

Supplementary Figure 5

Explanation of the surgical protocol (revised protocol as designed by D. Müller in Göttingen) and used for procedures conducted in Göttingen and later in Hamburg (in this case stereotactic planning and surgery was performed by D. Müller at the Universityhospital Hamburg-Eppendorf). The six digits in the 'head ventricle formula' represent: width of head (3 vs 6 for the patient vs 'model brain combination,' respectively), length of head (6 vs 6), and height of the head (5 vs 6) as measured with a caliper rule from the ears ('Ohrhöhe'; Fig. 1), width of lateral ventricles (5 vs 5), height of thalamus (5 vs 5) measured 12 mm behind the posterior rim of the anterior commissure, and the length of the third ventricle (6 vs 7). The intended position of the tip of the carrier probe represented recommended values. The z-coordinate (superior-inferior) defined in the a.p. view will deviate from its definition in the lateral view the more the frame is mounted obliquely (roll error) which occurred to some extent despite the use of ear olives. This error was also taken into account when the deviation of the probe from its intended target was determined. Further calculations were based on the actual position of the probe (cf. Suppl. Fig. 7).

Supplementary Figure 6

Surgical protocol for the sites explored by microstimulation (in this example 10) and lesioned (7; surgery was performed by D. Müller, University Hospital Hamburg-Eppendorf). The y-coordinate (laterality) was adjusted according to a formula taking both the width of the third ventricle and the head into account. A 'target' referred to 6/1 indicated the lateral border of the thalamus with the internal capsule 6 mm anterior to the posterior commissure at the first (i.e., 0.5 mm below the intercommissural plane) of three levels used to determine this border. The y-coordinate (laterality) of this point in the atlas (19.1 mm) was modified according the formula to 19.5 mm. It was intended to explore a site 9 mm medial to this point

('Modifikation') and coordinates were determined. These were used for calculations of 'S', 'M' and φ (cf. Suppl. Fig. 7) representing the values for advancement/retraction of the probe, the distance the electrode needs to be lowered and the angle for its extrusion, respectively. The last four columns were used to document effects of microstimulation and the settings for lesioning.

Supplementary Figure 7

Protocol used for calculation of 'S', 'M' and φ representing the values for advancement/retraction of the probe, the distance the electrode needs to be lowered and the angle for its extrusion, respectively (cf. Suppl. Fig. 6). The actual angle α of the probe was 29°. The next best spreadsheet was the one available for 30° which practically made no difference (cf. Suppl. Fig. 10). Calculations were established by W. Sendler and the protocol developed by W. Sendler and D. Müller.

Supplementary Figure 8

Sheet of Orthner's booklet with tables. Coordinates represent the lateral border (y-coordinate) of the left (links) and right (rechts) thalamus determined at three z (superior-inferior) levels in coronal slices from 2 mm posterior to 16 mm anterior to the posterior commissure. StB, width of forehead; KU, head circumference; VB, width of third ventricle; KB, width of head; OH, height of head from external auditory canal; KL, length of head; SVB, width of lateral ventricles; TH, height of thalamus; VL, length of third ventricle.

Supplementary Figure 9

Calibration curve for a string electrode. The result from 1979 (shown in A) was confirmed in 1982. However, when surgery was performed with this probe in 1975 values

must have differed according to the protocol shown in Suppl. Fig. 7. Corresponding values for M, l, and k can be read from the table.

Supplementary Figure 10

Spreadsheets used to determine values for A – H according to angulation of the trajectory (probe angles α and β). These were used for calculations as detailed in Suppl. Fig. 7. The probe from Suppl. Fig. 7 revealed actual angles of $\alpha = -29^\circ$ and $\beta = -13^\circ$. The next best values were those given for $\alpha = -30^\circ$ and $\beta = -12^\circ$ (this difference was of no practical relevance).

Fig. 5 (Suppl.)

Stereotaktische Maßwerte

Names: Operation: Kalauot-1 Datum: 9.12.75

Kopfhöhe: 14.6 Ohrhöhe: 13.7 Kopflänge: 18.9

Seitenfaktor: Längsfaktor: Kopf-Ventrikel-Formel: 365556

Ventrikellänge: 22.9 Ventrikelbreite: 10.5 Sonde Nr.1: 36

Thalamushöhe: 14.7 Seitenventrikelbreite: 37.6 Richtung am: 17.7.73

Modelkörperkombination: ne Kopf-Ventrikel-Formel: 666552

3. p. Durchschneidung: 55.7

Angestr., Sondenzirkelpunkt: $x = -15.0$ $y = -7.5$ $z = 2.0$ $\alpha = -30^\circ$ $\beta = -13^\circ$

Winkel der Hünebene zur Ringebene auf dem Seitenbild: 8°

Winkel der Hünebene zur Ringebene auf dem Längsbild: 3°

Die Gehirnmittellinie liegt in Eingriffshöhe mm 1/2 von der Ringachse

Der angezielte Zielpunkt liegt 22.7 mm vor / hinter

6.0 mm links / rechts

(nach dem Seitenbild) 43.5 mm über

" " Längsbild 43.6 mm über der Ringmitte

Differenz (d) = -0.1 mm

Abweichungen in Richtung

	x	y	z	mittl. z-Abweichung
Längsbild	<u>X</u>	<u>0.4</u>	<u>-0.2</u>	} <u>0.2</u>
Seitenbild	<u>0</u>	<u>X</u>	<u>-1.2</u>	
Differenz d _z			<u>-0.1</u>	
Korrigierte z-Abweichung Seitenbild			<u>-1.3</u>	

Sonden-Zielpunkt

	x	y	z
angestrebt	<u>-15.0</u>	<u>-7.5</u>	<u>2.0</u>
Abweichung	<u>0</u>	<u>0.4</u>	<u>-0.8</u>
erreicht	<u>-15.0</u>	<u>-7.1</u>	<u>1.2</u>

erreicht $\alpha =$ -24°

" $\beta =$ -13°

Annotations:

- Cranial measurements
- Magnification was constant in Hamburg and compensated by customized ruler
- Ventricle measurement incl. width of 3rd ventr.
- 'Model brain combination' chosen (ne)
- Angle between brain and frame (tilt and roll)
- Intended position of tip of probe (stx coord. as determined from ventriculography)
- Deviation of actual position of probe from intended position; the deviation in lateral projection (-1.2mm) is further corrected for difference between lateral and a.p. X-rays because of roll (0.1mm)
- 'Head-ventricle-formula' of patient
- No. of side electrode and date of calibration
- 'Head ventricle formula' of 'model brain combination'
- Intended position of tip of carrier probe relative to PC
- Position of MCP
- Deviation of z-coordinates between lateral and a.p. X-rays
- Calculation of actual coordinates of probe
- Actual angles of probe

Fig. 6 (Suppl.)

Op. 161 OPERATIONSprotokoll

Name:		Datum: 9.12.75		Blatt: 1	
erreichter Zielpunkt mit Sonde Nr. 36		x	y	z	Operation:
cc	B	daher Vektoren		a	b
		c	Kalkulation		

Faktoren der y-Modifikation (MGK u_e) $f_1 = \frac{18,5 - 5,2 - 4,6}{2} = 2,3$ $f_2 = \frac{18,5}{260} = 0,071$

6/1 $17,8 + 2,3 = 18,1$ $f_2 = 18,1$

Modification of lateral (y) coordinate according to:

$$y_{(E)} = (y_{MGK} + f_1) \times f_2$$

'Model brain combination' chosen and factors for modification of y coordinate:

- $f_1 = (VB_{pat} - VB_{MGK}) / 2$
- $f_2 = KB_{pat} / KB_{MGK}$

Nr.	S	M	φ	Ziel	Modifikation	x	y	z	Z	P	sec	mA		
1.	04	36	147	03°	6/1	0	9	0	6,0	-9,0	0,4	11	30	46

Brain-based coordinates after modification of

- y coordinate based on f_1 and f_2
- Surgeon's definition of target (i.e., move 9 mm medially)

=> These coordinates (6.0, -9.0, -0.4) were used to calculate M, S and φ (cf. Suppl. Fig. 7)

Columns Z, P, sec, mA were used to document the effects of microstimulation and parameters used for lesion generation

Fig. 7 (Suppl.)

Actual angles of carrier probe

x_S, y_S, z_S : actual position of probe
 x_E, y_E, z_E : intended position of
 extruded tip of side electrode (in this
 case -4, -10, 3.3)

Values for A – H were read from
 spreadsheets generated for different
 α and β angles (Fig. 10).
 This generates the rotation angle φ
 for the dial.

Dependent on \cos of φ follow
 instructions in left or right column and
 enter values in respective column.
 This generates I which is used to
 read M (mark) from the table with last
 calibration of the used electrode (Fig.
 9B). M is the distance the electrode
 had to be lowered from the probe.

t (3.09) is calculated as described.
 k (7.6) is read from the table with the
 last calibration of electrode (Fig. 9B).
 S (-4.5) indicates the direction and
 distance the carrier probe has to
 be lowered or advanced.

Name:

Operation:

Datum: 9.12.75

Blatt: 3

$\alpha = 29^\circ$ $\beta = 13^\circ$									
x_E	1	-4.0							
y_E	2	-10.0							
ΔX (1)-(2)	3	14.0							
y_S	4	-10.0							
z_S	5	-7.1							
ΔY (4)-(5)	6	-2.9							
z_E	7	3.3							
ΔZ (7)-(8)	8	1.2							
ΔZ (7)-(8)	9	2.2							
D=0.983	D·ΔY	10	2.85						
E=0.209	E·ΔZ	11	0.84						
	Q (10)+(11)	12	2.41						
F=0.866	F·ΔX	13	9.53						
G=0.5	G·ΔZ	14	1.05						
	R (13)+(14)	15	10.58						
	O/R (15):(16)	16	0.228						
	H	17	0.005						
	I·y (17):(18)	18	0.333						
	φ	19	1.98						
$ \cos \varphi > 0.7$		20,7	< 0.7	20,7	< 0.7	20,7	< 0.7	20,7	< 0.7
H·R (16):(17)		20							
Q (12)		21							
R (15)		22	10.58						
-cos φ		23	0.949						
-sin φ		24	0.333						
L (23):(24)		25	11.1						
M		26	13.4						
A=0.492		27	5.41						
B=0.181		28	2.32						
C=0.852		29	3.09						
t (29)+(30)		30	7.6						
k		31	4.5						
S (31)-(32)		32	-4.5						
Kontrolle: D·L·sin φ		33	5.41						
B·t		34	0.53						
(33)+(34)		35	2.90						
Δy		36							
Null (36)-(37)		37							

#10

Each column represents
 calculations for one target to
 be explored by stimulation
 and possibly lesioning.
 In this patient 10 targets were
 explored and 7 lesions were
 made with an insulated side
 electrode with a bare tip of 3
 mm.

Calculations performed for
 control purposes: result must
 equal Δy

Fig. 8 (Suppl.)

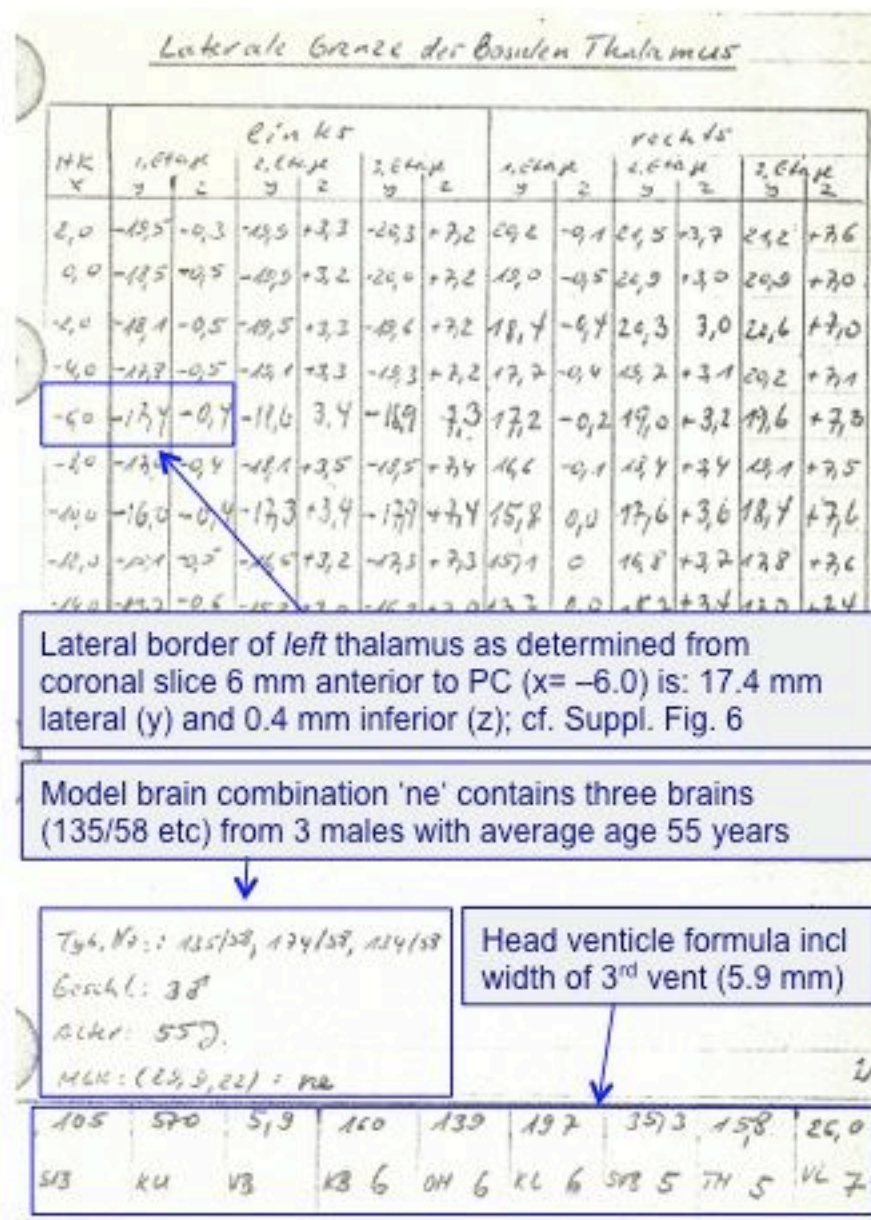


Fig. 9 (Suppl.)

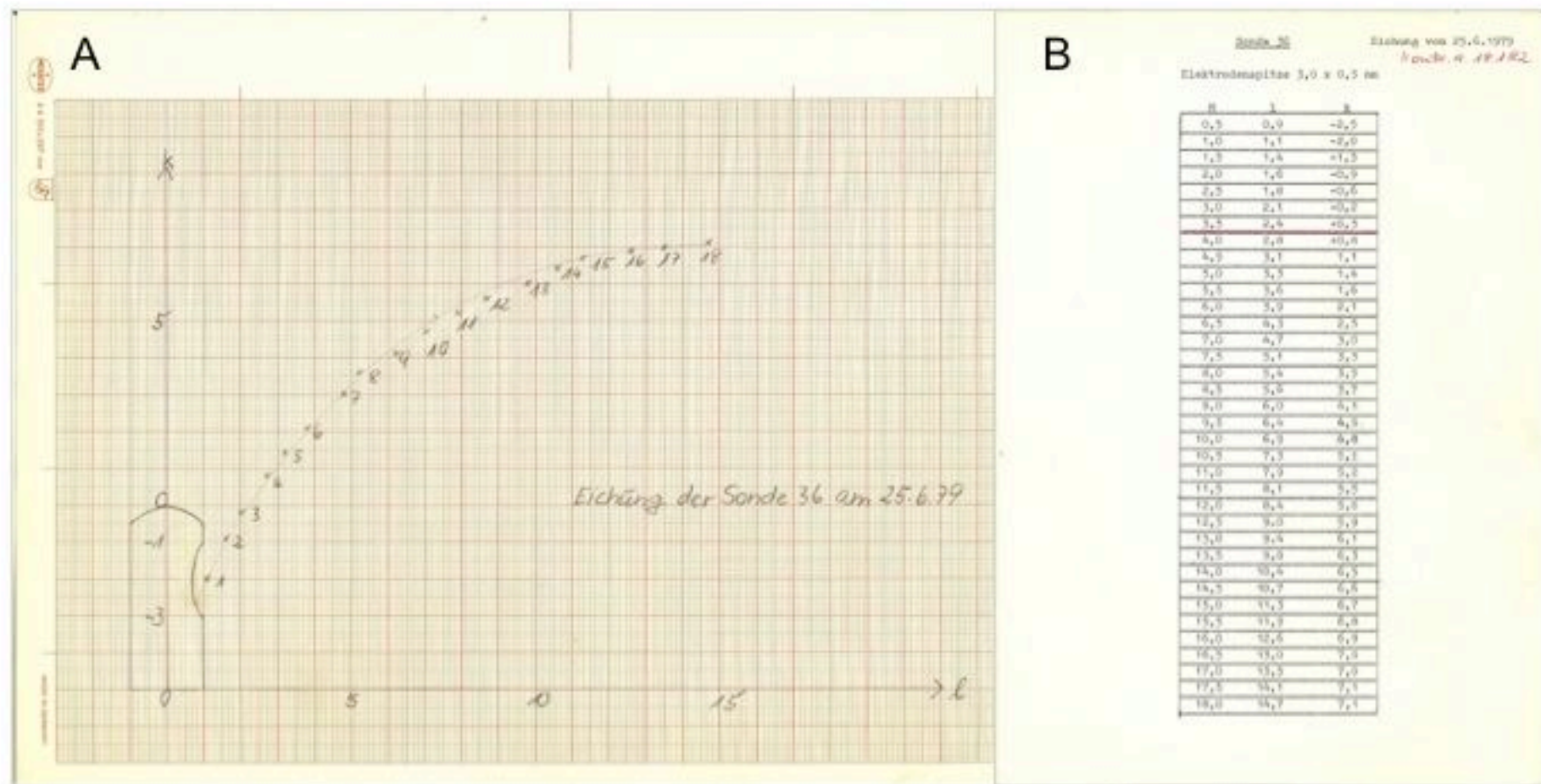


Fig. 10 (Suppl.)

ALPHA = -30	BETA	A	B	C	D	E	F	G	H
-57	0.300	0.800	-0.520	-0.600	-0.924	0.866	0.500	0.462	
-54	0.321	0.766	-0.557	-0.643	-0.885	0.866	0.500	0.442	
-51	0.341	0.730	-0.592	-0.683	-0.843	0.866	0.500	0.422	
-48	0.360	0.693	-0.624	-0.721	-0.800	0.866	0.500	0.400	
-45	0.378	0.655	-0.655	-0.756	-0.756	0.866	0.500	0.378	
-42	0.394	0.615	-0.683	-0.789	-0.710	0.866	0.500	0.355	
-39	0.409	0.574	-0.709	-0.819	-0.663	0.866	0.500	0.331	
-36	0.423	0.533	-0.733	-0.846	-0.615	0.866	0.500	0.307	
-33	0.436	0.490	-0.755	-0.872	-0.566	0.866	0.500	0.283	
-30	0.447	0.447	-0.775	-0.894	-0.516	0.866	0.500	0.258	
-27	0.457	0.404	-0.792	-0.915	-0.466	0.866	0.500	0.233	
-24	0.467	0.360	-0.808	-0.933	-0.415	0.866	0.500	0.208	
-21	0.474	0.315	-0.822	-0.949	-0.364	0.866	0.500	0.182	
-18	0.481	0.271	-0.834	-0.963	-0.313	0.866	0.500	0.156	
-15	0.487	0.226	-0.844	-0.974	-0.261	0.866	0.500	0.131	
-12	0.492	0.181	-0.852	-0.983	-0.209	0.866	0.500	0.105	
-9	0.495	0.136	-0.858	-0.991	-0.157	0.866	0.500	0.078	
-6	0.498	0.091	-0.862	-0.996	-0.105	0.866	0.500	0.052	
-3	0.499	0.045	-0.865	-0.999	-0.052	0.866	0.500	0.026	
0	0.500	0.000	-0.866	-1.000	0.000	0.866	0.500	0.000	
3	0.499	-0.045	-0.865	-0.999	0.052	0.866	0.500	-0.026	
6	0.498	-0.091	-0.862	-0.996	0.105	0.866	0.500	-0.052	
9	0.495	-0.136	-0.858	-0.991	0.157	0.866	0.500	-0.078	
12	0.492	-0.181	-0.852	-0.983	0.209	0.866	0.500	-0.105	
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