



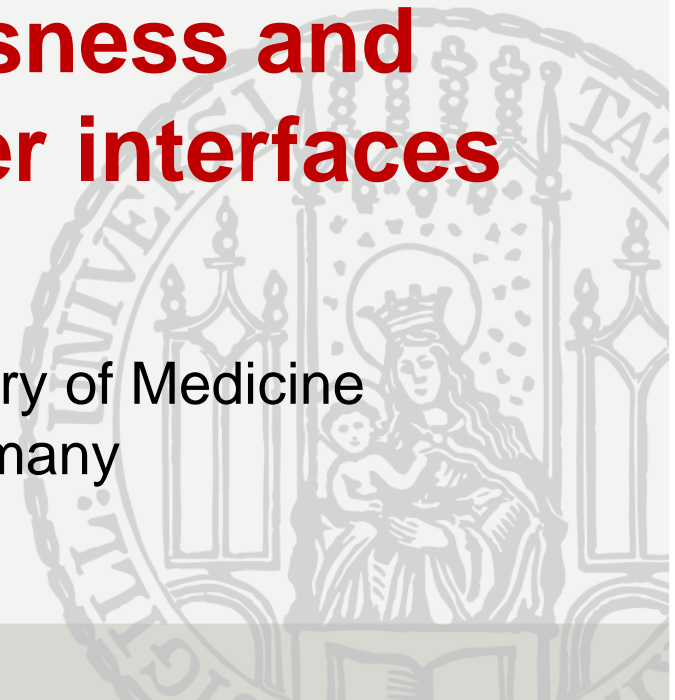
LUDWIG-
MAXIMILIANS-
UNIVERSITÄT
MÜNCHEN

European Association for Neuroscience and Law
Annual Meeting
Bonn, 9-10 September, 2013

**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

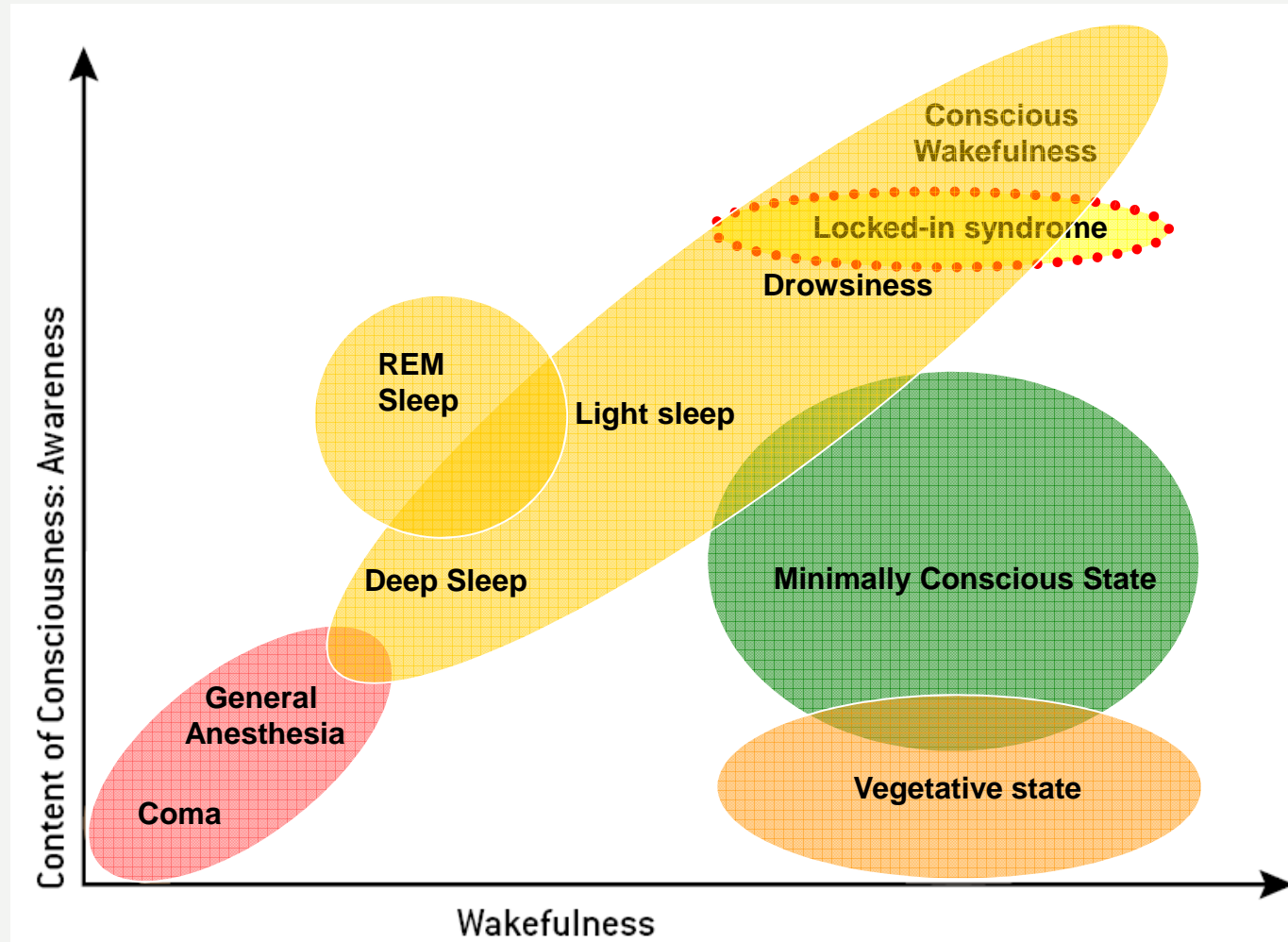
Conscious or unconscious?



Eyes closed
⇒ sleeping
⇒ **unconscious**



Eyes open
⇒ awake
⇒ **conscious**



MCS

VS

Laureys & Boly, Current Opinion in Neurology 2007



Table 2 | Differential diagnosis in severe brain injury survivors

Condition	Definition	Main clinical characteristics
Coma	Unarousable state of unresponsiveness	Absence of eye opening (even after intense stimulation) No evidence of awareness of the self or environment Condition protracted for more than one hour
Vegetative state	Wakefulness accompanied by the absence of any sign of awareness	Presence of eye opening and closing 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
Minimally conscious state	Wakefulness accompanied by inconsistent but reproducible signs of awareness	Presence of eye opening and closing 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 Lack of functional communication or object use
Locked-in syndrome	Impairment in the production of voluntary motor behaviour	Presence of eye-coded communication Preserved awareness Complete or partial inability to produce motor behaviour

Monti et al, BMJ 2010

Source of conflicts



Karen
Ann
Quinlan



Nancy
Cruzan



Tony
Bland



Terri
Schiavo



Eluana
Englaro



Ariel
Sharon

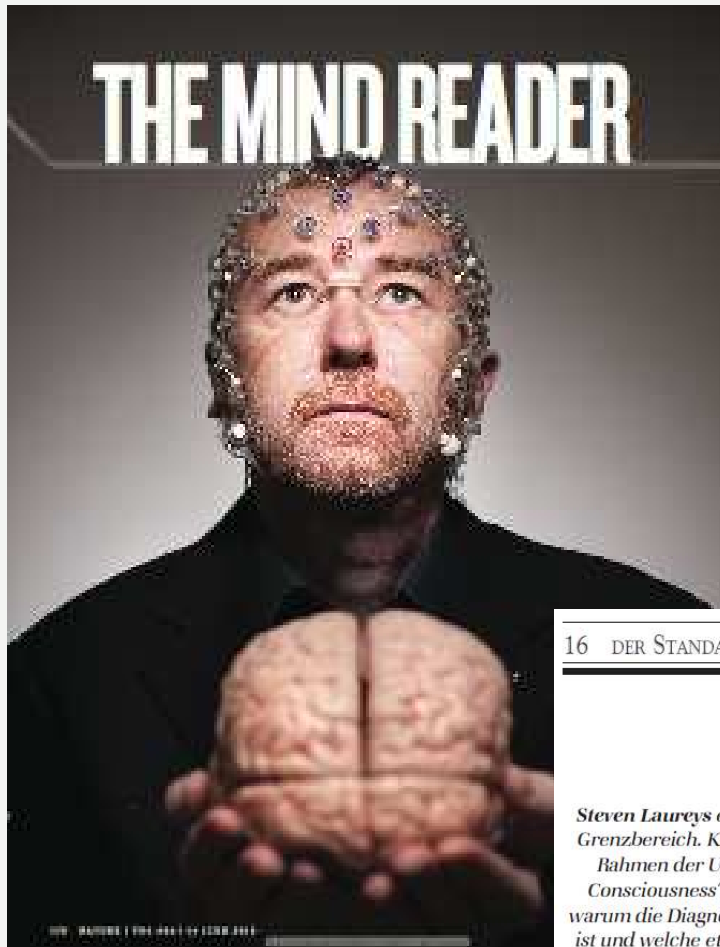




- All end-of-life care cases before the highest court concerned patients with disorders of consciousness (DOC)
- 1994-2010: 30 court decisions in 17 DOC cases (4 times up until highest federal court)
- In all 17 cases the main question was whether to administer artificial nutrition and hydration
- Legal 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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16 DER STANDARD

WISSENSCHAFT / FORSCHUNG SPEZIAL

MITTWOCH, 10. OKTOBER 2007

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 er, warum die Diagnose des Komas problematisch ist und welche ethischen Fragen er sich stellt.

STANDARD: Waren Sie schon mal bei einer Organentnahme dabei?

Laureys: Ja, eine ziemlich tech-

STANDARD: Sie sprechen nicht vom apallischen Syndrom.

Laureys: Dieser Begriff ist im deutschsprachigen Raum ver-



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

Di HB (2007) Neurology, Zhu J (2009) J Neurotrauma

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

Boly M (2008) Lancet Neurol

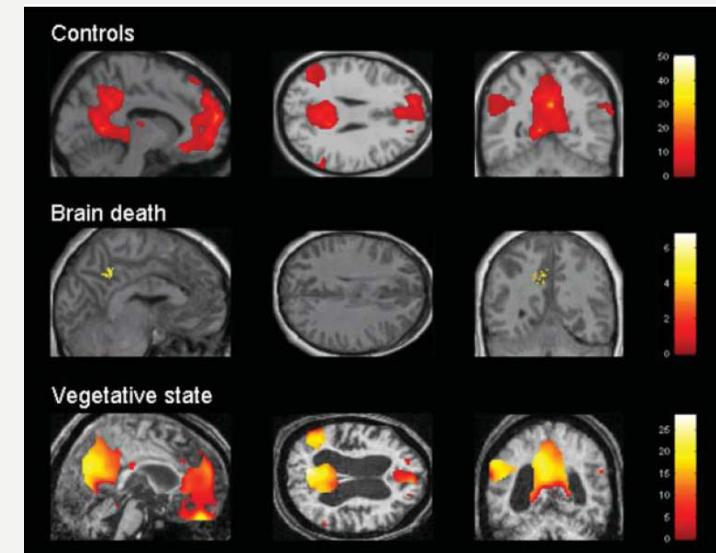
Resting state fMRI:

Default mode network of the brain:

Brain death - VS ↓↓ MCS = controls

Cauda F (2009) JNNP 80:429;

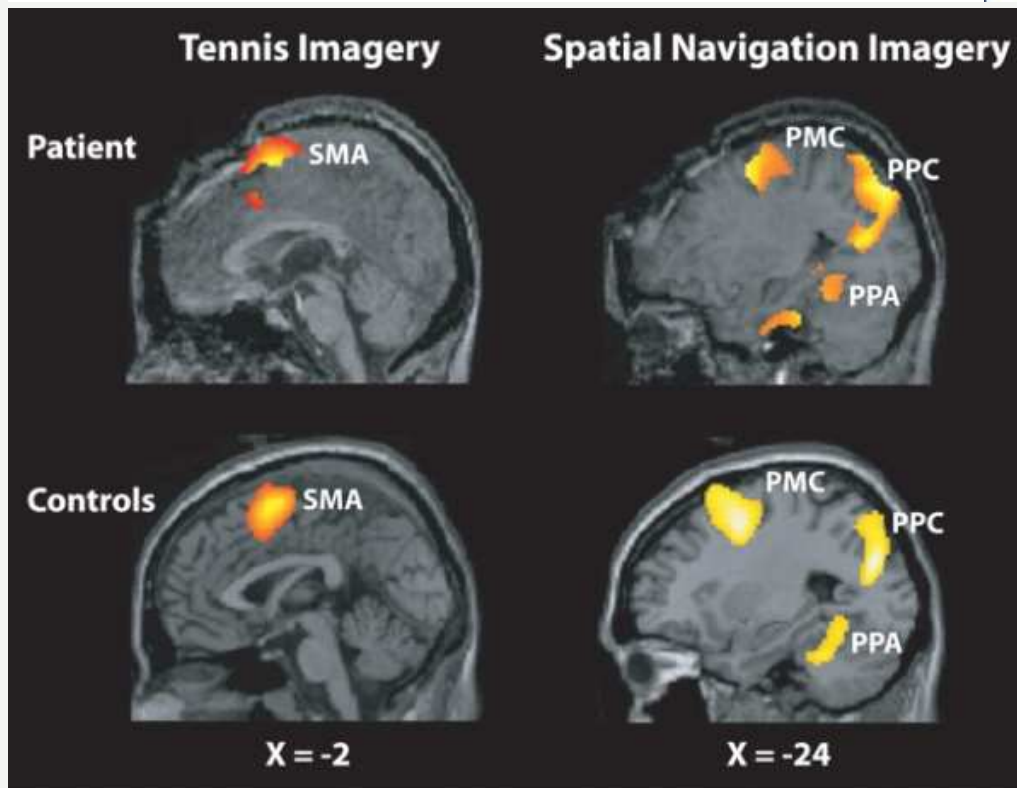
Boly M (2009) Hum Brain Mapp 30:2393



Detecting Awareness in the Vegetative State

Adrian M. Owen,^{1*} Martin R. Coleman,² Melanie Boly,³ Matthew H. Davis,¹ Steven Laureys,³ John D. Pickard²

Science

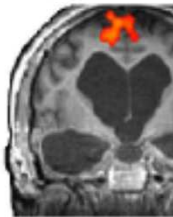
23 yo VS patient:

fMRI pattern similar to healthy controls in an imagination task

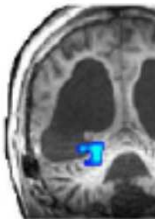
Owen et al., Science 2006

Imagine **T**er
Imagine **N**avi

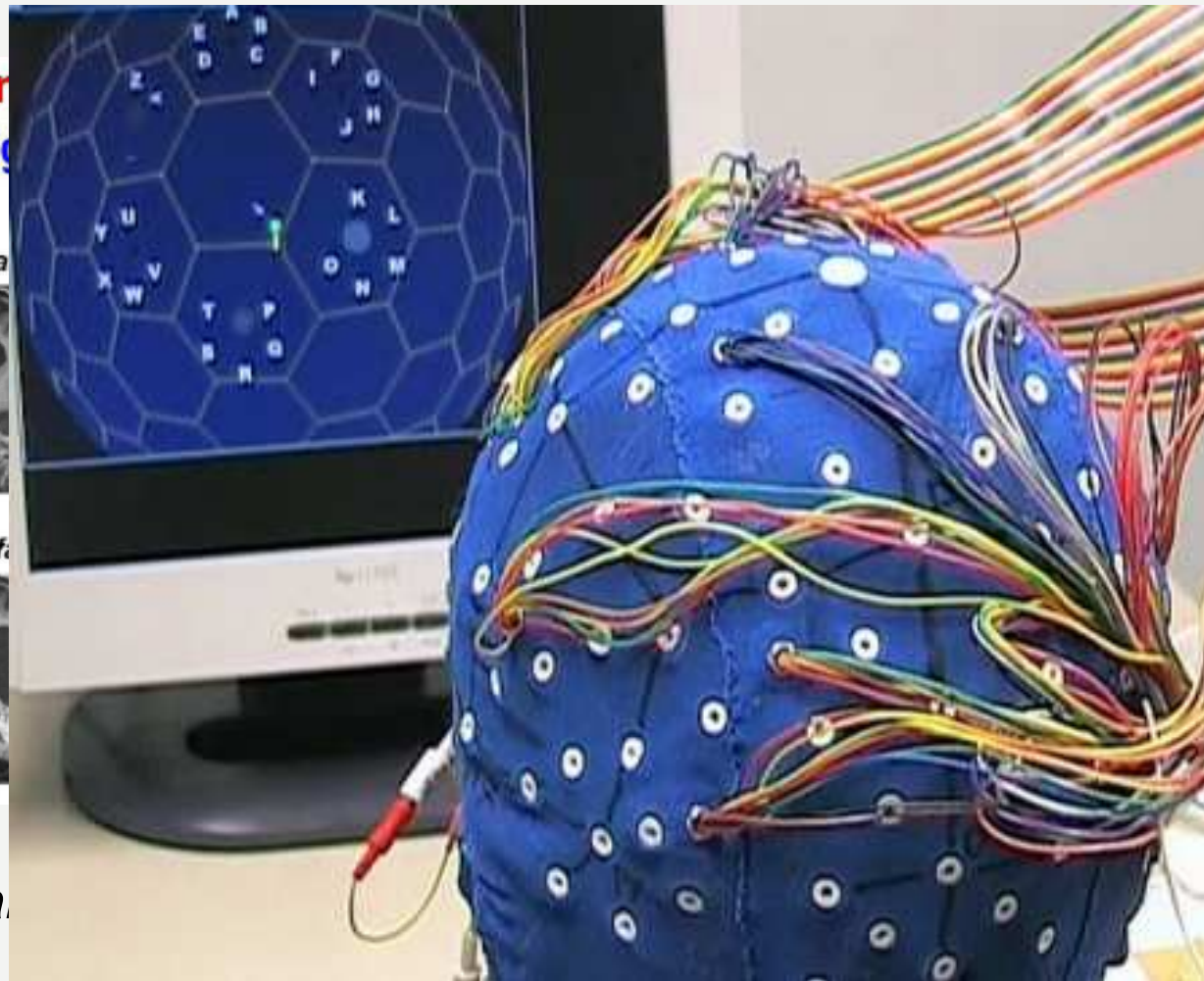
Is your fa



Is your fa



Monti et al



and/toe!"



Brain-Computer-Interface



HIRNFORSCHUNG | WACHKOMA

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

A recent case



Scott Routley, 39yo, diagnosed to be in a Vegetative State for 12 years after a car accident

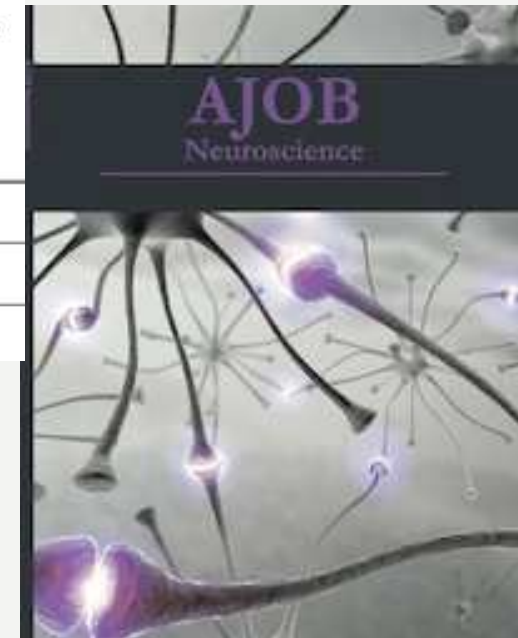


BBC
13/12/2012

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Assessing decision making capacity in the behaviorally non-responsive patient with residual covert awareness

Journal:	AJOB Neuroscience Journal
Manuscript ID:	UABN-2012-0124.R1
Manuscript Type:	Target Article



- **Aim:** using fMRI-based Brain-Computer Interface (BCI)
 - a) to determine decisional capacity
 - b) 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)

Threshold of decision making capacity	Potential net balance of expected benefits and harms	Potential consequences of decision	Example of binary question	Stakes of Decision
High Threshold	Potential harms substantially outweigh the benefits relative to alternative treatments	Radical and Irreversible	Do you consent to invasive research?	High
Medium Threshold	Potential harms are equal to the benefits relative to alternative treatments	Radical yet Reversible	Do you consent to appointing person X as your medical proxy?	Medium
Low Threshold	Potential benefits substantially outweigh the harms relative to alternative treatments	Mundane and Reversible	Do you wish to have more pain medications?	Low

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- Aim of **promoting autonomy** is laudible
- 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

➔ **Ethical assessment:** Burden? Raising false hopes? Delaying decisions? Delegating to pseudo-autonomy?



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Open Peer Commentaries

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

Ralf J. Jox, Ludwig-Maximilians-University Munich



**Thank you for
the attention!**

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