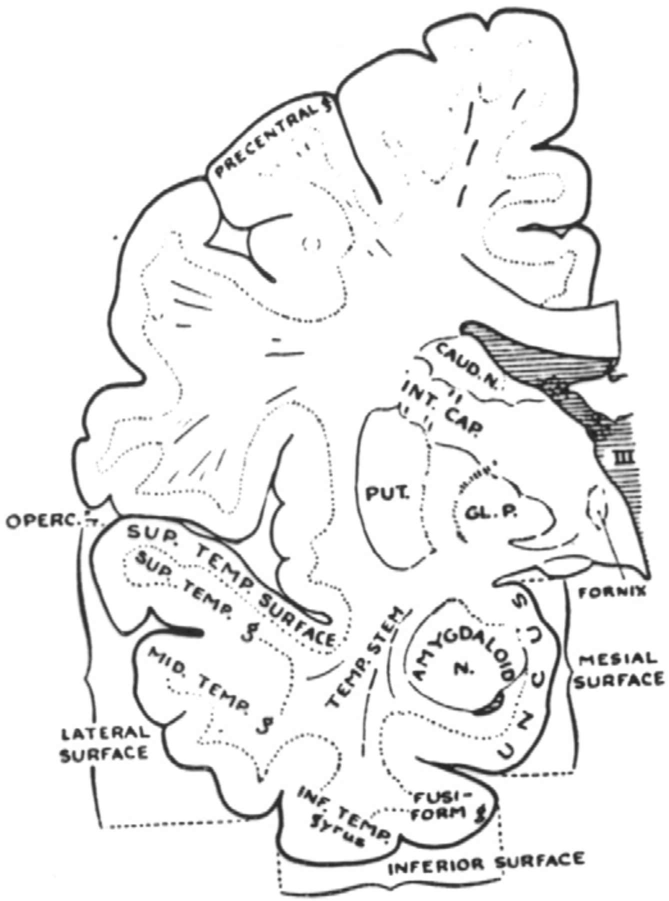
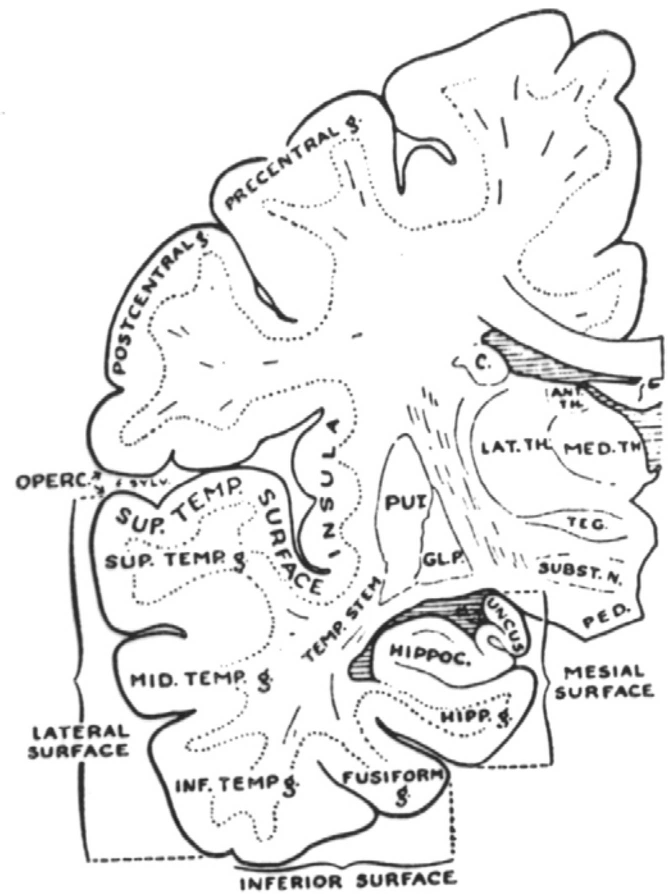
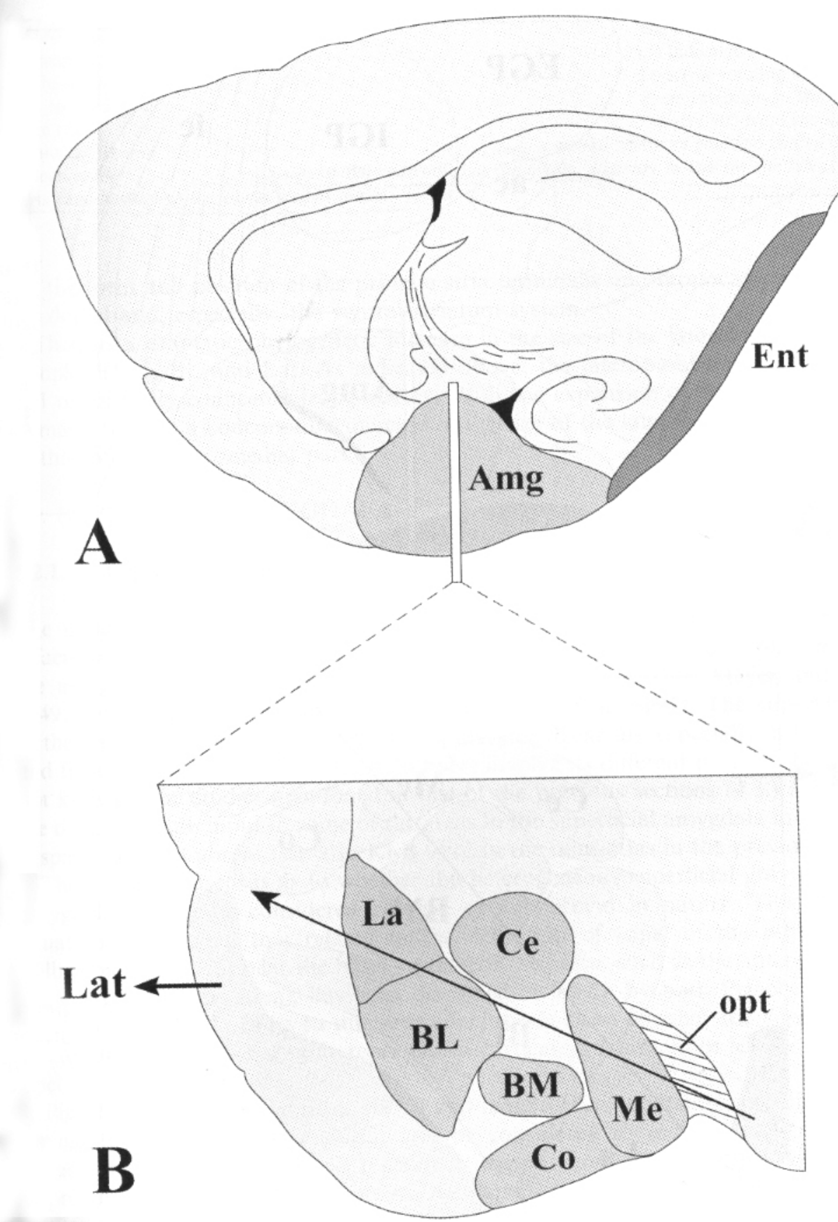
Limbic system-Amygdala

Medial Temporal Lobe. Amygdala and hippocampus



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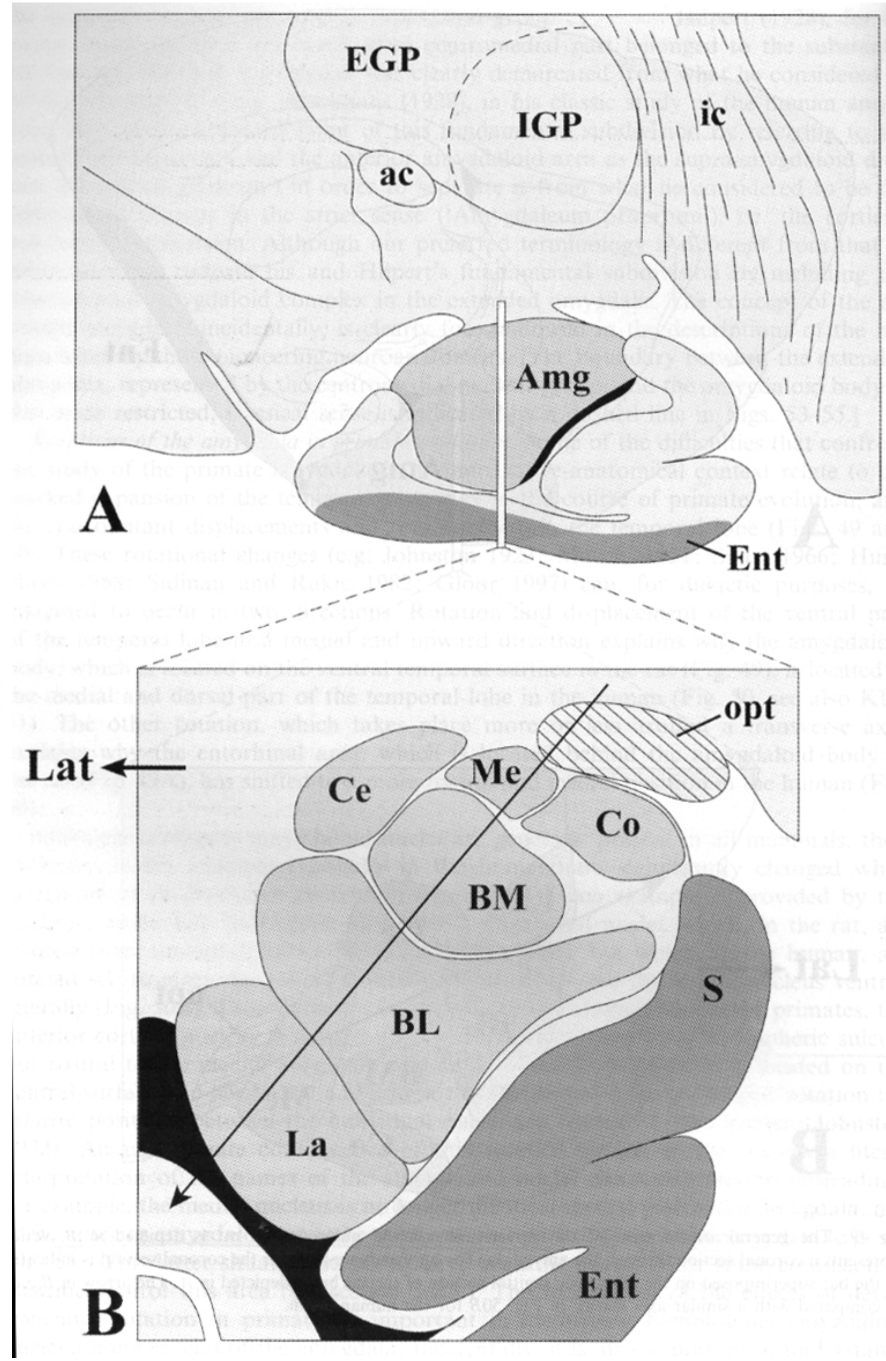
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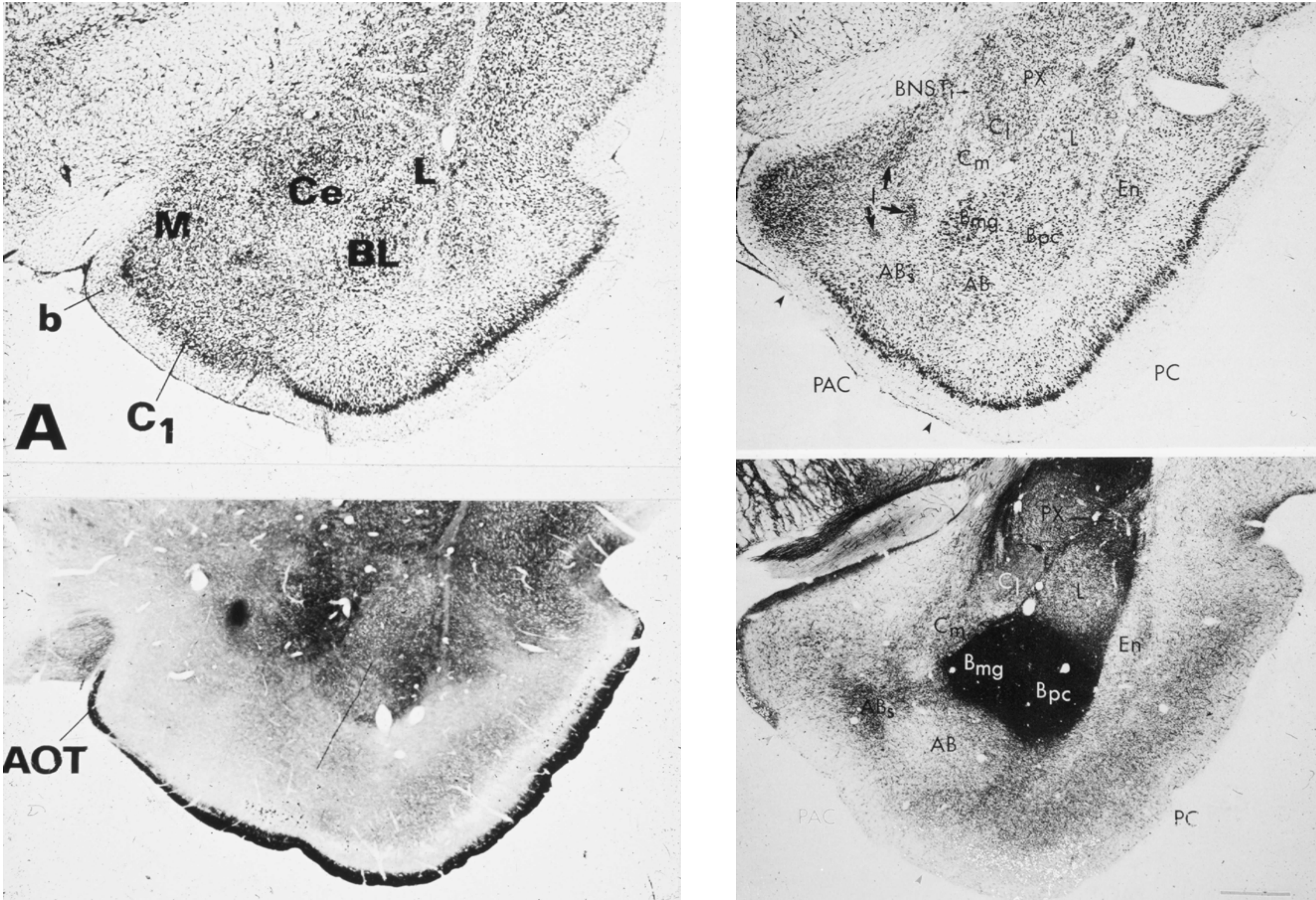

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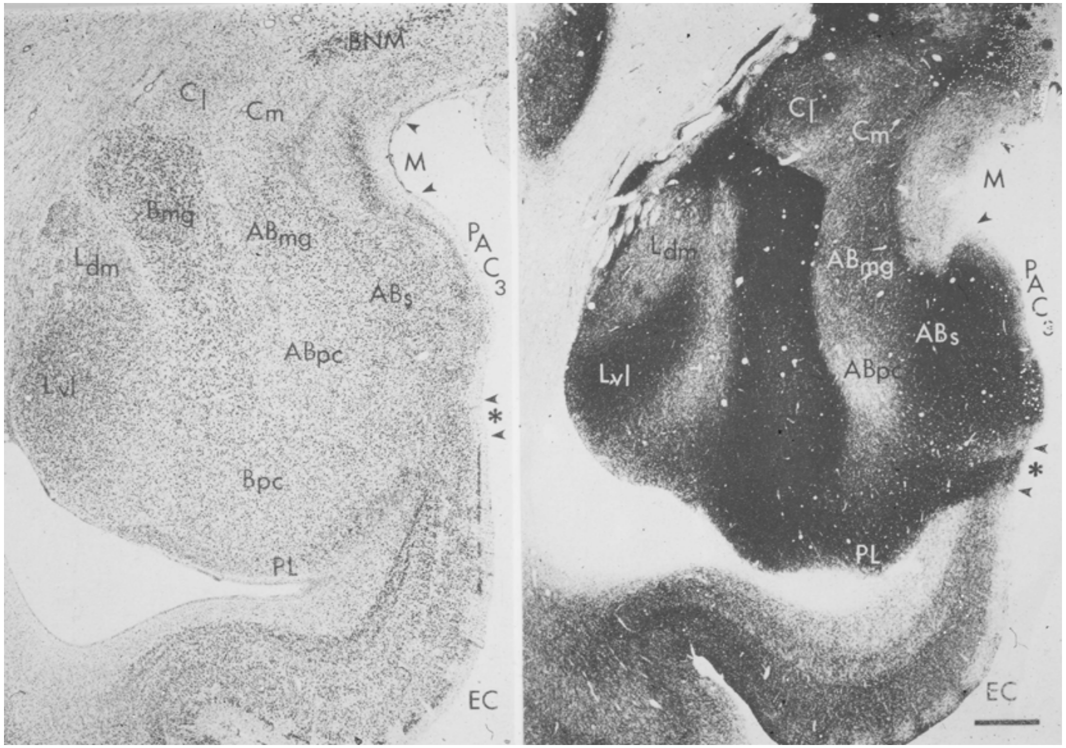
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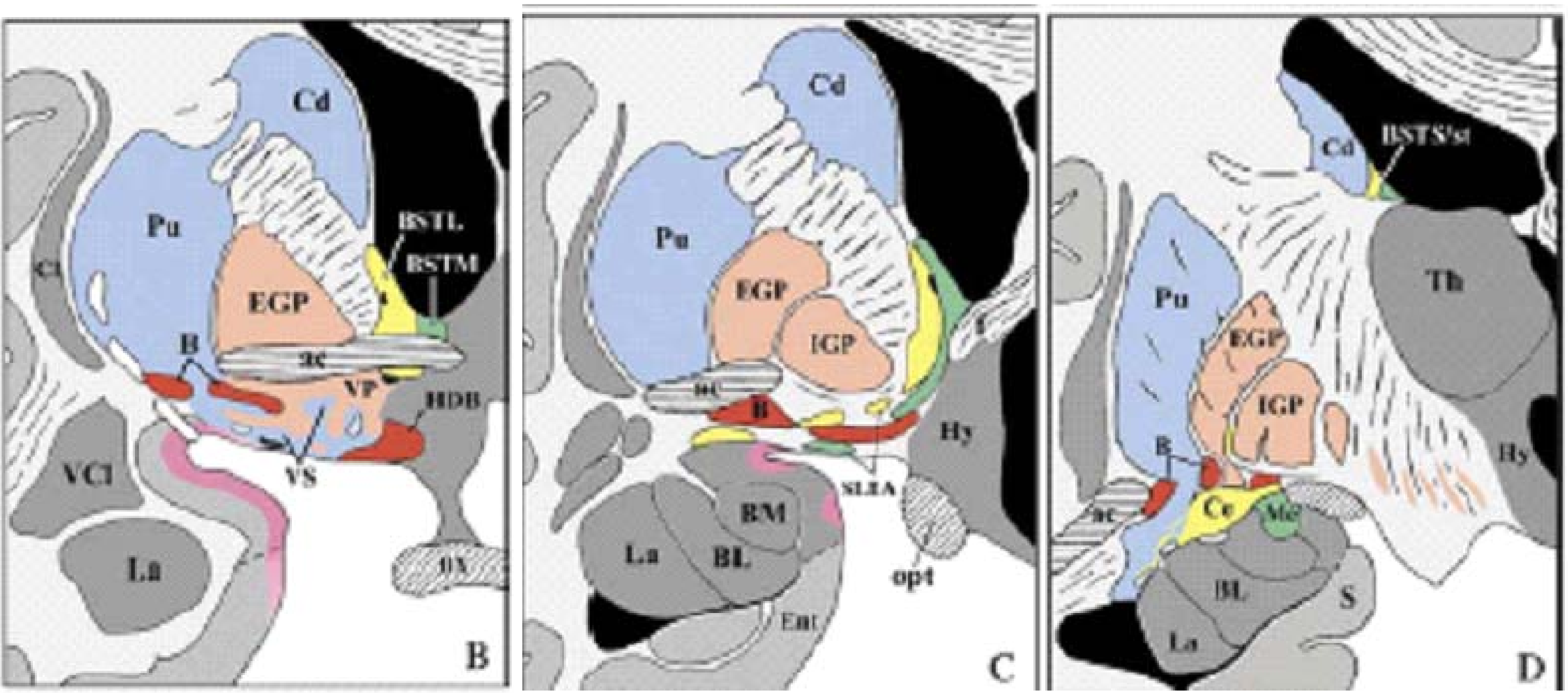
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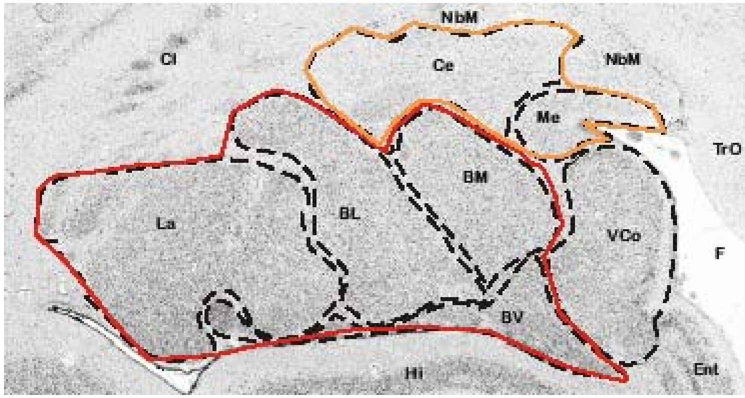
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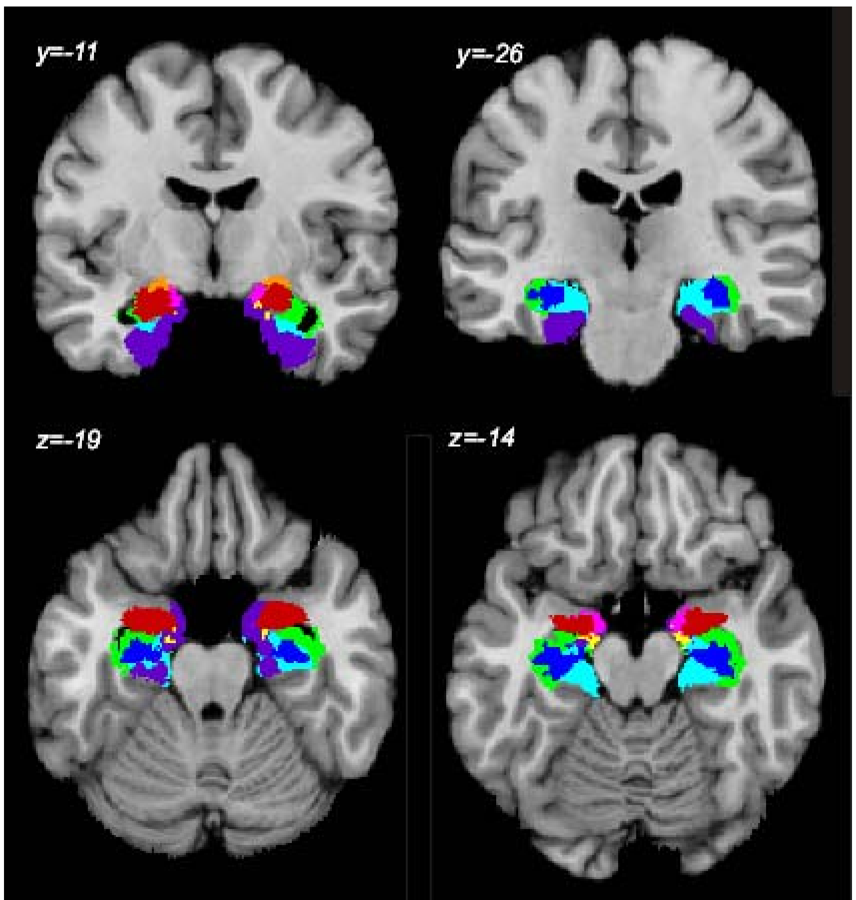
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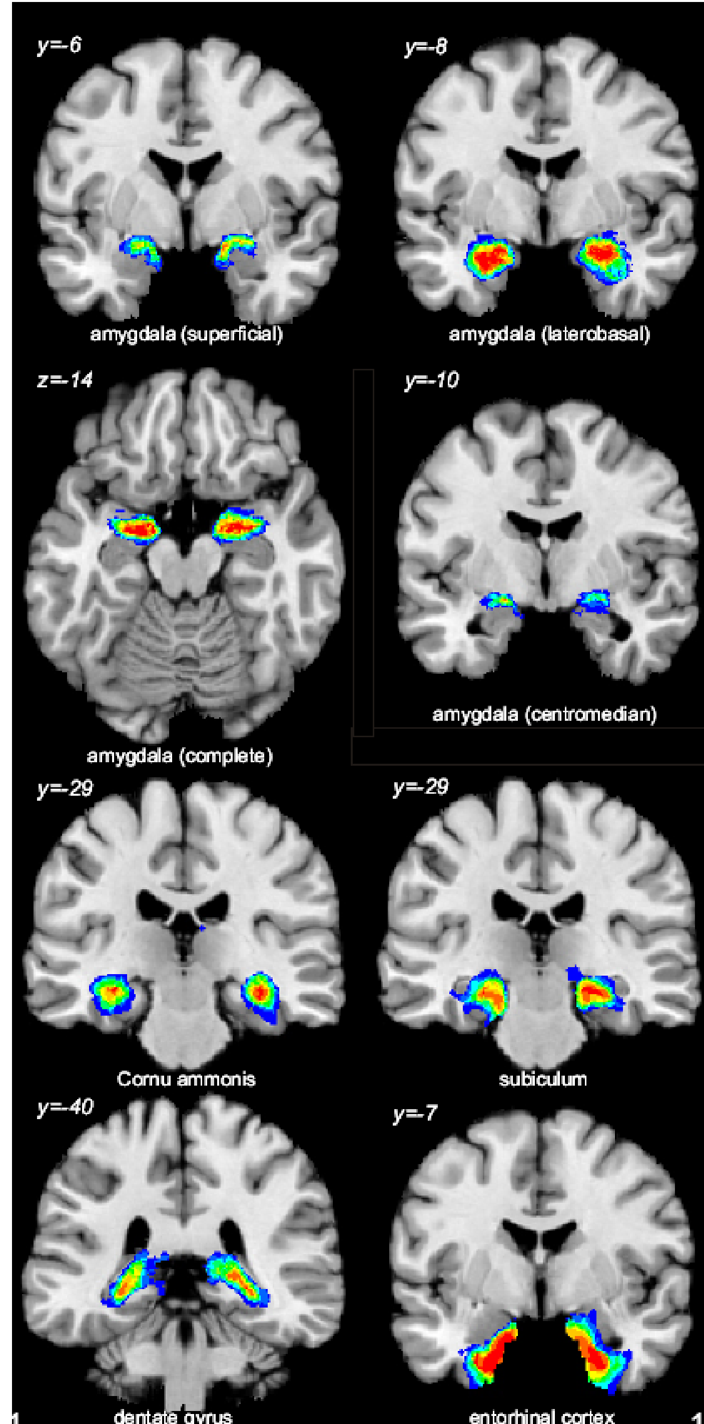
z=-19
z=-14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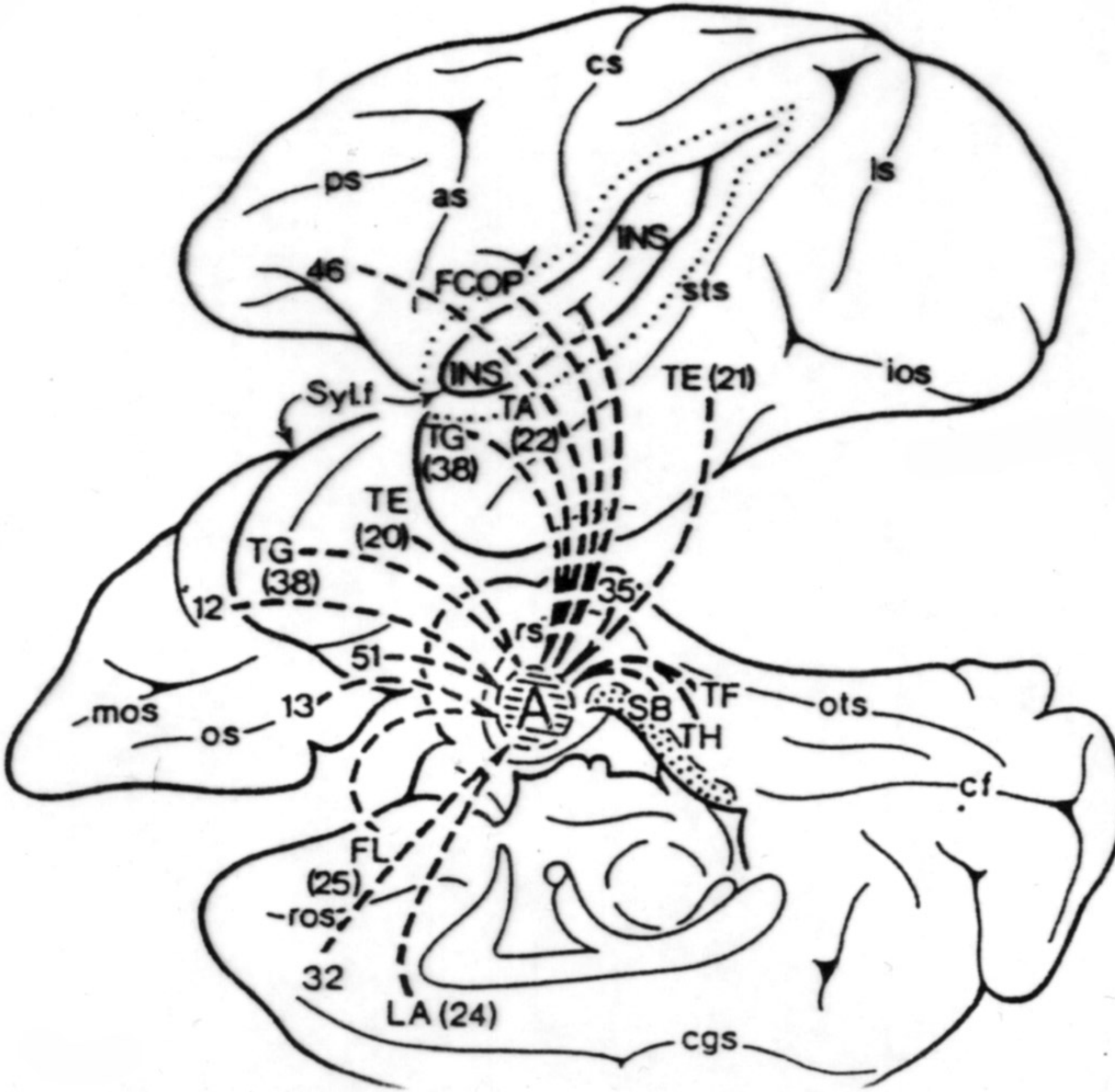
y=-8
amygdala (superficial)
amygdala (laterobasal)
z=-14
y=-10
amygdala (centromedian)
amygdala (complete)
y=-29
y=-29
Cornu ammonis
subiculum
y=-40
y=-7
dentate gyrus
entorhinal cortex
1
10

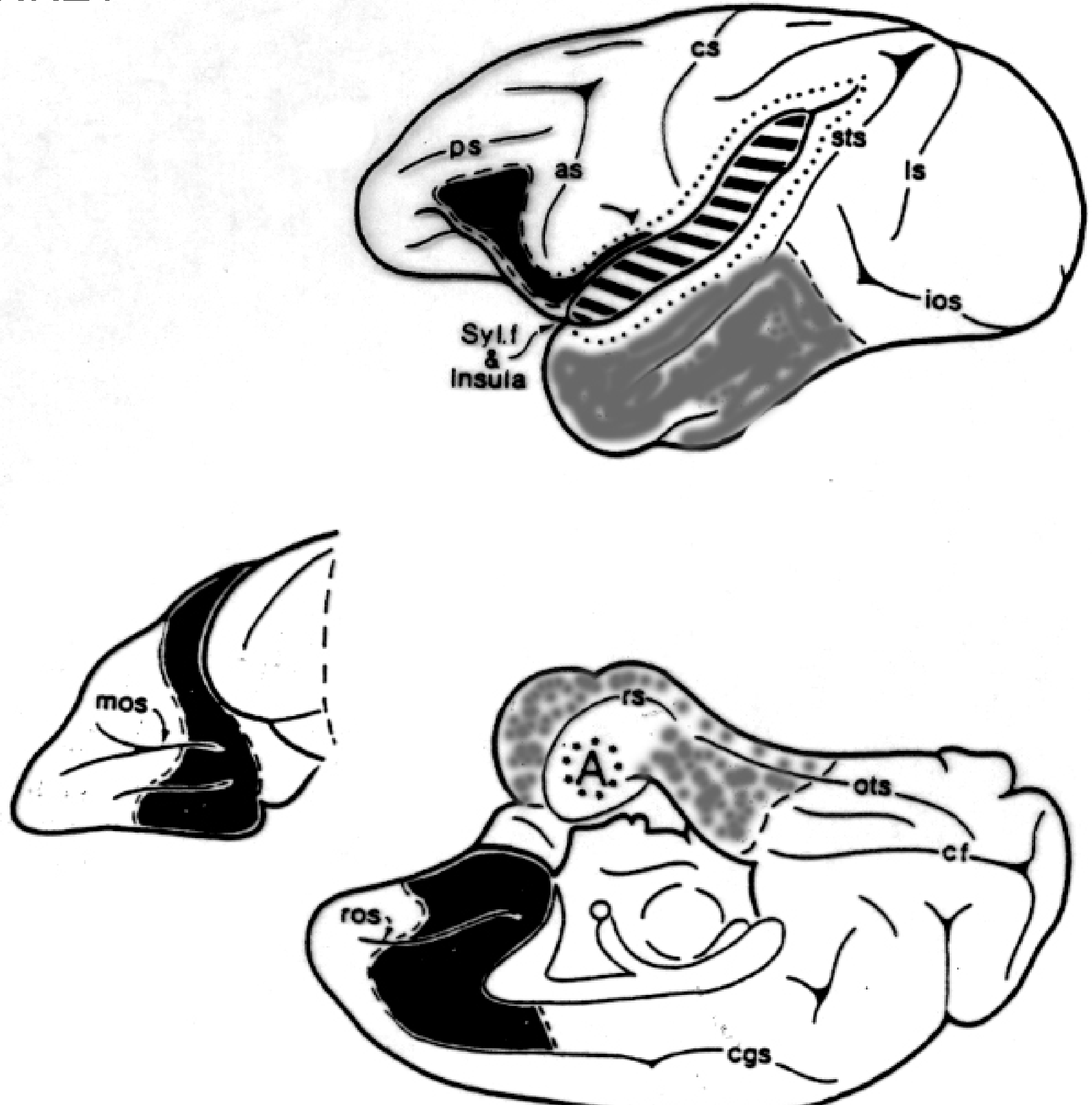
CORTICAL INPUT TO THE AMYGDALA



Projectios originate in associational areas in the <u>temporal</u> (TE, TF,TH, TG) <u>lateral prefrontal</u> (area 46), <u>orbitofrontal (</u>area 12), <u>cingulate </u>(areas, 24, 32), <u>insular </u>(INS), <u>perirhinal</u> (35), <u>subicular </u>(SB) cortical areas. There are no primary sensory projections

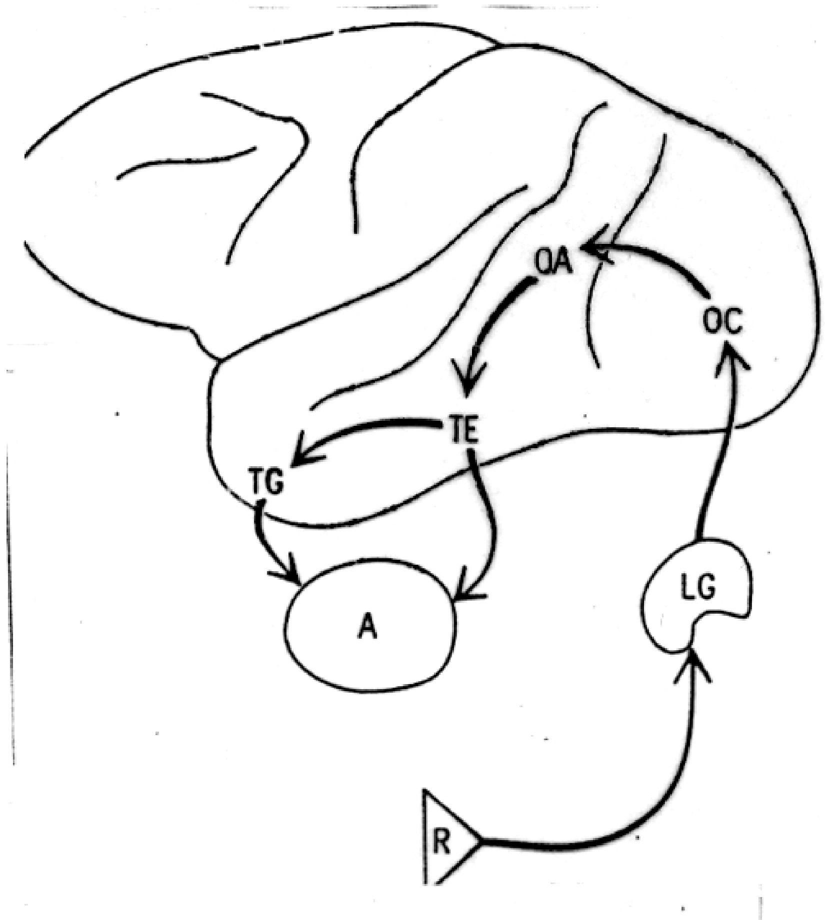
G. V Hoesen, 1981.

TOPOGRAPHY OF FRONTAL (black) TEMPORAL (gray) and INSULAR (hatched) AREAS that give rise to CORTICOAMYGDALOID PROJECTIONS IN THE RHESUS MONKEY



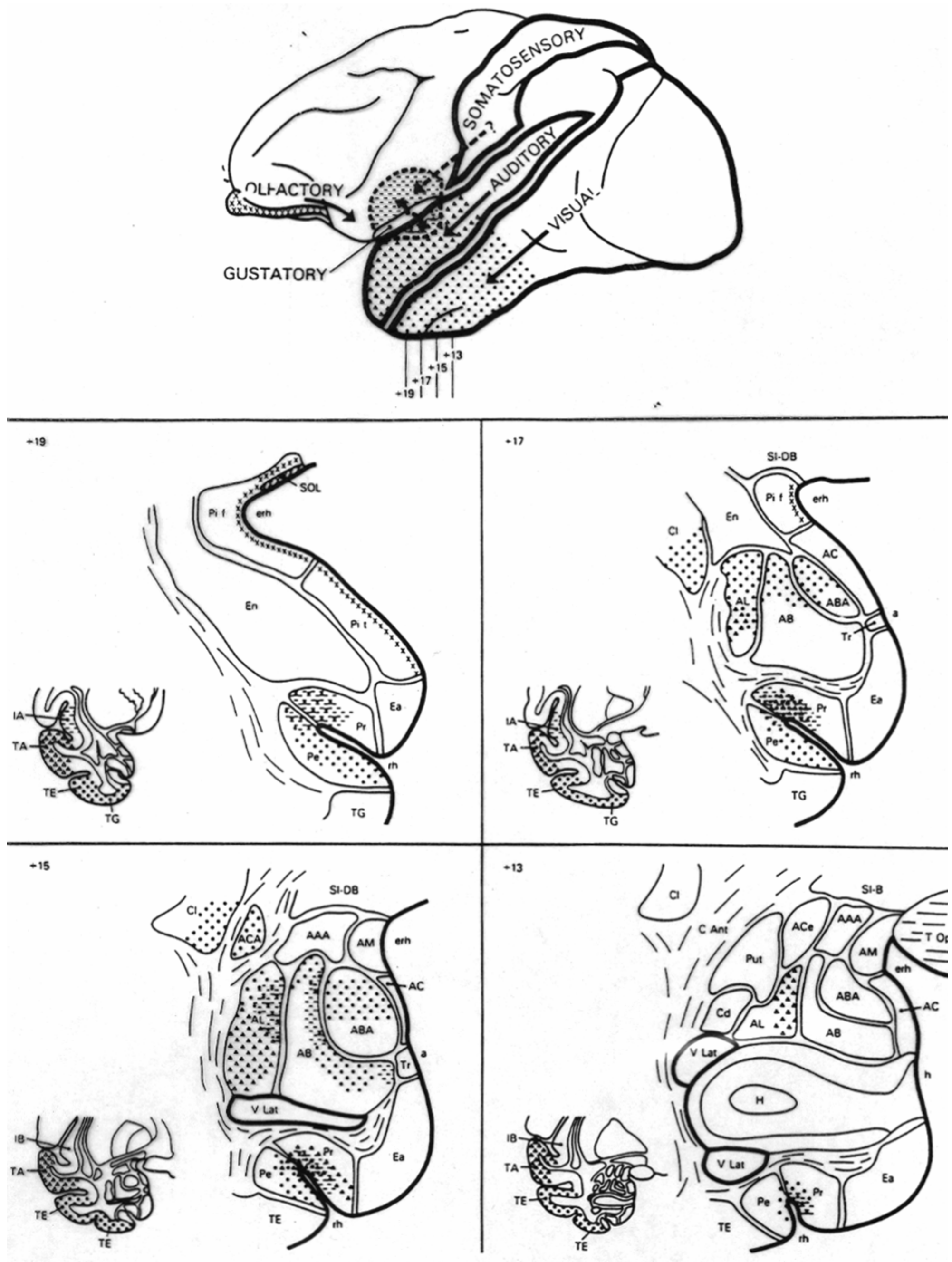
Gary van Hoesen, 1981

VISAUL PROJECTIONS TO THE AMYGDALA FROM CORTICAL AREAS IN THE MONKEY

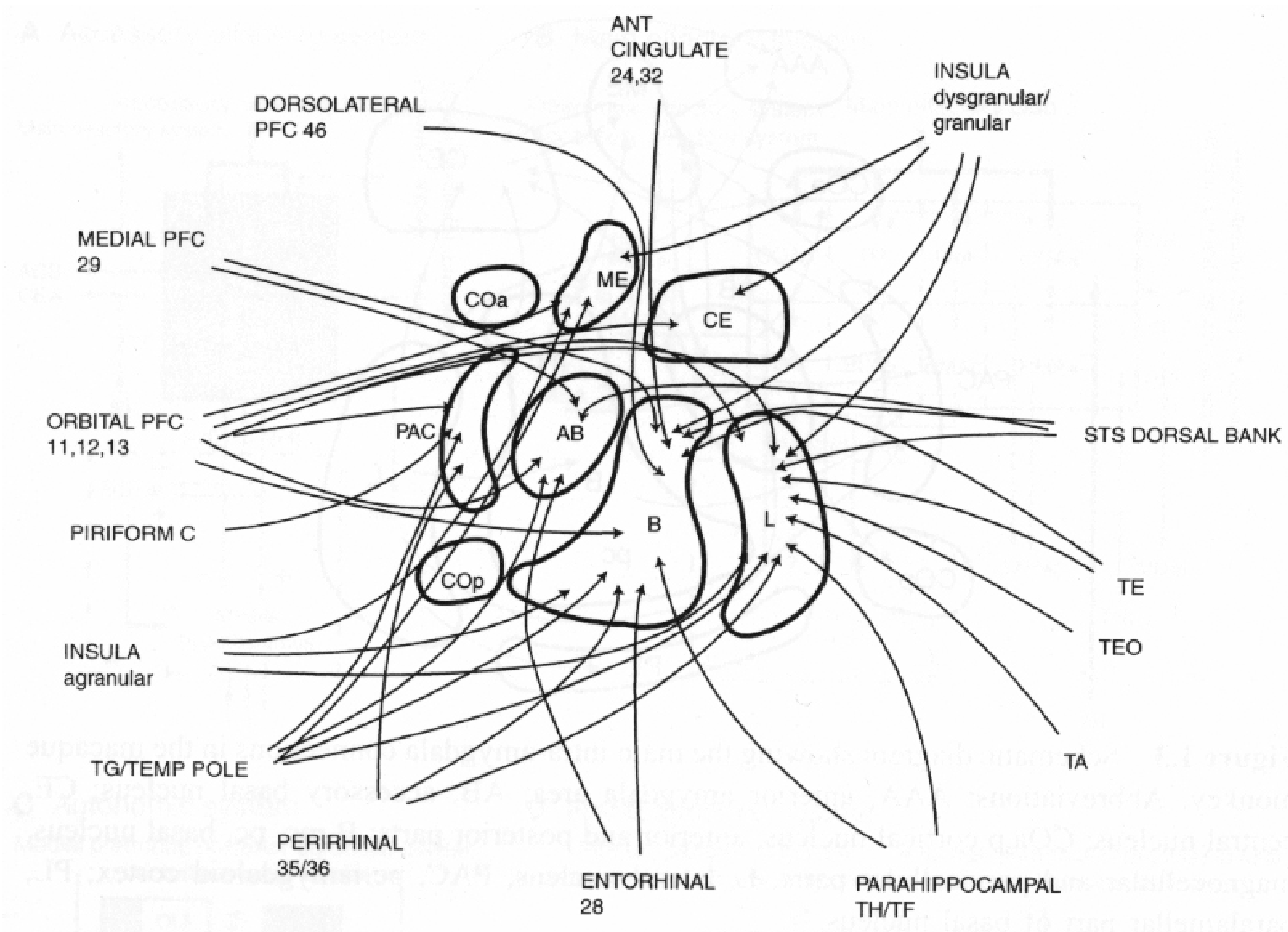


Visual inputs receievd by peripheral receptors ® are relayed through the LGN in the thalamus to occipital cortex (OC) and then to visual association cortex (OA). Visual signals then reach the amygdala (A) from the temporal pole (TG) or from the inferior temporal cortex (TE). These visual amygdala conenctions are necessary for processing the emotional significance of complex perceptual information

SENSORY-RELATED INPUT TO THE AMYGDALA

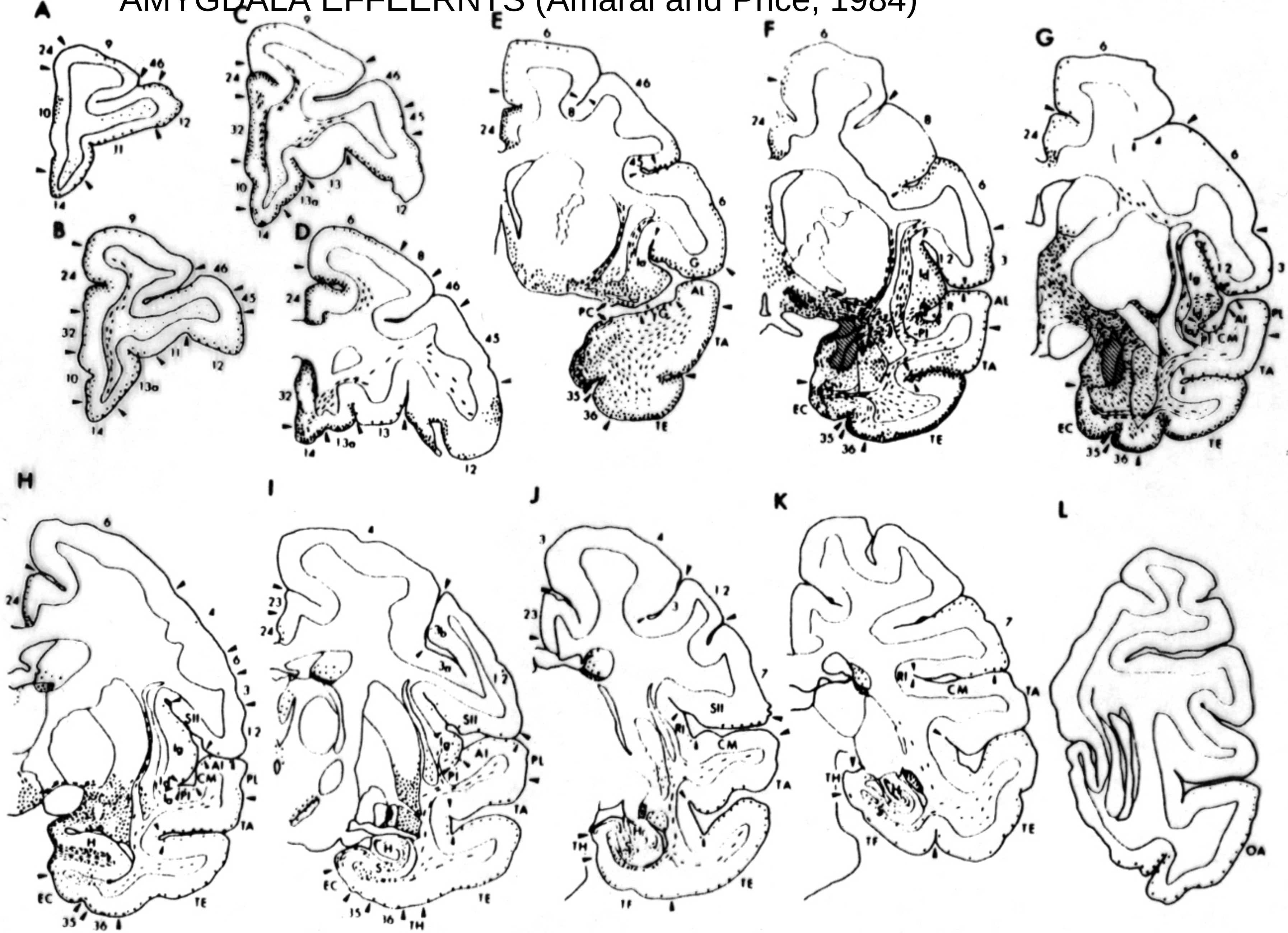


CORTICAL INPUT TO THE AMYGDALA

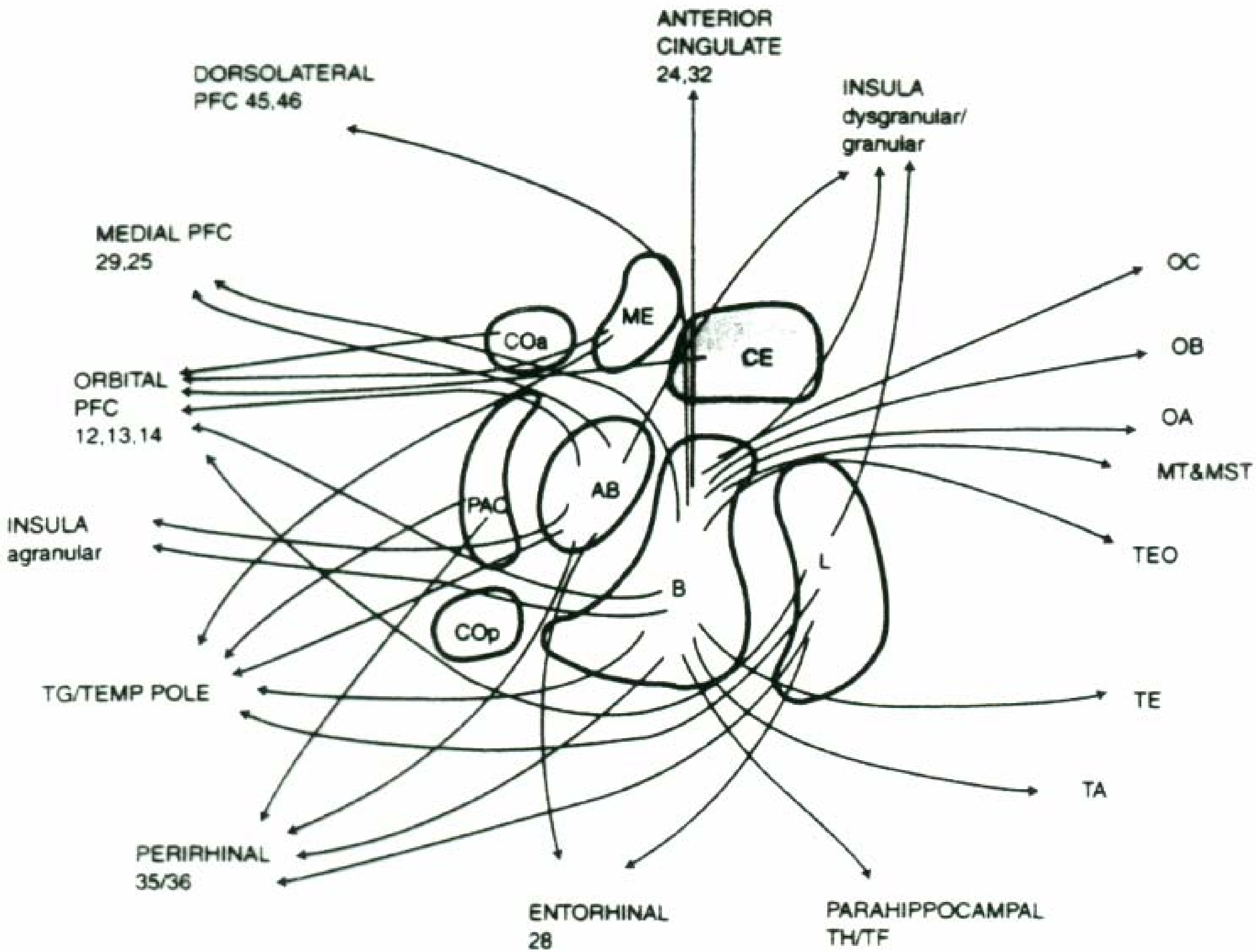


Aggleton, 2000

AMYGDALA EFFEERNTS (Amaral and Price, 1984)



AMYGDALA EFFERENTS TO CORTICAL REGIONS



AMYGDALO-HIPPOCAMPAL CONNECTIONS

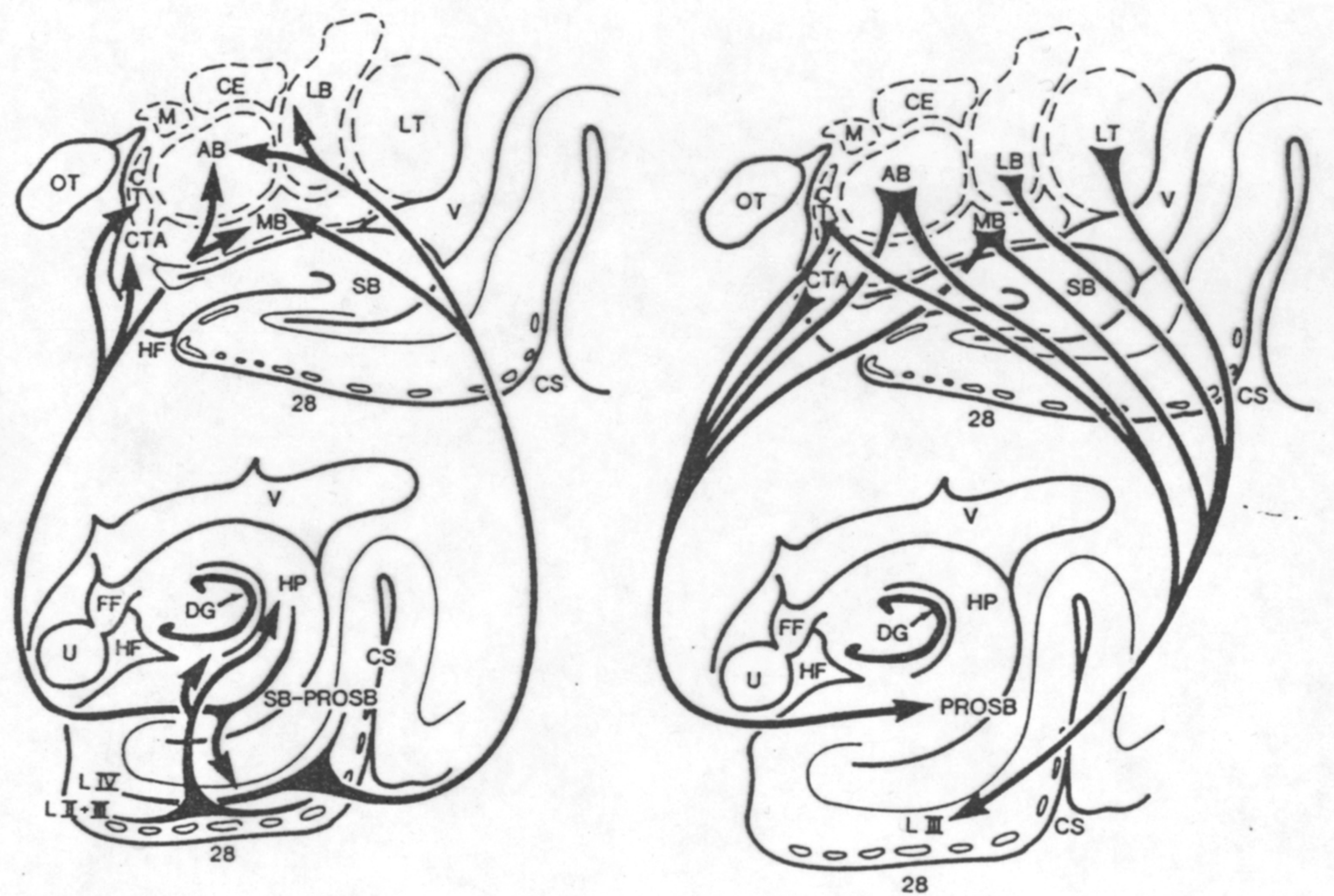
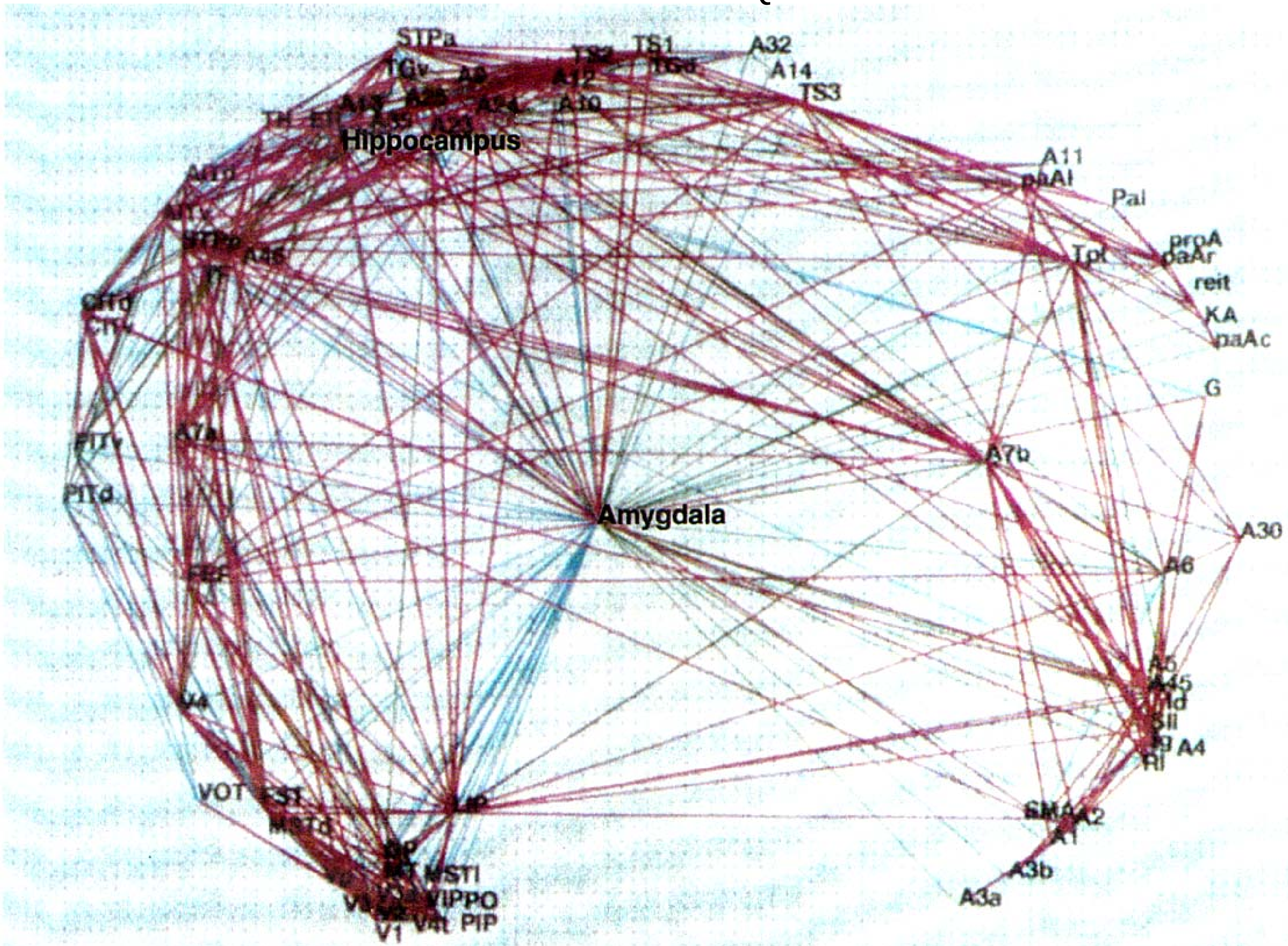
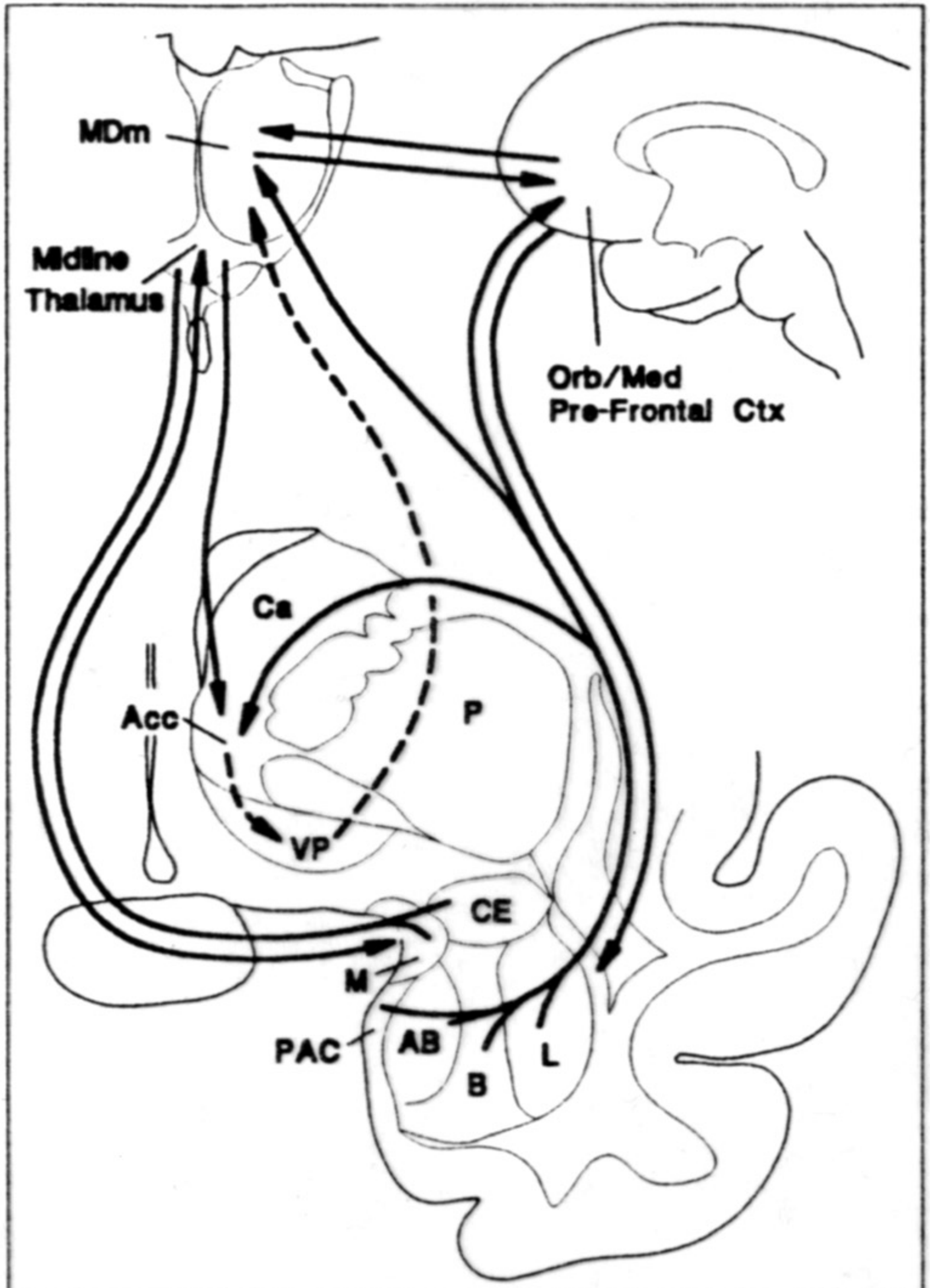


Figure 1. Connectional anatomy of the ventromedial lobe. Some probable hippocampal formation and entorhinal cortex (area 28) efferents to the amygdala (left) and some probable amygdaloid efferents to the hippocampal formation and entorhinal cortex (right) in the human are illustrated based on projections from experimental studies in the nonhuman primate (see text for details). Abbreviations: AB, accessory basal nucleus of the amygdala; CE, central nucleus of the amygdala; CS, collateral sulcus; CT, cortical nucleus of the amygdala; CTA, cortical transition area; DG, dentate gyrus; FF, fimbria fornix; HF, hippocampal fissure; HP, hippocampus; LB, lateral basal nucleus of the amygdala; LT, lateral nucleus of the amygdala; M, medial nucleus of the amygdala; MB, medial basal nucleus of the amygdala; OT, optic tract; PROSB, prosubiculum; SB, subiculum; U, uncal hippocampus; V, lateral ventricle; 28, Brodmann's area 28, entorhinal cortex.

TOPOLOGICAL ORGANIZATION OF MACAQUE CORTEX



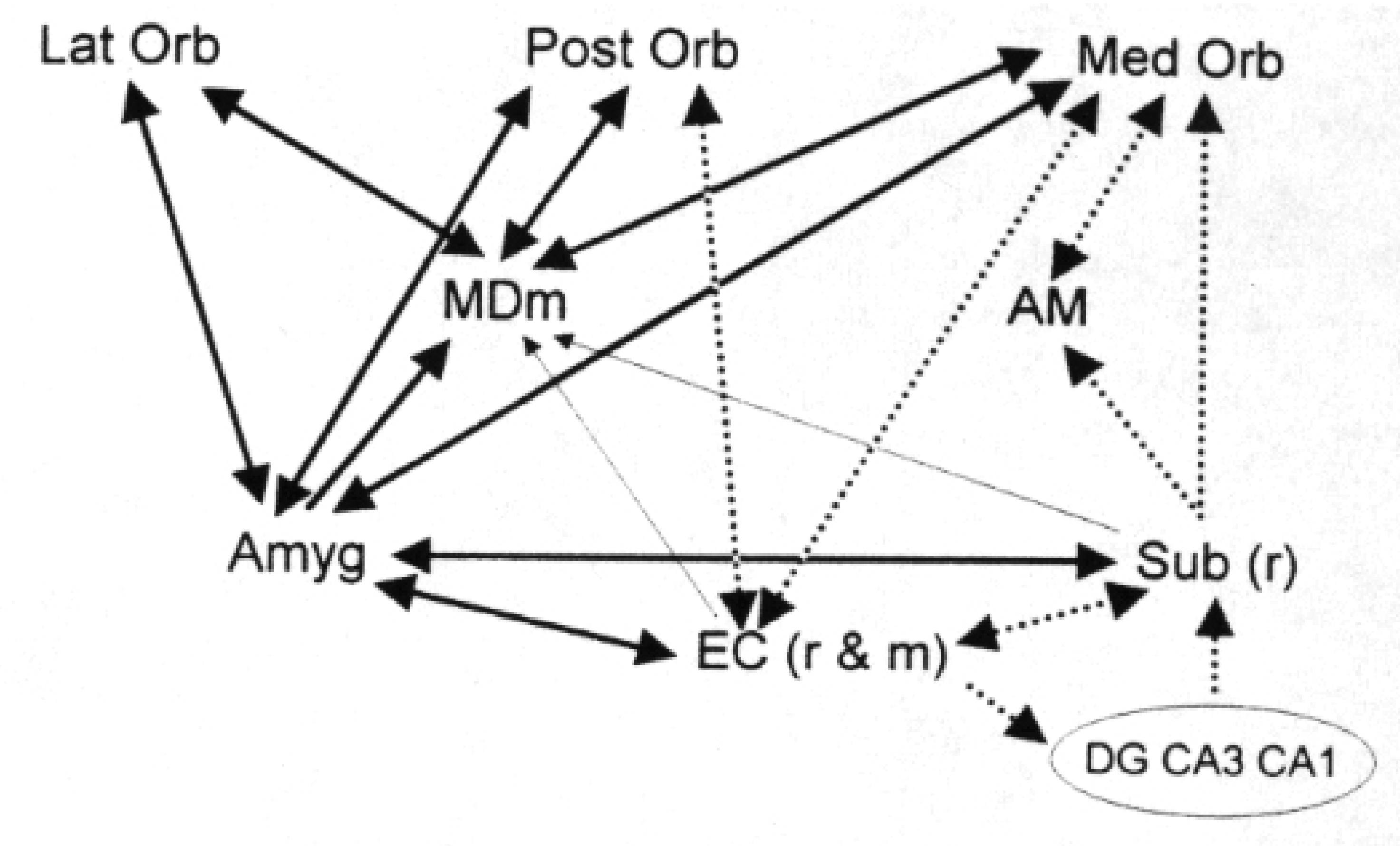
A total of 758 conenctions between 72 areas is represented, of which 136 (18%) are one-way. Reciprocal conenctions are shown in red (Young etal., 1994)



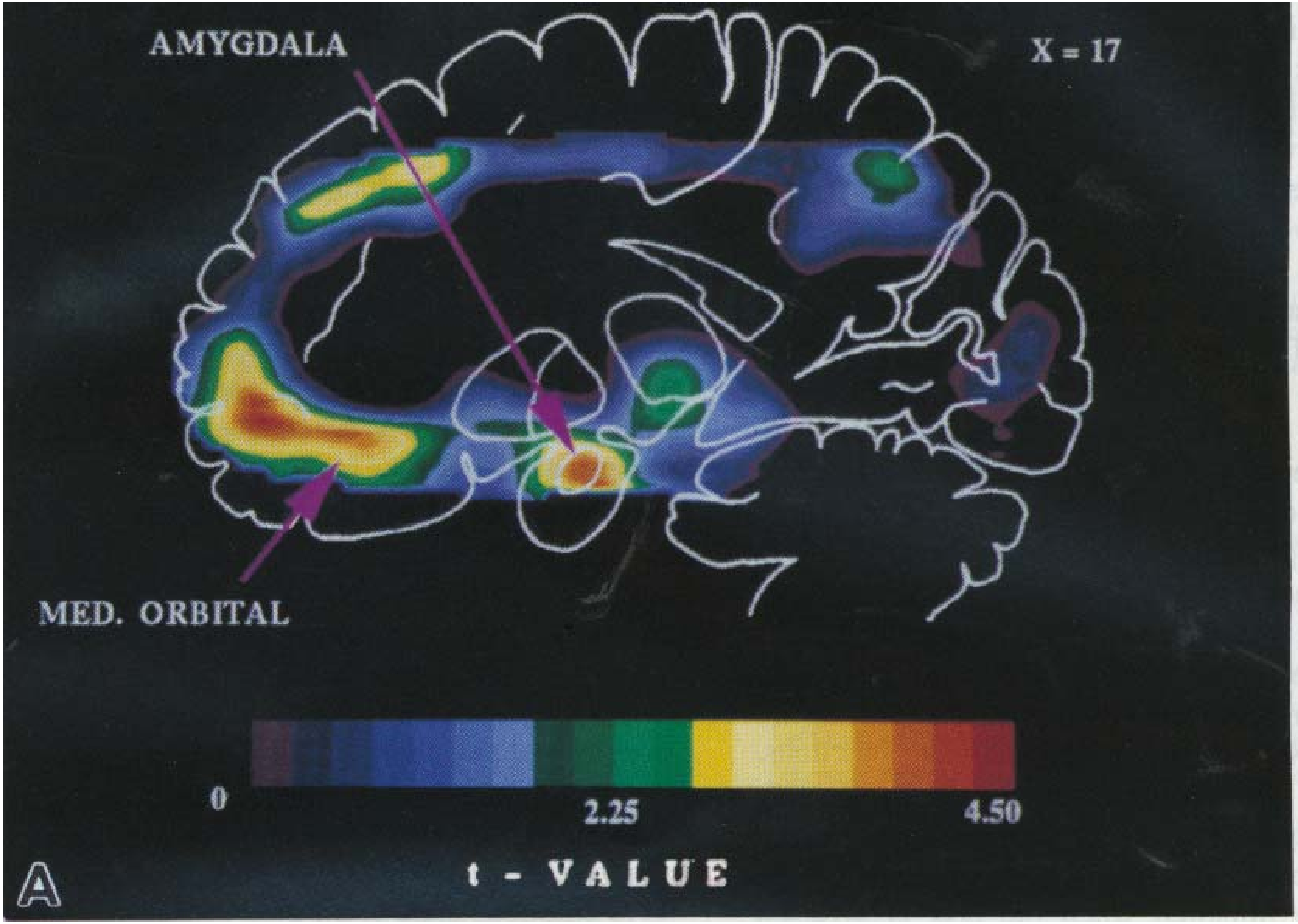
AMYGDALOID-PREFRONTAL CONNECTIONS

Various routes through which the amygdaloid complex can influence the function of the frontal lobe. 1) the amygdala has direct reciprocal connections with various regions of the orbital and medial frontal lobe. 2) the amygdala projects to the mediodorsal nucleus of the thalamus (MD) which, in turn projects to the same region of the frontal lobe that receive a direct amygdaloid input. 3) many amygdaloid nuclei project to the n. accumbens (Acc) that in turn projects via the ventral pallidum (VP) to the MD-prefrontal cortex.

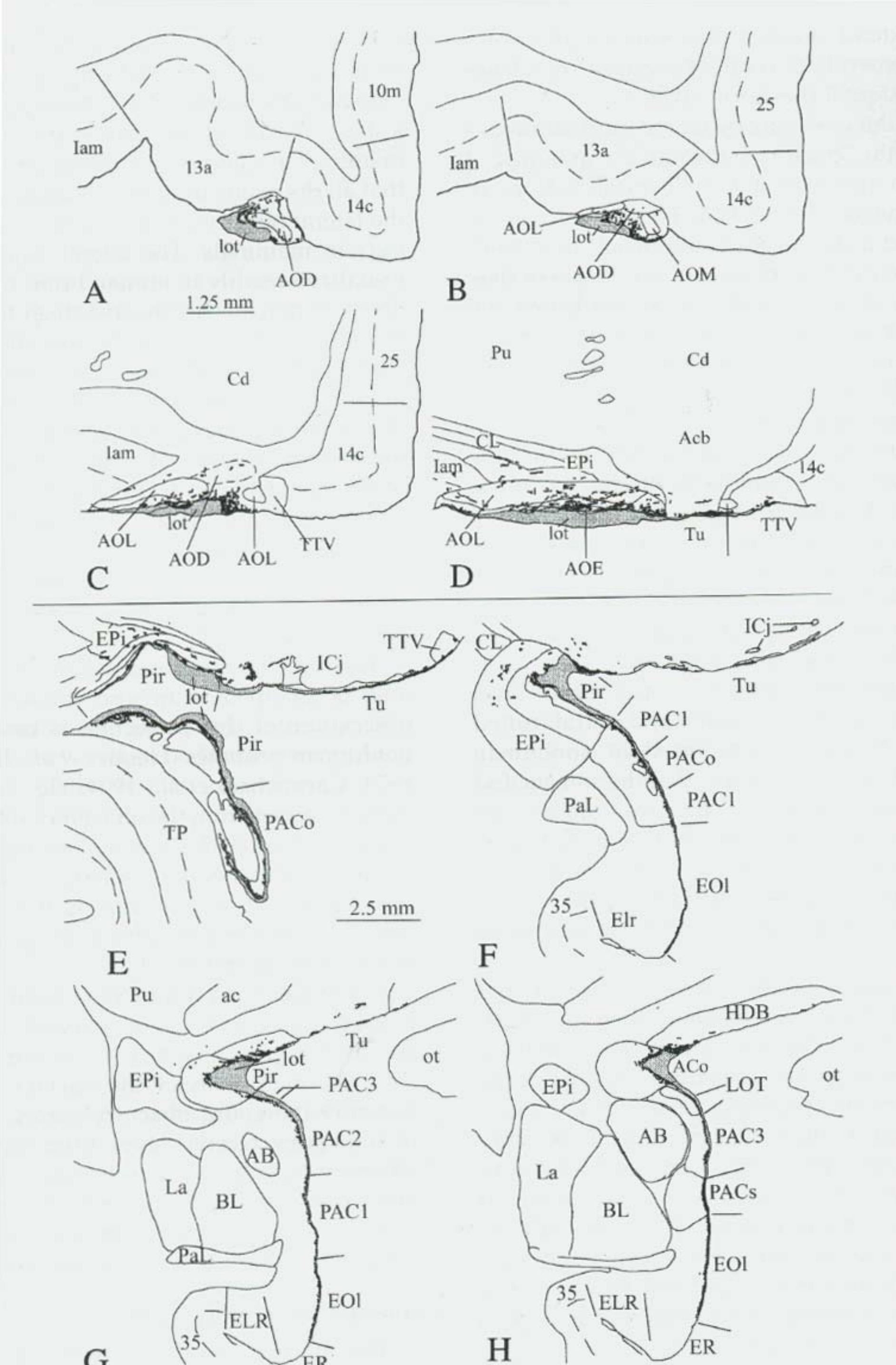
Connections within the anterior limbic system network involving the amygdala (solid lines) and the hippocampus (dotetd lines)



AM-anteromedial n. of the thalamus; MD- mediodorsal thalamic n; EC-entorhinal cortex; Sub –subiculum; DG- CA3-CA1- hippocampal regions (Carmichael and Price, 1995



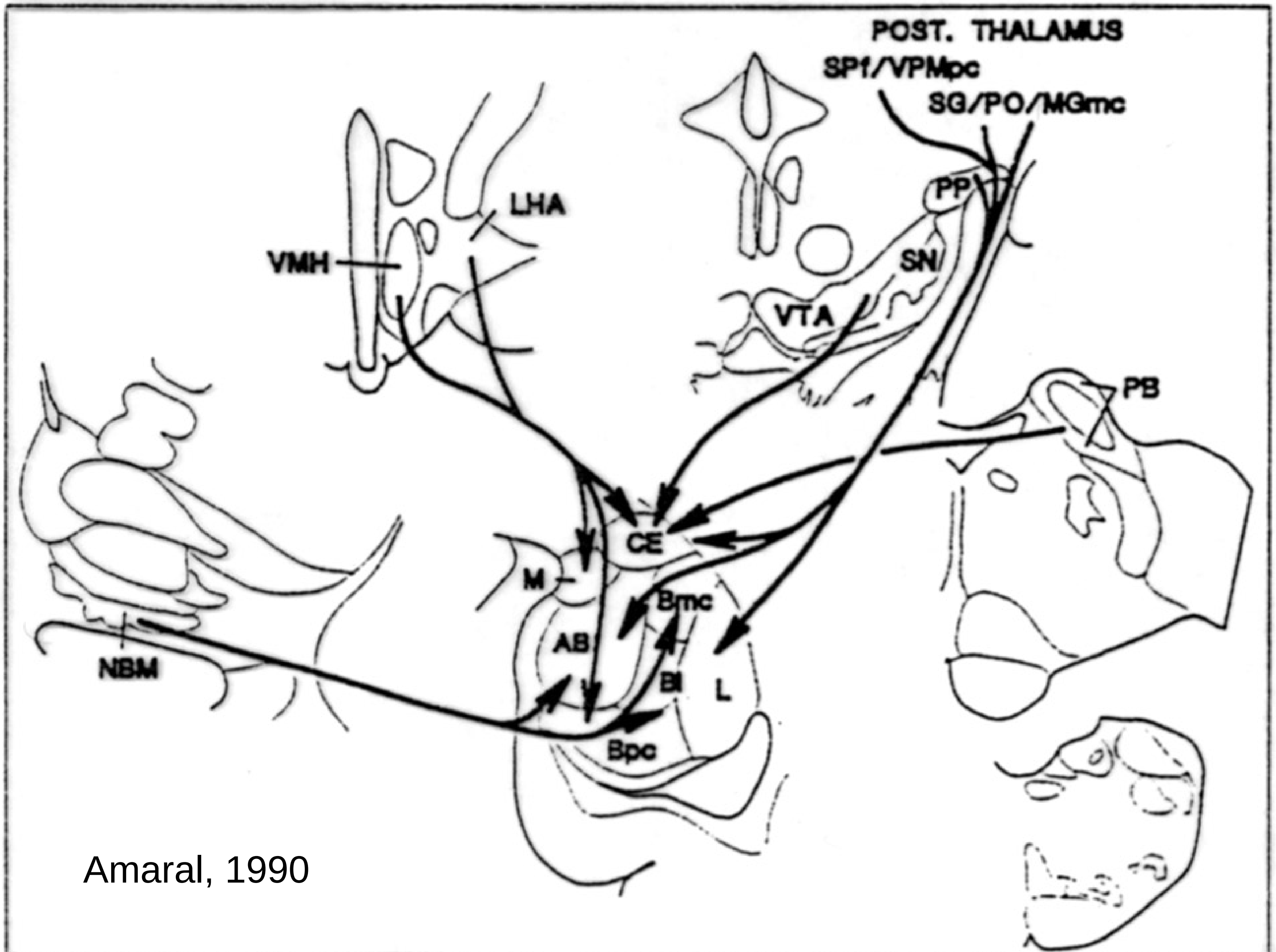
Increased blood flow in the left amygdala and medial orbital cortex of depressed subjects with unipolar clinical depression (Price et al., 1996)



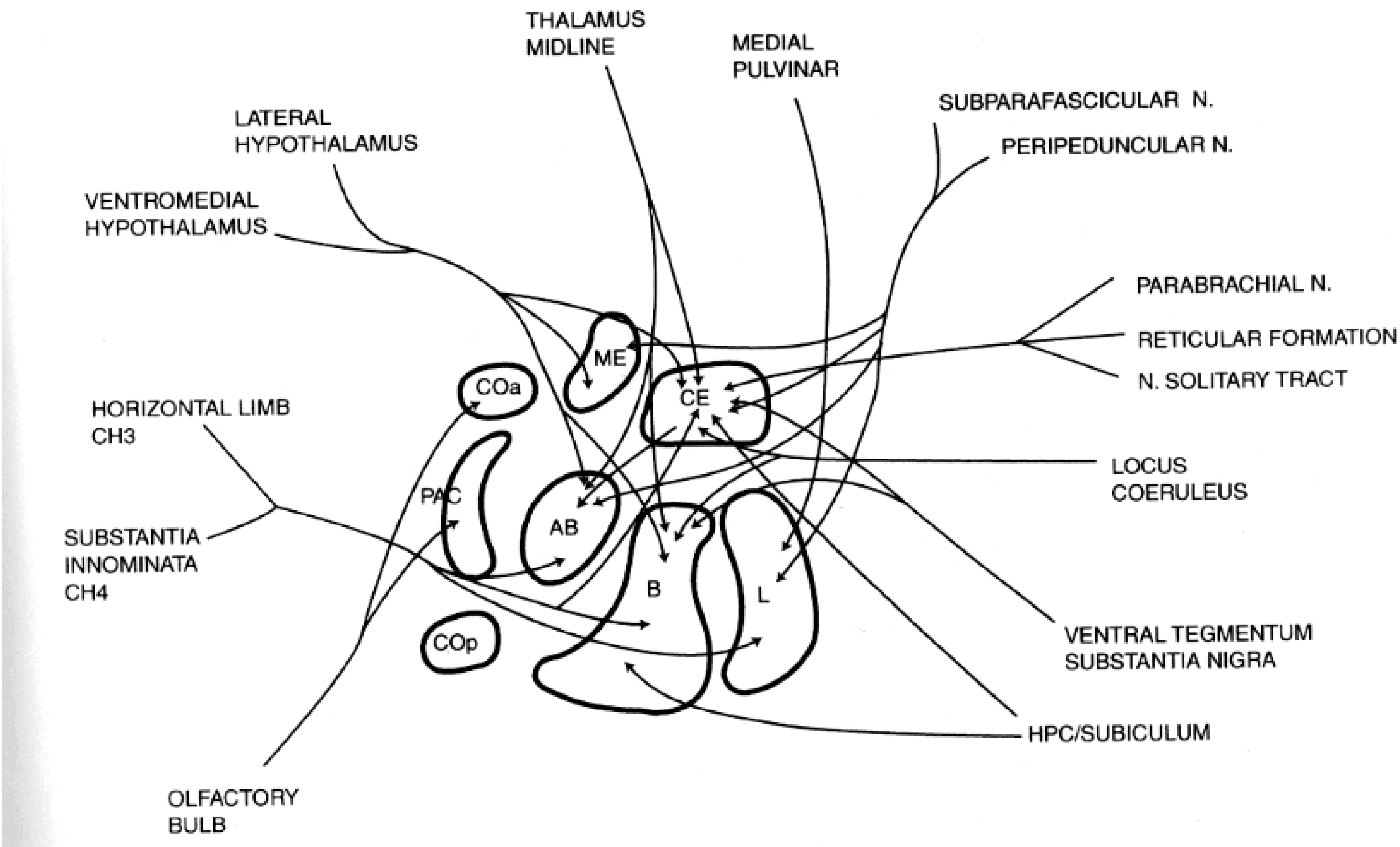
THE AMYGDALA IN OLFACTION

Distribution of fibers of the lateral olfactory tract in monkeys, that were labeled by an injection of the anterograde tarcer BDA into theolfactory bulb (Carmichael et al, 1994)

SUBCORTICAL AFFERENTS TO THE AMYGDALA

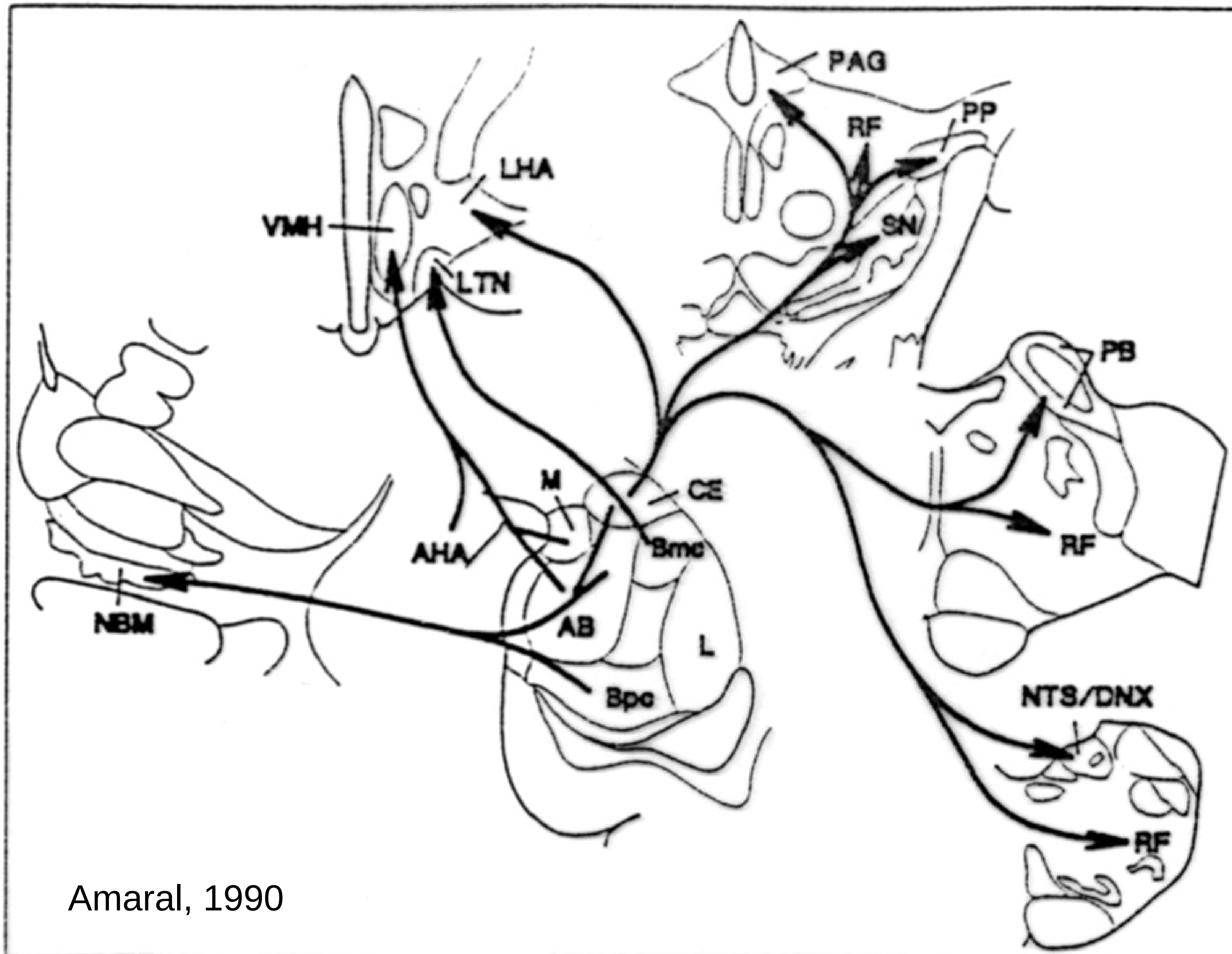


SUBCORTICAL PROJECTIONS TO THE AMYGDALA IN MACAQUE



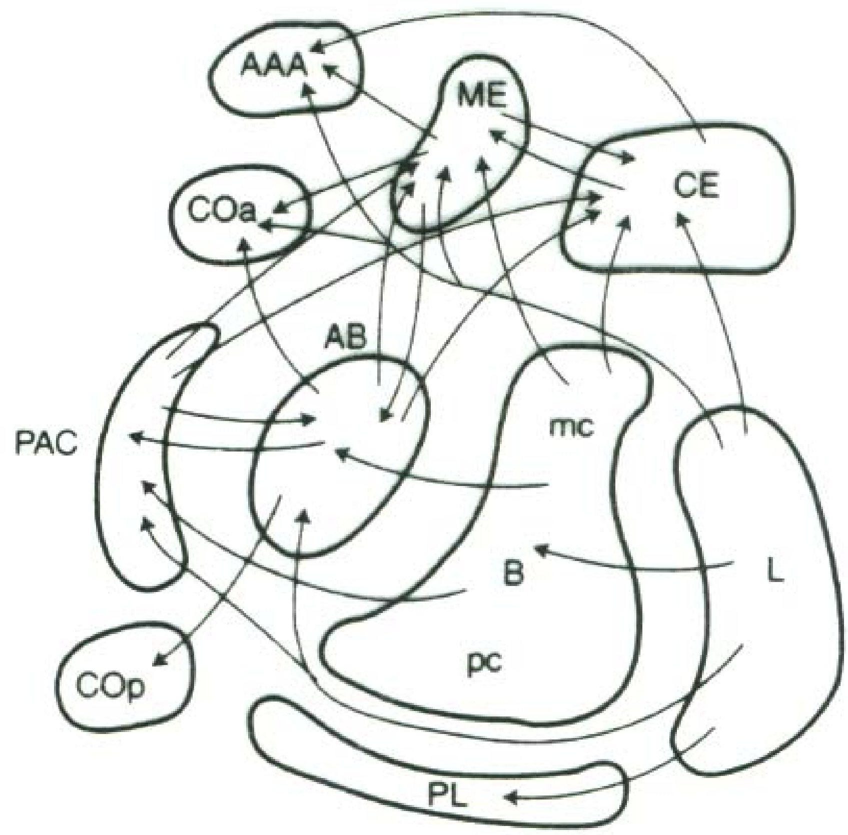
Aggleton, 2000

SUBCORTICAL EFFERENTS FROM THE AMYGDALA



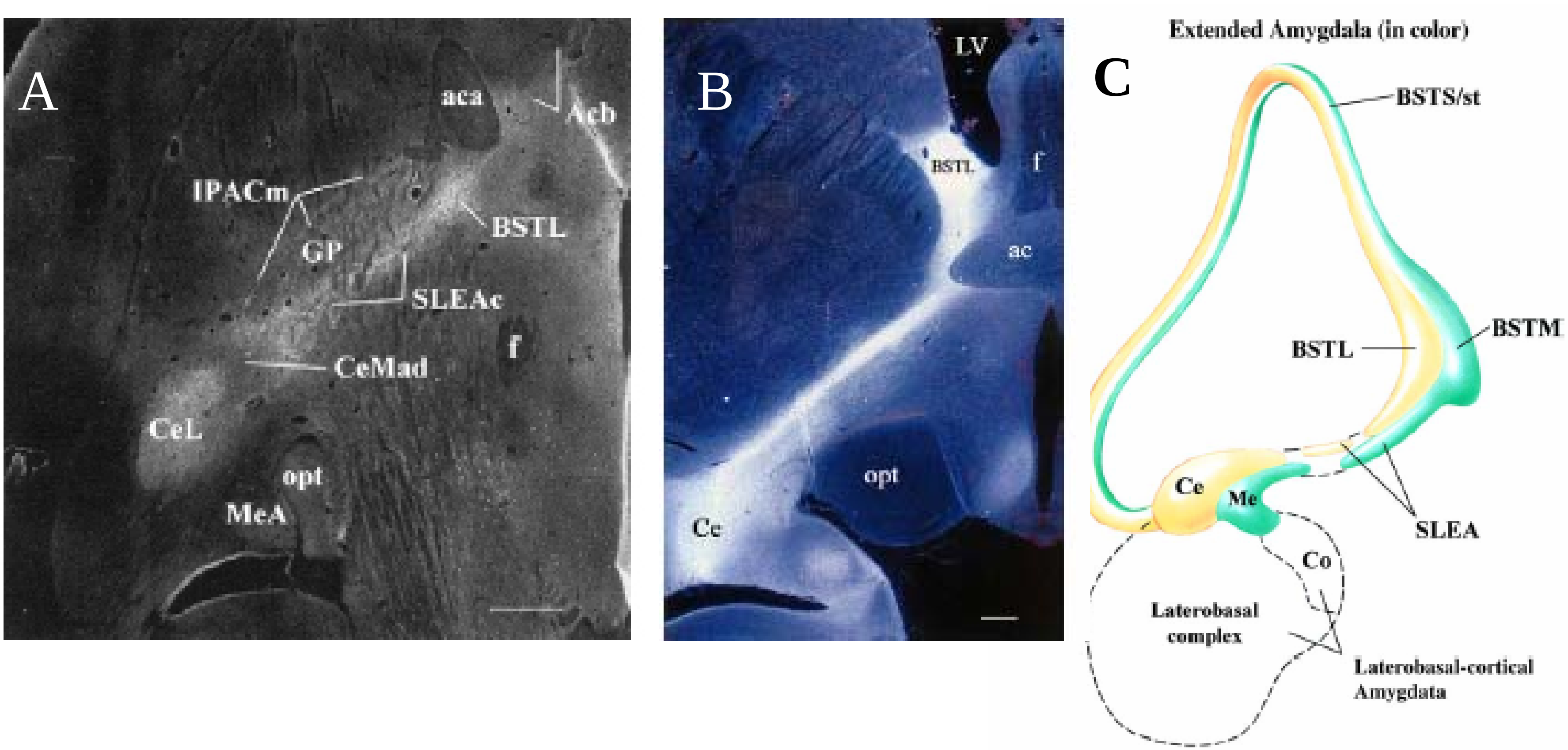
Amaral, 1990

INTRA-AMYGADALA CONENCTIONS IN MACAQUE



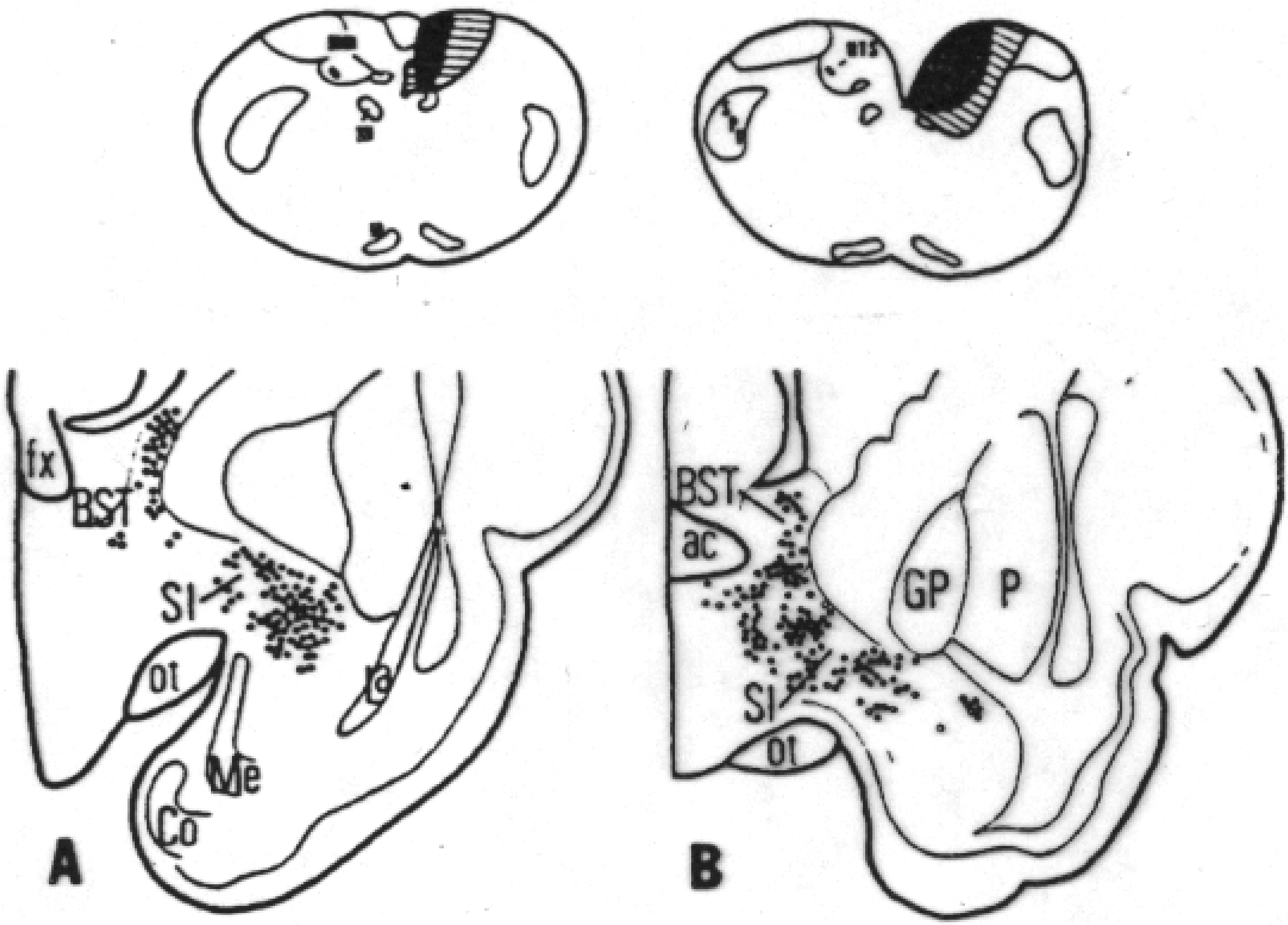
Aggleton, 2000

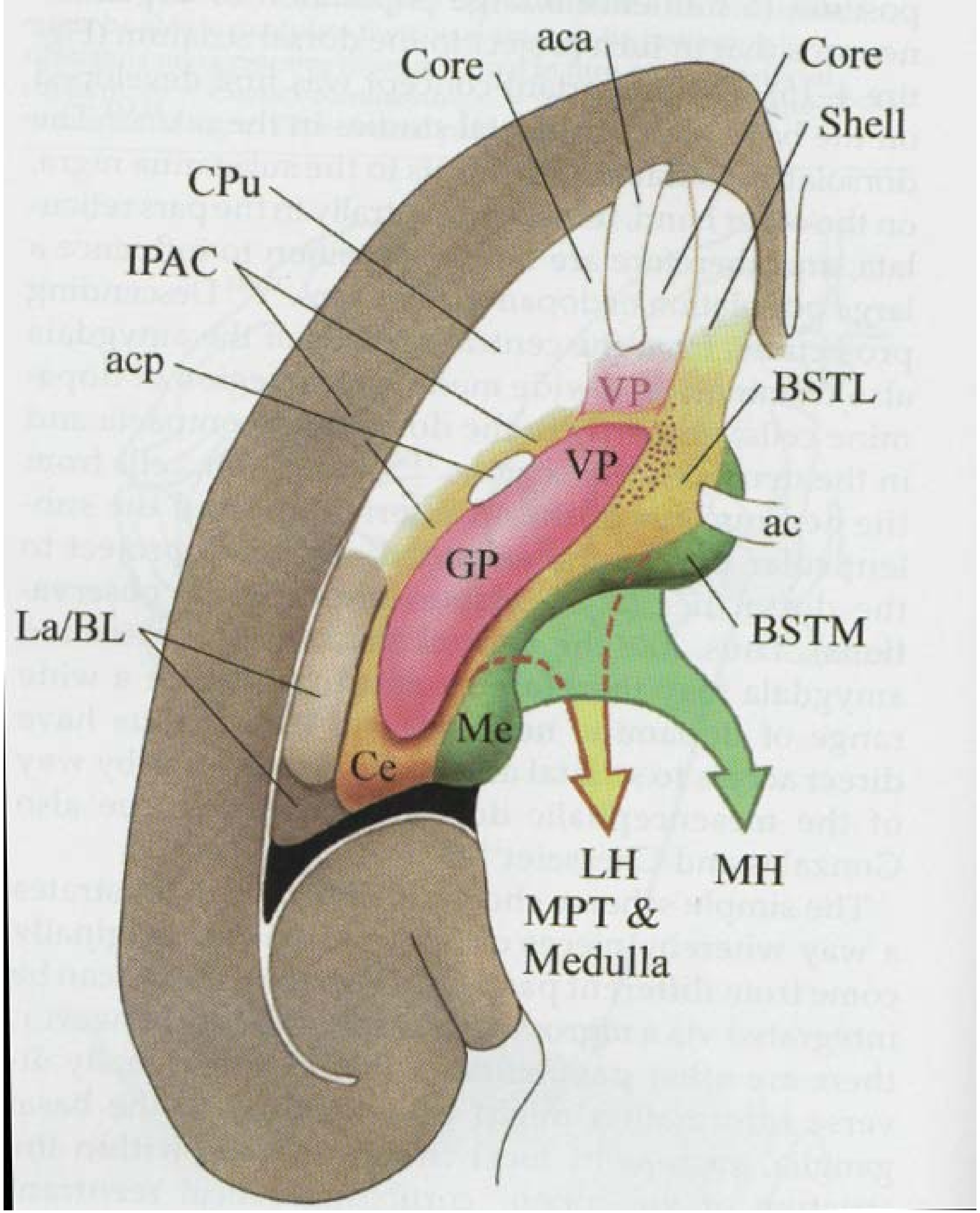
‘EXTENDED AMYGDALA’ IN RAT AND PRIMATES



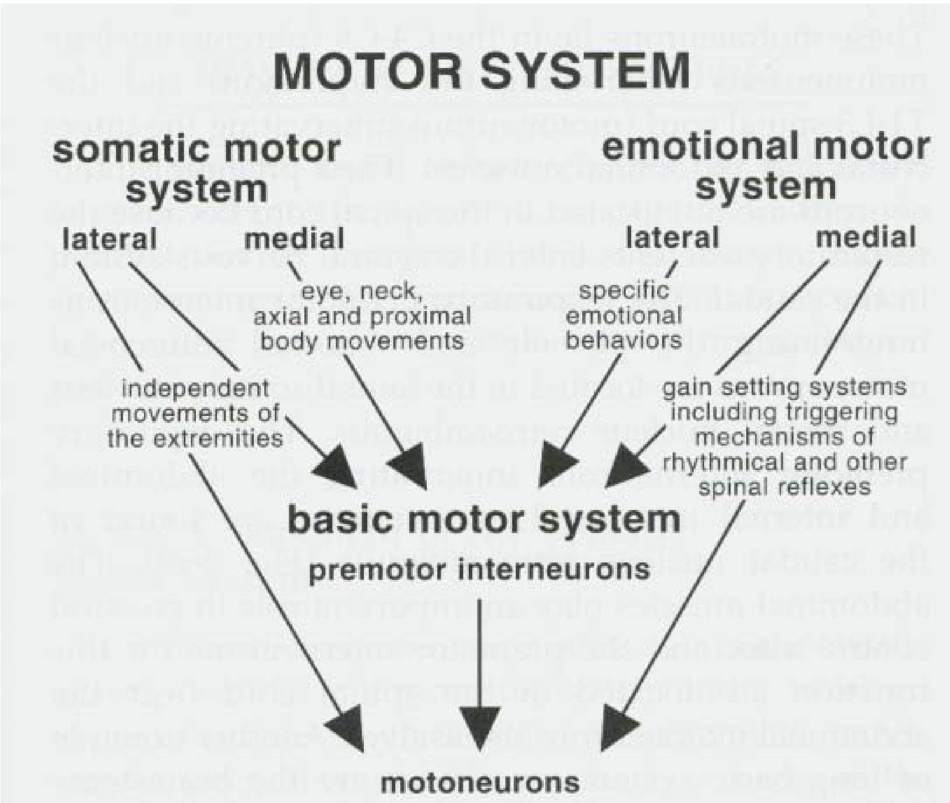
A:Dark field image of normal cupric silver staining of the central division of the extended amygdala in rat in horizontal section. **B**: Dark field image of the sublenticular area of the extended amygdala in rhesus monkey following an injection of 3H-amino acid in the region of the central amygdaloid nucleus (Ce). **C**: The extended amygdala shown in isolation from the rest of the brain, with theextension of the Ce and Medial (Me) amygdaloid nuclei within the stria terminalis (st) and through the sublenticular region of the bed nucleus of the stria terminalis (BST). From Heimer and Hoesen (in press)

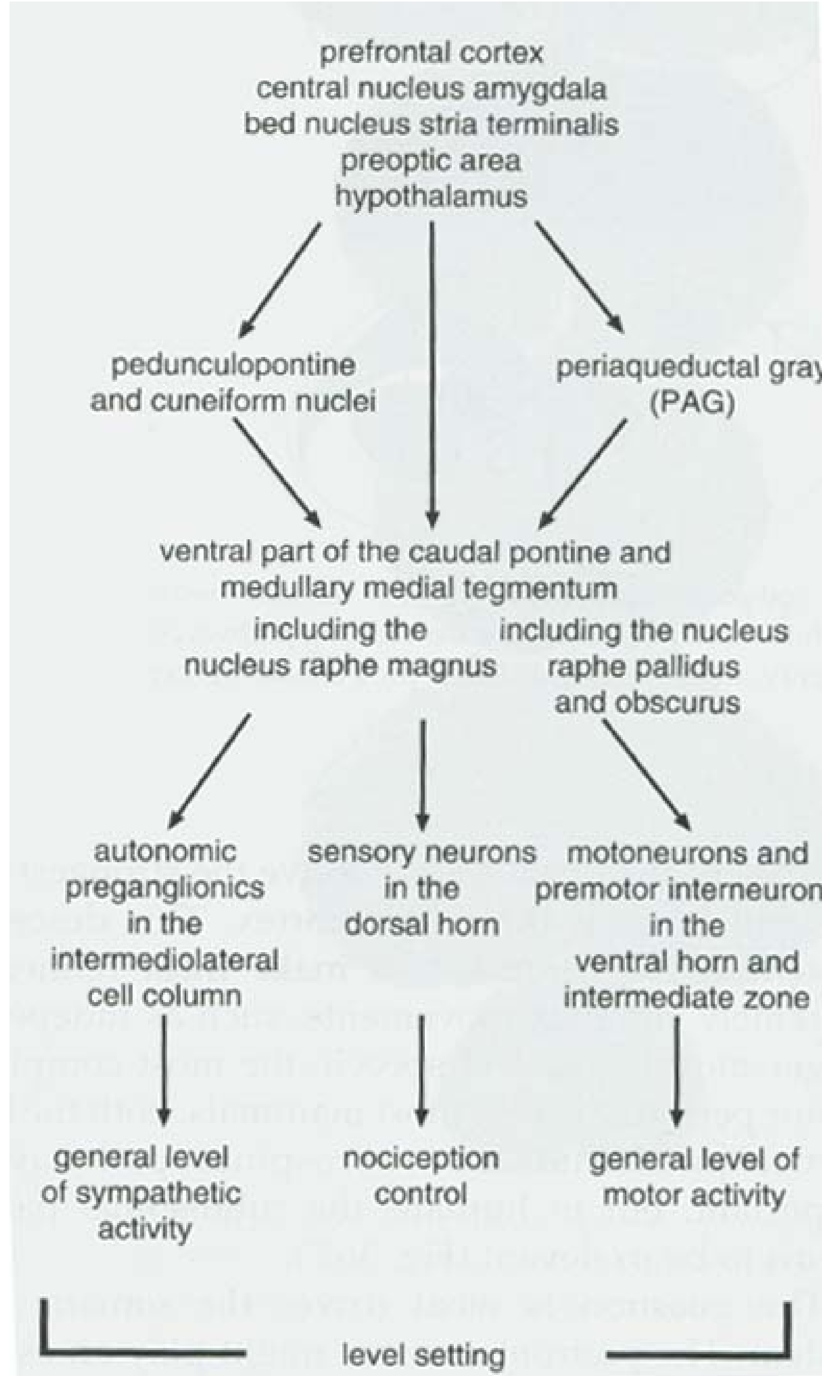
DESCENDING PROJECTIONS FROM THE 'EXTENDED' AMYGDALA



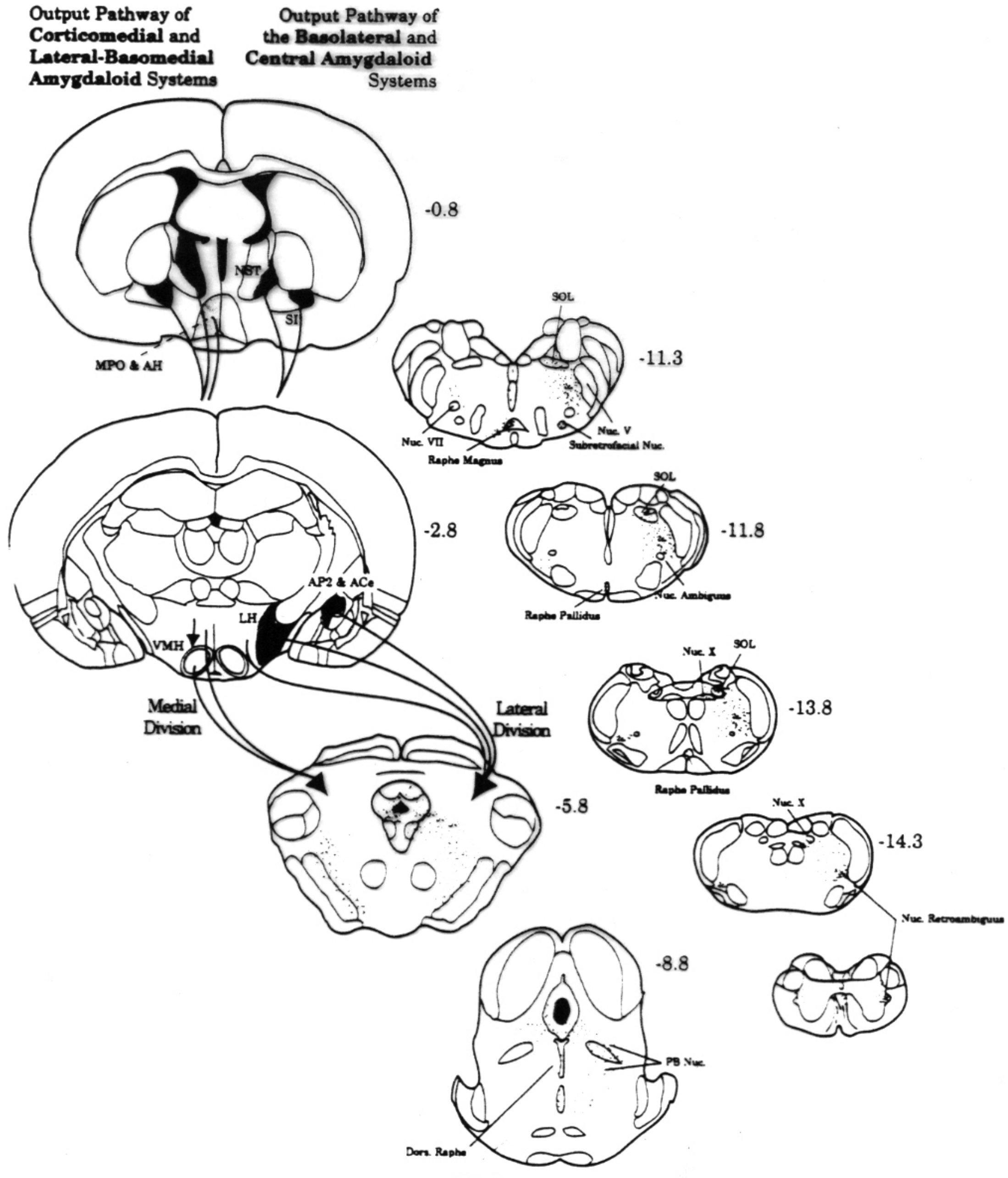


The broad arrows illustrate how the two divisions of the extended amygdala are characterized by different efferent targets. Whereas the medial EA is closely related to the medial hypothalamus (MH), the central EA provides the main output to the lateral hypothalamus (LH) and the somatomotor and autoomic centers in the brainstem. BSTL, BSTM-bed n. of the stria terminalis; MPT-mesopontine tegmentum

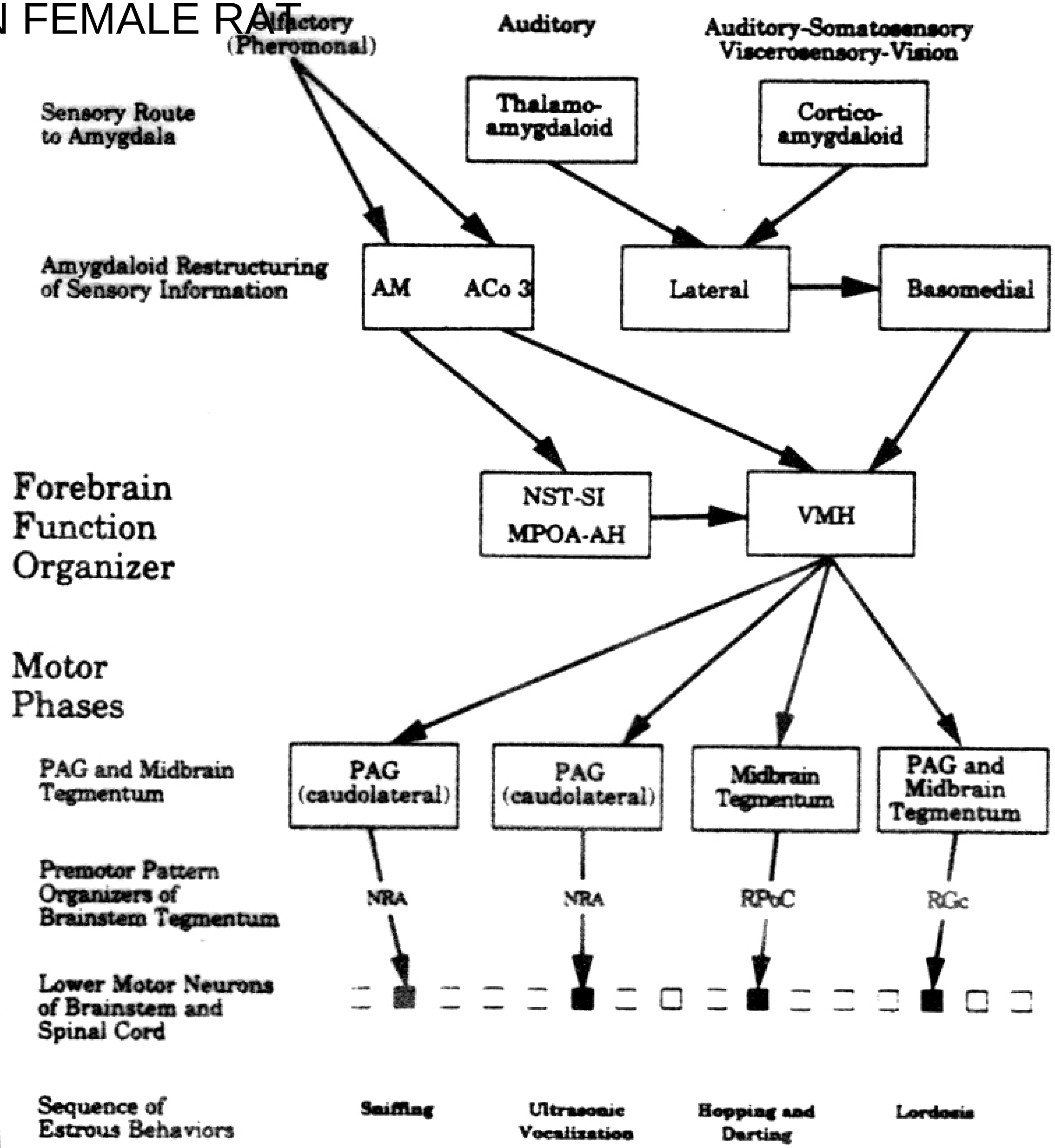

MOTOR SYSTEM
somatic motor system
lateral
medial
emotional motor system
lateral
medial
eye, neck, axial and proximal body movements
specific emotional behaviors
independent movements of the extremities
gain setting systems including triggering mechanisms of rhythmical and other spinal reflexes
basic motor system
premotor interneurons
motoneurons


prefrontal cortex
central nucleus amygdala
bed nucleus stria terminalis
preoptic area
hypothalamus
pedunculopontine and cuneiform nuclei
periaqueductal gray (PAG)
ventral part of the caudal pontine and medullary medial tegmentum
including the nucleus raphe magnus
including the nucleus raphe pallidus and obscurus
autonomic preganglionics in the intermediolateral cell column
sensory neurons in the dorsal horn
motoneurons and premotor interneurons in the ventral horn and intermediate zone
general level of sympathetic activity
nociception control
general level of motor activity
level setting

THALAMOAMYGDALOID PROJECTIONS IN THE RAT

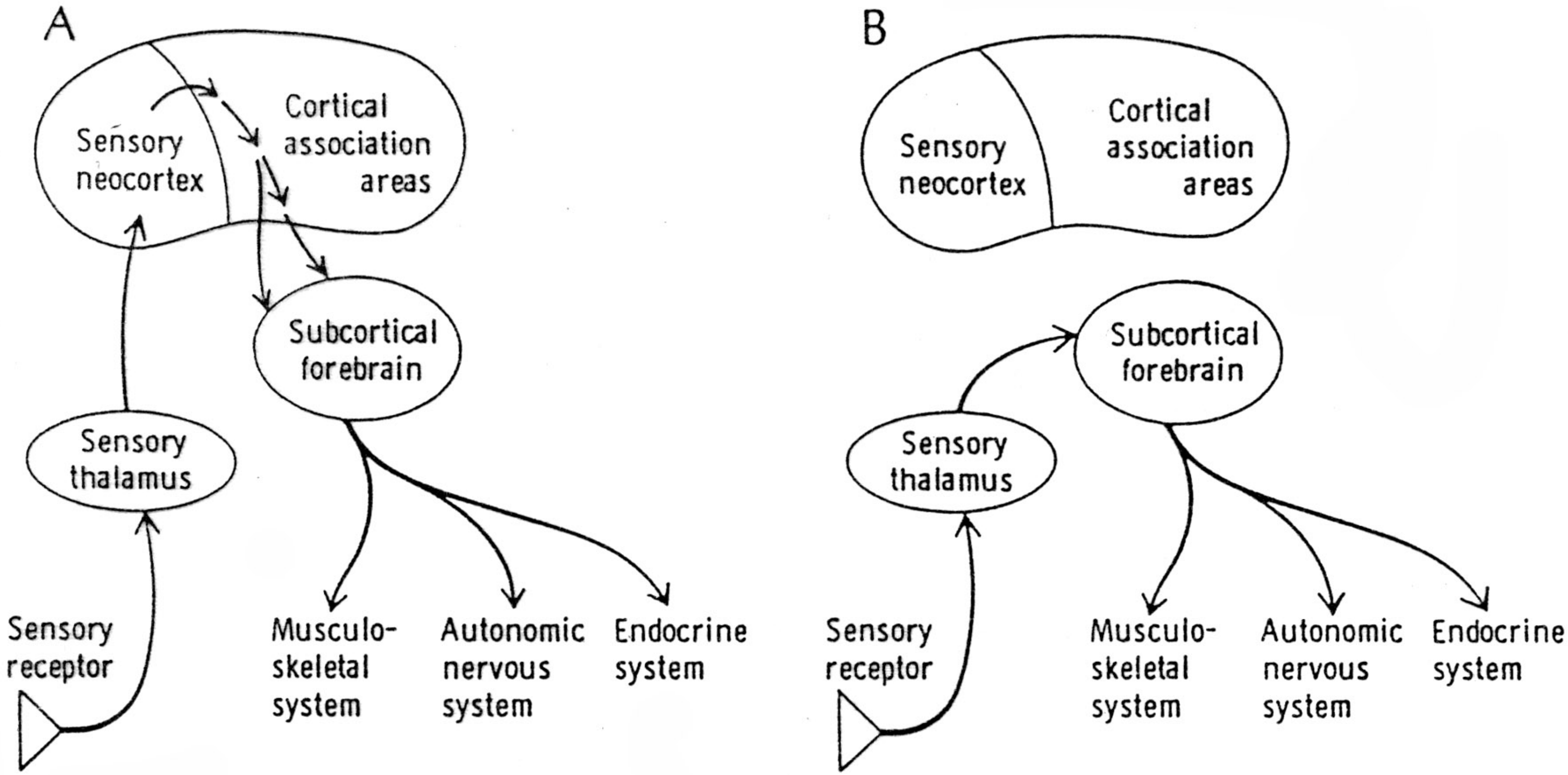


COORDINATED HYPOTHETICAL ACTIONS OF THE MEDIAL and LATERAL AMYGDALOID SYSTEMS UNDERLYING ESTROUS BEHAVIORS IN FEMALE RAT

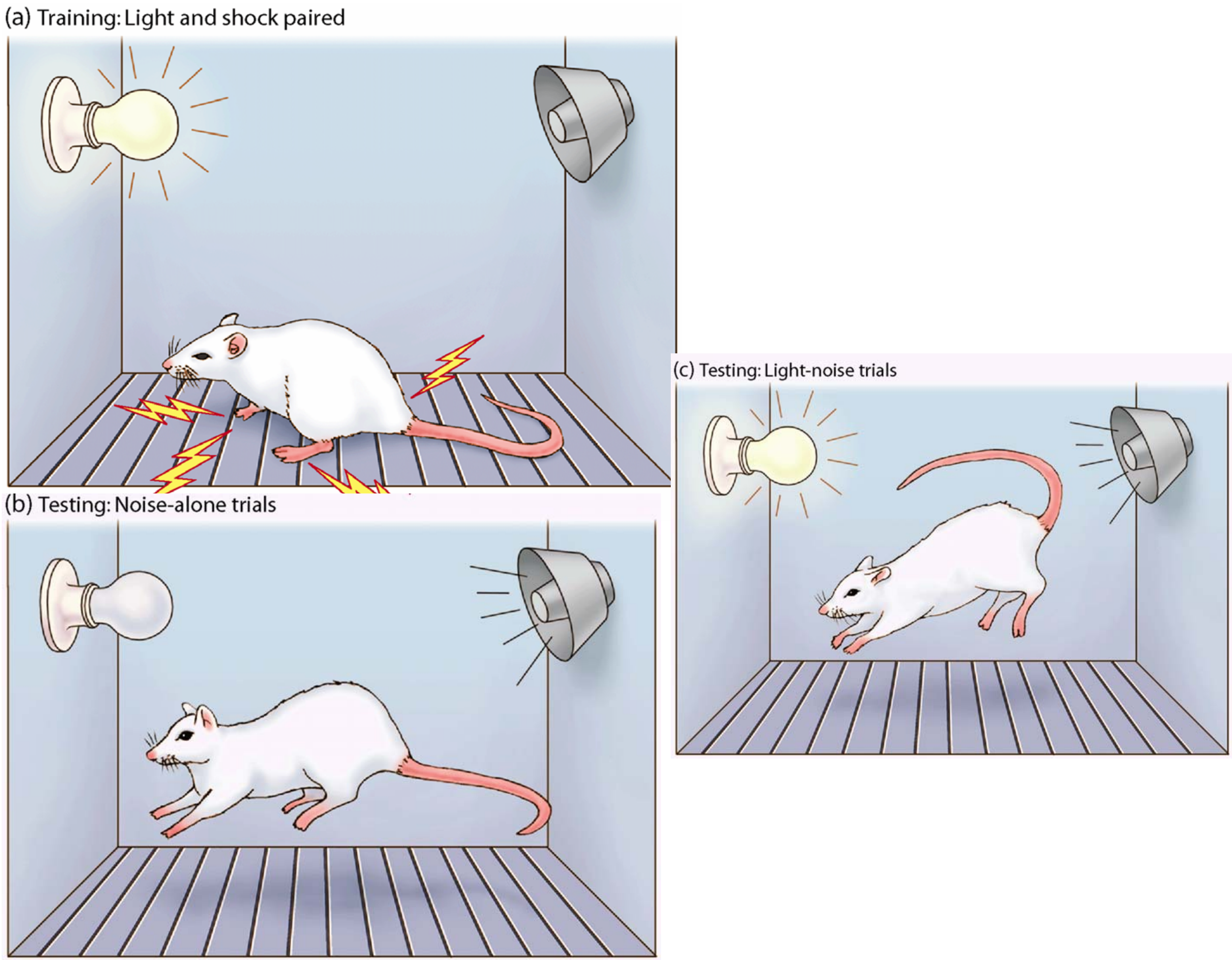


Turner and Herkenham, 1991

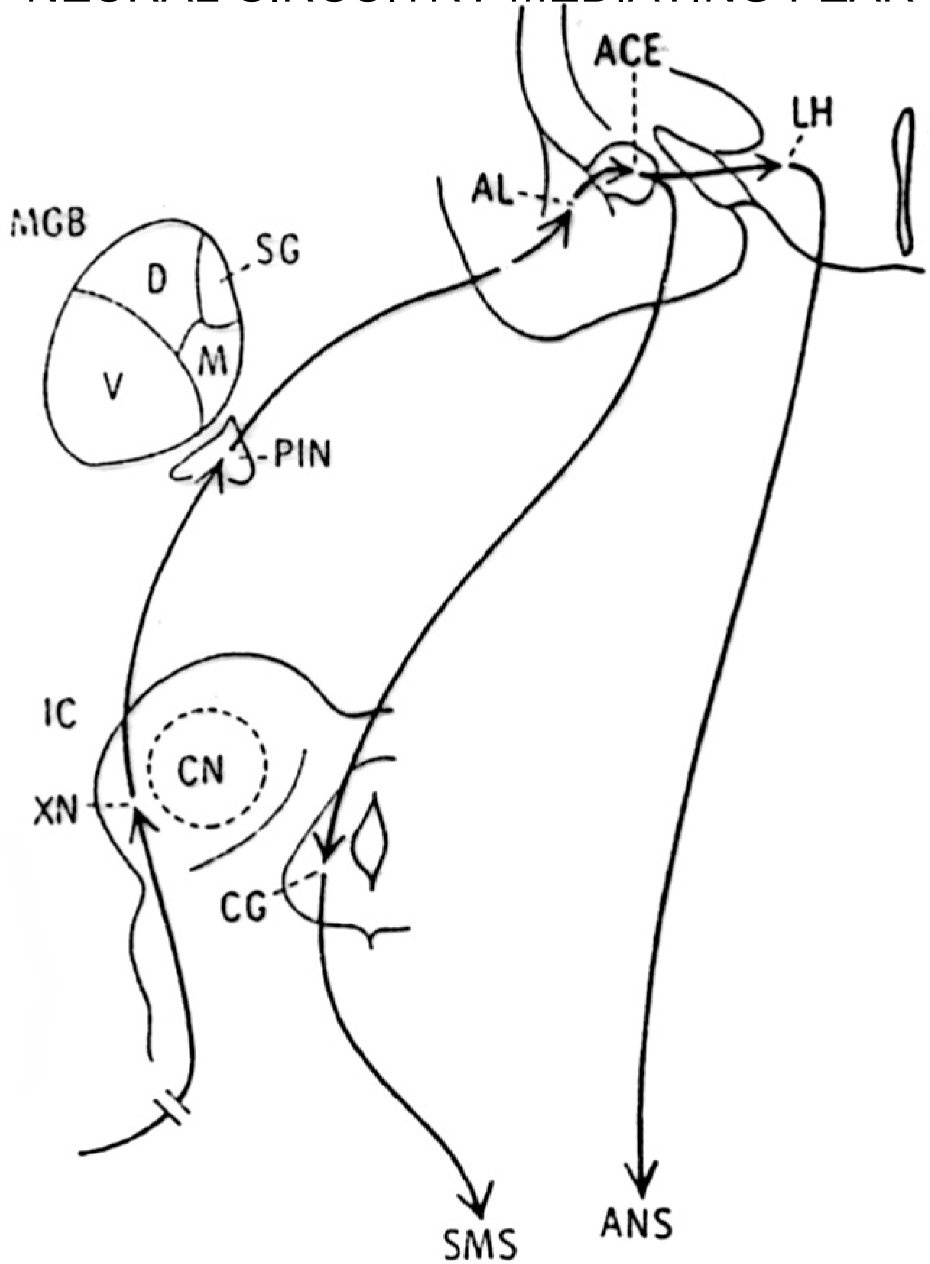
'LOW' AND 'HIGH ROAD' of EMOTIONAL PROCESSING



Pathways linking cortical (A) and thalamic (B) sensory receptive areas to regions of the subcortical forebrain that are involved in the processing of emotional information and in the regulation of behavioraql and visceral responses associated with emotional arousal.

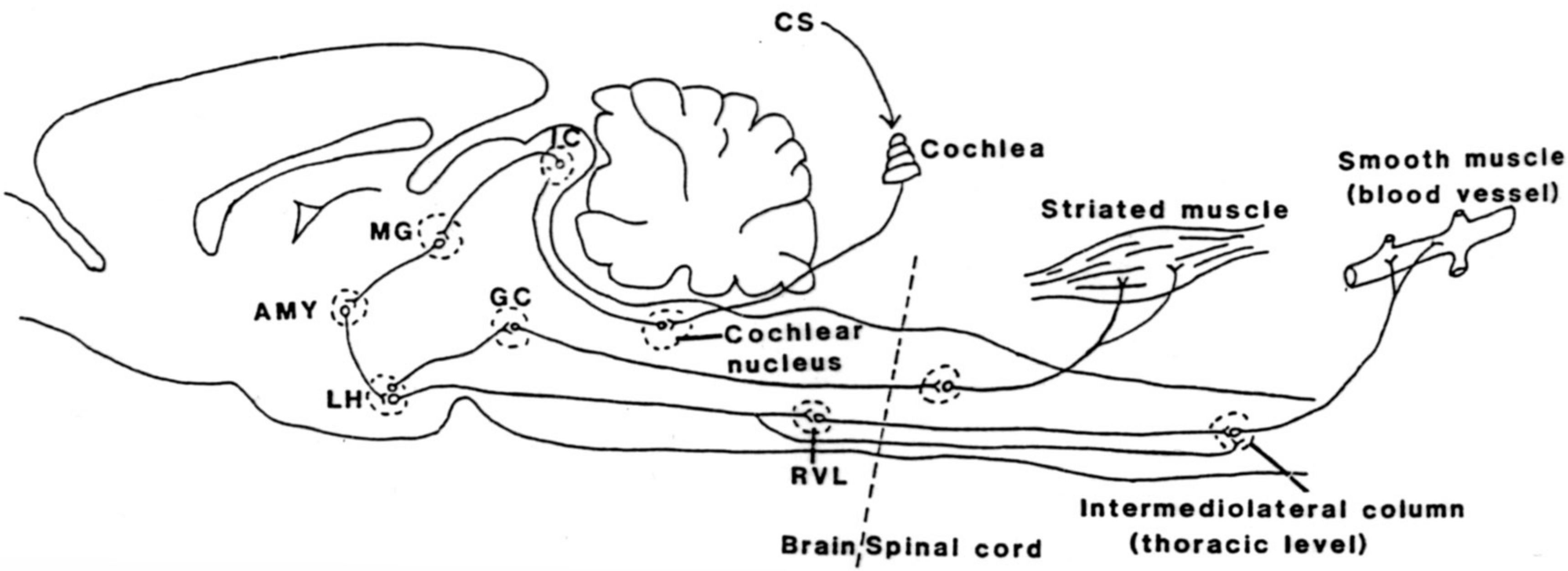

(a) Training: Light and shock paired
(b) Testing: Noise-alone trials
(c) Testing: Light-noise trials

NEURAL CIRCUITRY MEDIATING FEAR CONDITIONING 1.



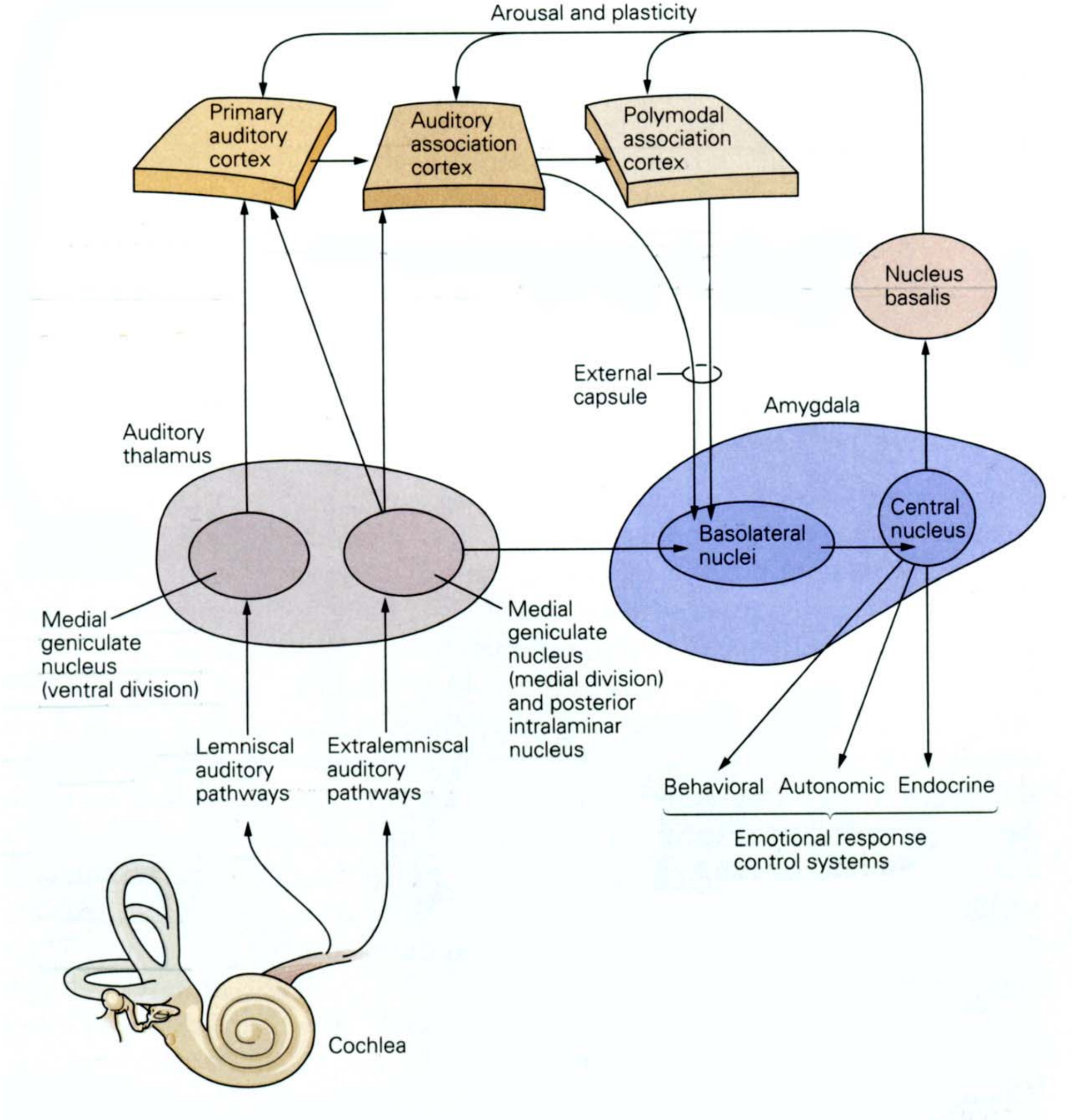
Acoustic inputs are relayed through the peripheral shell regions of the inferior colliculus to the posterior intralaminar nucleus and the medial division of the medial geniculate body (MGB). These areas then projects to the lateral n. of the amygdala. Efferents from the central amygdala bifurcate with projections to the lateral hypothalamic regions controlling arterial-pressure conditioned responses and projections to the central gray (CG) controlling freezing conditioned responses.

NEURAL PATHWAYS MEDIATING FEAR CONDITIONING 2.



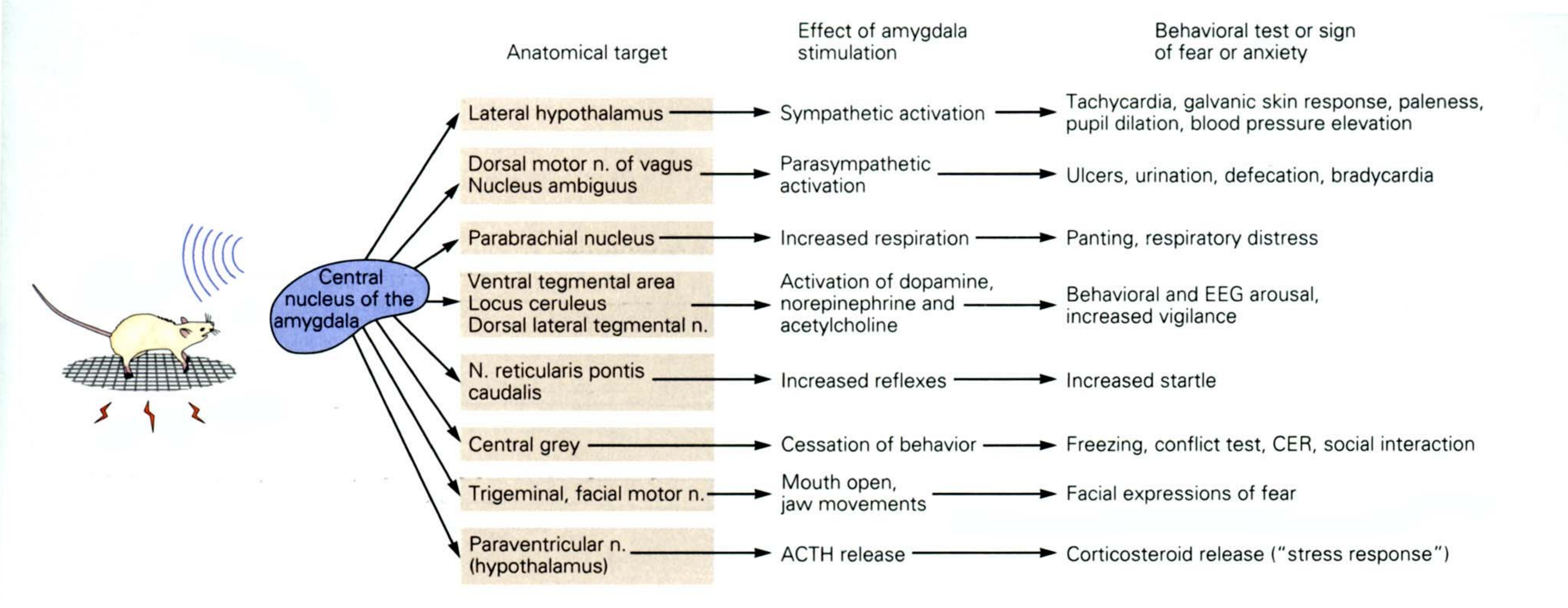
Schematic drawing of a median sagittal section of the rat brain indicating pathways essential for emotional behavior. IC: inferior colliculus; MG: medial geniculate body; AMY: amygdala; GC: central gray; LH: lateral hypothalamus; CS: conditional stimulus; RVL: rostral ventrolateral medulla (after Ledoux, 1987)

NEURAL CIRCUITRY MEDIATING FEAR CONDITIONING 3.



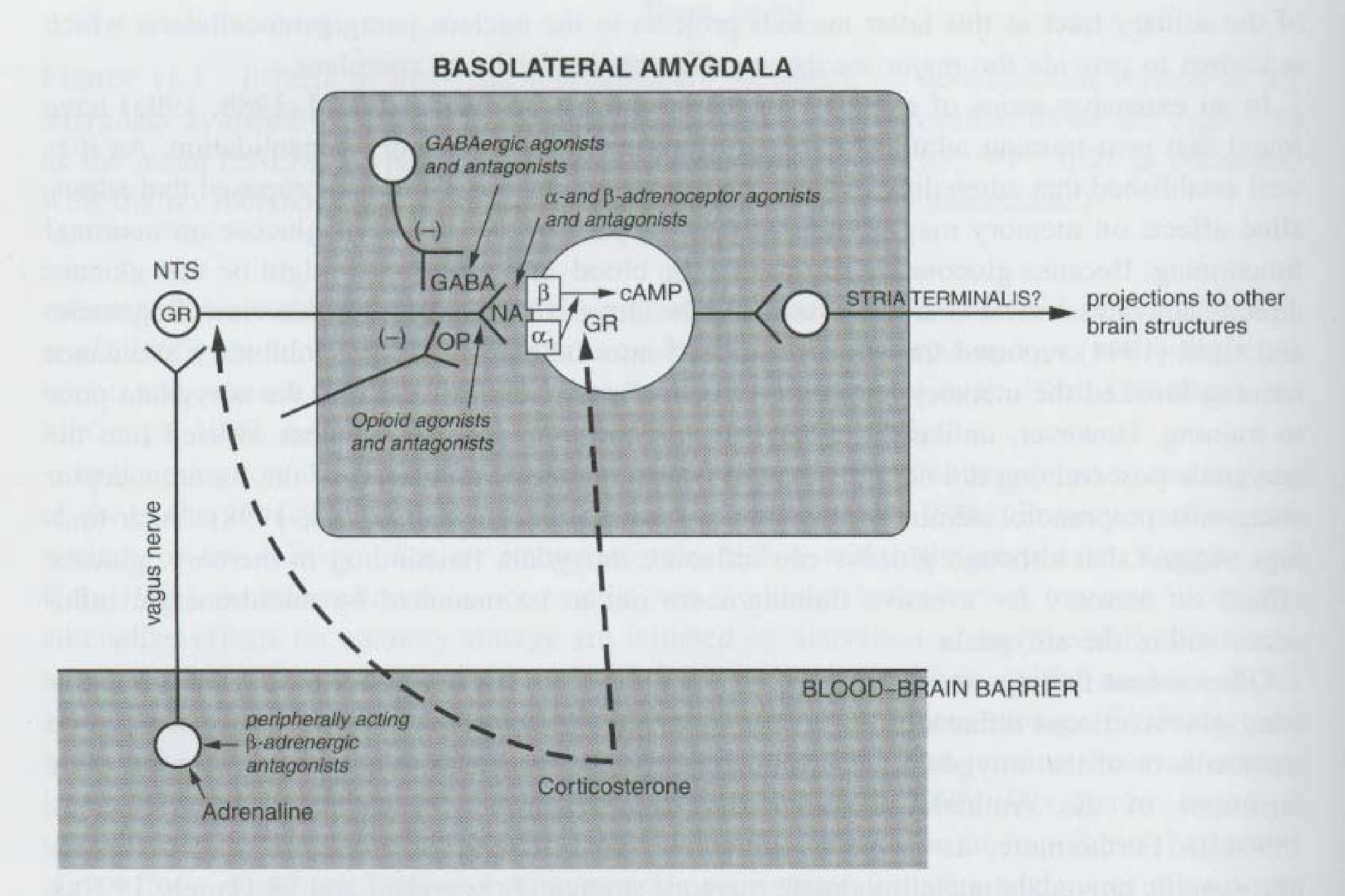
(LeDoux, 1992; Kandell, 2000)

NEURAL CIRCUITRY MEDIATING FEAR CONDITIONING 4



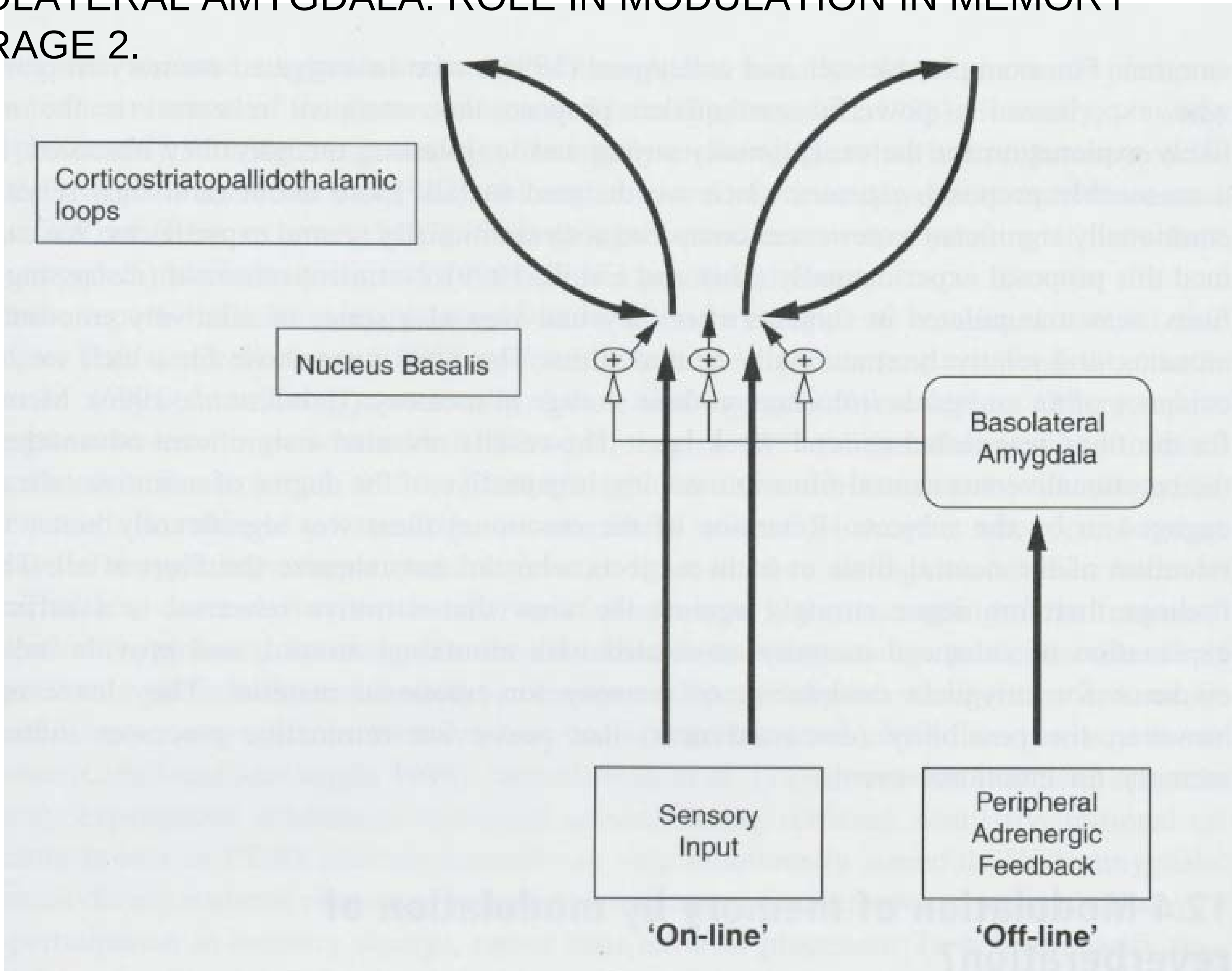
Connections between the central n. of amygdala and a variety of hypothalamic and brainstem areas that may be involved in different animal test of fear and anxiety (Davies, 1992).

BASOLATERAL AMYGDALA: ROLE IN MODULATION IN MEMORY STORAGE 1.



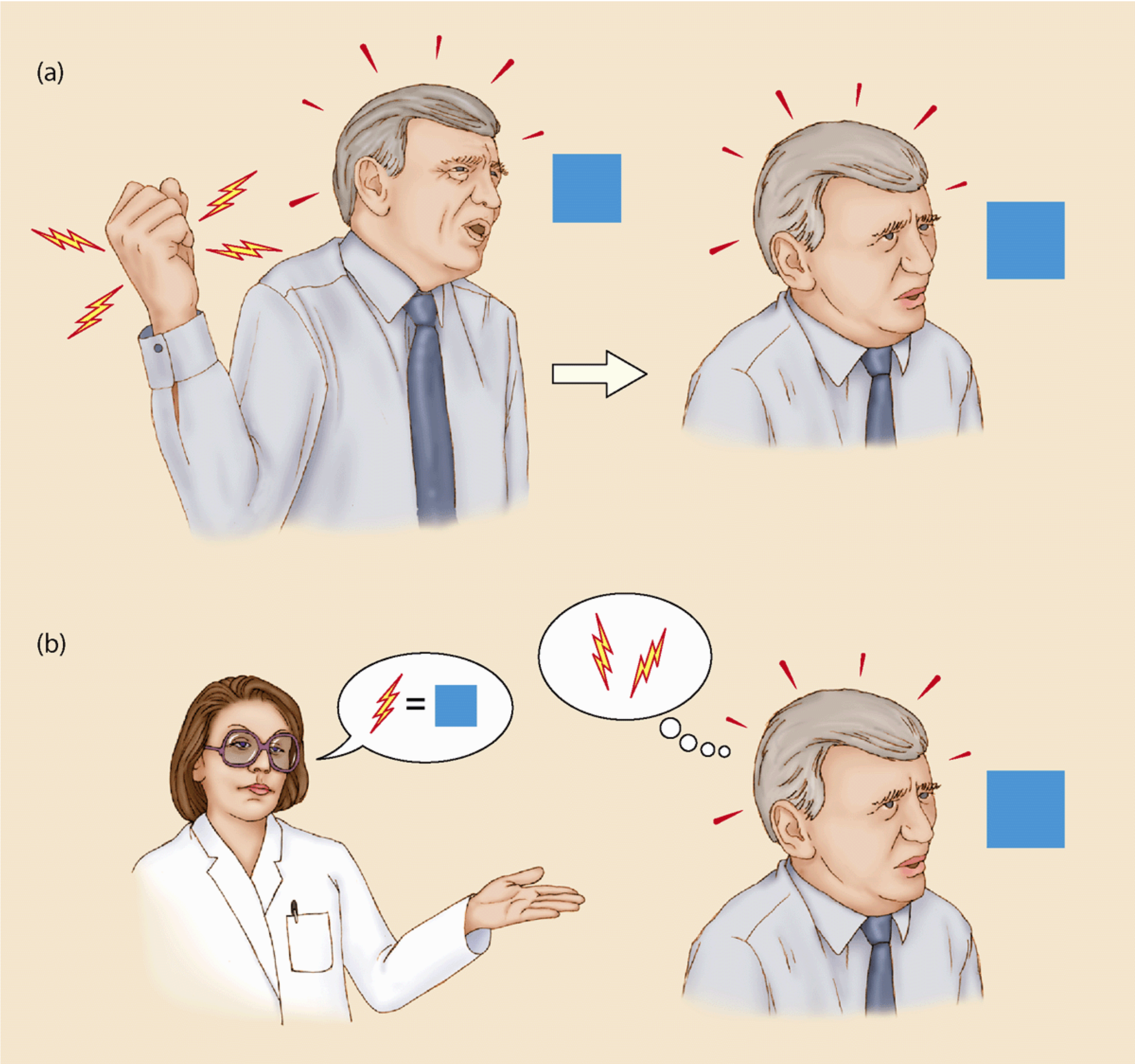
McGAUGH ET AL., 2000)

BASOLATERAL AMYGDALA: ROLE IN MODULATION IN MEMORY STORAGE 2.



Mechanism by which the BL, interacting with peripheral stress hormone feedback, may influence memory consolidation for emotionally arousing events (Cahill, 2000)

Two methods by which humans can learn about the aversive properties of an event.
(a) fear conditioning; (b) instructed fear (From Gazzaniga et al., 2002)



W. W. Norton

SM-   A case report Urbach-Wiethe disease
 (lipoid proteinosis, mineralization of medial temporal tissue

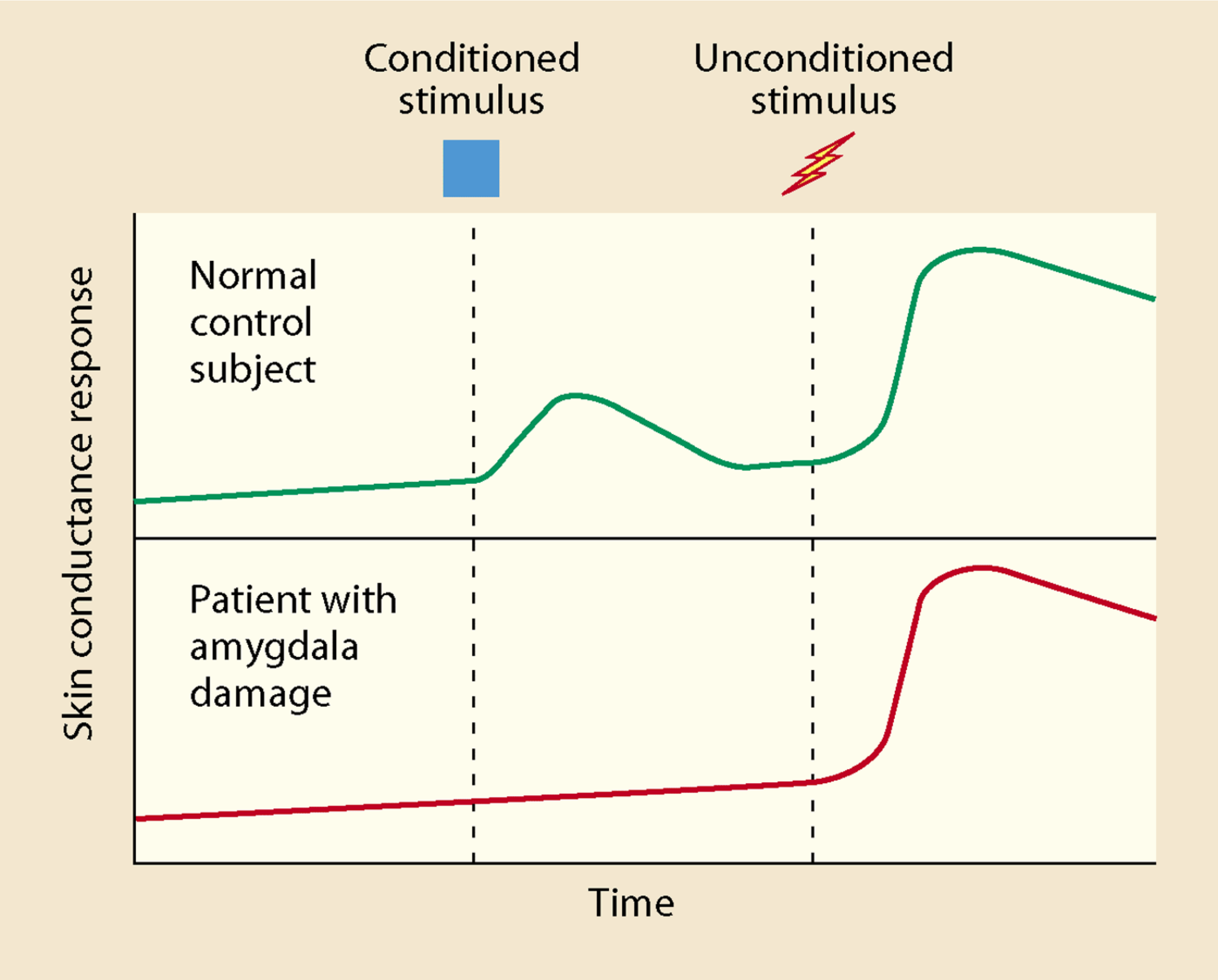
Behavior: Her interpersonal behavior show slight disinhibited style, she does not, however, exhibit any of the features of theclassic Kluver-Bucy syndrome.
Intellect: commensurate with her education
Memory: performance on all major components of the Wechsler Memory Scale-revised are within expectation
Speech and linguistic function: her speech is markedly hoarse. Naming, repetition, comprehension, reading and writing are all intact.
Visuoperceptual, visuospatial, visuocontstarctional function: intact
Executive function: she had some difficulties on tasks of executive function, which tap abilities such as judgment, planning and decision making.

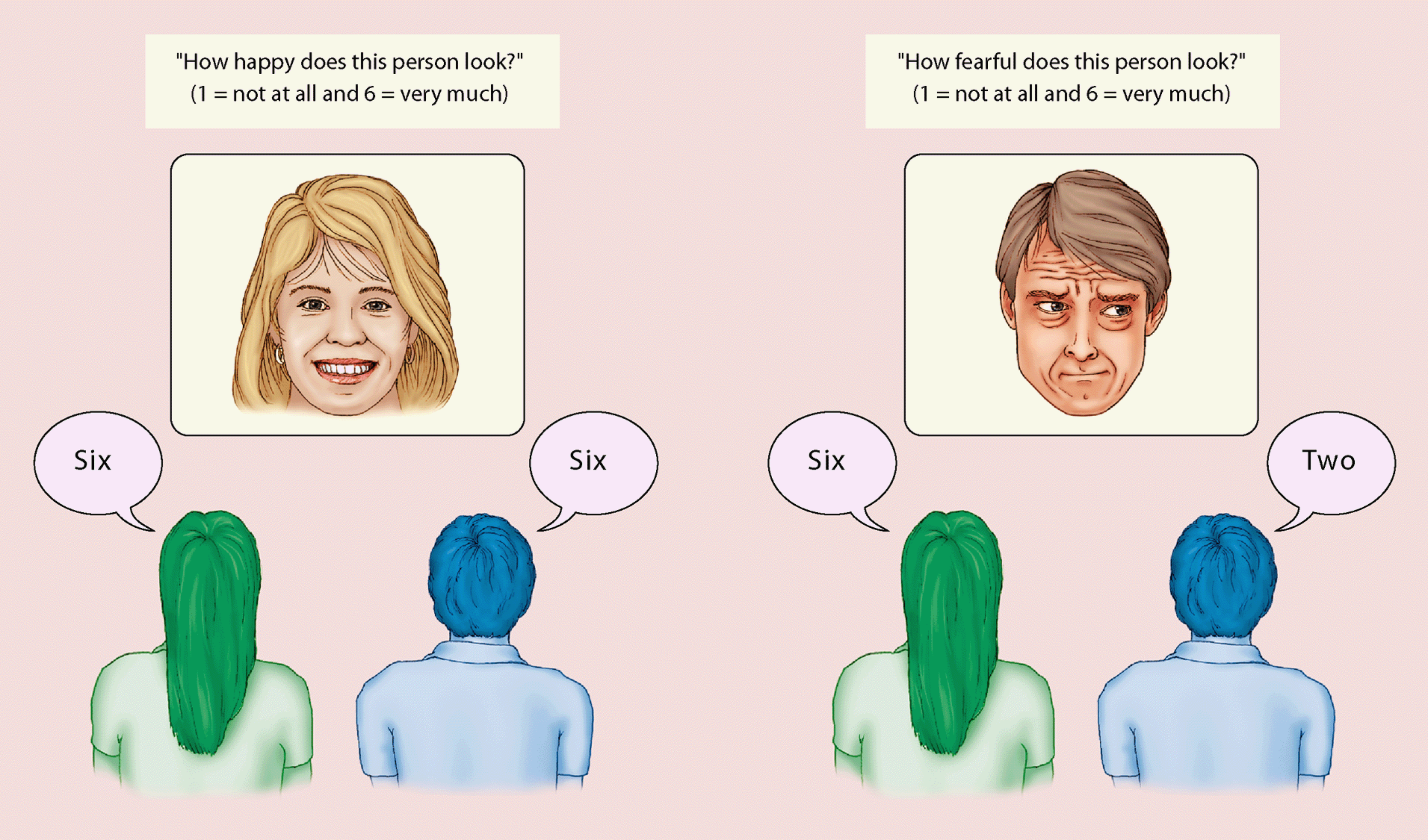
Recognition of emotion in facial expression: **SM stands out as specifically impaired in her ability to assign normal ratings to faces of fear**, but normal in her ability to recognize emotions other than fear.

Recognition of emotional arousal: **she was impaired in her ability to recognize the arousal signaled by stories and by words denoting negative emotions**.

SKIN CONDUCTANCE RESPONSE in NORMAL CONTROL AND AMYGDALA LESION IN HUMAN

The amygdala is important in implicit expression of emotional learning. (indirect emotional responses)In contrast the hippocampus is important to acquire explicit or declarative knowledge of emotional learning and memory. The amygdala can act to enhance the strength of explicit memories for emotional events by modulating the storage of these memories




"How happy does this person look?"
(1 = not at all and 6 = very much)
Six
Six
"How fearful does this person look?"
(1 = not at all and 6 = very much)
Six
Two