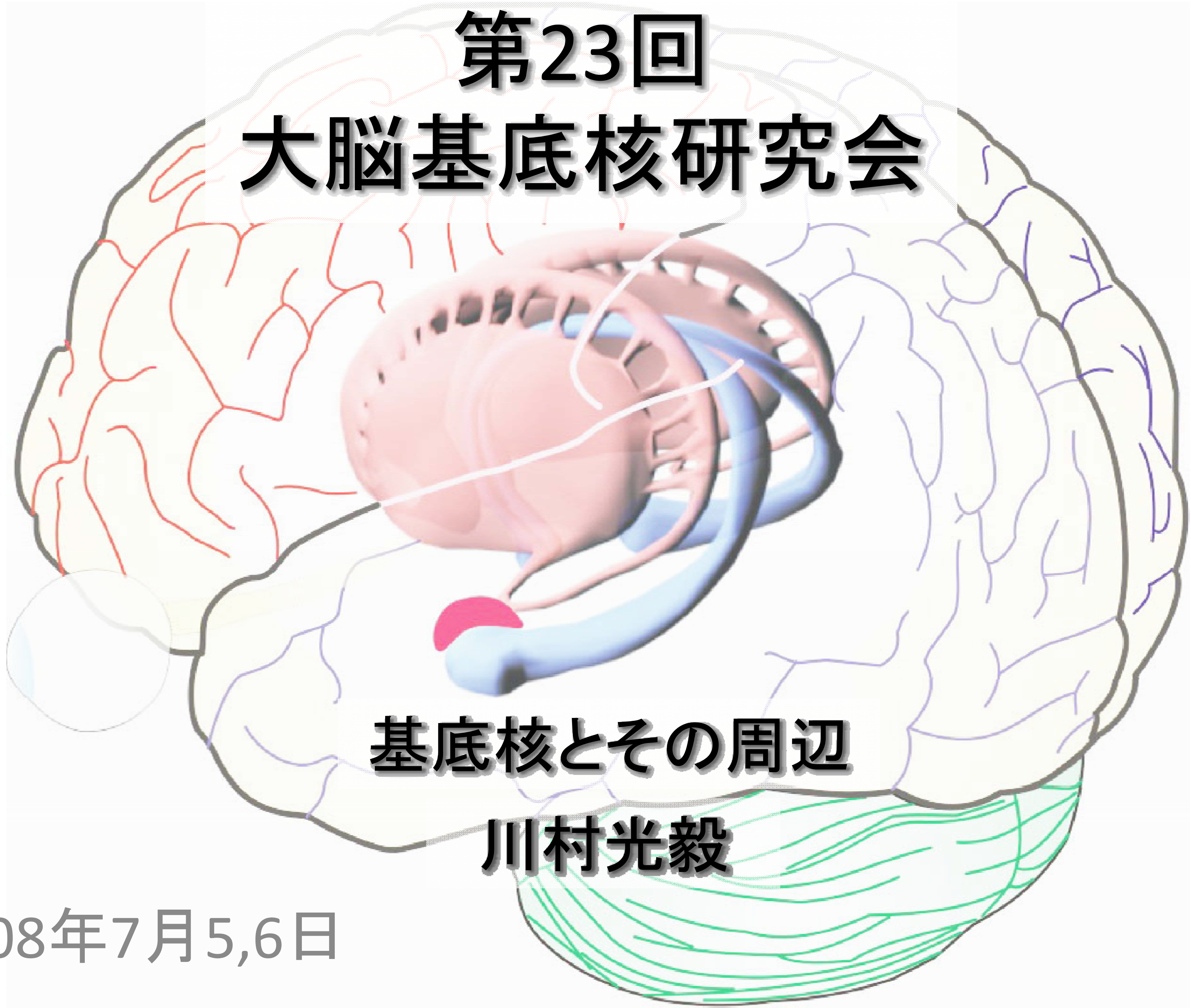
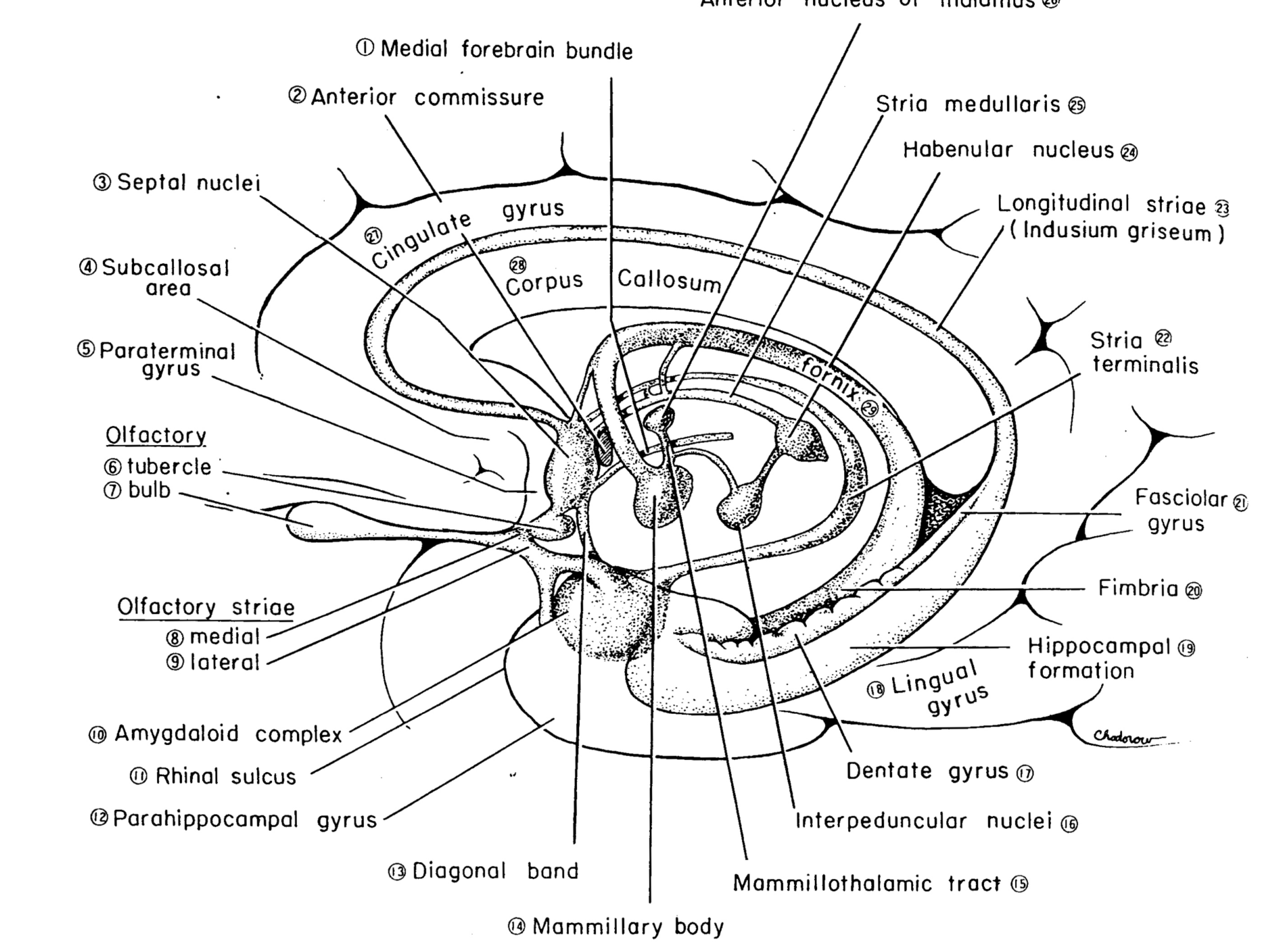
第23回
大脳基底核研究会



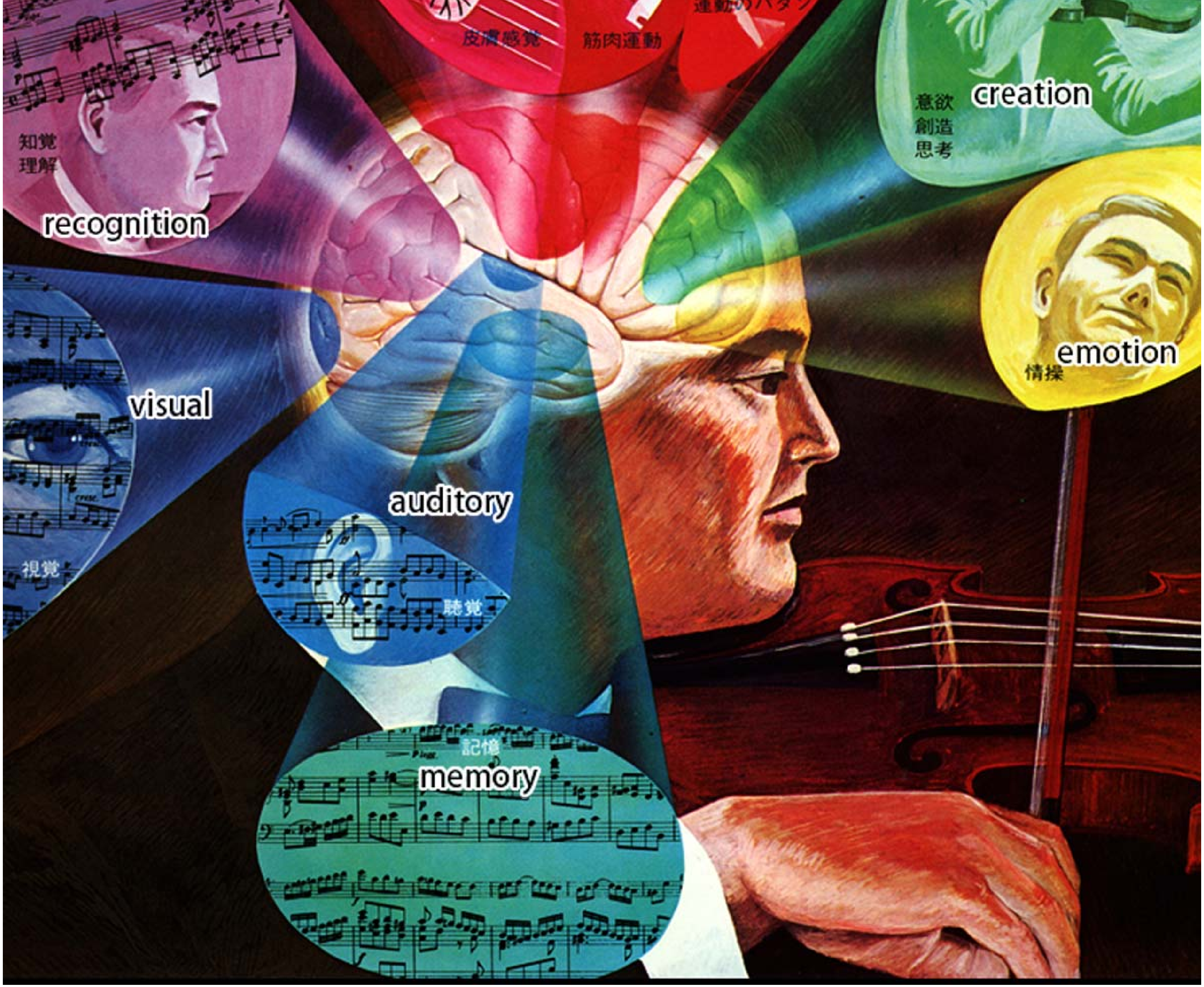
基底核とその周辺

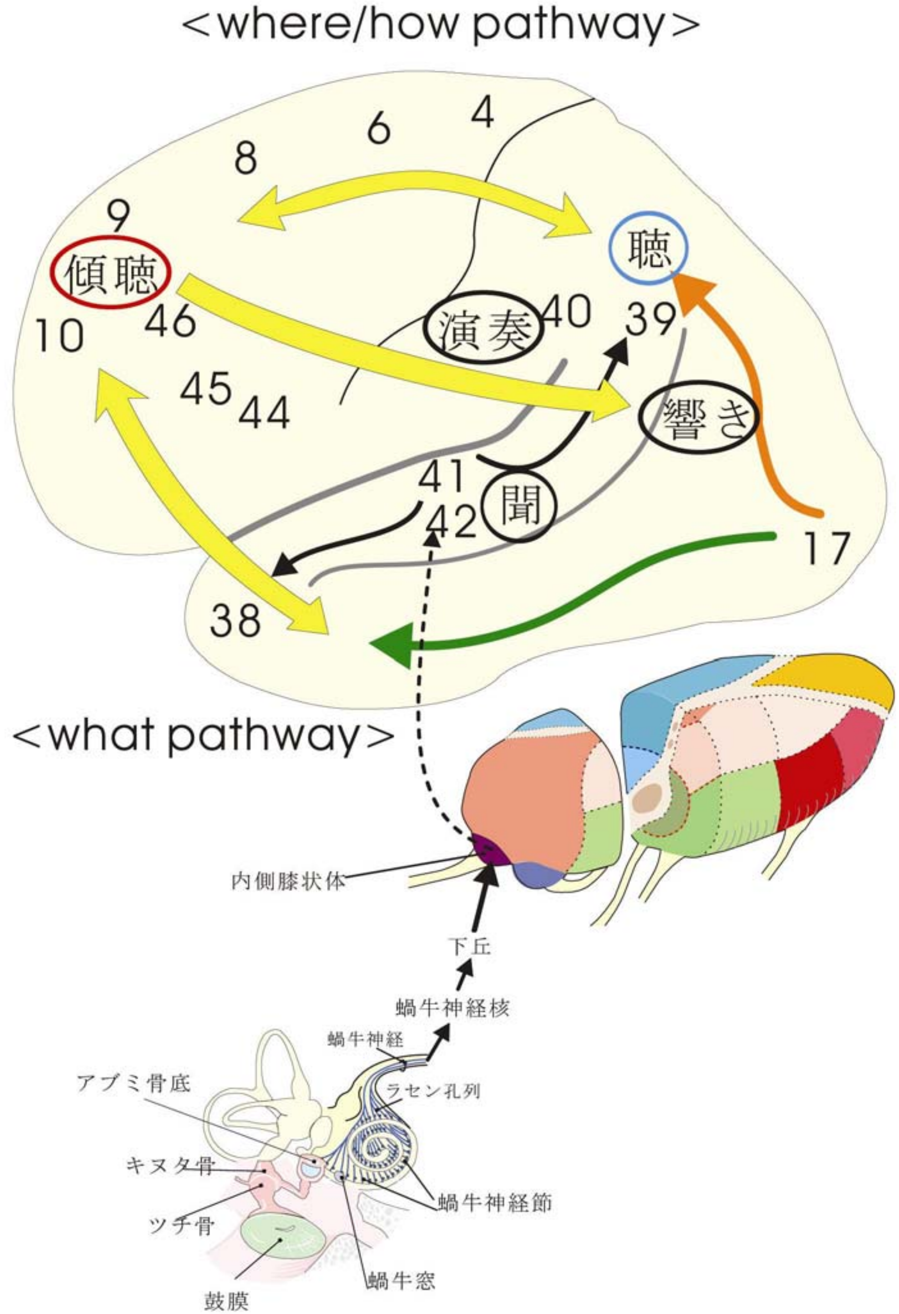
川村光毅

2008年7月5,6日



Anterior nucleus of thalamus ㉖
① Medial forebrain bundle
② Anterior commissure
③ Septal nuclei
④ Subcallosal area
⑤ Paraterminal gyrus
Olfactory
⑥ tubercle
⑦ bulb
Olfactory striae
⑧ medial
⑨ lateral
⑩ Amygdaloid complex
⑪ Rhinal sulcus
⑫ Parahippocampal gyrus
⑬ Diagonal band
⑭ Mammillary body
Mammillothalamic tract ⑮
Interpeduncular nuclei ⑯
Dentate gyrus ⑰
⑱ Lingual gyrus
Hippocampal formation ⑲
Fimbria ⑳
Fasciolar gyrus ㉑
Stria terminalis ㉒
Longitudinal striae ㉓ (Indusium griseum)
Habenular nucleus ㉔
Stria medullaris ㉕
㉗ Cingulate gyrus
㉘ Corpus Callosum
fornix ㉙
Chadorow


皮膚感覚
筋肉運動
creation
意欲
創造
思考
知覚
理解
recognition
emotion
情操
visual
auditory
視覚
聴覚
記憶
memory


<where/how pathway>
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傾聴
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演奏
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聴
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響き
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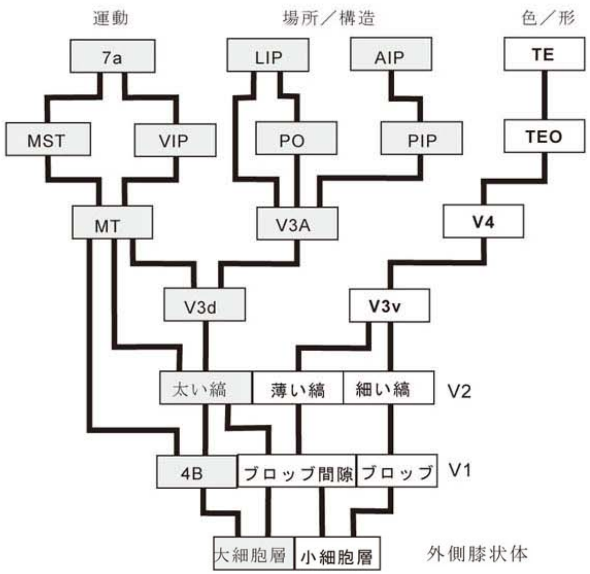
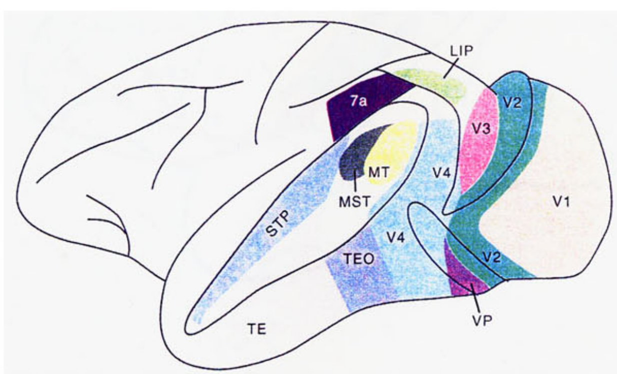
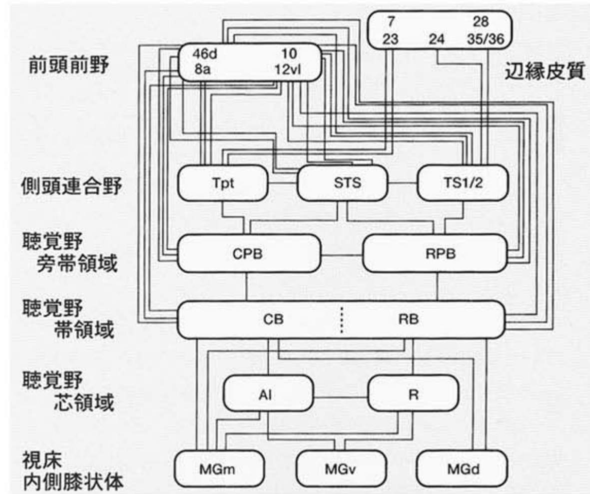
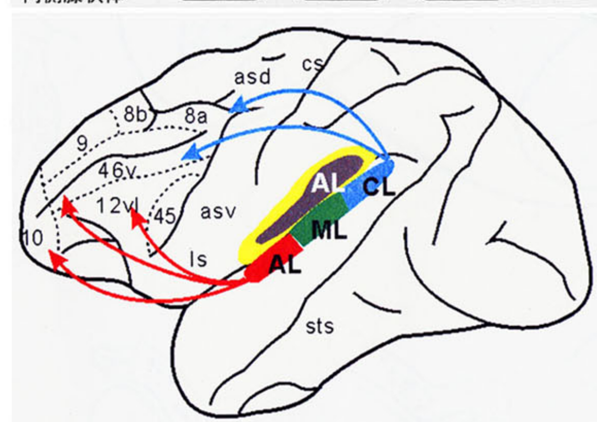
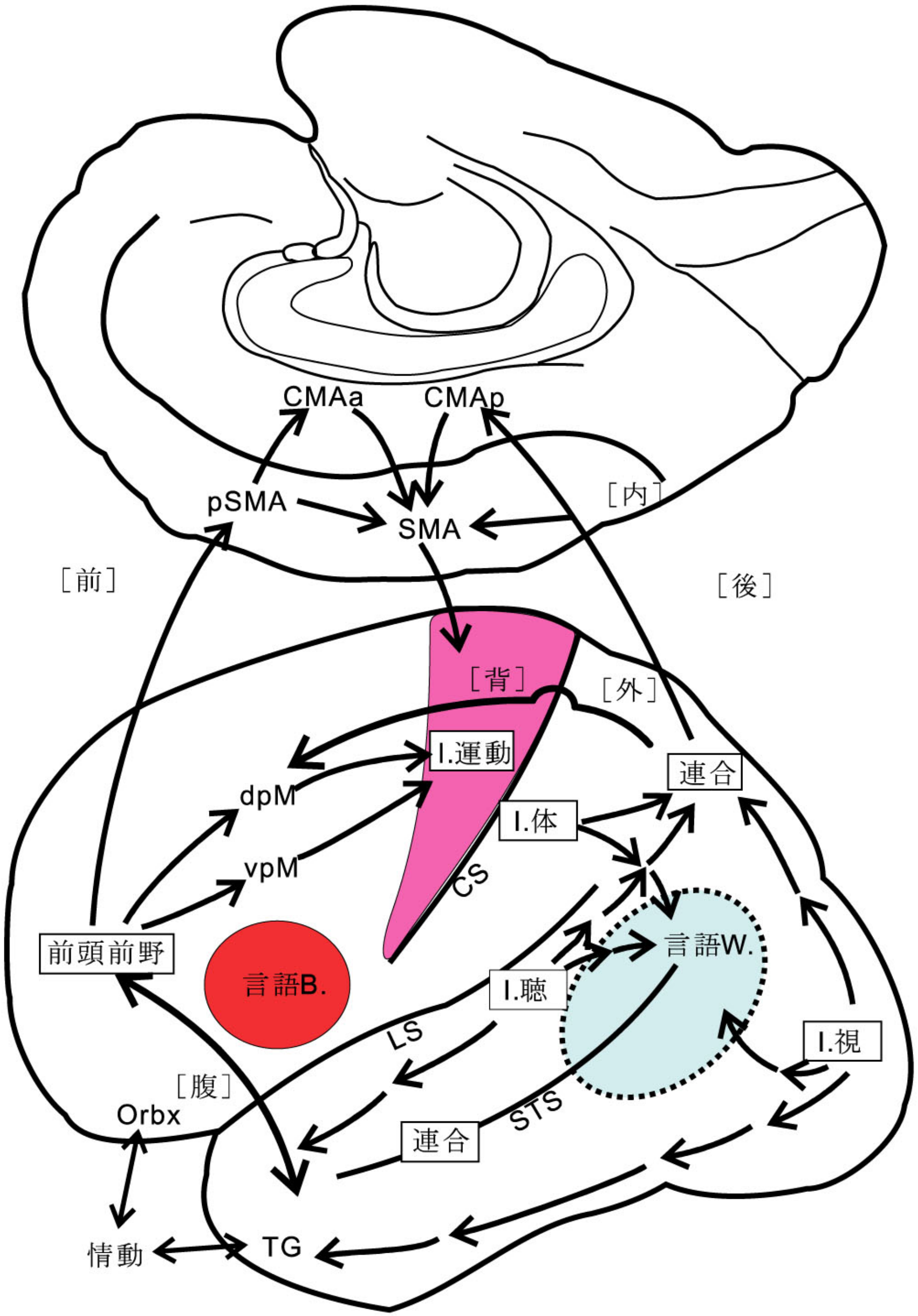
聞
17
38
<what pathway>
内側膝状体
下丘
蝸牛神経核
蝸牛神経
ラセン孔列
アブミ骨底
キヌタ骨
ツチ骨
鼓膜
蝸牛窓
蝸牛神経節

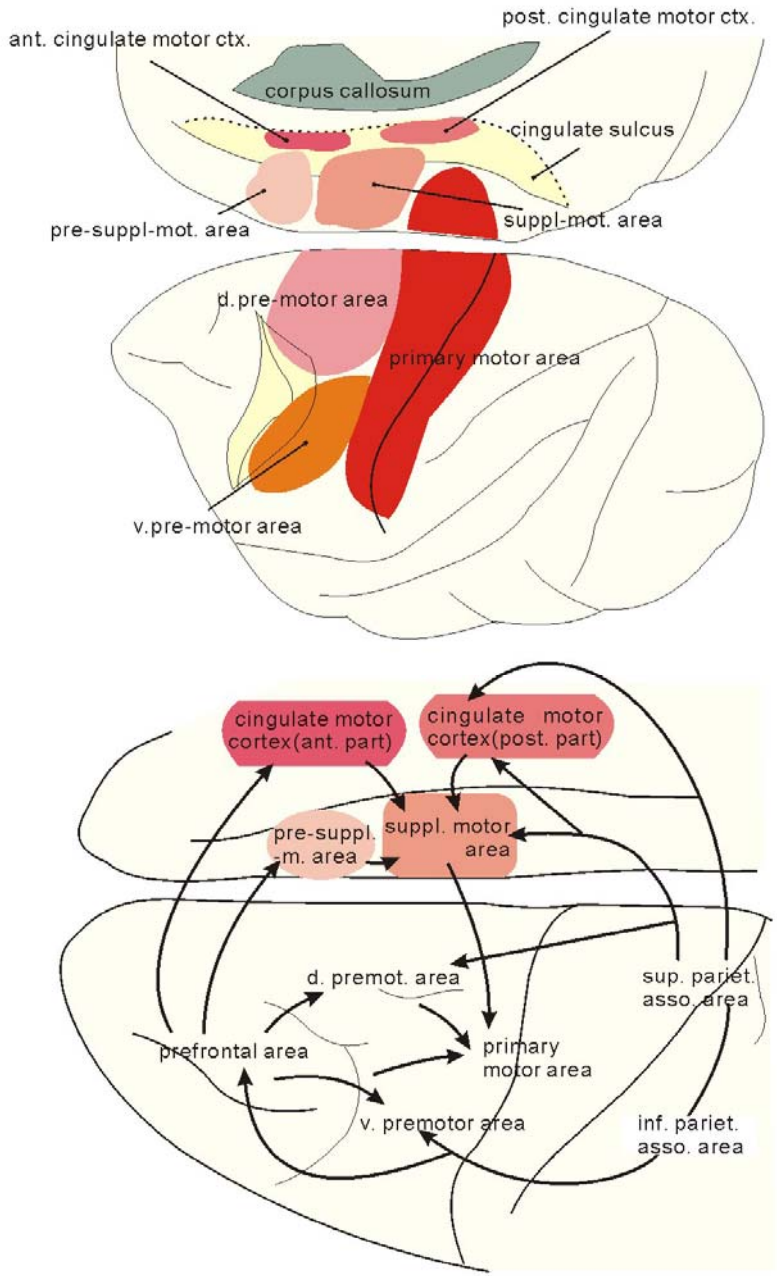

運動
場所／構造
色／形
7a
LIP
AIP
TE
MST
VIP
PO
PIP
TEO
MT
V3A
V4
V3d
V3v
太い縞
薄い縞
細い縞
V2
4B
ブロッブ間隙
ブロッブ
V1
大細胞層
小細胞層
外側膝状体


LIP
7a
V2
V3
MT
MST
V4
V1
STP
TEO
TE
VP

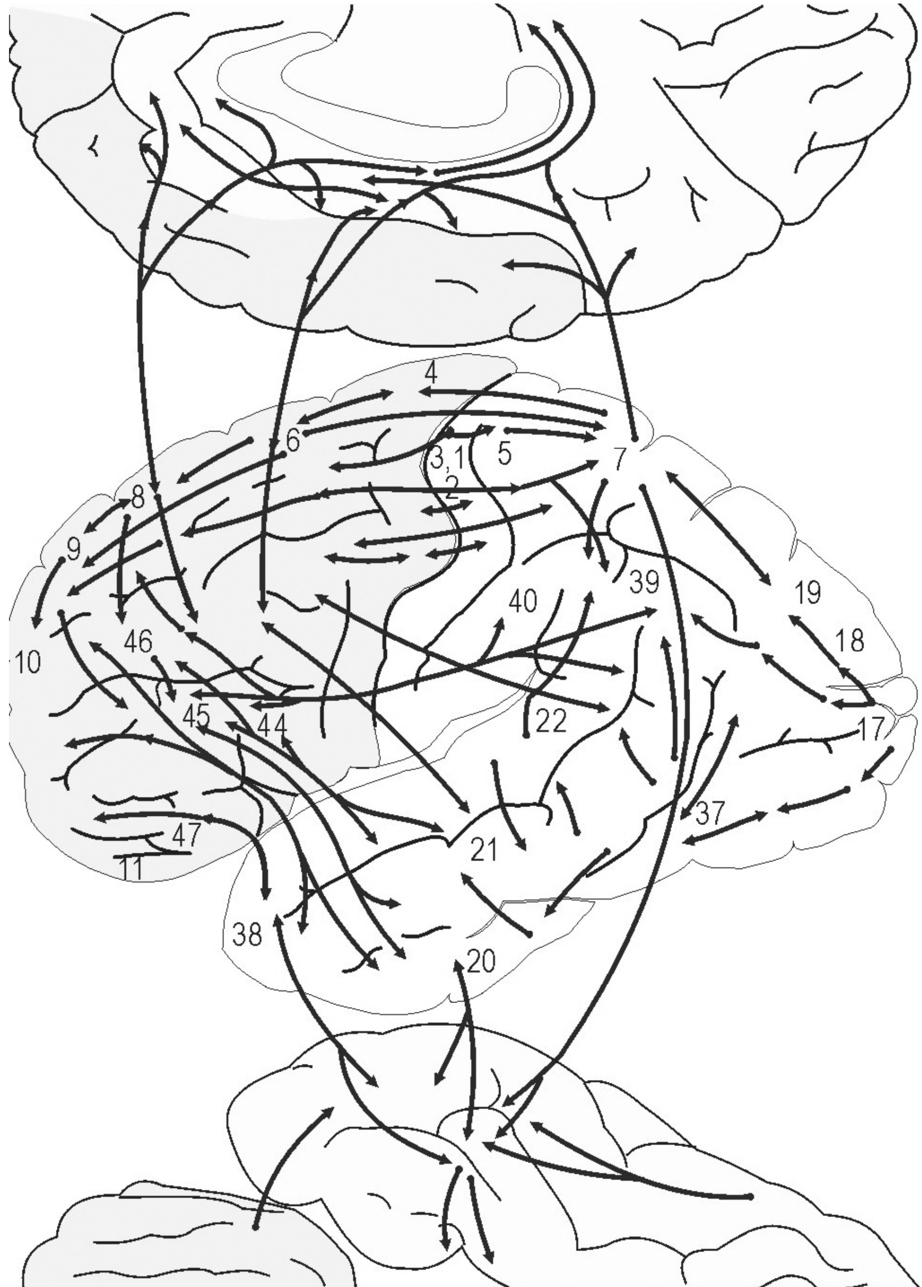

7
28
23
24
35/36
46d
8a
10
12vl
前頭前野
辺縁皮質
側頭連合野
Tpt
STS
TS1/2
聴覚野
旁帯領域
CPB
RPB
聴覚野
帯領域
CB
RB
聴覚野
芯領域
AI
R
視床
内側膝状体
MGm
MGv
MGd


asd
cs
8b
8a
9
46v
12vl
45
asv
10
ls
AL
CL
ML
AL
sts


CMAa
CMAp
pSMA
SMA
［内］
［前］
［後］
［背］
［外］
l.運動
dpM
連合
l.体
vpM
CS
前頭前野
言語B.
言語W.
l.聴
LS
l.視
［腹］
Orbx
連合
STS
情動
TG



Connections involving motor areas (Tanji, 1999)



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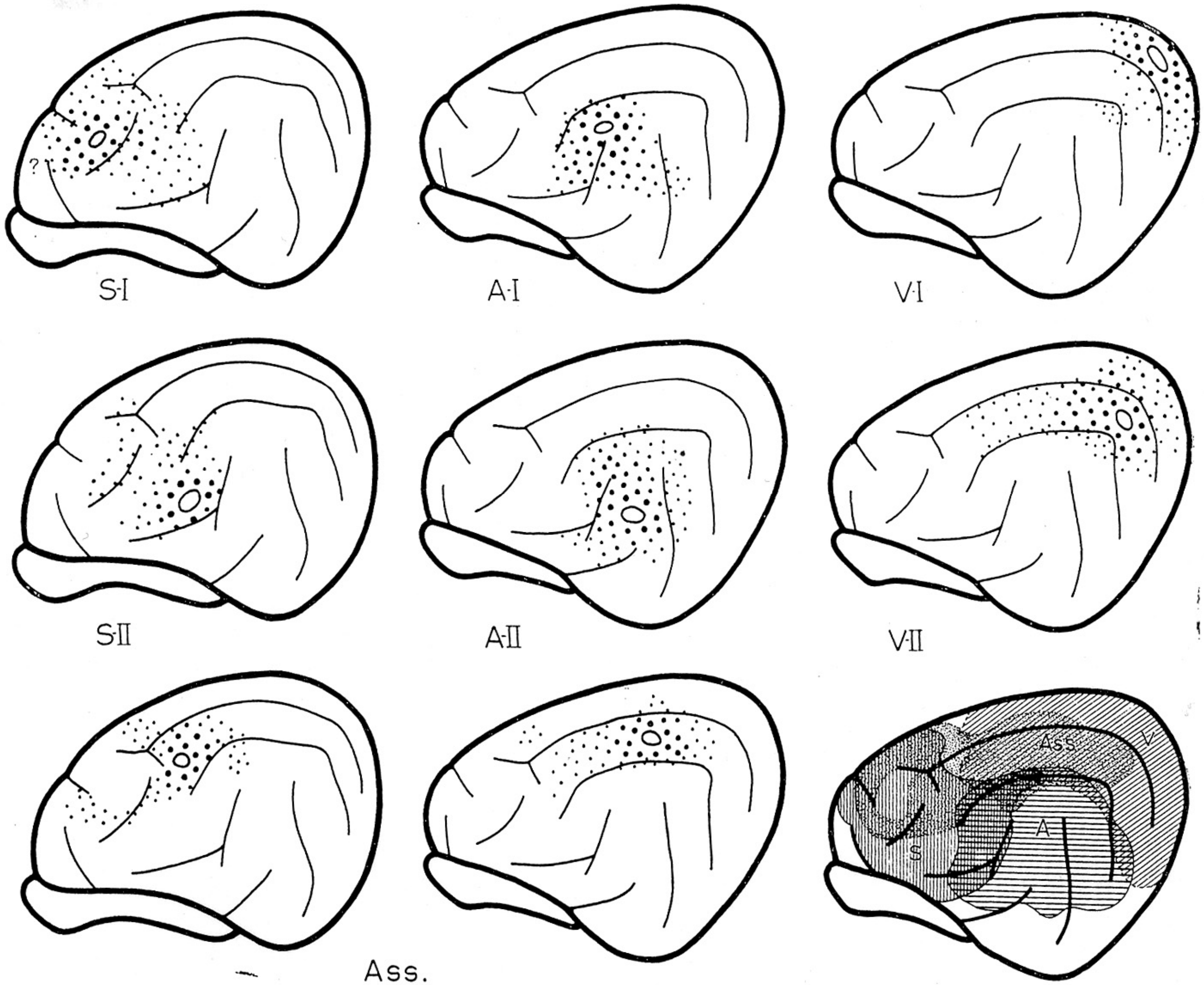
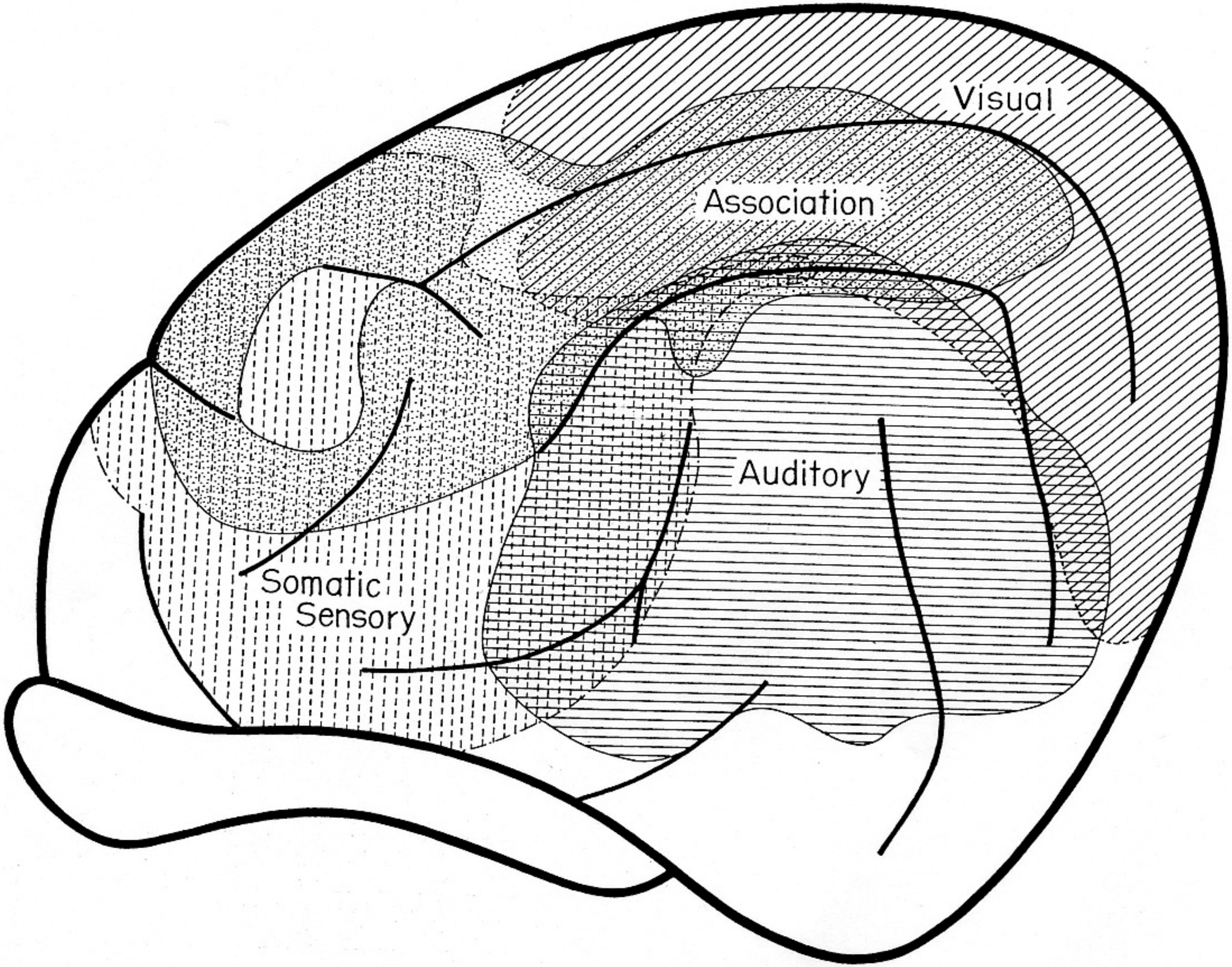
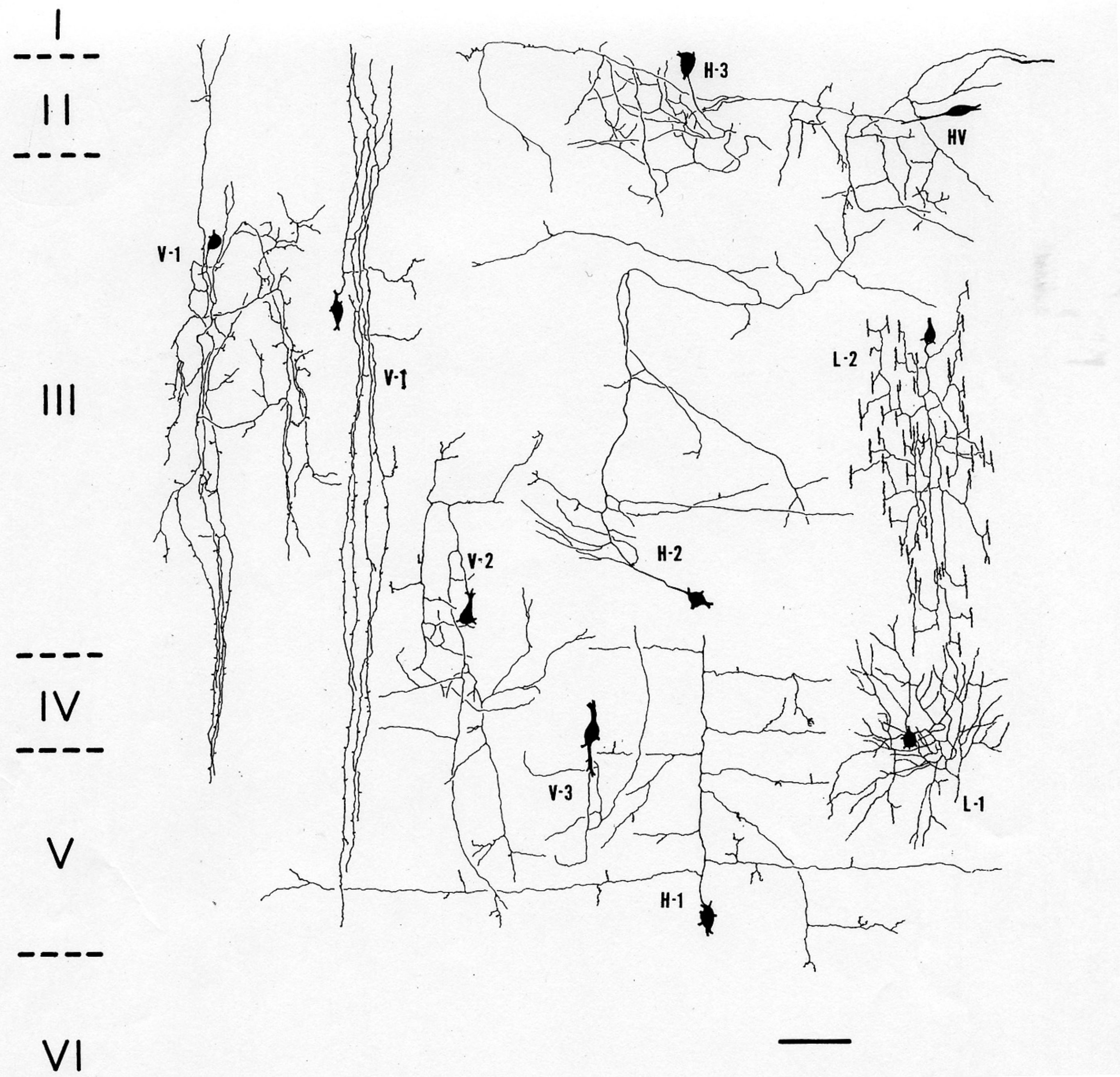

?
S-I
A-I
V-I
S-II
A-II
V-II
Ass.
Ass
V
A
S


Visual
Association
Auditory
Somatic
Sensory



I
II
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V-3
H-3
HV
H-2
H-1
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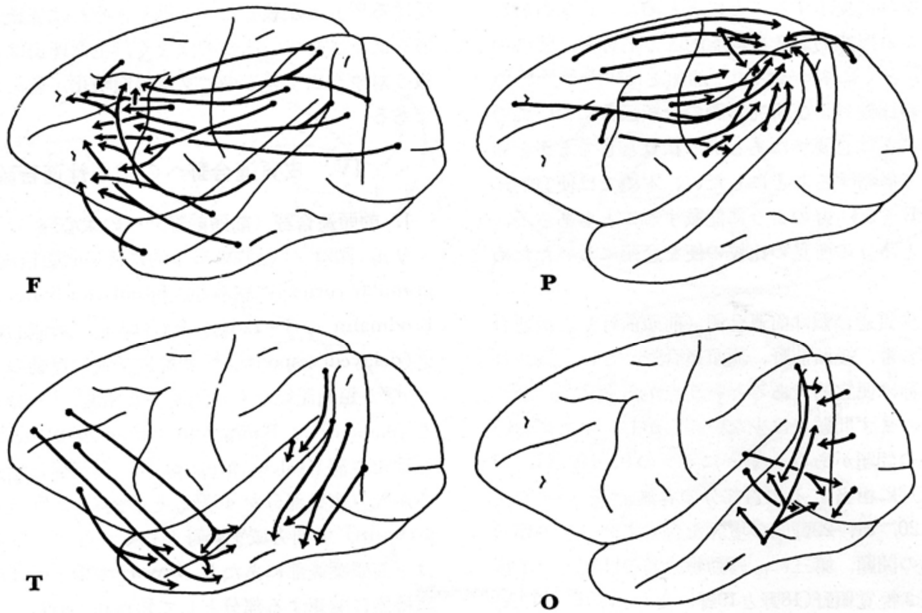
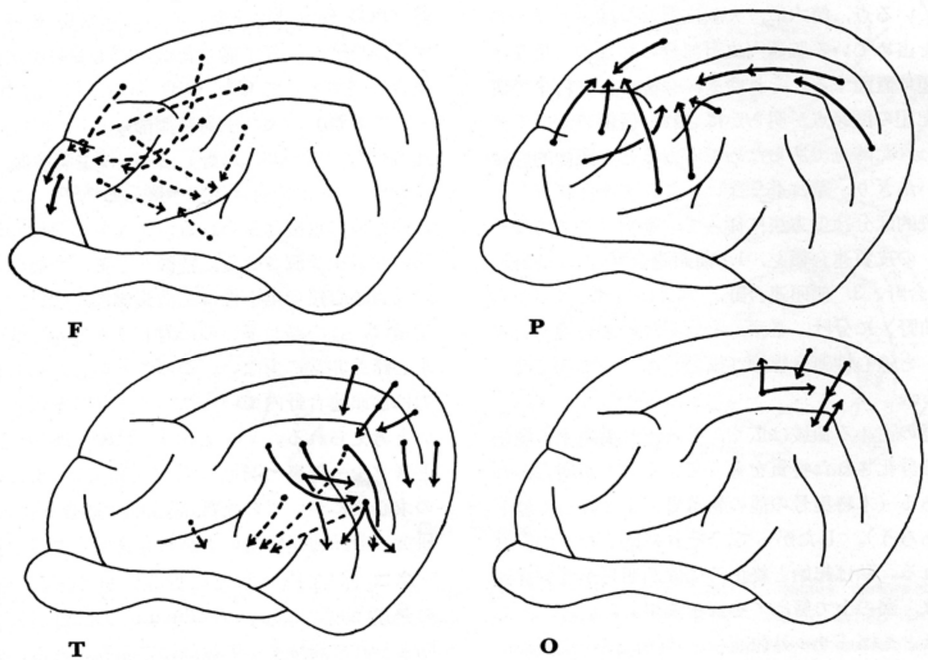
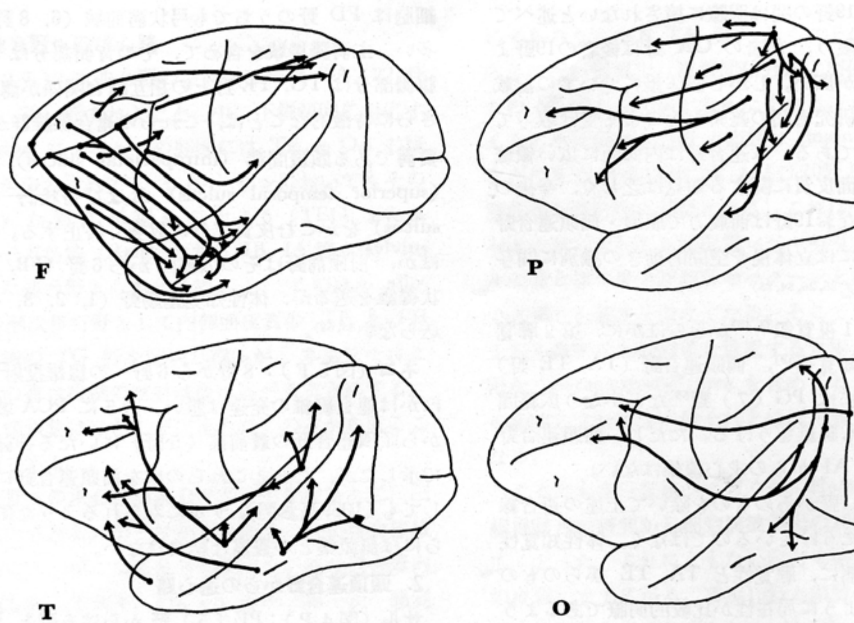
L-1



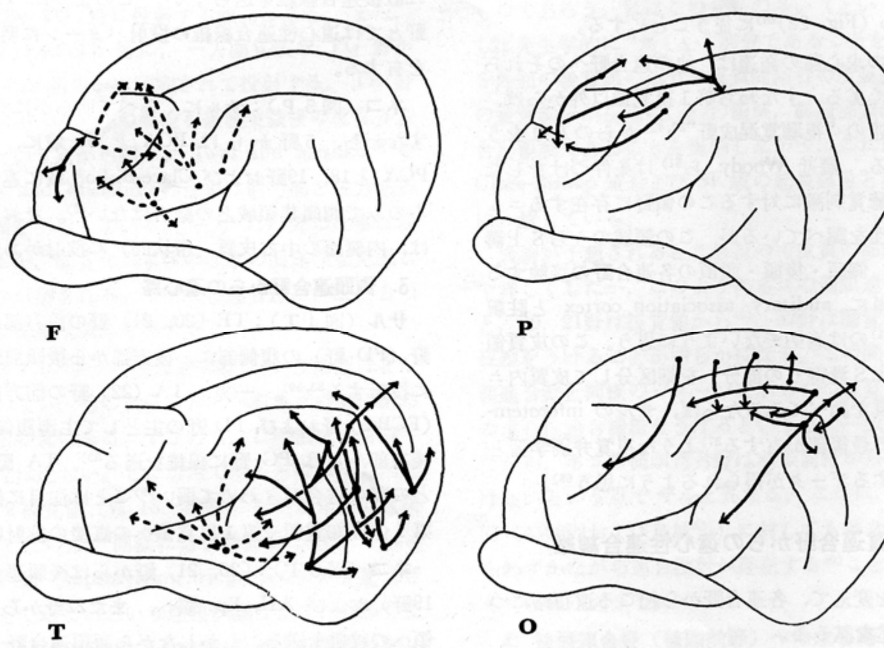
Monkey, afferents



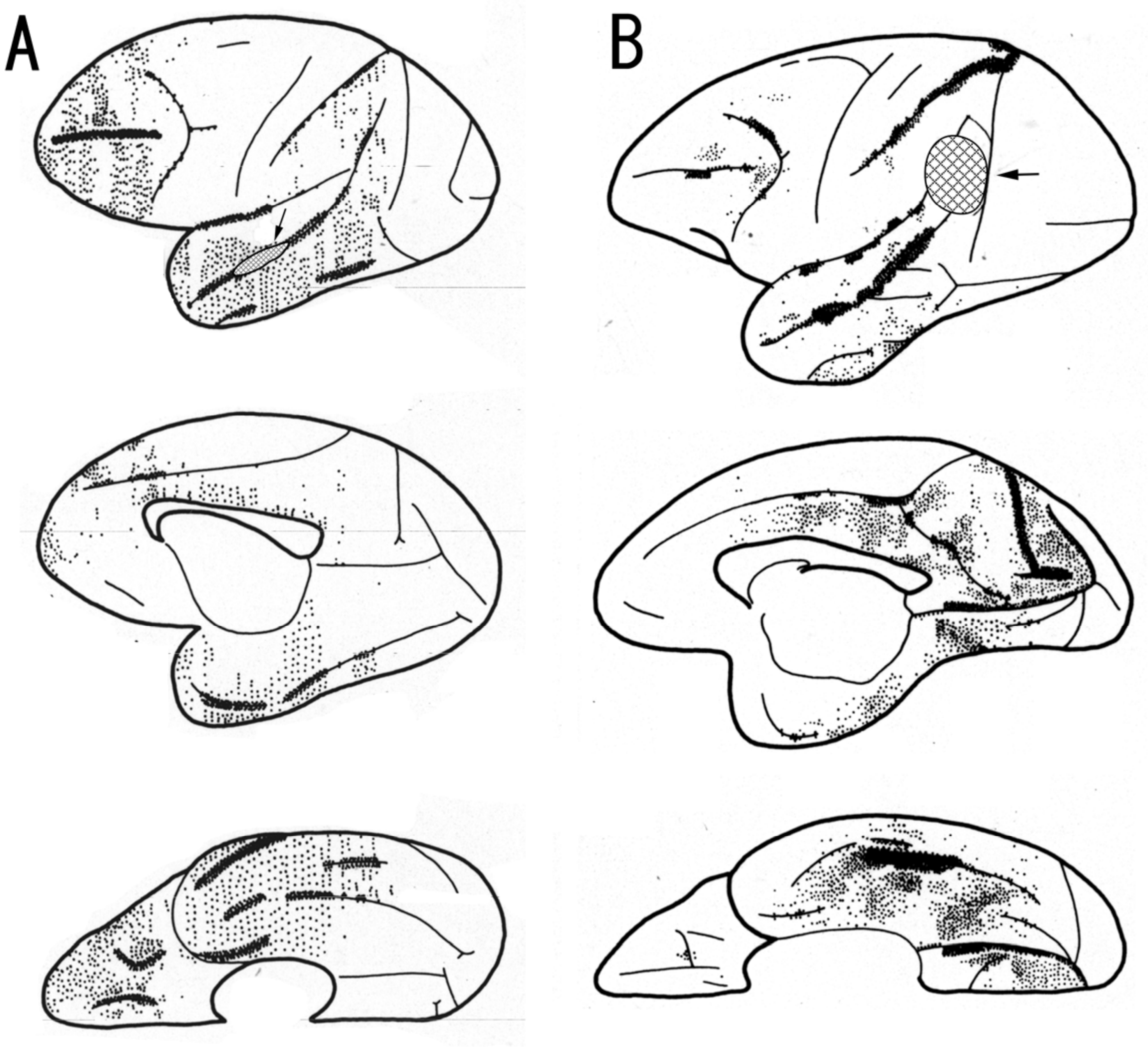
Cat, afferents

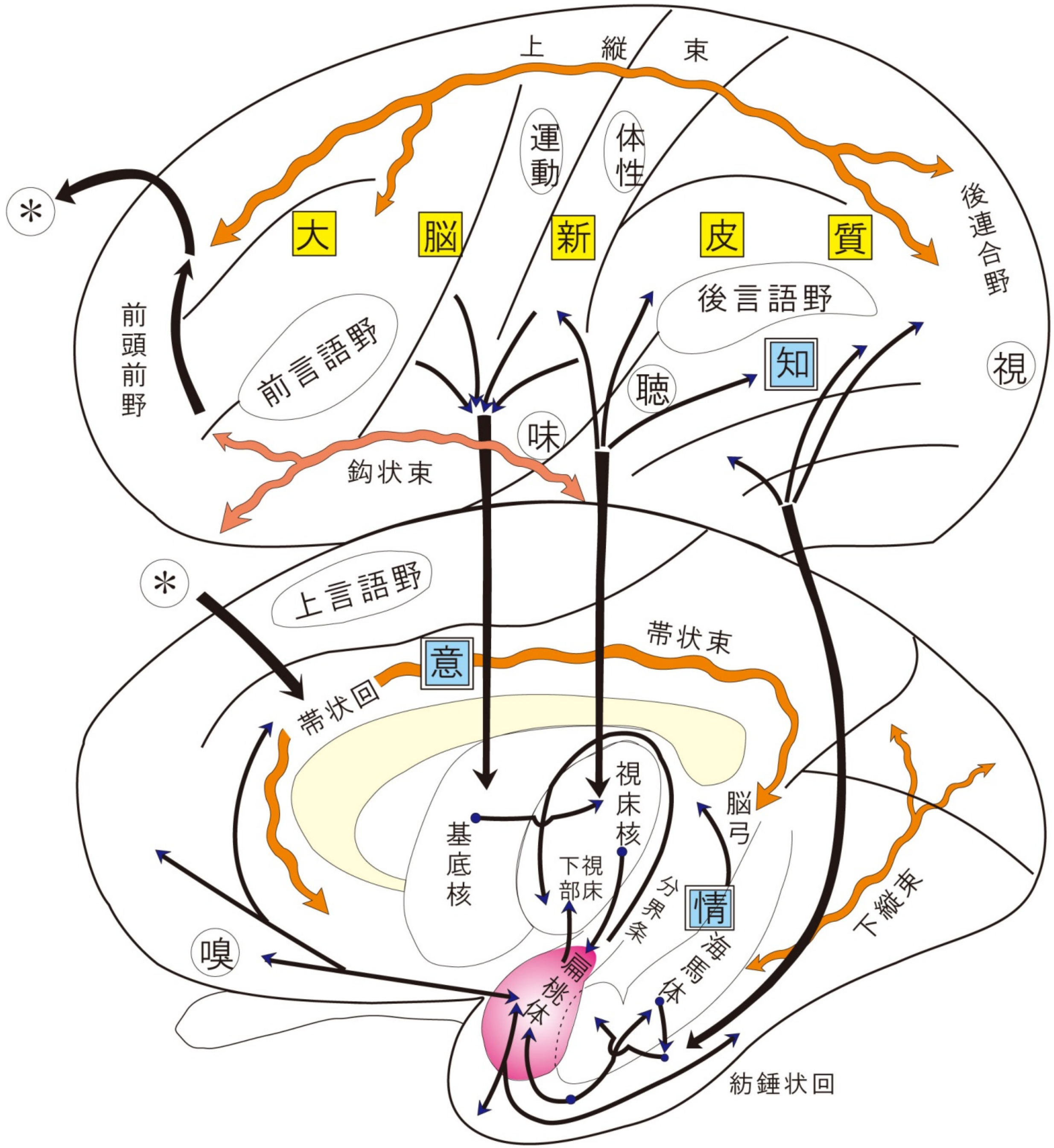


Monkey, efferents



Cat efferents


A
B



上縦束
運動
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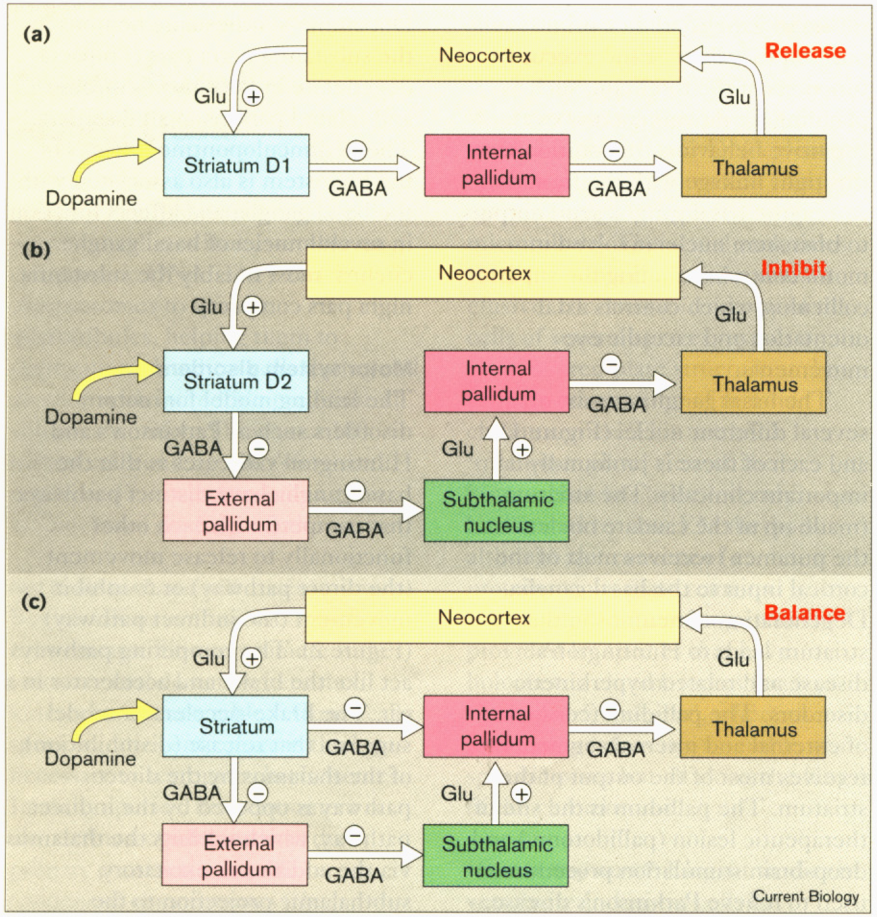
脳
新
皮
質
後連合野
前頭前野
前言語野
後言語野
知
視
聴
味
鉤状束
上言語野
帯状束
意
帯状回
視床核
基底核
下視床部
脳弓
分界条
情
海馬体
扁桃体
下縦束
嗅
紡錘状回

Figure 2

Graybiel (2000)



The brake–accelerator model for basal ganglia motor disorders. **(a)** The direct pathway (leading to release of movement) consists of two successive GABAergic connections, from the striatum to the internal pallidum and from the internal pallidum to the thalamus. This flow diagram suggests that excitatory (glutamate; Glu) inputs from the neocortex to the striatum would disinhibit thalamic neurons. Dopamine modulates the system mainly in the striatum, where it activates D1-class and D2-class dopamine receptors. **(b)** In the indirect pathway (leading to inhibition of movement), there is an extra step after the external pallidum, so that the subthalamic nucleus excites the internal pallidum. **(c)** Balance is achieved when these antagonistic systems are combined under normal circumstances.

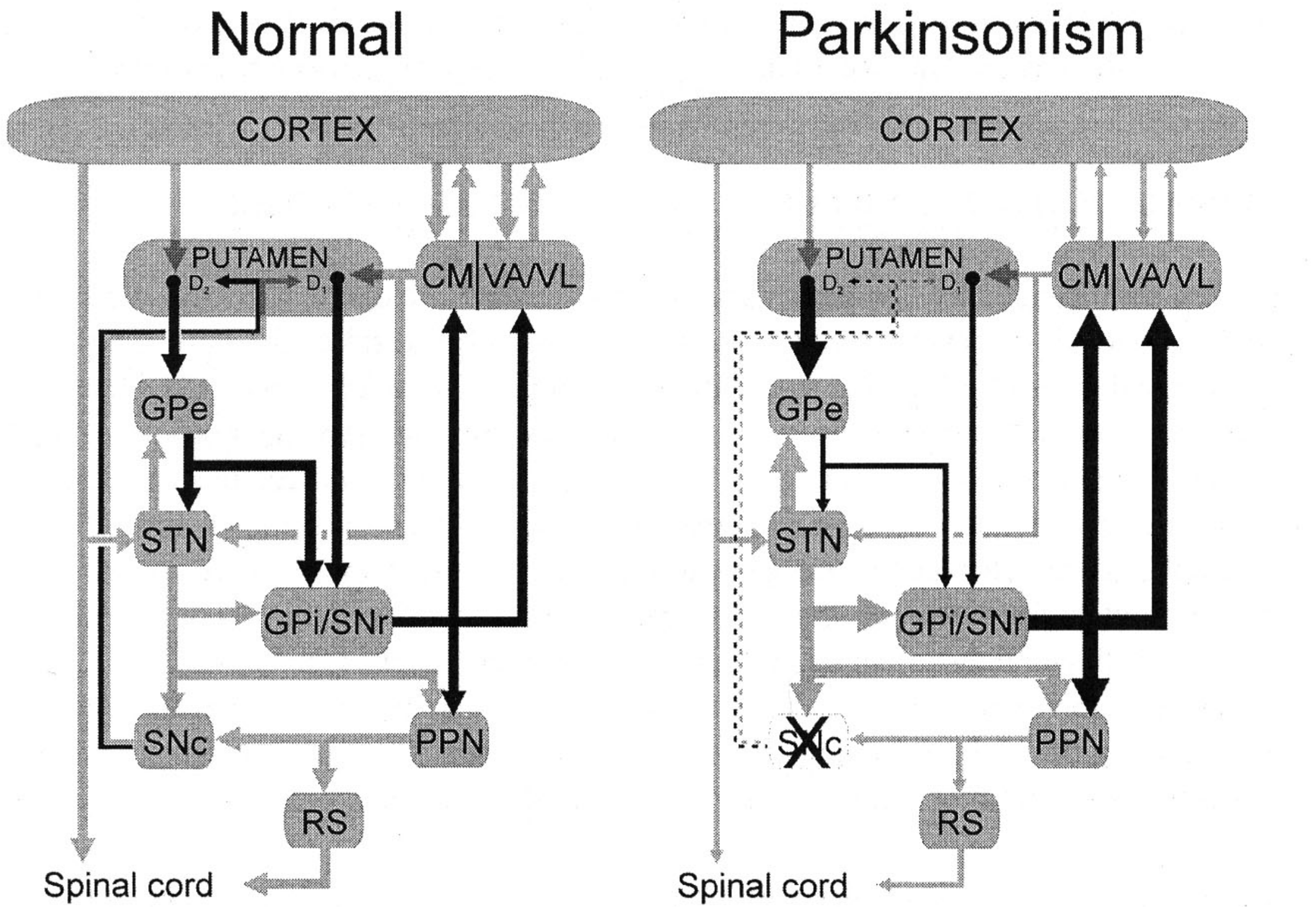


Figure 1. Normal anatomy of the basal ganglia and changes in the basal ganglia-thalamocortical circuitry in parkinsonism. Putamen and STN receive cortical input, which, via the basal ganglia output nuclei GPi and SNr, is transferred to thalamus and cortex. In parkinsonism, the dopaminergic SNc degenerates, resulting in increased activity along the 'indirect' pathways, and reduced activity along the 'direct' pathway, leading to increased basal ganglia output. RS: reticulospinal system. For other abbreviations see text.

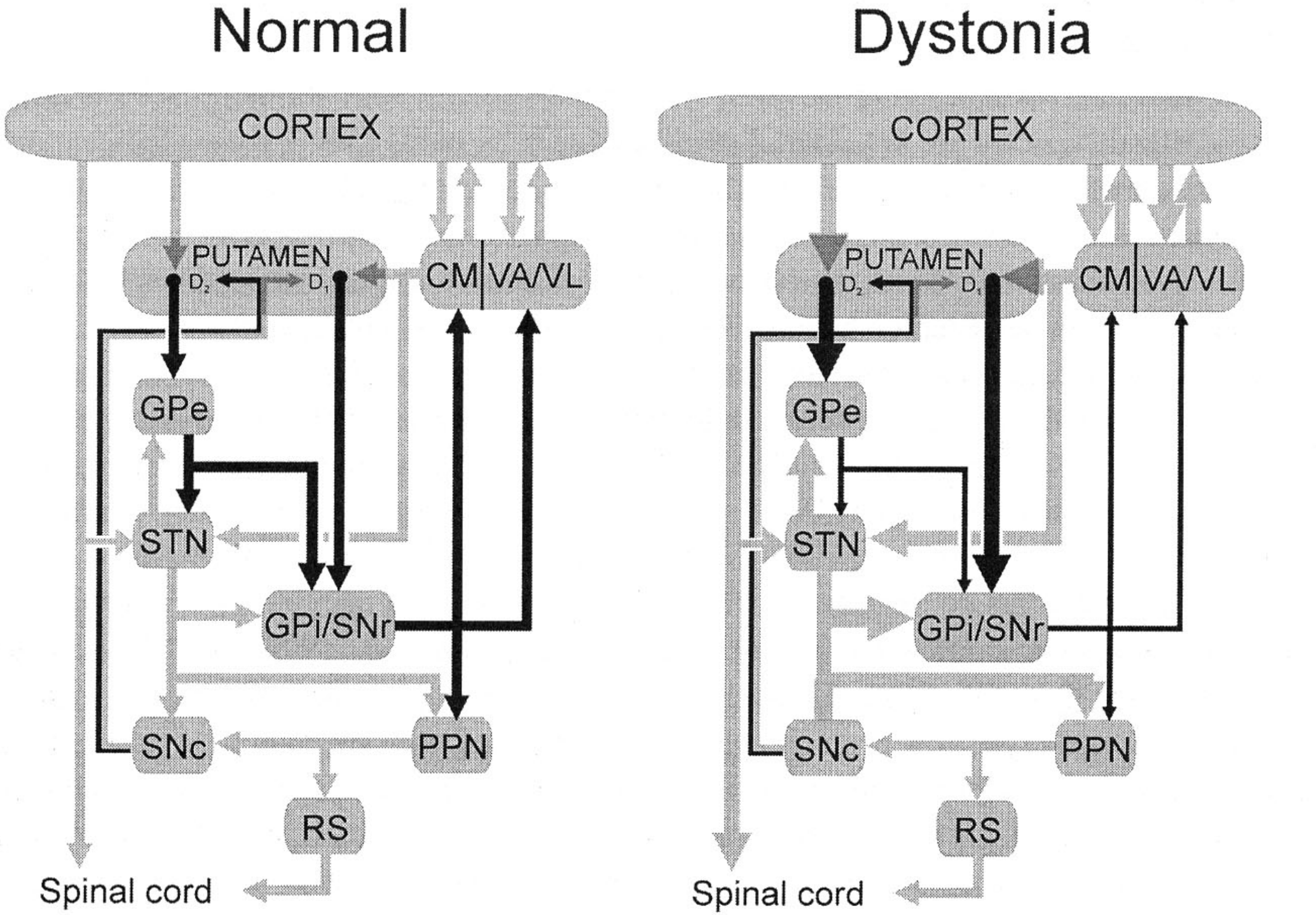


Figure 3. The pathophysiology of dystonia is less well understood than that of other movement disorders. It is thought that dystonia results form concomitant overactivity along both, the 'direct' and 'indirect' pathways. For abbreviations see Figure 1.

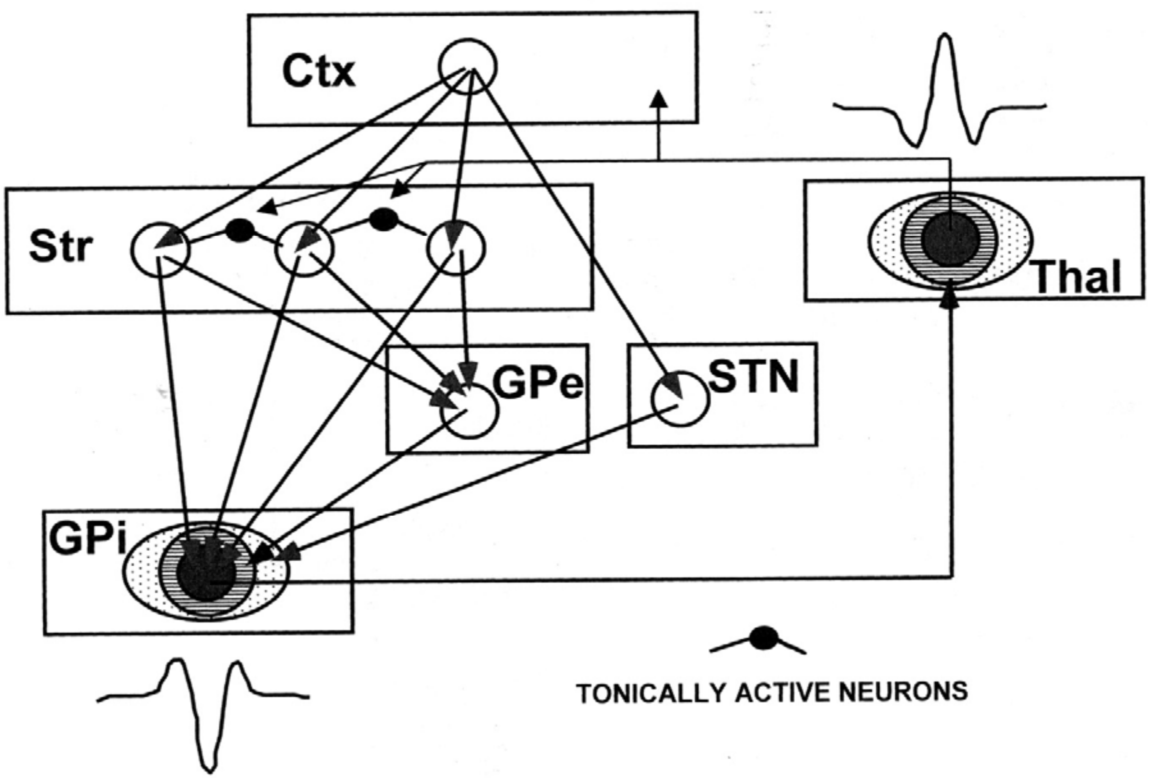
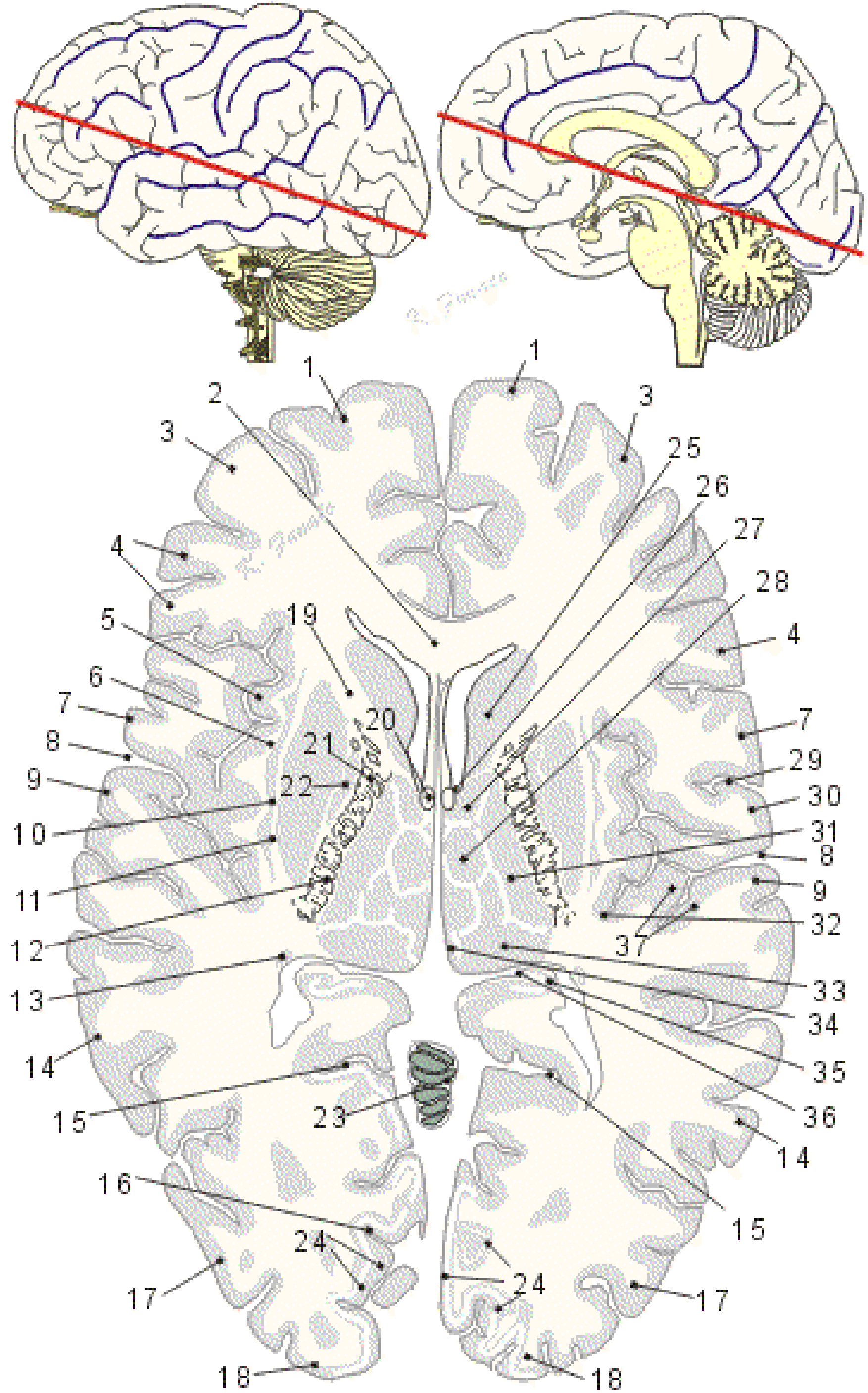


FIG. 1.4. How desired movements are focused through the basal ganglia. A single cortical area projects to several striatal areas whose outputs recombine in the globus pallidus. Tonically active neurons are involved in learning and probably pass information between related striatal areas. The indirect pathway operating via the LGP and STN produces a wide area of excitation in the MGP, and the direct pathway produces a narrow area of strong inhibition in this excited region. This pattern is reversed in the thalamus, resulting in a narrow area of disinhibition to support desired movements with a surrounding inhibition of competing movements. LGP, lateral globus pallidus; MGP, medial globus pallidus; STN, subthalamic nucleus.



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2008/04/01
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S 10.0 3.0
P +50.0
A -20.0
H 230
F 01N
HF/S/A
120KV
100MA
Carino
W80
+45
L
512*512
三芳病院

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2008/04/01
14:30:02.51
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P +60.0
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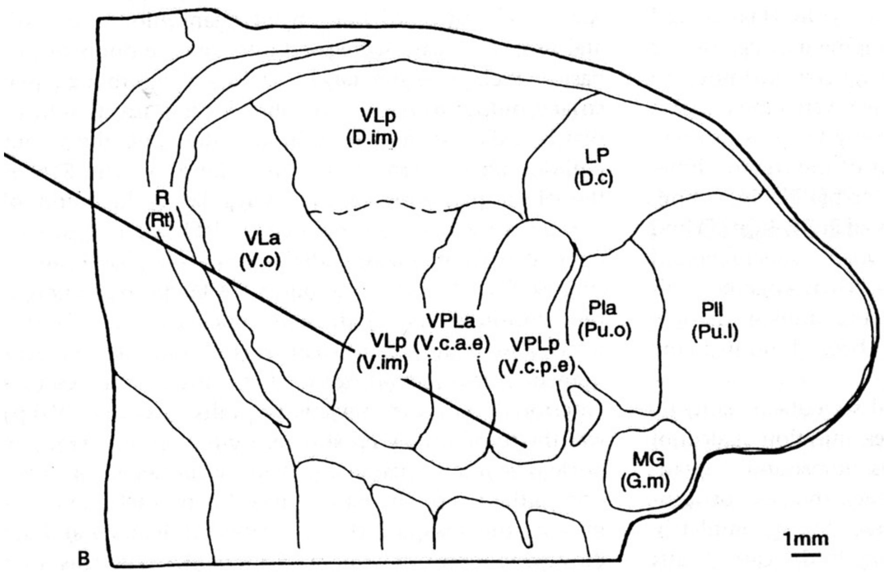
三芳病院



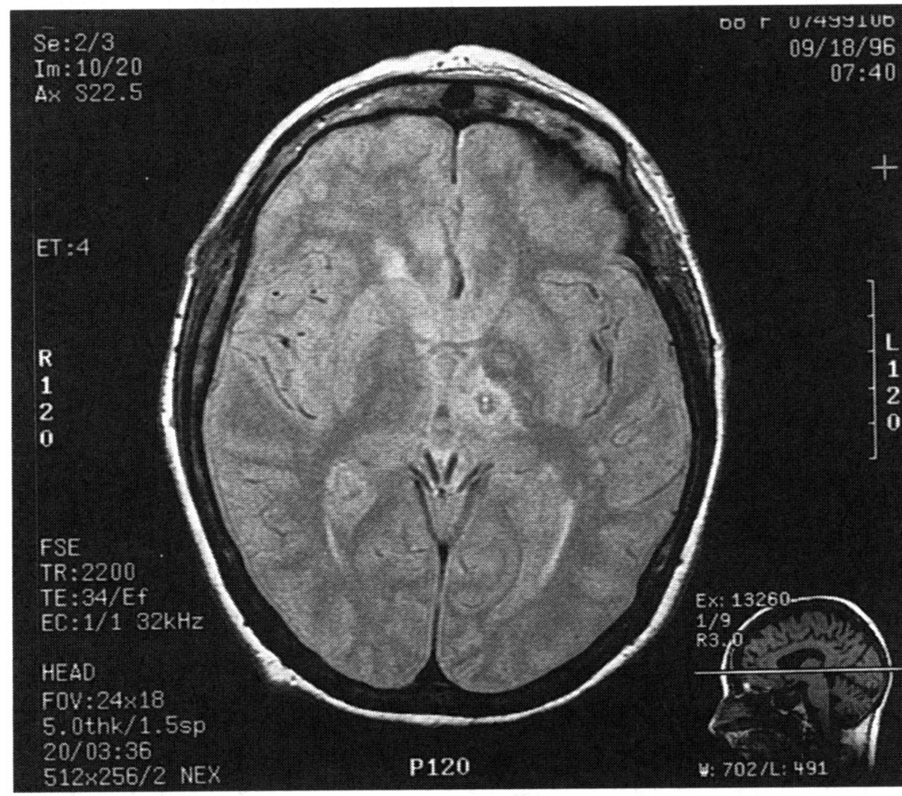
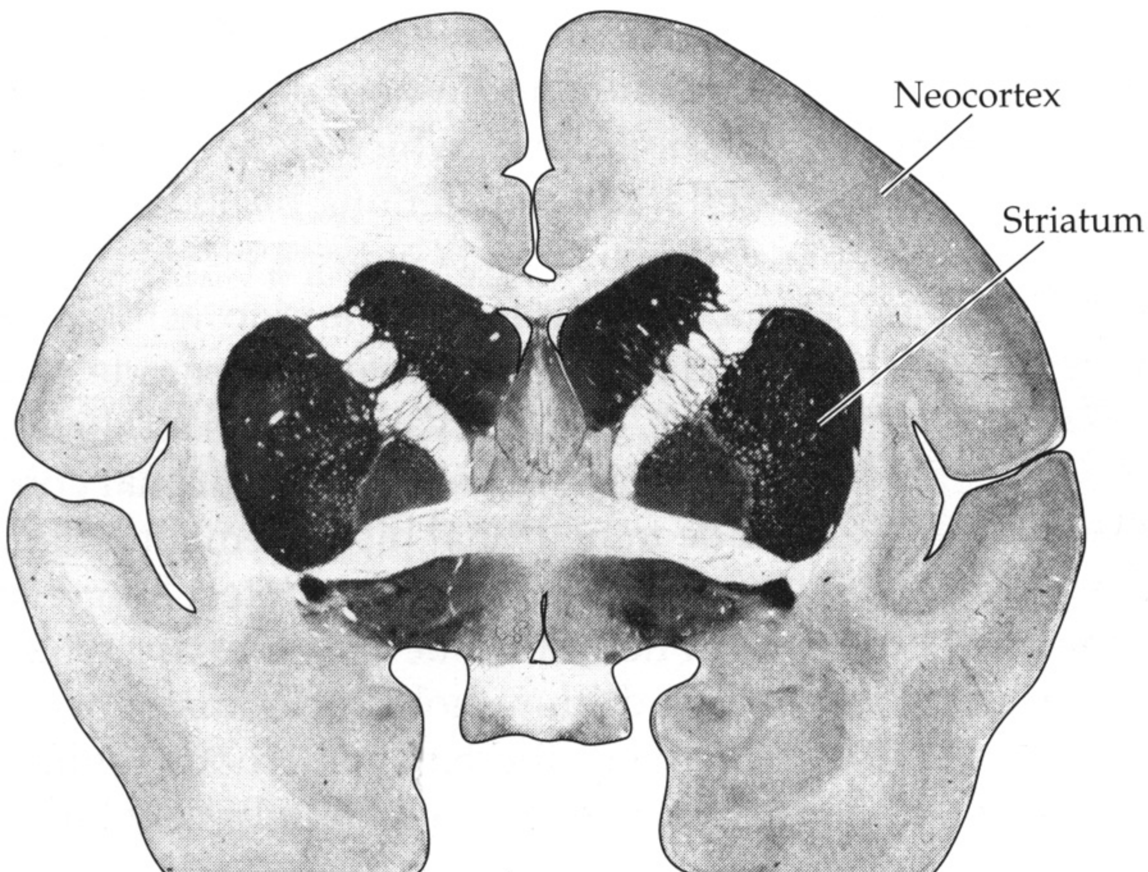
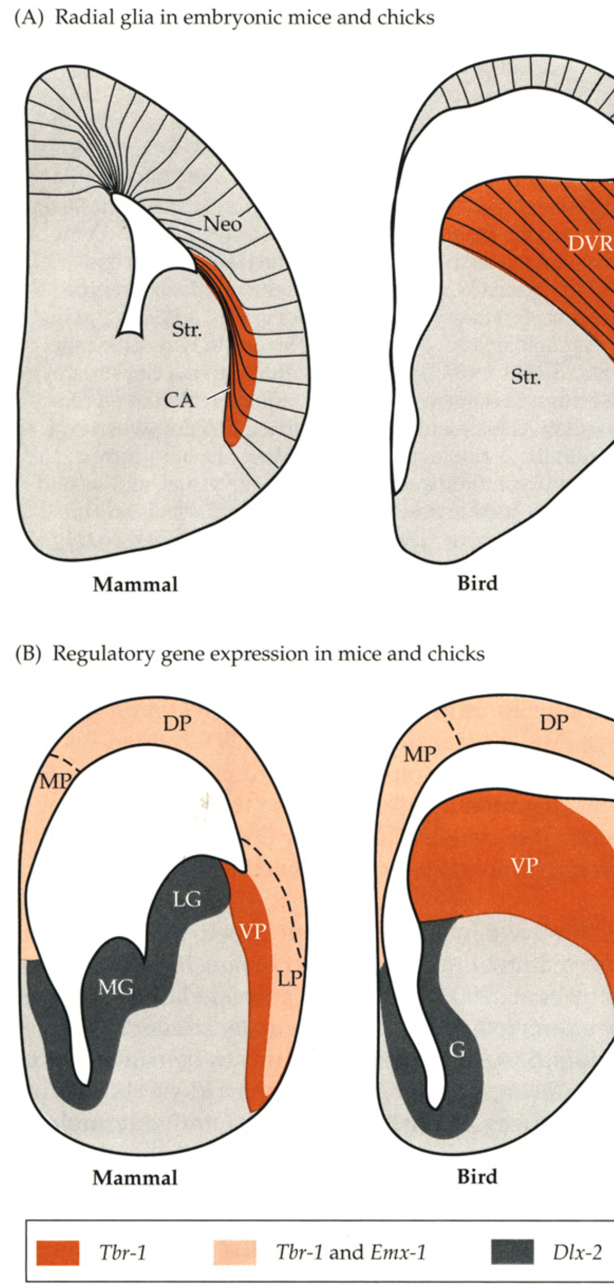


Figure 45.4 Axial FSE 2200/34 MR scans obtained 2 days after a left-sided VLp thalamotomy. Right-sided tremor at rest and intention tremor were completely abolished in this 68-year-old woman with Parkinson's disease and essential tremor.

(B) Squirrel monkey telencephalon




(A) Radial glia in embryonic mice and chicks
Neo
Str.
CA
DVR
Str.
Mammal
Bird
(B) Regulatory gene expression in mice and chicks
DP
MP
LG
VP
MG
LP
DP
MP
VP
LP
G
Mammal
Bird
Tbr-1
Tbr-1 and Emx-1
Dlx-2

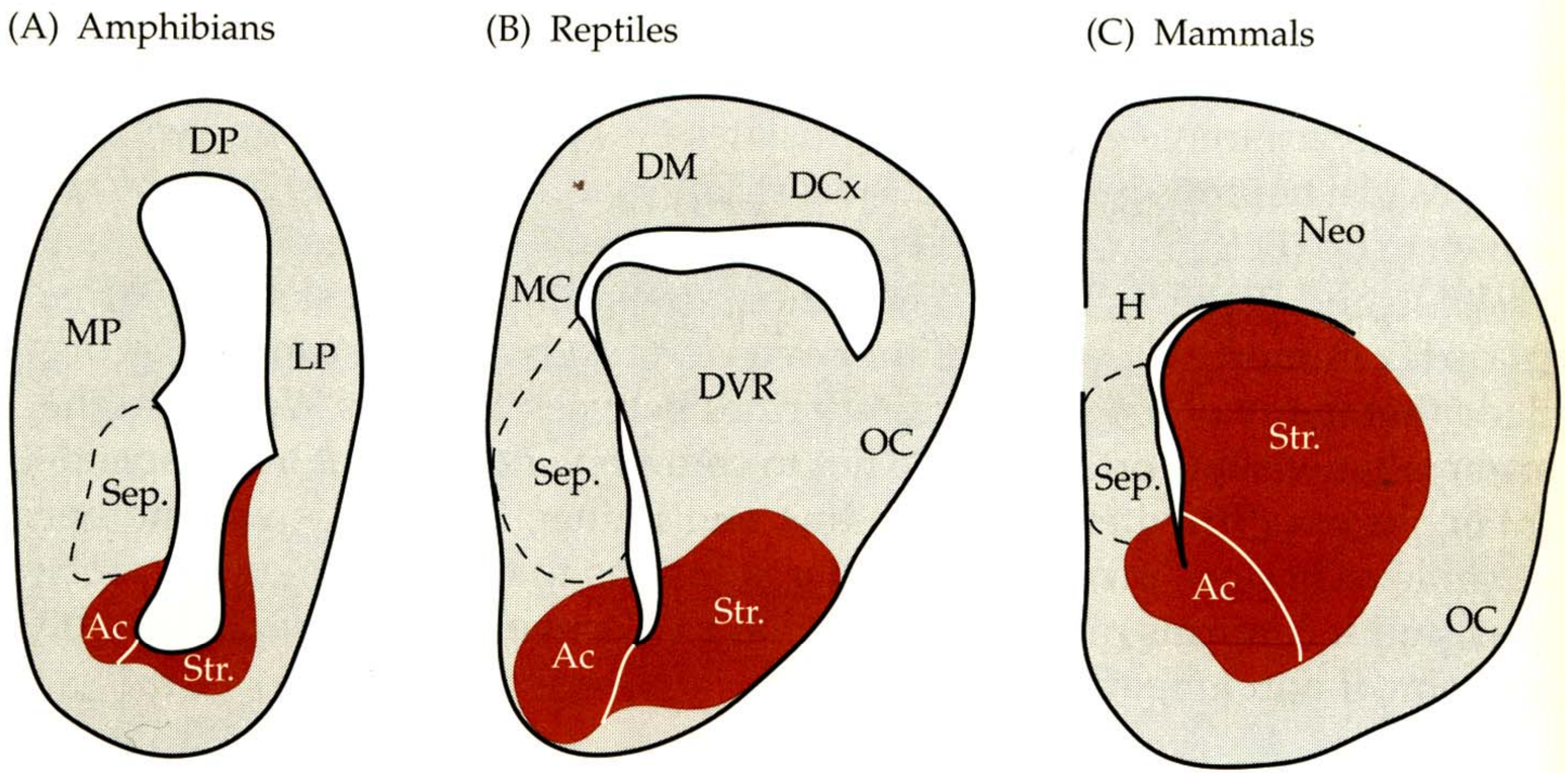
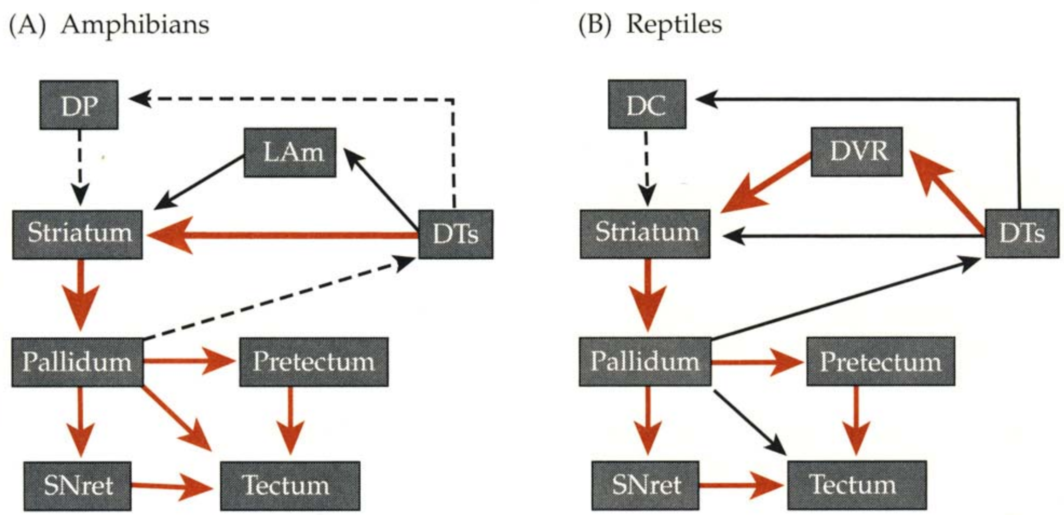


Figure 8.12 The Position of the Forebrain's Basal Ganglia in Tetrapods The striatum (Str.) and nucleus accumbens (Ac; also called the ventral striatum) occupy topologically equivalent positions in the telencephalon of (A) amphibians, (B) reptiles, and (C) mammals. The nucleus accumbens is generally located in the medial subpallium, just ventral to the septum (Sep.). The striatum, in contrast, generally lies lateral to the nucleus accumbens and occupies most of the ventrolateral subpallium. Other abbreviations: DCx = dorsal cortex; DM = dorsomedial cortex; DP = dorsal pallium; DVR = dorsal ventricular ridge; H = hippocampus; LP = lateral pallium; MC = medial cortex; MP = medial pallium; Neo. = neocortex; OC = olfactory cortex. (After Reiner et al., 1998; Marín et al., 1998.)



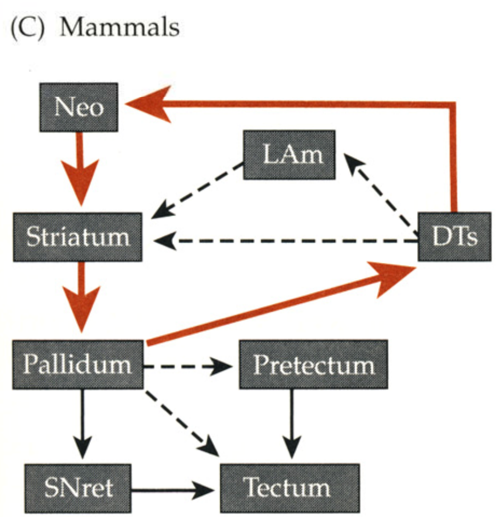
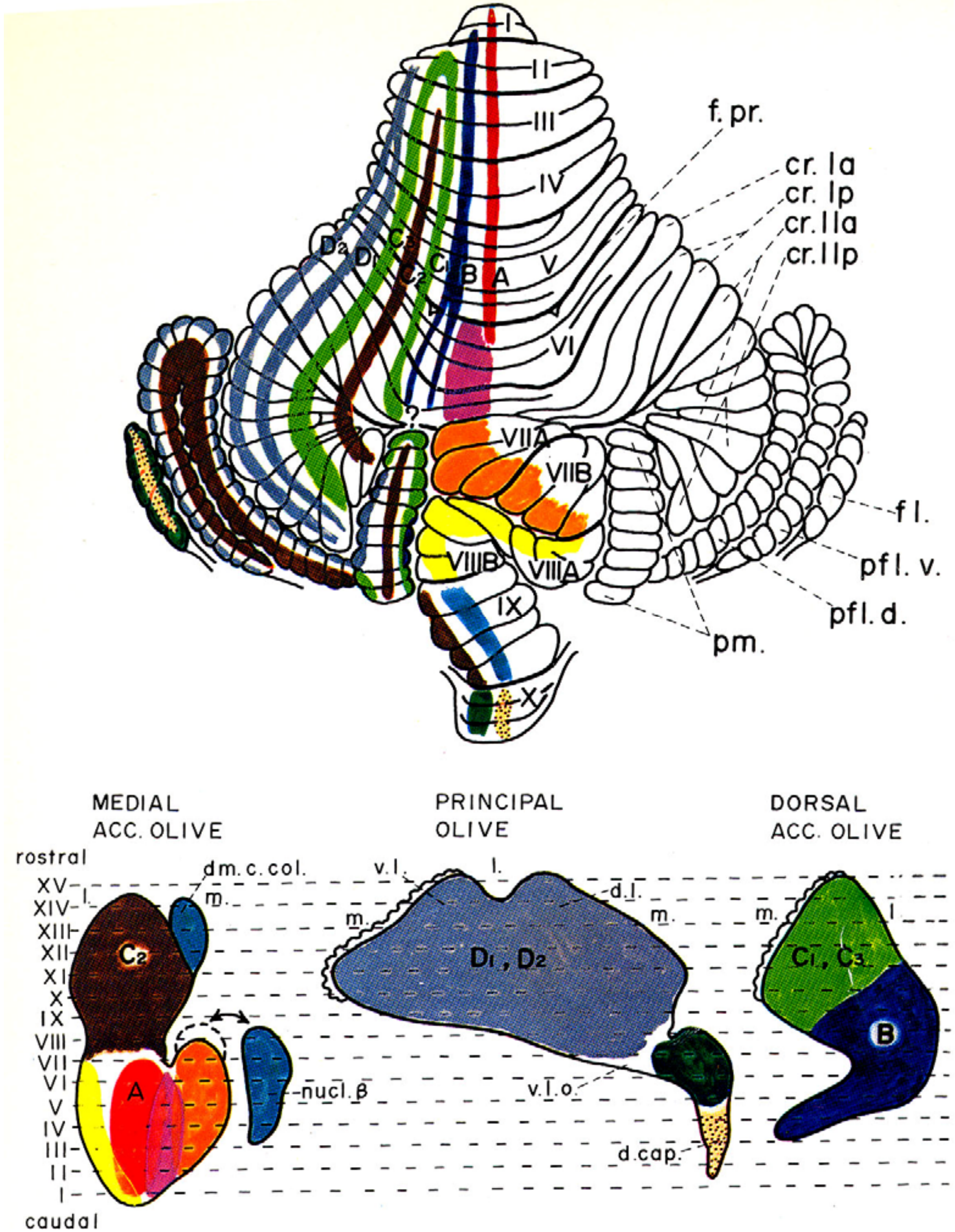


Figure 8.13 Connectivity of the Basal Ganglia in Tetrapods In this schematic diagram, connection strengths are represented by line width and arrowhead size, with thin, dashed arrows indicating the weakest connections. Based on these connection strengths, it is possible to estimate the predominant lines of information flow through the basal ganglia (red arrows). Such an analysis suggests that the striatum's major input comes (A) from the dorsal thalamus in amphibians, (B) from the DVR in reptiles and birds, or (C) from the neocortex in mammals. The striatal outflow also differs between taxonomic groups, being directed mainly toward the tectum in reptiles and amphibians, and toward the dorsal thalamus in mammals. Omitted from this figure are the dopaminergic inputs to the striatum, which are highly conserved across the vertebrates (see Chapter 3). Abbreviations: DC = dorsal cortex; DP = dorsal pallium; LAM = lateral amygdala; DTs = sensory dorsal thalamus; SNret = Substantia nigra, pars reticularis; Neo = Neocortex; Pretec = Pretectum; DVR = Dorsal ventricular ridge.



I
II
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VIIA
VIIB
VIIIB
VIIIA
IX
X
D2
D1
C3
C1
C2
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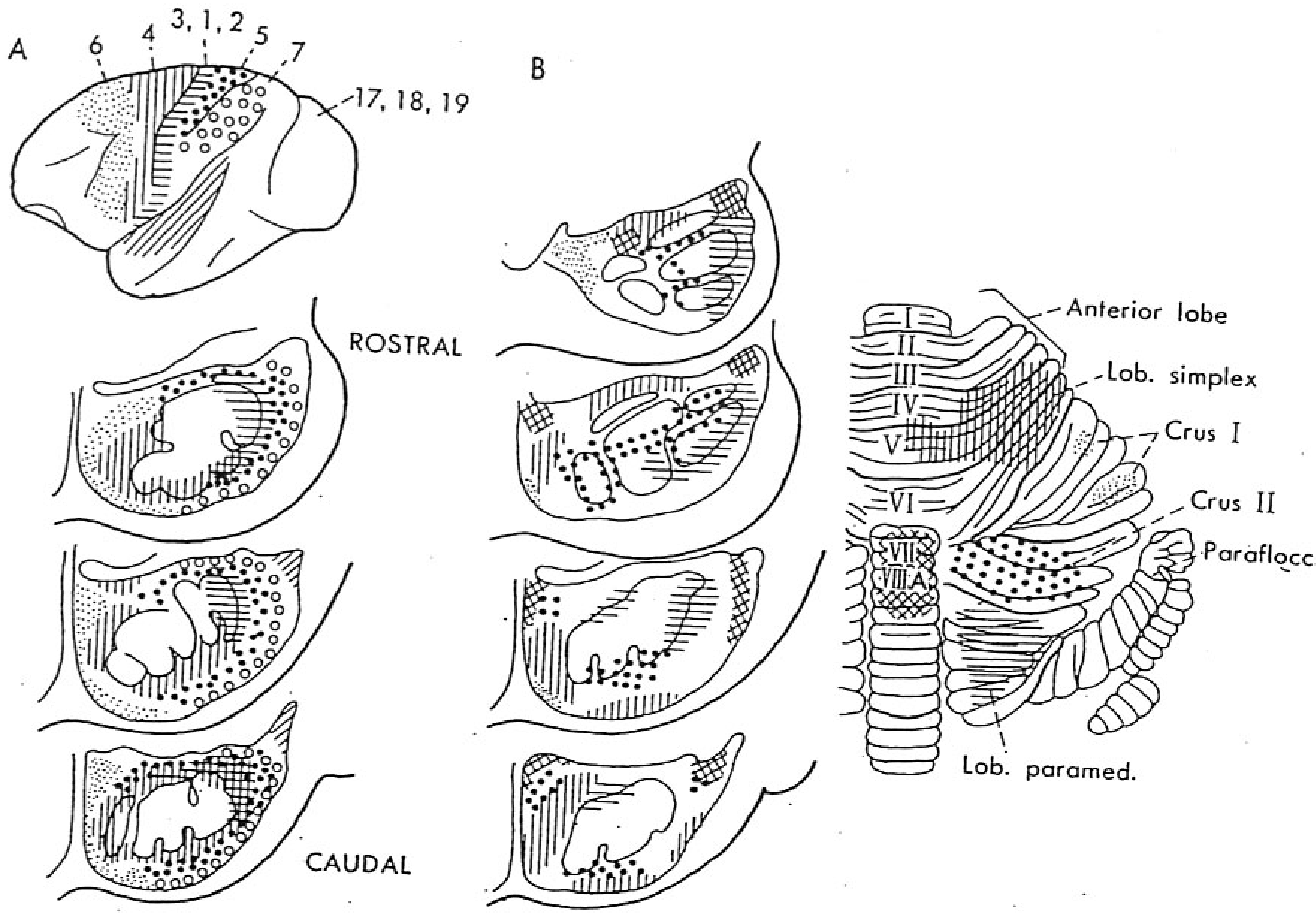
f. pr.
cr. Ia
cr. Ip
cr. IIa
cr. IIp
fl.
pfl. v.
pfl. d.
pm.
MEDIAL ACC. OLIVE
PRINCIPAL OLIVE
DORSAL ACC. OLIVE
rostral
caudal
XV
XIV
XIII
XII
XI
X
IX
VIII
VII
VI
V
IV
III
II
I
dm.c.col.
l.
m.
C2
A
nucl. β
v.l.
d.l.
D1, D2
v.l.o.
d.cap.
C1, C3
B



A
6
4
3, 1, 2
5
7
17, 18, 19
ROSTRAL
CAUDAL
B
I
II
III
IV
V
VI
VII
VIIIA
Anterior lobe
Lob. simplex
Crus I
Crus II
Paraflocc.
Lob. paramed.

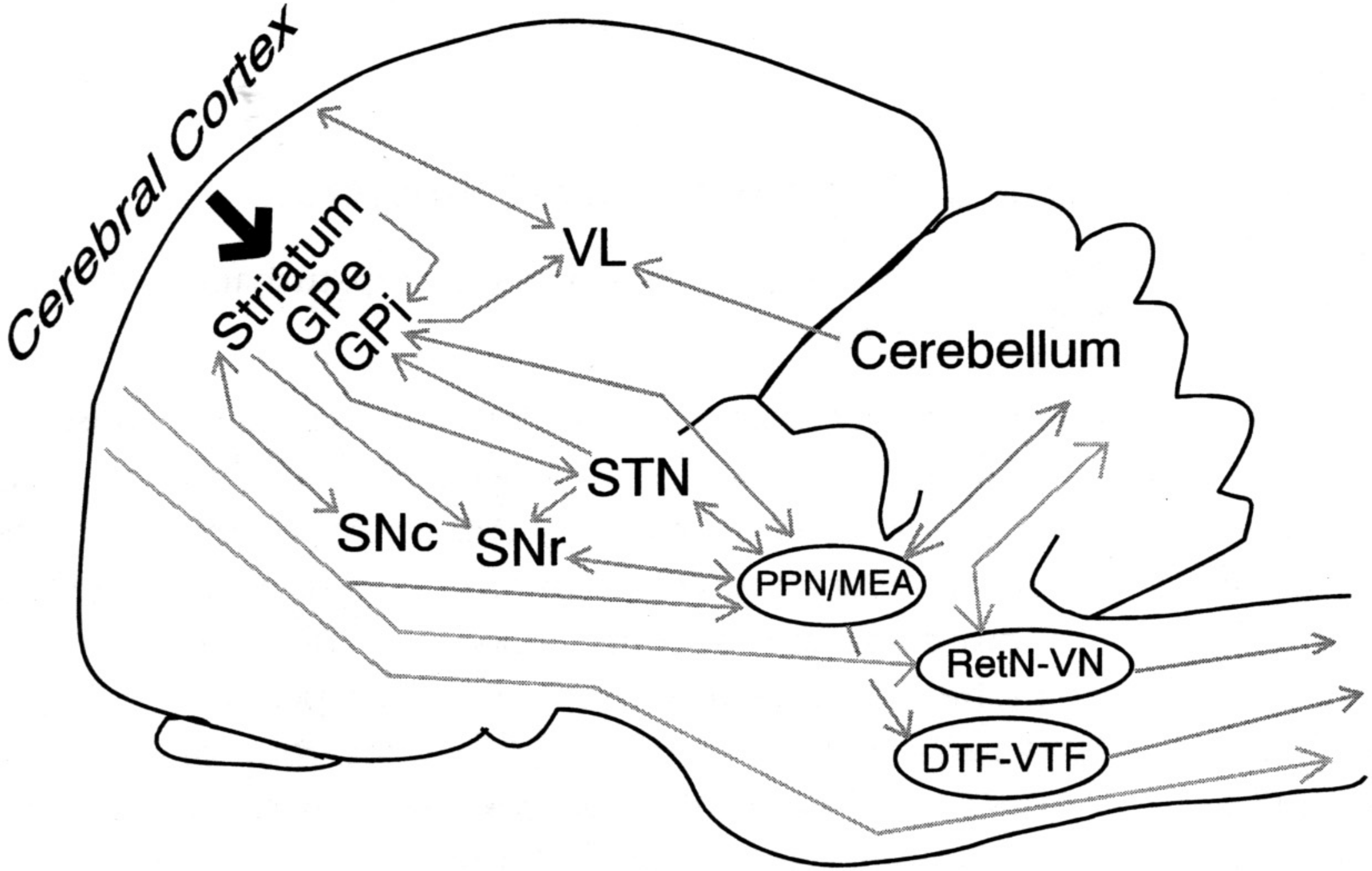


FIG. 2.5. Pathways involved in the supraspinal control of posture and movement. GPe and GPi, globus pallidus externa and interna; DTF and VTF, dorsal and ventral tegmental fields; PPN/MEA, pedunculopontine nucleus/midbrain extrapyramidal area; Ret. N., reticular nuclei; VN, lateral vestibular nucleus; SNr and SNc, substantia nigra pars reticulata and compacta; STN, subthalamus; VL, ventrolateral thalamus.

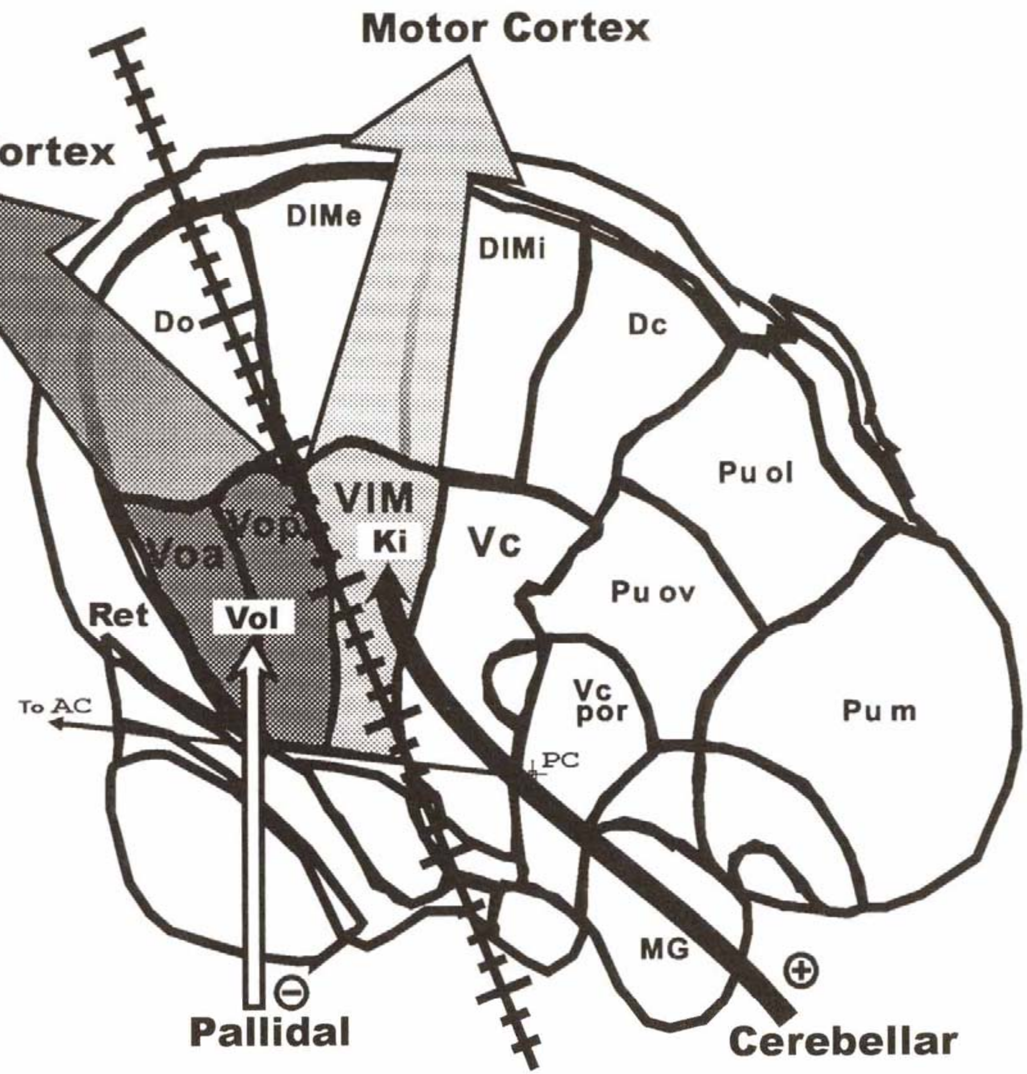
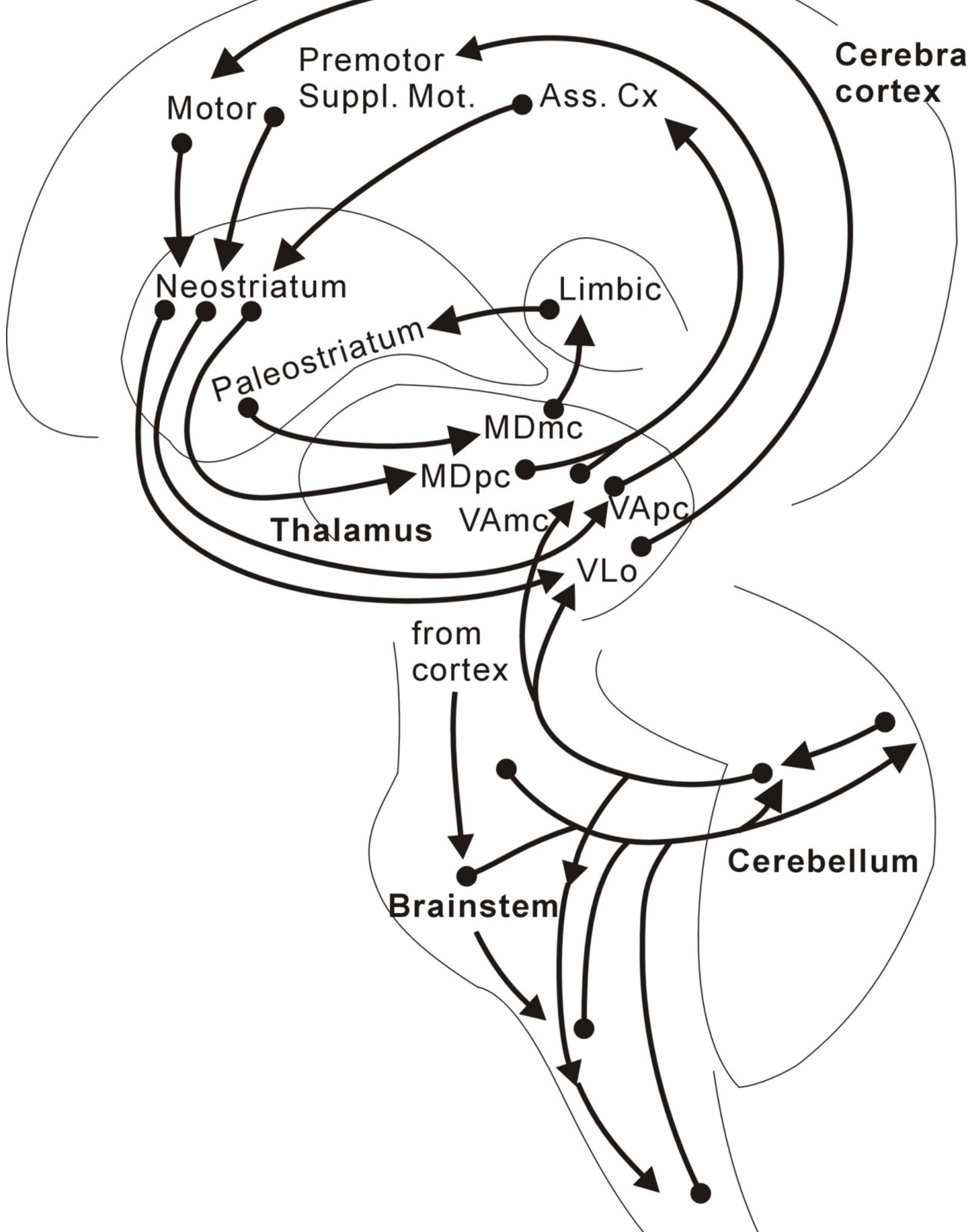
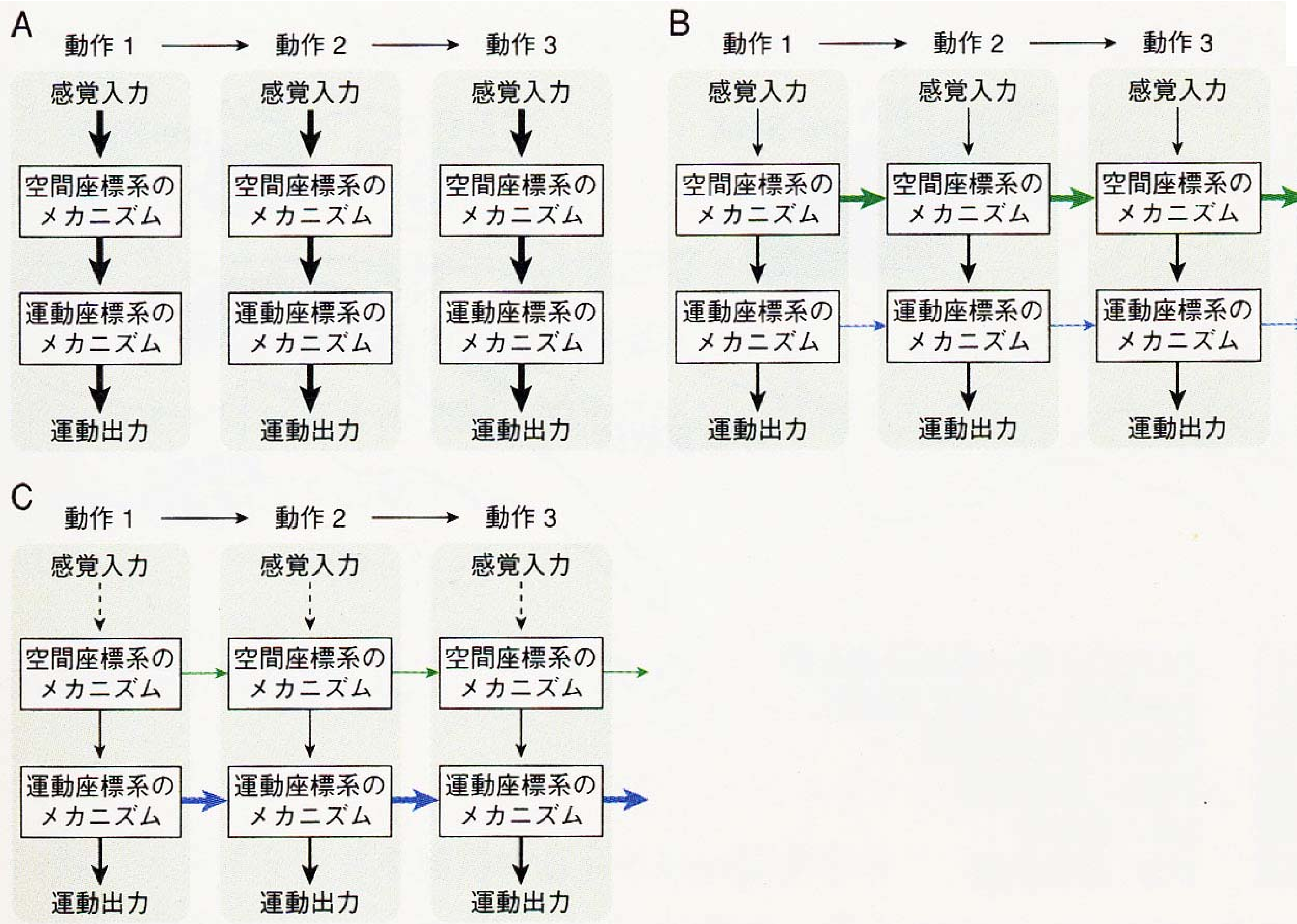


Figure 1. Diagram showing a sagittal section of the human thalamus at 14.5mm lateral to the midline. A typical electrode track is shown superimposed on the section (1 mm scale). Also shown are the presumed cerebellar- and pallidal-receiving areas of thalamus (Hirai and Jones, 1989; Macchi and Jones, 1997). Abbreviations: AC = anterior commissure; Dc = dorsal caudal nucleus; Dim.e = dorsal intermediate external nucleus; Dim.i = dorsal intermediate internal nucleus; Do = dorsal oral nucleus; MG = medial geniculate nucleus; PC = posterior commissure; Pu = pulvinar (m = medial; ol = oral lateral; ov = oral ventral) nucleus; Ret = reticular nucleus; Vc = ventral caudal nucleus; Vc.por = ventral caudal portae nucleus; Vim = ventral intermediate nucleus; Voa = ventral oral anterior nucleus; Vop = ventral oral posterior nucleus.


Premotor
Suppl. Mot.
Motor
Ass. Cx
Cerebral
cortex
Neostriatum
Limbic
Paleostriatum
MDmc
MDpc
VAmc
VApc
Thalamus
VLo
from
cortex
Cerebellum
Brainstem


A
動作 1
動作 2
動作 3
感覚入力
感覚入力
感覚入力
空間座標系のメカニズム
空間座標系のメカニズム
空間座標系のメカニズム
運動座標系のメカニズム
運動座標系のメカニズム
運動座標系のメカニズム
運動出力
運動出力
運動出力
B
動作 1
動作 2
動作 3
感覚入力
感覚入力
感覚入力
空間座標系のメカニズム
空間座標系のメカニズム
空間座標系のメカニズム
運動座標系のメカニズム
運動座標系のメカニズム
運動座標系のメカニズム
運動出力
運動出力
運動出力
C
動作 1
動作 2
動作 3
感覚入力
感覚入力
感覚入力
空間座標系のメカニズム
空間座標系のメカニズム
空間座標系のメカニズム
運動座標系のメカニズム
運動座標系のメカニズム
運動座標系のメカニズム
運動出力
運動出力
運動出力

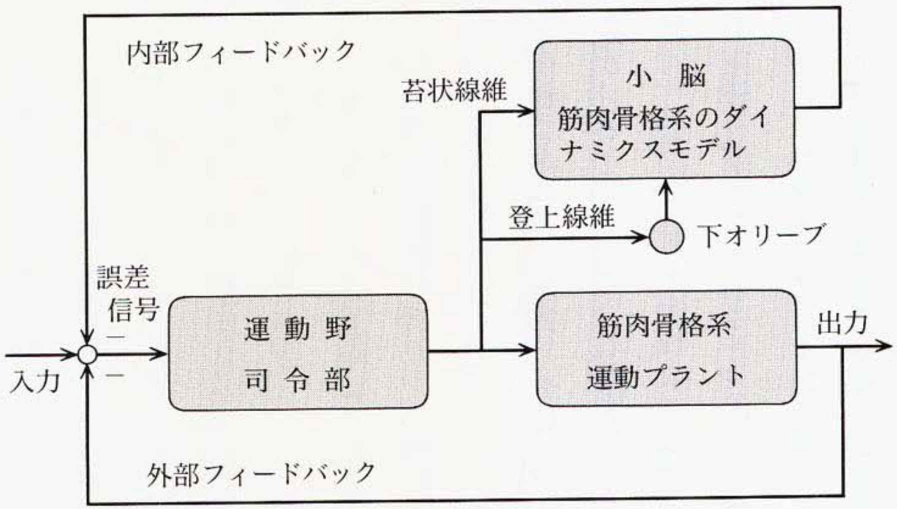


図 20　ダイナミクスモデル運動制御系

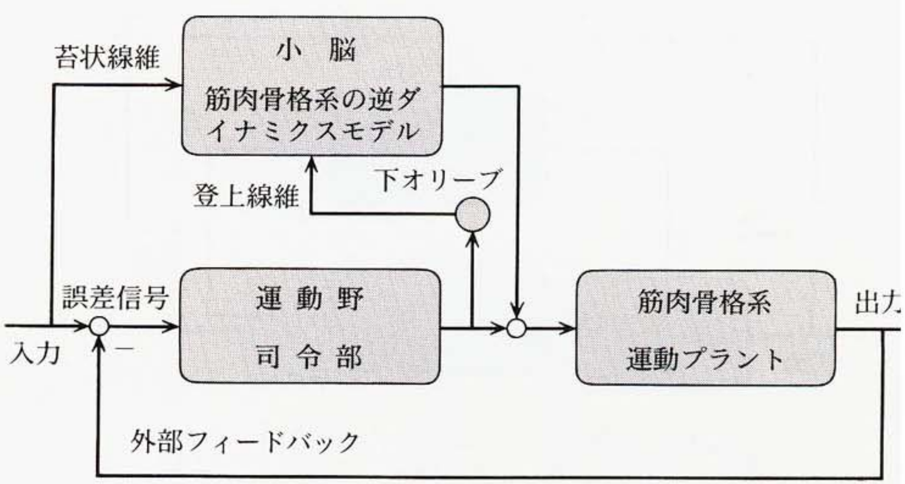


図 21　逆ダイナミクスモデル運動制御系

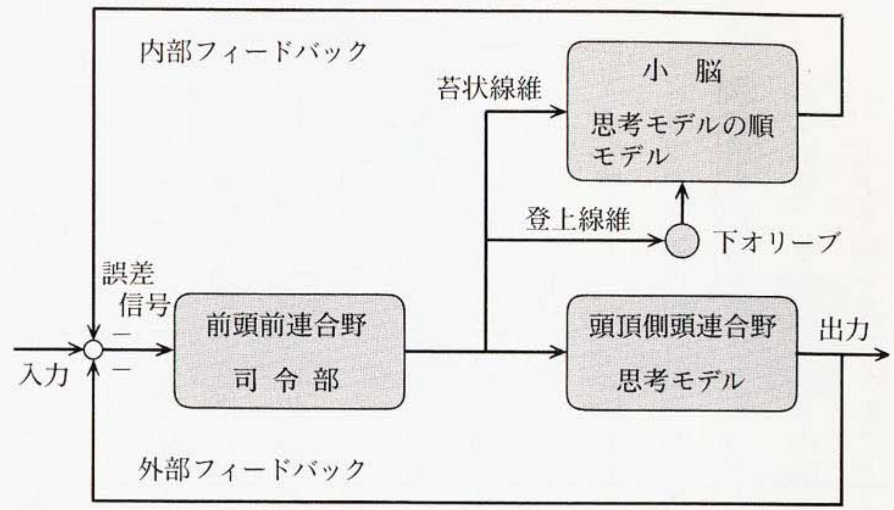


図 22　思考モデルの順モデルを組み込んだ思考系

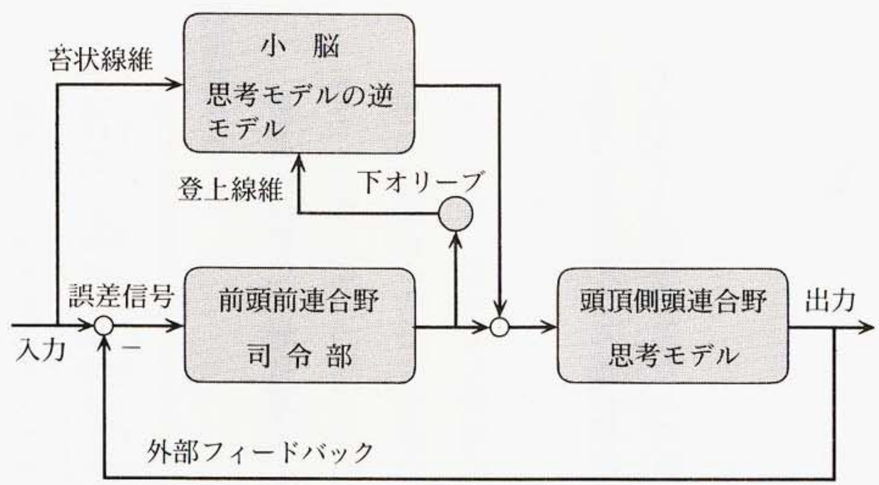
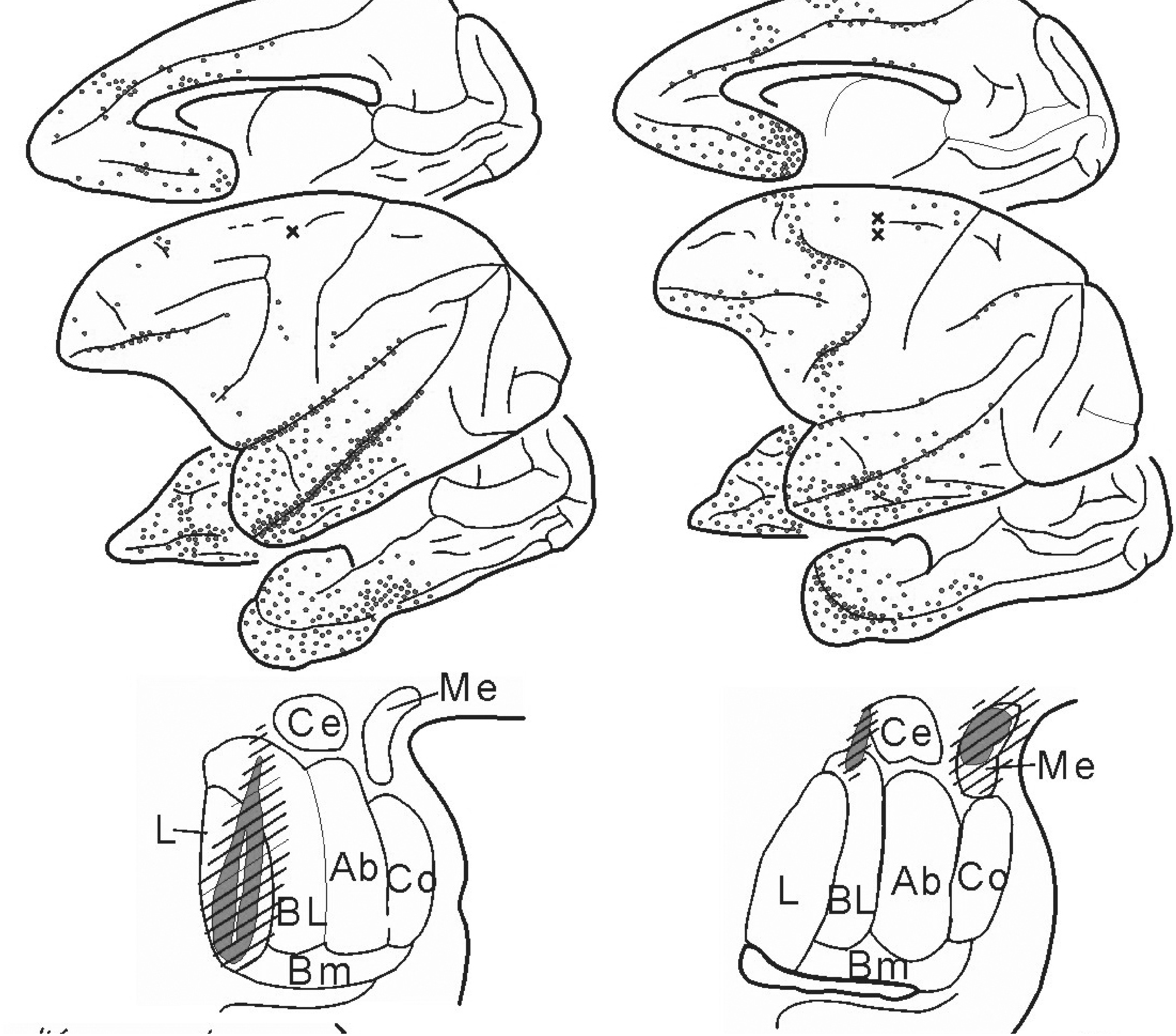
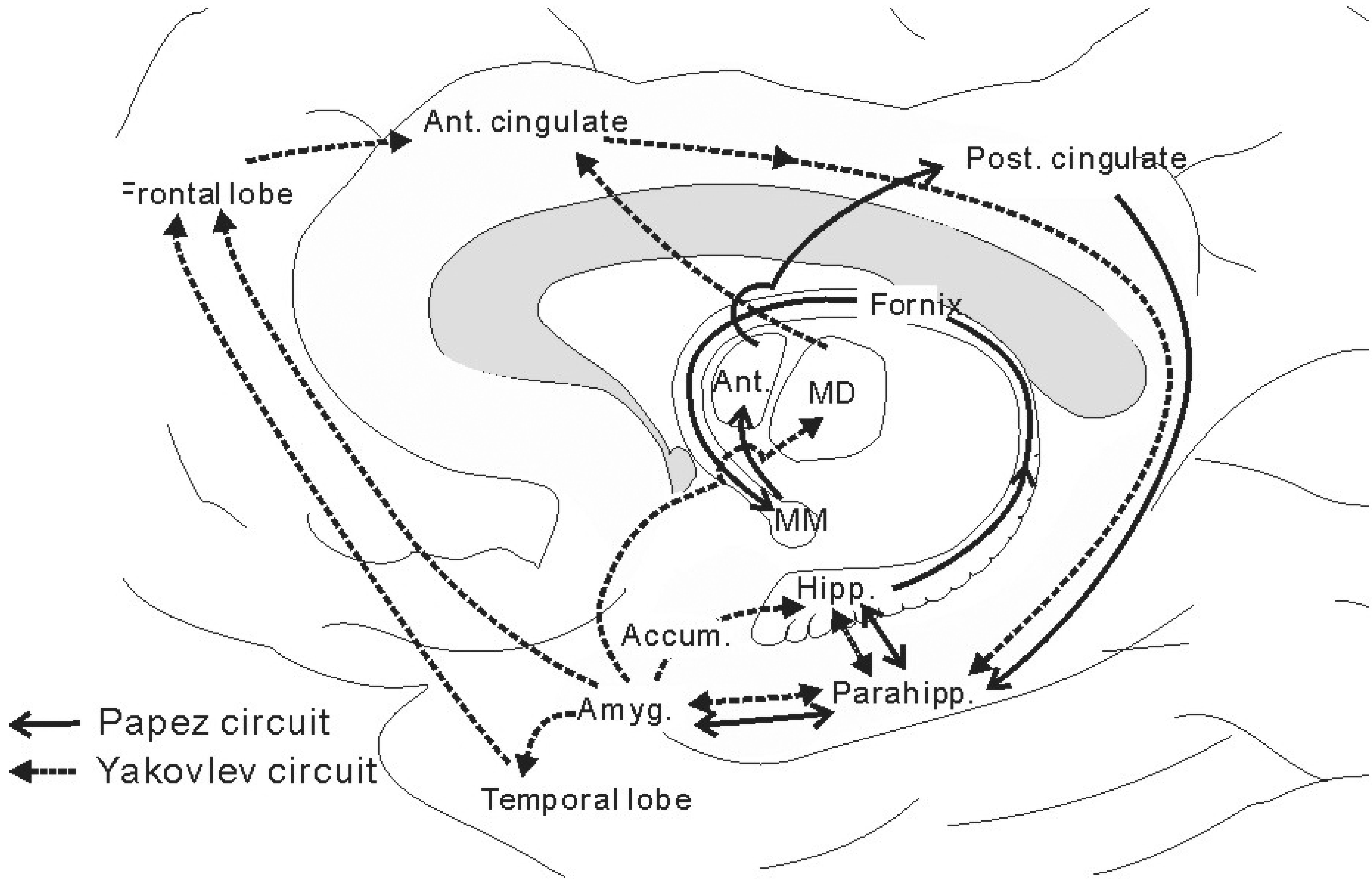
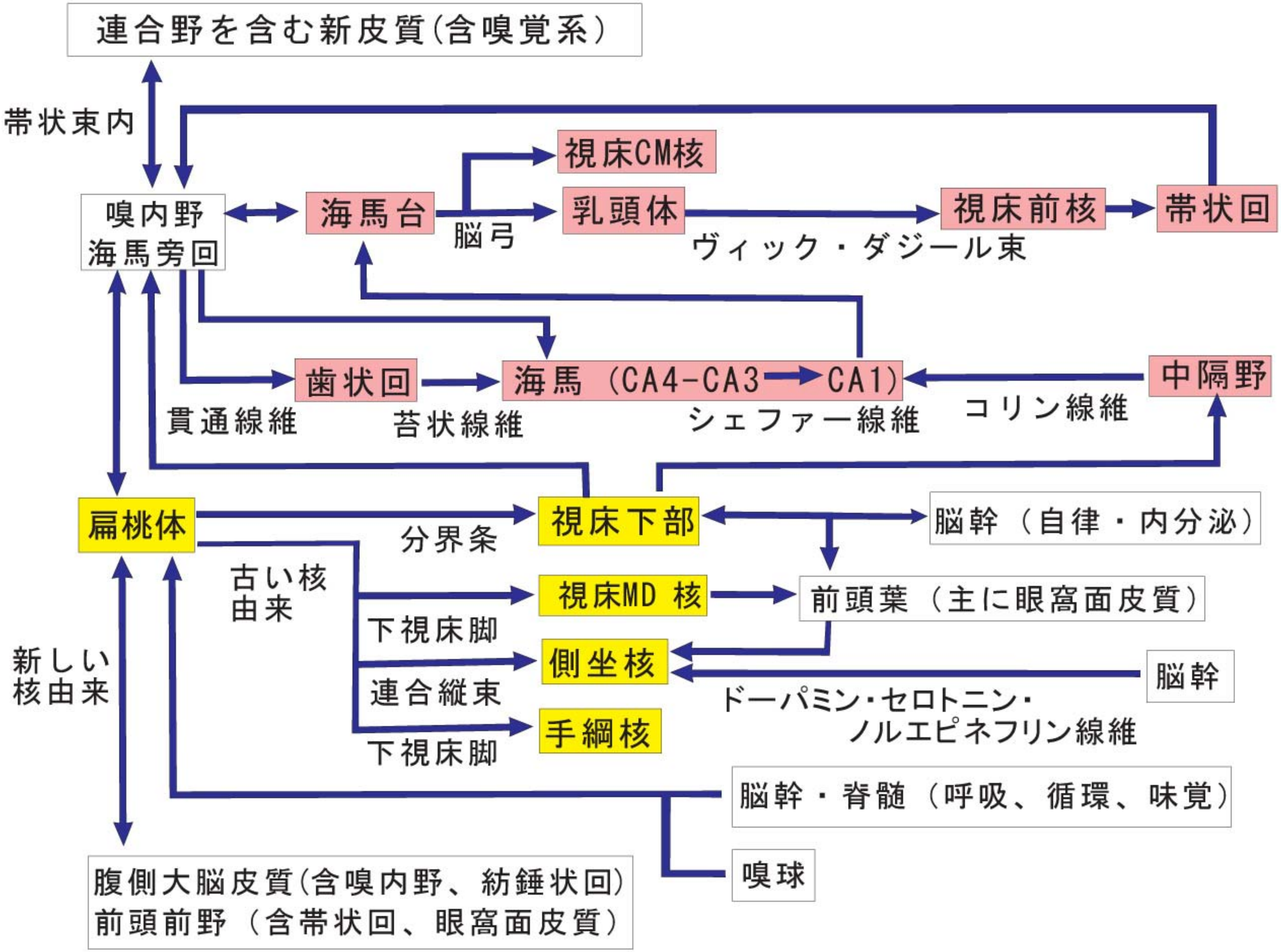


図 23　思考モデルの逆モデルを組み込んだ思考系


Me
Ce
L
Ab
Co
BL
Bm
Ce
Me
L
BL
Ab
Co
Bm



Ant. cingulate
Post. cingulate
Frontal lobe
Fornix
Ant.
MD
MM
Hipp.
Accum.
Parahipp.
Amyg.
Temporal lobe
Papez circuit
Yakovlev circuit



連合野を含む新皮質(含嗅覚系)
帯状束内
嗅内野
海馬旁回
海馬台
視床CM核
乳頭体
脳弓
視床前核
帯状回
ヴィック・ダジール束
歯状回
海馬（CA4-CA3
CA1)
中隔野
貫通線維
苔状線維
シェファー線維
コリン線維
扁桃体
視床下部
脳幹（自律・内分泌)
分界条
古い核
由来
視床MD 核
前頭葉（主に眼窩面皮質)
下視床脚
側坐核
脳幹
新しい
核由来
連合縦束
ドーパミン・セロトニン・
ノルエピネフリン線維
手綱核
下視床脚
脳幹・脊髄（呼吸、循環、味覚)
嗅球
腹側大脳皮質(含嗅内野、紡錘状回)
前頭前野（含帯状回、眼窩面皮質)

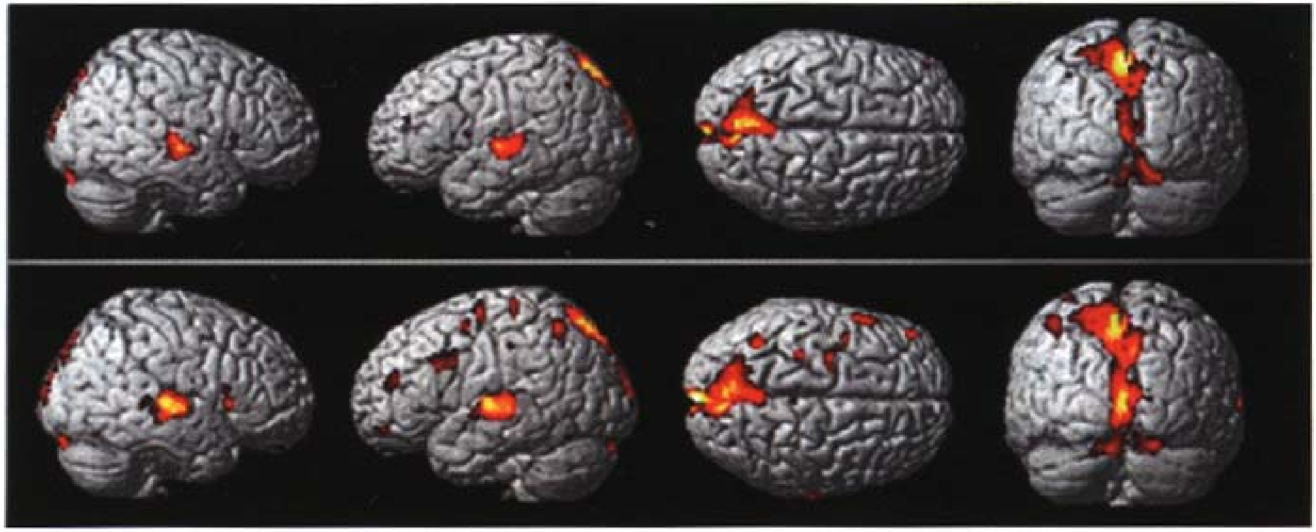


図３　健常者の課題に対する構えに関連する脳活動
(a) 注意を聴覚に向けているとき　(b) 注意を視覚に向けているとき

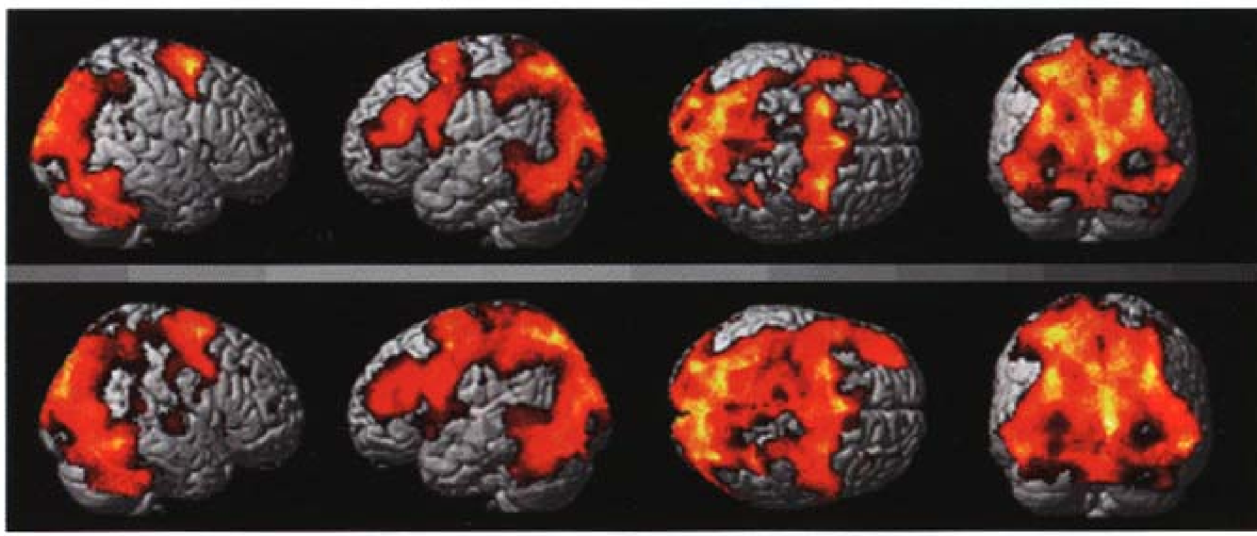
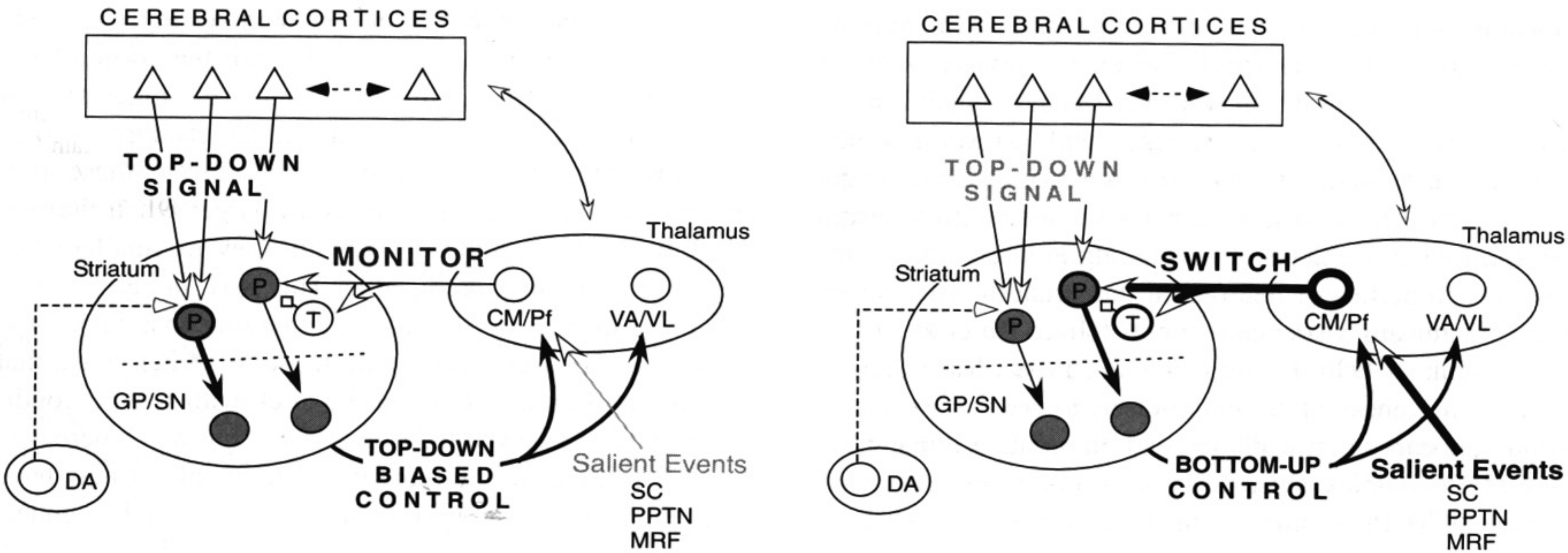
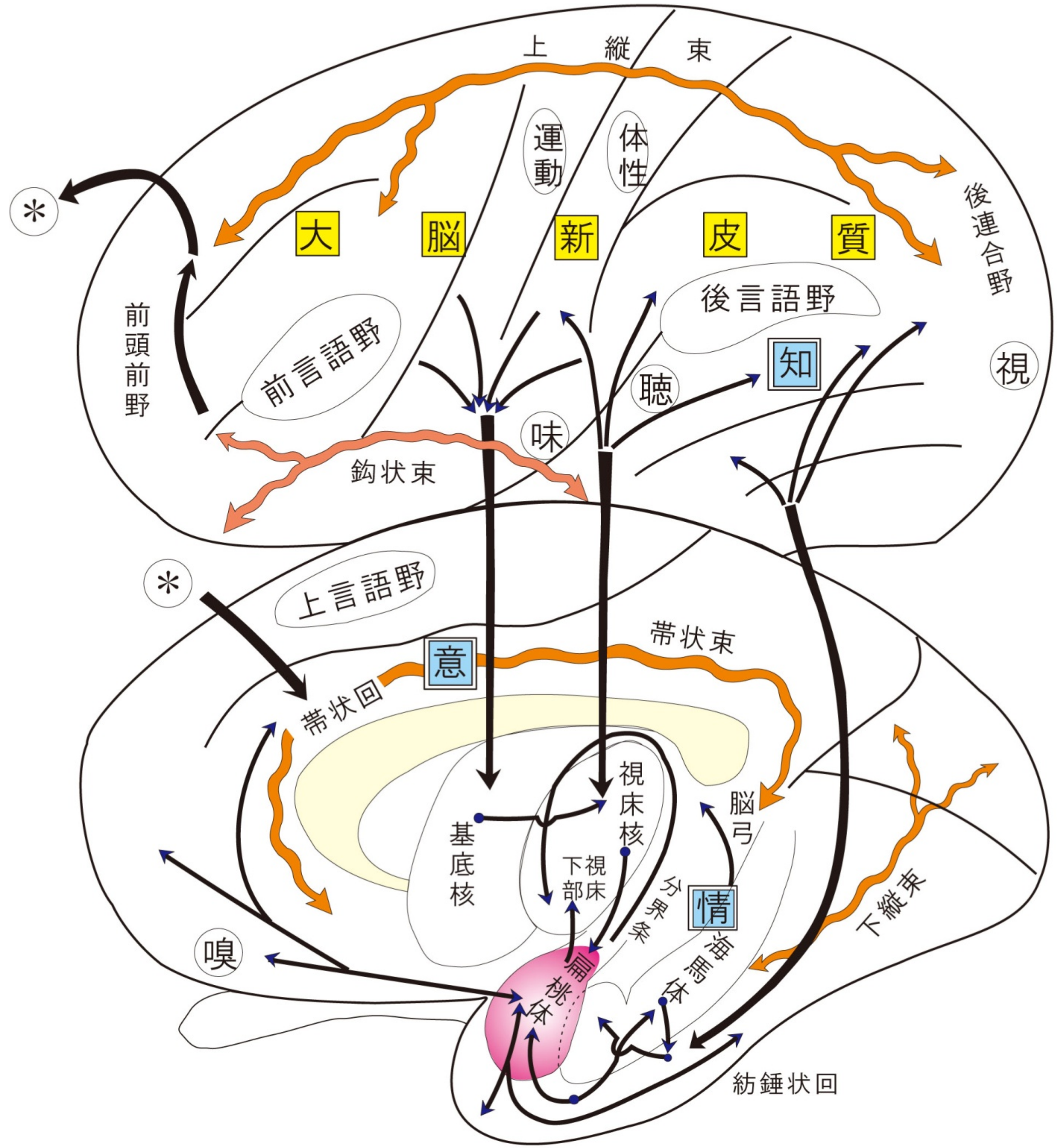
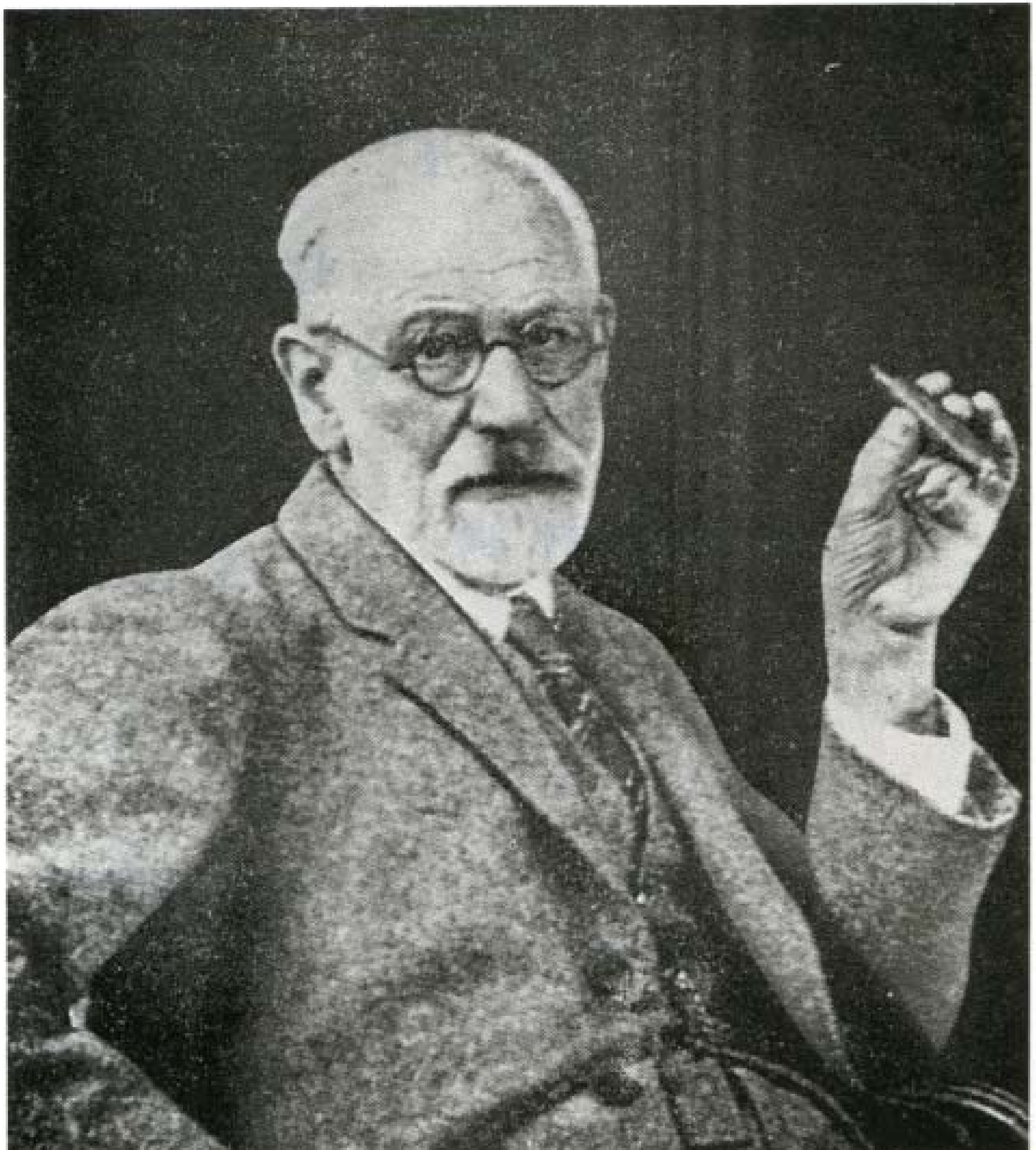


図４　統合失調症患者の課題に対する構えに関連する脳活動
(a) 注意を聴覚に向けているとき　(b) 注意を視覚に向けているとき



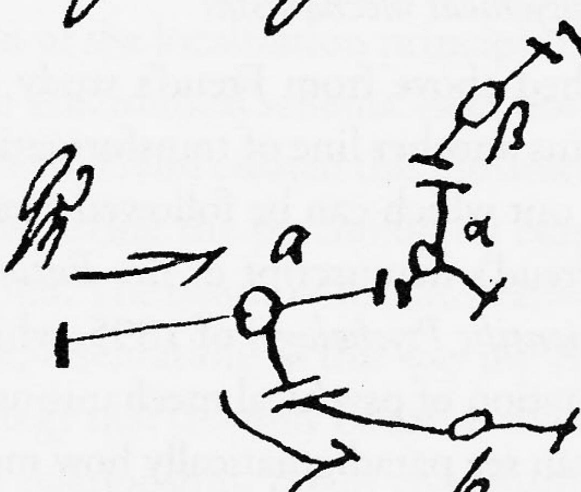
Kimura et al. (2005)


上縦束
運動
体性
大
脳
新
皮
質
後連合野
前頭前野
前言語野
後言語野
知
視
聴
味
鈎状束
上言語野
帯状束
意
帯状回
視床核
基底核
下視床部
脳弓
分界条
情
海馬体
扁桃体
下縦束
嗅
紡錘状回

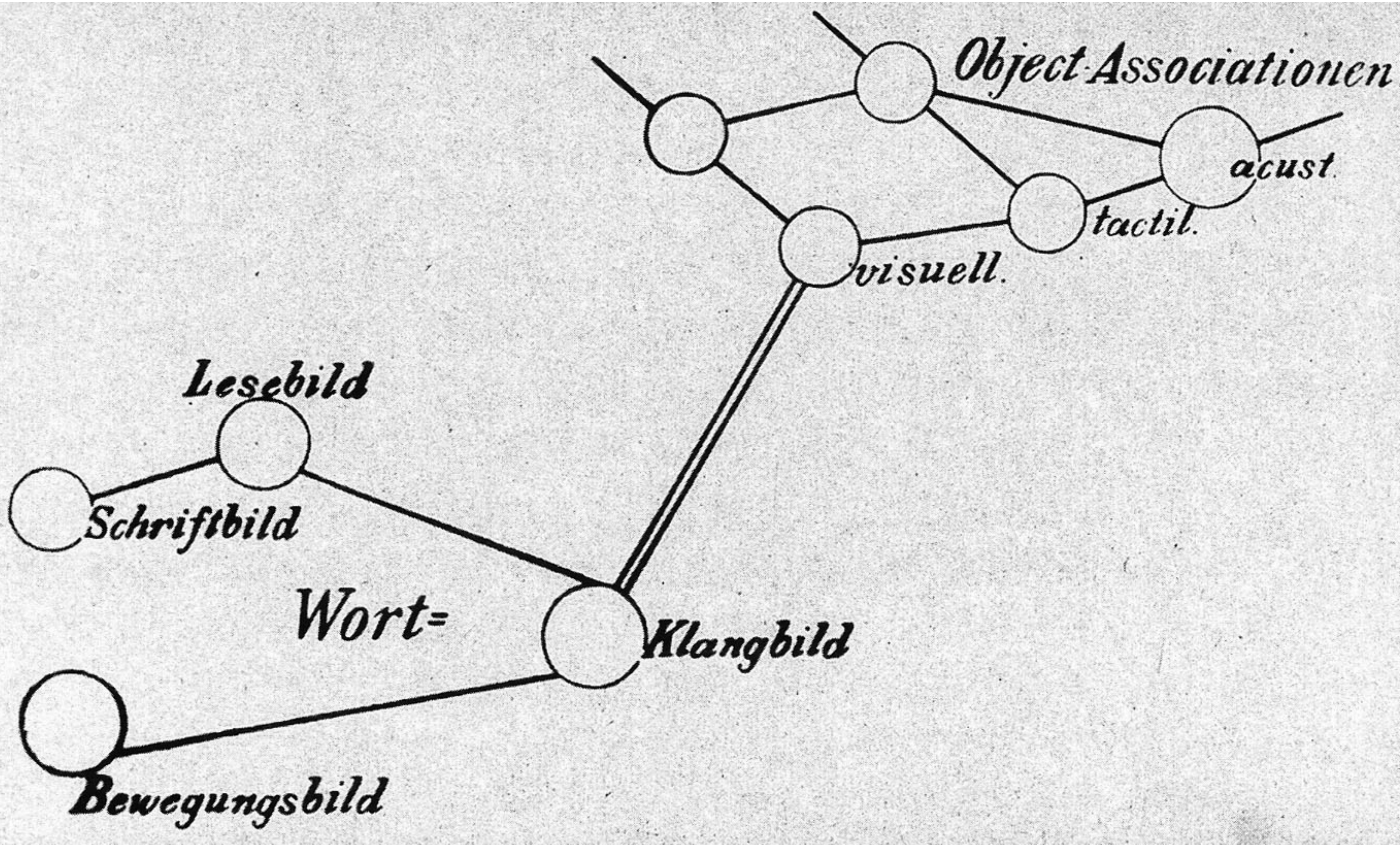


シャルコーの臨床講義

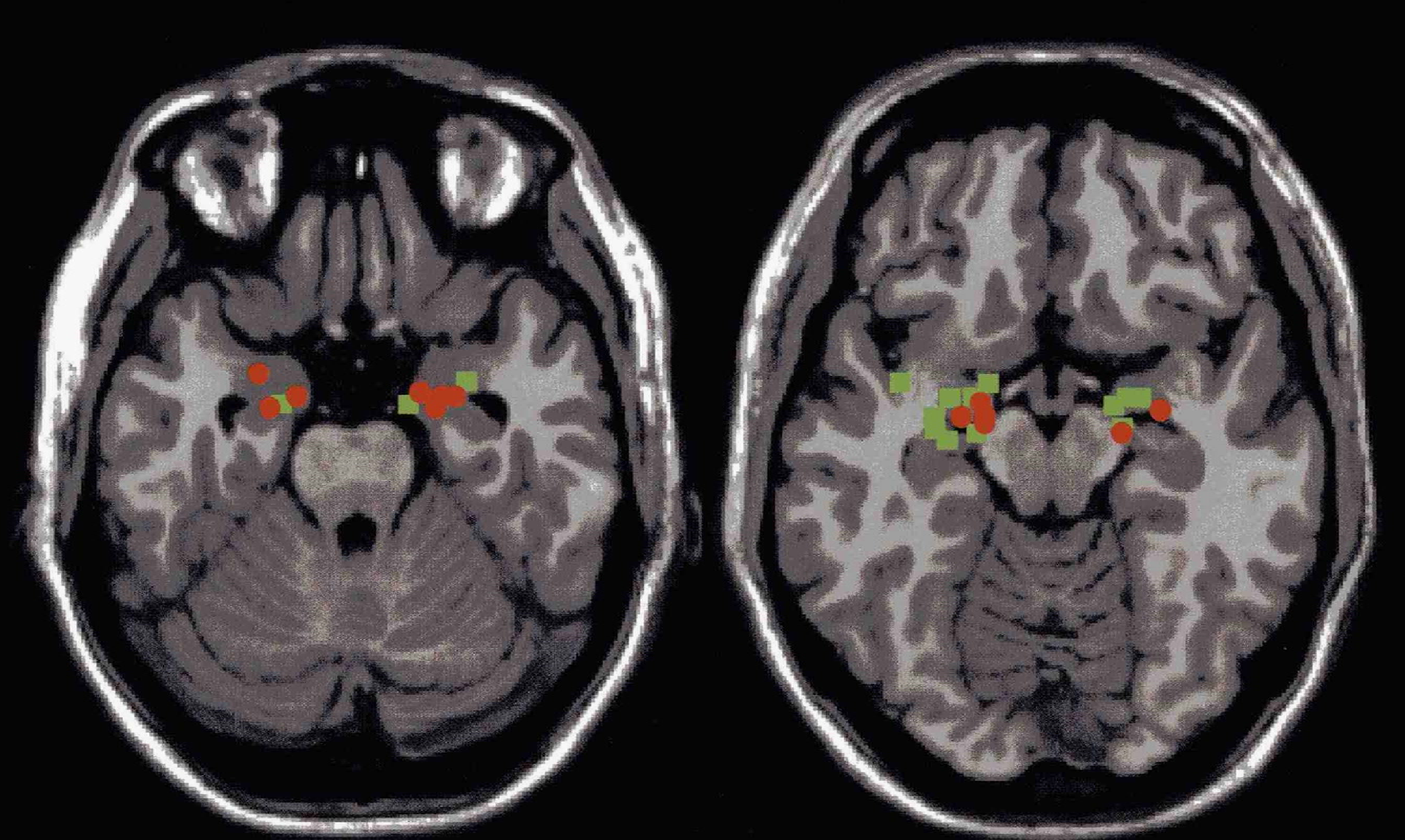
Stellen wir uns das Ich als ein
Netz besetzter gebahnter N vor, etwa so.



außen (φ) her
fließt nach dem
Neuron die Seiten
daß sie nur [illegible]
[illegible] her u

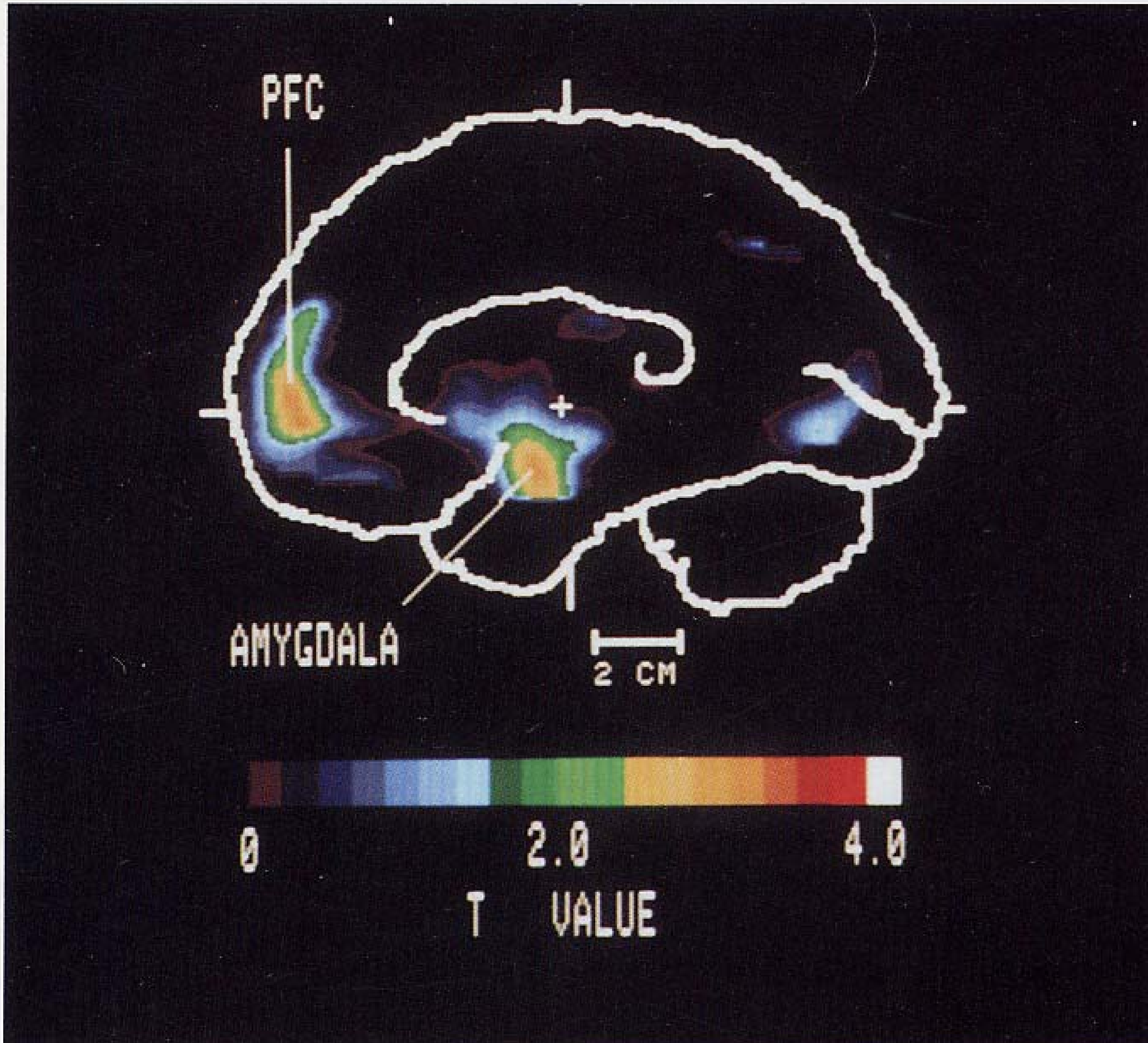

Object-Associationen.
acust.
tactil.
visuell.
Lesebild
Schriftbild
Wort=
Klangbild
Bewegungsbild

扁桃体と情動



ANDREW CALDER

機能的磁気共鳴画像装置（fMRI）で，脳の下部断面（左）と上部断面（右）を観察した。驚愕の表情を処理する時（緑）と条件付けされた恐怖に反応する時（赤）には扁桃体の左右両側が活性化することが示された。ただし，この2つの状況での情報処理には大きな差があり，驚愕の表情では扁桃体左上部が特に活発に働くのに対し，条件付けされた恐怖に対する反応は左右均等だ。


PFC
AMYGDALA
2 CM
0
2.0
4.0
T VALUE

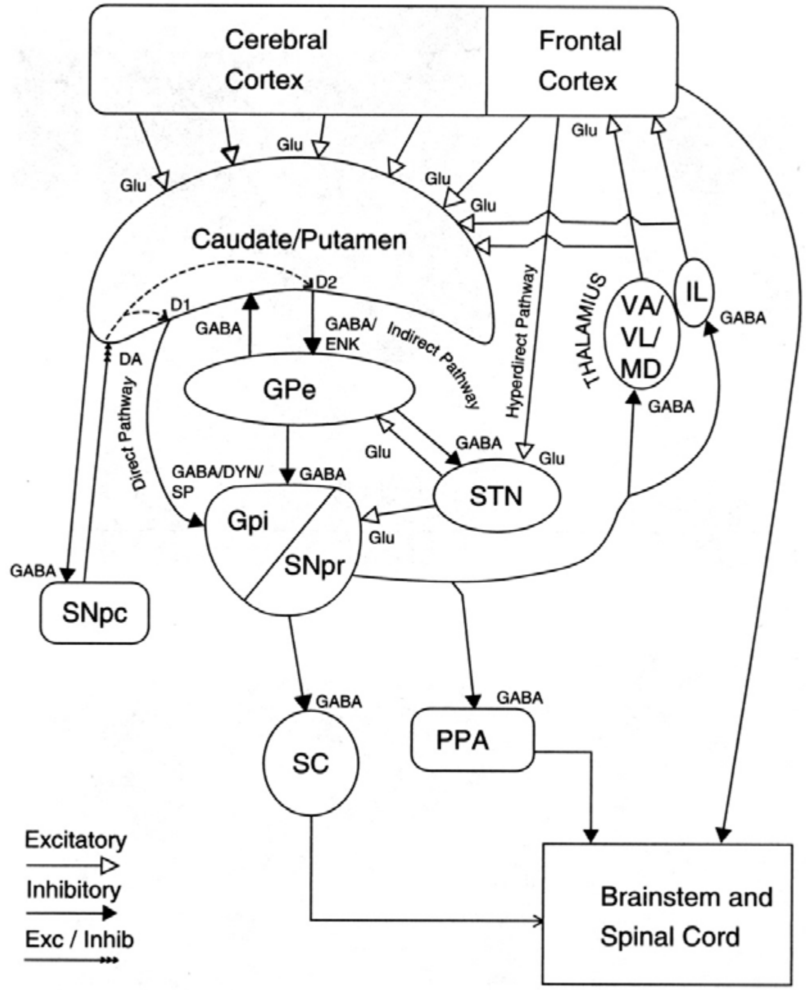
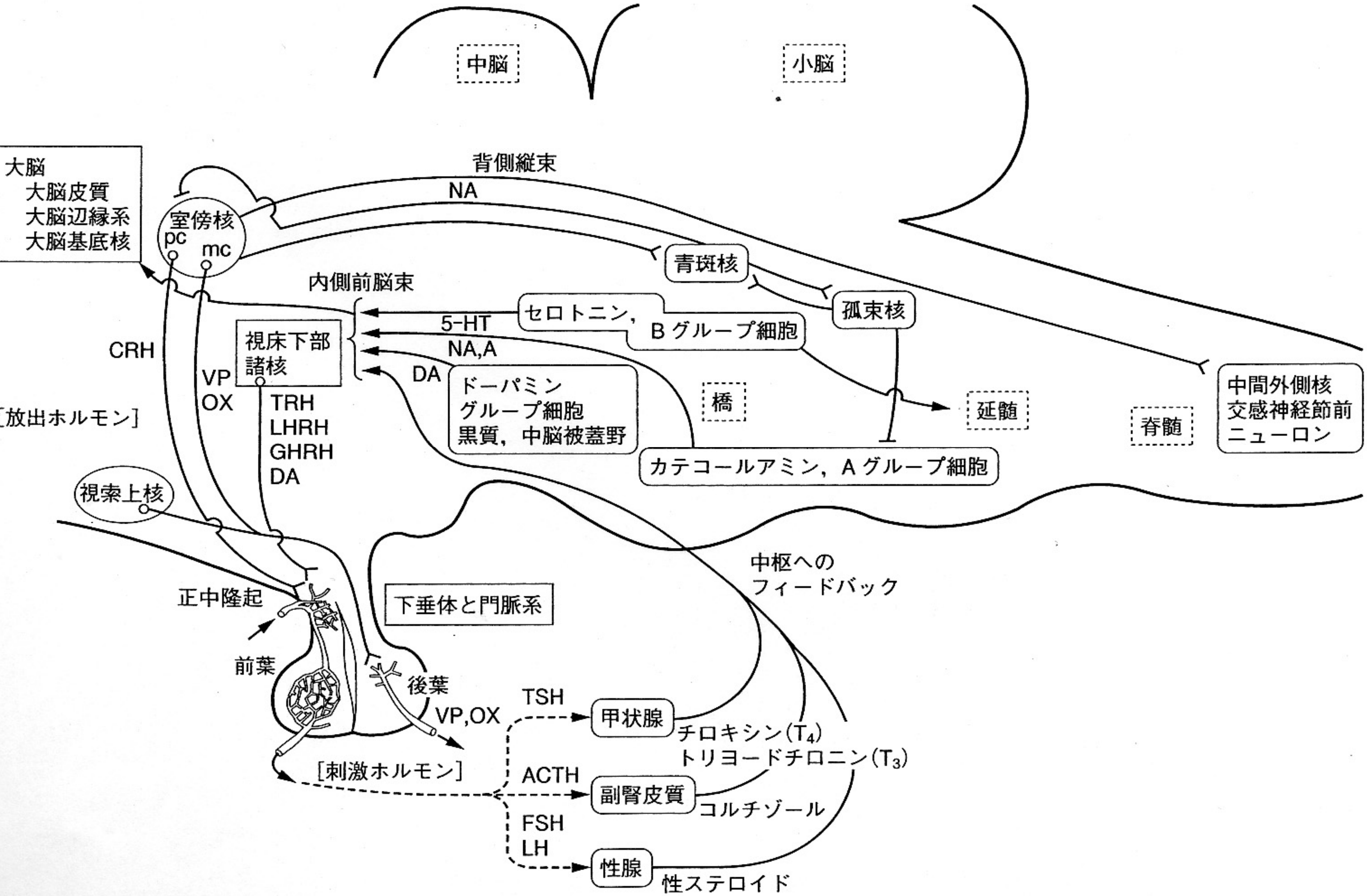
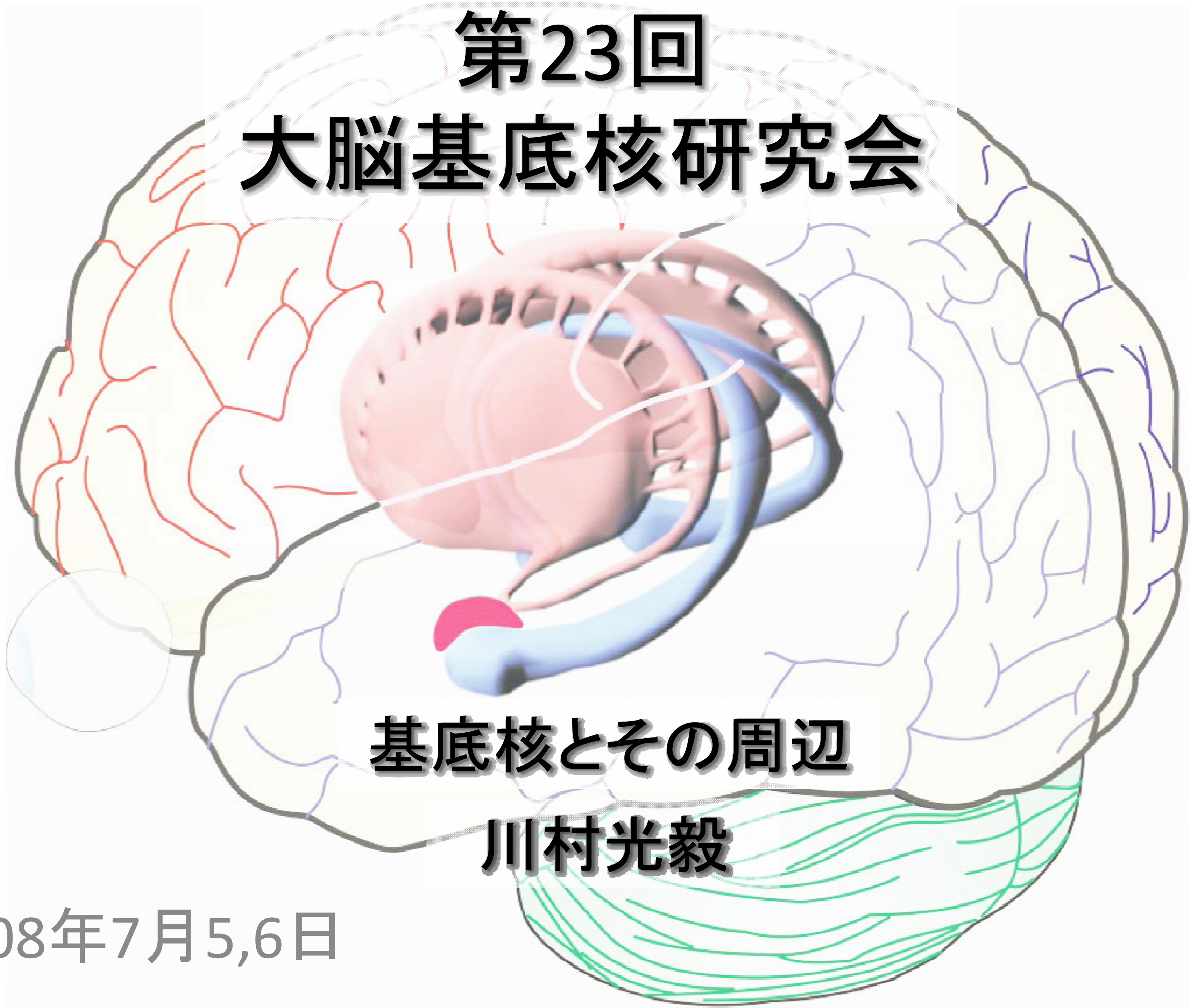


Figure 1.1 Simplified schematic diagram of basal ganglia–thalamocortical circuitry. Excitatory connections are indicated by open arrows, inhibitory connections by filled arrows. The modulatory dopamine projection is indicated by a three-headed arrow. dyn, dynorphin; enk, enkephalin; GABA, gamma-aminobutyric acid; glu, glutamate; GPe, globus pallidus pars externa; GPi, globus pallidus pars interna; IL, intralaminar thalamic nuclei; MD, mediodorsal nucleus; PPA, pedunculopontine area; SC, superior colliculus; SNpc, substantia nigra pars compacta; SNpr, substantia nigra pars reticulata; SP substance P; STN, subthalamic nucleus; VA, ventral anterior nucleus; VL, ventral lateral nucleus.



中脳
小脳
大脳
大脳皮質
大脳辺縁系
大脳基底核
背側縦束
NA
室傍核
pc
mc
青斑核
内側前脳束
孤束核
セロトニン，
Bグループ細胞
5-HT
NA,A
DA
視床下部
諸核
CRH
VP
OX
ドーパミン
グループ細胞
黒質，中脳被蓋野
橋
延髄
脊髄
中間外側核
交感神経節前
ニューロン
[放出ホルモン]
TRH
LHRH
GHRH
DA
カテコールアミン，Aグループ細胞
視索上核
中枢への
フィードバック
正中隆起
下垂体と門脈系
前葉
後葉
VP,OX
TSH
甲状腺
チロキシン(T_4)
トリヨードチロニン(T_3)
[刺激ホルモン]
ACTH
副腎皮質
コルチゾール
FSH
LH
性腺
性ステロイド



第23回
大脳基底核研究会

基底核とその周辺

川村光毅

2008年7月5,6日