

What is mindBEAGLE?

mindBEAGLE is a new method that can be used with patients who have disorders of consciousness (DOC) and live with one of the following conditions due to a serious brain injury:

Coma → Unresponsive Wakefulness Syndrome → Minimal Consciousness → Locked-In Syndrome

In the assessment phase, mindBEAGLE will provide information about the level of awareness and consciousness of the patient. As long as patients have enough cognitive function to understand spoken messages, mindBEAGLE can be used as a communication tool. The system uses three different approaches to assess consciousness or to communicate: movement imagination, auditory stimulation, and vibrotactile stimulation. mindBEAGLE is an easy-to-setup, fast assessment tool compared to fMRI.



Auditory and Tactile Stimulation & Motor Imagery

mindBEAGLE uses auditory and vibrotactile stimulation to elicit typical brain responses that are based on a certain level of awareness and conscious processing in the patient's brain. Verbal instructions and tones are presented via in-ear phones. For assessment, numerous stimuli are randomly mixed with rare/infrequent target stimuli (e.g. tones with a different pitch). Vibrotactile stimulators can be attached to different areas of the patient's body, such as the hands and feet. Patients perform motor imagination of left and right hand involvement to allow the BCI to assess whether or not they are following the command.



Communication via Tactile Stimuli

If the patient is able to understand and follow the training instructions by counting the required stimuli, mindBEAGLE can be used for communication. The patient is asked to focus on the vibration of a vibro-tactor placed on a specific body part (e.g. right hand). When the patient is asked a simple YES or NO question, she or he has to focus on vibrations from the left hand to answer with YES. If the patient wants to answer with NO, she or he has to focus on vibrations on the right hand.



Communication via Motor Imagination

mindBEAGLE can measure the imagination of an arm or hand movement. In this case, the patient has to imagine the movement in order to answer a question. For example, the movement of the left hand means YES and the movement of the right hand means NO.



Positive Effects of mindBEAGLE

Motor imagery and vibrotactile stimulation pair brain responses with motor behavior, a principle that g.tec also uses as a rehabilitation strategy for stroke patients. This powerful principle paired association could also have a positive effect to DOC/Coma patients.

"With this experiment we understood that my mother can listen to us. Since she stopped moving her limbs and eyes we have been continuing to talk to her without any feedback. Now we know that she can feel that we love her and we are happy for that."

Angelina (Palermo, Italy). Her mother Carmelina has been diagnosed with the completed locked-in syndrome in 2013.



mindBEAGLE is a product of g.tec (GUGER TECHNOLOGIES OG) in Austria. g.tec develops and produces biosignal amplifiers and other tools for disabled people that use BCIs.

g.tec's products and research activities have been widely described in peer-reviewed research publications, demonstrating the quality of our tools and methods.

Experts about mindBEAGLE



"mindBEAGLE combines important electro-physiological tests that allow us to search for signs of consciousness after coma. The big advantage of mindBEAGLE is that it is integrated. You can take it to any patients and plug them in to get the results directly. It is still a challenge and it doesn't work with all the patient. mindBEAGLE is a big help for us to use the paradigms as they are implemented in mindBEAGLE for very challenging patients."

Dr. Steven Laureys, Coma Science Group, University of Liège, Belgium



"mindBEAGLE helps us to work with individuals in their home environments to determine if they have measureable evoked potentials."

Dr. Melanie Fried Oken, Oregon Health & Science University, USA

SCIENTIFIC REFERENCES

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Z. R. Lugo, J. Rodriguez, A. Lechner, R. Ortner, I. S. Gantner, A. Kübler, S. Laureys, Q. Noirhomme, C. Guger (2013): A vibrotactile P300-based BCI for consciousness detection and communication. In Clin EEG and Neurosci, 2013.

R. Ortner, Z. Lugo, R. Prückl, C. Hintermüller, Q. Noirhomme, C. Guger (2013): Performance of a tactile P300 speller for healthy people and severely disabled patients. In proceedings of the 35th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC'13), July, 3-7 2013, Osaka, JP.

mindBEAGLE Mobile Assessment Service

The mindBEAGLE Mobile Assessment Service is based in the mindBEAGLE Center in Schiedlberg (Austria) and offers assessments with the mindBEAGLE system in hospitals or even in each patient's home environment. To try this unique service, please contact:

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mind**BEAGLE**
CONSCIOUSNESS ASSESSMENT & COMMUNICATION

Assessment & Communication with DOC/Coma Patients



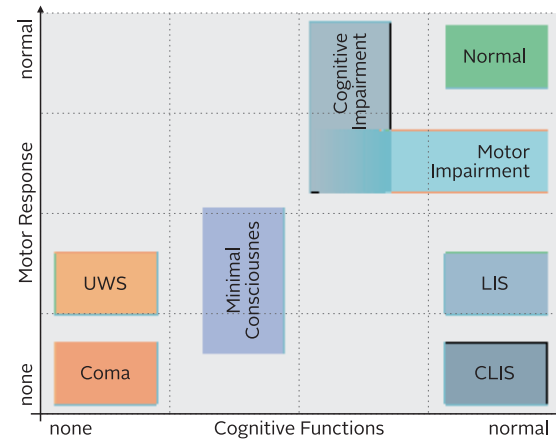
www.mindBEAGLE.at

Assessment & Communication with Coma Patients

Lack of feedback is a huge barrier when it comes to medical diagnosis or clarification of a coma patient's condition. Imaging techniques such as fMRI (Functional magnetic resonance imaging) have successfully been used with non-responsive patients to learn more about relevant brain activity. However, fMRI has many problems—it is not portable, affordable or accessible for most patients, and is completely impractical for frequent use.

One peer-reviewed study showed that over 40% of patients diagnosed as vegetative are reclassified as (at least) minimally conscious when assessed by expert teams. For this and other reasons listed above, Brain-Computer Interface (BCI) technology using EEG (electroencephalogram) has been adapted for DOC assessment, creating a much more practical way to measure brain activity, assess disorders of consciousness (DOC) in patients and provide simple communication for some of them.

Disorders of Consciousness



Coma: Coma is characterized by the absence of consciousness.

Unresponsive Wakefulness Syndrome (UWS): People have emerged from coma. They show periods of eye opening yet remain unresponsive. They may exhibit reactions, but still lack cognitive functions.

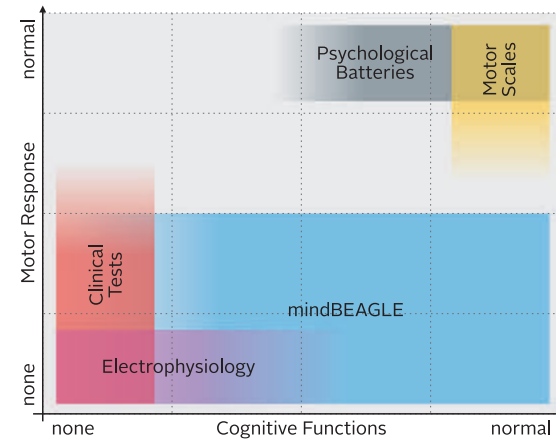
Minimal Consciousness: Patients show limited and transient (but clearly discernible) evidence of some consciousness.

Locked-In State (LIS): Patients often have minor deficits in cognition, but are consciously aware. They have very limited motor control. Communication can be possible via residual motor functions, e.g. movements of the eyes.

Completely Locked-In Status (CLIS): People have lost all their motor functions, but are usually conscious.

Cognitive Impairments: Types of cognitive impairments include dementia, amnesia, or attentional disorders.

Types of Assessment



Clinical Tests: Standard clinical tests are based on behavioral observation. This means the patient has to be able to show at least some voluntary motor responses. Due to the subjective interpretation of these movements, misclassifications can occur.

Psychological Batteries: Parameters like intelligence (nonverbal or general), attention or memory are tested by a wide range of different neuropsychological tests.

Motor Scales: The motor skill of patients is measured by motor scales. They are used (for example) after stroke to assess residual motor function and further to measure the therapeutic success of stroke rehabilitation.

mindBEAGLE: mindBEAGLE uses Brain-Computer Interface (BCI) technology for a quick and easy assessment of a DOC patient's condition, and even provides basic communication with some of them. mindBEAGLE aims to find out if a patient understands and can follow basic task instructions, even when diagnosed with a vegetative state (UWS—Unresponsive Wakefulness Syndrome), minimally conscious state or (completely) locked-in state (LIS/CLIS).

Benefits for physicians, therapists, caregivers and family members

- learn about the patient's perception, consciousness and understanding
- assess if patients are able to follow instructions
- identify periods of wakefulness
- support a longitudinal screening to investigate stability, improvement of response, or daily changes in awareness

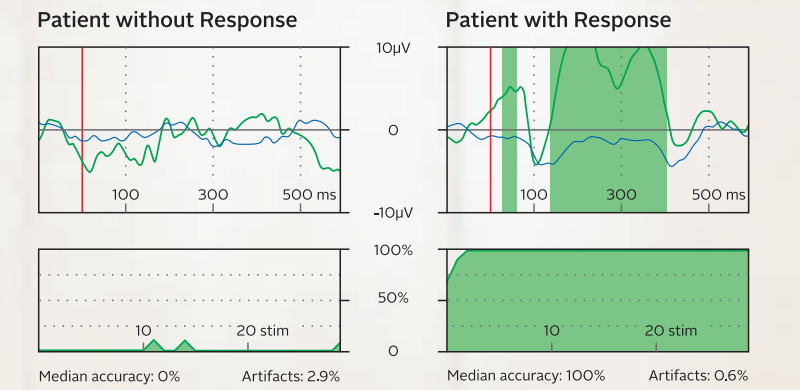
Imagine you are trapped in your body. You cannot move or speak. But you can hear, feel and think.

If patients can perceive auditory and tactile stimuli, they might be able to communicate via mindBEAGLE!

Vibrotactile Stimuli for Assessment via Evoked Potentials (EP)

that allows the patient to say "YES" by focusing on right hand
that allows the patient to say "NO" by focusing on left hand

These evoked potentials show the brain's response to target stimuli in green and to non-target stimuli in blue (bottom row, both columns). If there is a significant difference between the two responses at particular times, then the area is shaded in green. Very often these responses are difficult to interpret, so the BCI's performance accuracy is also calculated and displayed by the computer (line graphs in first row, both columns). If accuracy reaches 100%, then it can be concluded that the patient is definitely able to perform the task correctly; if the accuracy is 0%, then the patient cannot perform the task or is sleeping.



The mindBEAGLE System the processing system with mindBEAGLE software

EEG Cap used to record brain activity with 16 electrodes

In-Ear Phones used to deliver verbal instructions (e.g. to imagine left or right hand movement) for communication and the assessment of Evoked Potentials (EPs)