*The anaesthetist's job is highly skilled.*

# Understanding anaesthesia could help us all

**The Braccia project is studying the complex interactions between electrical activity in the brain, and oscillations in heart and breathing activity during anaesthesia. The findings may reveal new ways to monitor the depth of anaesthesia. The research could be of much wider relevance, however, because coupled oscillatory systems are all around us, in the natural world and in modern technology. Investigating anaesthesia could therefore also help us to understand and control many other complex systems.**

Anaesthesia is a subtle and imperfect science, with the level of anaesthesia needing to be very carefully controlled to avoid awareness and pain while minimising the risk of complications. The Braccia project is exploring ways in which the brain's electrical activity, especially delta and gamma brain waves, and their interactions with heart and breathing activity, vary with the depth of anaesthesia. This work looking into the complexities of human physiology is part of the NEST PATHFINDER initiative on 'Tackling complexity in science'.

The project will use measurements on humans and rats to explore the causal relationships between oscillations in the brain, heart and respiratory system. It asks the fundamental question: 'Which oscillations are the drivers of others and which are being driven by others?'

The first step is to develop a methodology to test for causal relationships between interacting complex systems. Human subjects will be monitored while awake and under anaesthesia. The results will then be used to develop systems that can model the oscillatory behaviour of human, and more generally mammalian, physiology.

## From the specific to the general

The need for a better understanding of anaesthesia is driven by the enormous medical and societal importance of this technique, without which most modern complex surgical procedures would be impossible. The physiology of anaesthesia is not well understood, however, and the mechanisms causing loss of consciousness remain mysterious. Complications due to inadequate control of anaesthesia range from a patient experiencing pain and some unwanted level of awareness, to rare extreme reactions that can lead to brain damage or even death. The most common problem is some awareness during surgery, which affects approximately 1 in every 900 patients. This is particularly undesirable in those procedures in which a patient is unable to indicate that they have become aware and can feel pain, as can happen when a muscle relaxant is used, for example during *Caesarean* section.

Greater understanding of how the body is behaving during anaesthesia, and how consciousness and the sensation of pain can be better monitored, would clearly be of enormous benefit in improving general practice in the operating theatre.

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# BRACCIA

*Levels of anaesthetic need to be carefully calculated for each patient.*

## AT A GLANCE

***Official title***
*Brain, respiration and cardiac causalities in anaesthesia*

***Coordinator***
*UK: Lancaster University, Department of Physics*

***Partners***
- *Czech Republic: Academy of Sciences, Institute of Computer Sciences*
- *Germany: University of Potsdam, Institute of Complex Systems*
- *Norway: University of Oslo, Ulleval Hospital*
- *Slovenia: University of Ljubljana, Faculty of Medicine*
- *Switzerland: Swiss Federal Institute of Technology*
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*Web: http://www.cordis.lu/nest*

Complex oscillating systems are found everywhere, however. They are involved in many other aspects of physiology, but also occur in industrial and engineering settings, within the operation of computer software, and in the many chemical and physical interactions of the natural environment. Insights gained by studying the complexities of anaesthesia could be relevant to such varied fields as software development, aeronautical engineering and environmental management.
The project is a collaboration between physicists, electrical engineers, information theorists, medical scientists and clinicians. This wide multidisciplinarity reflects the fact that, although directly focused on anaesthesia, it is exploring aspects of complex science that are important in a huge range of situations.

**The Braccia project will greatly enhance our knowledge about what is going on in the body during surgery.**

## Significant possibilities

The most immediate aim of the Braccia project is to develop the methods and the understanding needed to create a new and improved kind of anaesthetic monitor. If the results of the project are as useful as the partners hope, the next step will be to prepare the ground for a large-scale study that would refine and test such a monitoring system. The Braccia project may be the first step towards building a simple but highly effective anaesthesia control system that will be found in every operating theatre, and used to provide precise management of anaesthesia in a way that is completely impossible today.
Even if that dream is not fulfilled, however, the project will greatly enhance our knowledge about what is going on in the body during surgery, and our understanding of the many interactions within complex systems in general.



SIXTH FRAMEWORK PROGRAMME