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Title : Relationship between the cortical activity in prefrontal cortex and the emotions felt while watching preventive messages about cyclists' safety in urban environment

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Abstract

Several researches, using functional near-infrared spectroscopy (fNIRS), report an activation of the prefrontal cortex during the presentation of emotional stimuli such as images (Hoshi 2009, Doi 2013, Balconi 2015, Bendall 2016), or video clip (Matsuo 2003, Leon-Carrion 2006, Bandara 2018); a significant increase in the oxygenated-hemoglobin concentration is often observed for negative stimuli in the prefrontal area. The study of prefrontal cortex activation during the presentation of emotion inducing short films related to road safety is a new approach in this area of research.

The goal of the current experiment was to study the relationship between the prefrontal cortical activity while watching short films with road safety message and the self-assessed emotional state of the participants.

Five short films (average length 33s), specially designed for this study and aimed at motorists, provide messages to increase motorists' awareness for cyclists' safety in urban environment. These messages emphasize the necessity of maintaining a minimum distance from cyclists, the risk of car excessive speed, the usage of mobile phone while driving, the danger of right-turn and the danger of door opening situations. In order to induce emotions with different intensity, these preventive messages have been created with 2 communication modes: educative (focusing on the information and the effective measures to reduce the risk for cyclists) and emotional (focusing on the unavoidable accident). Five other short neutral films (showing the nature) over a comparable period have been created without preventive messages.

The prefrontal cortical activity has been assessed with changes in the concentration of oxygenated hemoglobin molecules in the blood, ΔHbO_2 . The self-assessed emotional state of participants has been measured during the films with a mood box (a specific device which can record the intensity and the valence of emotions reported by the participant with a rotating knob connected to a potentiometer) and with an emotional wheel completed after the films.

41 men (25.3 years old, $\sigma= 4.9$), holders of driving licenses (6 years, $\sigma=5.2$) were randomly allocated to 3 groups (educative communication mode, emotional communication mode, and control group).

The short films were shown twice. First, participants watched successively the 5 films (with a black screen presented for 30s between each film). Their cerebral activity was recorded with a functional near-infrared spectroscopy (fNIRS) system (NIRSport). They were instructed to pay attention to the films. After watching the films, participants completed an emotional wheel (Rogé 2015) to collect the maximum intensity of 8 positive and 8 negative emotions felt during the films. The participants had to tell what they remembered about the films. While watching again the same short films, participants were required to indicate the intensity and the valence of their emotions using the Mood Box.

The analysis of the collected data showed a positive and significant correlation between the ΔHbO_2 recording immediately after each short film and the intensity of the negative emotions collected with the emotional wheel after the end of the first screening. Participants with the higher ΔHbO_2 had the higher

intensity of self-assessed negative emotions. Similarly, the higher the intensity of negative emotions collected with the Mood Box during the second screening, the higher the ΔHbO_2 during the first screening. In contrast, there was no apparent relationship between the physiologic response and the intensity of positive emotions, neither with the data coming from the emotional wheel after the first screening, nor with the intensity recorded with the Mood Box during the second one.

This study leads to the conclusion that the variation of the prefrontal cortical activity (through an increase of concentration change of oxygenated hemoglobin) could provide a good marker for assessing the intensity of negative emotions felt during safety messages. The method used in the current study enables to collect data during and after the safety message delivery without relying on the information or answers provided by the participants. This method could be a useful alternative for persons having difficulties in assessing their negative emotions.

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