



Pathophysiologie der neurogenen Dysphagien

Mario Prosiegel

*Wissenschaftlicher Leiter
Zentrum für Schluckstörungen*

**Jahrestagung 2006 der Österreichischen Wachkoma Gesellschaft
20. Oktober 2006 in Wien**

Übersicht

- Schluckstörungen und VS-Betroffene (Literatur)
- Großhirn + kortikobulbäre Bahnen
- Hirnstamm
- Koordination des Schlückens, bes.
 - NTS als wichtige Relaisstation afferenter Inputs
 - Central Pattern Generators (CPGs)
- Plastizität des ZNS
- Pharmaka
- Bedeutung für VS-Patienten

Kretschmer (1940):

„Die Kranken liegen mit geöffneten Augen da [...] Trotz Wachsein ist der Patient unfähig zu sprechen, zu erkennen, sinnvolle Handlungsformen erlernter Art durchzuführen. Dagegen sind bestimmte vegetative Elementarfunktionen, wie etwa das Schlucken erhalten. Daneben treten die bekannten, frühen Tiefenreflexe, wie Saugreflex, Greifreflex hervor.“

<p>ANA, 1993 (Ann Neurol 33:386-390)</p>	<p>Swallowing may be preserved.</p>
<p>The Multi-Society Task Force on PVS, 1994 (NEJM 330:1499-1508)</p>	<p>In most patients, [...] swallowing reflexes are preserved. Except for a lack of coordination in [...] swallowing, gastrointestinal function remains nearly normal.</p>
<p>Bernat, 1999 (Postgrad Med J 75:321–324)</p>	<p>Liquid and food placed in the mouth may be swallowed. A few [...] patients can take all their nourishment orally. In the vast majority of patients, however, there is gross disturbance of the swallowing mechanism.</p>

Higashi et al., 1973 (J Neurol, Neurosurg & Psychiatry 40:876-885)

Juni 1973

(n=110)

Juni 1974

(n=64)

Juni 1976

(n=38)

Swallowing
movements

50,5%

57,4%

81,6%

26% oral ernährt

N = 25 (Wach-)Koma

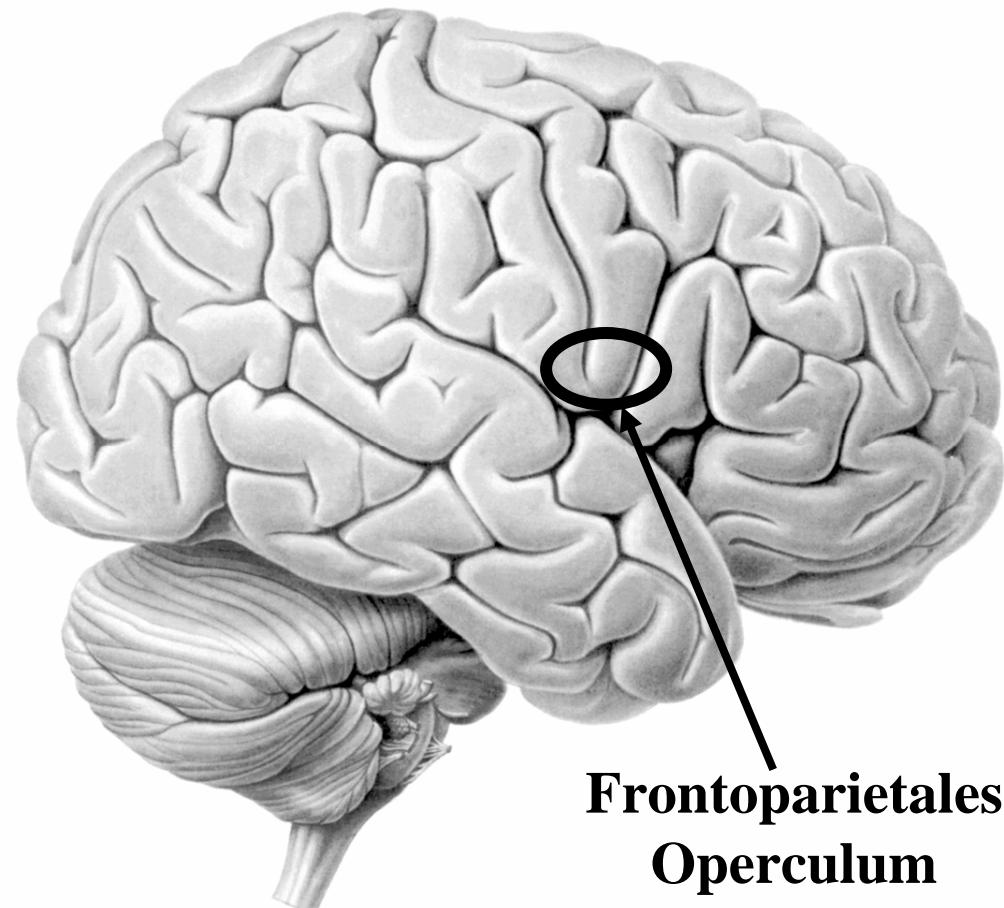
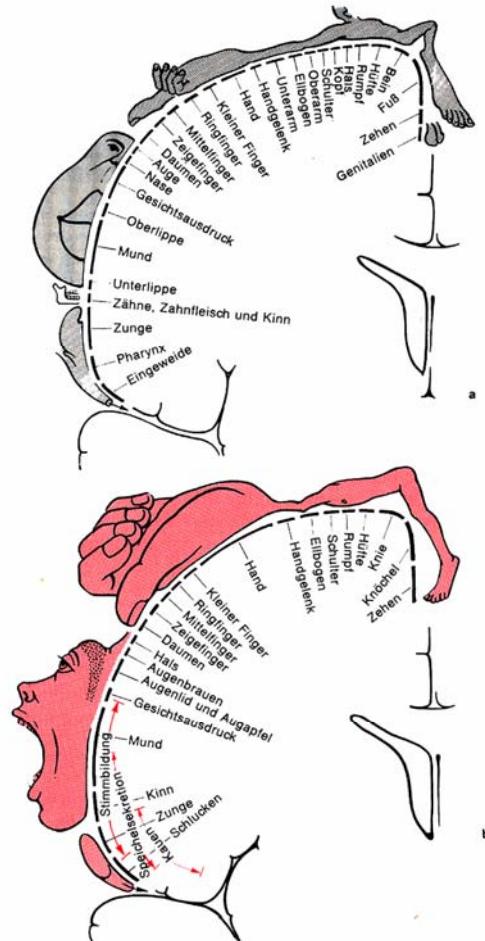
Intervall zwischen Trauma und Wiederaufnahme der oralen Ernährung besitzt eine gute Vorhersagekraft hinsichtlich des kognitiven Status.

(“The clinical variable with a significant predictive value on most neuropsychological scores was the interval from head trauma to the recovery of oral feeding.”)

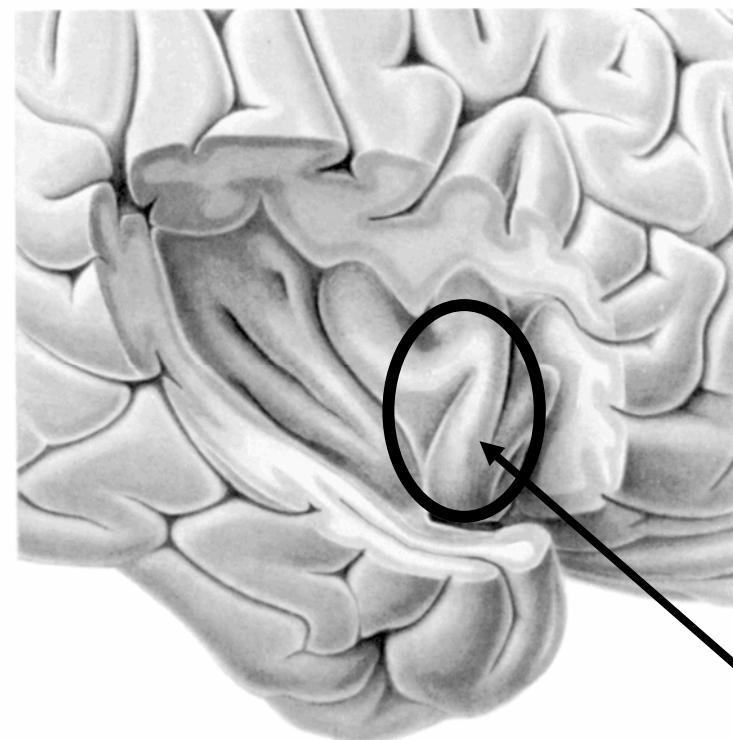
Formisano et al.

Clinical predictors and neuropsychological outcome
in severe traumatic brain injury patients.

Acta Neurochir (Wien) 2004;146:457-562



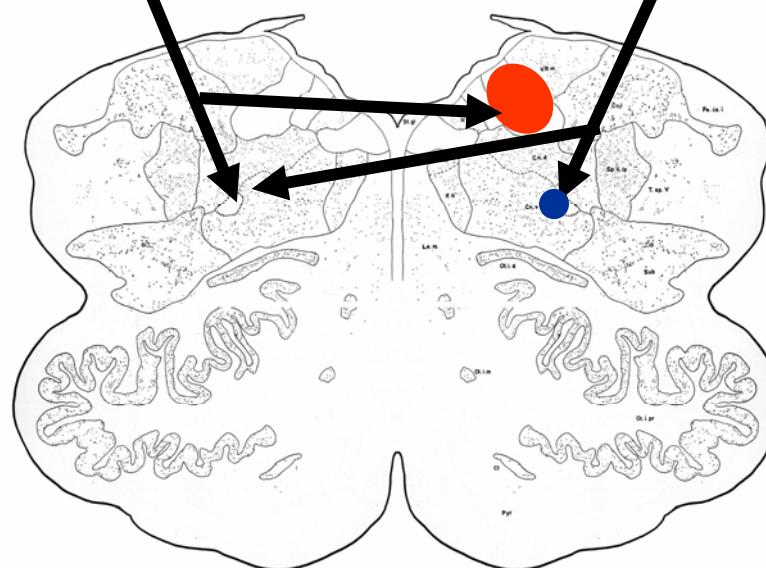
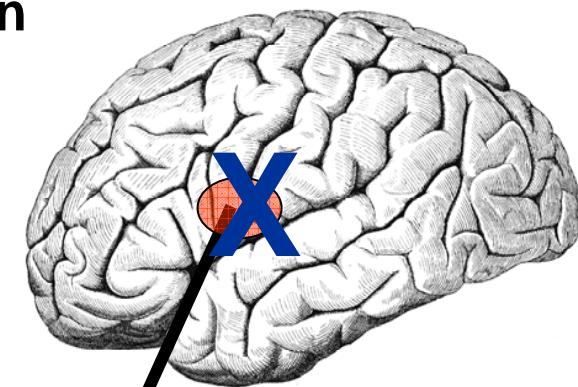
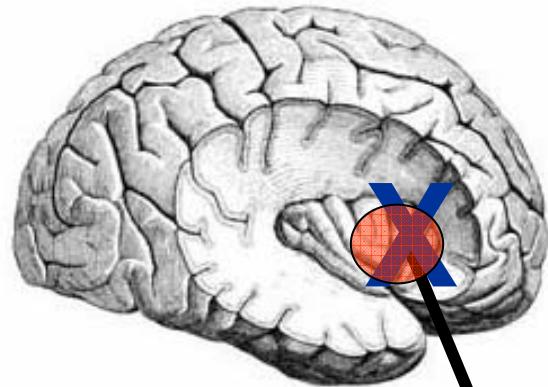
Großhirn



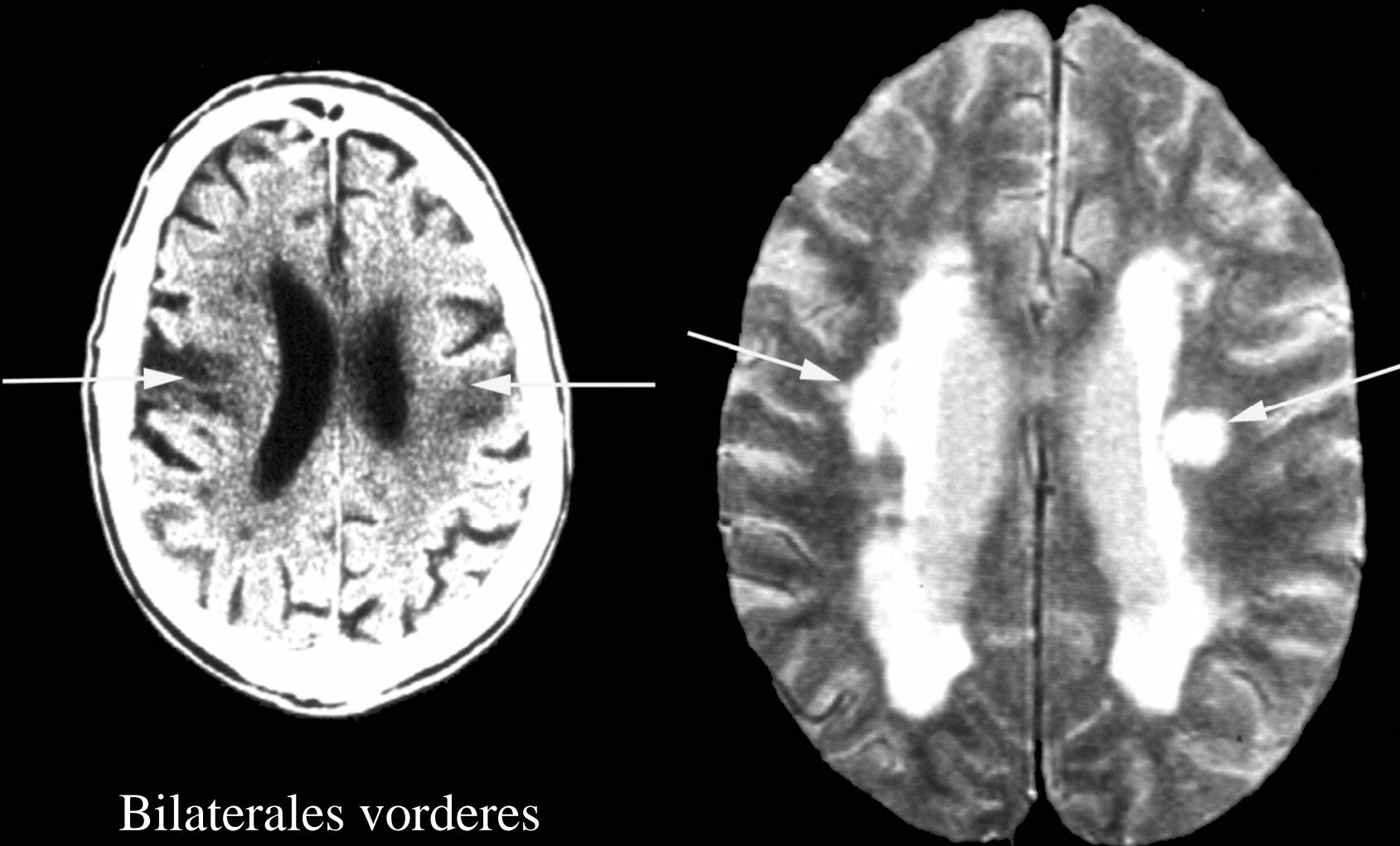
**Vordere
Insel**

Schluck-Kortex und kortikobulbäre Bahnen

Großhirn



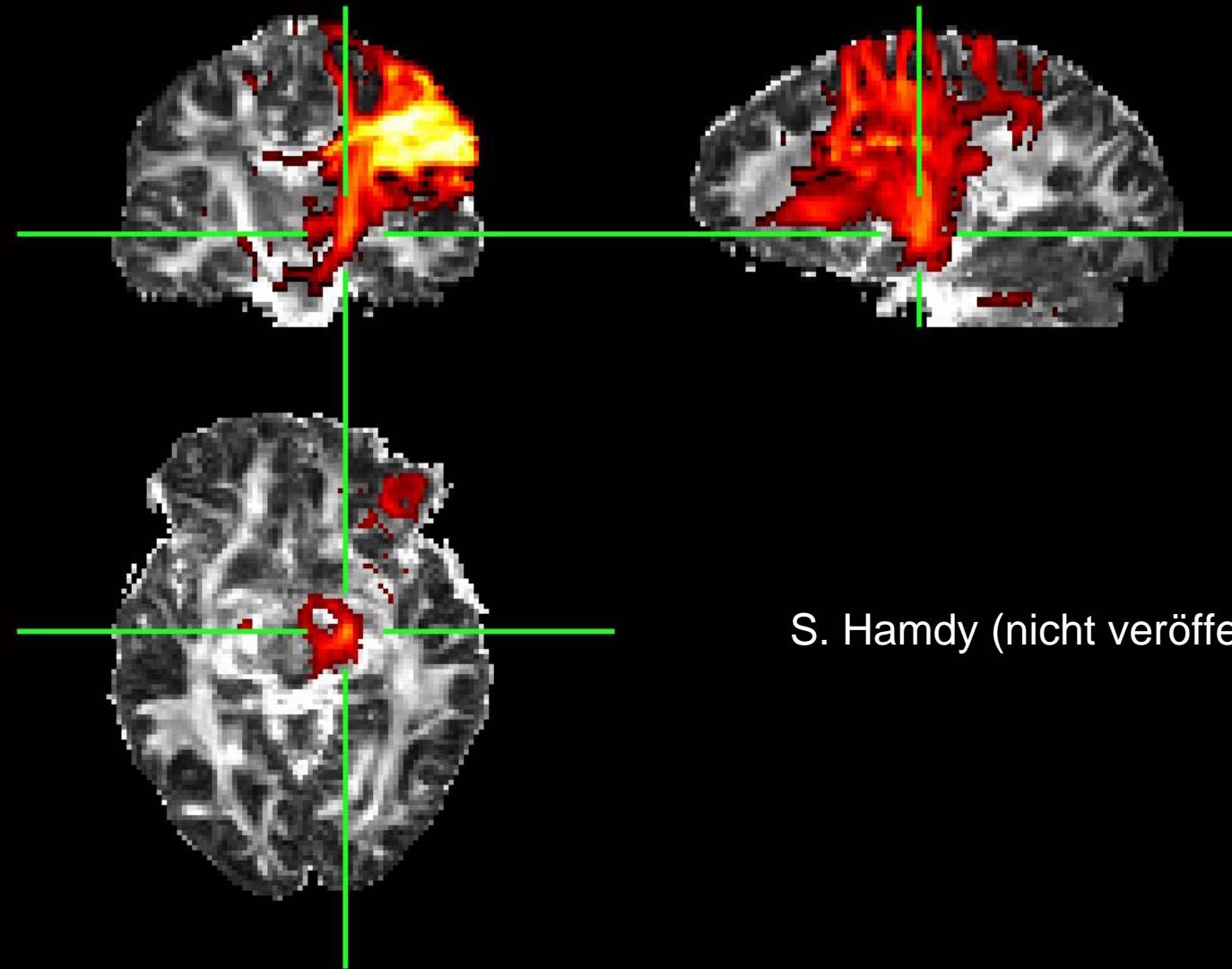
Großhirn



Bilaterales vorderes
Operculumsyndrom
Foix-Chavany-Marie

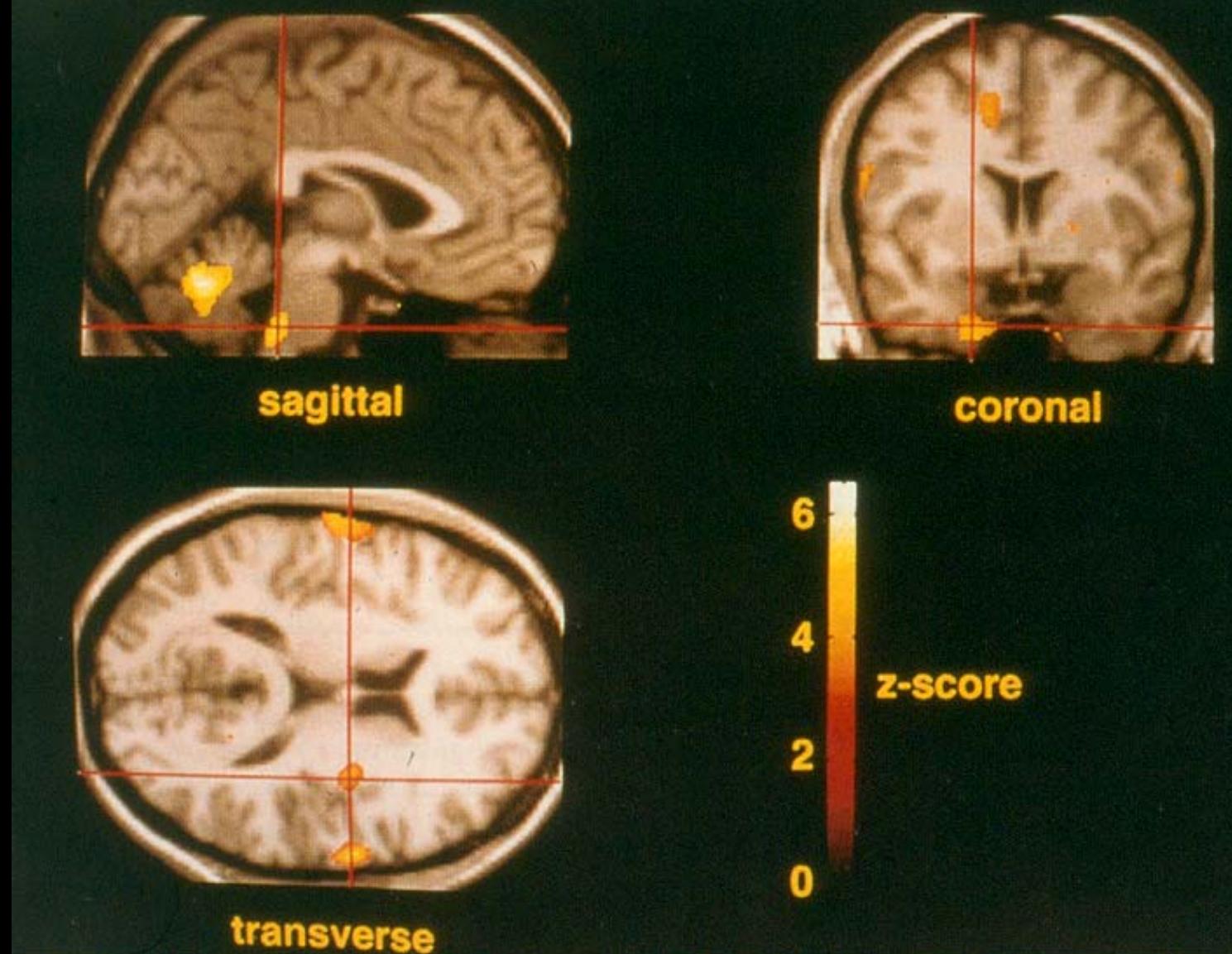
Pseudobulbärparalyse

Großhirn



S. Hamdy (nicht veröffentlicht)

Großhirn



Hamdy S, Rothwell JC, Brooks DJ, Bailey D, Aziz Q, Thompson DG.
Identification of the cerebral loci processing human swallowing with H₂(15)O PET activation.
J Neurophysiol 1999;81:1917-1926

Hamdy S, Rothwell JC, Brooks DJ, Bailey D, Aziz Q,
Thompson DG.

Identification of the cerebral loci processing human
swallowing with H₂(15)O PET activation.

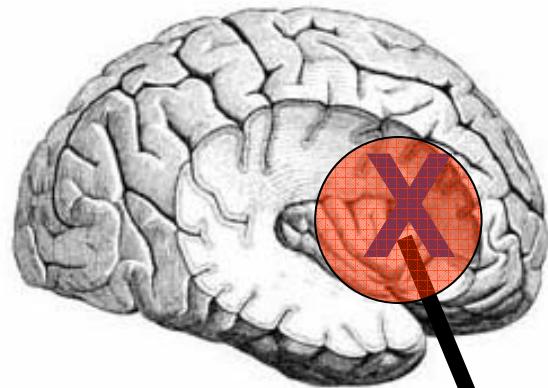
J Neurophysiol 1999;81:1917-1926

Die 8 Probanden zeigten folgende Aktivationsmuster:

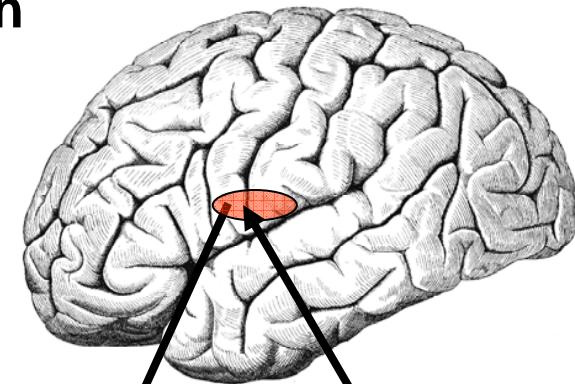
- 4: rechts > links
 - 2: rechts < links
 - 2: rechts = links
- } **Schluckdominanz bei 6 Probanden**

Schluck-Kortex und kortikobulbäre Bahnen

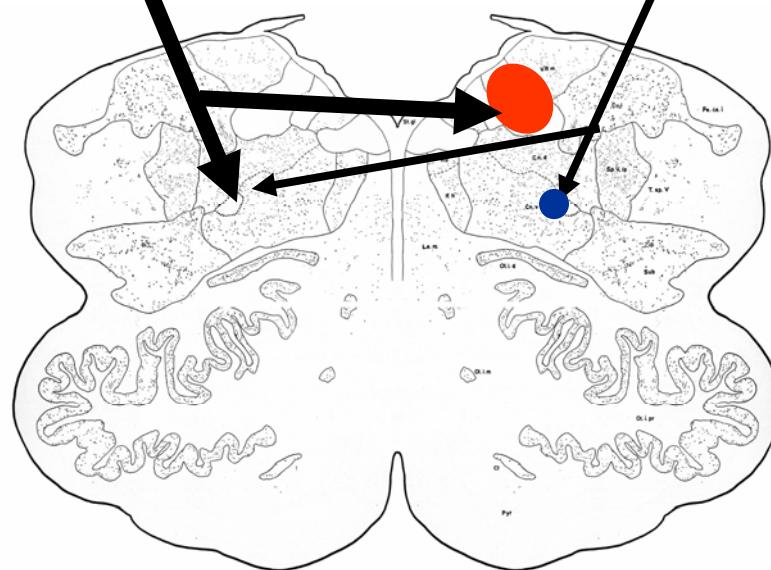
Großhirn



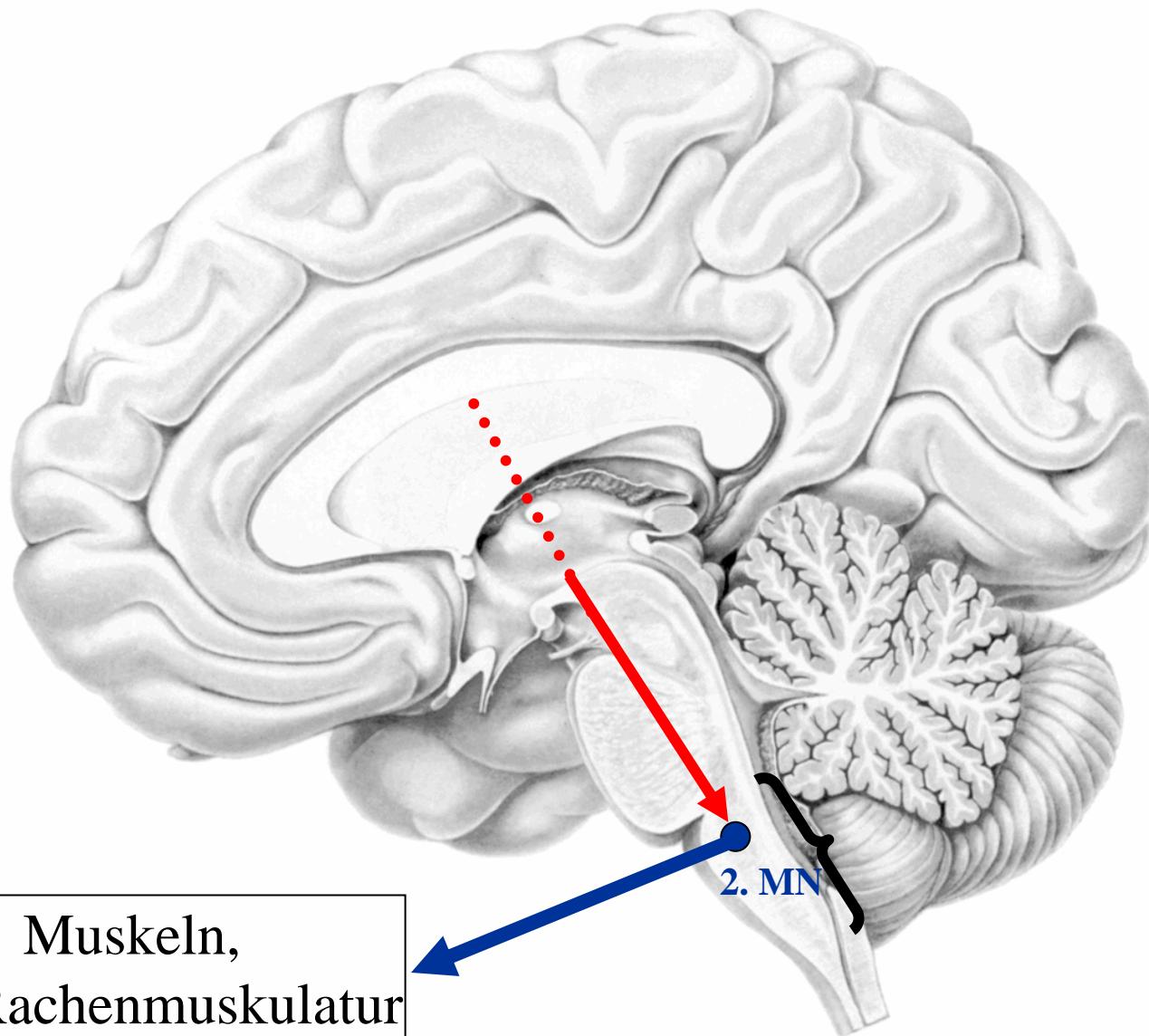
X



frontoparietales
Operculum

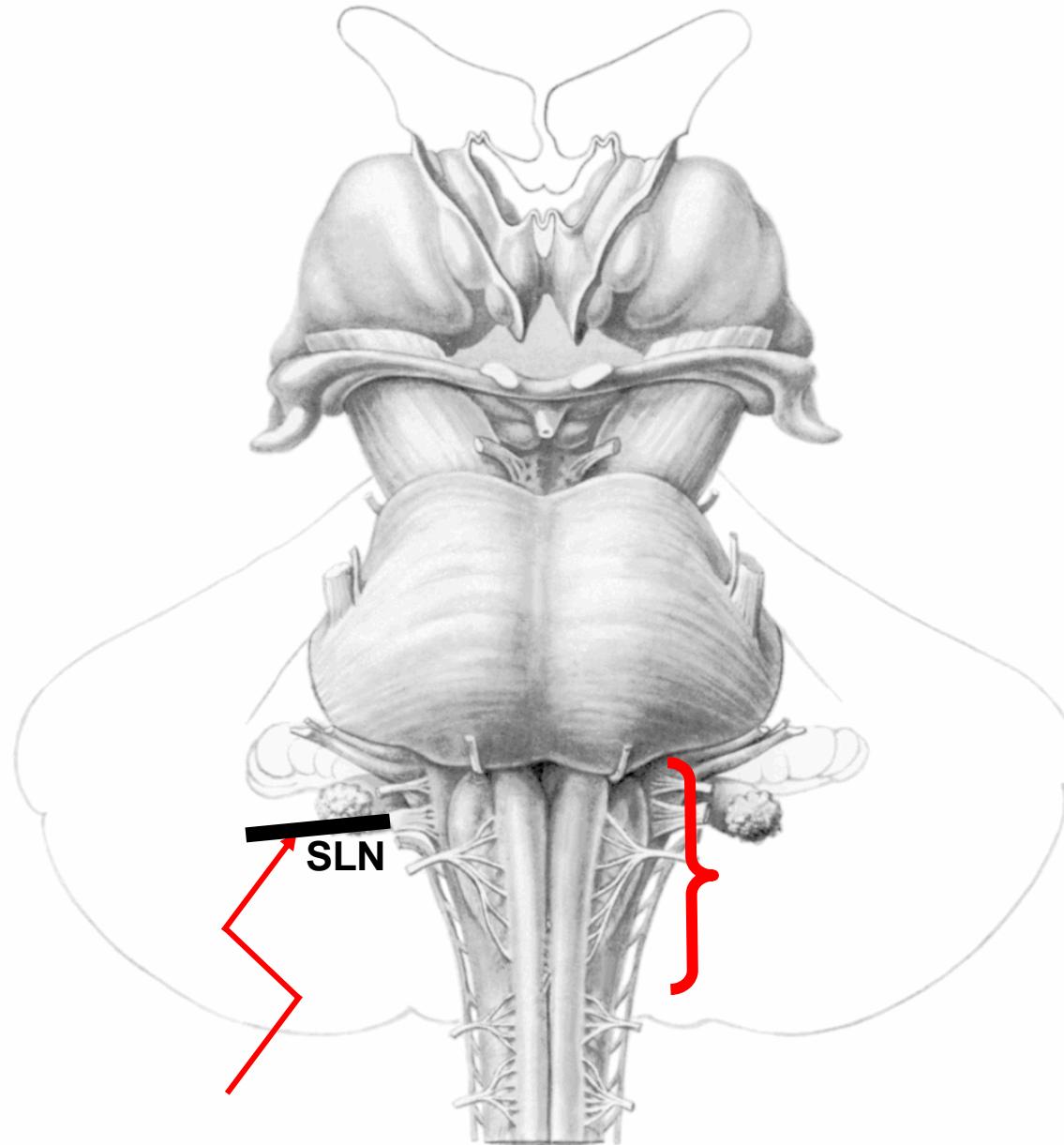


Hirnstamm



Muskeln,
z.B. Rachenmuskulatur

Hirnstamm



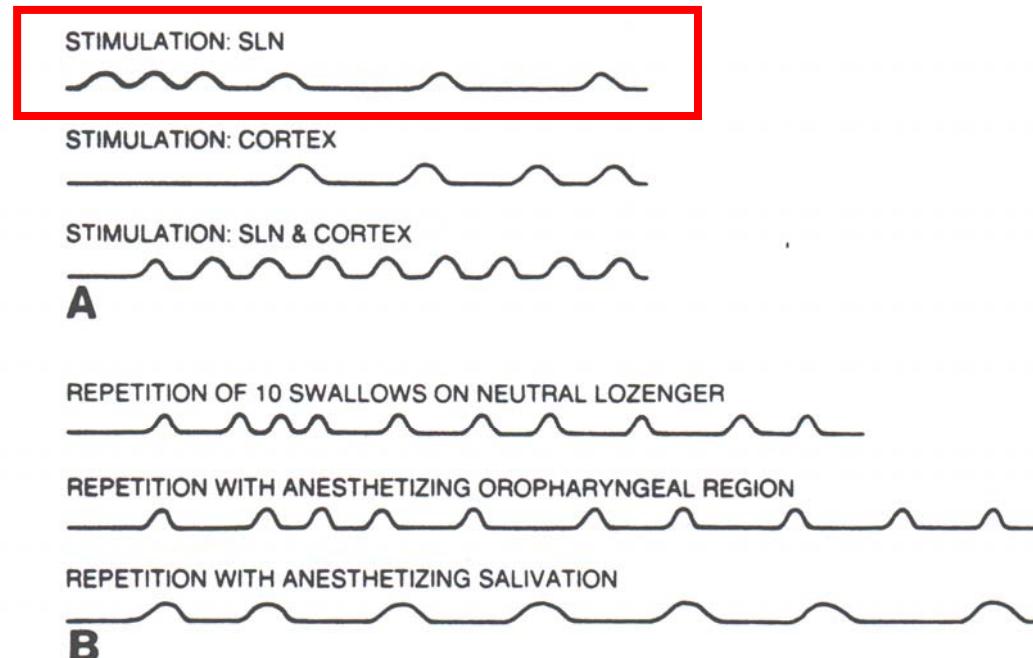


Fig. 8. A schematic representing the repetition of swallowing activity as noted by a marker, such as electromyographic activity of one muscle that is involved during the pharyngeal phase. **A**, the repetitions of repeated pharyngeal swallows when stimulating the superior laryngeal nerve or the cortex or the combination of the two simultaneously. Stimulation of the peripheral nerve and the precentral cortex simultaneously elicits more swallowing. (After Sumi 1969). **B** examples of the time taken to repeat ten swallows on a neutral lozenge and then the effect after anesthetizing the oropharyngeal region or anesthetizing salivation. Anesthetizing the sensory input of the oropharyngeal region or preventing salivation requires repeated swallows that take a much longer time. (After Mansson and Sandberg 1974, 1975a, b).

Doty & Bosma, 1956

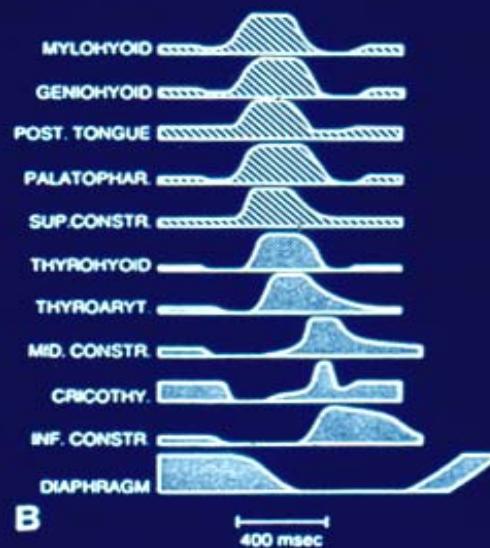
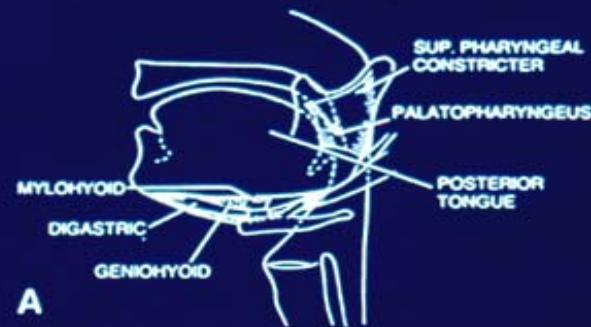


Fig. 5. Swallowing: pharyngeal phase. A location of the muscles that contract during the first part of the pharyngeal phase of deglutition, commonly defined as the "leading complex." B the sequence of muscle recruitment during the entire pharyngeal phase with the muscles involved in the leading complex distinguished from those muscles that are active later in the sequence. The total duration of activity varies with the level of anesthetic. Note that prior to or after swallowing there is a period of inhibition of activity that surrounds the activation of the muscles during the pharyngeal phase. (Adapted from Doty and Bosma 1956).

Doty & Bosma, 1956

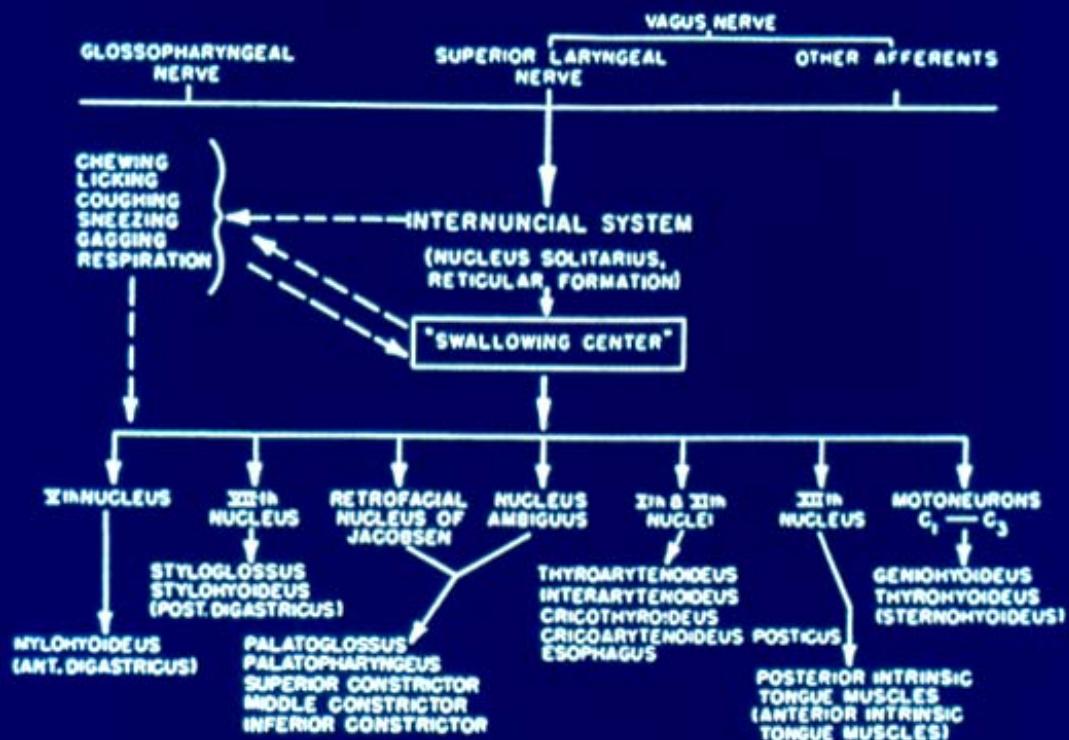


FIG. 4. Outline of neural system concerned in deglutition. Additional functions, overlapping in their afferent and efferent channels, are represented as having possible interaction with swallowing. The muscle innervation is conventional save for inclusion of retrofacial nucleus as per Szentágothai (10). Muscles shown in parentheses failed to participate in deglutition or did so to a negligible degree.

Ca. 80% tonische Muskelfasern (Typ I)

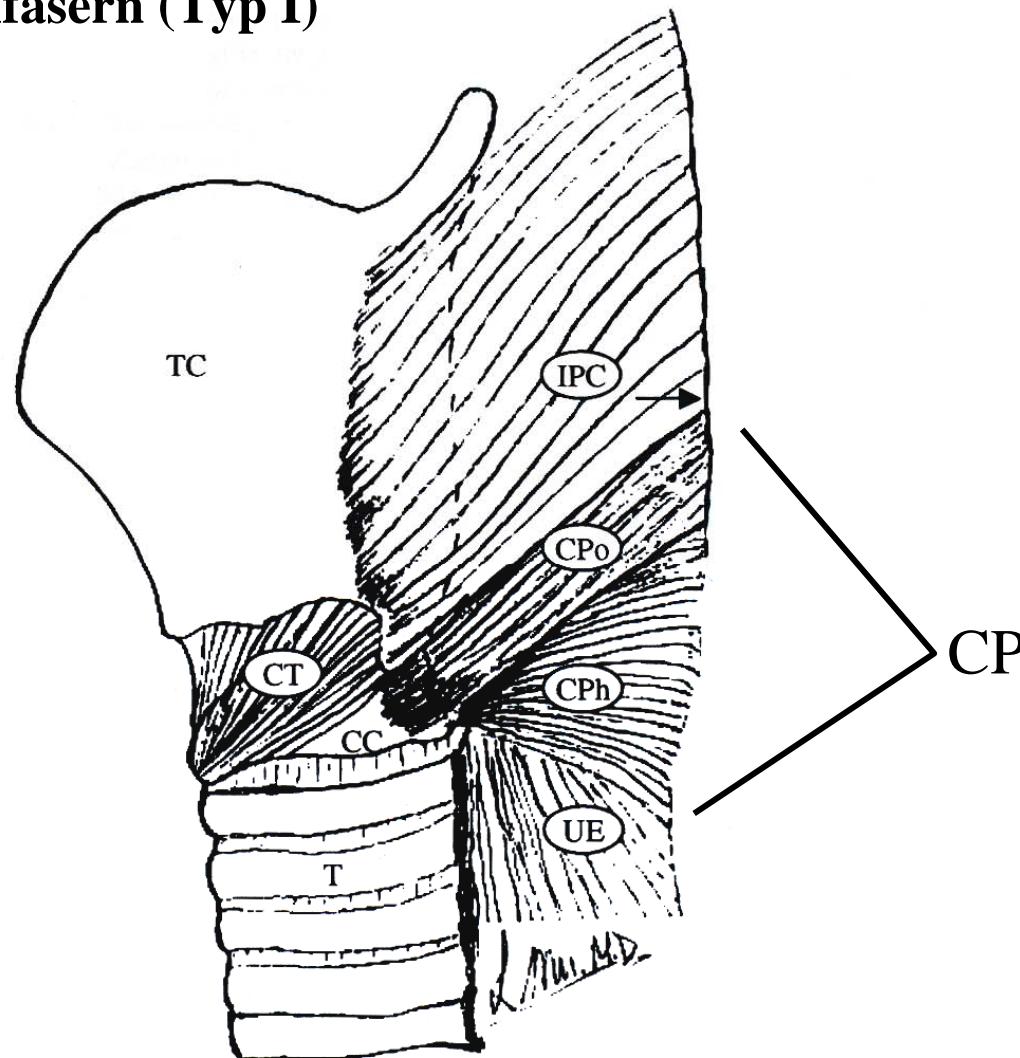
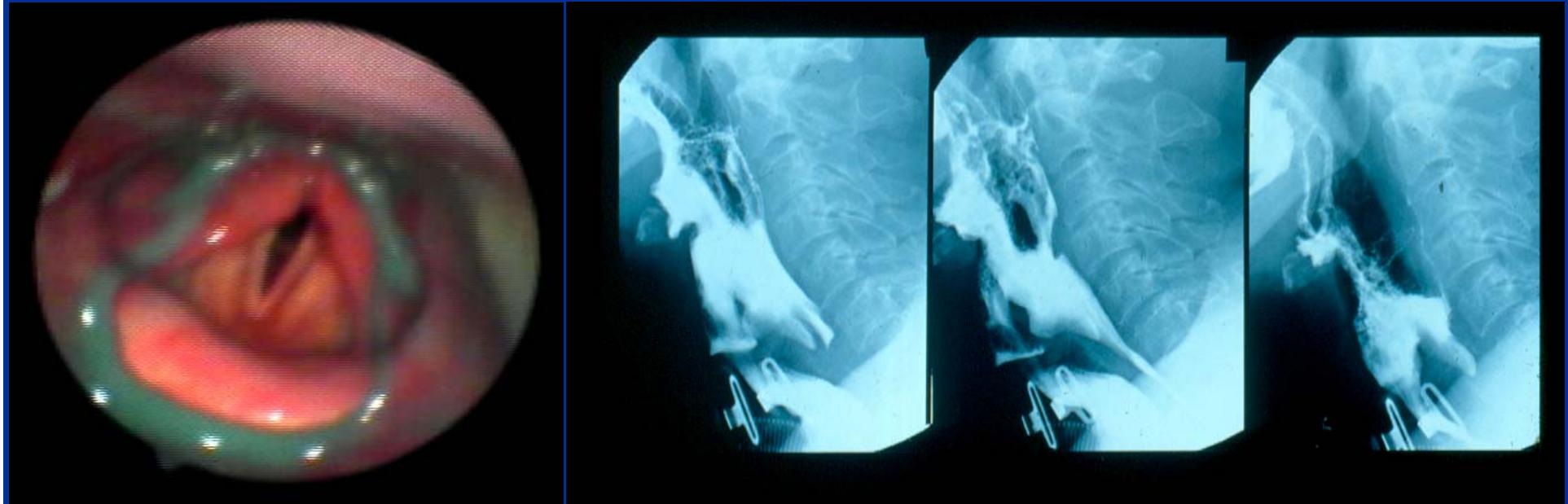


Fig. 1. Schematic of the human cricopharyngeus (CP) muscle and its surrounding structures (lateral view), illustrating the locations and dimensions of the horizontal and oblique compartments in the CP. The horizontal CP (CPh) originates from the posterior edge of the arch of the cricoid cartilage on one side and inserts into the corresponding area on the opposite side. The oblique CP (CPo) originates from the posterolateral aspect of the arch of the cricoid cartilage and inserts into the median raphe (arrow). CC—cricoid cartilage, CT—cricothyroid muscle, IPC—inferior pharyngeal constrictor muscle, T—trachea, TC—thyroid cartilage, UE—upper esophagus.

Koordination des Schluckens (CPGs)



Flexible Laryngoskopie
(Fiberoptic Endoscopic
Evaluation
of Swallowing = FEES)

Videofluoroskopie
(Videofluoroscopic Swallowing
Study = VFSS)

Koordination des Schluckens (CPGs)

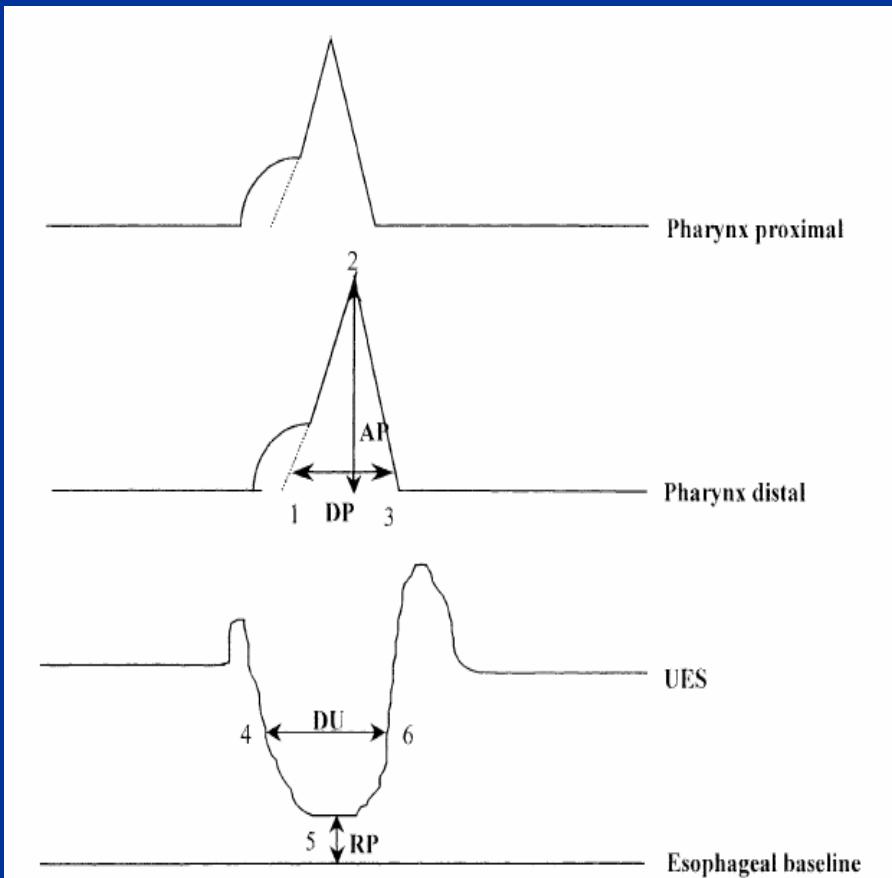


Fig. 1. Schematic of the pharynx contraction and UES relaxation during swallowing. **Pharynx proximal:** manual estimation by extrapolating the pharyngeal clearing contraction to baseline onset. **Pharynx distal:** 1 = start of contraction, 2 = peak of contraction, 3 = end of contraction. **UES:** 4 = start of UESR, 5 = nadir UESR, 6 = end of UESR. AP = amplitude pharyngeal contraction, DP = duration pharyngeal contraction, DU = duration UES relaxation, RP = residual pressure UES relaxation.

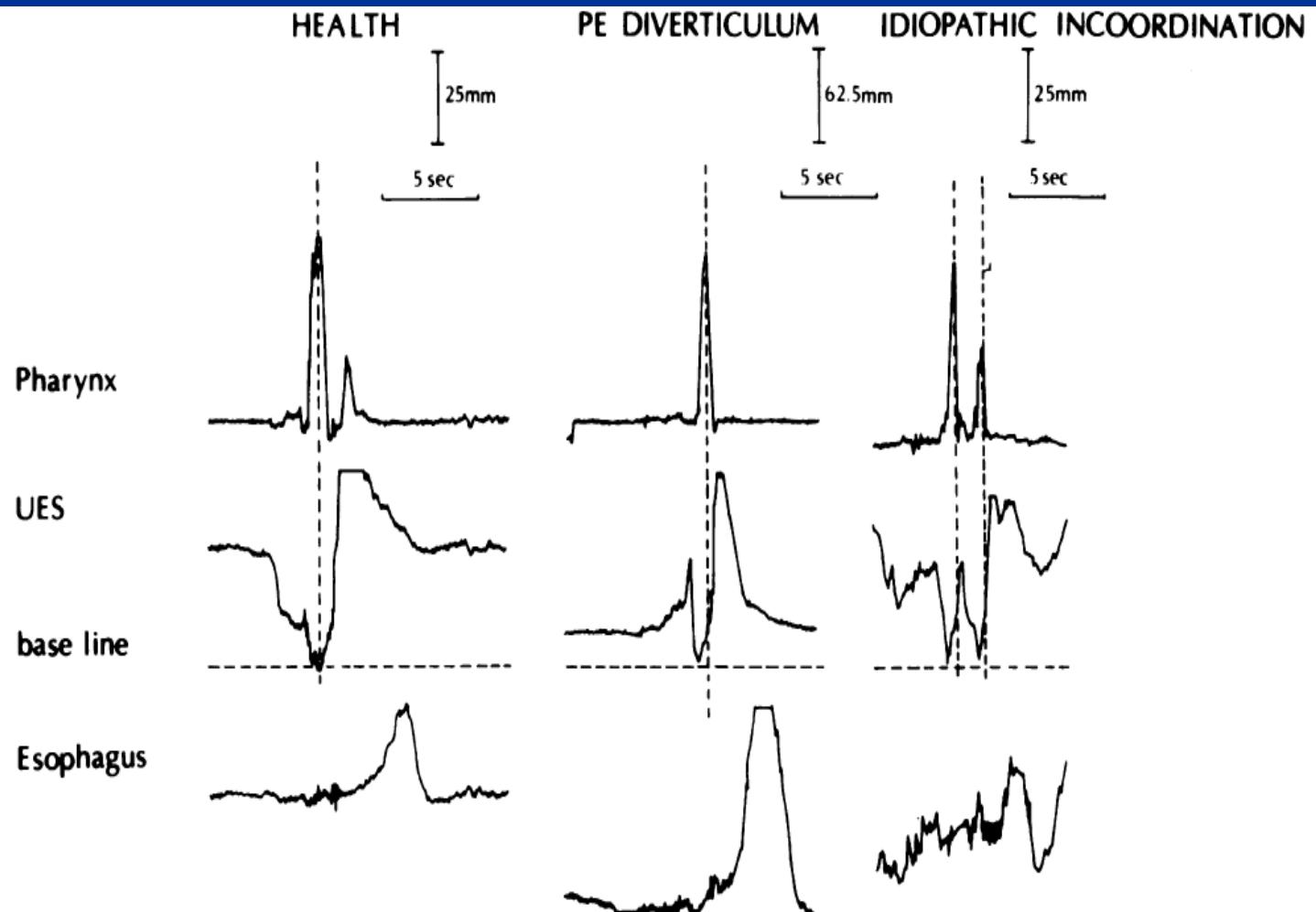
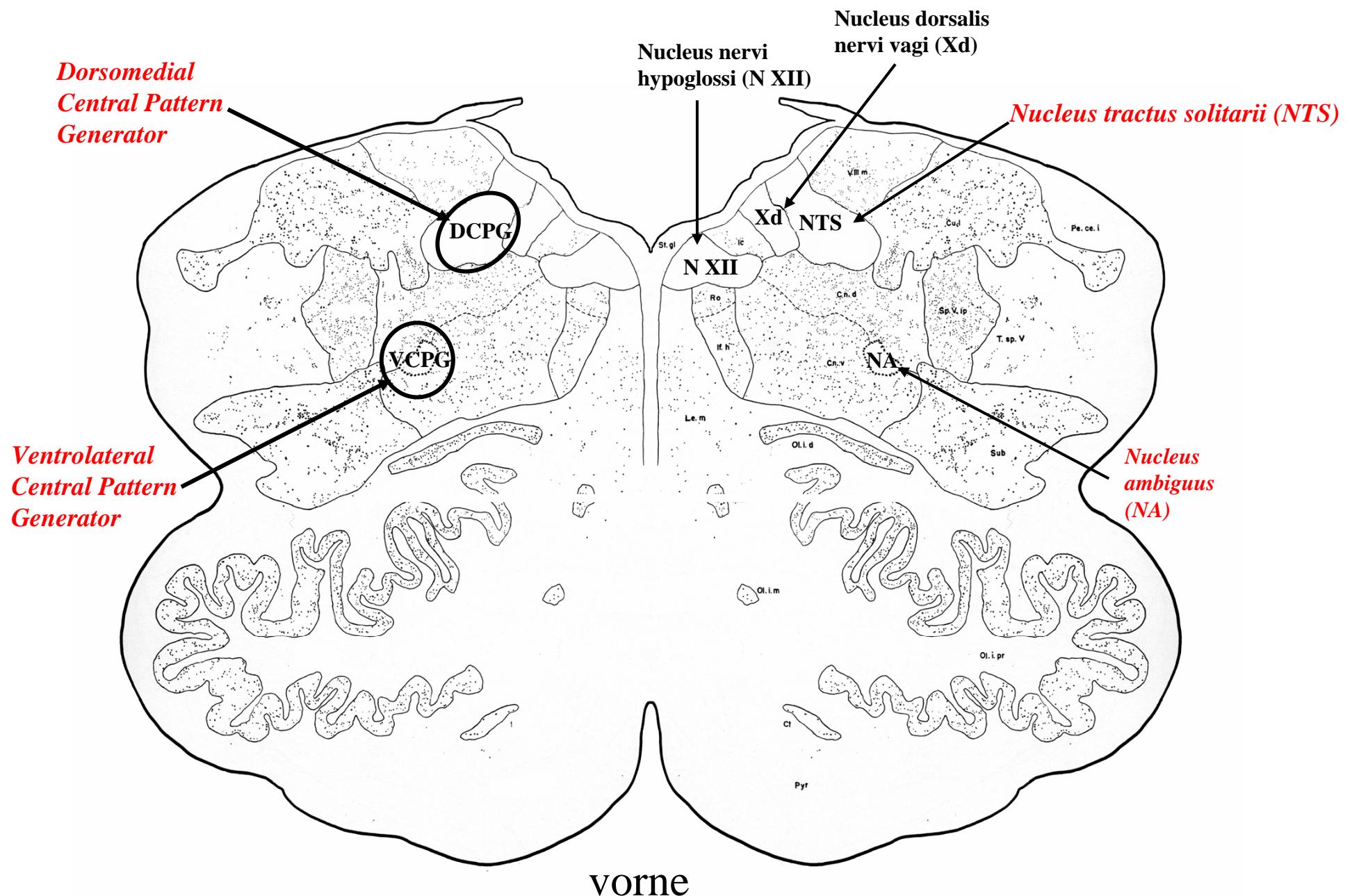


FIG. 5. Degllutitive responses of UES in health (left), pharyngoesophageal diverticulum (middle), and idiopathic incoordination (right). Vertical dotted line is drawn through point of peak pharyngeal contraction. Only in health (left) does it coincide with maximal point of relaxation of UES. (↓ = Swallow.)

Koordination des Schluckens (CPGs)



Koordination
des
Schluckens (CPGs)

Dorsomediale CPGs (Nähe NTS)

enthalten

Generator (Master) Neurons

Planung der räumlich-zeitlichen
Koordination des Schluckablaufs



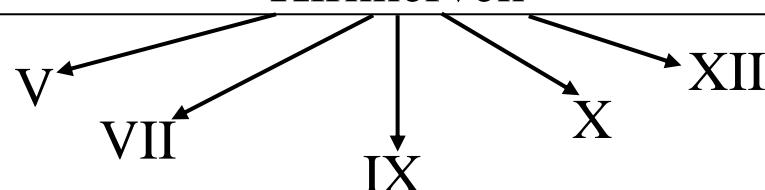
Ventrolaterale CPGs (Nähe NA)

enthalten

Switching Neurons

Weiterleitung des koordinierten
Output auf die Kerne der

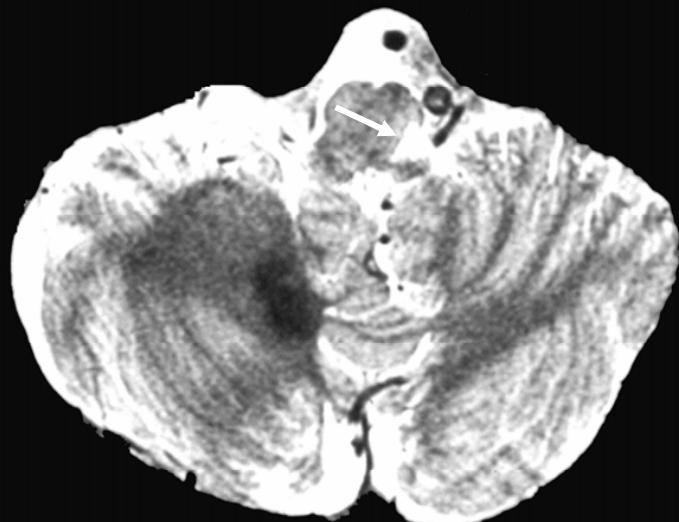
Hirnnerven



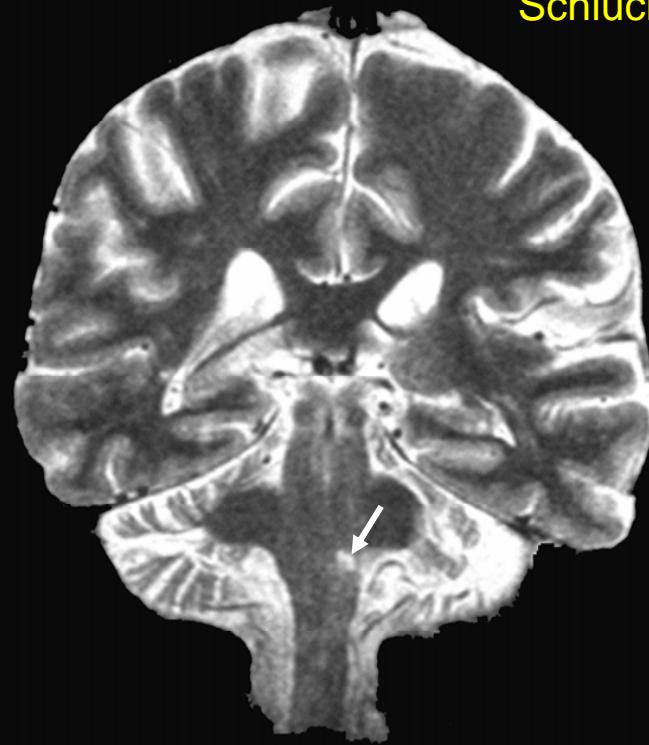
Wallenberg-Syndrom

Koordination
des
Schluckens (CPGs)

A



B



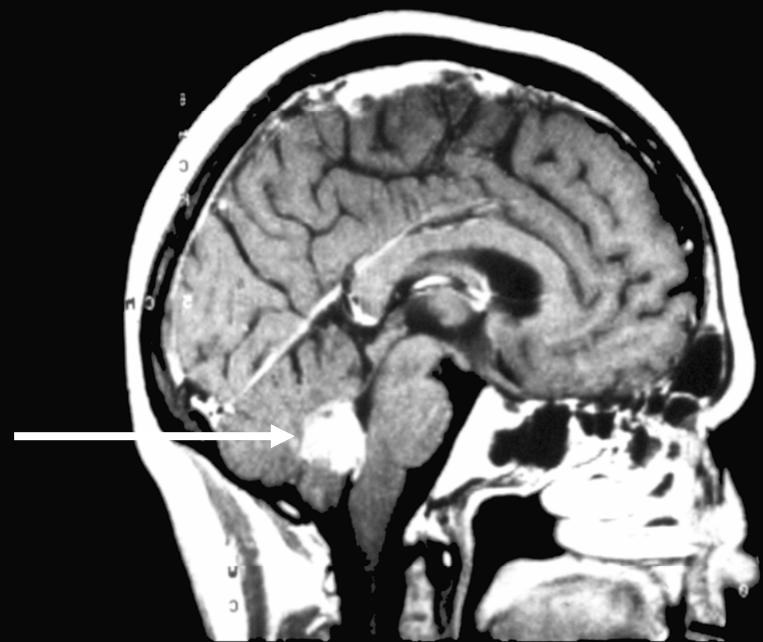
C



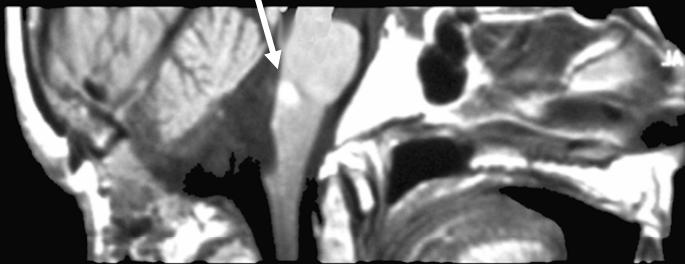
Tumoren des IV. Ventrikels

Koordination
des
Schluckens (CPGs)

A

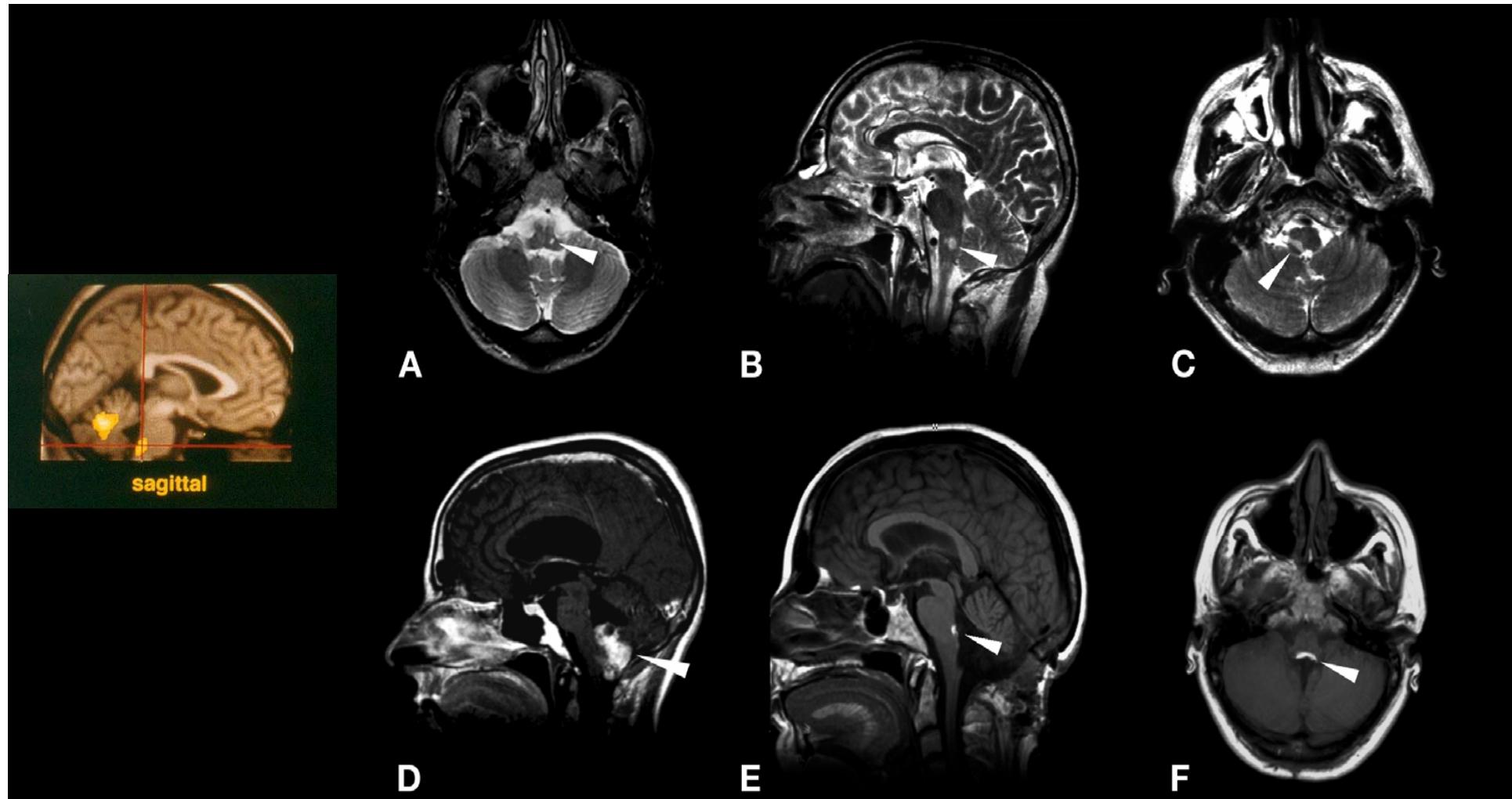


B



C





A=Infarkt bei Avellis-Syndrom; B, C=Infarkt bei Wallenbergsyndrom

D=Ependymom IV. Ventrikel;
E ,F=postoperative Blutung in der hinteren Medulla oblongata

**The localization of central pattern generators for swallowing in humans –
a clinical-anatomical study on patients with unilateral paresis of the vagal nerve,
Avellis' syndrome, Wallenberg's syndrome, posterior fossa tumours and
cerebellar hemorrhage**

M. Prosiegel, R. Höling, M. Heintze, E. Wagner-Sonntag, and K. Wiseman

Neurological Hospital Munich, Munich, Germany

Interpretation. Our results point to the fact, that in humans the dorsomedial central pattern generators (CPGs) for swallowing are situated in the rostral part of the dorsal medulla oblongata near the NTS/surrounding RF (especially Nucleus parvocellularis) and that the dorsomedial CPGs are superior to the ventrolateral CPGs (near the NA/surrounding RF) with regard to their swallowing-relevance.

Koordination des Schluckens (CPGs)

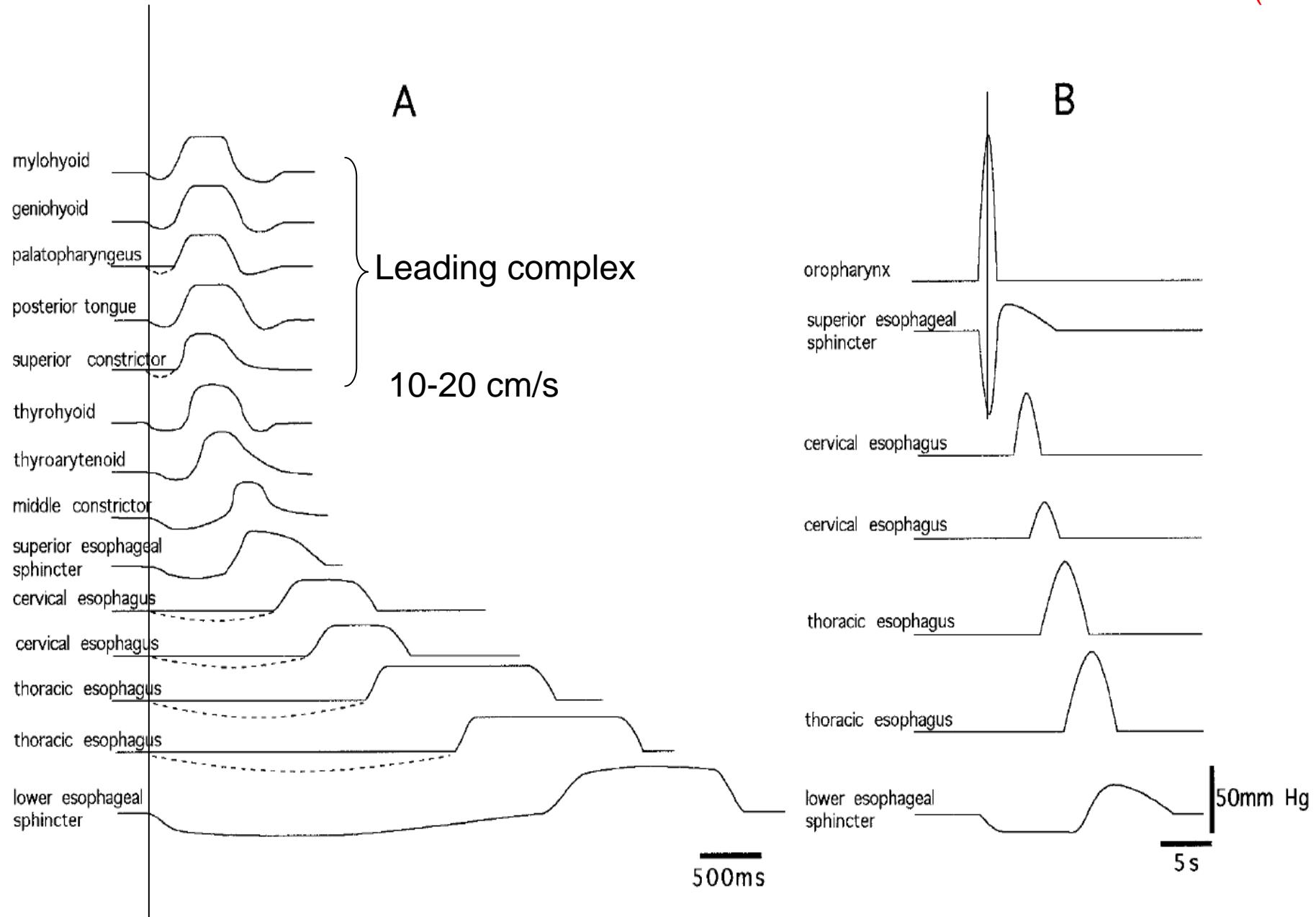
PHYSIOLOGICAL REVIEWS

Vol. 81, No. 2, April 2001

Brain Stem Control of Swallowing: Neuronal Network and Cellular Mechanisms

ANDRÉ JEAN

Koordination des Schluckens (CPGs)



Koordination des Schluckens (CPGs)

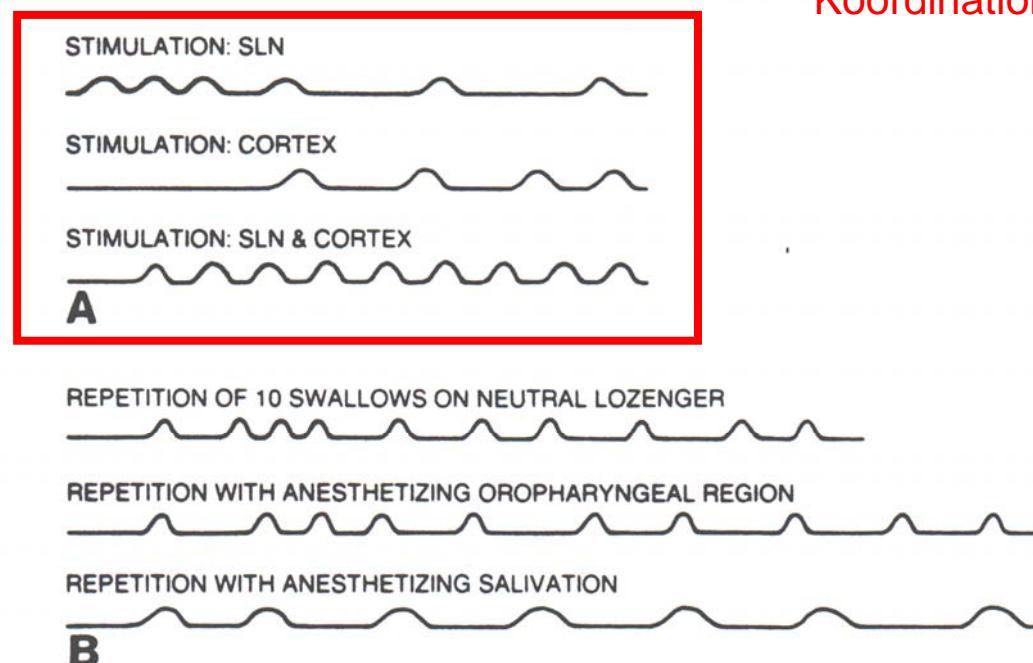
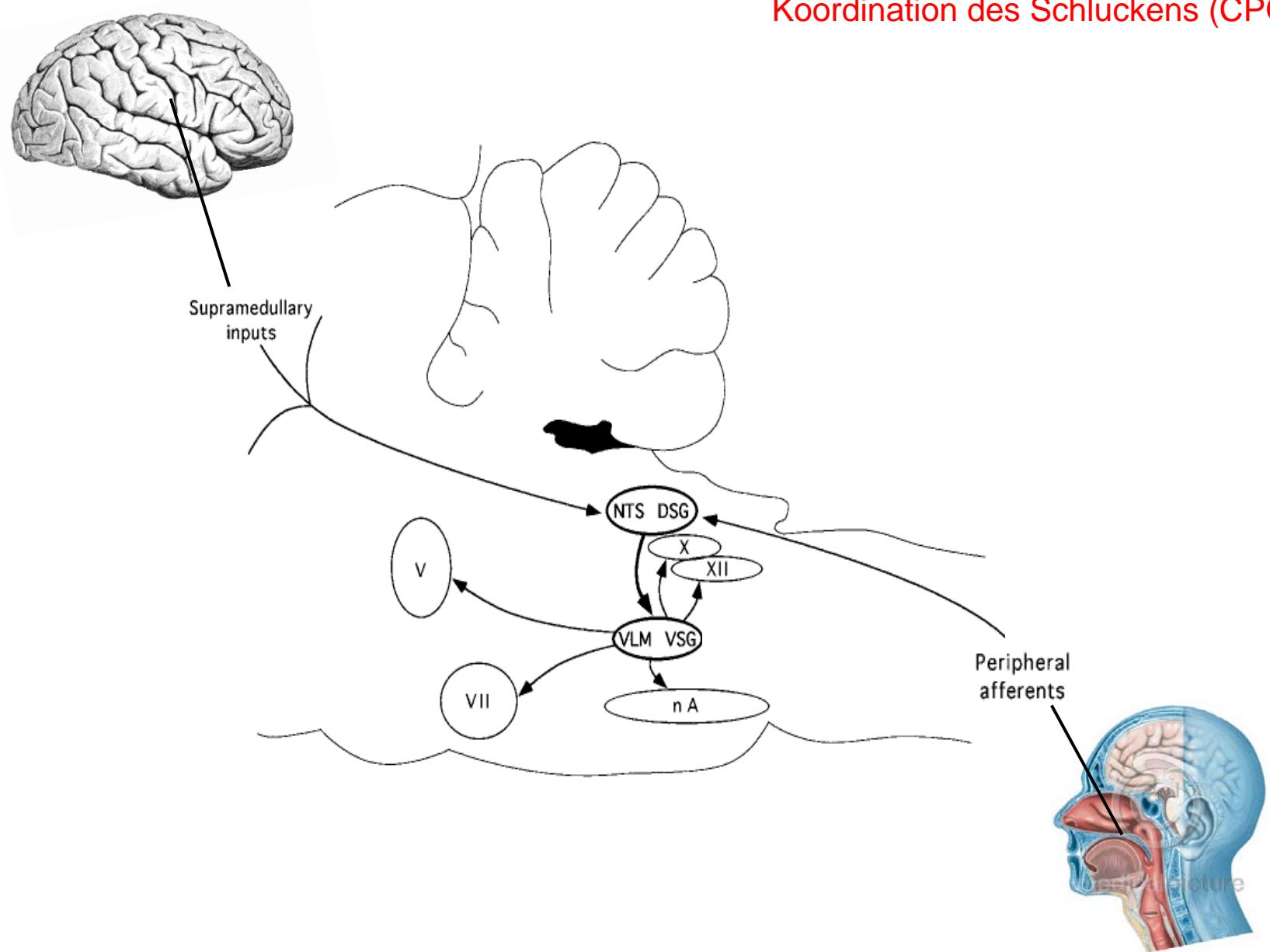


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Koordination des Schluckens (CPGs)



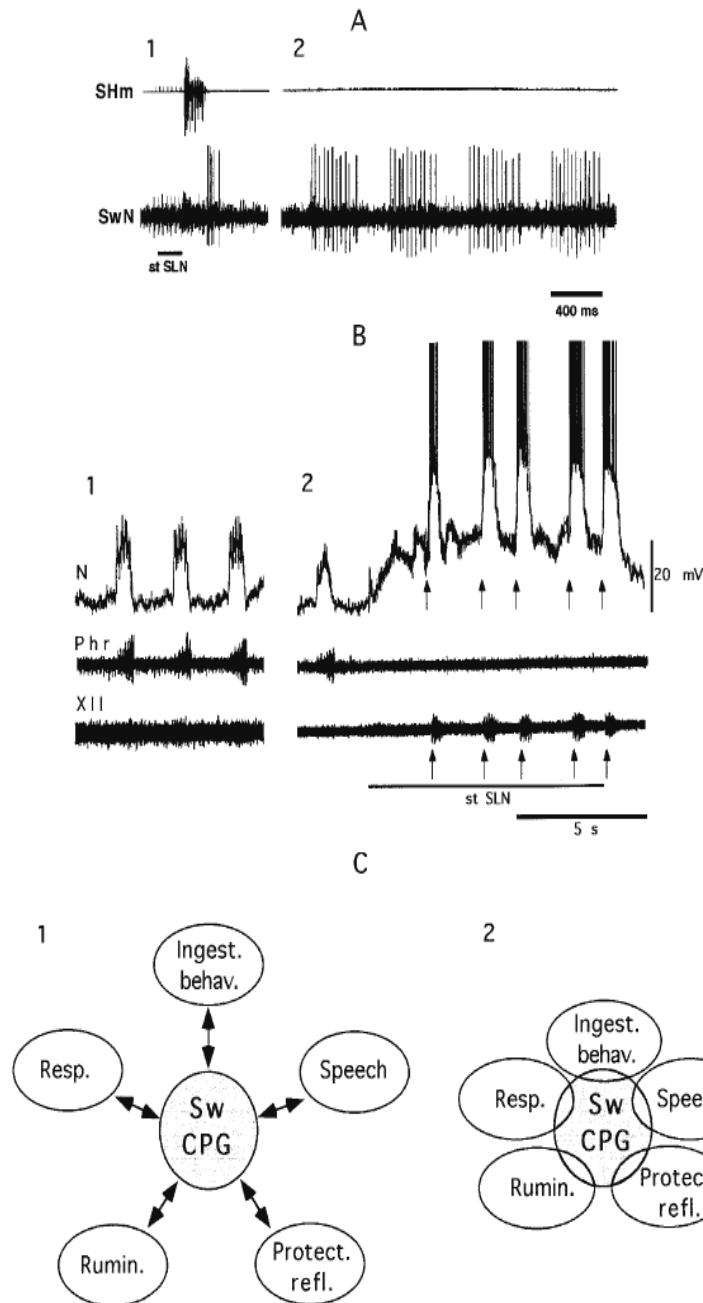


FIG. 10. Multifunctional activities in swallowing neurons and diagram of the possible flexibility of the swallowing CPG. **A:** extracellular recordings on decerebrate rats of the activity of a VSG neuron. In 1, the neuron (SwN) exhibited the typical burst firing pattern during swallowing (SHm: suprahyoid muscles EMG) evoked by SLN stimulation. Without any swallowing motor event, a pattern of rhythmic activities (in 2), associated with the respiratory cycle (not recorded), was elicited by ionophoretic application of kainate, showing the presence of a subliminal respiratory drive. [Adapted from Kessler (172).] **B:** intracellular recordings of the activity of a cat NTS neuron (N). In 1, this neuron exhibited cyclic depolarization of its membrane potential in phase with the inspiratory activity recorded from the phrenic nerve (Phr). In 2, during fictive swallowing (bursting activities recorded in the XII nerve) elicited by stimulating the SLN, the respiratory neuron became a swallowing neuron, since its burst firing activity was in phase with the swallowing. [Adapted from Bianchi and Grélot (22).] **C:** the swallowing CPG may be a dedicated circuit (1) with neurons subserving only this function. This CPG has connections with other CPGs, such as those involved in ingestive behavior (licking, sucking, mastication), speech, protective reflexes (emesis, coughing), rumination, and respiration, to ensure functional interactions under physiological conditions. Alternatively, the swallowing CPG may be a reorganizing circuit (2) consisting of pools of flexible neurons, i.e., neurons which can function in several CPGs involved in the organization of various kinds of motor behavior.

Elektrische Stimulation des Rachens

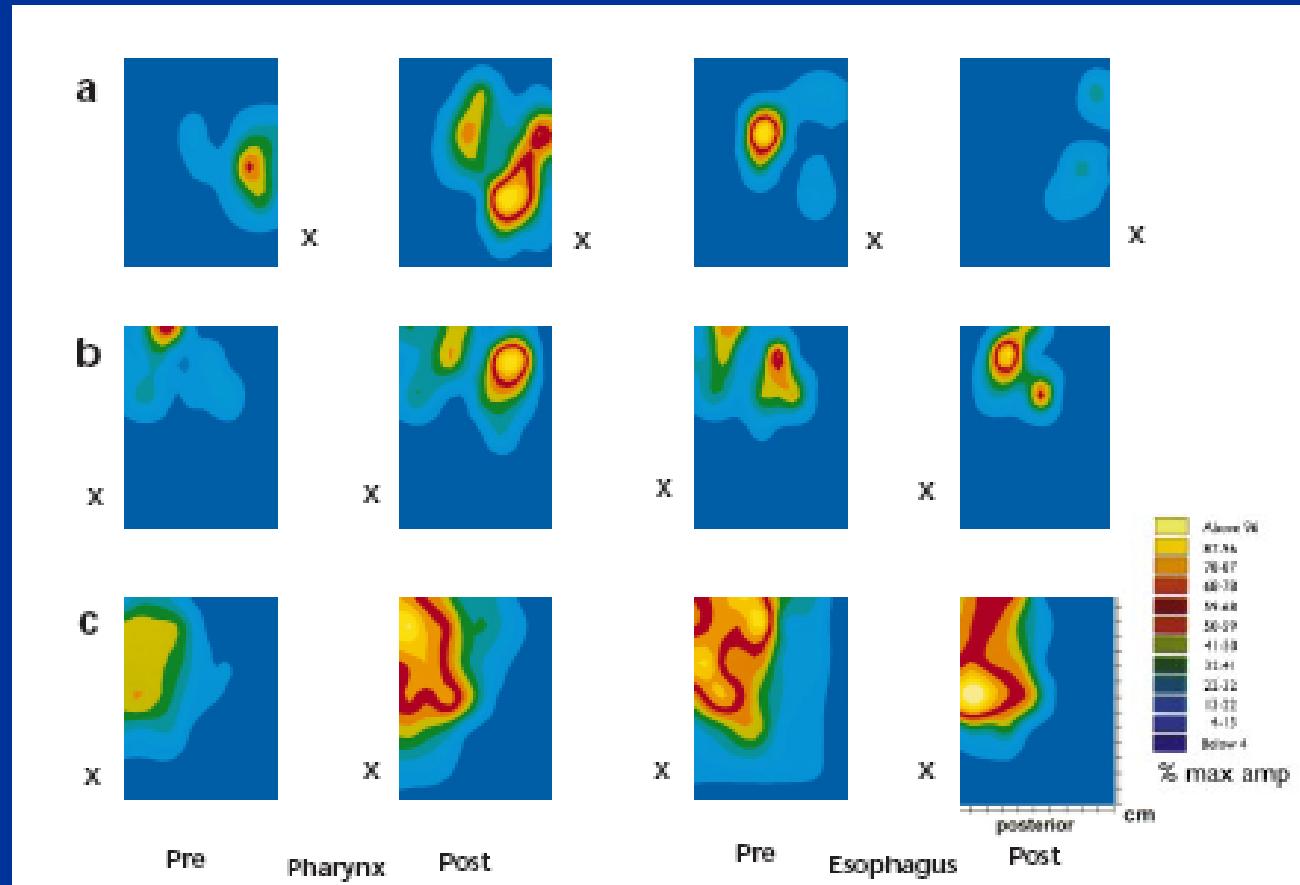


Fig. 3 Changes in swallowing motor representation by pharyngeal stimulation. Topographic maps of the pharynx and esophagus, before and after pharyngeal stimulation, are shown for three subjects (a-c) in one hemisphere (left in (a), right in (b) and (c)). Each map is viewed from above, with the position of the cranial vertex marked X. The scale represents the percentage maximum response amplitude in each subject. In all three subjects shown, the area of pharyngeal representation increases after stimulation, but that of the esophagus decreases, each displaying asymmetric changes in the extent of their representations.

Hamdy S, Rothwell JC, Aziz Q, Singh KD, Thompson DG. Long-term reorganization of human motor cortex driven by short-term sensory stimulation. *Nat Neurosci* 1998;1:64-68

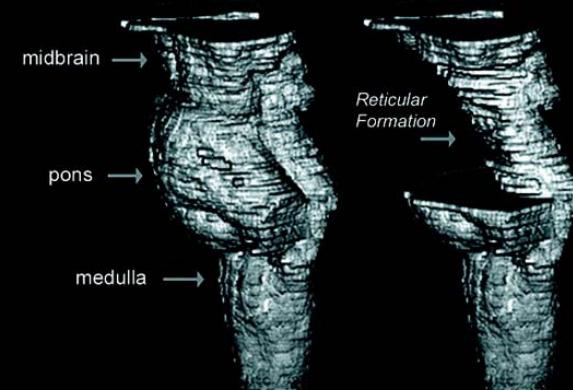
Pharmakologische Beeinflussung ?

- Exzitatorische Aminosäuren (EAA)
 - NMDA-Rezeptoren im Hirnstamm
- Apomorphin
 - Injektion in A. carotis -> Schlucken↑
 - Injektion in A. vertebralis -> Schlucken↓

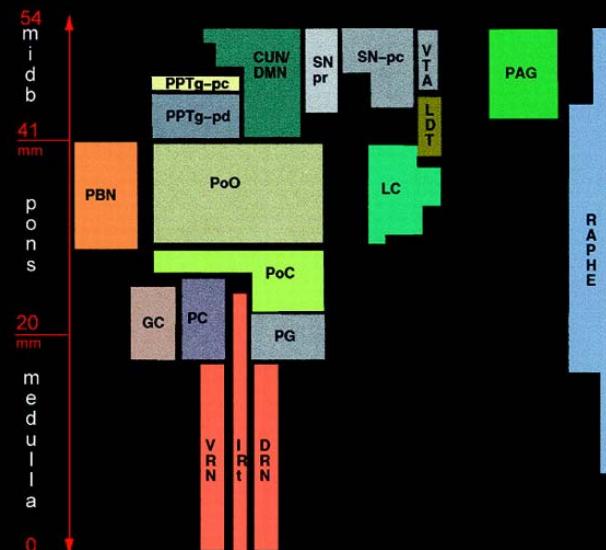
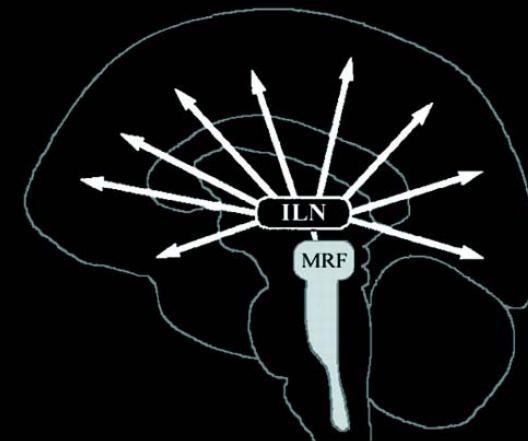
Bedeutung für VS-Patienten

- Sensorische Regulation
 - unspezifisch ?

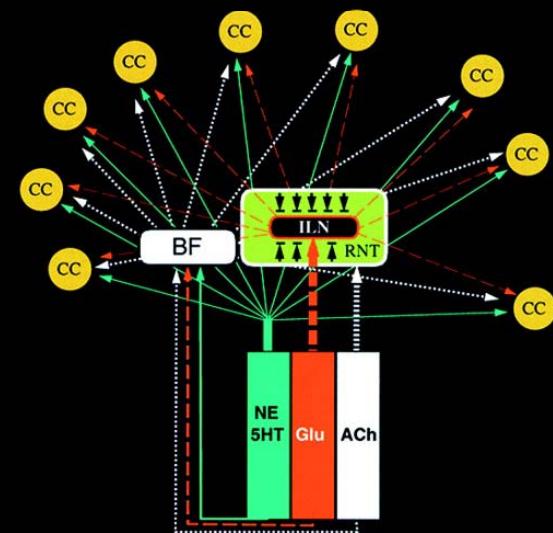
The reticular formation and the ARAS



A

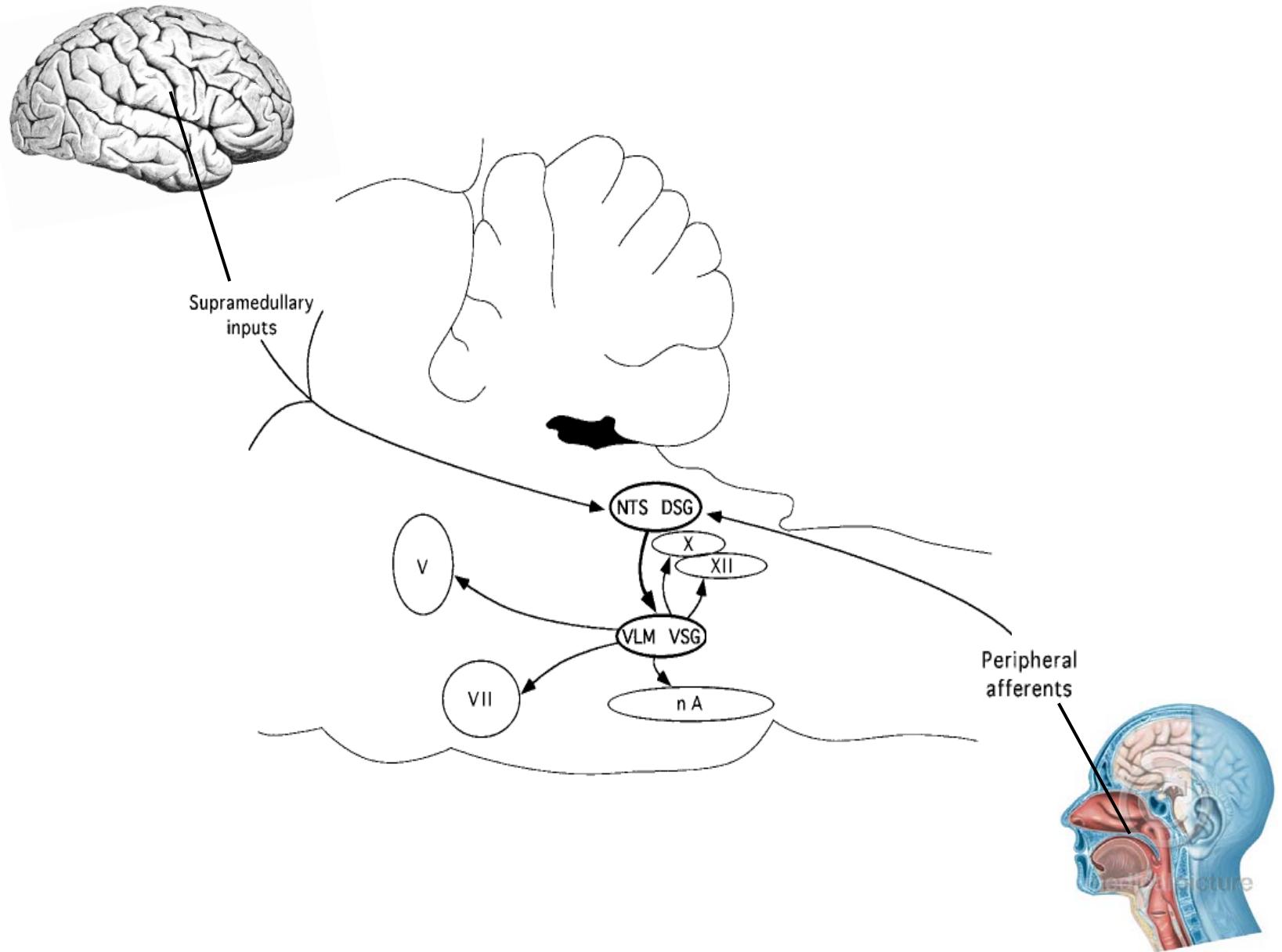


B



Bedeutung für VS-Patienten

- Sensorische Regulation
 - unspezifisch ?
 - Stimulation oro-fazio-pharyngealer Bereiche ?



Bedeutung für VS-Patienten

- Sensorische Regulation
 - unspezifisch ?
 - Stimulation oro-fazio-pharyngealer Bereiche ?
- Kortikale Plastizität
 - elektrische Pharynxstimulation ?

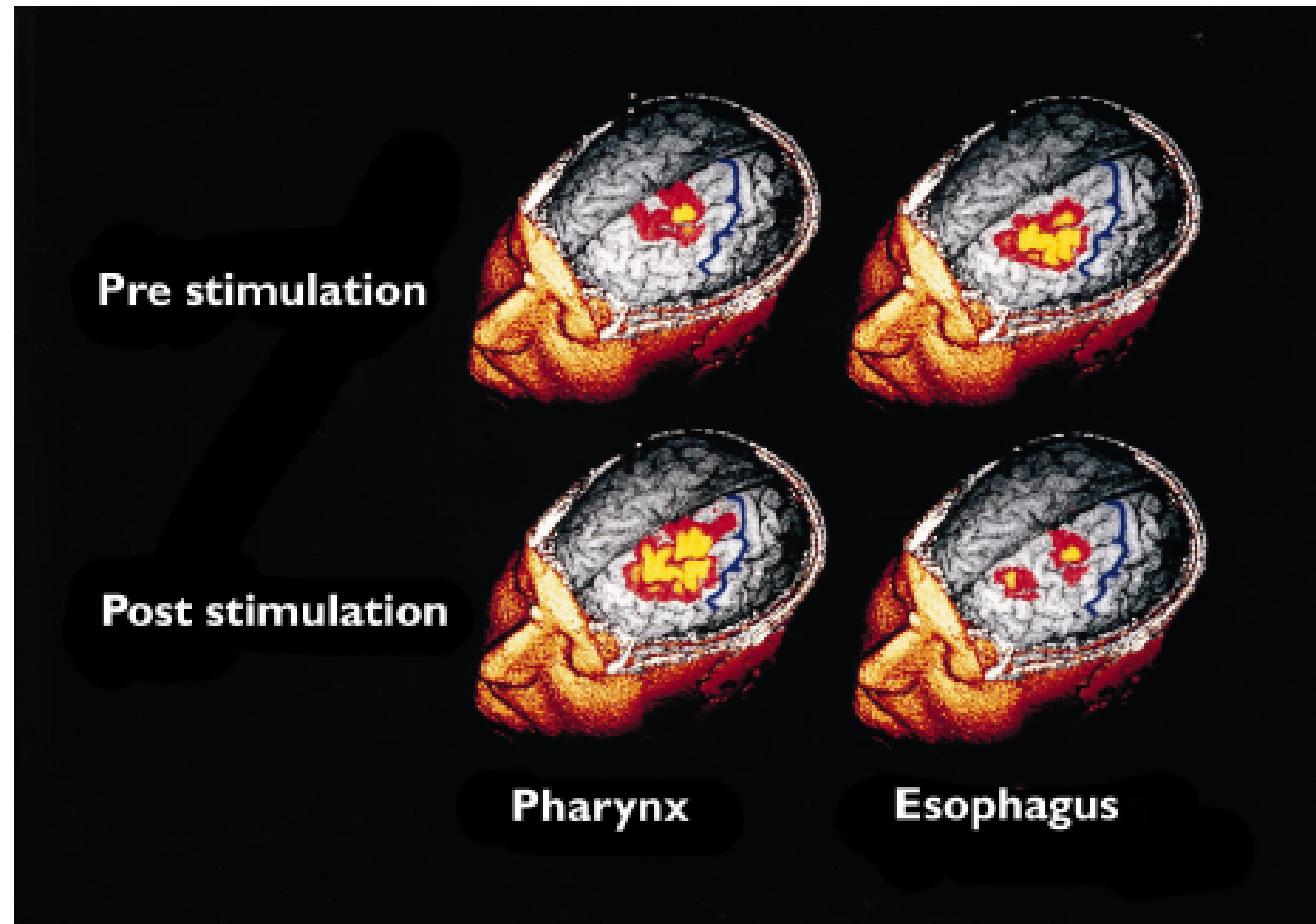
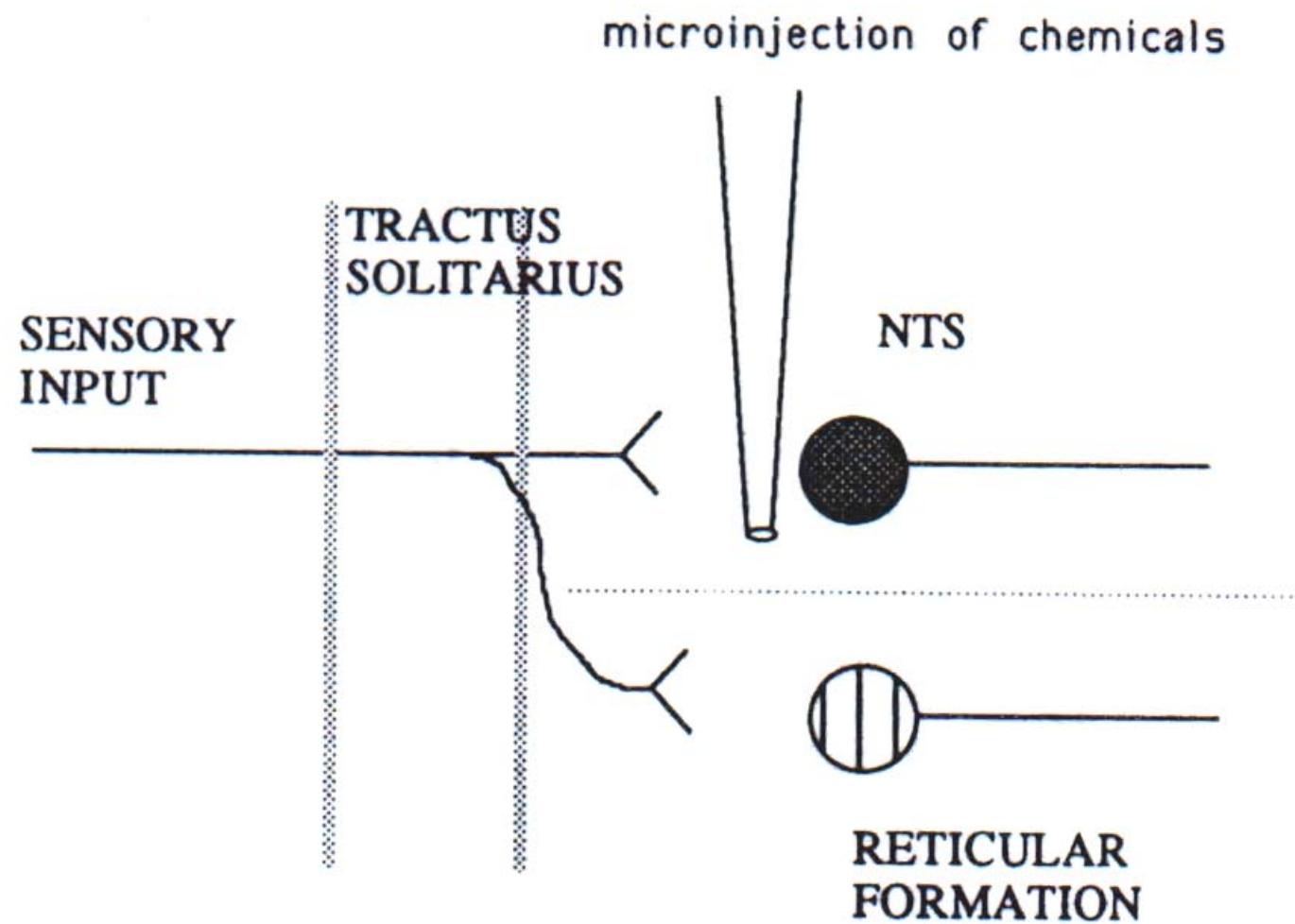


Fig. 4 MRI co-registration of scalp maps. A series of left lateral oblique surface brain MRI images from one representative subject are shown, onto which the topographic data (colored areas, increasing from red to yellow) have been coregistered¹⁹. The central sulcus is indicated in blue. After pharyngeal stimulation, the representation of the pharynx on the anterior aspect of the precentral gyrus and middle and superior frontal gyri expands anterolaterally, whereas that of the esophagus contracts.

Bedeutung für VS-Patienten

- Sensorische Regulation
 - unspezifisch ?
 - Stimulation oro-fazio-pharyngealer Bereiche ?
- Kortikale Plastizität
 - elektrische Pharynxstimulation ?
- Pharmakotherapie
 - spezifisch ?



Bedeutung für VS-Patienten

- Sensorische Regulation
 - unspezifisch ?
 - Stimulation oro-fazio-pharyngealer Bereiche ?
- Kortikale Plastizität
 - elektrische Pharynxstimulation ?
- Pharmakotherapie
 - spezifisch ?
- Schrittmacher in CPGs ?

prosiegel@t-online.de