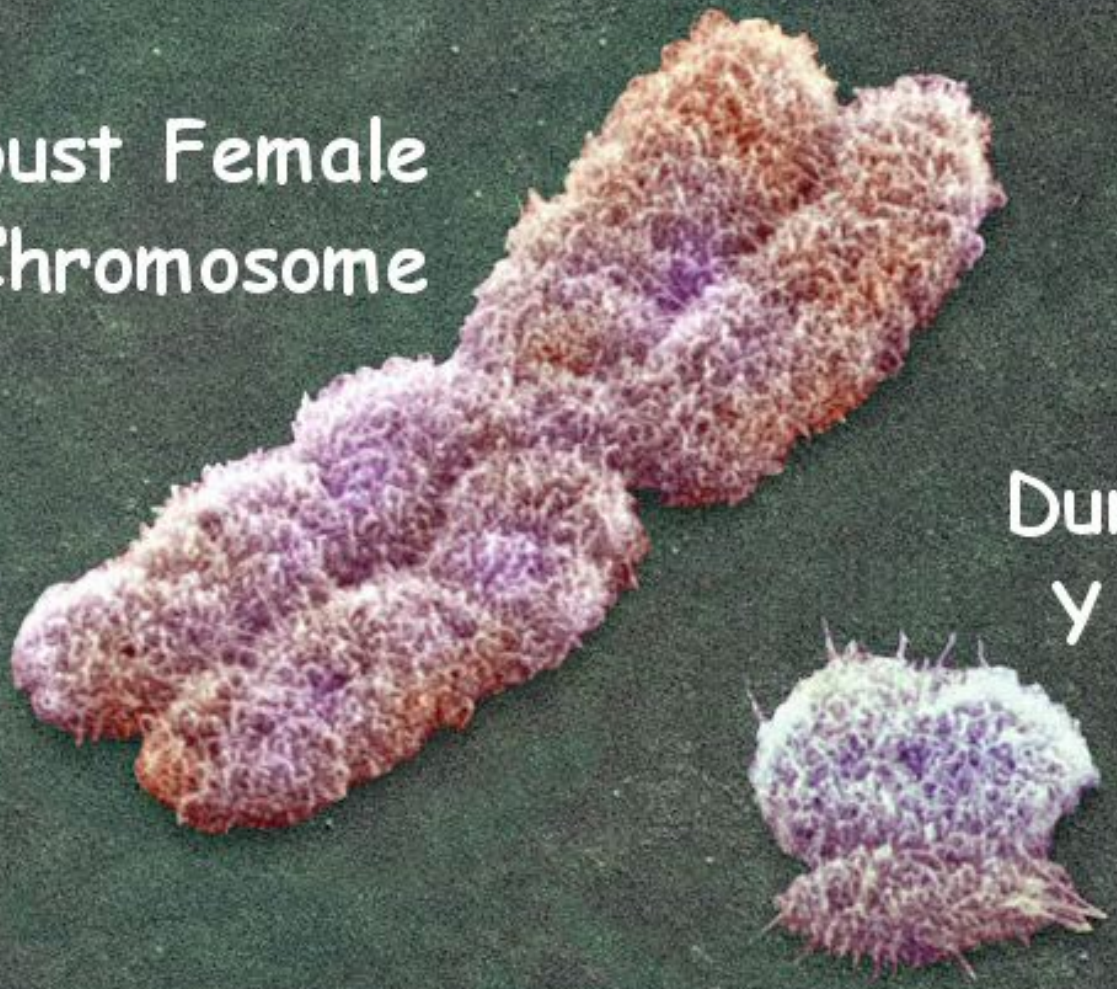
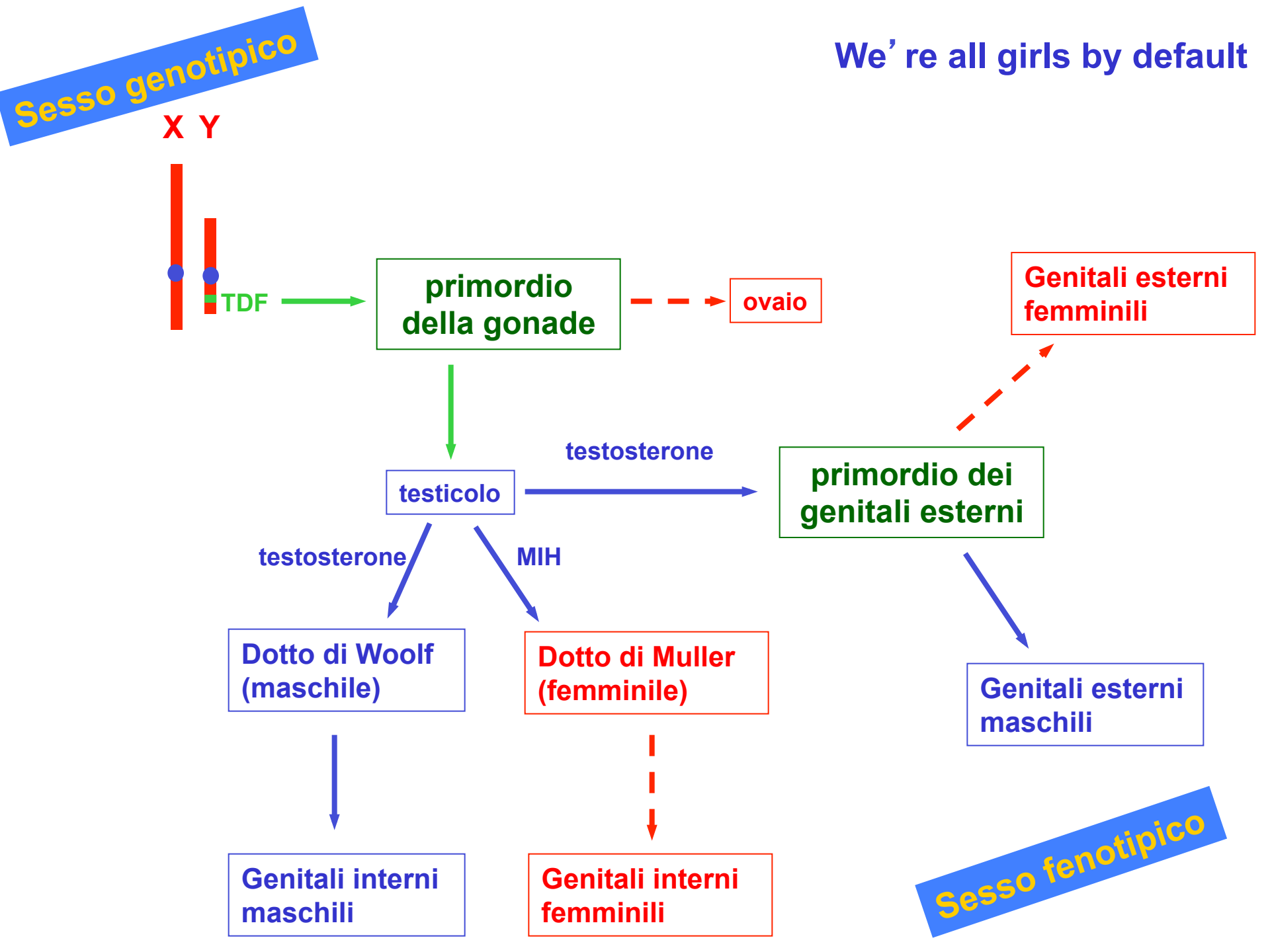
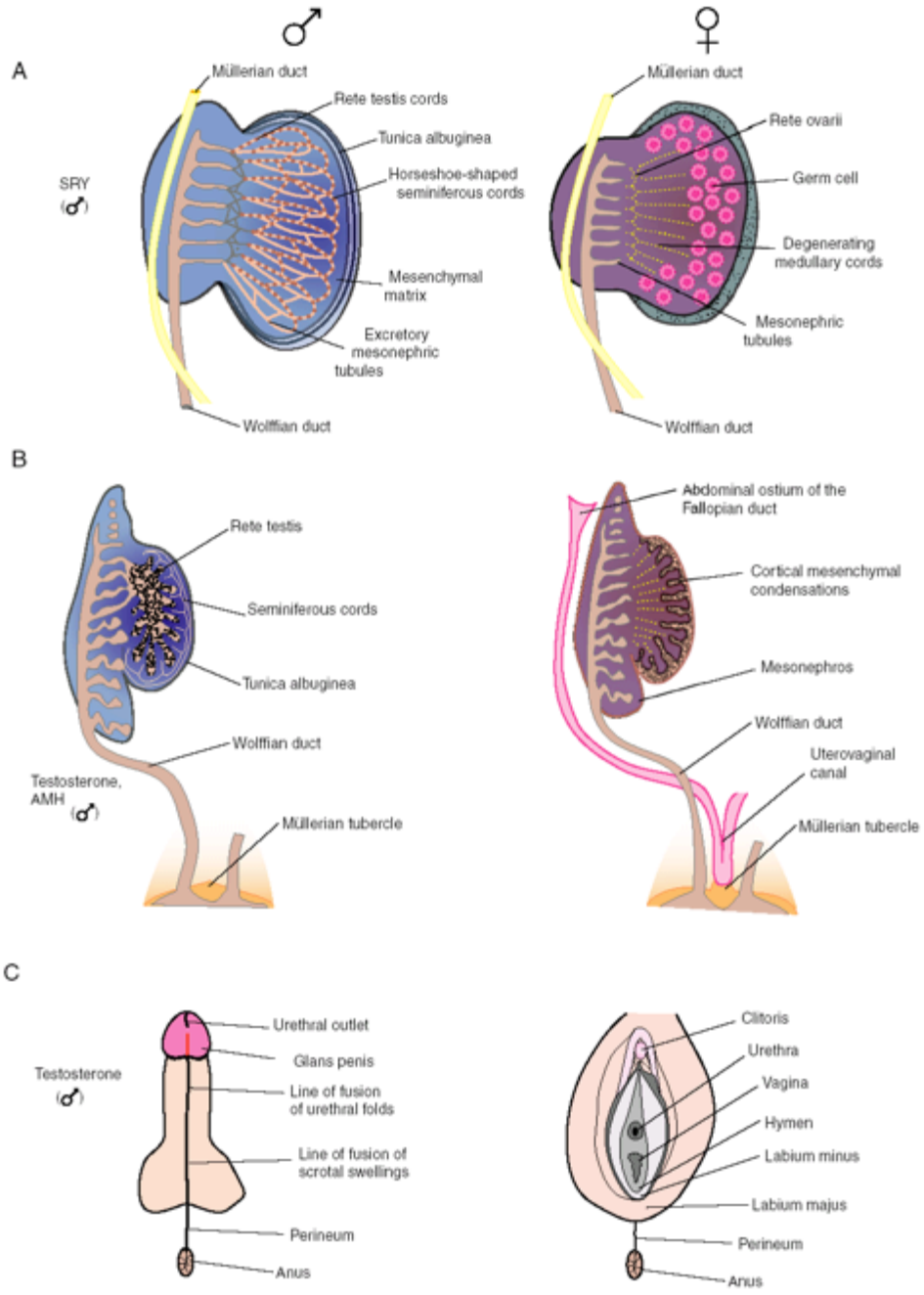
Pair bonding e comportamento sessuale

And They Think They Are Equal?




Sesso genotipico
We' re all girls by default
X Y
TDF
primordio della gonade
ovaio
Genitali esterni femminili
testosterone
testicolo
primordio dei genitali esterni
testosterone
MIH
Dotto di Woolf (maschile)
Dotto di Muller (femminile)
Genitali esterni maschili
Genitali interni maschili
Genitali interni femminili
Sesso fenotipico



primordio della gonade
struttura unica bipotente

Induzione in senso maschile da TDF (cromosoma Y)

primordi dei genitali interni
due strutture unipotenti

Dotto di Woolf (maschile)
Dotto di Muller (femminile)

La gonade maschile (testicolo) produce due ormoni, che determinano lo sviluppo in senso maschile:
Testosterone (DHT): promuove lo sviluppo del dotto di Woolf
MIH (anti-Muller hormone): inibisce lo sviluppo del dotto di Muller

primordio dei genitali esterni
struttura unica bipotente

Induzione in senso maschile da Testosterone

effetti degli ormoni sessuali sul SNC e sul comportamento

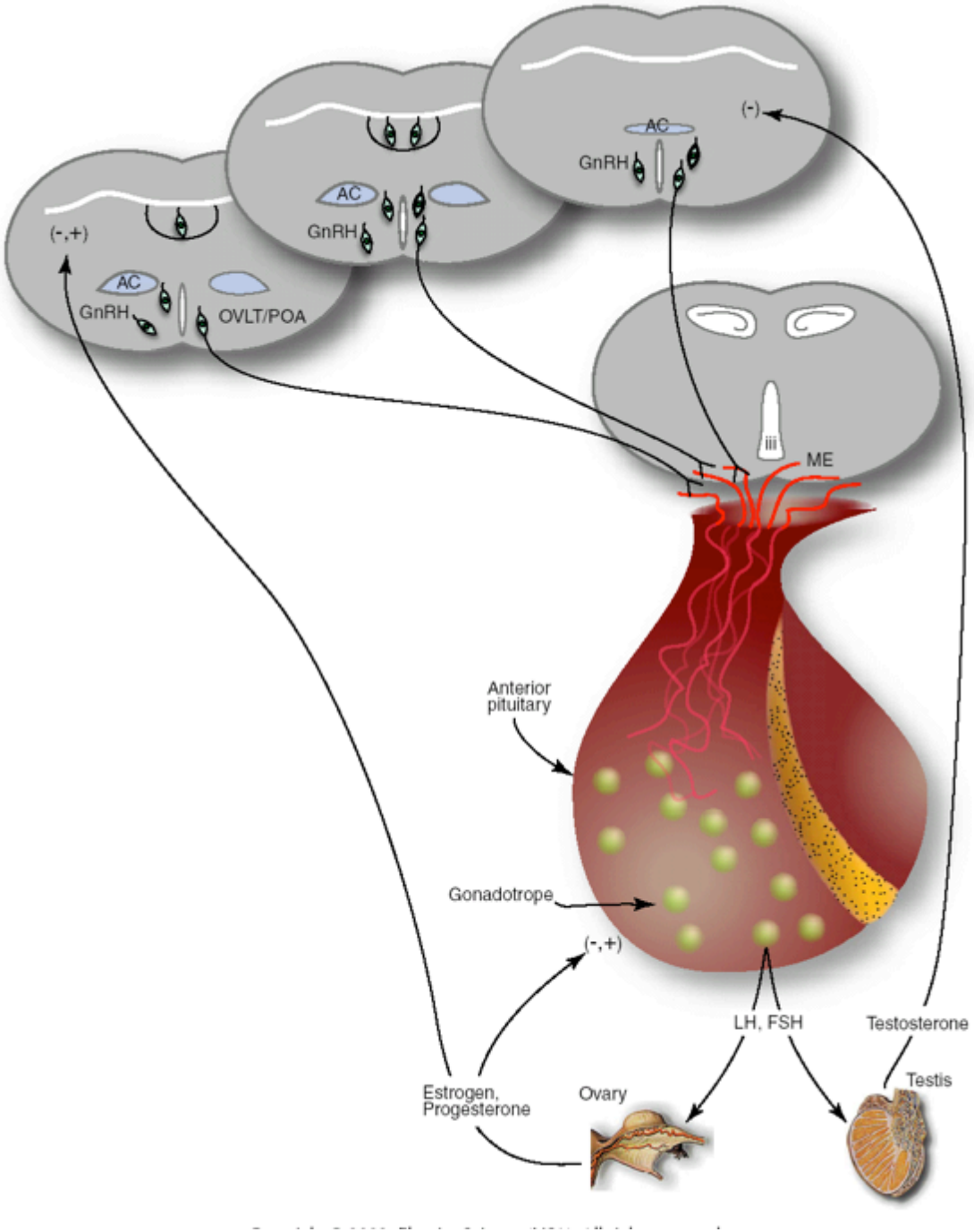
Di organizzazione

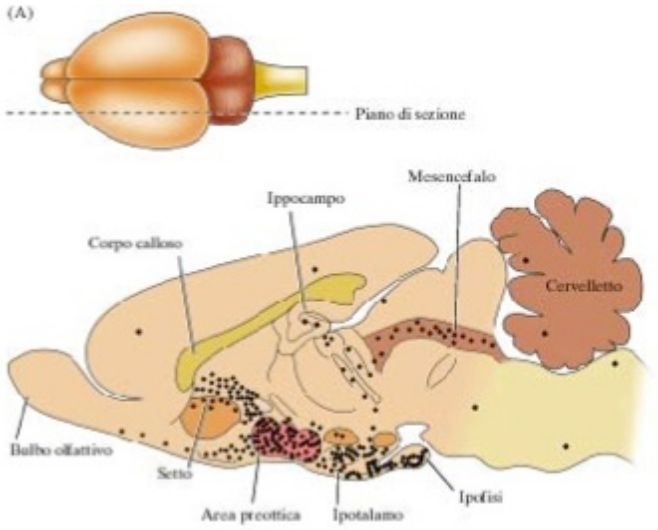
- Durante il periodo critico (sviluppo)
- Permanenti ed irreversibili

Di attivazione

- Nell'adulto (pubertà)
- Temporanei e reversibili

Dimorfismi: differenze di struttura
Diergismi: differenze di funzione



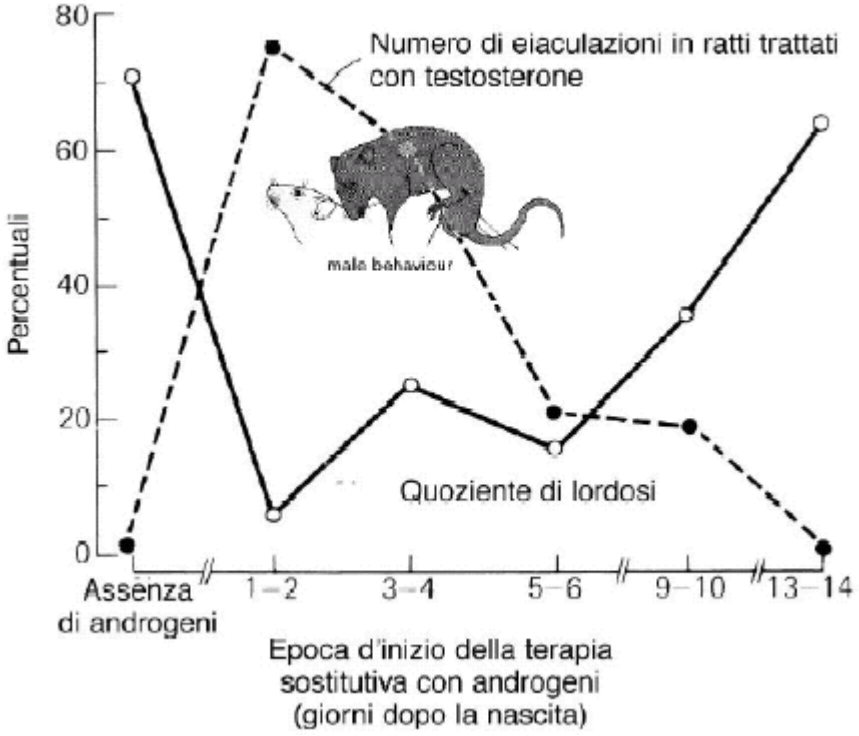


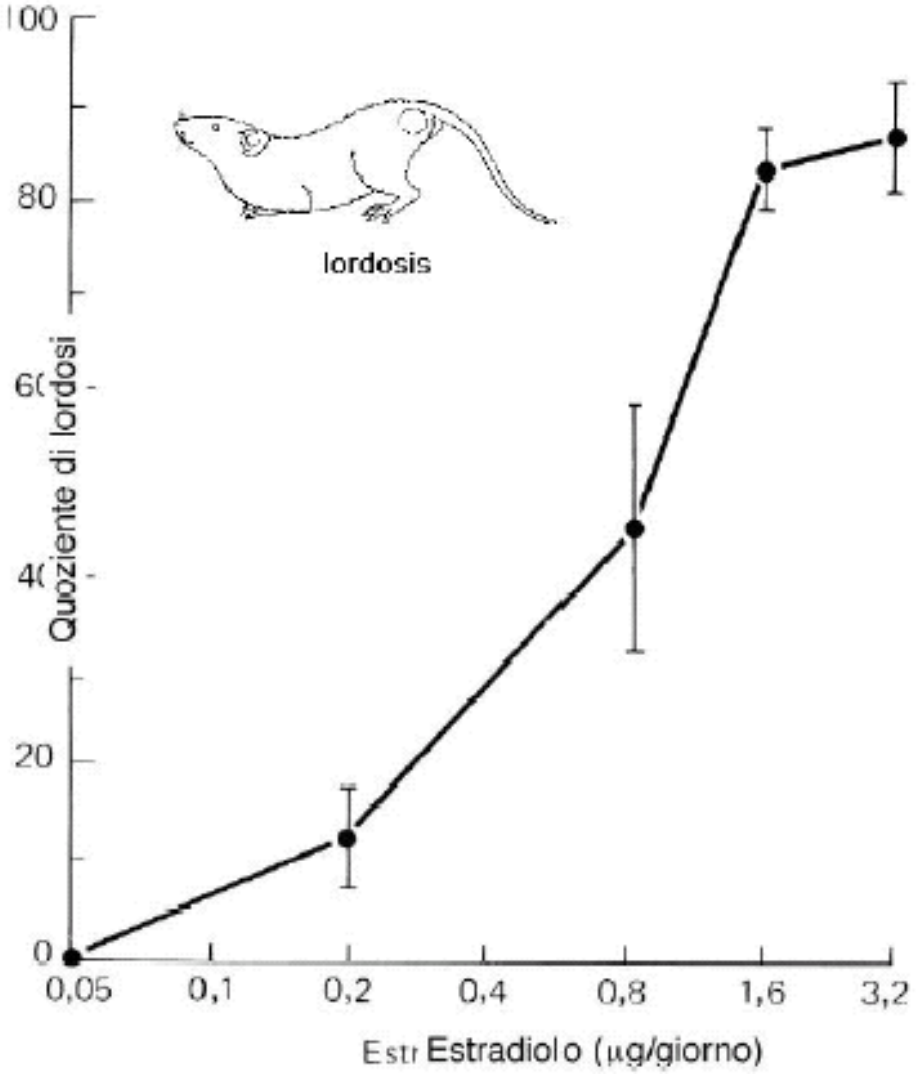
Diergismi comportamentali

1. **Aggressività**
2. **Cura della prole**
3. **Comportamento riproduttivo**

- **Corteggiamento**
- **Lordosi (F nei mammiferi)**
- **Copula (M nei mammiferi)**

Il comportamento sessuale, maschile o femminile, è in relazione con la quantità di ormone circolante (testosterone o estrogeni).





Sviluppo
(periodo critico)

ormone →  → **Modificazioni anatomo-funzionali**
(effetto di organizzazione)

↓

Adulto (pubertà)

ormone →  → **Comportamento**
(effetto di attivazione)

maschio

sviluppo

testosterone

femmina

sviluppo

Estrogeni
bassi livelli

Modificazione anatomo-funzionale del SNC

mascolinizzazione - femminizzazione

testosterone

Effetto di organizzazione

estrogeni

adulto

adulto

Effetto di attivazione

comportamento sessuale maschile

comportamento sessuale femminile

femmina

sviluppo

testosterone

testosterone

estrogeni

comportamento sessuale maschile

maschio

sviluppo

castrazione

testosterone

estrogeni

comportamento sessuale femminile

maschio

sviluppo

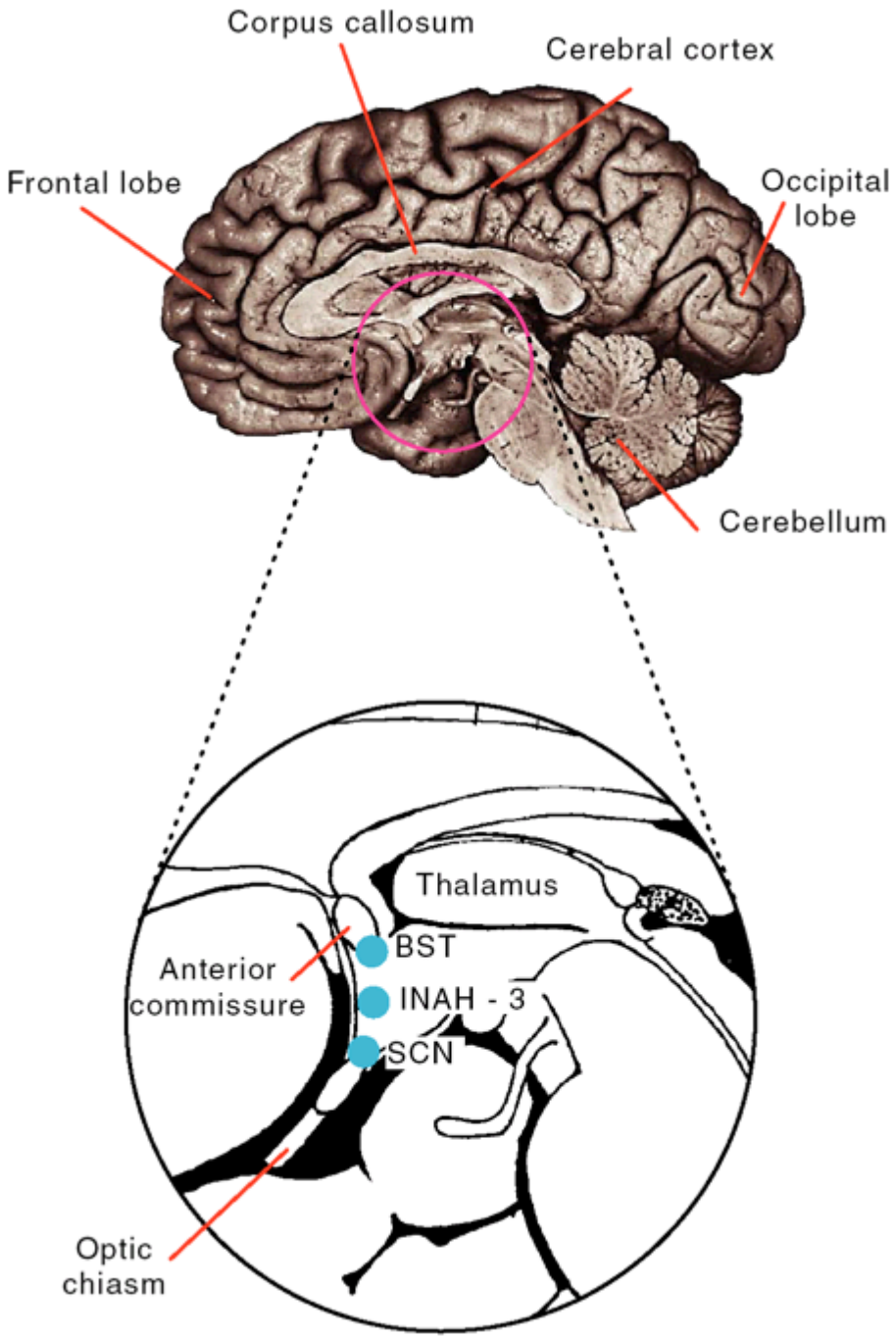
castrazione

testosterone

testosterone

estrogeni

comportamento sessuale maschile



Strutture dimorfiche nel SNC umano

Strutture più grandi nel maschio

- Nucleo della stria terminale
- Nuclei interstiziali dell'ipotalamo anteriore (INAH3)
- Nucleo dimorfico dell'area preottica (SDN-POA)
- Nucleo di Onuf (midollo spinale)

Strutture più grandi nella femmina

- Commissura anteriore
- Corpo calloso

Asimmetria maggiore nel maschio

- Planum temporale

Strutture con forma diversa

- Splenio del corpo calloso
- Nucleo soprachiasmatico (ipotalamo)

Dolore

1. Donne più sensibili agli stimoli nocicettivi
1. Oppioidi più efficaci nelle donne che negli uomini

Linguaggio

1. Aree del linguaggio più grandi in femmine
1. lateralizzazione maggiore nei soggetti maschi e nei destrimani
1. dislessia più nei maschi e associata a microdigenesia

Capacità cognitive

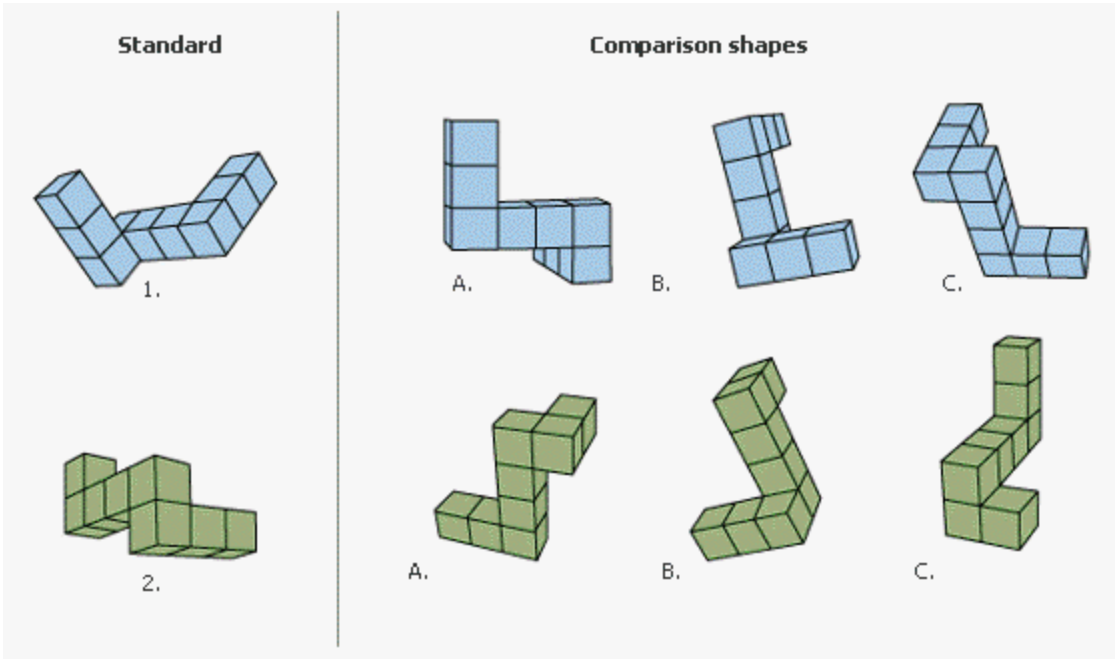
1. Equivalenza nei test intellettivi, ma:
   - maschi migliori performance logico-matematiche, pilotaggio, orientamento spaziale
   - femmine migliori capacità linguistiche , memoria verbale, lavori di precisione

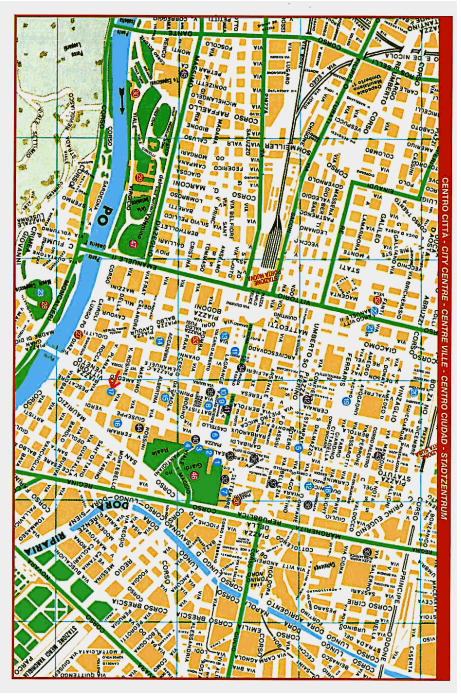
Table I. Some abilities favouring men and women, respectively

PROBLEM-SOLVING TASKS FAVOURING MEN	PROBLEM-SOLVING TASKS FAVOURING WOMEN
SPATIAL ORIENTATION – making a correction for a change in orientation of an object, e.g., "mental rotation"	**OBJECT LOCATION MEMORY** – recall of the location of objects in an array
VISUALIZATION – determining how a depicted object will appear when manipulated, e.g. folded	**PERCEPTUAL SPEED** – rapid identification of matching or designated items
LINE ORIENTATION – matching the slope of a line	**VERBAL MEMORY** – recall of a story, paragraph or list of unrelated words
MATHEMATICAL REASONING – solving a novel mathematical problem	**NUMERICAL CALCULATION** – adding, subtracting, etc., of given numbers
THROWING ACCURACY – hitting a distant target	**DEXTERITY** – manual tasks involving precision

Table II. Prepubertal sex differences in cognitive and motor function.

AUTHOR/ YEAR	AGES	FINDINGS
Rosser *et al.*, 1984	4–5	Boys better at spatial rotation
Vederhus & Krekling, 1996	9	Boys better on spatial tasks
Lunn, 1997	3–4	Boys better on targeting
Levine *et al.*, 1999	5–6	Boys better on spatial transformations, mazes
Denckla & Rudel, 1974	5–11	Girls faster at colour naming
Ingram, 1975	3–5	Girls better at copying hand postures
McGuinness *et al.*, 1990	7–10	Girls better memory for words


Standard
Comparison shapes
1.
2.
A.
B.
C.
A.
B.
C.



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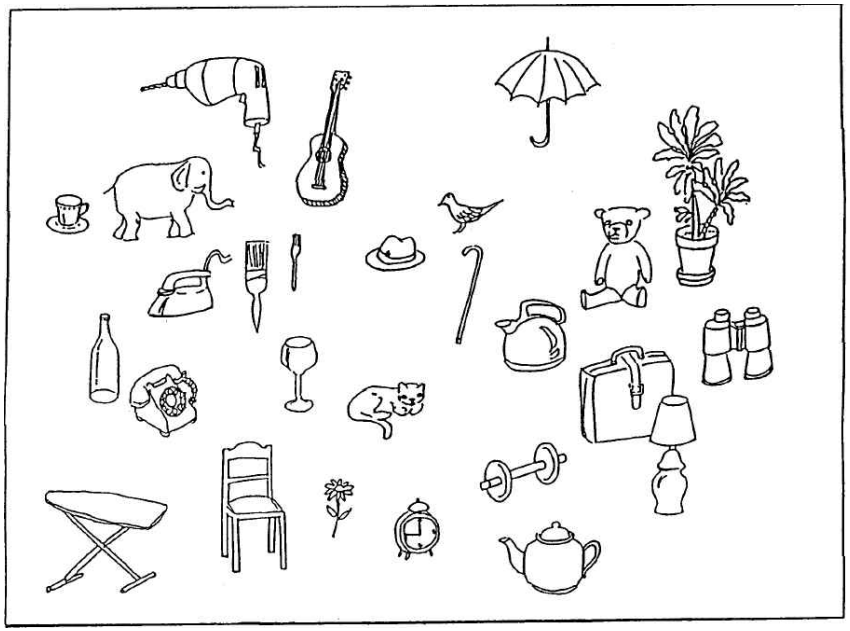

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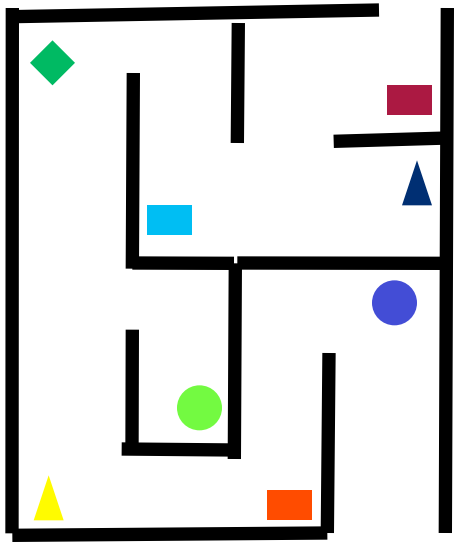
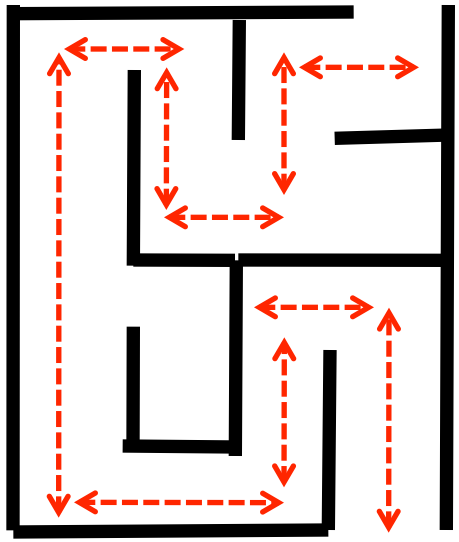
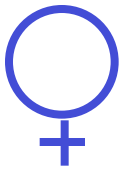
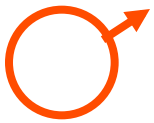








schizofrenia

- Incidenza maggiore nelle femmine
- eziologia ancora ignota ma riscontro di alterazioni a livello encefalico
- Nelle donne significativa assenza della massa intermedia del talamo

Morbo di Alzheimer

- Maggiore incidenza in soggetti di sesso femminile forse legata alla brusca diminuzione di estrogeni circolanti
- terapia ormonale sostituiva non migliora i sintomi in fase conclamata, ma ritarda insorgenza della malattia se attuata in fase precoce

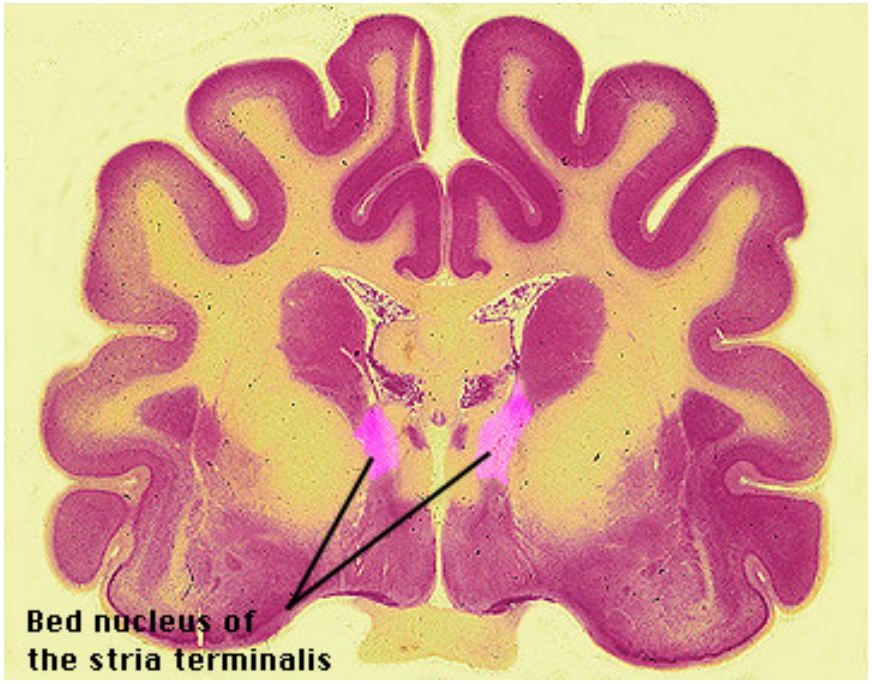
Morbo di Parkinson

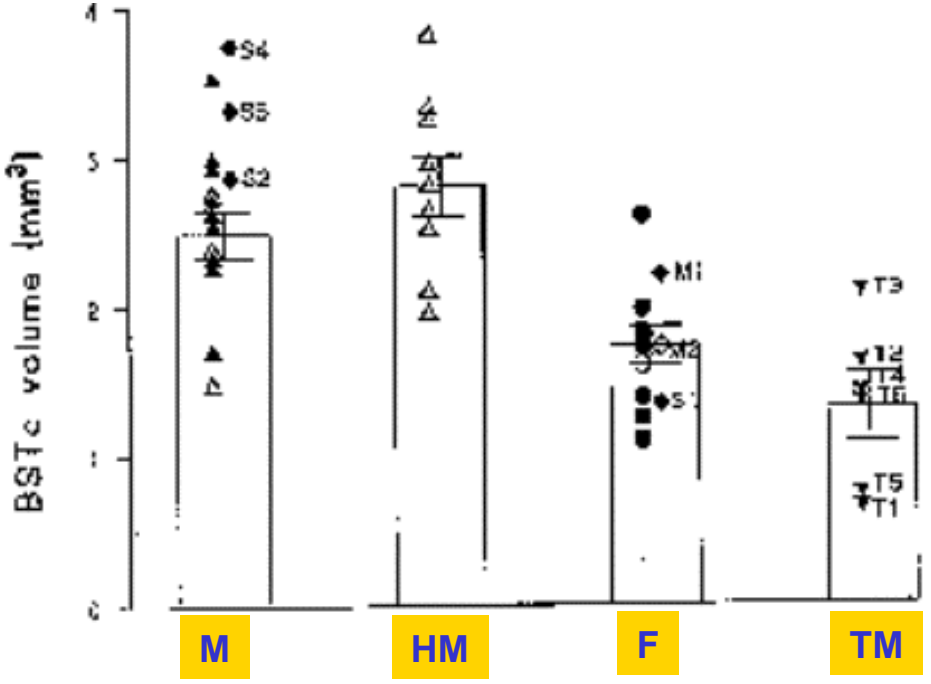
- Eziologia sconosciuta (genetica? tossica?)
- incidenza maggiore nei soggetti maschi
- mediante PET individuate zone della corteccia frontale dimorfiche

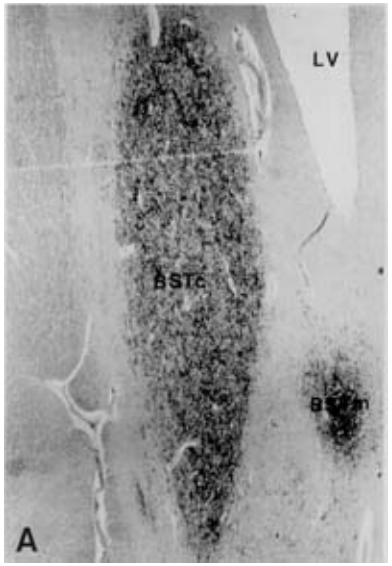
Dimorfismo ed orientamento sessuale

Problemi metodologici per le indagini nell'uomo

- Non è possibile allestire gruppi sperimentali omogenei
- Difficoltà nel ricostruire la "storia clinica" dei soggetti di studio
- Presenza di patologie neurologiche o altre (AIDS)
- I reperti autoptici hanno condizioni diverse a seconda delle modalità di prelievo e conservazione

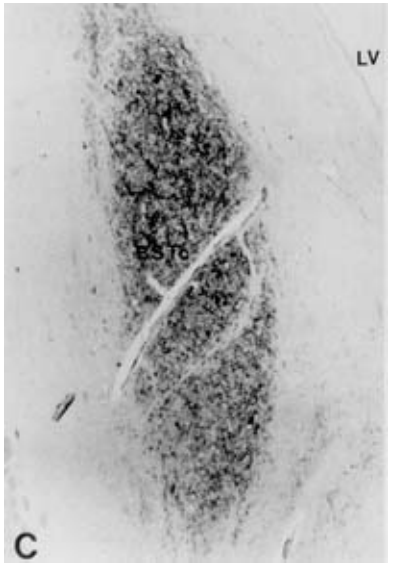




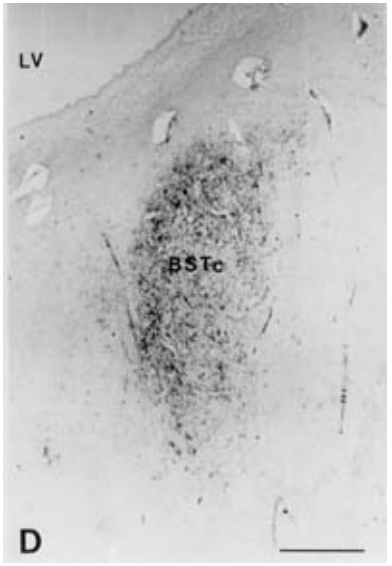


M

F



M omo

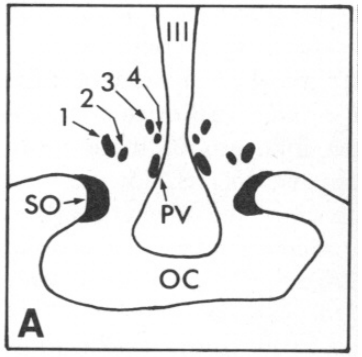


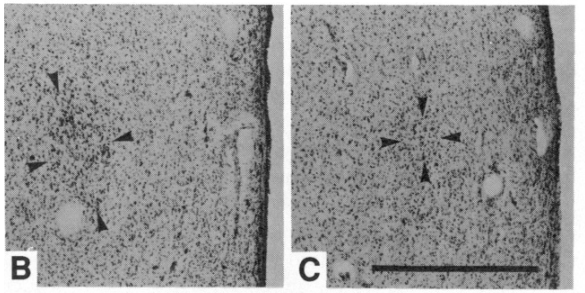
M-F trans

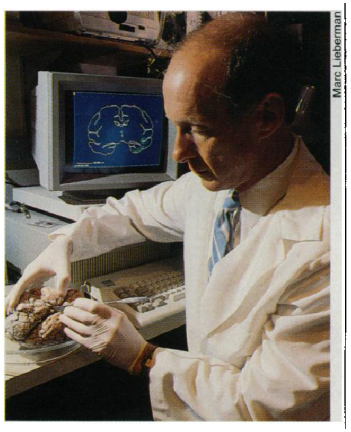
A Difference in Hypothalamic Structure Between Heterosexual and Homosexual Men

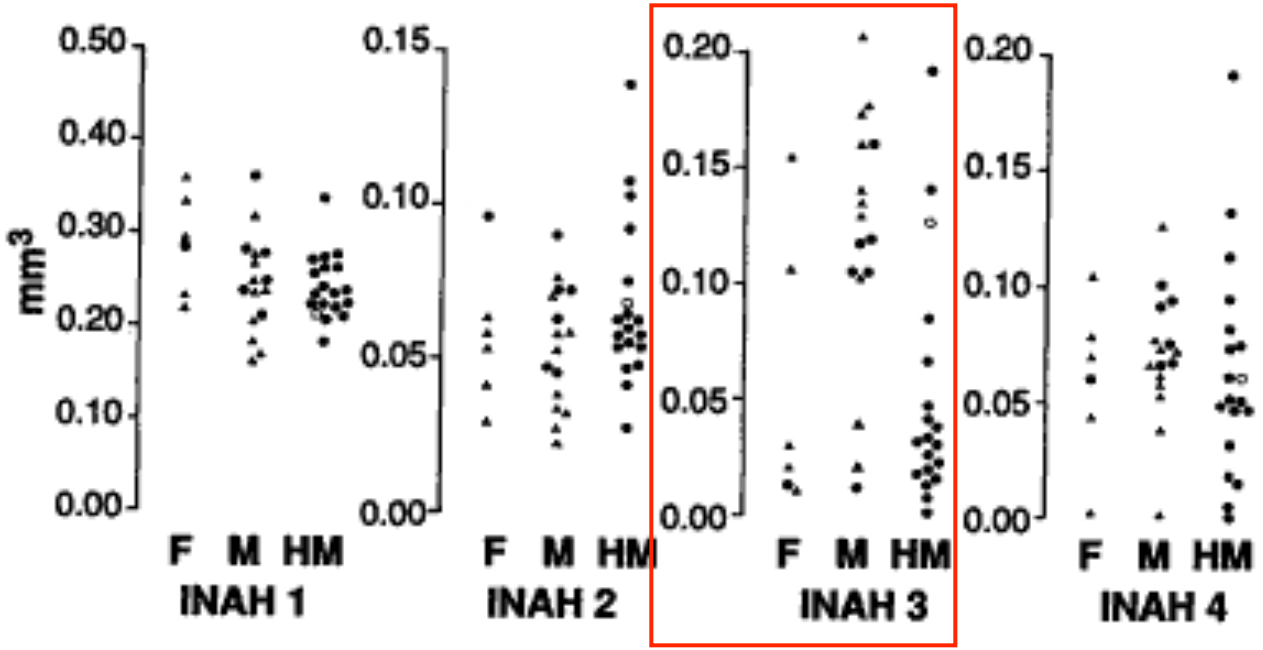
SIMON LEVAY

The anterior hypothalamus of the brain participates in the regulation of male-typical sexual behavior. The volumes of four cell groups in this region [interstitial nuclei of the anterior hypothalamus (INAH) 1, 2, 3, and 4] were measured in postmortem tissue from three subject groups: women, men who were presumed to be heterosexual, and homosexual men. No differences were found between the groups in the volumes of INAH 1, 2, or 4. As has been reported previously, INAH 3 was more than twice as large in the heterosexual men as in the women. It was also, however, more than twice as large in the heterosexual men as in the homosexual men. This finding indicates that INAH is dimorphic with sexual orientation, at least in men, and suggests that sexual orientation has a biological substrate.







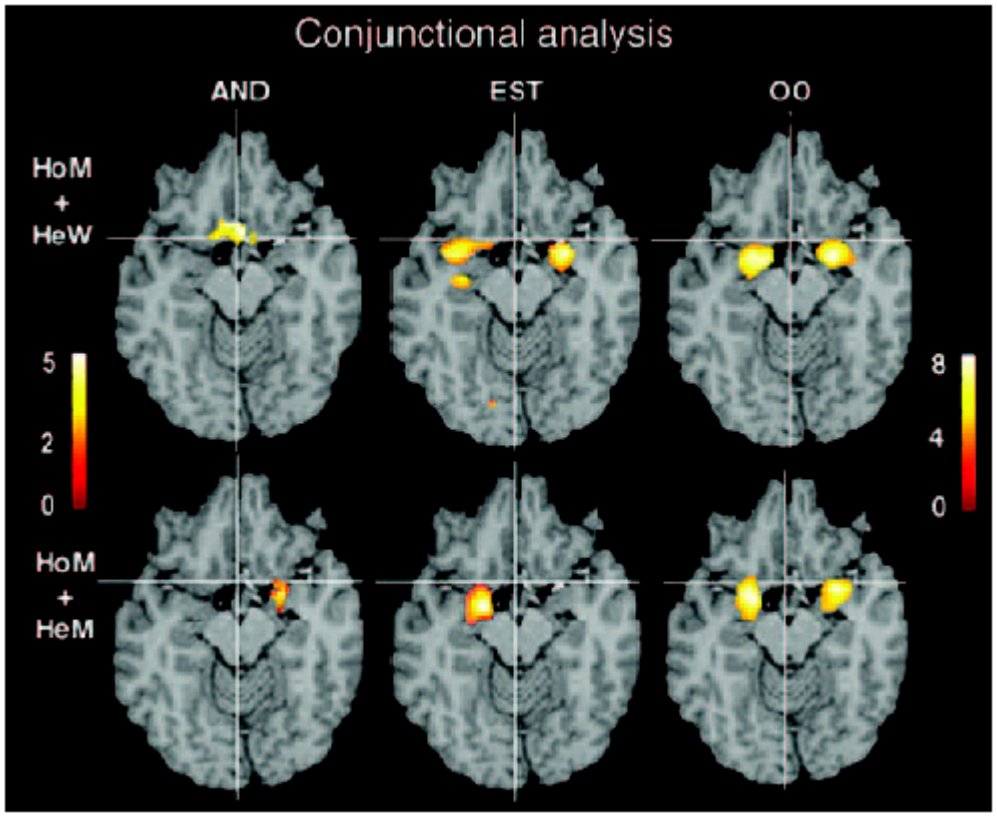


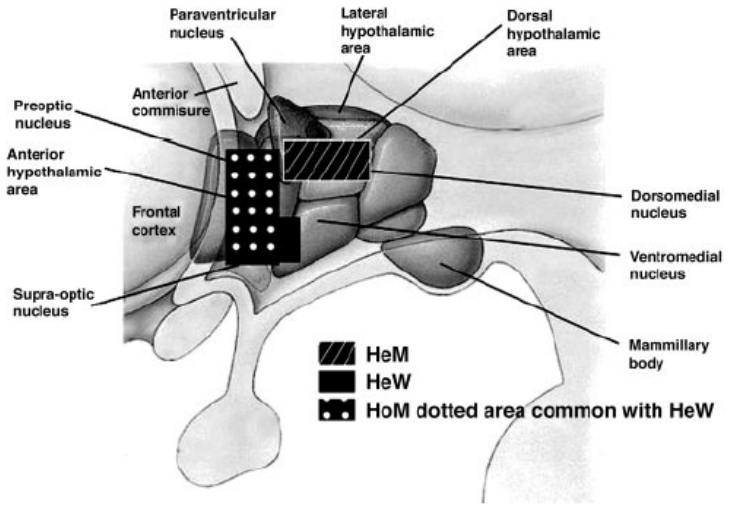
Brain response to putative pheromones in homosexual men

Ivanka Savic*†‡, Hans Berglund§, and Per Lindström*

Departments of *Clinical Neuroscience and §Medicine, Karolinska University Hospital, 171 76 Stockholm, Sweden; and †Department of Neuroscience, Center for Gender-Related Medicine, Karolinska Institute, 171 77 Stockholm, Sweden

Edited by Jan-Åke Gustafsson, Karolinska Institute, Huddinge, Sweden, and approved April 4, 2005 (received for review October 27, 2004)



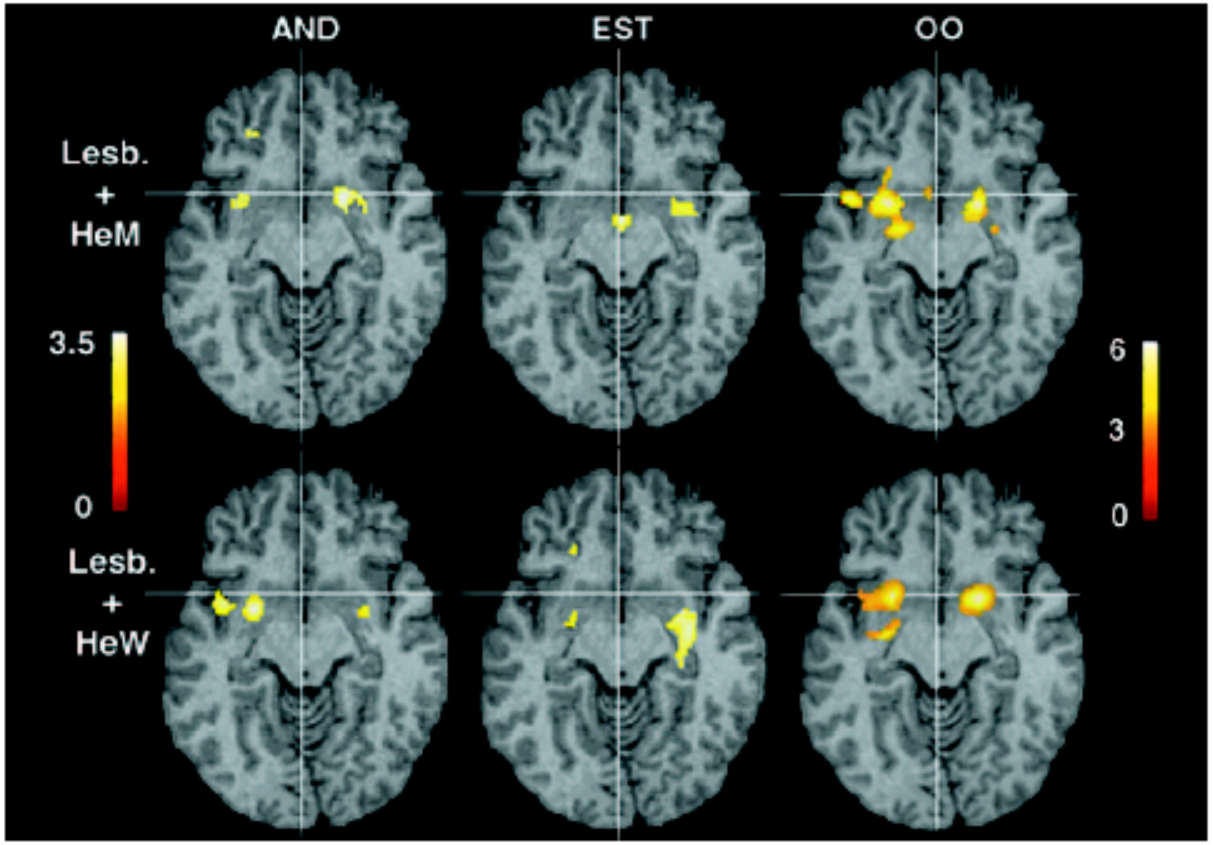


Brain response to putative pheromones in lesbian women

Hans Berglund*, Per Lindström†, and Ivanka Savic†‡

*Department of Medicine, and †Stockholm Brain Institute, Department of Clinical Neuroscience, Karolinska University Hospital, Karolinska Institutet, 171 76 Stockholm, Sweden

Edited by Jan-Åke Gustafsson, Karolinska Institutet, Huddinge, Sweden, and approved March 11, 2006 (received for review January 13, 2006)



Studi genetici

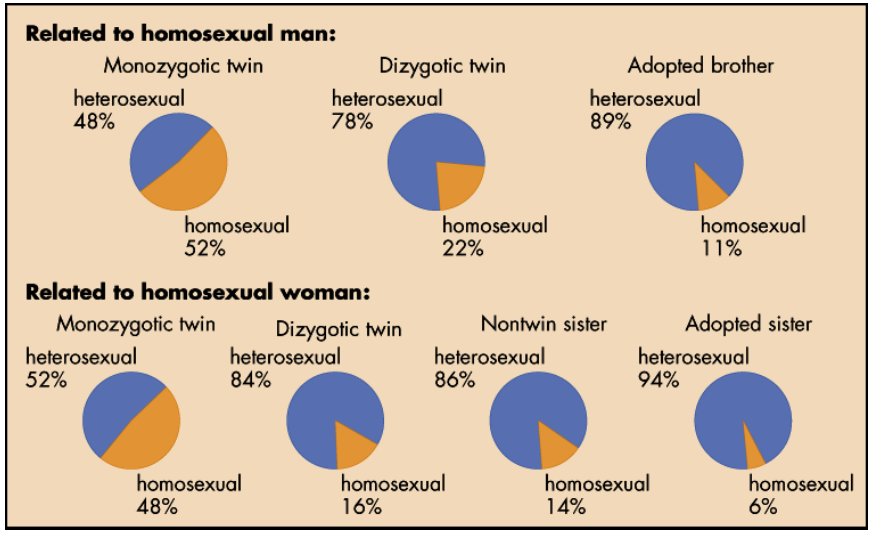
% orientamento omosessuale nella popolazione normale = 2-10% (m 4-5%)

occurrence of homosexuality among brothers

- 52% of identical (monozygotic) twins of homosexual men
- 22% of fraternal (dizygotic) twins
- 9% of the non-twin brothers
- 11% of adoptive brothers of homosexual men were likewise homosexual

occurrence of homosexuality among sisters

- 48% of identical (monozygotic) twins of homosexual women
- 16% of fraternal (dizygotic) twins were likewise homosexual
- 6% of adoptive sisters of homosexual women were likewise homosexual



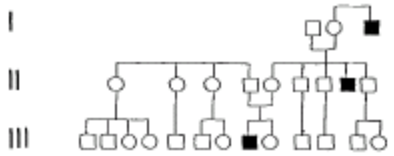
A Linkage Between DNA Markers on the X Chromosome and Male Sexual Orientation

Dean H. Hamer, Stella Hu, Victoria L. Magnuson, Nan Hu, Angela M. L. Pattatucci

The role of genetics in male sexual orientation was investigated by pedigree and linkage analyses on 114 families of homosexual men. Increased rates of same-sex orientation were found in the maternal uncles and male cousins of these subjects, but not in their fathers or paternal relatives, suggesting the possibility of sex-linked transmission in a portion of the population. DNA linkage analysis of a selected group of 40 families in which there were two gay brothers and no indication of nonmaternal transmission revealed a correlation between homosexual orientation and the inheritance of polymorphic markers on the X chromosome in approximately 64 percent of the sib-pairs tested. The linkage to markers on Xq28, the subtelomeric region of the long arm of the sex chromosome, had a multipoint lod score of 4.0 ($P = 10^{-5}$), indicating a statistical confidence level of more than 99 percent that at least one subtype of male sexual orientation is genetically influenced.

Locus	Location	AL*	HET†	Sib-pairs‡			z_1§	$2\ln L(z_1)$‖	P¶
				[D]	[S]	[–]			
A. .KAL	p22	6	0.77	5	16	14	0.51	0.01	ns
B. .DXS996	p22	11	0.84	7	14	18	≤.5	≤0	ns
C. .DXS992	p	8	0.87	6	13	19	≤.5	≤0	ns
D. .DMD1	p21	9	0.78	3	10	23	≤.5	≤0	ns
E. .DXS993	p11	6	0.80	3	14	17	≤.5	≤0	ns
F. .DXS991	p	8	0.77	8	14	14	0.57	0.61	ns
G. .DXS986	q	10	0.71	7	20	10	0.65	2.11	ns
H. .DXS990	q	7	0.76	4	19	13	0.55	0.25	ns
I. .DXS1105	q	5	0.48	3	20	9	≤.5	≤0	ns
J. .DXS456	q21	10	0.85	8	20	8	0.75	7.95	0.00241
K. .DXS1001	q26	10	0.82	8	16	13	0.60	1.09	ns
L. .DXS994	q26	5	0.75	7	17	13	0.55	0.26	ns
M. .DXS297	q27	5	0.70	5	21	8	0.71	4.25	0.01963
N. .FMR	q27	17	0.79	6	17	14	0.56	0.45	ns
O. .FRAXA	q27	8	0.72	4	17	13	0.56	0.38	ns
P. .DXS548	q27	6	0.67	7	20	7	0.73	5.21	0.01123
Q. .GABRA3	q28	4	0.35	2	23	3	0.74	2.39	ns
R. .DXS52	**q28**	**12**	**0.79**	**9**	**22**	**6**	**0.81**	**11.83**	**0.00029**
S. .G6PD	**q28**	**2**	**0.36**	**4**	**24**	**2**	**0.85**	**6.38**	**0.00577**
T. .F8C	**q28**	**2**	**0.41**	**5**	**24**	**3**	**0.82**	**6.56**	**0.00522**
U. .DXS1108	**q28**	**6**	**0.71**	**8**	**22**	**4**	**0.85**	**12.87**	**0.00017**
V. .DXYS154#	**q28**	**10**	**0.71**	**8**	**22**	**5**	**0.83**	**12.84**	**0.00017**
R/S/T/U/V	**q28**		**0.99**	**12**	**21**	**7**	**0.82**	**18.14**	**0.00001**

DH99002



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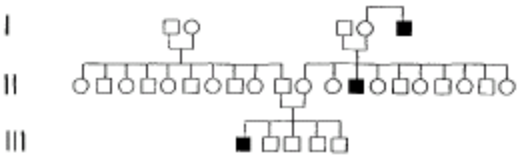
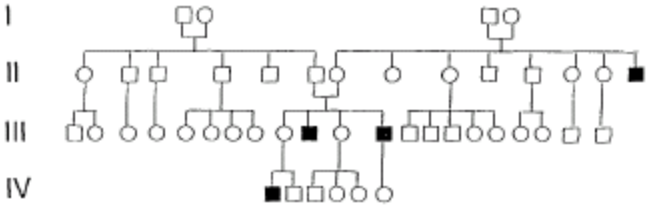
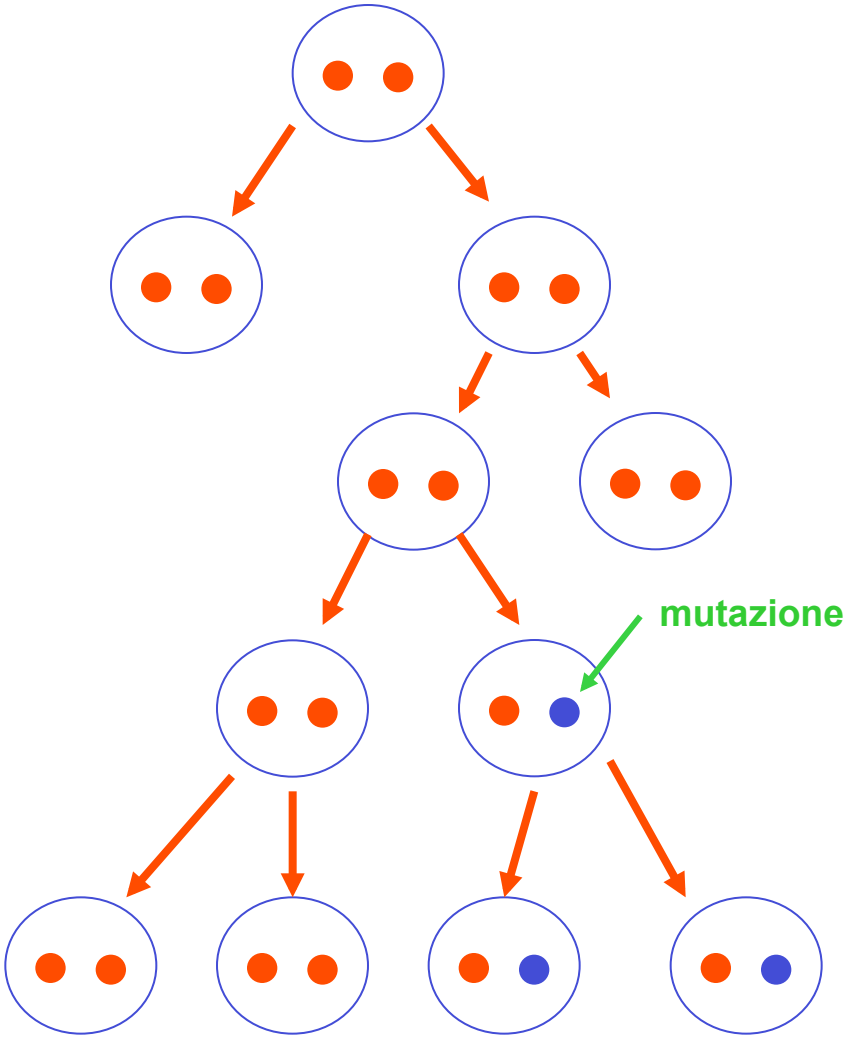


DH321

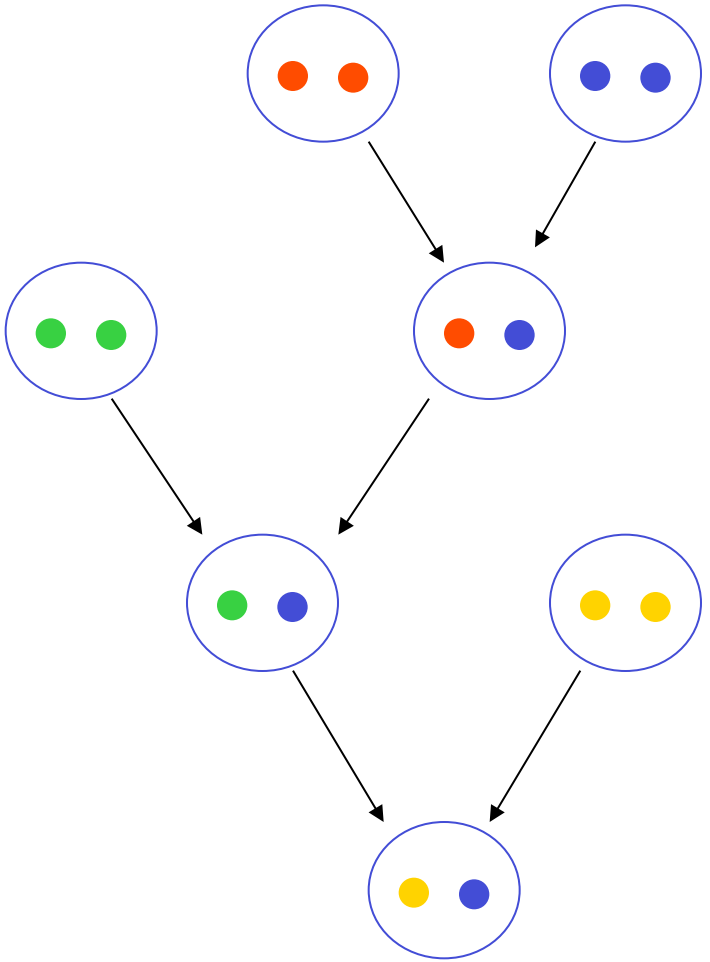


DH210

Vantaggio evoluzionistico della riproduzione sessuata

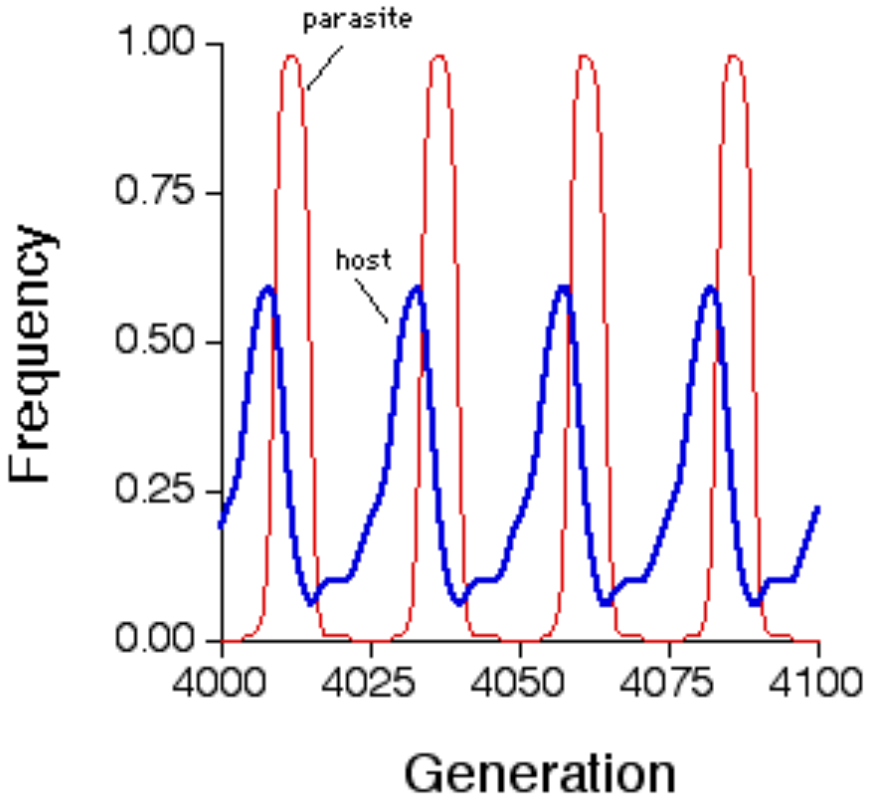


riproduzione asessuata - partenogenesi



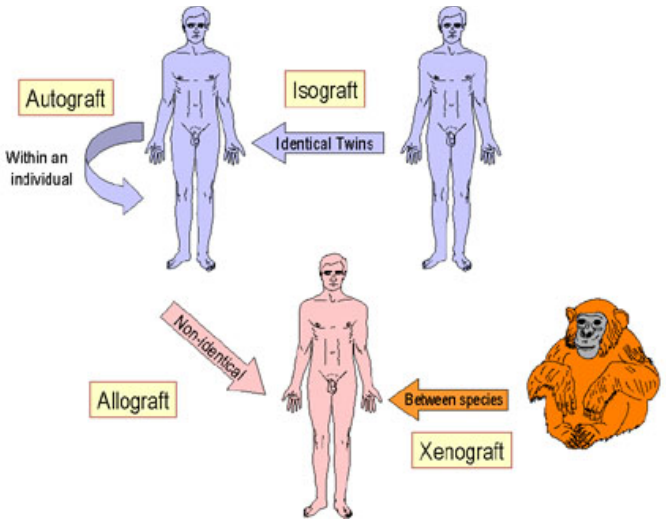
riproduzione sessuata

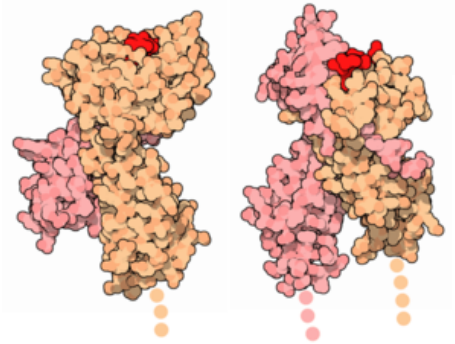
The “Red Queen” hypothesis

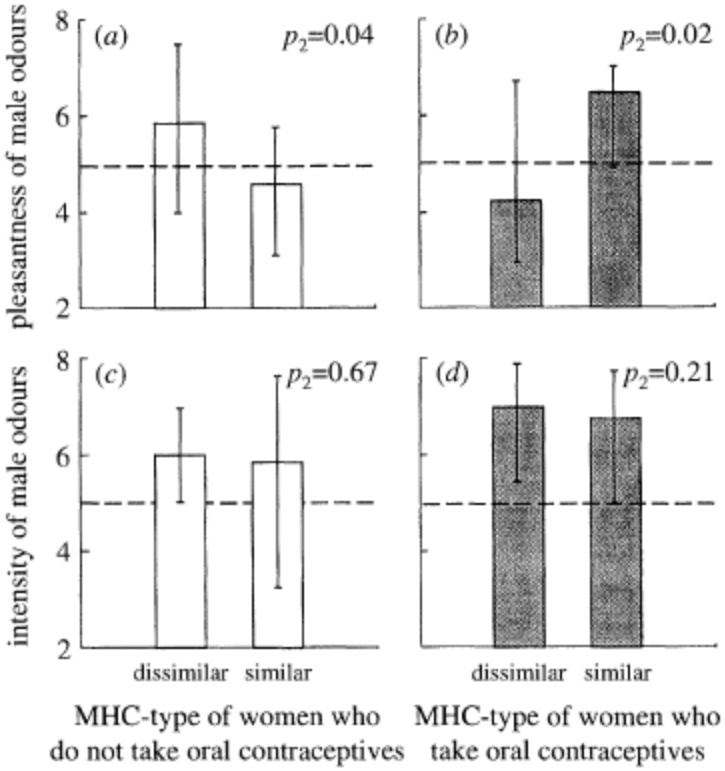


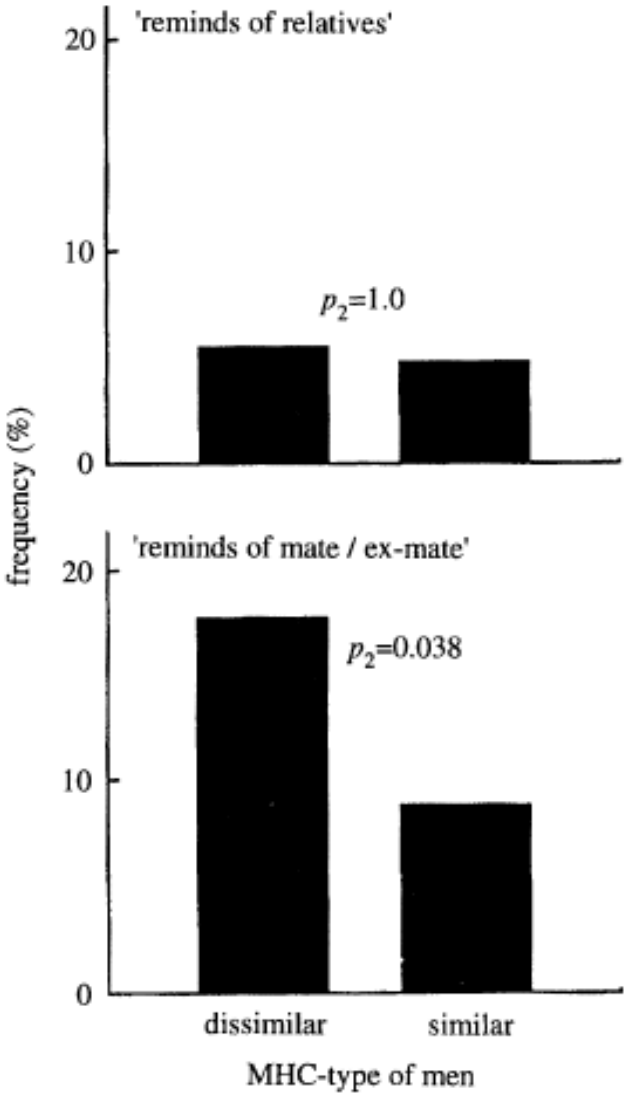
"Now, here, you see, it takes all the running you can do to keep in the same place”

MHC Complesso maggiore di istocompatibilità



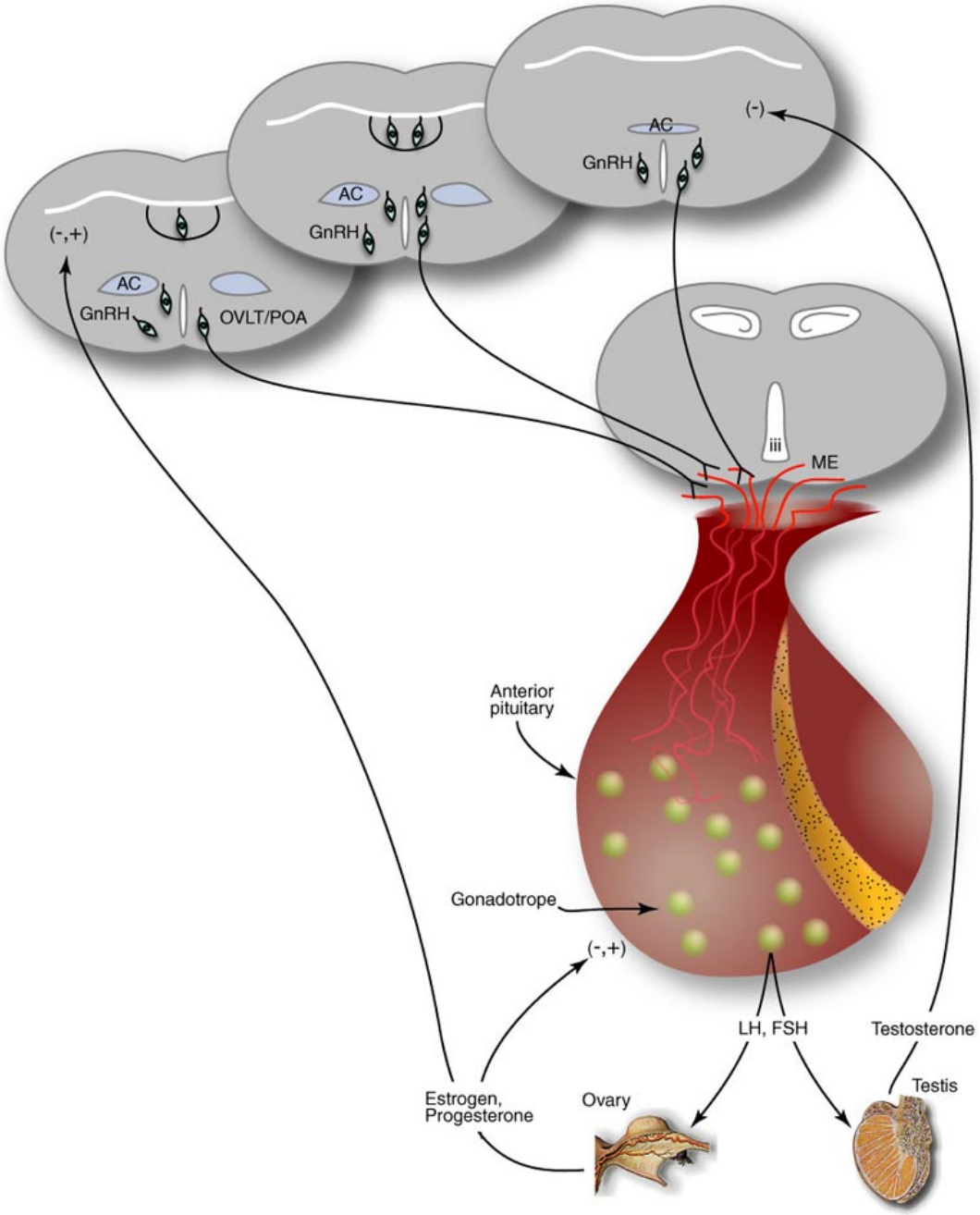


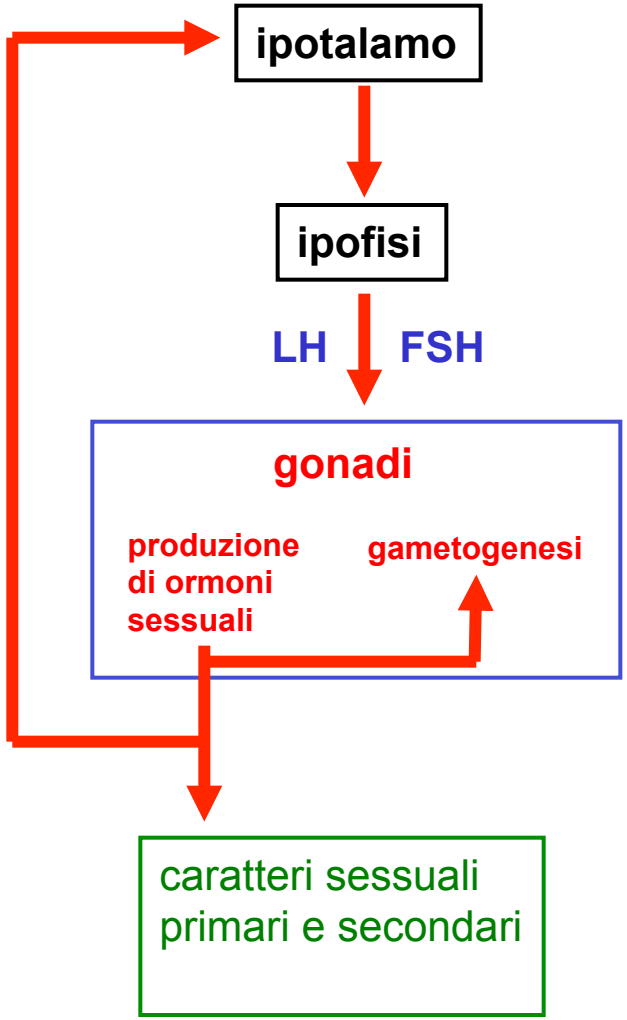


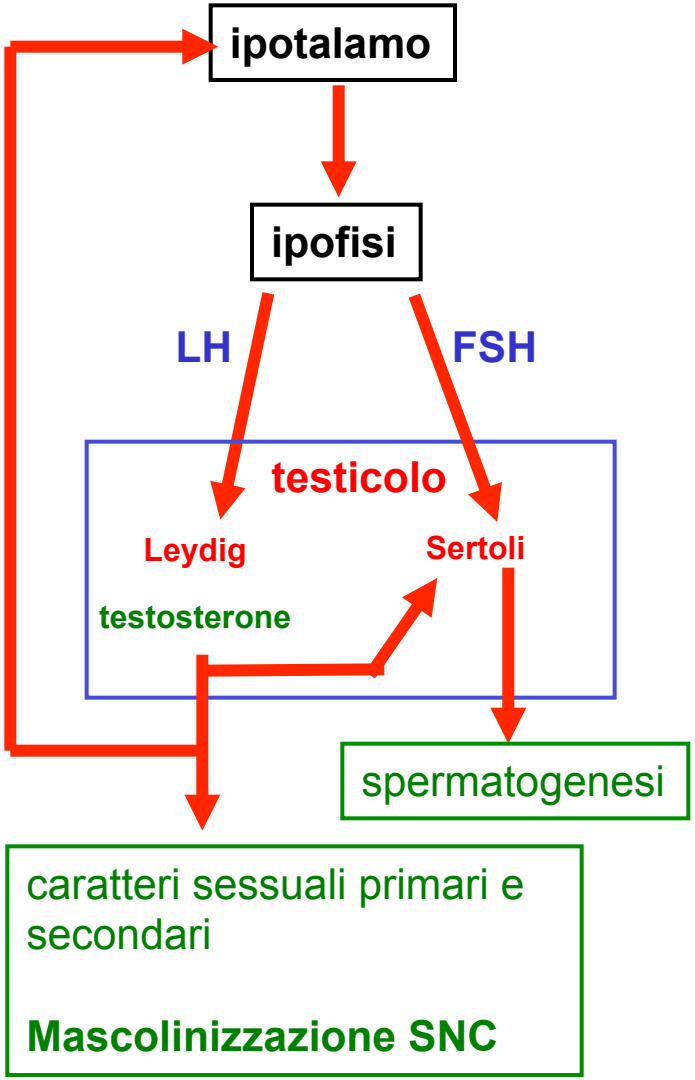


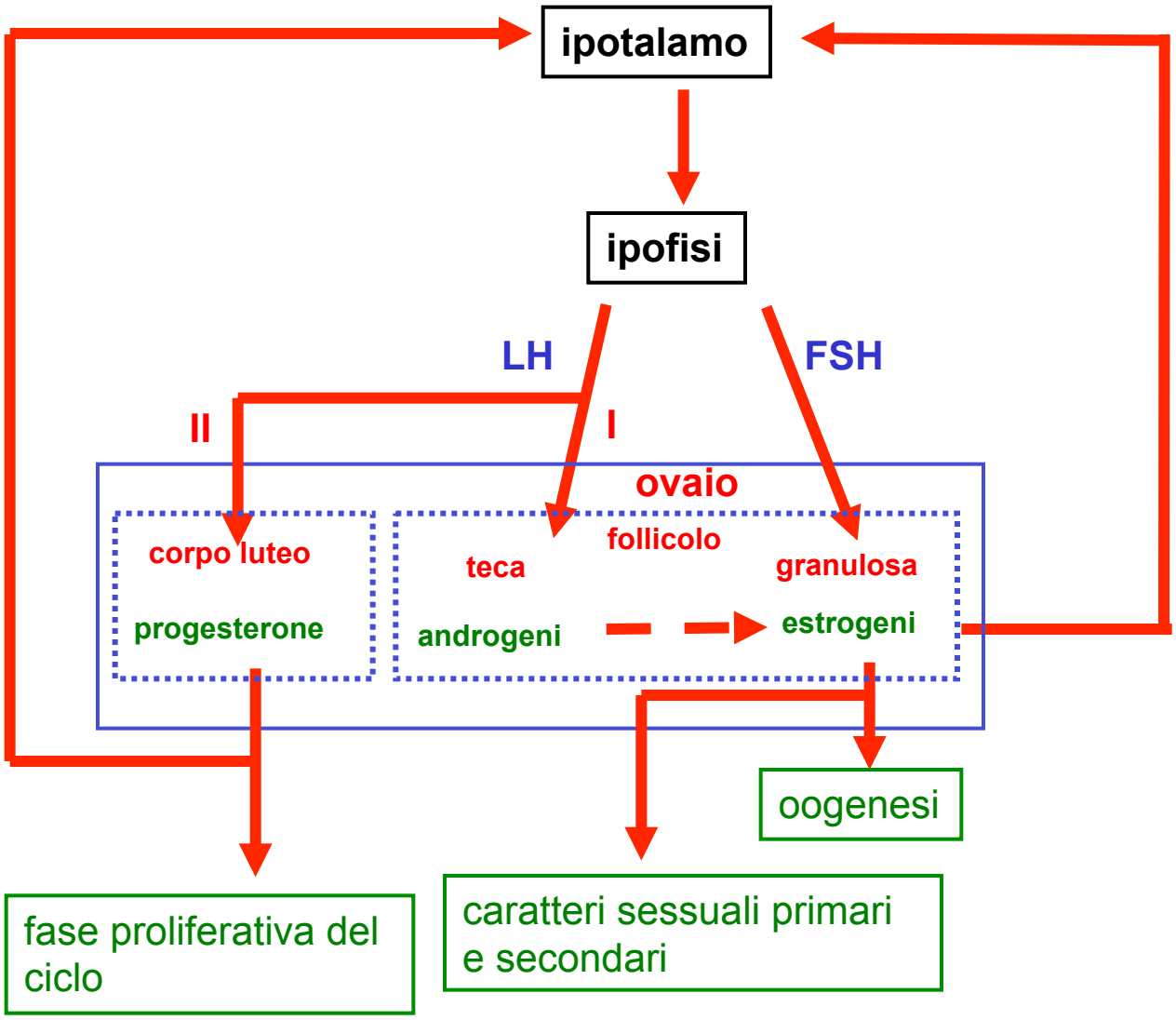
L'ipotalamo controlla la funzione sessuale attraverso le gonadotropine ipofisarie

A loro volta, gli ormoni sessuali agiscono sulla funzione dell'ipotalamo




ipotalamo
ipofisi
LH
FSH
gonadi
produzione di ormoni sessuali
gametogenesi
caratteri sessuali primari e secondari


ipotalamo
ipofisi
LH
FSH
testicolo
Leydig
Sertoli
testosterone
spermatogenesi
caratteri sessuali primari e secondari
Mascolinizzazione SNC


ipotalamo
ipofisi
LH
FSH
II
I
ovaio
corpo luteo
progesterone
follicolo
teca
androgeni
granulosa
estrogeni
oogenesi
fase proliferativa del ciclo
caratteri sessuali primari e secondari

Strategie di accoppiamento nel regno animale

Poliginia

Molto frequente fra i mammiferi (giraffe, oranghi ecc..)

Esempi di rapporto stabile (harem; gorilla, elefanti marini)

Poliandria

Rara nei vertebrati (ecc.. Falaropo)

Monogamia

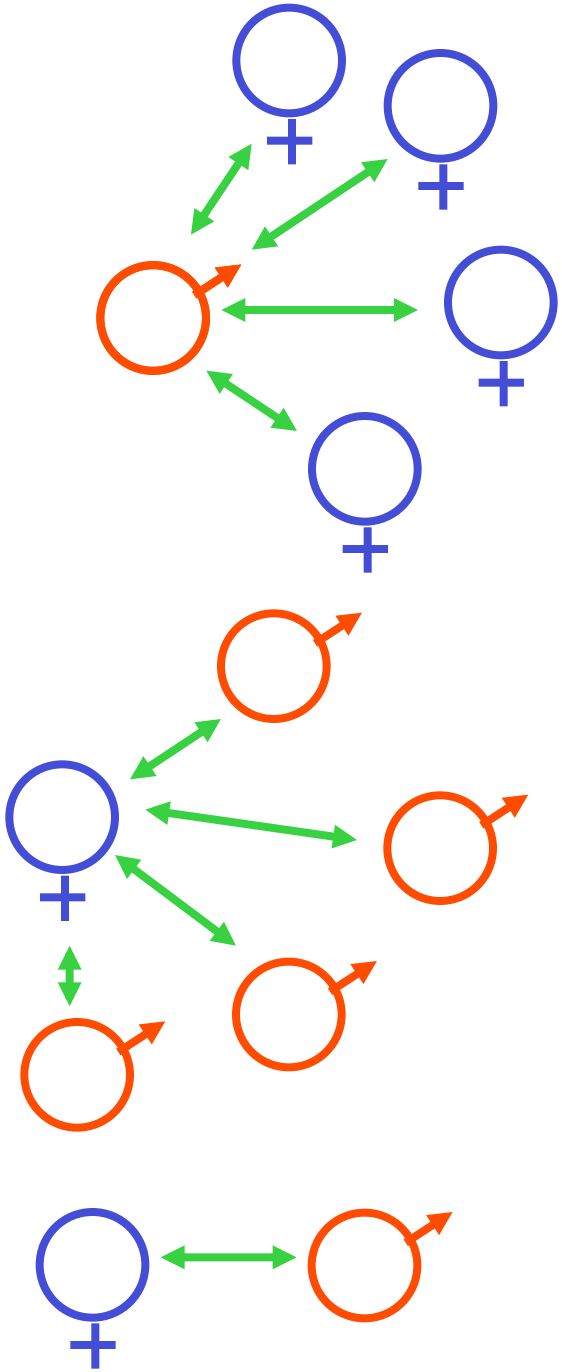
90% degli uccelli (cova)

3% dei mammiferi

12% dei primati

Gli umani sono tendenzialmente monogami

Anche nelle società poliginiche, la maggior parte delle coppie sono monogamiche



A causa della competizione per le femmine, la poliginia è associata a:

Maggior differenza di massa corporea fra maschi e femmine (gorilla, leoni marini)
Maggiore differenza nei caratteri sessuali secondari

Altri fattori importanti che determinano le strategie di accoppiamento sono:

1. **La periodicità della recettività della femmina**
2. **La possibile promiscuità delle femmine (competizione del seme)**
3. **La partecipazione dei maschi alle cure parentali**

anatra canadese

pavone

Le specie monogame tendono ad essere monomorfiche perché maschi e femmine svolgono compiti simili

Le specie poligame sono spiccatamente dimorfiche, perché maschi e femmine non svolgono compiti simili (in particolare nell'allevamento dei piccoli)

buone qualità vs buoni geni


titi monkey


gorilla

Chimps

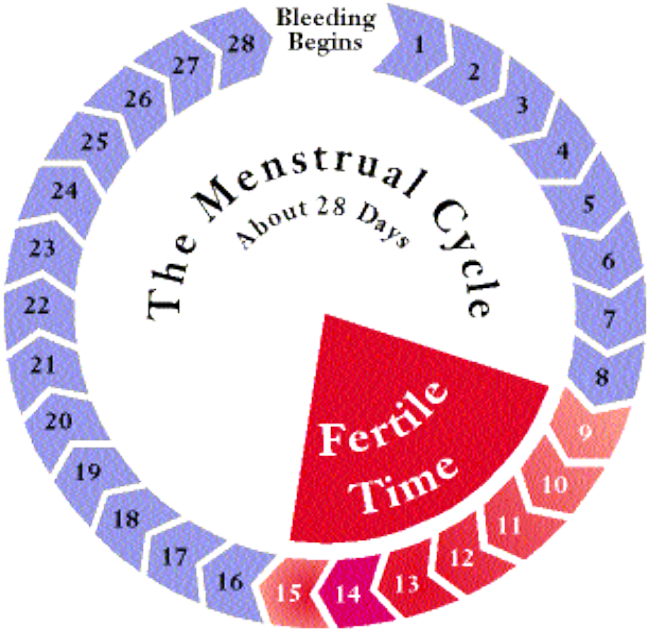
Società gerarchica
Patriarcale
Non promiscui
Paternità certa
Infanticidio

Bonobos

Società non gerarchica
Matriarcale
Promiscui
Paternità incerta
No infanticidio

Nella nostra specie ci sono due caratteristiche particolari:

- **La fertilità femminile non è esteriormente evidente**
- **L'accoppiamento non avviene in pubblico**



Arvicola delle praterie (microtus ochrogaster)

Fortemente sociale e stabilmente monogamo

Maschio e femmina condividono la tana e la cura della prole

Il maschio difende strenuamente la femmina e la prole

Arvicola delle montagne (microtus montanus)

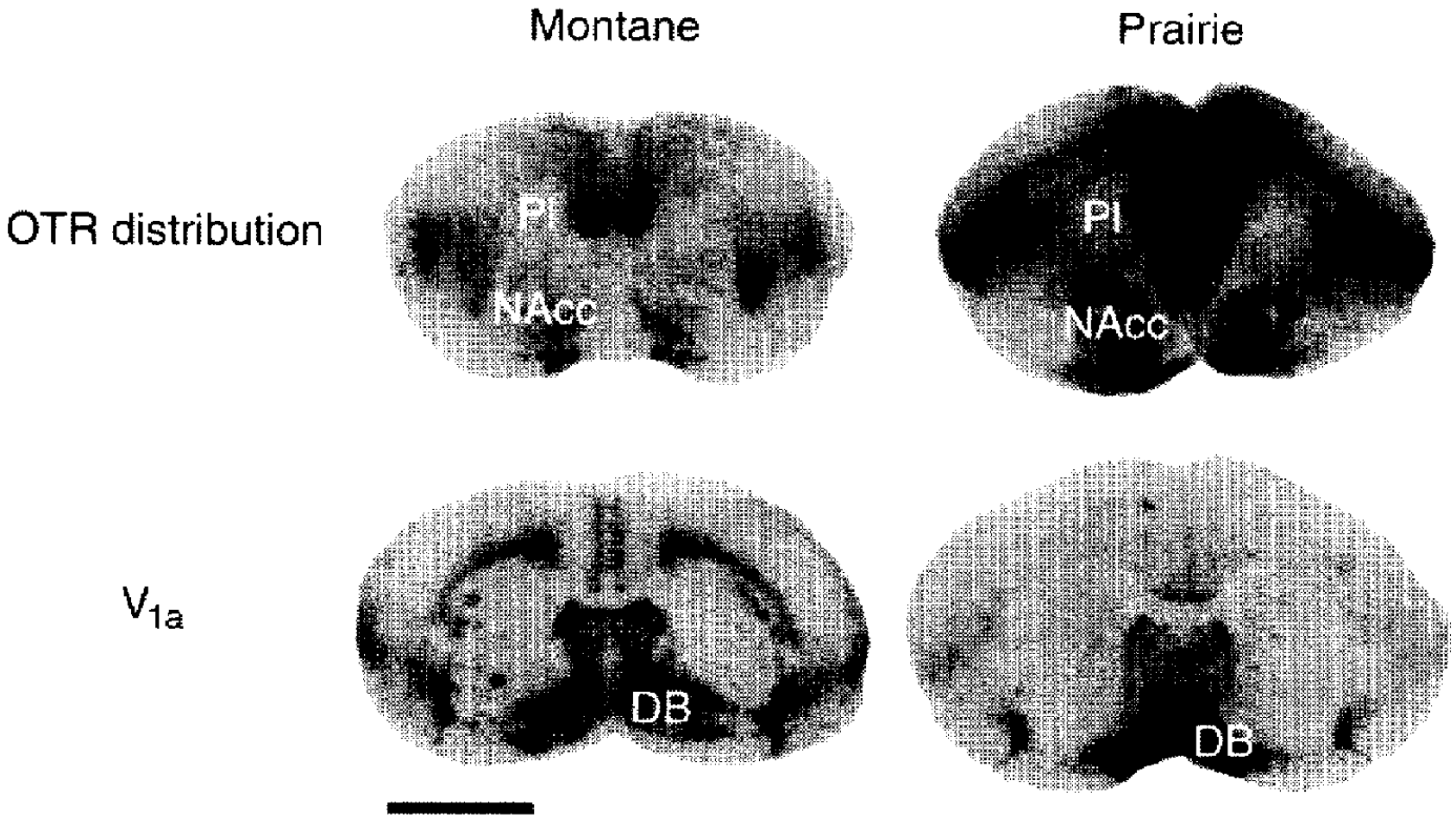
Asociale e promiscuo

Ogni individuo vive isolato in una tana propria

Il maschio non partecipa alla cura della prole

La femmina abbandona i piccoli molto presto

Distribuzione dei recettori per ossitocina e vasopressina nel cervello delle arvicole di montagna e della prateria

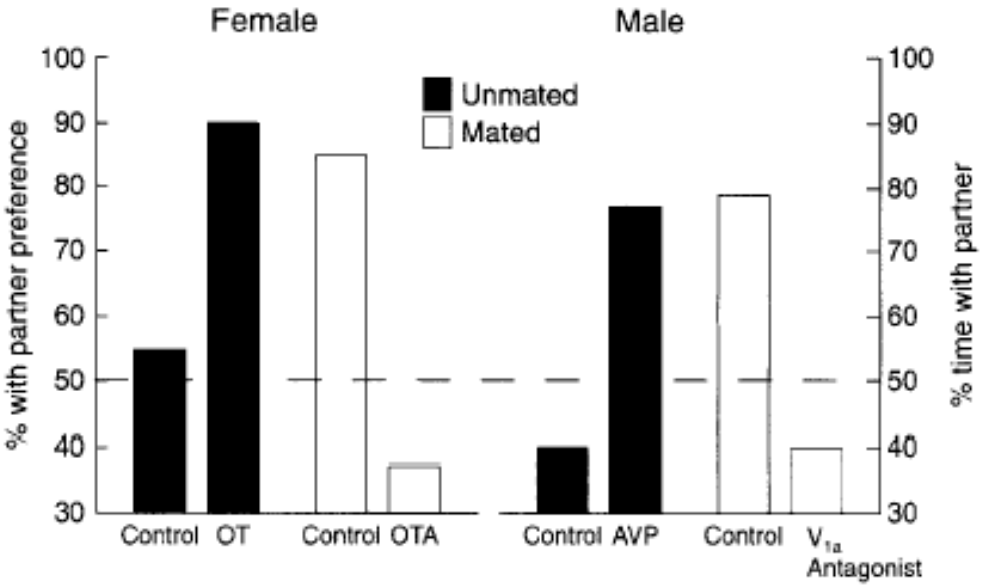


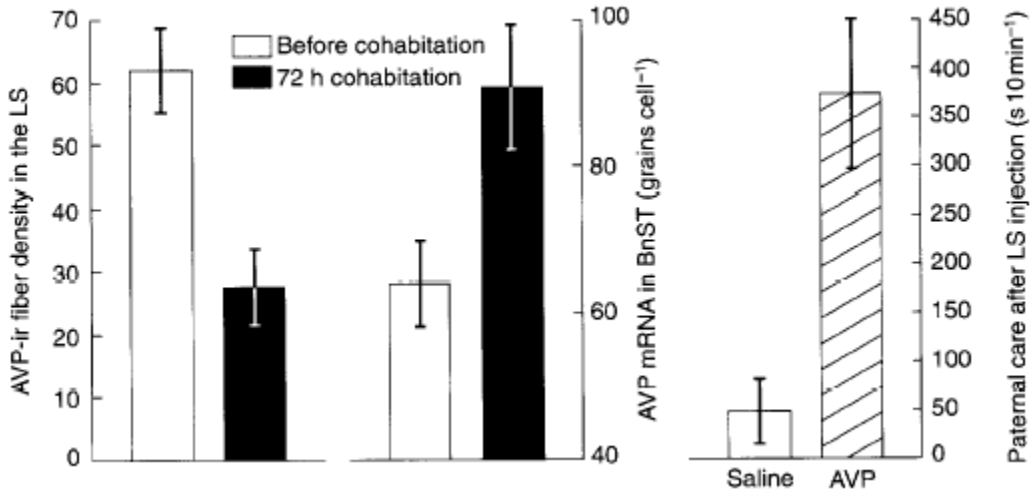
Effetti della somministrazione di ossitocina e vasopressina nel cervello delle arvicole di montagna e della prateria

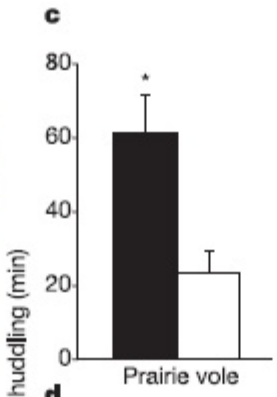
TABLE 2. Effects of central administration of oxytocin and vasopressin on social behavior

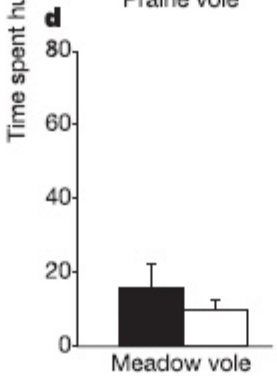
Behavior	Oxytocin	Vasopressin	Refs
Effects in rodents			
Affiliative behavior	+++	?	8
Sexual behavior	+++	?	9,10
Maternal behavior	+++	+	11,12
Social memory	++	+++	13,14
Territorial behavior	?	+++	15
Male aggression	?	+++	16
Effects in monogamous voles			
Partner preference in females	+++	–	17,18
Partner preference in males	–	+++	19
'Selective' aggression	–	+++	19
Paternal care	?	+++	20

+++, marked effect; ++, moderate effect; +, some effect; –, no effect; ?, effect unknown.







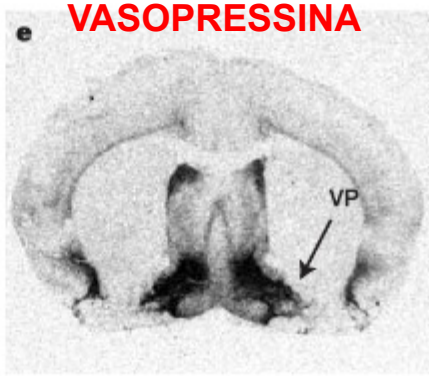


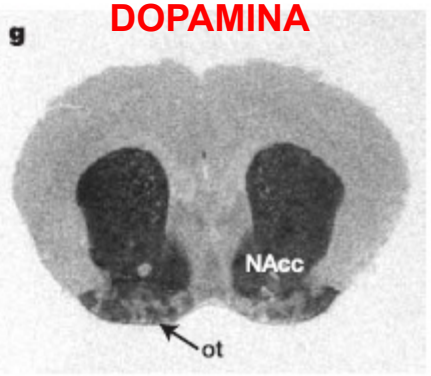
VASOPRESSINA

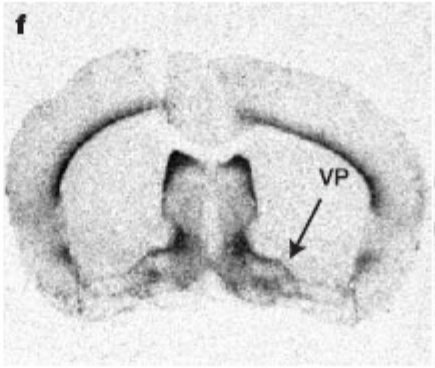
DOPAMINA

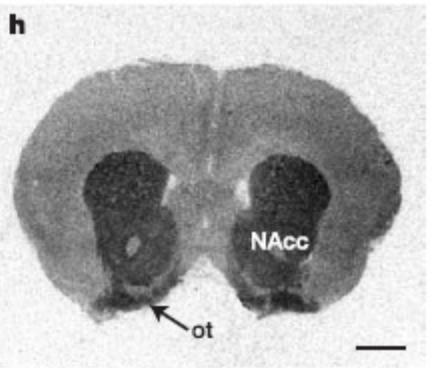
prateria

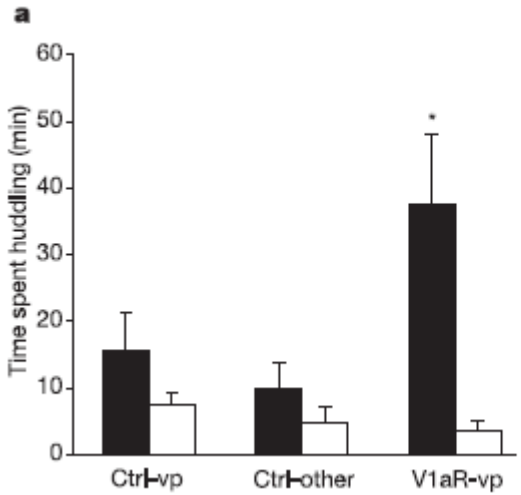
montagna

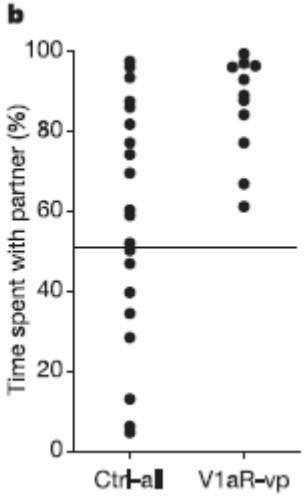


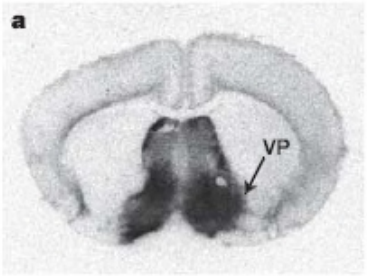


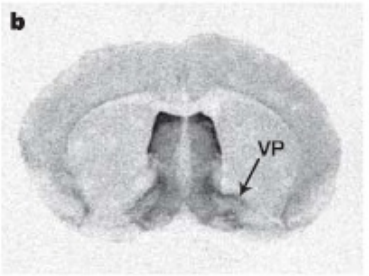


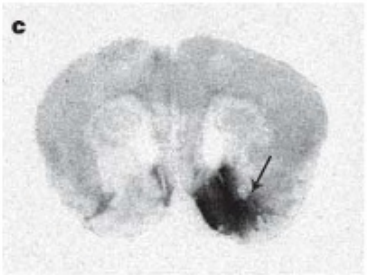


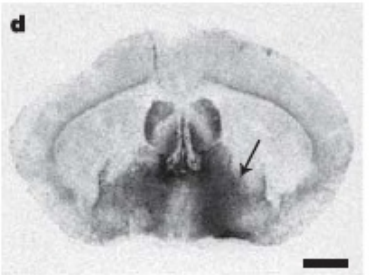








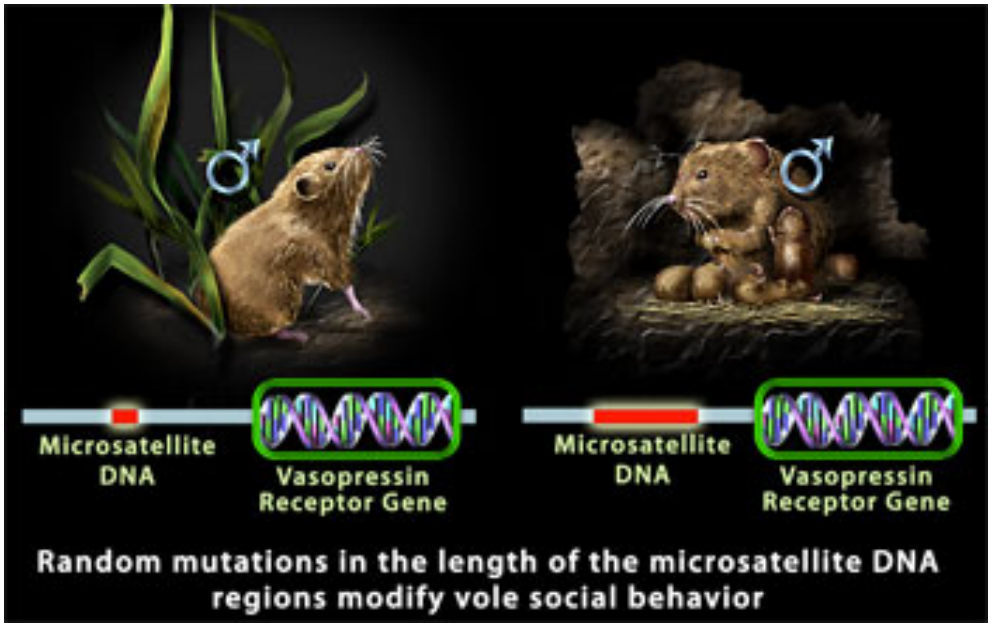


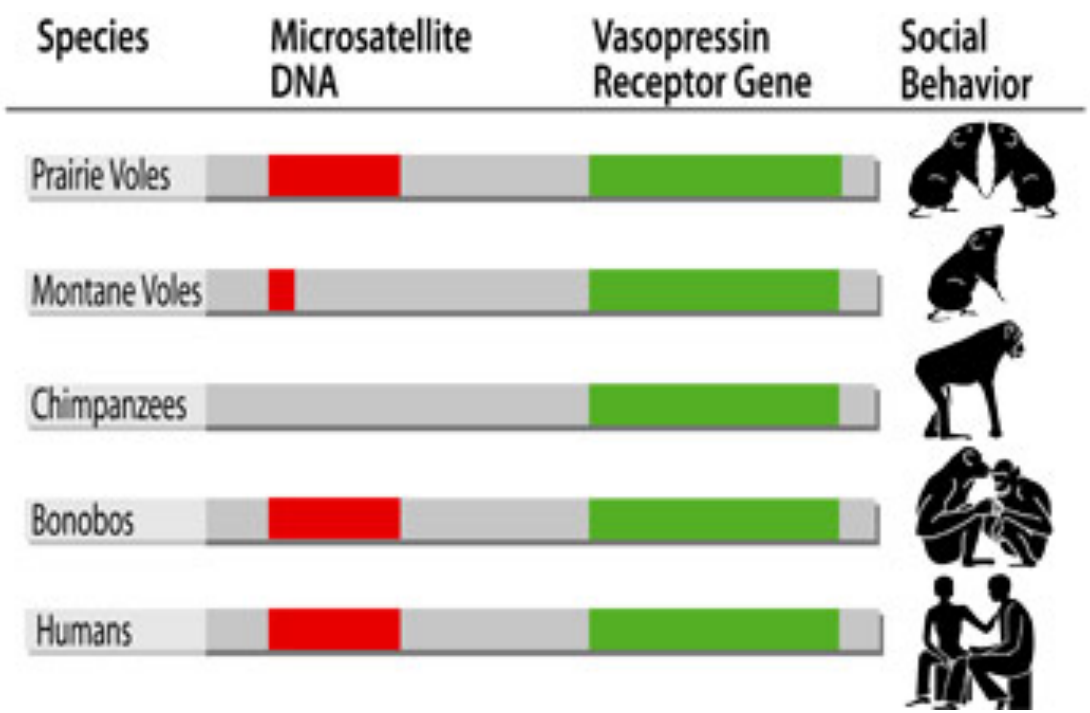


Microsatellite Instability Generates Diversity in Brain and Sociobehavioral Traits

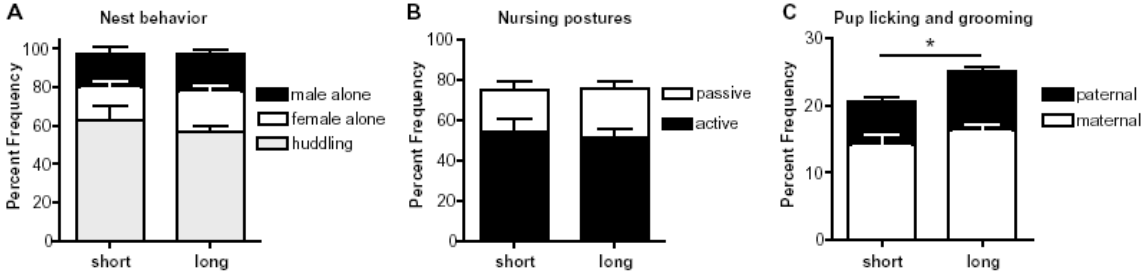
Elizabeth A. D. Hammock and Larry J. Young*

Repetitive microsatellites mutate at relatively high rates and may contribute to the rapid evolution of species-typical traits. We show that individual alleles of a repetitive polymorphic microsatellite in the 5′ region of the prairie vole *vasopressin 1a receptor* (*avpr1a*) gene modify gene expression in vitro. In vivo, we observe that this regulatory polymorphism predicts both individual differences in receptor distribution patterns and socio-behavioral traits. These data suggest that individual differences in gene expression patterns may be conferred via polymorphic microsatellites in the cis-regulatory regions of genes and may contribute to normal variation in behavioral traits.

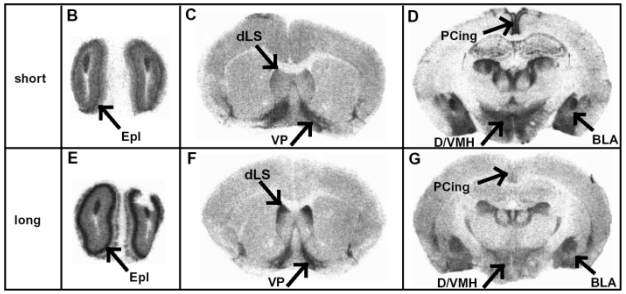




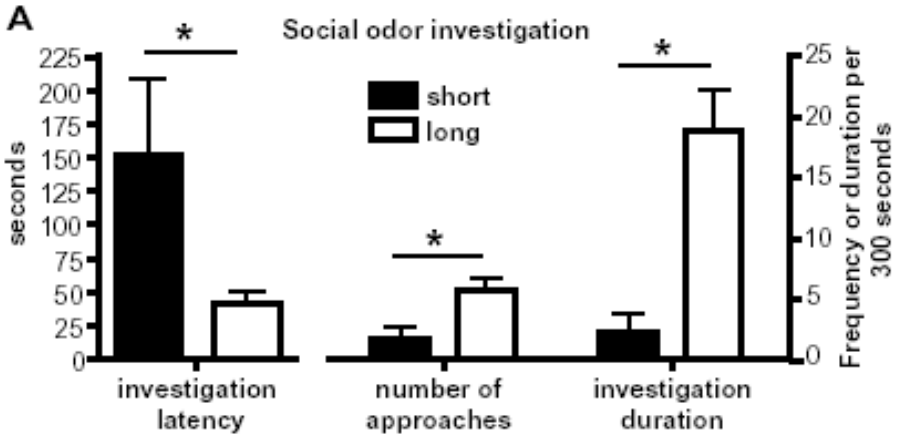
Cure parentali

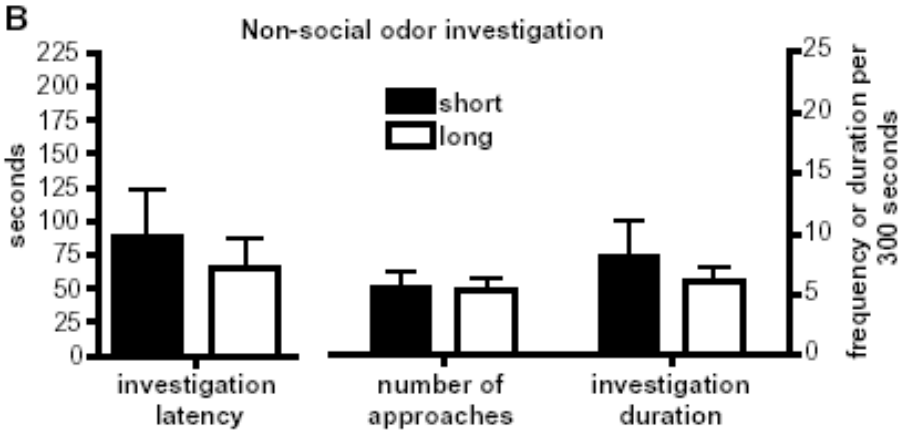


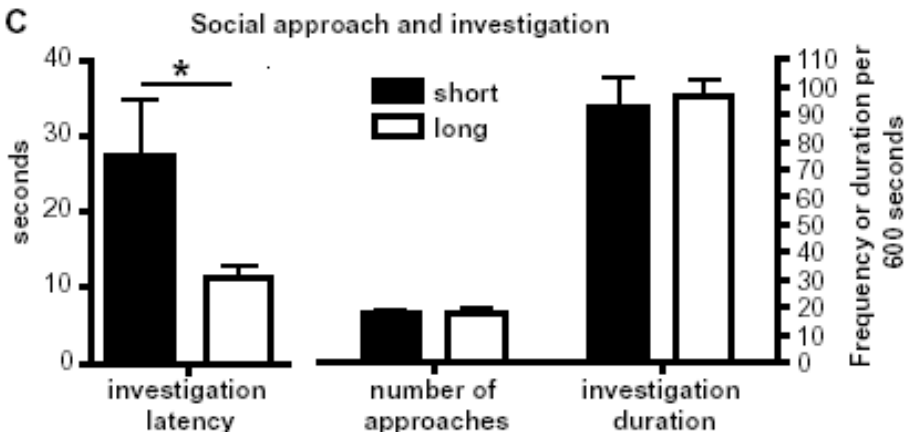
Distribuzione del recettore ADH

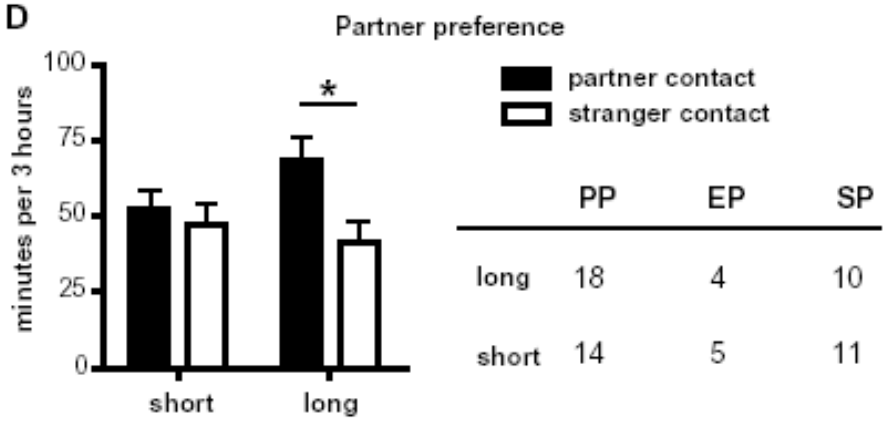


Riconoscimento sociale









	PP	EP	SP
long	18	4	10
short	14	5	11

Genetic variation in the vasopressin receptor 1a gene (*AVPR1A*) associates with pair-bonding behavior in humans

Table 1. Association between the different microsatellite polymorphisms in the *AVPR1A* 5′ flanking region and the Partner Bonding Scale

Men				Women			
Repeat	*df*	*F*	*P*	Repeat	*df*	*F*	*P*
GT_{25}	21, 148	0.39	0.99	GT_{25}	18, 138	1.05	0.41
RS1	16, 187	1.03	0.43	RS1	15, 197	0.99	0.46
RS3	19, 157	2.48	0.001	RS3	21, 166	1.19	0.27

Only genotypes for which $n > 10$ were included in the analyses.

Table 3. Effect of 0, 1 or 2 334 alleles on male reports on the Partner Bonding Scale, marital crisis, and marital status

	Number of 334 alleles					
Measure	0	1	2	*df*	*F*	*P*
Mean score for the Partner Bonding Scale in the three groups						
Partner Bonding Scale	48.0 (6.50)	46.3 (6.16)	45.5 (6.71)	2, 143	8.40	0.0004
Frequency and column-wise percentage of subjects reporting marital crisis/threat of divorce in the three groups						
Have you experienced marital crisis or threat of divorce during the last year?						
No	469 (85%)	277 (84%)	27 (66%)	2, 143	5.00	0.008
Yes	81 (15%)	51 (16%)	14 (34%)			
Frequency and column-wise percentage of subjects being married or cohabiting in the three groups						
Marital status						
Married	457 (83%)	275 (84%)	28 (68%)	2, 143	4.36	0.01
Cohabiting	96 (17%)	52 (16%)	13 (32%)			

Values for the Partner Bonding Scale are means with standard deviation in brackets.