

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. 6 (Suppl.)

Op. 161 OPERATIONSprotokoll

Name: _____ Datum: 9.12.75 Blatt: 1

erreichter Zielpunkt mit Sonde Nr. 36 i x y z Operation:

cc B daher Vektoren : a b c *Kalmanstrukt.*

Faktoren der y-Modifikation (MGK u_e): $f_1 = \frac{18,5 - 5,2 - 4,6}{2} = 2,3$ $f_2 = \frac{19,6}{20} = 0,97$

$6,1 \cdot 17,8 + 2,3 = 11,7 - f_2 = 18,0$ $17,8$

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	Prof	M	φ	Ziel	Modifikation	x	y	z	Z	P	sec	mA
1.	04	36	14	20°	6/1	0 9 0	6,0	-9,0	0,4	11°	30	46	

S, adjustment of carrier probe
 Prof, absolute position of probe at start
 M, distance the electrode has to be lowered from the probe
 φ , angle of dial
 Ziel, coordinates from 'model brain combination' for anatomical reference structure (cf. Suppl. Fig. 8)
 Modifikation, surgeons definition of target, i.e. intended position of electrode in patient (e.g. x mm medial to internal capsule)

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

11° 30 52

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: Thalamicotomy L Blatt: 3
 Datum: 9.12.75

$\alpha = 29^\circ$									
$\beta = 13^\circ$									
x_z	1	-4.0							
x_S	2	-15.0							
ΔX	3	11.0							
y_z	4	-10.0							
y_S	5	-7.1							
ΔY	6	-2.9							
z_z	7	3.3							
z_S	8	1.2							
ΔZ	9	2.1							
D=0.983	D· ΔY	10	2.85						
E=0.209	E· ΔZ	11	0.44						
	Q	12	2.41						
F=0.866	F· ΔX	13	9.53						
G=0.5	G· ΔZ	14	1.05						
	R	15	10.58						
	O/R	16	0.228						
	H	17	0.105						
	Igy	18	0.333						
	φ	19	1.98						
	Icos φ / 2.07	20	2.07						
	Icos φ / 4.07	21	4.07						
	H·R	22	10.58						
	Q	23	0.949						
	R	24	11.1						
	-cos φ	25	11.4						
	L	26	13.4						
	M	27							
A=0.492	A· ΔX	28	5.41						
B=0.181	B· ΔY	29	0.53						
C=0.852	C· ΔZ	30	1.79						
	t	31	3.09						
	k	32	7.6						
	S	33	-4.5						
Kontrol	D·L·sin φ	34	5.165						
	B·t	35	0.539						
	ΔY	36	-2.9						
	Null	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.)

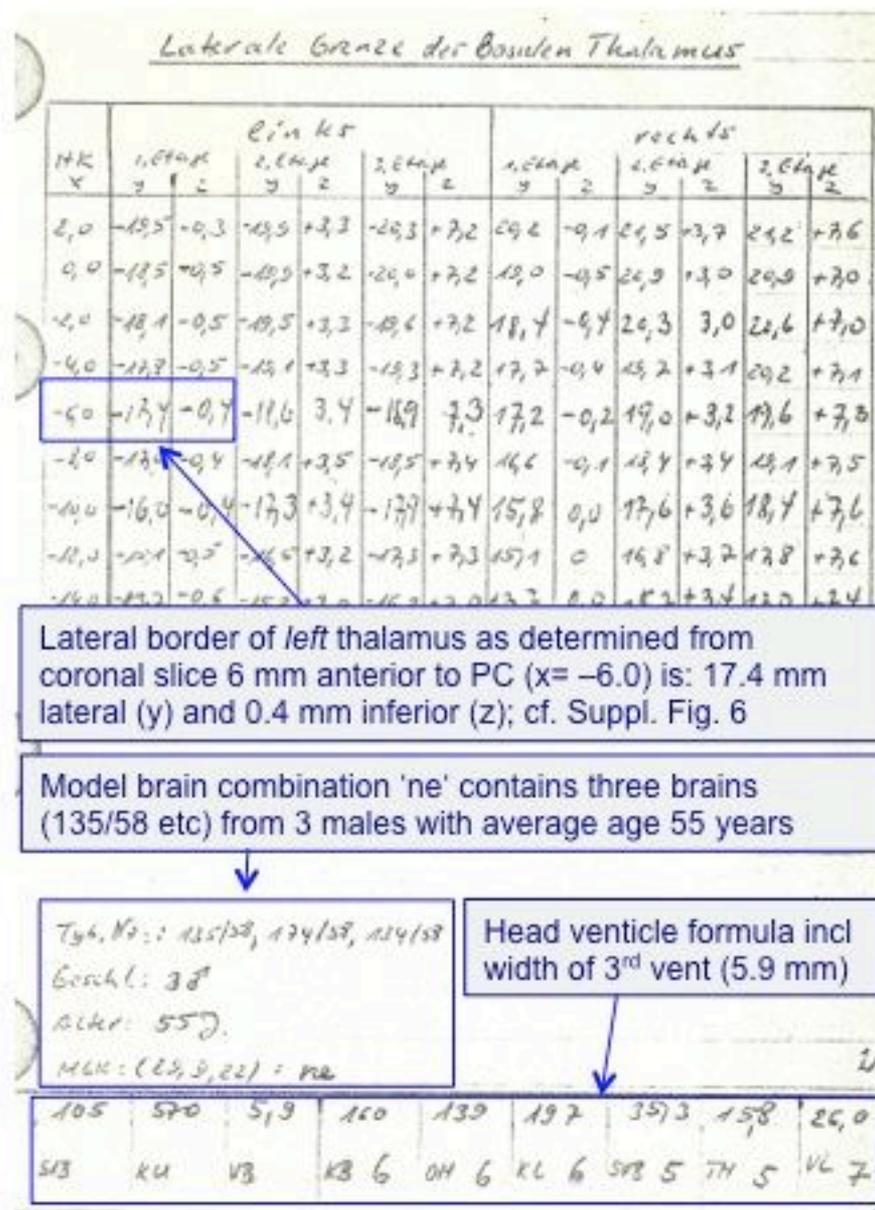


Fig. 9 (Suppl.)

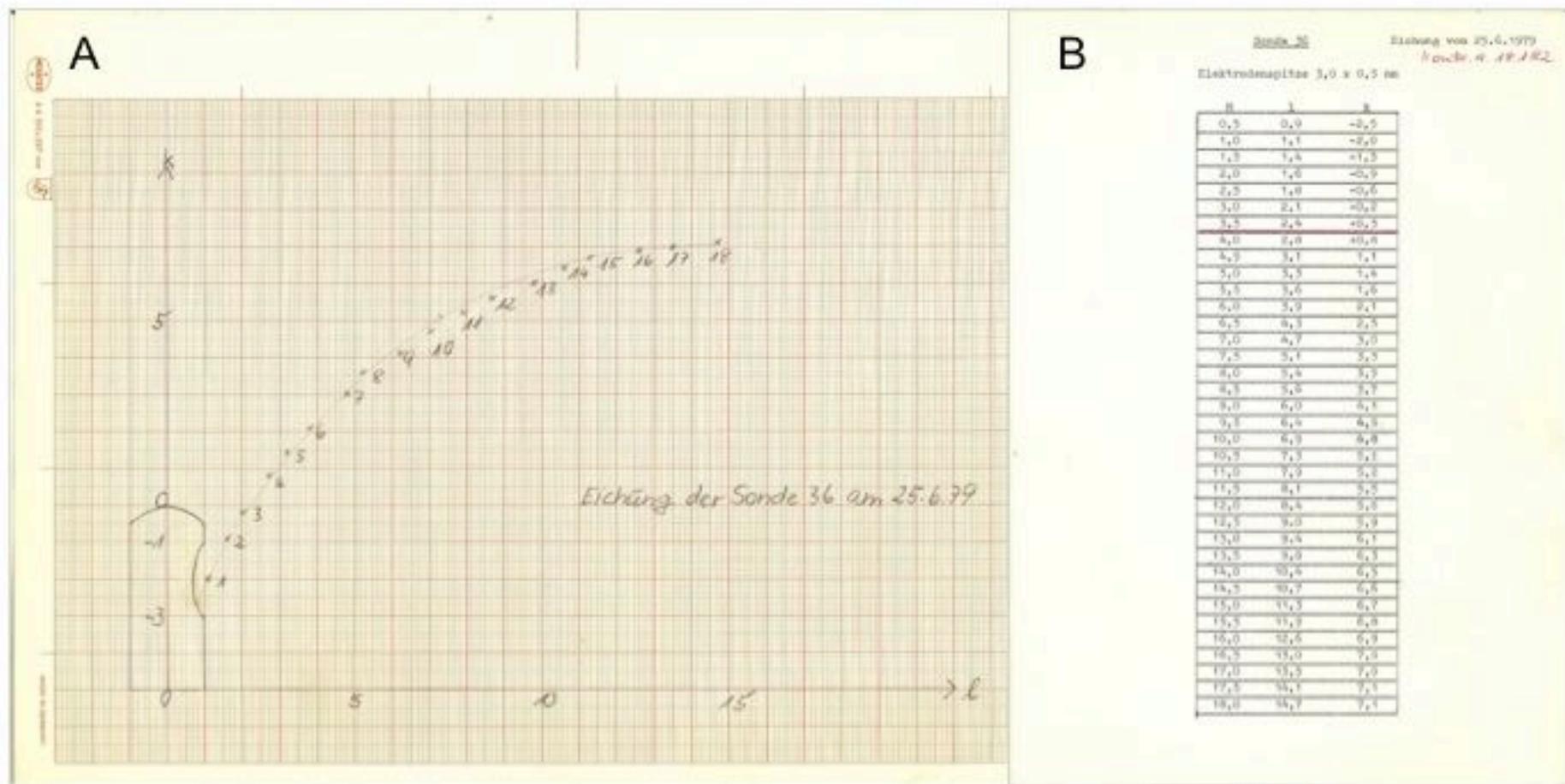


Fig. 10 (Suppl.)

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	
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48	0.360	-0.693	-0.624	-0.721	0.800	0.866	0.500	-0.400	
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