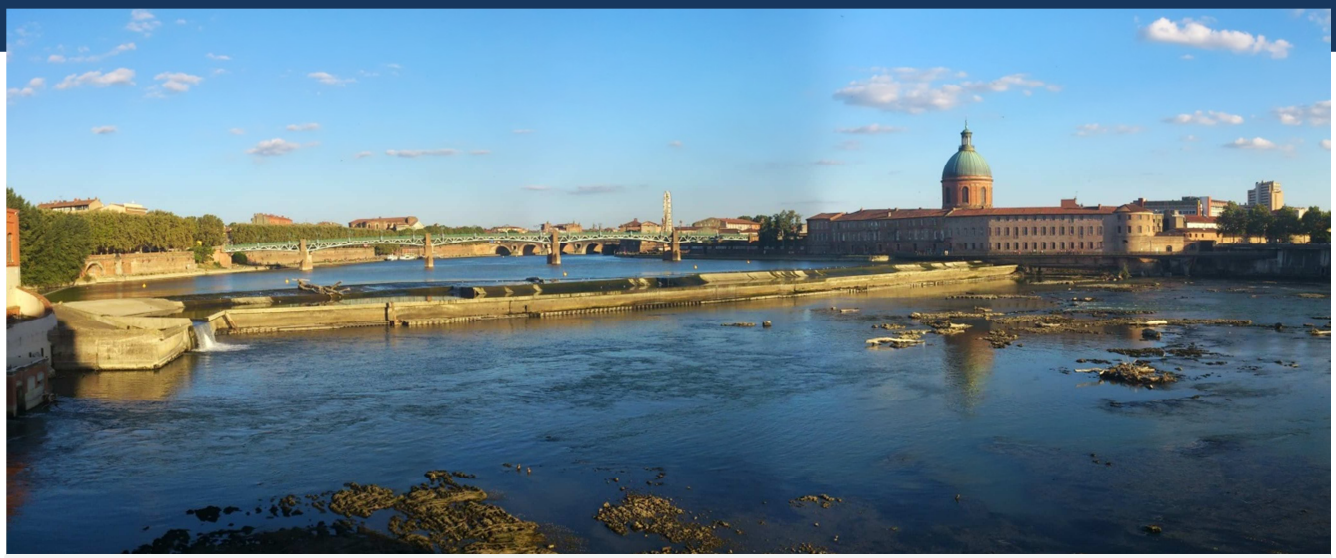

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Attentional switch from external toward internal world: a psychophysiological marker

Ms SERVAIS, Anais (ENAC & CerCo); Prof. HURTER, Christophe (ENAC); Dr BARBEAU, Emmanuel (CerCo)

Content

Let's have an experience. Read the following question and try to answer as sincerely as possible. Meanwhile, observe what's going on in your mind. Here is the question: "What gift did you receive for Christmas?". To answer this question, we need to create a temporary internal mental space to which our attention will focus (Tulving, 2002). This attentional switch from external towards internal mental world is commonly referred as mindwandering. Since attention is a limited resource, it cannot focus simultaneously on outside and inside worlds: while our attention is focused on our internal world, we are largely blind to external stimulations (Fernandes & Moscovitch, 2000). There is a perceptual decoupling (Smallwood & Schooler, 2006) which is one of the most threatening aspect of the mindwandering (Schooler et al., 2011).

Obviously, mindwandering seems extremely dangerous in situations that require special attention to the outside world (e.g. airplane pilot). However, although the mindwandering impair the performance in various activities (e.g. Kam et al. 2012), it has too seldom been studied as a potential cause of human error in the aeronautical field. Perhaps because mental wandering is difficult to measure. In fact, the most common assessment method is based on self-report, which has several biases including social desirability for pilots (Casner & Scholler, 2014). To overcome this problem, we study a specific type of mindwandering, i.e. autobiographical memory retrieval that can be easily triggered in lab by a question like the one you just answered.

Aviation accidents related to attentional lapses continue to occur (NTSB, 2014). Currently, the origin of these lapses remains unknown but mindwandering, given perceptual decoupling, could be a potential cause. Although the risk factors in the working environment are not all discovered, it is now well documented that the monotonous tasks generate higher rates of mindwandering. If we look at these results in parallel with the increasing automation in the cockpits, it can be scary. Effectively, the automation modifies the human-machine interaction putting the pilot in a supervisory role, also referred as out-of-the-loop situations. Recently, Gouraud et al. (2018) have shown a greater frequency of mindwandering in an automated environment than when the task had to be performed manually. Therefore, we urgently need an objective marker allowing a real-time detection of mindwandering.

Mindwandering is frequently associated with oculometric features reducing visual processing: an increased blink frequency and duration, fewer and longer fixations, longer saccades durations, a smaller mean pupil size and a higher variability of changes in pupil dilation, reduced microsaccade activity and reduced divergence angle (Annerer-Walcher et al., 2018; Benedek et al., 2017; Grandchamp et al., 2014; Gwizdka, 2019; Walcher et al., 2017). Although these works identified some typical ocular features during mindwandering, none used these markers to detect mindwandering in real time. We hypothesize that the combination of different oculometric features could constitute a physiological marker allowing the online identification of mindwandering, which could be used to monitor attention fluctuations, for example during airplane piloting. We investigate this psychophysiological marker with behavioral studies.

Keywords : Eye tracking, EEG, fNIRS, Other measurement methods, Brain computer interfaces