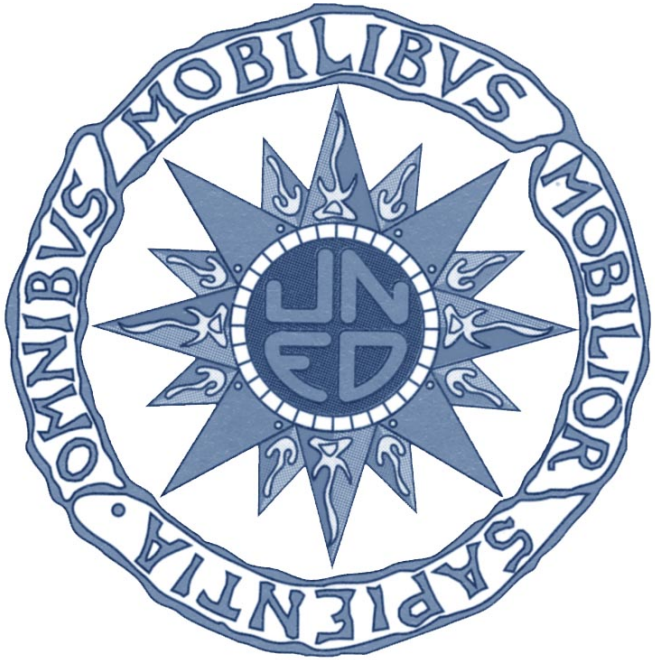


NEUROBIOLOGÍA DE LAS EMOCIONES POSITIVAS

Departamento de Psicobiología

Emilio Ambrosio

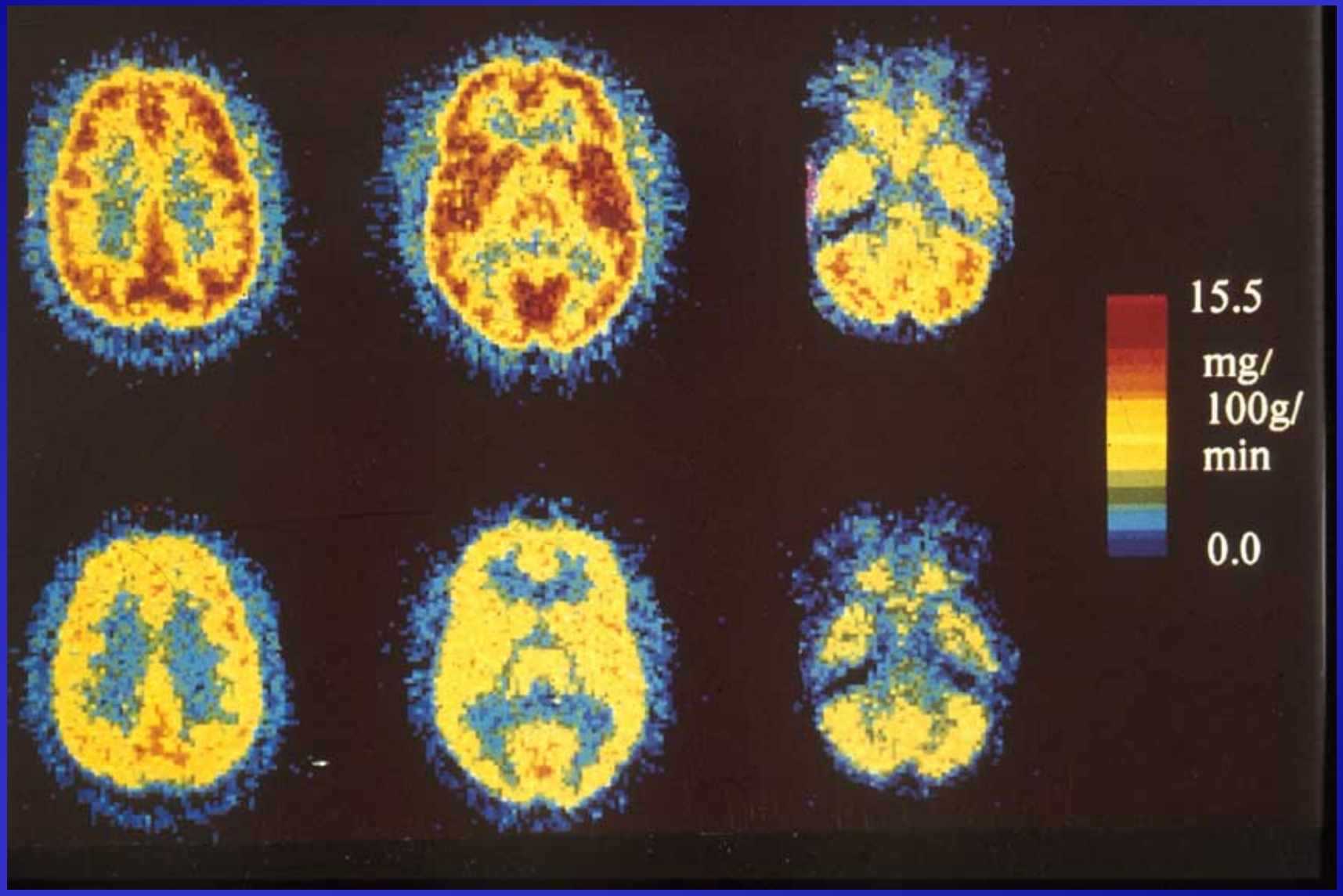
CONSIDERACIONES SOBRE LA FELICIDAD

-Las personas tenemos la posibilidad de aumentar nuestra dicha.

-A ello contribuye la plasticidad cerebral y la educación.

- Es preciso aprender a orientar nuestras actitudes y emociones en la dirección de mayores cotas de disfrute.


SIEMENS
ECAT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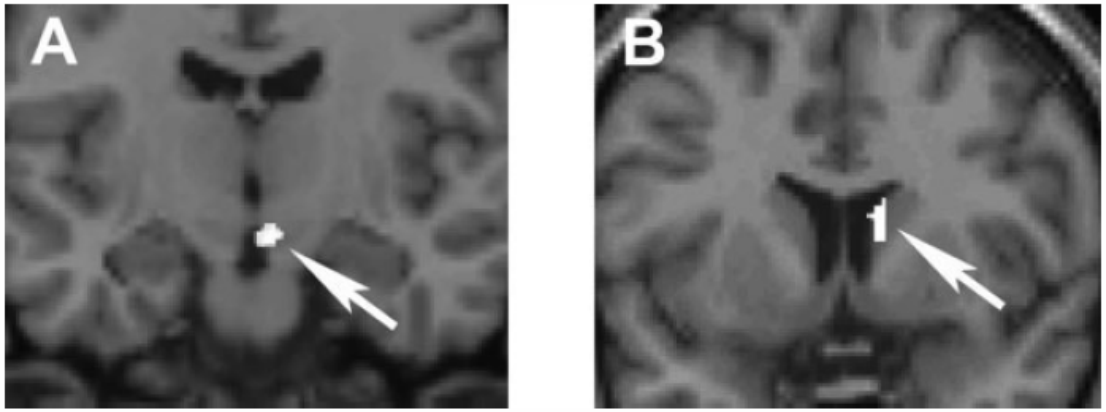
NEUROANATOMÍA DEL ENAMORAMIENTO (I)

Fig. 1. Group activation regions detected as individuals looked at an image of their beloved compared to an image of an acquaintance (see Aron et al., 2005, for details). The regions of activation (white) are from anatomically normalized data and are superimposed on a template brain from SPM99. **A:** The right ventral tegmental area (arrow) was activated. **B:** The right caudate nucleus (arrow) was activated. Data from other studies of mammals suggest that these regions are involved in reward and motivation functions.



NEUROANATOMÍA DEL ENAMORAMIENTO (II)

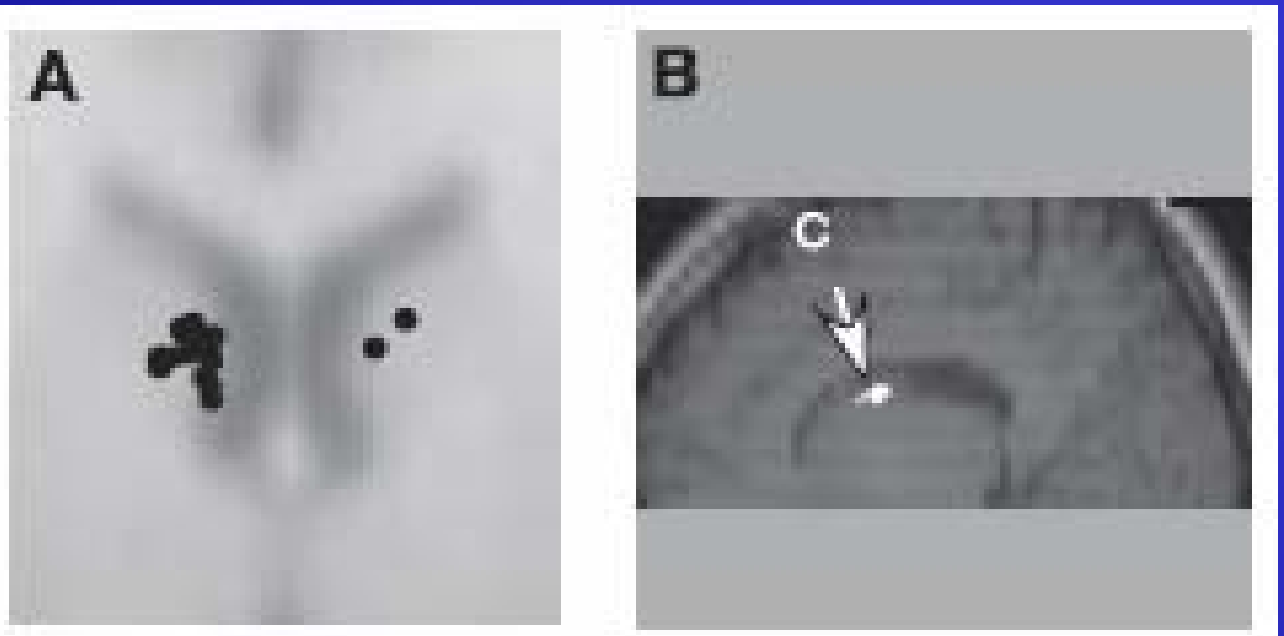
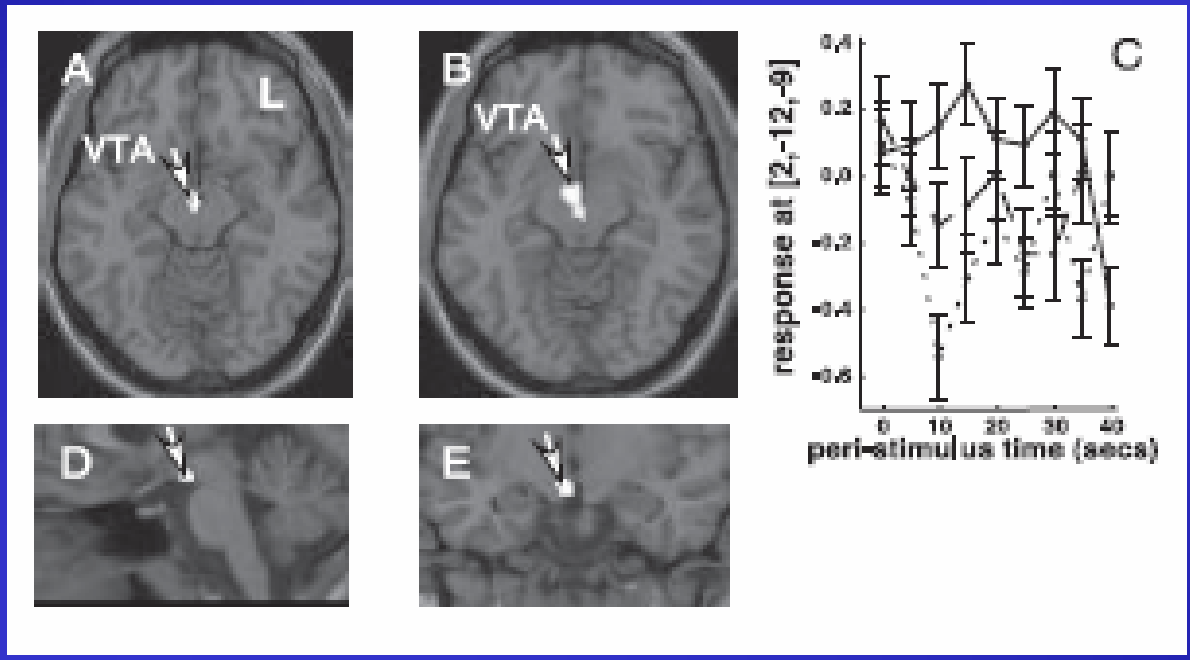
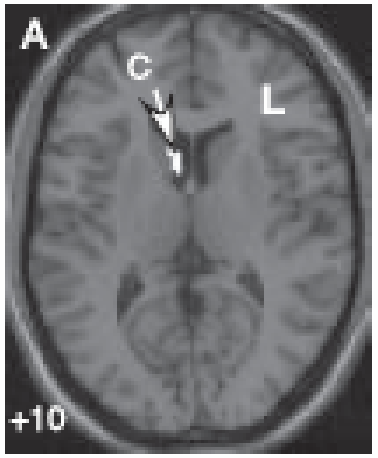


FIG. 1. Caudate nucleus activation, positive-minus-neutral contrast. *A*: an enlargement of an axial section through the caudate nucleus from the MNI T1 template that averaged 305 subjects. Black dots show peak activation points for each participant in the present study. Activation points were near the medial edge of the caudate in the vicinity of Talairach coordinates 12, 11, 14 (dark gray areas are lateral ventricles). *B*: a sagittal section from an individual participant shows the extent of the posterior dorsal caudate activation (arrow). Images in this and all following figures are presented in radiologic convention (participants' left on the right side of the image). C, caudate.

NEUROANATOMÍA DEL ENAMORAMIENTO (III)



NEUROANATOMÍA DEL ENAMORAMIENTO (IV)



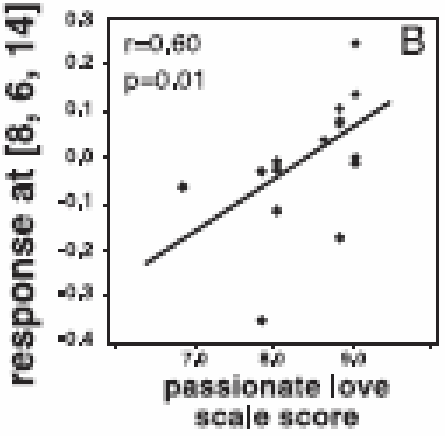


FIG. 3. Activation in the anteromedial caudate body was correlated with the passionate love scale (PLS) scores of participants. *A*: caudate location for the correlation (arrow). *B*: correlation of activity in the caudate with PLS scores. Location of responses shown in graph are given in Talairach coordinates. C, caudate; L, left side.

NEUROANATOMÍA DEL ENAMORAMIENTO (V)

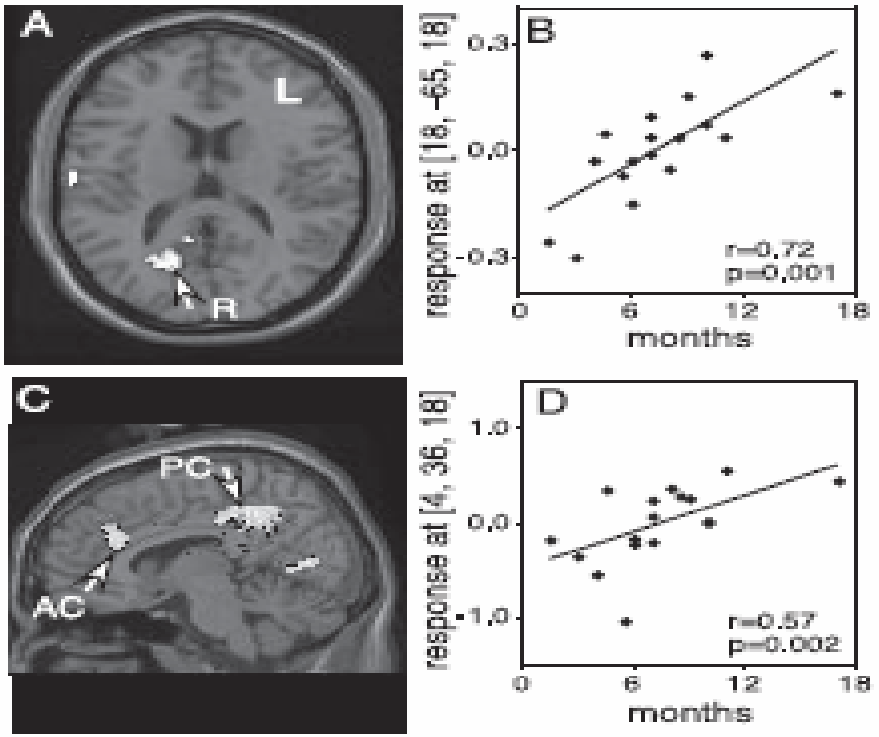


FIG. 5. Length of time in love correlated with activation in specific regions. Regions are indicated on axial (*A*) and sagittal (*C*) sections. *A*: cluster location for the retrosplenial cortex correlation (arrow) is similar to a region correlated with satiation while eating chocolate (Small et al. 2001). *B*: correlation for the peak voxel in the cluster labeled R in *A*. *C*: location of voxel clusters correlated with relationship length in the AC and PC (arrows). *D*: graph of the correlation between the BOLD response and months in love for the AC. AC, anterior cingulate cortex; PC, posterior cingulate cortex; R, posterior cingulate/BA30 retrosplenial cortex.

NEUROANATOMÍA DE LA ATRACCIÓN FISICA

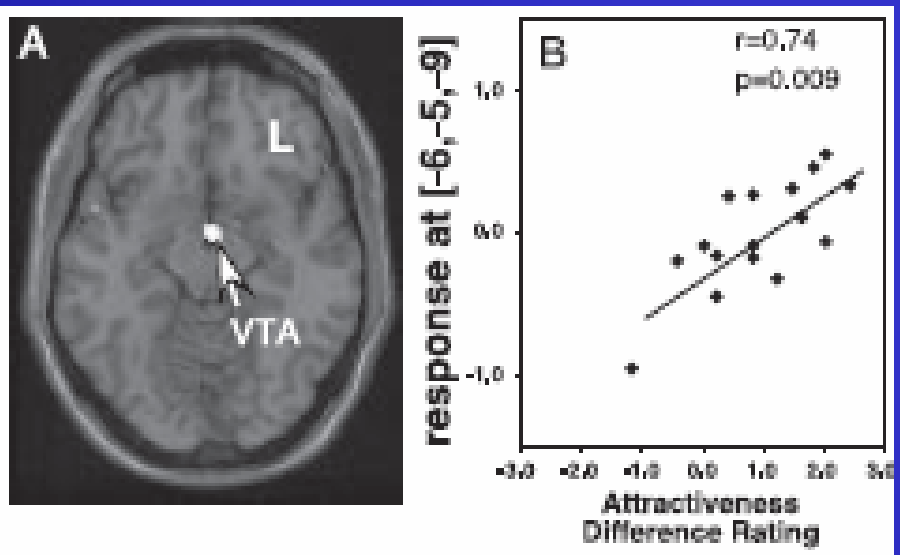


FIG. 4. Activity in the VTA for the positive-minus-neutral contrast wa correlated with the independently rated attractiveness of the positive minus th attractiveness of the neutral faces. *A*: activation is on the *left* and on the midlin (arrow) and different from the localization of activation in Fig. 2, *A* and *B*. *B* neural activity in response to positive images was greater when the positiv face was more attractive than the neutral face.

NEUROANATOMÍA DEL AMOR MATERNAL (I)

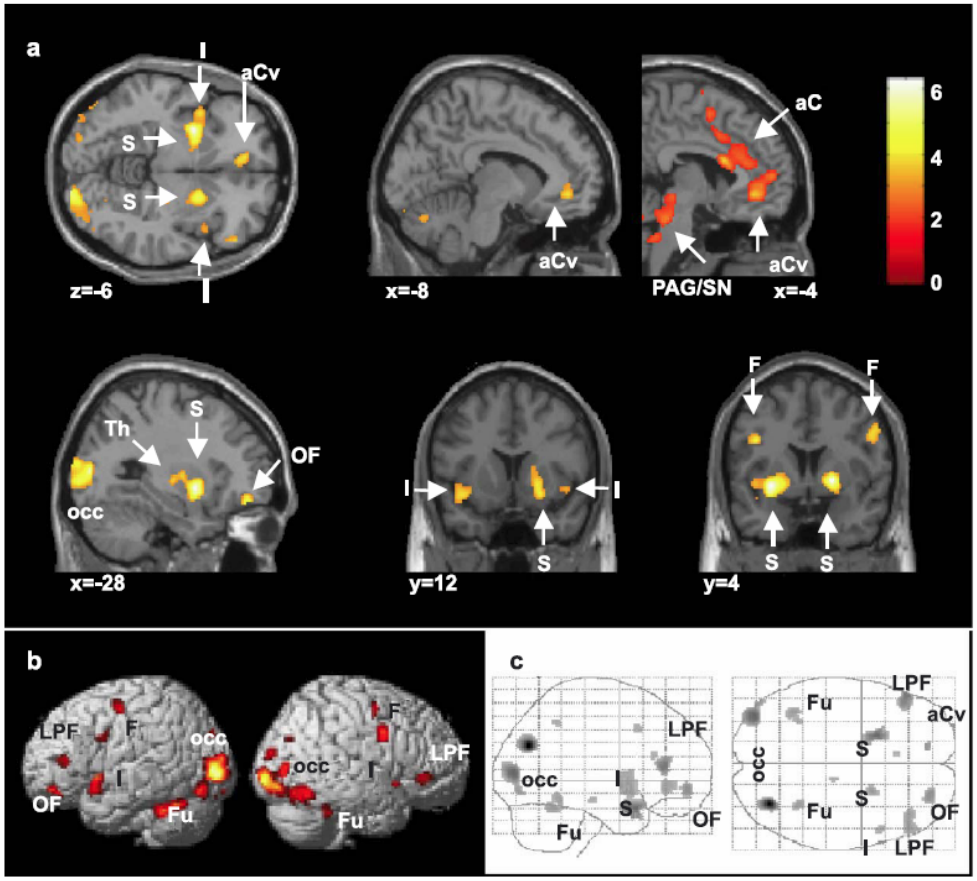


Fig. 1. Activations with maternal love. (a,b) Activations revealed when mothers viewed their own child versus an age and familiarity matched acquainted child (contrast: cO vs. cA), superimposed on a template structural brain. For illustration, sections and rendered brains are thresholded at $P < 0.005$, uncorrected, with an extent threshold of 6 voxels ($Z = 2.88$, random effects, $n = 19$), the back-set section at $P < 0.05$ to show the extent of activity in the aC (overlapping with romantic love activity). Note that all labeled regions reached a threshold of at least $P < 0.001$ (uncorrected) or $P < 0.05$ (corrected) (see Table 2). (c) Control for emotional valence: the same results were obtained with the contrast ([cO vs. cA] vs. [aF vs. aA]), that is, when activity related to adult friendship was subtracted from maternal love. Shown are glass-brain views ($P < 0.001$, uncorrected) to provide an overview of this contrast in the whole brain. Abbreviations: aC = anterior cingulate cortex; aCv = ventral aC; C = caudate nucleus; F = frontal eye fields; Fu = fusiform cortex; I = insula; LPF = (ventral) lateral prefrontal cortex; occ = occipital cortex; OF = orbito-frontal cortex; Tha = thalamus; S = striatum (consisting of putamen, caudate nucleus, globus pallidus); PAG = periaqueductal (central) gray; SN = substantia nigra. Color scale: Z-values, applies to sections only. Sections: transverse: bottom = right, coronal: right = right.

NEUROANATOMÍA DEL AMOR MATERNAL (II)

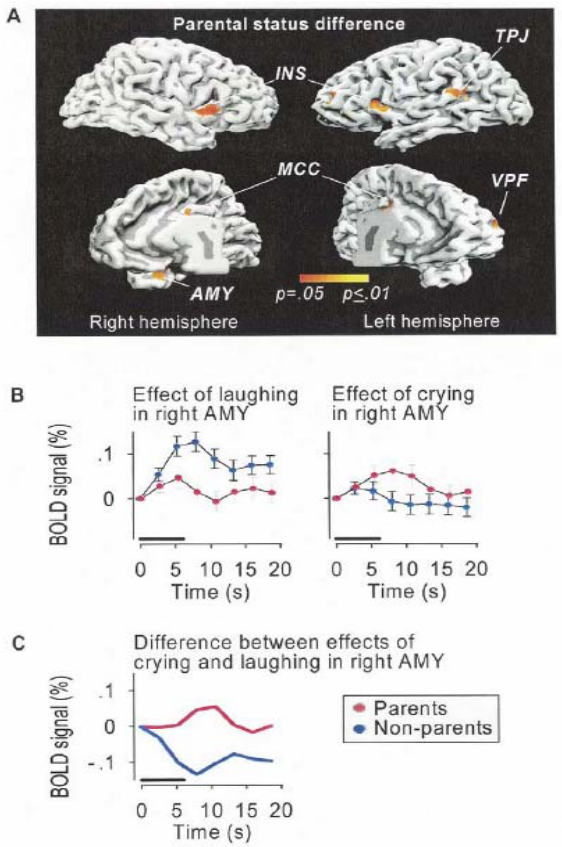
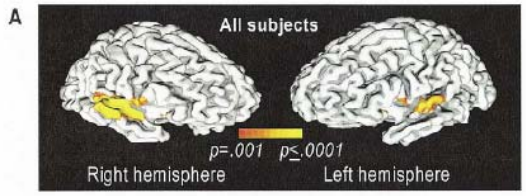


Figure 3. Parental status effect on human brain response to infant crying and laughing. Differential brain responses to crying and laughing in parents ($n = 20$) versus nonparents ($n = 20$). **(A)** Lateral and medial sides of isolated hemispheres. The p values, corrected for multiple comparisons, were obtained from statistical t maps calculated with general linear model contrasts (further details in Table 1). Note, except for left VPF (x/y/z coordinates, −43/43/16; z score, 3.51), right MCC (2/1/31; z score, 3.79), and left TPJ (−50/−47/16; z score, 3.55), all areas are corrected for multiple comparisons considering all voxels of the whole brain. **(B)** Blood oxygen level–dependent (BOLD) signal time course (mean and standard error) in the right amygdala; horizontal line indicates 6-sec duration of stimulation. **(C)** The group (parents vs. nonparents) × stimulus (crying vs. laughing) interaction in the right amygdala is illustrated by the positive net effect of crying minus laughing in parents and the negative net effect of crying minus laughing in nonparents. The same pattern of BOLD signal time course as that illustrated in **B** and **C** was present in the other brain areas shown in **A**. VPF, ventral prefrontal cortex. INS, insula; TPJ, temporoparietal junction; MCC, middle cingulate cortex; AMY, amygdala.

NEUROANATOMÍA DEL AMOR MATERNAL(III)



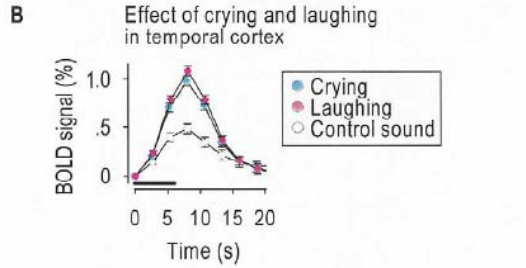
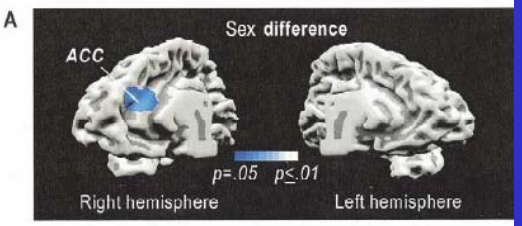


Figure 1. Pattern of human brain response to infant vocalizations. **(A)** Lateral view of right and left hemispheres, with color-coded brain areas that were activated by infant crying and laughing, in contrast to a neutral control stimulus. The subjects group (n = 40) was composed of 10 women and 10 men with young children and 10 women and 10 men without children. The activated areas in the temporal cortex included Heschl's gyri, polar and temporal planes, superior temporal sulci, and superior and middle temporal gyri. The p values, corrected for multiple comparisons, were obtained from statistical t maps calculated with general linear model contrasts. **(B)** Blood oxygen level–dependent (BOLD) signal time course (mean and standard error) in activated regions shown in **A**; horizontal line indicates 6-sec duration of stimulation.



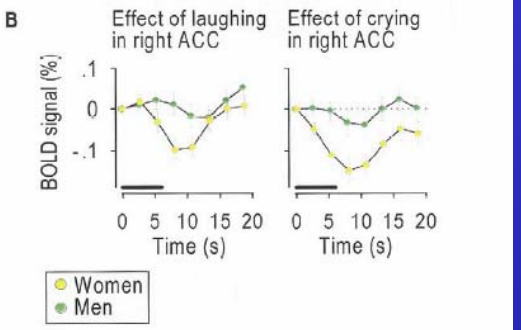


Figure 2. Sex difference in human brain response to infant vocalizations. Differential brain responses to crying and laughing in women (n = 20) vs. men (n = 20). **(A)** Medial side of isolated hemispheres, with color-coded brain area that showed a significant sex difference of response. The p values, corrected for multiple comparisons, were obtained from statistical t maps calculated with general linear model contrasts (further details in Table 1). **(B)** Blood oxygen level–dependent (BOLD) signal time course (mean and standard error) in activated region; horizontal line indicates 6-sec duration of stimulation. ACC, anterior cingulate cortex.

NEUROANATOMÍA DEL AMOR MATERNAL Y DEL ENAMORAMIENTO (I)

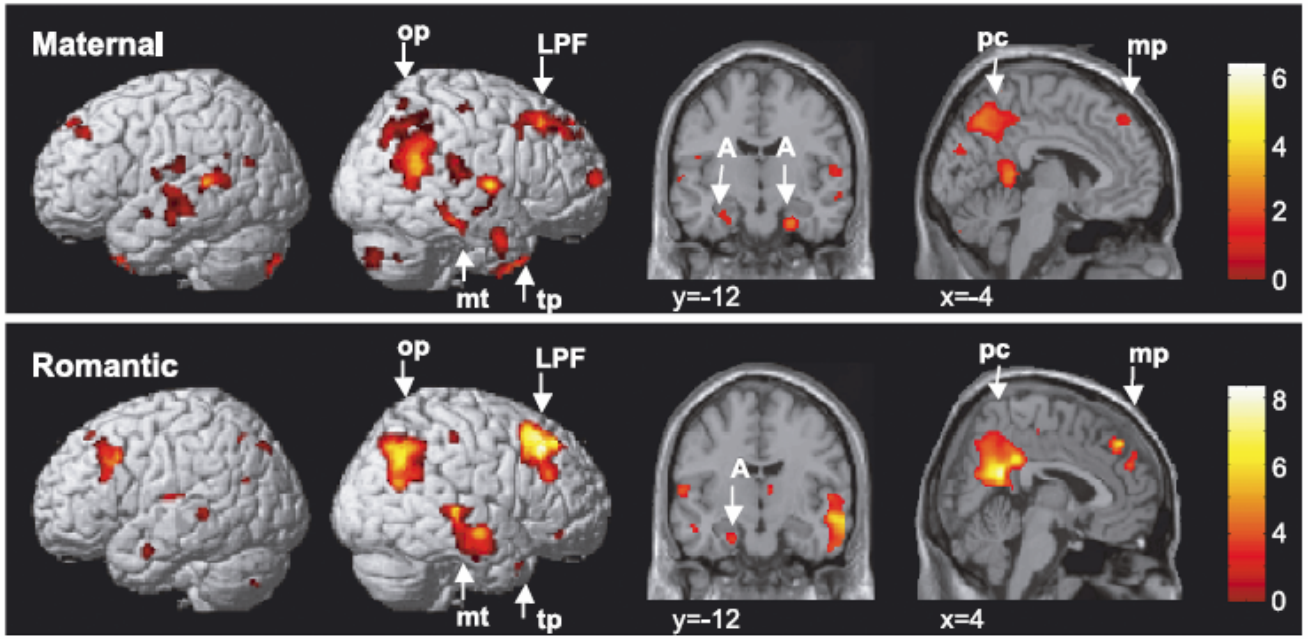


Fig. 2. Deactivated regions with maternal and romantic love. The sections and rendered views show regions whose activity was suppressed with maternal love (cO vs. cA) (top). These regions were the same as those that were deactivated with romantic love (viewing loved partner vs. friends) in our previous study (bottom). All labeled regions reached significance at $P < 0.05$, corrected for small volume (for illustration, following thresholds were used—top: $P < 0.05$, uncorrected; bottom: $P < 0.001$, uncorrected). Abbreviations: A = amygdaloid cortex, pc = posterior cingulate cortex, mp = mesial prefrontal/paracingulate gyrus; mt = middle temporal cortex; op = occipitoparietal junction; tp = temporal pole.

NEURONATOMÍA DEL AMOR MATERNAL Y DEL ENAMORAMIENTO (III)

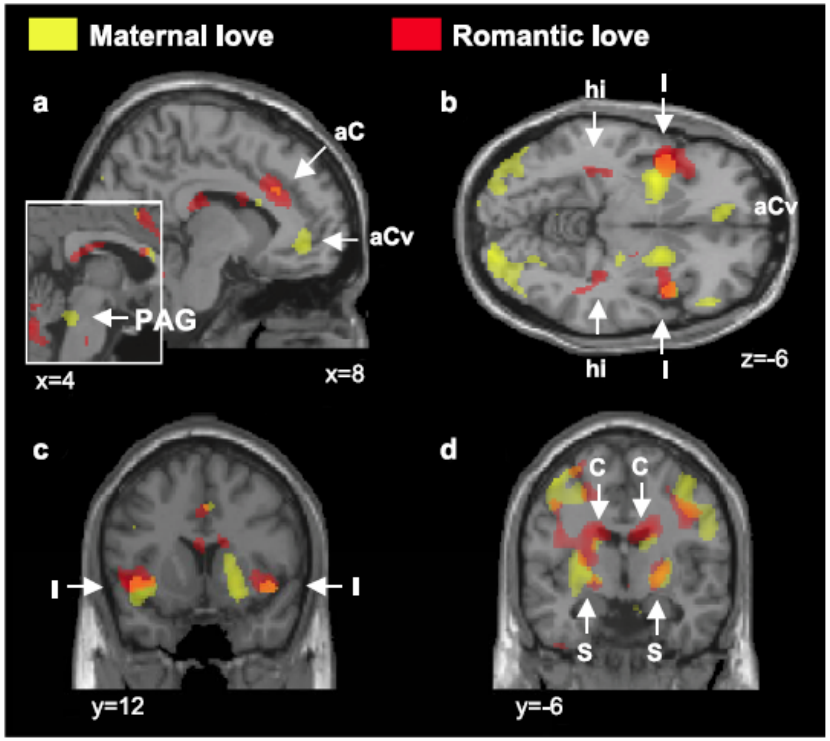


Fig. 3. Overlap between activity of maternal love and romantic love. Activity obtained in this study (contrast: cO vs. cA) was colored in yellow and overlaid on sections through a template brain, along with activity obtained in our previous study on romantic love (contrast: 'loved partner vs. friends') colored in red. Note that all regions displayed here for romantic love also reached significance when only female or only male subjects were included ($P < 0.001$, see Methods and text). The activation of aCv with maternal love overlapped with activation of the same region in female subjects only in romantic love ($P < 0.005$). For illustration, a–c were thresholded at $P < 0.01$, and d with $P < 0.05$, to reveal overlapping activity in the caudate nucleus. hi = hippocampus. See Fig. 1 for additional abbreviations.

NEURONATOMÍA DELAMOR MATERNAL Y DEL ENAMORAMIENTO (IV)

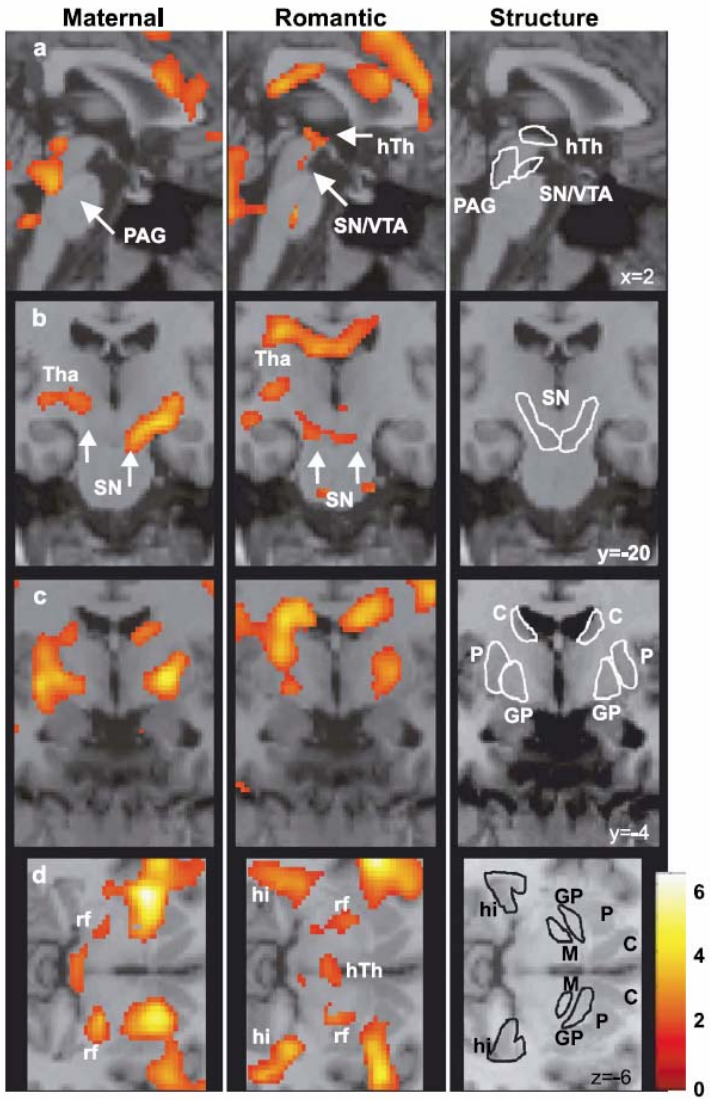
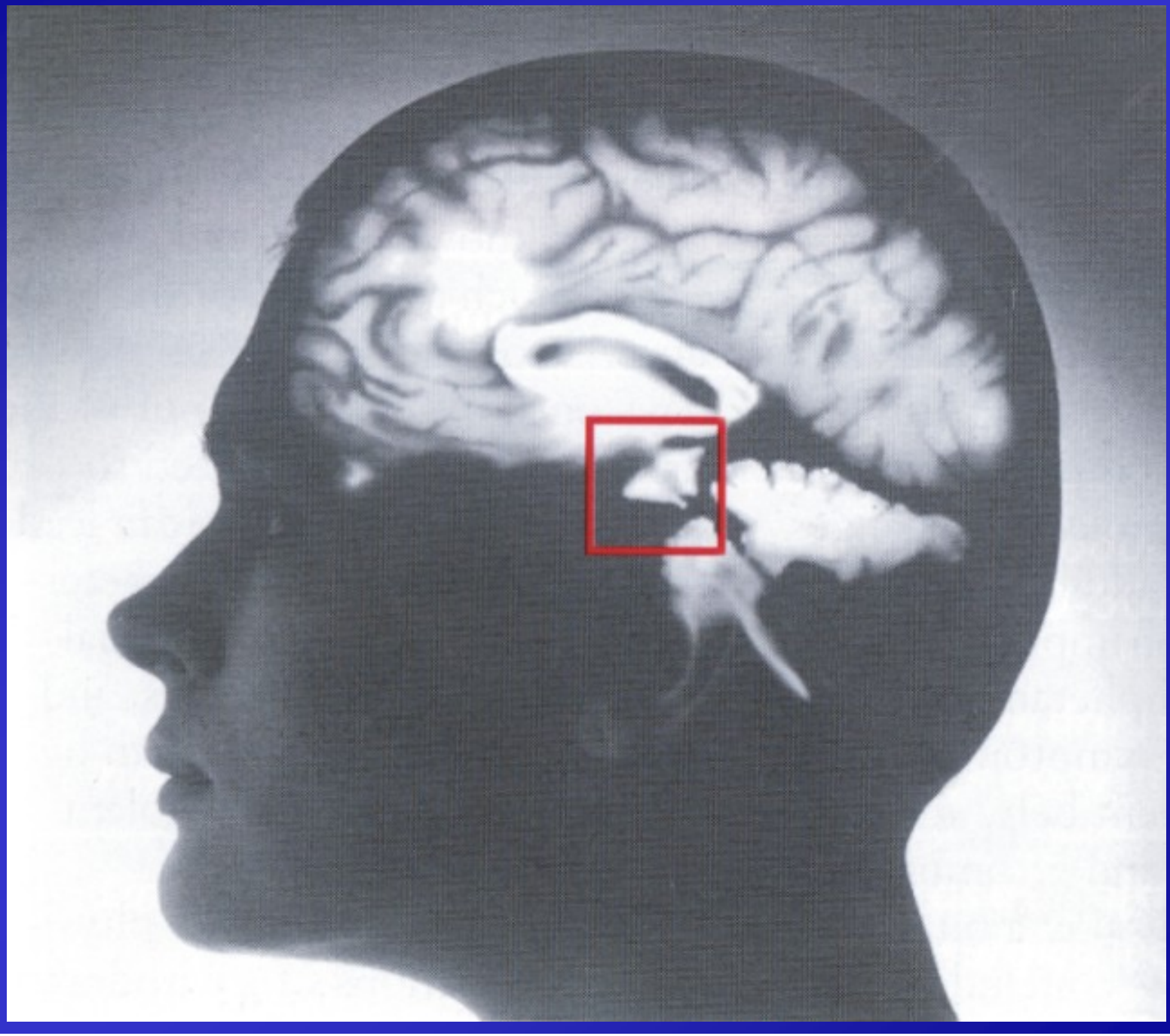
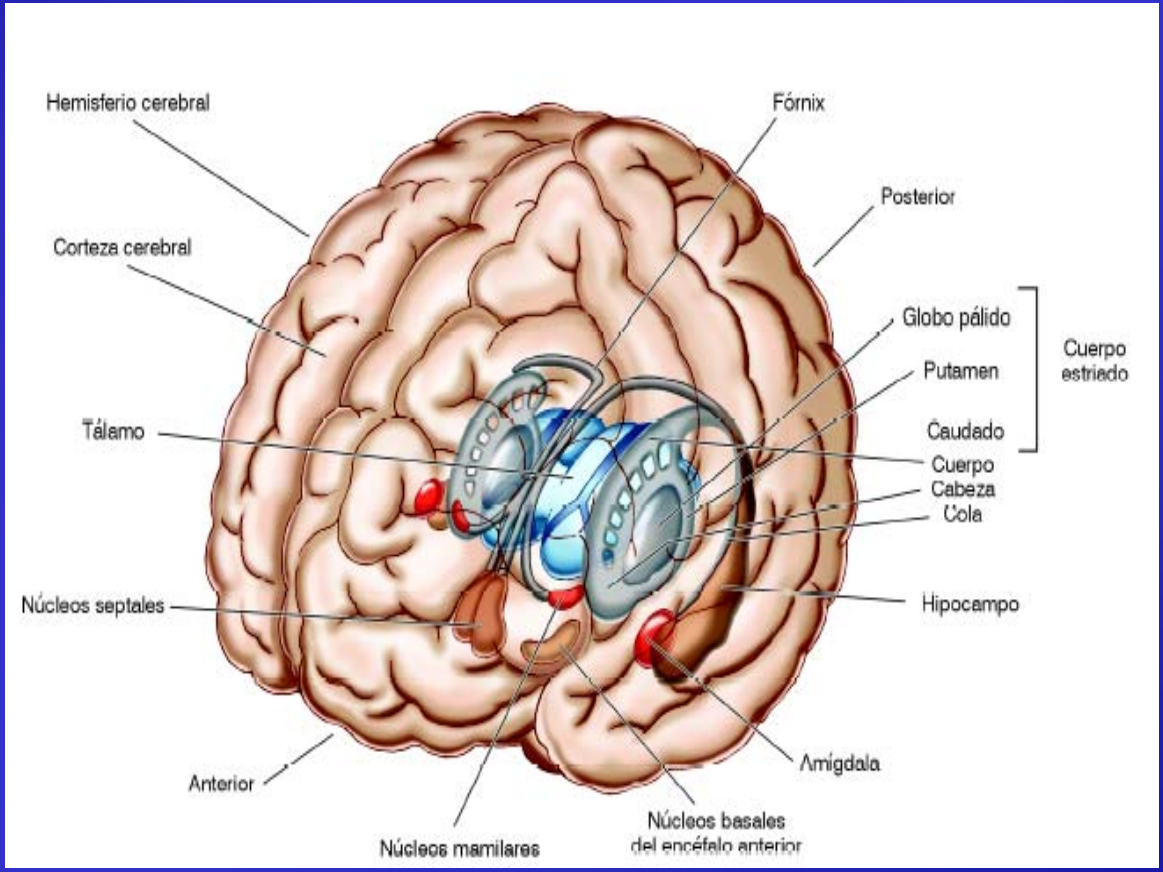
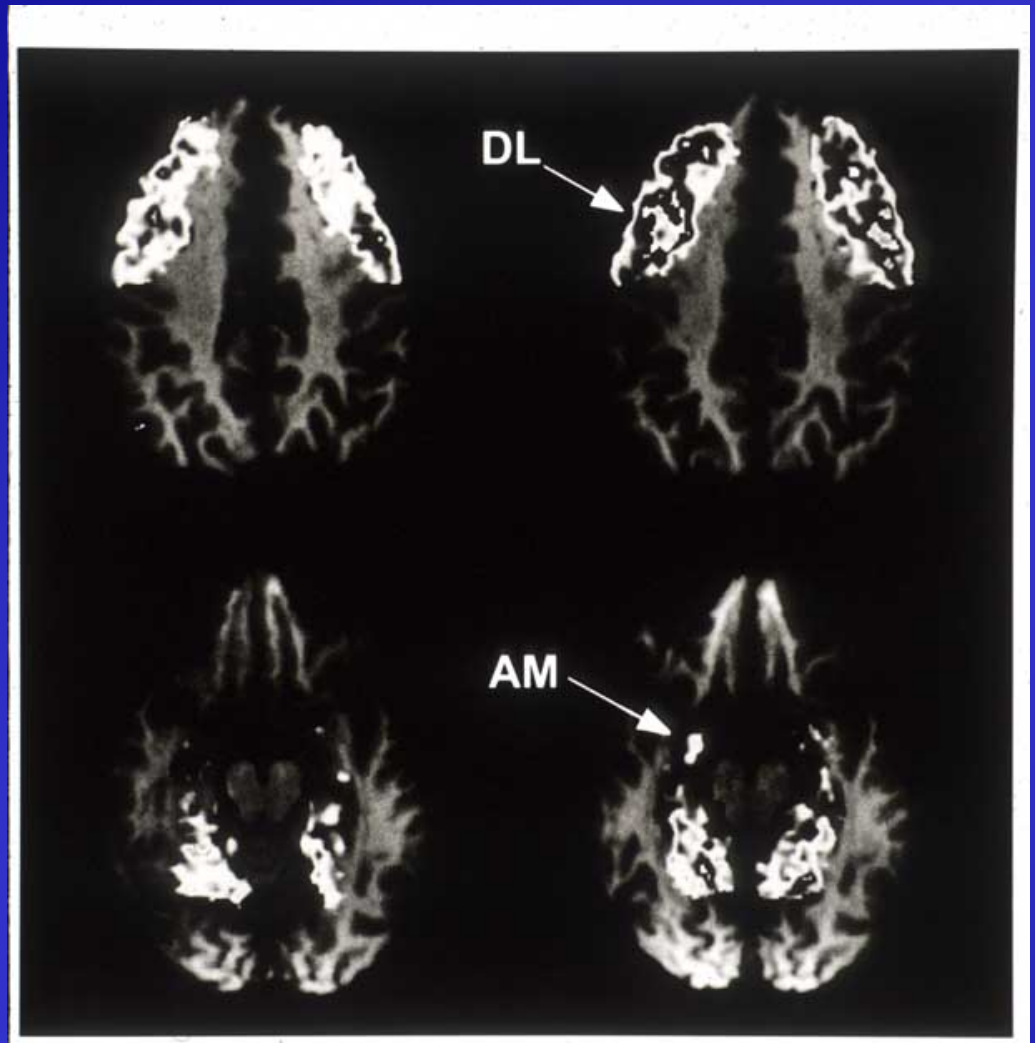


Fig. 5. Regions that contain a high density of receptors for oxytocin and vasopressin and their overlap with activity related to maternal and romantic love. All labeled regions contain a high density of these attachment related neurohormones in the human (Loup et al., 1991). Abbreviations: C = caudate nucleus; GP = globus pallidus; hi = hippocampus; hTh = hypothalamus; P = putamen; PAG = periaqueductal (central) gray; M = nucleus of Meynert; rf = retrorubal fields/ intralaminar/subthalamic nuclei; SN = substantia nigra; Tha = lateral thalamus; VTA = ventral tegmental area. For illustration, the extent of activity is shown at thresholds of $P < 0.05$, uncorrected. Sections have the same orientation as in previous figures. (a): sagittal, (b,c): coronal, (d): transverse.



NEUROANATOMÍA DE LA DROGADICCIÓN



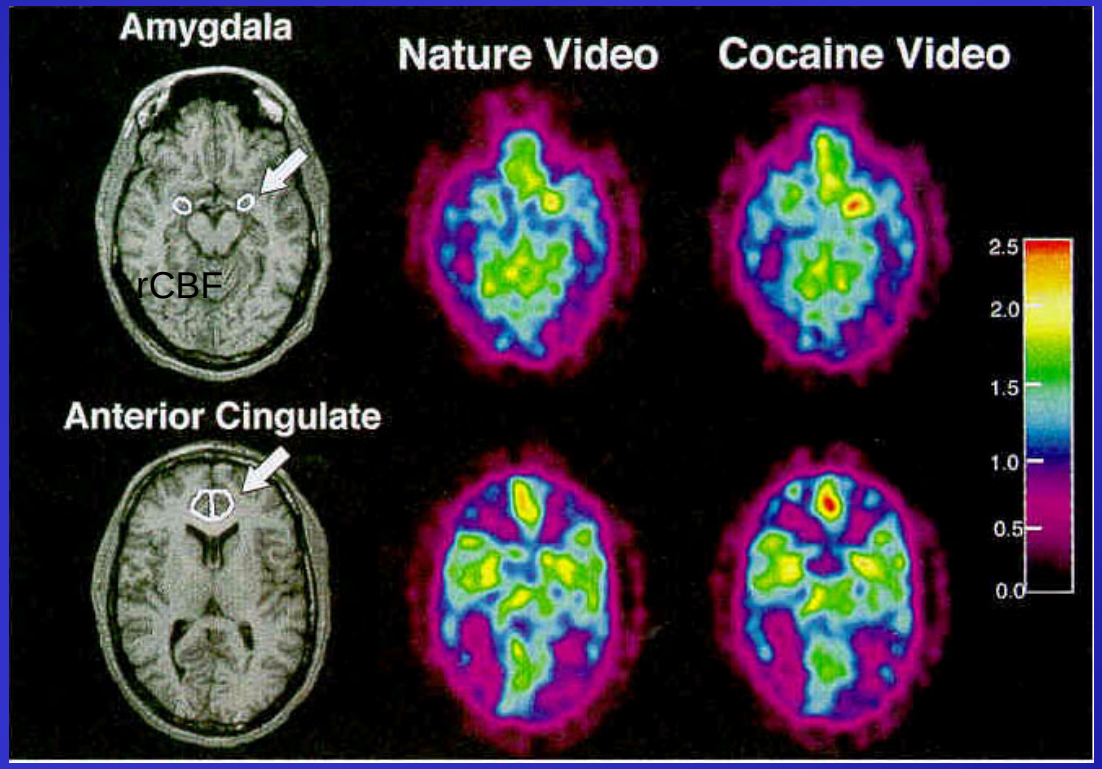


PET scans conducted at NIDA's Brain Imaging Center reveal selective activation of brain circuits during cocaine craving. Scans from volunteers who experienced a high level of cue-induced cocaine craving show activation of brain regions implicated in several forms of memory. The scans at right show activation of the dorsolateral prefrontal cortex (DL), which is important in short-term memory, and the amygdala (AM), which is implicated in emotional influences on memory. When these volunteers were exposed to neutral (non-drug-related) cues, this activation was not seen (scans at left).

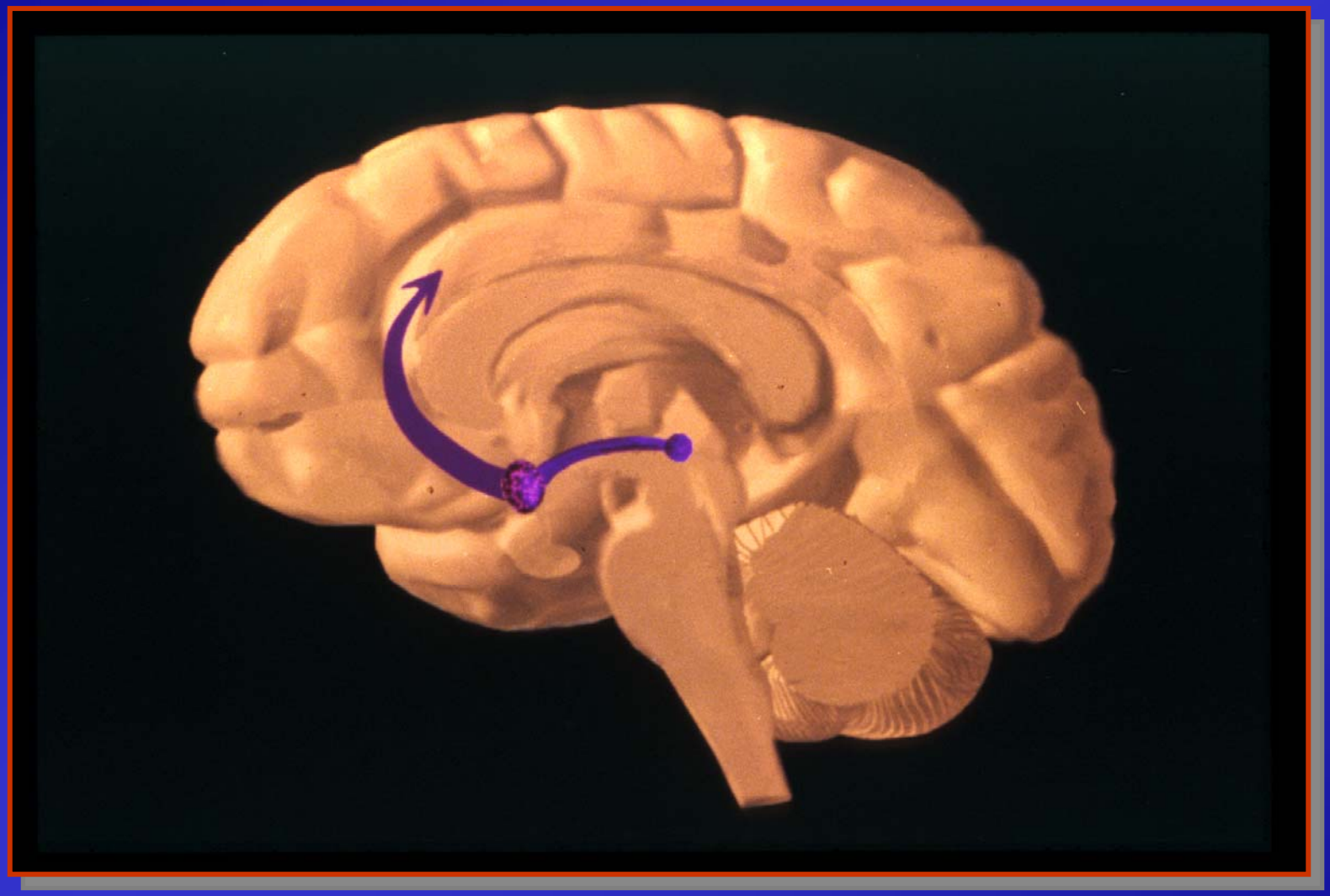
Activación límbica durante el *craving* de cocaína inducido con señales

CHILDRESS y cols.

AM. J. Psychiatry 156: 11-18; 1999



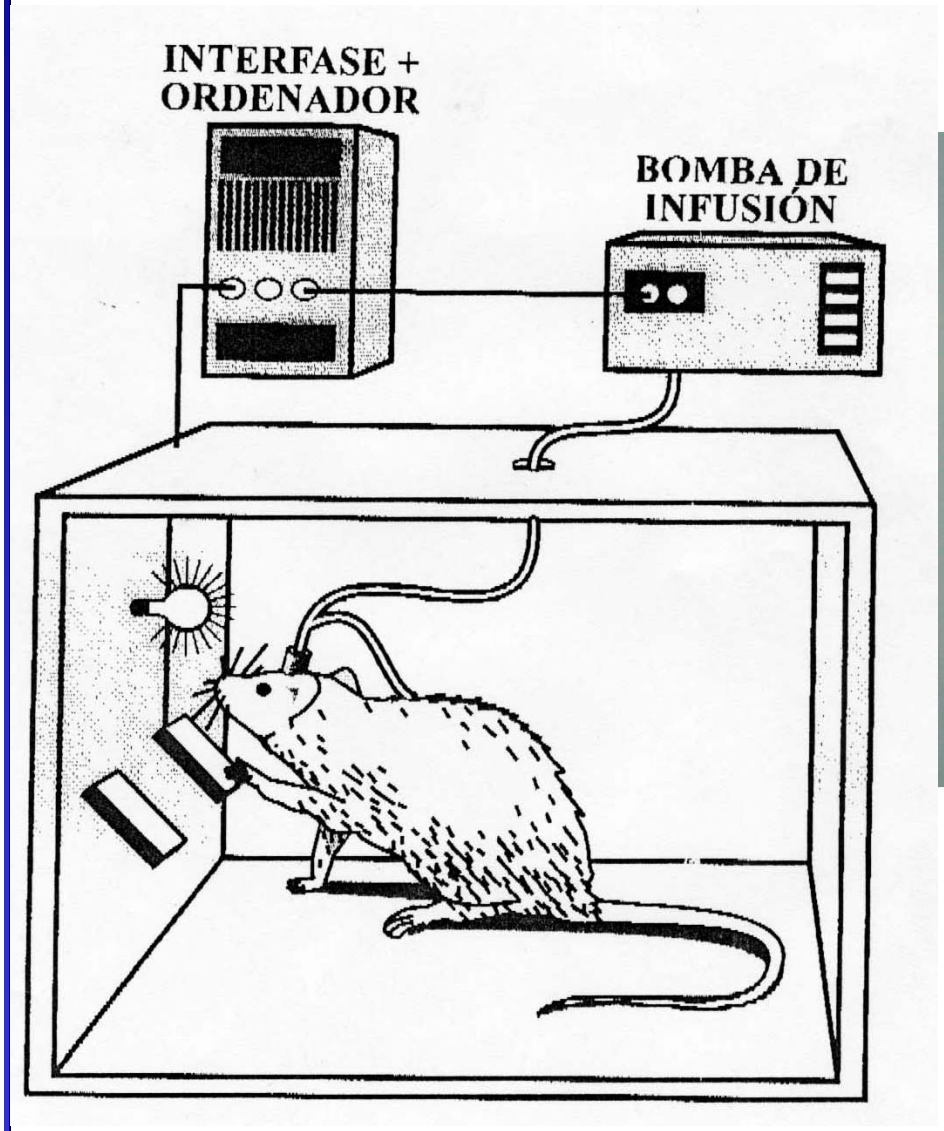
Incremento diferencial de rCBF en amigdala y cingulado anterior (PET; [150] -water)



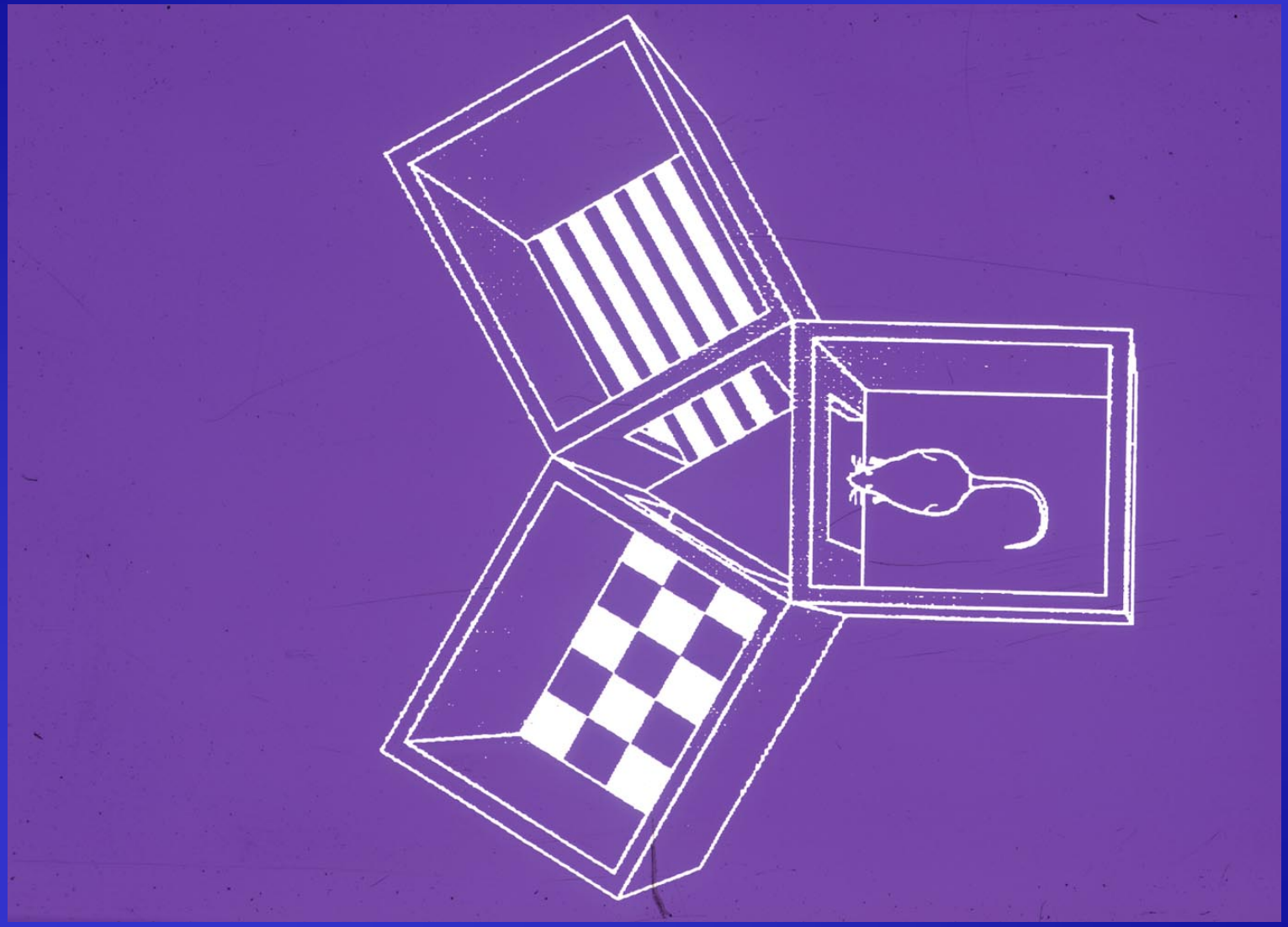
ALGUNOS TIPOS DE EMOCIONES POSITIVAS COMUNES A ANIMALES Y HUMANOS

1. Las que implican una interacción activa con el medio ambiente (jugar; explorar nuevos ámbitos...etc).
2. Las que resultan de aliviar necesidades homeostáticas de los organismos.
3. Las que se producen cuando se dan situaciones de satisfacción y ausencia de estrés.

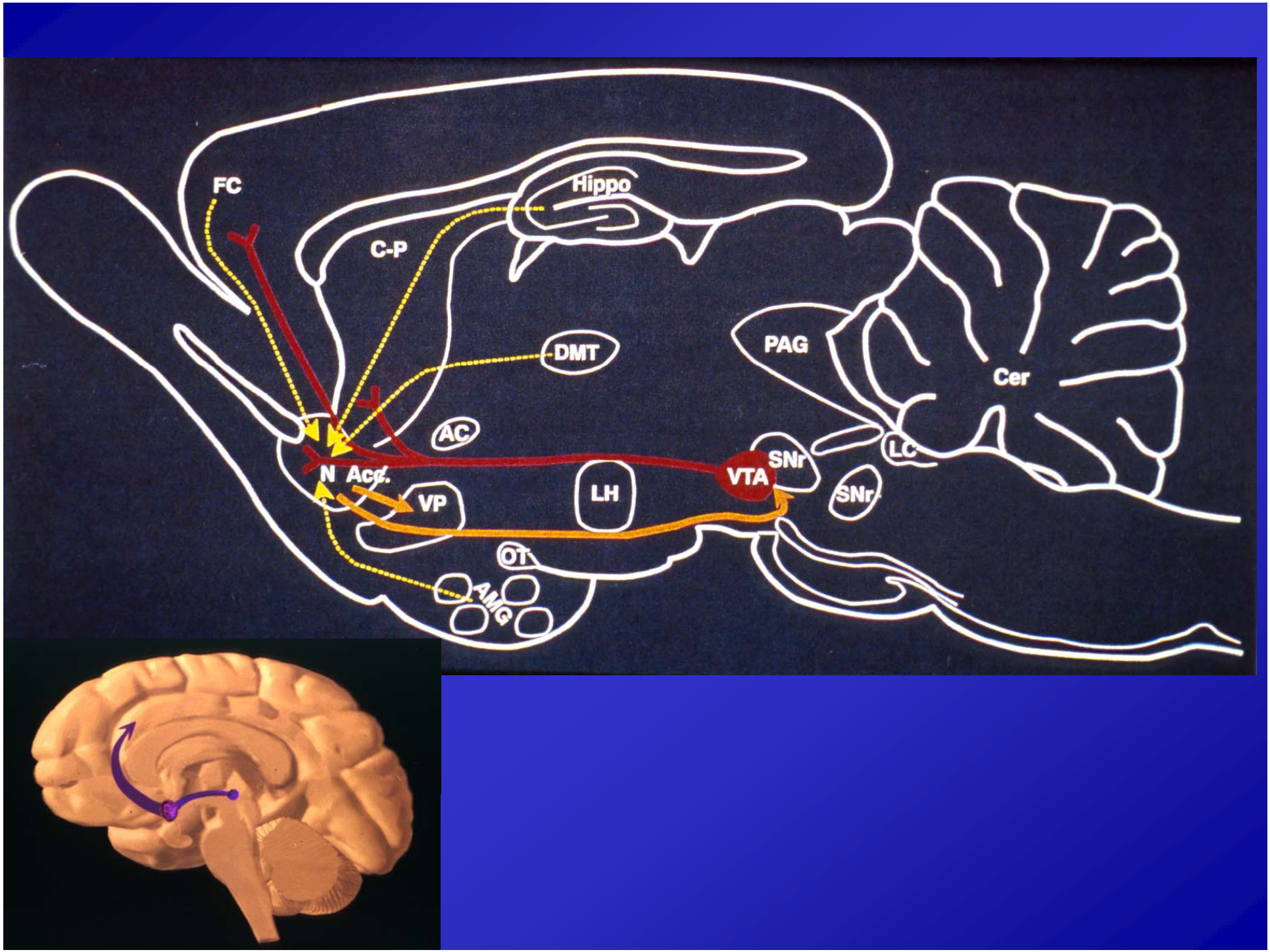
AUTOADMINISTRACIÓN INTRAVENOSA DE DROGAS



Evaluación de la preferencia por un lugar emocionalmente positivo



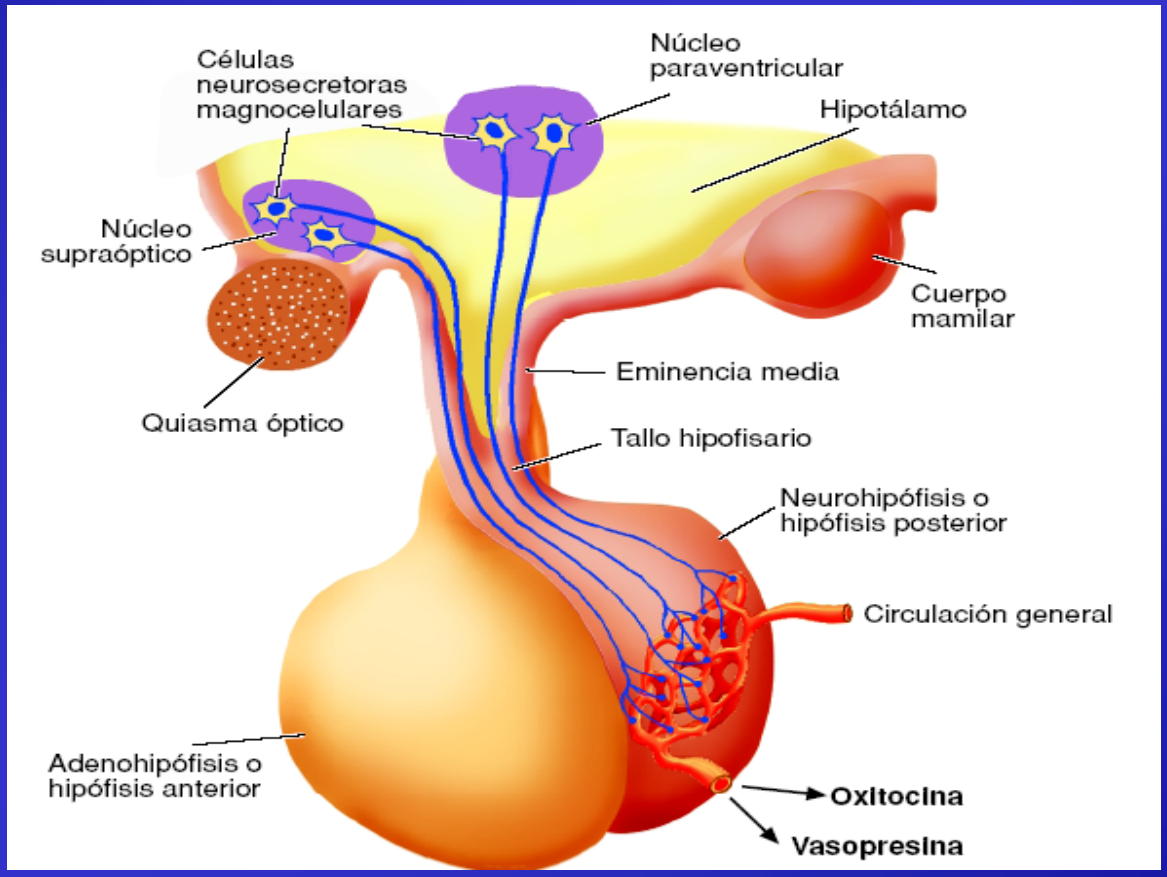
La mayoría de las drogas de abuso muestran preferencias en este test

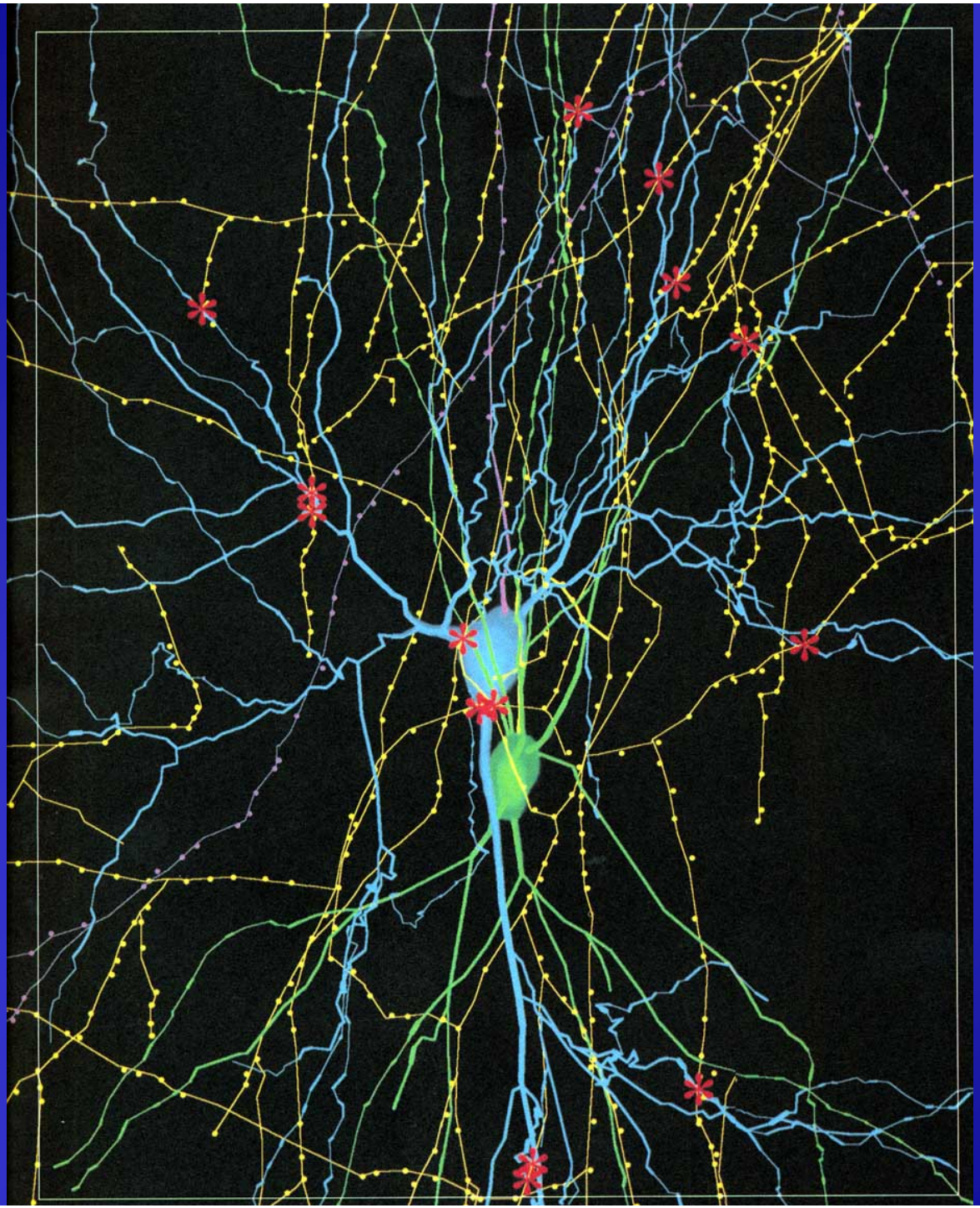

FC
Hippo
C-P
DMT
PAG
Cer
AC
N Acc.
VP
LH
VTA
SNr
LC
SNr
OT
AMG

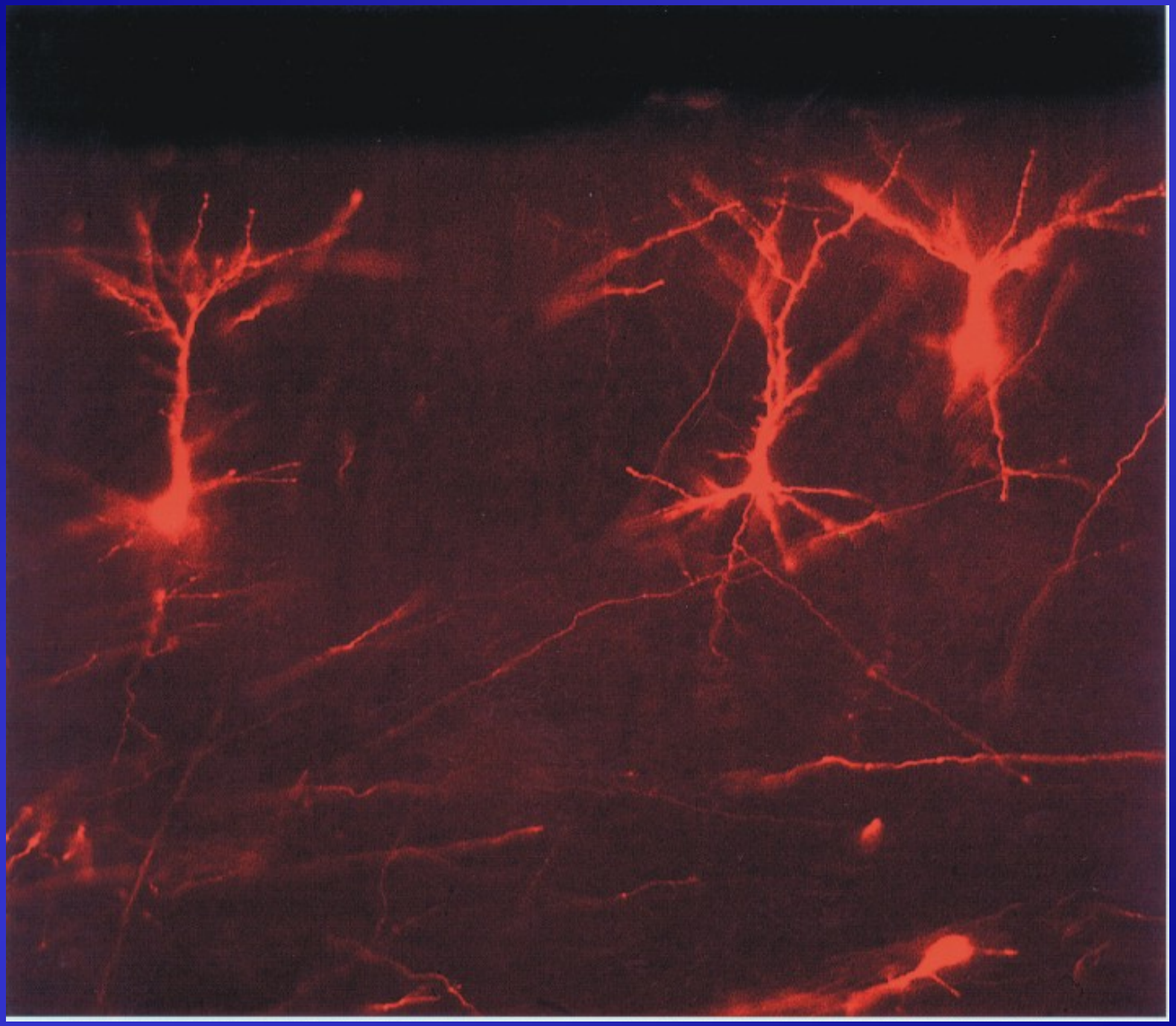
Sustancias neuroactivas implicadas en las emociones positivas

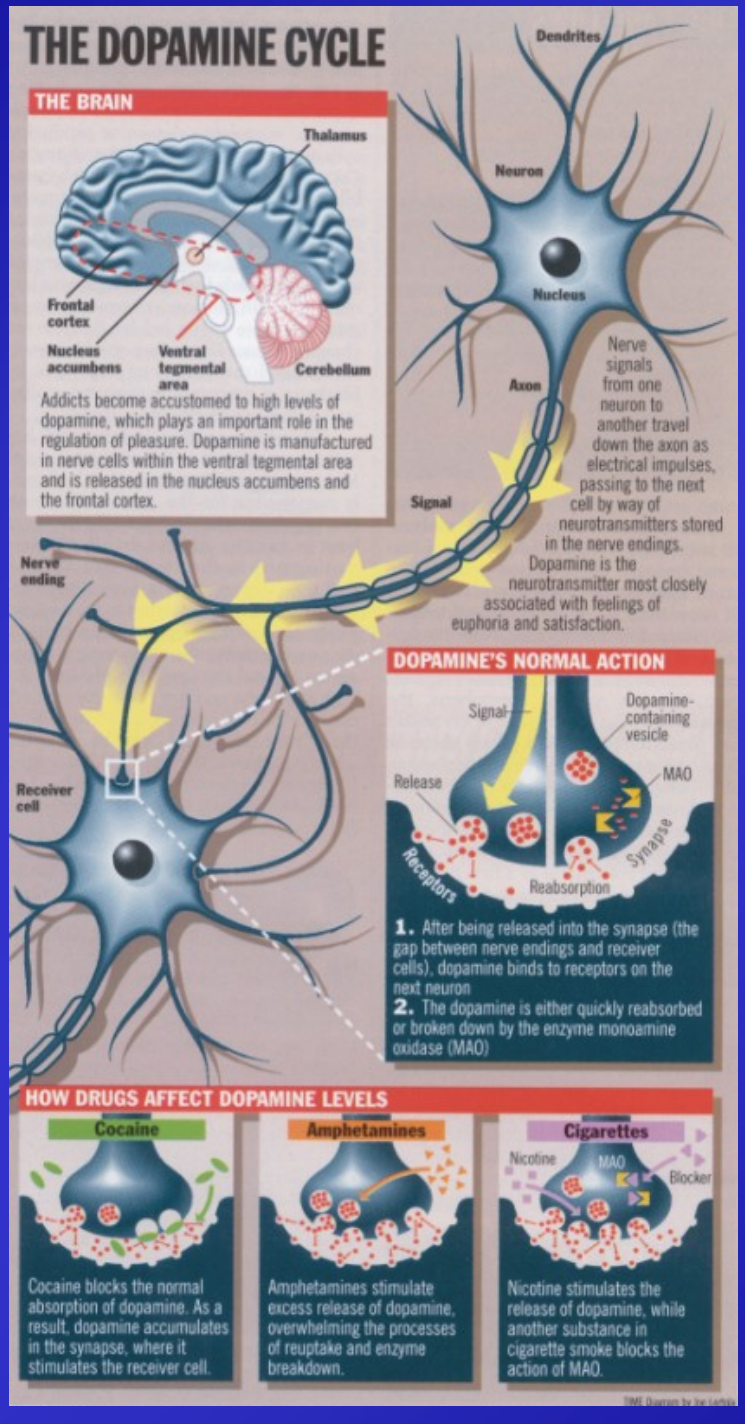
1. Las que activan las drogas de abuso (dopamina, opiáceos, endocannabinoides, GABA).
2. Neuropéptidos como la neurotensina, CART, neuropéptido Y.
3. Oxitocina y vasopresina.

NEUROHORMONAS HIPOTALÁMICAS








THE DOPAMINE CYCLE
THE BRAIN
Thalamus
Frontal cortex
Nucleus accumbens
Ventral tegmental area
Cerebellum
Addicts become accustomed to high levels of dopamine, which plays an important role in the regulation of pleasure. Dopamine is manufactured in nerve cells within the ventral tegmental area and is released in the nucleus accumbens and the frontal cortex.
Dendrites
Neuron
Nucleus
Axon
Signal
Nerve signals from one neuron to another travel down the axon as electrical impulses, passing to the next cell by way of neurotransmitters stored in the nerve endings. Dopamine is the neurotransmitter most closely associated with feelings of euphoria and satisfaction.
Nerve ending
Receiver cell
DOPAMINE'S NORMAL ACTION
Signal
Dopamine-containing vesicle
Release
MAO
Synapse
Receptors
Reabsorption
1. After being released into the synapse (the gap between nerve endings and receiver cells), dopamine binds to receptors on the next neuron
2. The dopamine is either quickly reabsorbed or broken down by the enzyme monoamine oxidase (MAO)
HOW DRUGS AFFECT DOPAMINE LEVELS
Cocaine
Cocaine blocks the normal absorption of dopamine. As a result, dopamine accumulates in the synapse, where it stimulates the receiver cell.
Amphetamines
Amphetamines stimulate excess release of dopamine, overwhelming the processes of reuptake and enzyme breakdown.
Cigarettes
Nicotine
MAO
Blocker
Nicotine stimulates the release of dopamine, while another substance in cigarette smoke blocks the action of MAO.

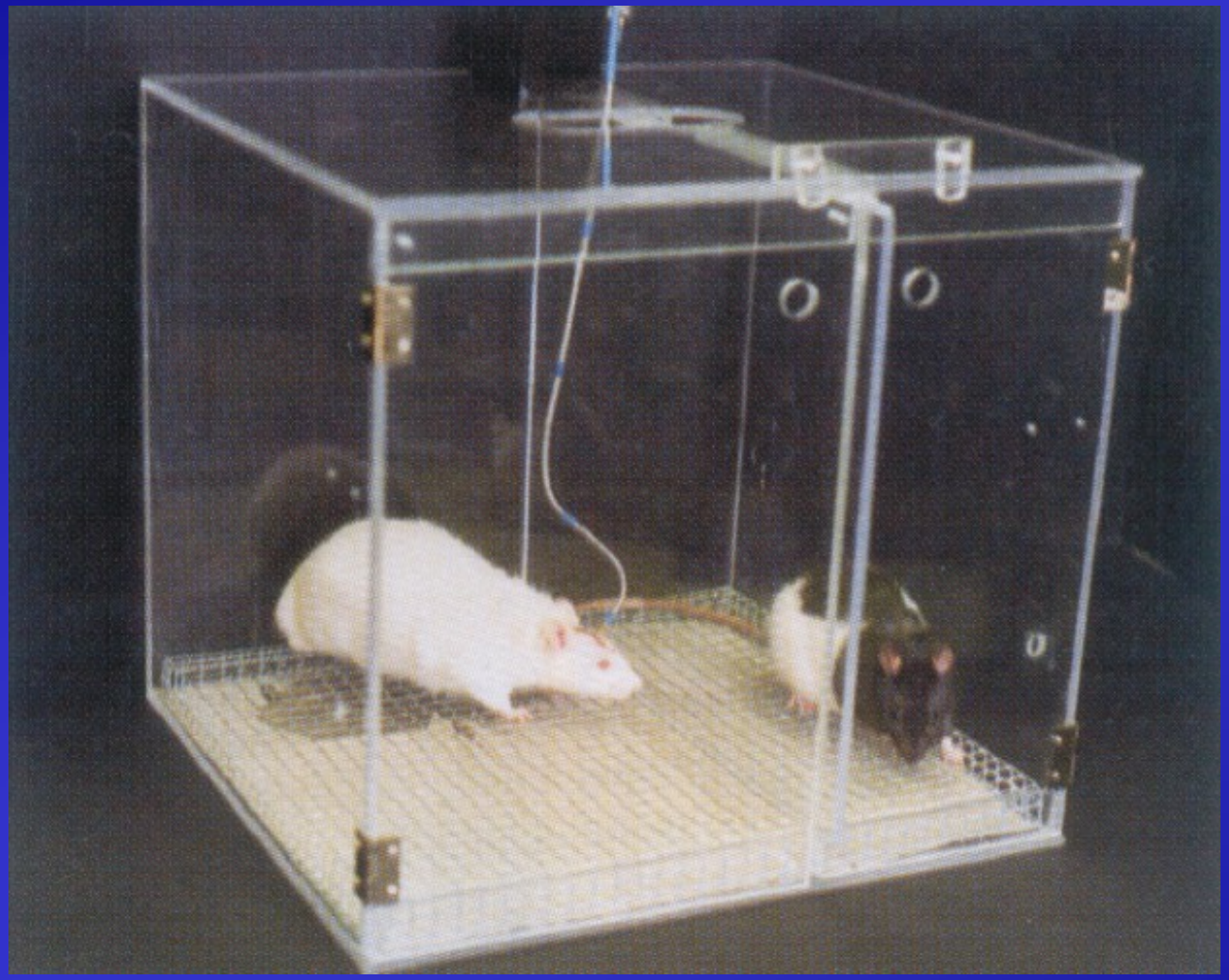
BASES ANATÓMICAS DE LAS EXPERIENCIAS EMOCIONALES POSITIVAS

1. Las regiones implicadas se localizan subcorticalmente, con la excepción de las cortezas orbitofrontal, cingulada anterior e insular.
2. Principales áreas:

   -estriado ventral (núcleos accumbens, ventral pálido).

   - amígdala.

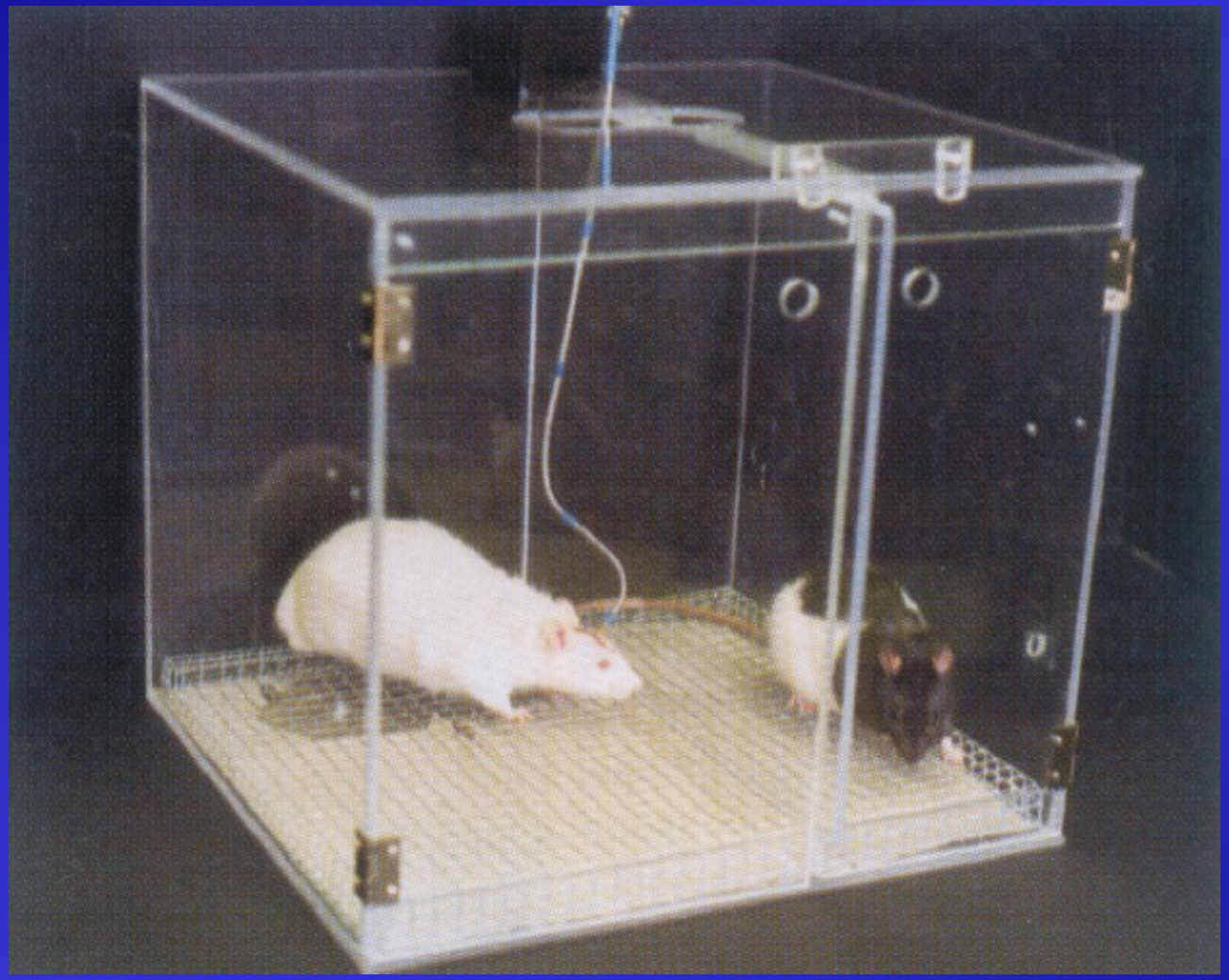
   - área tegmental ventral.



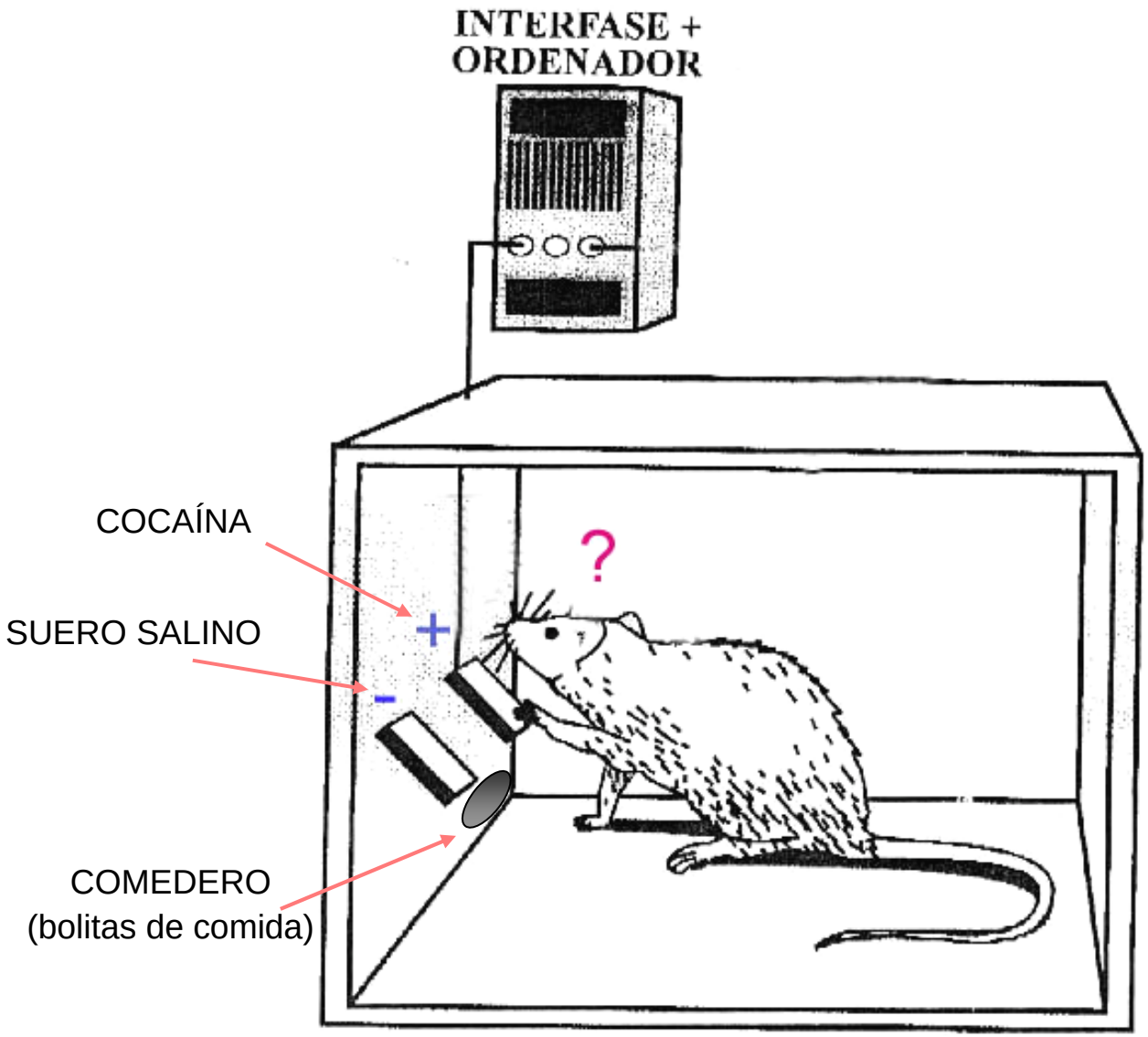
La importancia de la dopamina en las emociones positivas

1. Los efectos positivos de los psicoestimulantes están mediados por la actividad de la dopamina en el estriado ventral.
2. Los antagonistas de la dopamina atenúan los efectos positivos de los psicoestimulantes.
3. El rasgo de la personalidad Extroversión está asociado a la actividad dopaminérgica.

La dopamina participa en la anticipación del refuerzo



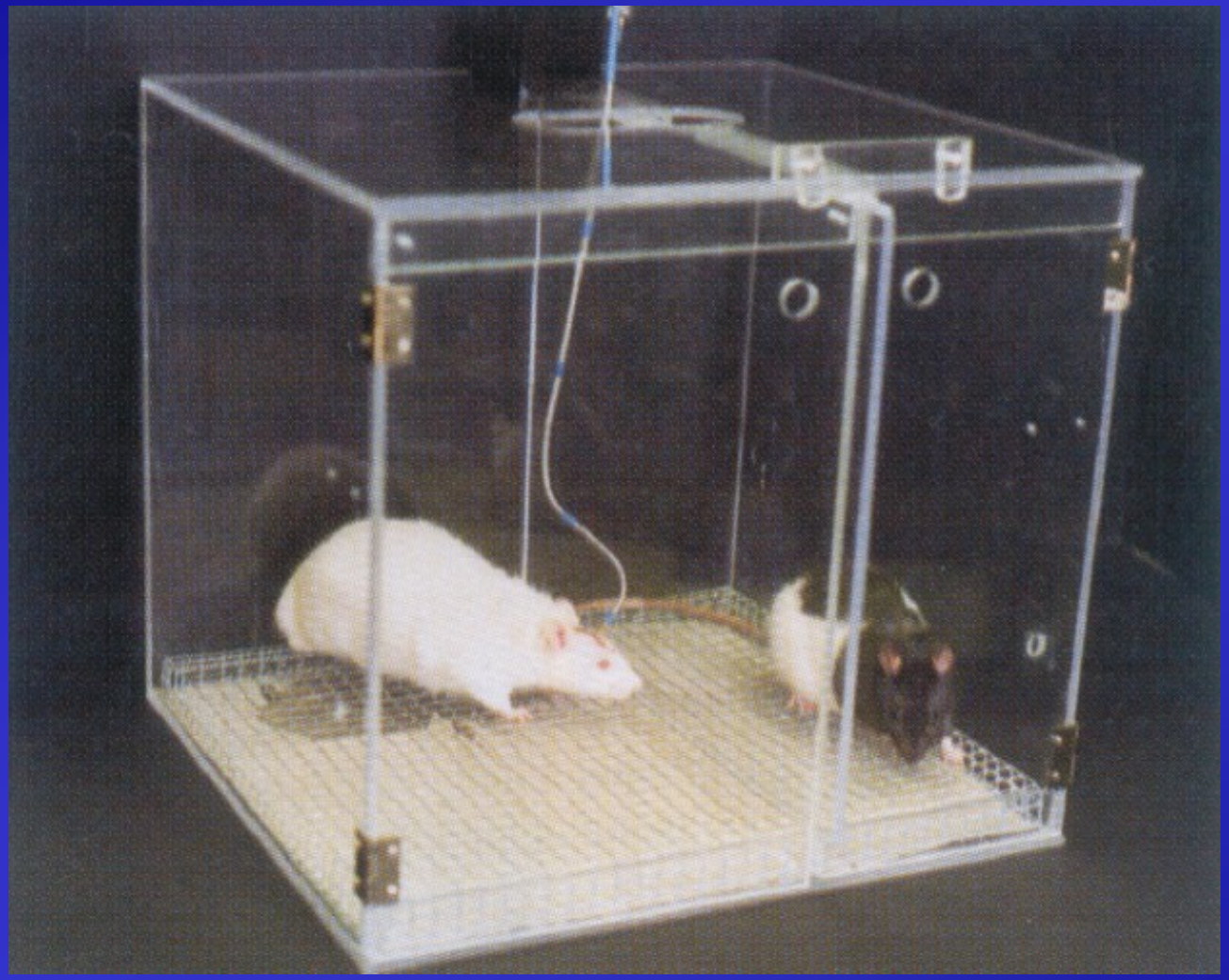
La dopamina participa en la anticipación del refuerzo



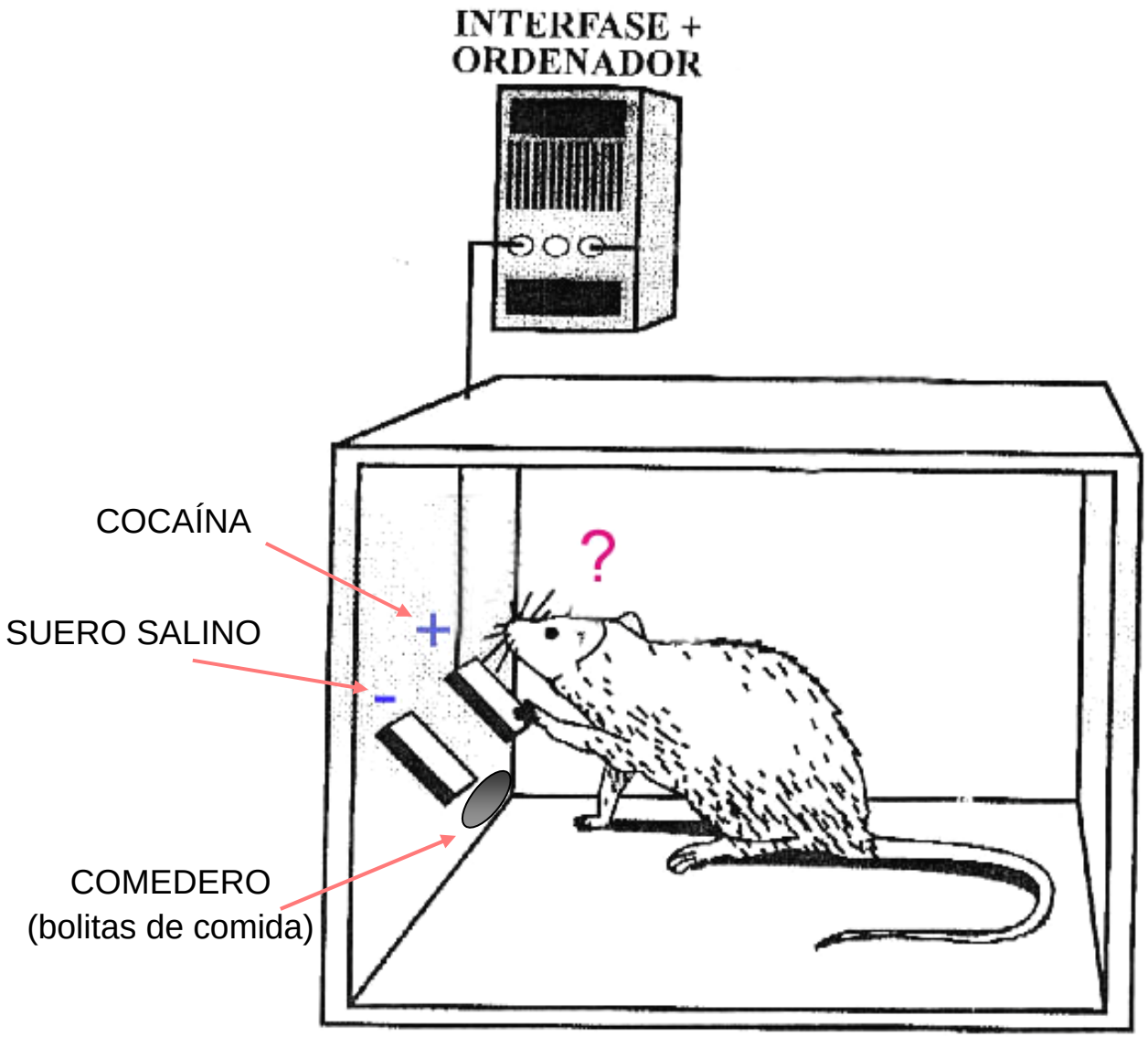
VOCALIZACIONES ULTRASÓNICAS EN ANIMALES

- Una medida de las emociones positivas en animales son las emisiones ultrasónicas de 50 khz.
- Se producen en:
  - Fase anticipatoria de la conducta sexual
  - Anticipación de la estimulación eléctrica intracraneal
  - Anticipación de los efectos esperados de las drogas de abuso
  - Conductas de juego
  - Estimulación somatosensorial por parte del experimentador (hacer cosquillas)

La anticipación del refuerzo provoca vocalizaciones



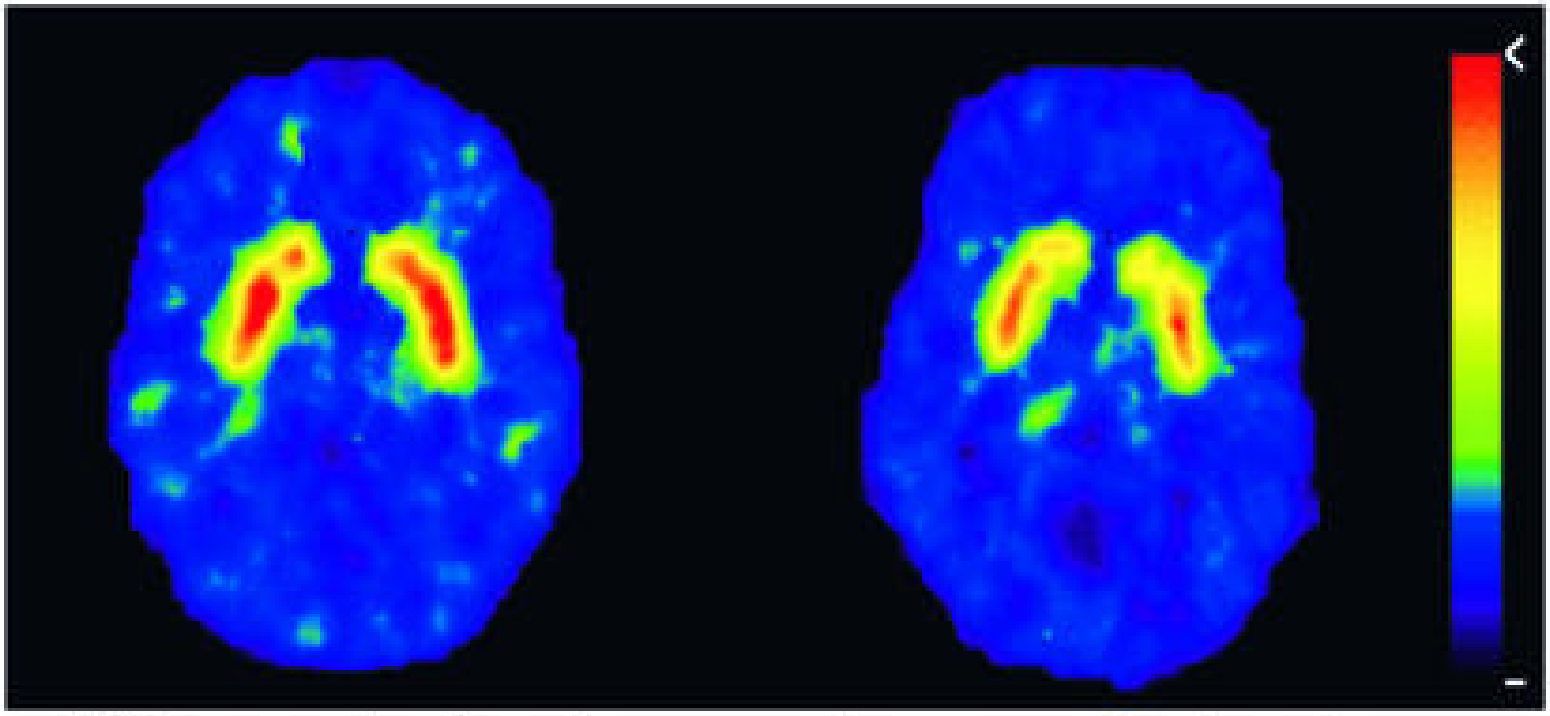
La anticipación del refuerzo provoca vocalizaciones



CARACTERISTICAS DE LAS VOCALIZACIONES ULTRASÓNICAS EN ANIMALES

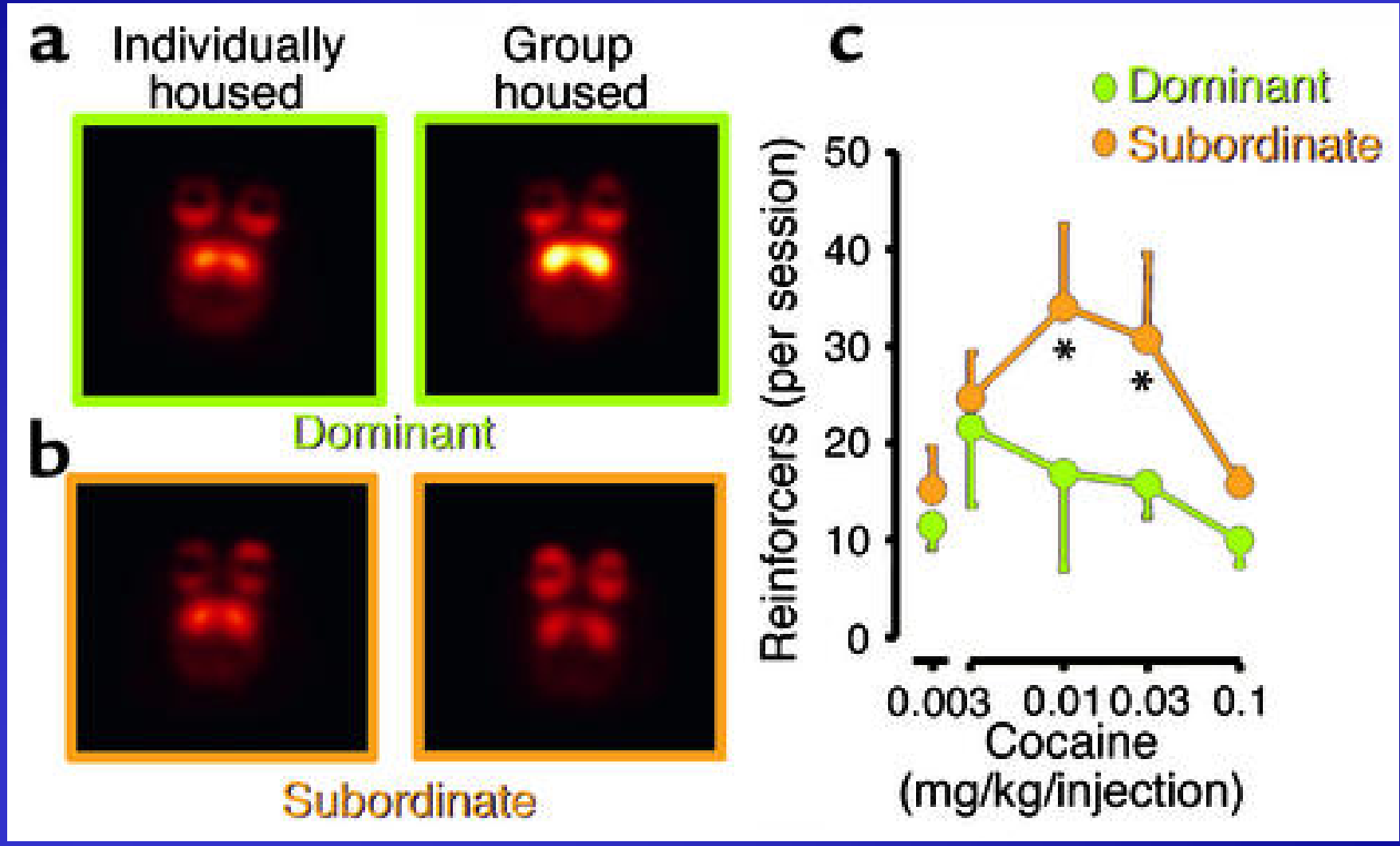
- Aparece más comúnmente en:
  - Adolescentes
  - Hembras

Están reguladas por el sistema dopaminérgico



High receptor level
unpleasant response

Low receptor level
pleasant response


a
Individually housed
Group housed
Dominant
b
Subordinate
c
Dominant
Subordinate
Reinforcers (per session)
50
40
30
20
10
0
*
*
0.003
0.01
0.03
0.1
Cocaine
(mg/kg/injection)

¿SE DA LA FELICIDAD EN LOS ANIMALES?

- En la génesis de las emociones positivas parece haber una preponderancia subcortical
- Las experiencias emocionales positivas y las experiencias afectivas en general pueden considerarse estadios previos de la conciencia, en términos evolutivos.
- La mayoría de los mamíferos tienen básicamente muy similares formas de “conciencias” afectivas.
- La interacción de la afectividad en la conciencia “cognitiva” aún debe ser investigada en profundidad, pero su influencia parece ser importante.

CONCLUSIONES

- Las áreas cerebrales que regulan las emociones positivas parecen solaparse con las del reforzamiento.
- Pueden distinguirse dos grandes subcircuitos:
- - Anticipación del refuerzo:
  - estriado ventral-sistema dopaminérgico
- Sensación placentera:
  - estriado ventral y corteza orbitofrontal-Sistemas opioidérgico y gabaérgico.