



Karl Landsteiner Institute
of Neurorehabilitation and
Space Neurology

Diagnosis and Prognosis of Patients in the Apallic Syndrome and Defect States

F. Gerstenbrand¹⁾, St. Golaszewski,^{1,2)} A.Kunz^{1,2)}, E.Trinka²⁾

¹⁾ Karl Landsteiner Institute of Neurorehabilitation and Space Neurology, Vienna, Austria
²⁾ Neurological Department of Christian Doppler Clinic, Salzburg, Austria

8th World Congress for Neurorehabilitation

April 8-12,2014
Istanbul, Turkey

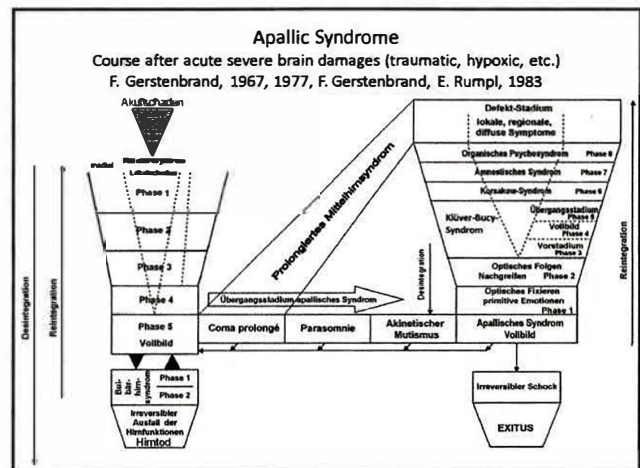
Symptoms of Apallic Syndrome/ Vegetative State

- Coma Vigile
- No recognition of the surrounding
- No contact to the surrounding
- No reaction to external stimuli
- Sleep-wake-rhythm fatigue regulated
- Optomotoric disturbances
- Flexed-stretched position of extremities and trunk
- Primitive motor patterns (oral, grasping, etc.)
- Dysregulation of the vegetative system
- Remission in principle possible

Apallic syndrome, pat. E.S., 19^a traumatic brain injury, 1992



Treatment program in special center for apallic syndrome
No tertiary lesions, minimal secondary lesions
Remission after 5 months to minimal defect state



Apallic Syndrome - Remission Stages Innsbruck Remission-Scale - 1

- Phase I: Optic fixation – reduction of Coma vigile, sopor
- Phase II: Optic tracking – sleep-wake-rhythm normalizing, stupor
- Phase III: Pre-Klüver-Bucy-Phase – combination of primitive motor reflexes, wakeful
- Phase IV: Klüver-Bucy-Phase – Klüver-Bucy reflexes, obnubilation, voluntary movements starting

Apallic Syndrome - Remission Stages Innsbruck Remission-Scale - 2

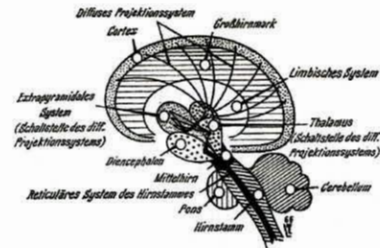
- Phase V: Post-Klüver-Bucy-Phase – hypersomnia, communication possible
- Phase VI: Korsakov syndrome – voluntary behavior, disorientation, confusional states
- Phase VII: Amnestic phase – emotional irritation
- Phase VIII: Psycho-organic syndrome – aware, awake, alertness reduced

Minimally Conscious States

(Giacino et al, 1997)

- Crude consciousness: alertness
- Phenomenal consciousness: registration of external and internal phenomena
- Access consciousness: directed attention, cognitive awareness, decision making
- Critics:
 - No detailed neurological symptomatology
 - Phenomenological description
 - Etiology generally open
 - Comparable with different remission phases of AS/VS

Apallic Syndrome Neuropathophysiological explanation F. Gerstenbrand, 1967



Anatomical basis:
multiregional
lesions in different
brain areas

Functional basis:
ascending
reticular system,
failure

Abb. 67. Schematische Darstellung der verschiedenen Hirnformationen durch deren Ausfall das Symptomenbild des apallicen Syndroms entstehen kann. Einzeichnung des reticulären Systems im Hirnstamm und des diffusen Projektionsystems.

Apallic Syndrome Disturbance of Consciousness

- Alertness and wakefulness undisturbed
- No awareness of the surrounding
- No contact to the surrounding
- No specific reaction to the surrounding
- Disturbed reaction to external stimuli
- Vegetative reaction to internal, external stimuli
- Absence of all cognitive functions

Consciousness F. Plum and J.B. Posner

The limits of consciousness are hard to define satisfactorily and quantitatively and we can only interfere the self-awareness of others by their appearance and by their acts.

Consciousness

- Awareness
- Alertness
- Wakefulness
- Attention
- Arousal
- Intact Default Mode Network

Awareness

- Visual awareness
- Auditory awareness
- Interoceptive awareness
- Emotional awareness
- Self awareness

Cognition Cognitive Abilities I

- Perception
- Comprehensiveness
- Recognition
- Assessment
- Processing
- Reliability

Cognition Cognitive Abilities II (Self recognition)

- Self reliability
- Responsiveness
- Conceptivity
- Accessment
- Subjectivity
(Cogito ergo sum)

Consciousness Main Operating System

- Linked cortical network
- Ascending reticular system
 - Functioning (alertness)
 - Activation with different stimuli
 - All incoming sensory stimuli
 - Optic, acoustic, proprioception etc.
 - Medication
- Functional activation, biochemical activation, physical activation
 - Function like a “joy stick”
- “Switcher” unknown

Basis of Brain Functions

- Cortical network for the different brain functions interlinked
- Activation system of the cortical network ascending reticular system
- Functioning system to accept and to evaluate incoming stimuli as well as control of outgoing messages
- Access to the archive of memories and the ability to add new experiences

Examination for Disorders of Consciousness

- Neurological bed side examination
- Coma recovery scale revised (CRS-R)
- EEG, event related potentials
 - semantic oddball paradigm - SOP,
 - own name paradigm - ONP
- fMRI, event related potentials
 - semantic oddball paradigm - SOP,
 - own name paradigm - ONP etc.
 - sensory stimulation, vibration

Functional Magnetic Resonance Imaging (fMRI)

- Method of registering incoming stimulations in the different brain regions, network compound
- Using the BOLD effect (Blood Oxygenation Level Depend)

Stimulation of Brain Functions used for fMRI

- No Stimulation, resting network
- Sensory Stimulation
 - Vibro stimulation
 - Acoustic stimulation
 - Visual stimulation
 - Pain stimulation
- Cognitive Stimulation
 - Language stimulation
 - Imagery stimulation
 - Memory stimulation

Paradigms in fMRI

- Stimulus related paradigms
 - Sensory paradigm
 - Sensible stimulation (vibro stimulation)
 - Pain stimulation (electric medianus stimulation)
 - Visual stimulation, acoustic stimulation
 - Cognitive paradigm
 - Language paradigm (semantic discrimination)
 - Own name paradigm (self awareness)
 - Emotional paradigm (reaction on cry/ laughing, face)
 - Memory paradigm (Warrington Test)
 - Motor-Imagery (tennis play, mental navigation)
- Stimulation independent paradigm (silent paradigm)
 - Default Mode Network

Hierarchy in fMRI Paradigms (Kotchoubey, Schwarzbauer)

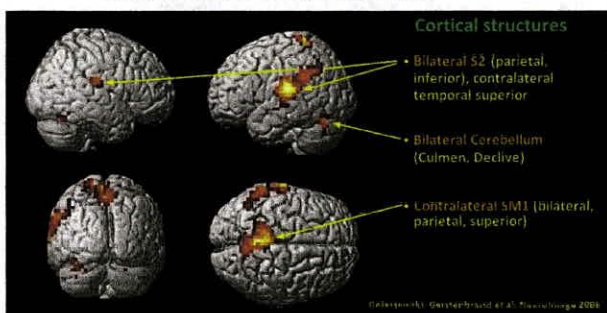
- Diffuse resting stimulation „Silent Paradigm“
- Vibro Stimulation
- Emotional Paradigm (cry/laughing, face)
- Language Paradigm (semantic discrimination meaningful/non-meaningful)
- Memory Paradigm (Warrington Test)
- Mental Imagery

Vibration stimulation to the foot sole:
amplitude 1 mm, frequency 50 Hz



Foot sole vibration BOLD effect, healthy controls

Stimulus: 50 Hz, A=1mm / Group analysis



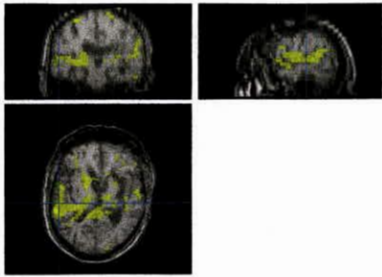
Cortical structures, healthy controls Vibration Paradigms

- Bilateral Gyrus cinguli anterior und posterior
- Insulärer Kortex, posterior parietal (left-dominant)

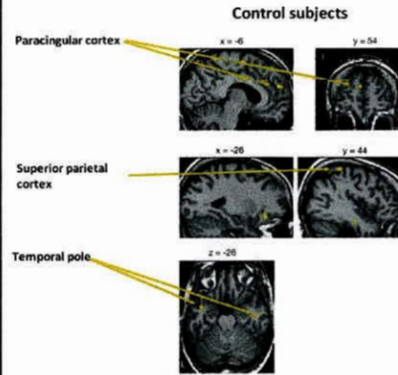
Subcortical structures

- Bilateral Thalamus (somatosensory nuclei), contralateral Nucleus lentiformis
- Bilateral Nucleus caudatus

Apallic Syndrome, Vibration Stimulation, BOLD effect



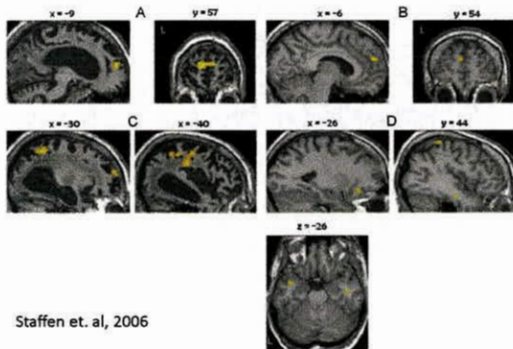
Own name paradigm (ONP)/fMRI: healthy controls
BOLD effect, group analysis



- Kampe KK et al., J Neuroscience 2003: Consistent activity in „medial prefrontal Cortex“.
- Northoff et al., Trends Cogn Sci 2004: Processing of self-referential stimuli in cortical midline structures (CMS), fundamental for model of the own personality‘.

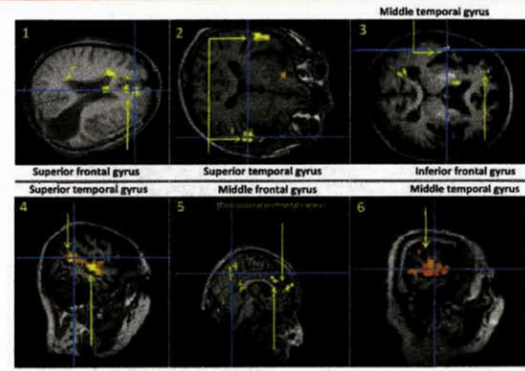
Staffen et al, JNNP, 2006

Higher Language Processing, BOLD effect
Apallic Syndrome: Higher activity in own > foreign name



Staffen et. al, 2006

BOLD contrast for the Own Name and the Sentence Paradigma

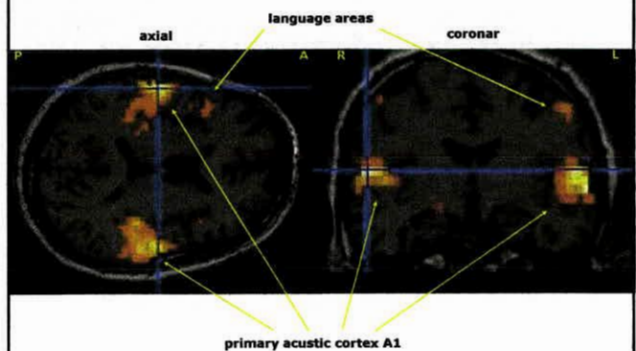


- 1) MCS 2: own name > not own name
- 2) UWS 11: own name > silence
- 3) UWS 3: sentences > silence
- 4) UWS 6: meaningful > non-meaningful
- 5) MCS 3: own name > silence
- 6) UWS 7: sentences > silence

Locked In Plus Syndrome
LIS-Additional Symptoms

- Acinetic mutism (Cairns et al, Skultety)
 - Lesion region 3rd ventricle, periaqueductal
- Sopor
- Stupor (Plum, Posner)
 - Lesion intralaminar nucleus thalami
- Hypersomnia (Jefferson)
 - Lesions mesodiencephal
- Parasomnia (Facon et al)
 - Lesion periaqueductal

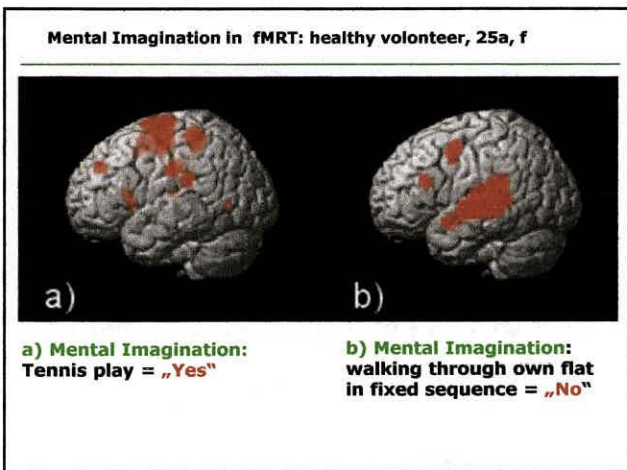
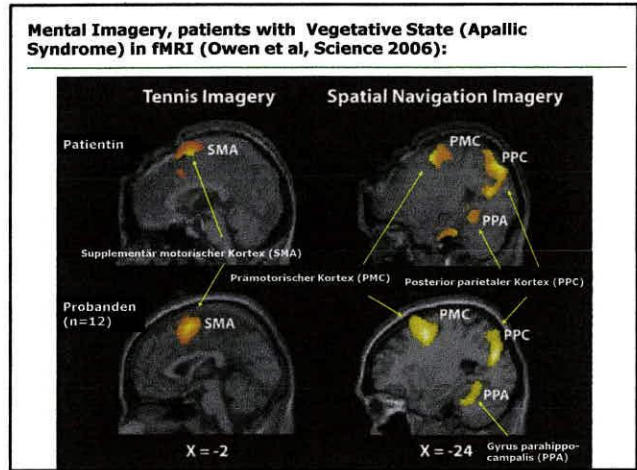
Locked-In-Plus Syndrome, Basilar thrombosis,
Phase of hypersomnia, fMRI/SOP



Specific fMRI response in VS patients

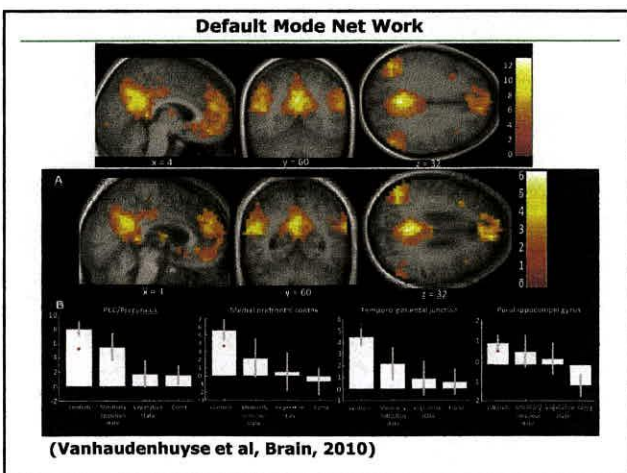
patient number	vibrotactile stimulation	silence vs name	own name vs foreign name	silence vs sentence	semantic oddball
VS#1	no	no	no	no	no
VS#2	no	no	yes	yes	no
VS#3	no	no	no	yes	no
VS#4	yes	yes	yes	yes	yes
VS#5	no	yes	no	yes	no
VS#6	yes	yes	yes	yes	yes
VS#7	no	yes	no	no	no
VS#8	no	yes	yes	yes	yes
VS#9	yes	no	no	no	no
VS#10	yes	no	no	no	no
VS#11	no	yes	no	yes	no
VS#12	yes	no	no	no	no
VS#13	yes	no	no	yes	no
VS#14	no	yes	yes	yes	no
VS#15	no	no	no	no	no

⇒ 8 patients with higher order speech processing and cortical response to a self-referential stimulus, 3 patients AS in remission



Default Mode Network
Raichle 2001

- Function:**
 - Attention-demanding cognitive task
 - Cognitive processes (day dreaming, mind wandering, stimulus, independent source, self related source)
- Anatomical basis:**
 - Precuneus bilateral
 - Temporo-parietal junctions
 - Medial prefrontal cortex
- Level of consciousness, paraclinical brain marker**



Misdiagnosis in patients with Apallic Syndrome, consciousness disorders

Apallic Syndrome, defect states (MCS) with severe chronic disorders of consciousness are misdiagnosed up to 43%

(Andrews et al, 1996; Schnakers et al, 2009)

World Federation for NeuroRehabilitation presents its Biennial Congress




WFNR
World Federation for NeuroRehabilitation



8th World Congress for
NeuroRehabilitation
Towards New Horizons
in NeuroRehabilitation



Abstract Book



April 8 - 12, 2014
Istanbul - Türkiye

www.wcnr2014.org