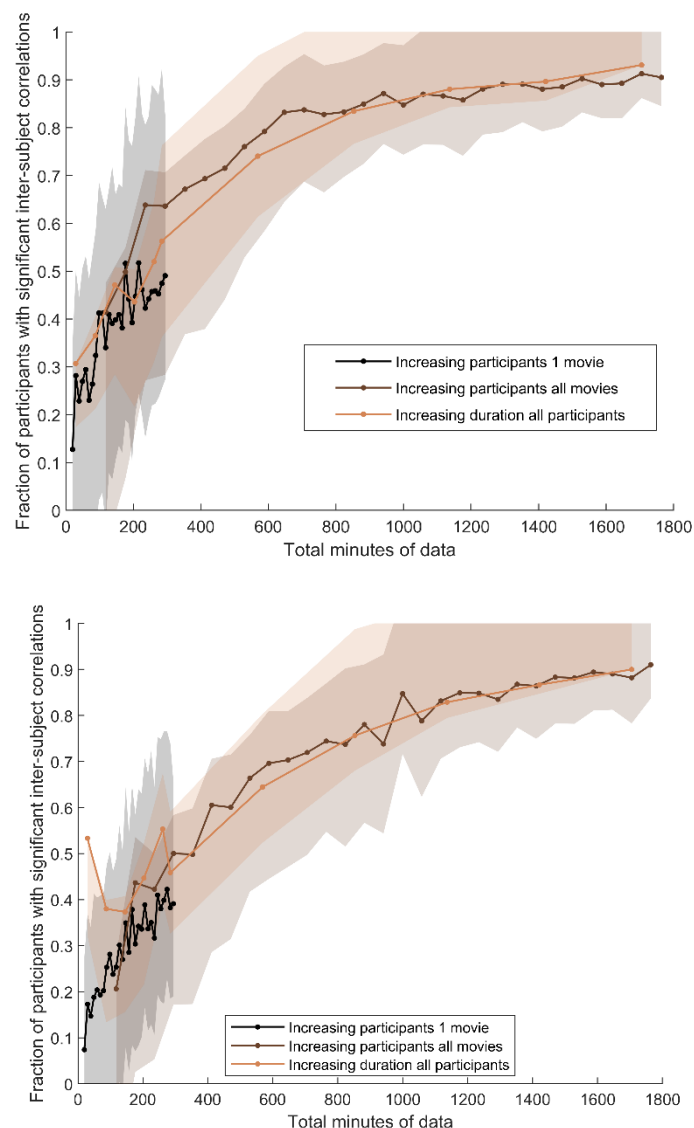


Figure 1. Fraction of participants with significant inter-subject correlations for HR (top) and EDA (bottom) when increasing the number of participants or increasing the stimulus duration, both expressed in the total minutes of data included.

References

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