Talking with a brain: Disorders of consciousness and the use of brain-computer interfaces

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1. Disorders of consciousness

2. Neuroimaging: spectacular studies

3. Brain-computer-interface: the vision

4. Ethics and law: some critical comments
Conscious or unconscious?

Eyes closed  ⇒  sleeping  ⇒  unconscious

Eyes open  ⇒  awake  ⇒  conscious
Overview

Laureys & Boly, Current Opinion in Neurology 2007

MCS

VS
### Table 2 | Differential diagnosis in severe brain injury survivors

<table>
<thead>
<tr>
<th>Condition</th>
<th>Definition</th>
<th>Main clinical characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coma</td>
<td>Unarousable state of unresponsiveness</td>
<td>Absence of eye opening (even after intense stimulation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No evidence of awareness of the self or environment</td>
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<td></td>
<td></td>
<td>Condition protracted for more than one hour</td>
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<tr>
<td>Vegetative state</td>
<td>Wakefulness accompanied by the absence of any sign of awareness</td>
<td>Presence of eye opening and closing</td>
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<tr>
<td></td>
<td></td>
<td>Absence of any reproducible purposeful behaviour including (a) no evidence of non-response to sensory stimulation; (b) no evidence of awareness of the self or the environment; (c) no evidence of language comprehension or expression</td>
</tr>
<tr>
<td>Minimally conscious state</td>
<td>Wakefulness accompanied by inconsistent but reproducible signs of awareness</td>
<td>Presence of eye opening and closing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presence of inconsistent but reproducible purposeful behaviour including (any of) (a) non-reflexive response to sensory stimulation; (b) awareness of the self or the environment; (c) language comprehension or expression</td>
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<tr>
<td></td>
<td></td>
<td>Lack of functional communication or object use</td>
</tr>
<tr>
<td>Locked-in syndrome</td>
<td>Impairment in the production of voluntary motor behaviour</td>
<td>Presence of eye-coded communication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preserved awareness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complete or partial inability to produce motor behaviour</td>
</tr>
</tbody>
</table>
Source of conflicts

Karen Ann Quinlan

Nancy Cruzan

Tony Bland

Terri Schiavo

Eluana Englaro

Ariel Sharon

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26/09/2013
- All end-of-life care cases before the highest court concerned patients with disorders of consciousness (DOC)

- **1994-2010**: 30 court decisions in 17 DOC cases (4 times up until highest federal court)

- In all 17 cases the main question was whether to administer artificial nutrition and hydration

- Legal surrogate: 12x adult children, 3x partner, 1x father

- Decisions always based on patient autonomy

  *Budick T et al. Nervenheilkd 2012;4:231-5*
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Das Thema Bewusstsein ist sexy

Steven Laureys erforscht das Bewusstsein im Grenzbereich. Kürzlich sprach er in Wien im Rahmen der Uni-Tagung „Conference on Consciousness“. Stefan Löffler erklärte, warum die Diagnose des koma-related Syndrome problematisch ist und welche ethischen Fragen er sich stellt.

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Determining awareness

- **MCS**: Brain activity in fMRI/AEP similar to controls if own name or familiar faces are presented
  

- **MCS**: PET activity pattern in response to painful stimuli is similar to that of controls (but not for VS)
  
  *Boly M (2008) Lancet Neurol*

**Resting state fMRI:**
Default mode network of the brain:
Brain death - VS ↓↓ MCS = controls

23 yo VS patient:

fMRI pattern similar to healthy controls in an imagination task

Owen et al., Science 2006
Establishing communication

Monti et al. NEJM 2010

"Move your right hand/toe!“

Brain-Computer-Interface
Messen statt diskutieren!

Mit Hilfe von Hirnscans können Forscher feststellen, ob ein Patient im Wachkoma bei Bewusstsein ist oder nicht. Im zweiten Teil der neuen G&G-Rubrik schildert der Neurowissenschaftler Christof Koch, wie diese und andere Techniken eines Tages helfen können, subjektives Erleben objektiv zu bestimmen.

Gehirn & Geist, Heft 7-8, 2010
Scott Routley, 39yo, diagnosed to be in a Vegetative State for 12 years after a car accident
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Aim: using fMRI-based Brain-Computer Interface (BCI)

- to determine decisional capacity
- to express treatment decision/
  to get informed consent

Article should provide conceptual basis
Decision-making capacity is seen as a necessary condition for legal competence.

Capacity is the sum of 4 necessary criteria:
Communication, understanding, appreciation, reasoning

(Appelbaum P, NEJM 2007)

These criteria are “decomposed” into cognitive faculties, e.g.:

3) reasoning → ability to engage short-term memory,
ability to retrieve long-term memory,
ability to process logic inferences

Intactness of faculties is measured by fMRI/MRI/EEG
**Standardized tests** are used, e.g. MacArthur Competence Assessment Tool Treatment (MacCAT-T) or the Mini-Mental State Examination (MMSE)

<table>
<thead>
<tr>
<th>Threshold of decision making capacity</th>
<th>Potential net balance of expected benefits and harms</th>
<th>Potential consequences of decision</th>
<th>Example of binary question</th>
<th>Stakes of Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Threshold</td>
<td>Potential harms substantially outweigh the benefits relative to alternative treatments</td>
<td>Radical and Irreversible</td>
<td>Do you consent to invasive research?</td>
<td>High</td>
</tr>
<tr>
<td>Medium Threshold</td>
<td>Potential harms are equal to the benefits relative to alternative treatments</td>
<td>Radical yet Reversible</td>
<td>Do you consent to appointing person X as your medical proxy?</td>
<td>Medium</td>
</tr>
<tr>
<td>Low Threshold</td>
<td>Potential benefits substantially outweigh the harms relative to alternative treatments</td>
<td>Mundane and Reversible</td>
<td>Do you wish to have more pain medications?</td>
<td>Low</td>
</tr>
</tbody>
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Aim of **promoting autonomy** is laudable

Yet, this aim will hardly be achieved when the method is **reductionist**:

1) *Patient autonomy can also be respected and promoted below the threshold of capacity/competence*

2) *Autonomy and capacity are not solely cognitive: emotional & social abilities needed (e.g. hope, despair)*

3) *Isolated assessment of cognitive functions is insufficient to judge the integrative function of capacity*
4) Capacity cannot be adequately determined by asking yes/no questions in fMRI: pt can neither explain reasons nor pose questions

5) The moral responsibility of the capacity assessment requires an interpersonal dialogue

Maybe other techniques would be favourable, e.g. BCI-based letter selection, EEG instead of fMRI

BCI is more useful in appraising the patient wellbeing than determining capacity & getting informed consent

Interface Cannot Replace Interlocution: Why the Reductionist Concept of Neuroimaging-Based Capacity Determination Fails

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Thank you for the attention!

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