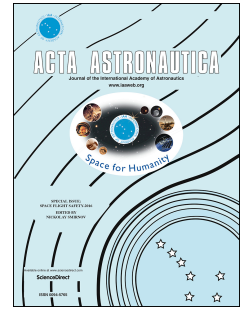


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Camille Gontier



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HOW TO PREVENT MIND-WANDERING DURING AN EVA ? PRESENTATION OF A MIND-WANDERING DETECTION METHOD USING ECG TECHNOLOGY IN A MARS-ANALOG ENVIRONMENTCamille Gontier^a

^aFormer student at ISAE Supaéro (Institut Supérieur de l'Aéronautique et de l'Espace), 10 avenue Edouard Belin, 31400 Toulouse, France, scientific officer of the MDRS 164 mission, cam.gontier@gmail.com

Abstract

The purpose of this study is to detect mind-wandering in an Extra-Vehicular Activity (EVA) context during a long supervision task. Detection is realized using an electro-cardiogram and measures of heart rate variability. Experienced by everyone, mind-wandering depicts the state of mind where thoughts are not related to the current action. Its deleterious aspect regarding performance suggests a need to take mind-wandering seriously as an impediment to manned space missions' safety. Previous research confirmed the hypothesis according to which several physiological responses can be used to track down mind-wandering. ECG recordings are both easy to obtain and analyze, statistically related to mind-wandering, and easy to record during extra-vehicular activities. Data analyzed in this paper have been recorded during a Mars-analog mission (MDRS 164), from February 20 to March 6 2016 at the Mars Desert Research Station (Utah). During various cognitive tasks, the subject had his ECG and awareness levels monitored at the same time to see if a correlation between these two measures can be used in a Mars-mission environment. At different time intervals, the subject was interrupted using the thought probe method to inquire about his thoughts. Heart Rate Variability (HRV, which power in high frequencies is related to the parasympathetic system and is expected to vary with mind-wandering) was then computed from recorded data, and its statistical changes during on-task and off-task thoughts were assessed. Although data revealed no significant differences nor coherent trends in HRV-related metrics between the two conditions, results are paving the way towards a better understanding of ECG-recordings and their use during space-analog missions.

Keywords: mind-wandering, heart rate variability, human factors, Mars analog mission, MDRS

Acronyms/Abbreviations

- Electrocardiogram (ECG)
- Extra-vehicular activity (EVA)
- Heart rate variability (HRV)
- Mars Desert Research Station (MDRS)
- Mind-wandering (MW)

1. Introduction*1.1 The deleterious aspect of mind-wandering*

Research on mind-wandering is firstly justified by its deleterious aspect regarding performance. Common sense taught us that off-task thinking leads to errors and a decrease in performance in various tasks. Indeed, spontaneous and decoupled thoughts prevent us from having a complete and precise representation of the external environment, which could be of dramatic aftermath when it comes to operating a complex system, such as an aircraft or during manned space missions. An interesting area of research would be to determine whether the ecological validity of studies about mind-wandering in laboratories could be adapted to daily life-like situations. The aim is thus to ultimately detect and

prevent the deleterious consequences of mind-wandering in real life operations.

A high number of mind-wandering episodes has proven to be correlated with bad reading comprehension [1] and to be associated with a high number of errors during sustained attention and continuous stimulus monitoring tasks [2]. Moreover, from a neural point of view, mind-wandering episodes are correlated to activations of the default network, an area of the brain related to rest state and lack of focus on the outside, and are thus associated with a decrease in information analysis [3, 4].

Studies about mind-wandering, as it seems to be related to the level of fatigue and alertness of an operator, are particularly put into practice to prevent traffic accidents. Indeed, mind-wandering can engender a failure to monitor the environment while driving, and is associated with risk of crash involvement as drivers tend to focus visual attention narrowly on the road ahead while being off-task [5]. More specifically, mind-wandering while driving, by decoupling attention from visual and auditory perceptions, can jeopardize the ability of the driver to incorporate information from the environment, thereby threatening safety on the roads.

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