

## *PhD proposal – Aeronautic/Neurophysiology/Virtual Reality*

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**Context:** the following thesis project has been shortlisted by the Aéronautique and Astronautique doctoral school of Toulouse France (ED AA, <http://edaa.isae.fr/>). We are looking for a serious PhD candidate whom we could present for the final selection (file to be completed for the 6th of June, selection following an oral presentation of the candidate the 22nd of June).

**Thesis project:** Let's have an experience of the mind that will help to understand this thesis project. Read the following question and try to answer as sincerely as possible. Meanwhile, watch what's going on in your mind. Here is the question: "What gift did you give to your spouse / friend for their last birthday?". To answer this question, we need to create a temporary internal mental space to which our attention will focus. Since attention is a limited resource, it cannot focus on both the outside and the inside. This is easily observed because our eyes, at that moment, flee and focus on a neutral zone of space; it is a phenomenon easily observable in ecological condition. This very specific cognitive process is called the *attentional shift*<sup>1</sup> (from the outside world to our inner world, or mental world). During this shift and while we are keeping our attention on our mental world, we are almost blind to the outside world. Obviously, this is extremely dangerous when the attention must remain focused on the outside world, as when one is an airplane pilot or air traffic controller.

This thesis will specifically study this cognitive moment with three parts:

1 / **Evaluate the perceptive** capacities of individuals during the attentional shift. Since the hypothesis is that the perceptual capacities are almost zero during a certain period of time, this thesis should make it possible to quantify this duration (our preliminary data suggest that this time may be of several seconds). This hypothesis will be validated through *behavioral* and *functional MRI* studies to study the activation of visual areas before, during and after the shift.

2 / **Identify physiological markers** of this shift so in order to trigger alarms. Our hypothesis is that eye-tracking should allow a good, real time, monitoring of this moment.

3 / **Test our assumptions in Virtual Reality (VR)** by applying protocols specific to the field of piloting and air traffic control.

**Scientific issues:** The attentional shift has never been studied in aeronautics despite its potential importance. This study will bring into play several scientific fields: the study of cognitive processes, the massive processing of large amounts of data with the analysis of functional MRIs and finally the virtual reality field.

**Aeronautical and societal issues:** This thesis will help to better understand this cognitive phenomenon and directly apply the potential results in the field of flight control and air traffic control. For example, new design rules could be defined and thus applied to future HMIs intended for air traffic controllers or pilots. By extension, this work will contribute to all areas where the vigilance of an operator involves security issues.

**Expected skills:** the candidate is expected to have a background in signal processing, programming and statistics as well as cognitive neuroscience and neuroimaging. Any combination of these will be considered.

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<sup>1</sup> [https://en.wikipedia.org/wiki/Attentional\\_shift](https://en.wikipedia.org/wiki/Attentional_shift)

The candidate will have good social and adaptive skills in order to be able to work in two different scientific environments.

**Supervision** of the PhD candidate will be multidisciplinary and shared among two host laboratories:

- Dr. Christophe Hurter, HDR, professor, head of the group "Interactive data visualization" (DataVis) at ENAC. christophe.hurter@enac.fr, <http://recherche.enac.fr/~hurter>

- Dr. Emmanuel Barbeau, HDR, CNRS research director, head of the Memory and Learning of Objects and Scenes (MAOS) team at the Centre de recherche Cerveau et Cognition (UMR 5549, CNRS-UPS), emmanuel.barbeau@cns.fr, <http://www.cerco.ups-tlse.fr/~barbeau>