

Olfaction: the unexplored sense

Relationship to premature infants' feeding

- Olfaction and Breastfeeding
- Olfactory physiology and anatomy
- Investigations & clinical applications

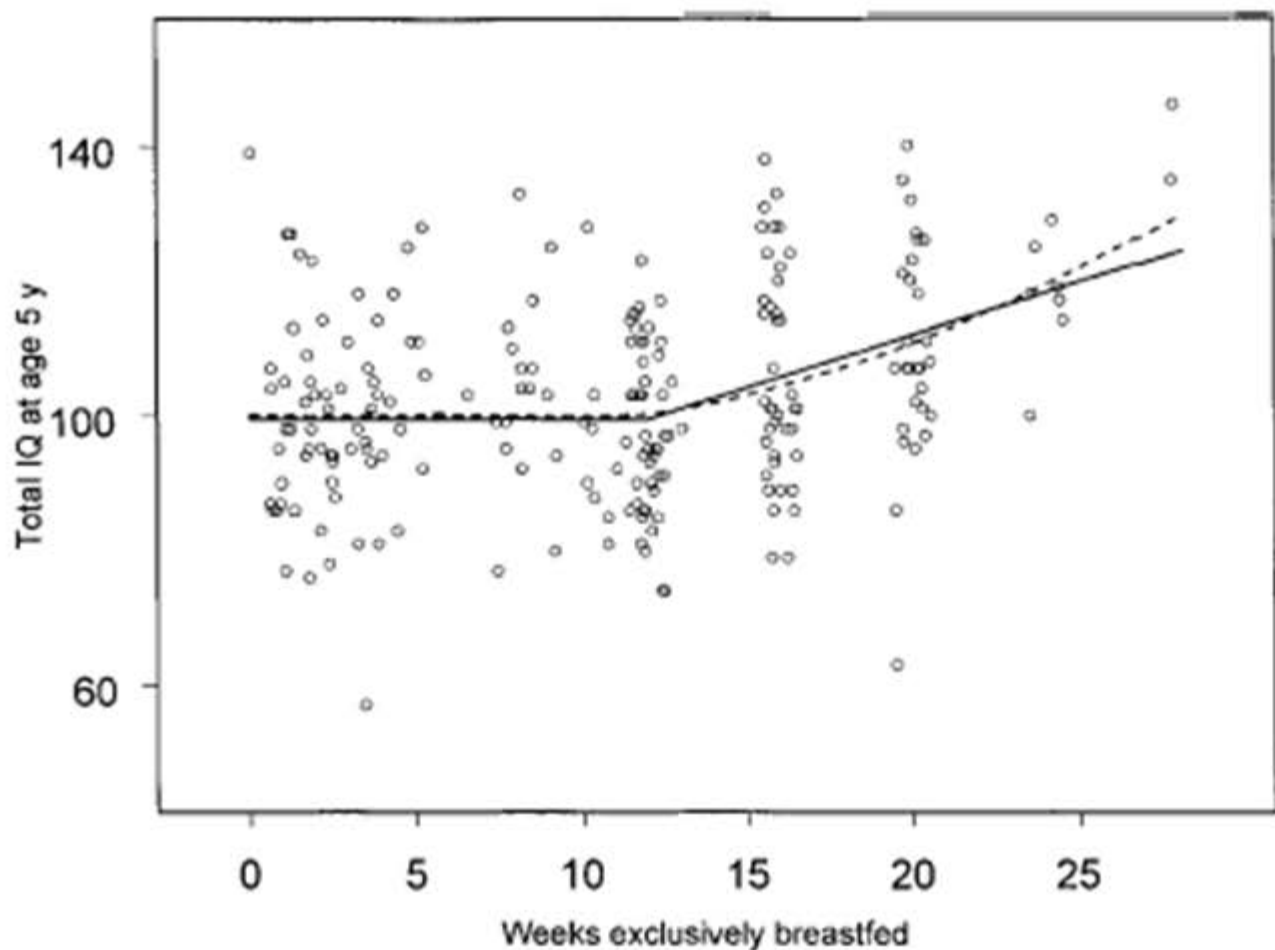


Varendi et al. 1994 Does the newborn baby find the nipple by smell? *Nature* 344, 989.

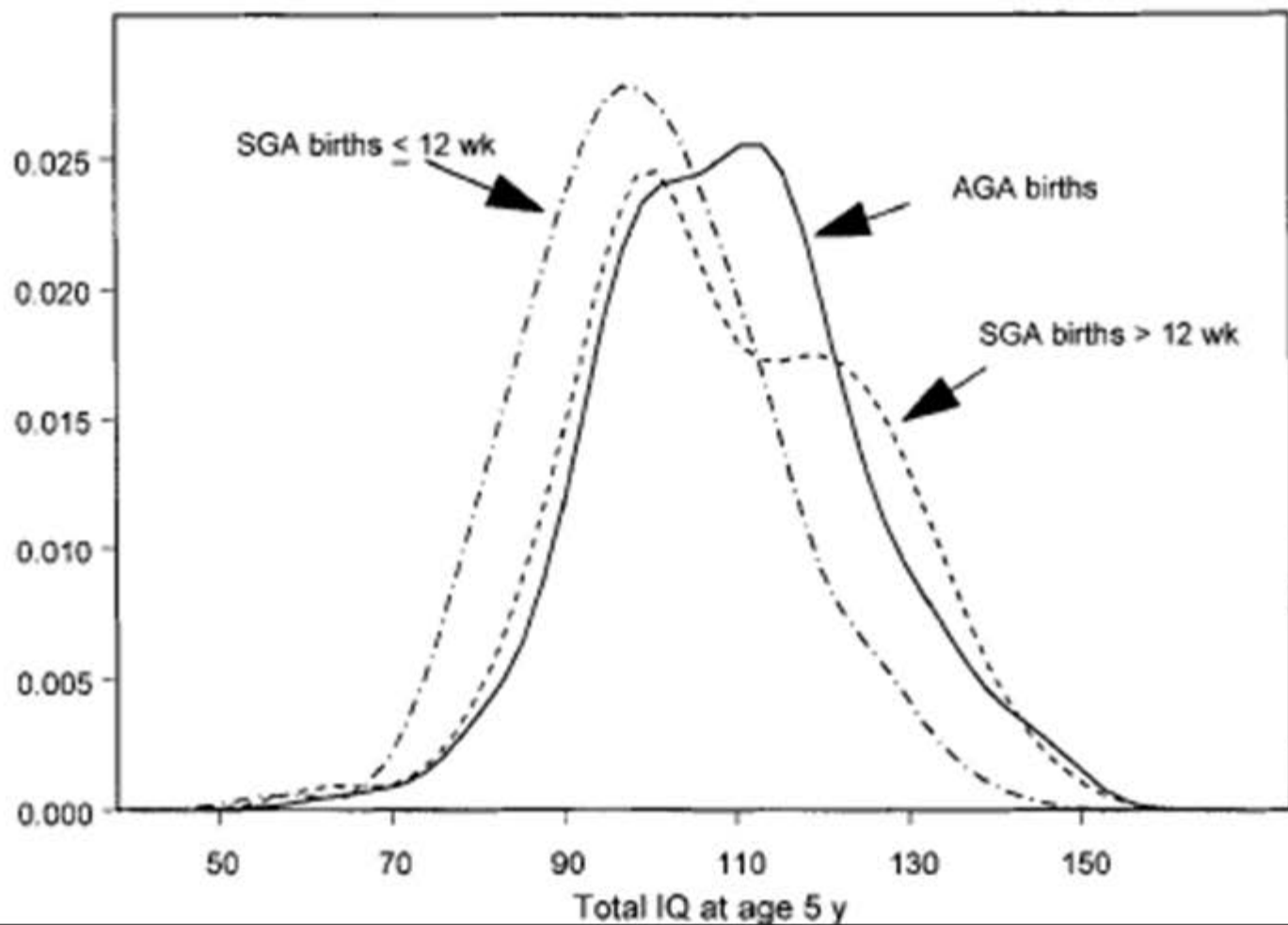
Premies' path to breastfeeding



UNDER CONSTRUCTION



“Effect of breastfeeding on cognitive development of infants born small for gestational age” Rao MR et al. *Acta Paediatr* 91: 267, 2002



“Effect of breastfeeding on cognitive development of infants born small for gestational age” Rao MR et al. *Acta Pediatr* 91:267, 2002

Breast Feeding Duration (≥ 46 weeks)

Univariate Logistic Regression

<u>Independent Variables</u>	Odds Ratio	95% CI	p
Visit class (High vs. low)	2.61	1.02, 6.68	0.05
Birthweight	1.01	0.93, 1.10	0.85
Gestational age at birth	0.96	0.83, 1.13	0.64
Growth/week	0.99	0.98, 1.00	0.08
Sex	0.80	0.32, 1.96	0.62
Multiple gestation	1.16	0.42, 3.23	0.78
Mom employed	1.75	0.68, 4.49	0.24
Mom age(>28,≤28)	5.29	1.95, 14.39	<0.01

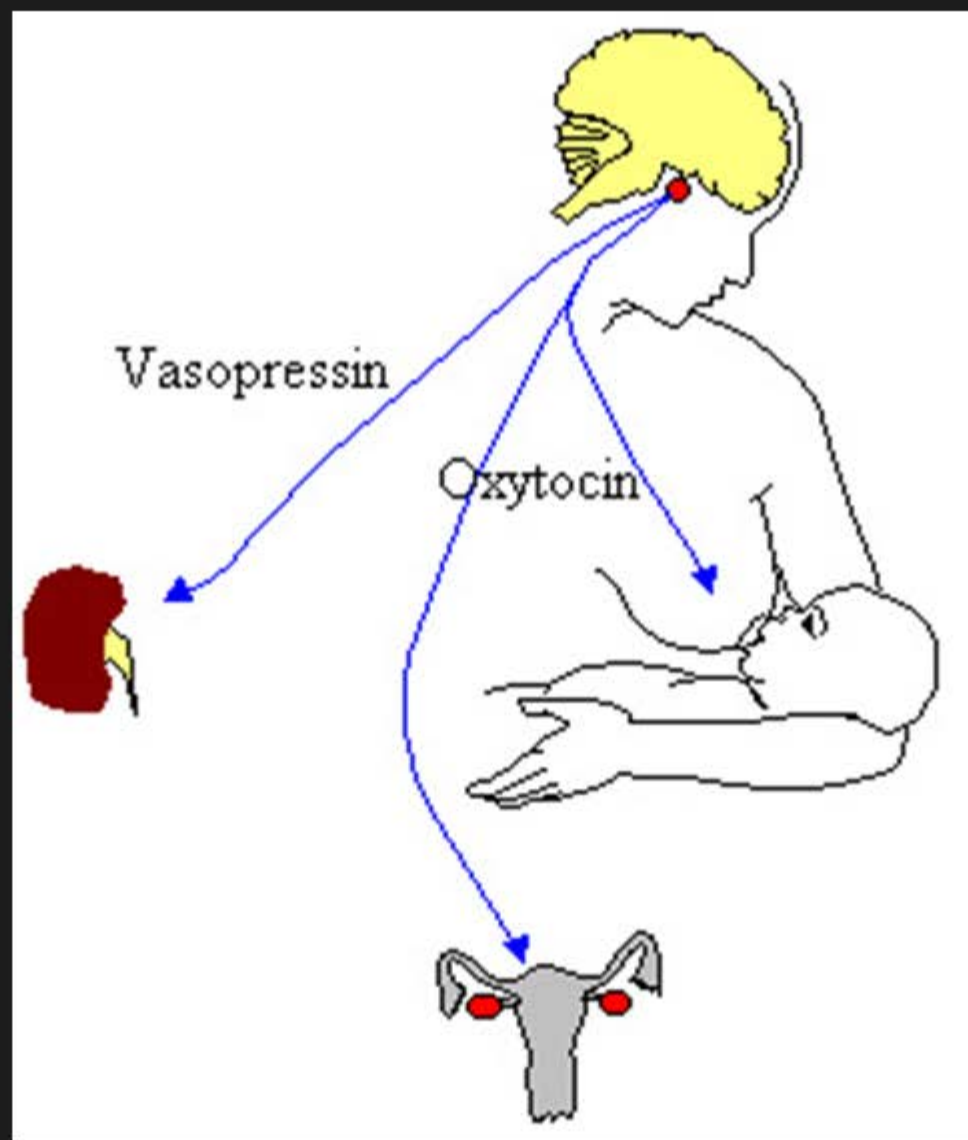
Risk Factors:

Prematurity

- Teenage mother
- Low socioeconomic level
- Low educational level
- Cigarette smoking

Not Breastfeeding

- Teenage mother
- Low socioeconomic level
- Low educational level
- Cigarette smoking

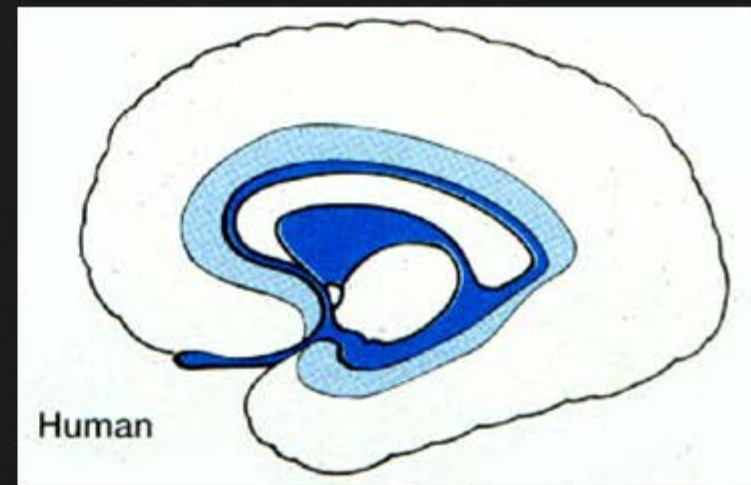
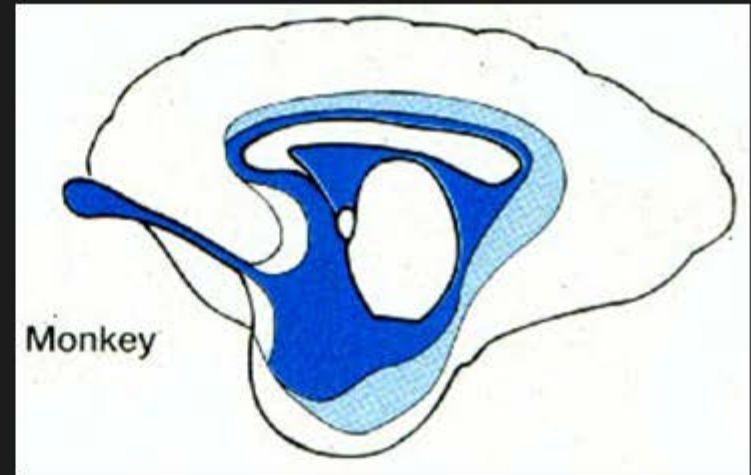
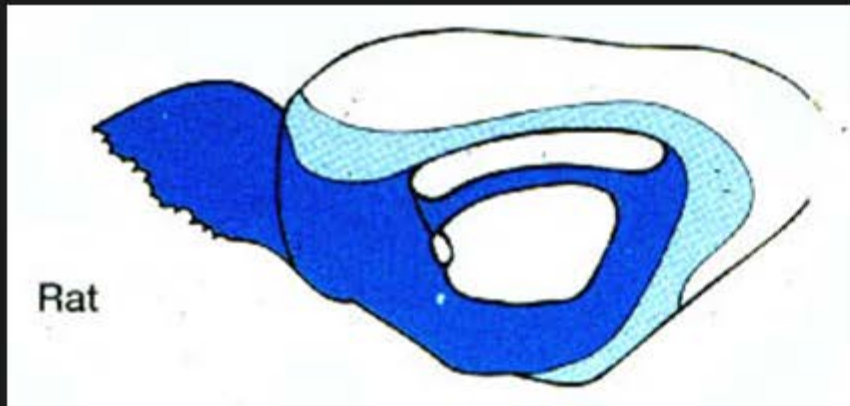


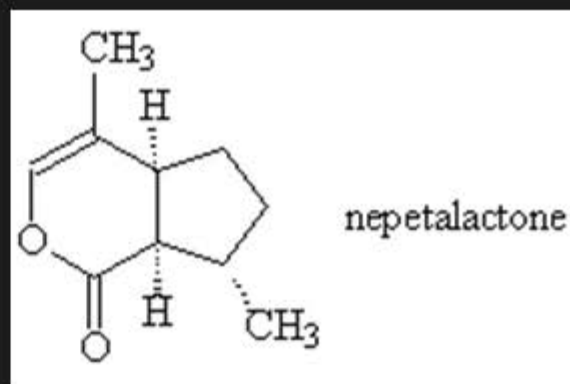
“Are you my mother?”





Humans, like other primates are “microsmatic” mammals





The fetus receives a prenatal ‘flavor’ education via amniotic fluid

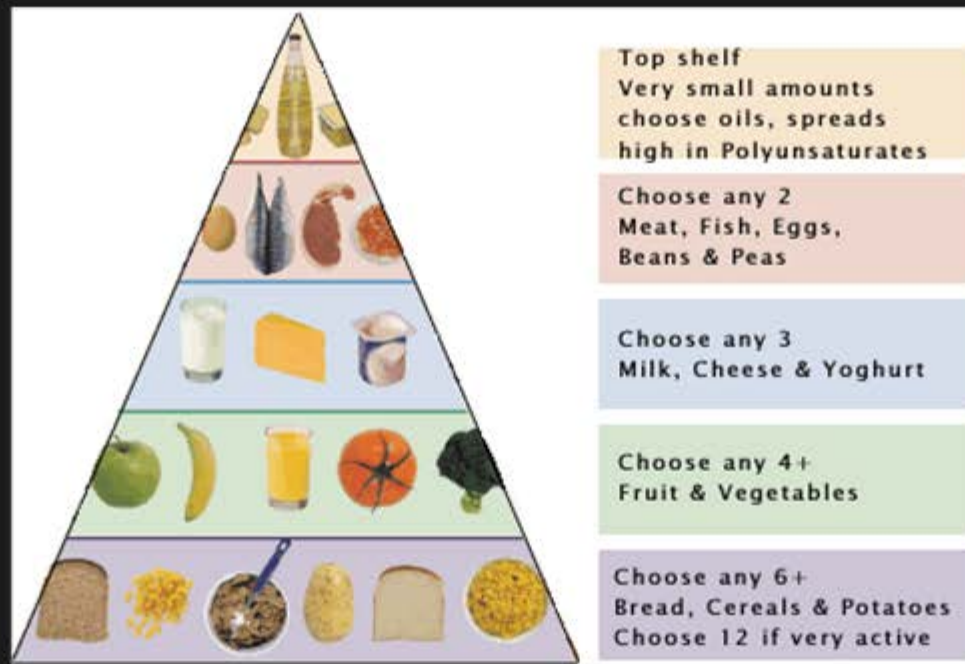


Varendi, H., Porter et al 1996. **Attractiveness of amniotic fluid odor: evidence of prenatal olfactory learning.** *Acta Paediatrica* 85, 1223-1227.

Conveying a chemical perception - facial expression

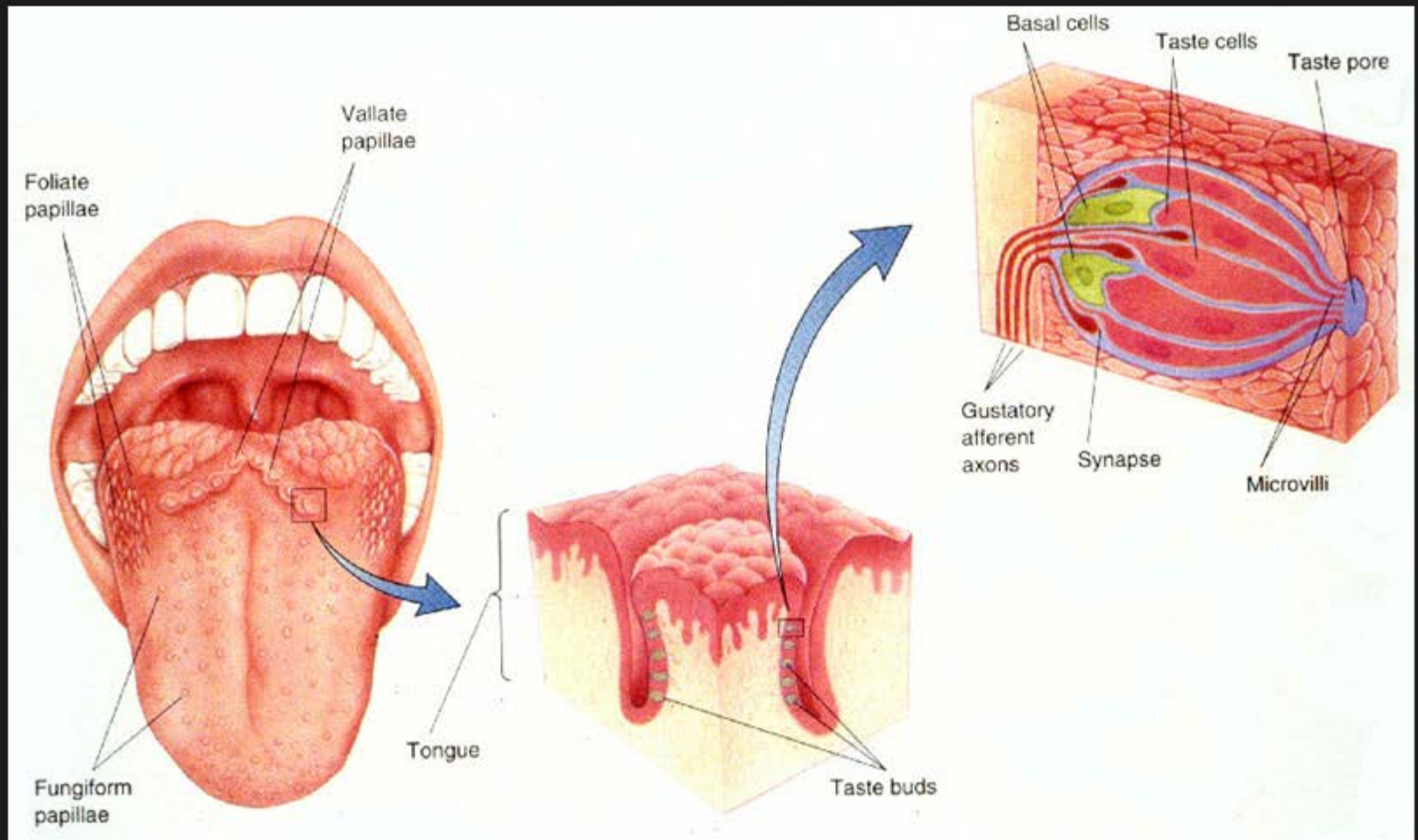


Accounting for taste ...

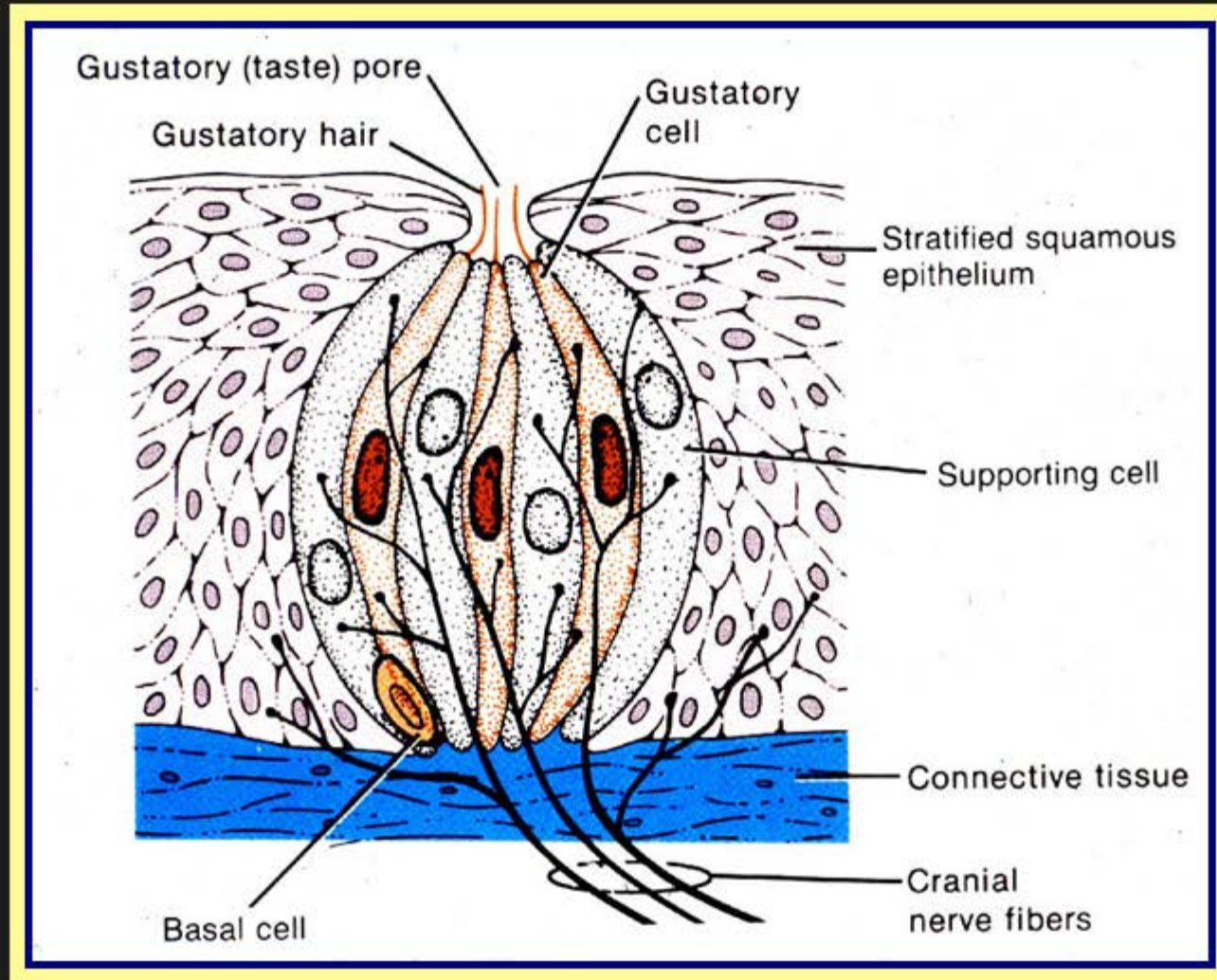


www.nehb.ie

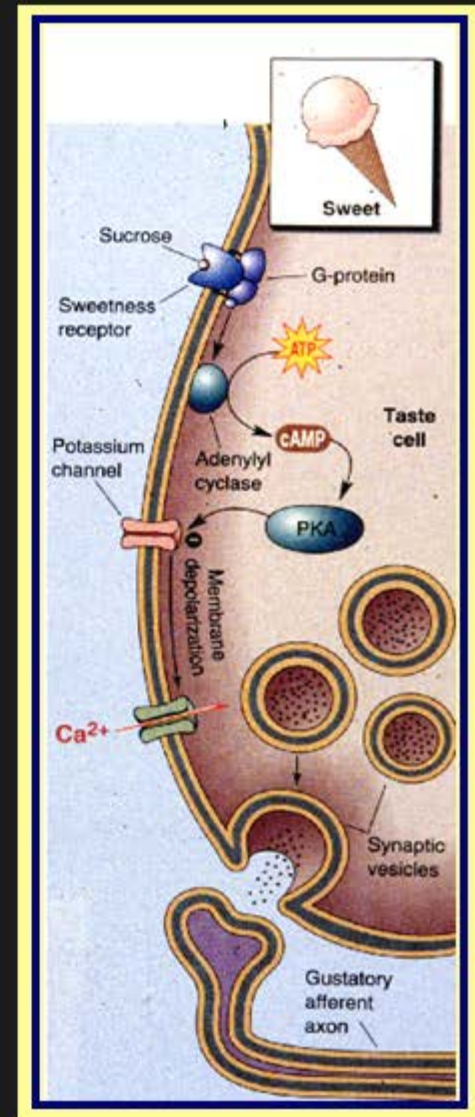
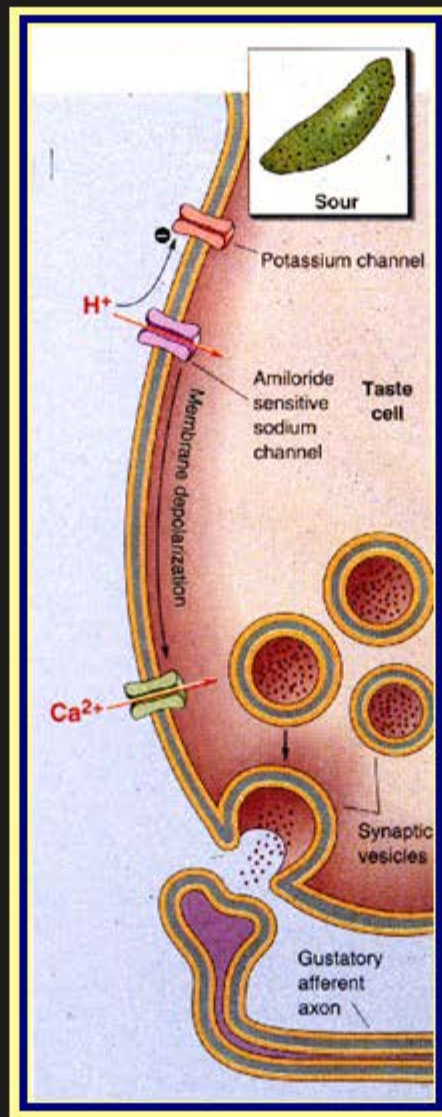
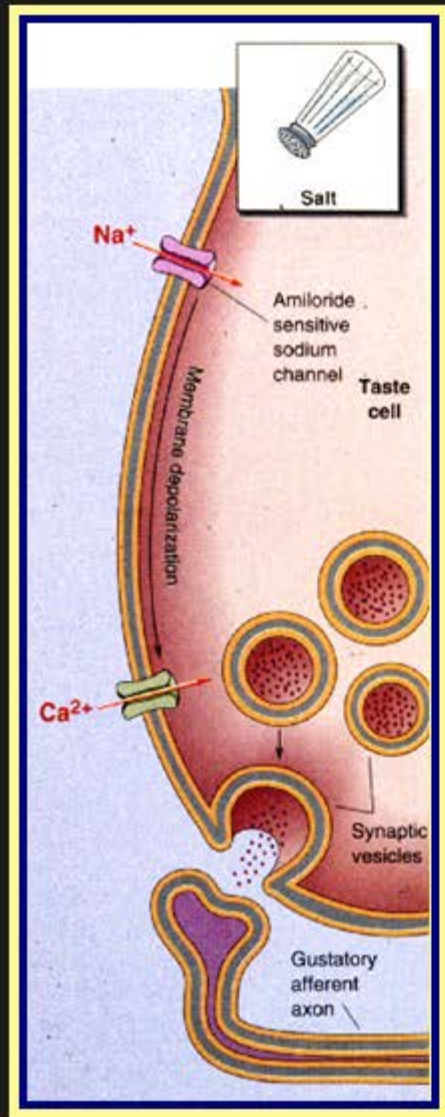
Olfaction vs. Gustation



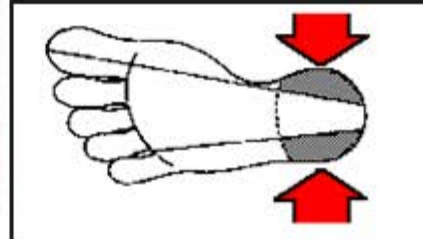
Gustatory cells specialized epithelial cells



Gustatory mechanism

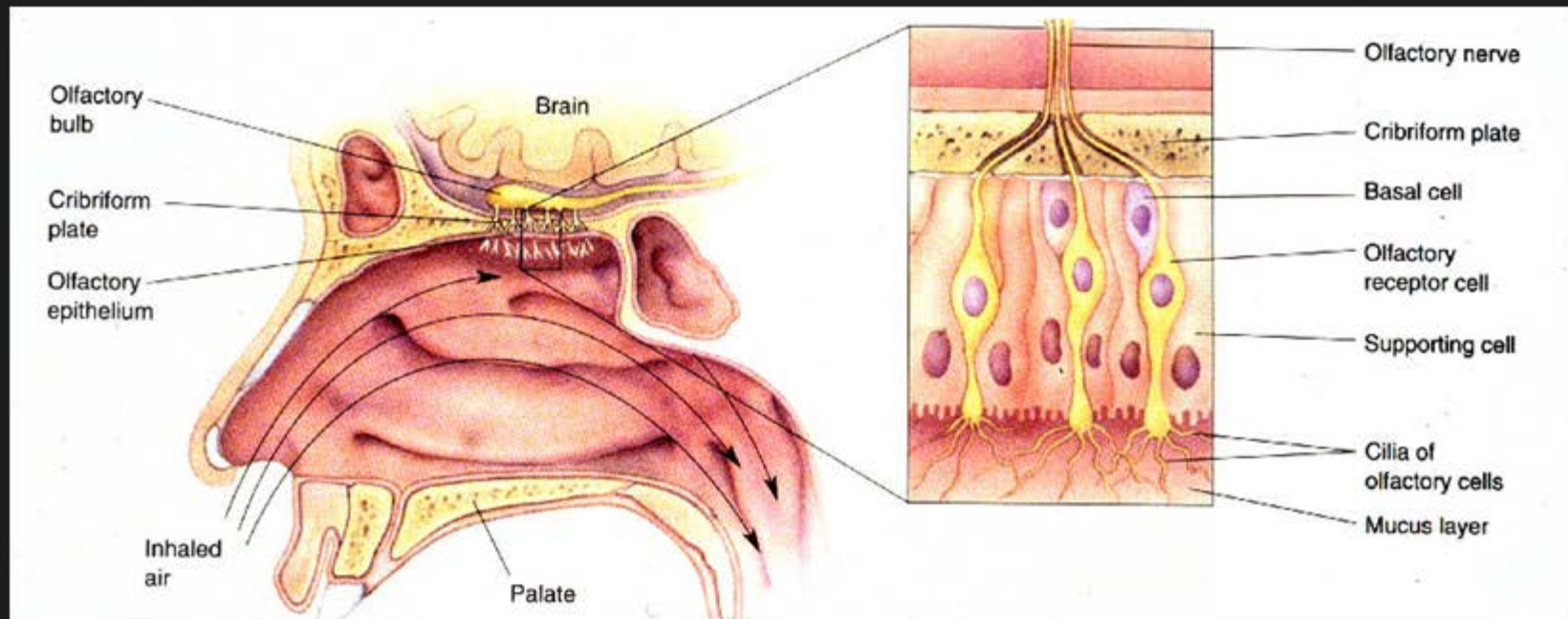


Sweet tastants have a clinically significant analgesic effect

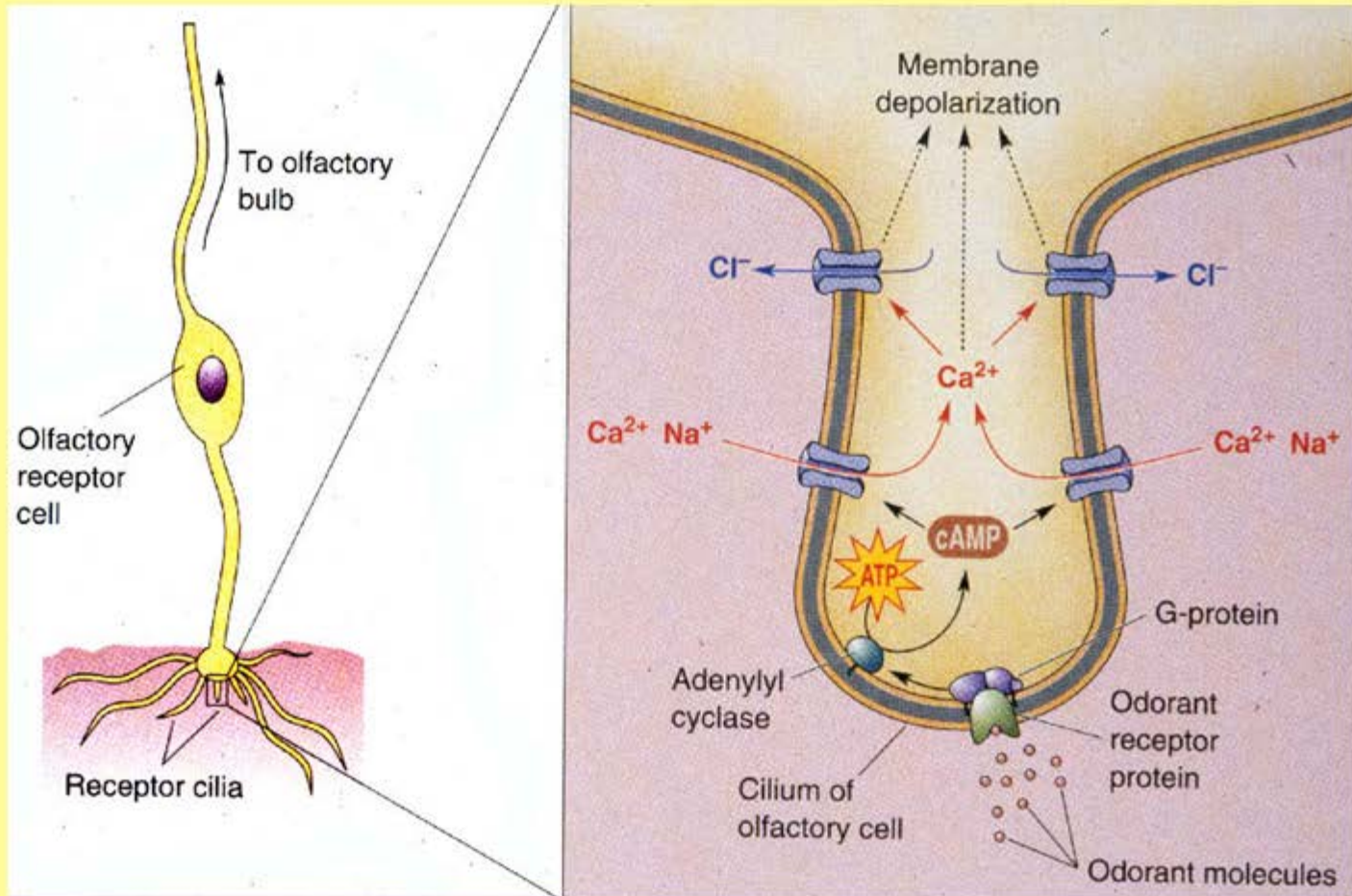


Olfaction – anatomy and physiology

Primary olfactory receptors are neurons that “report” directly to the brain

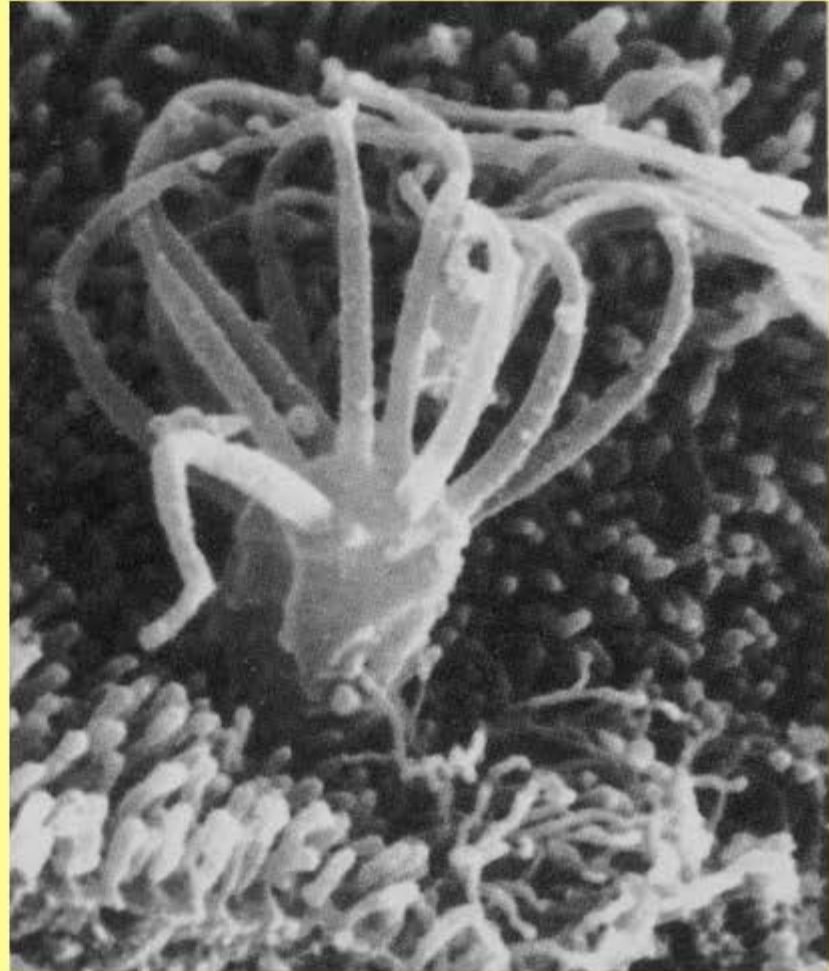


Olfactory Mechanism



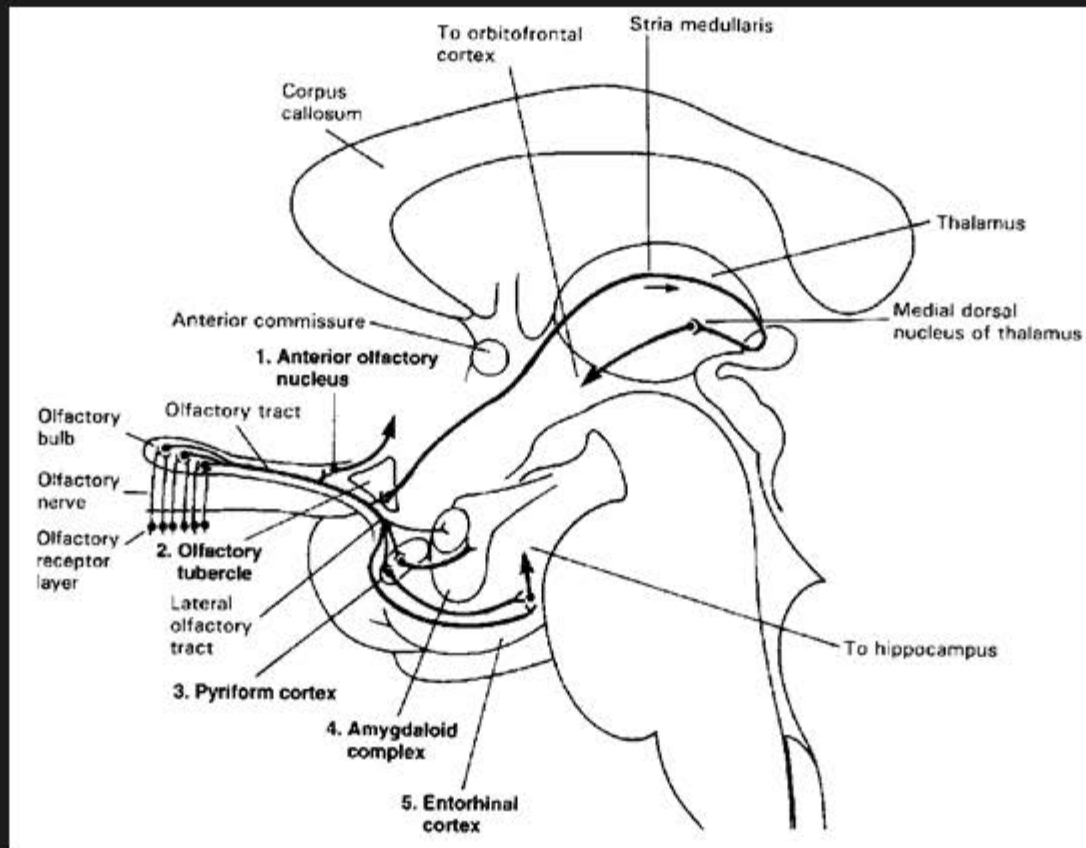
Olfactory Receptor-Ligand Interactions-

Shape or chemical resonance?

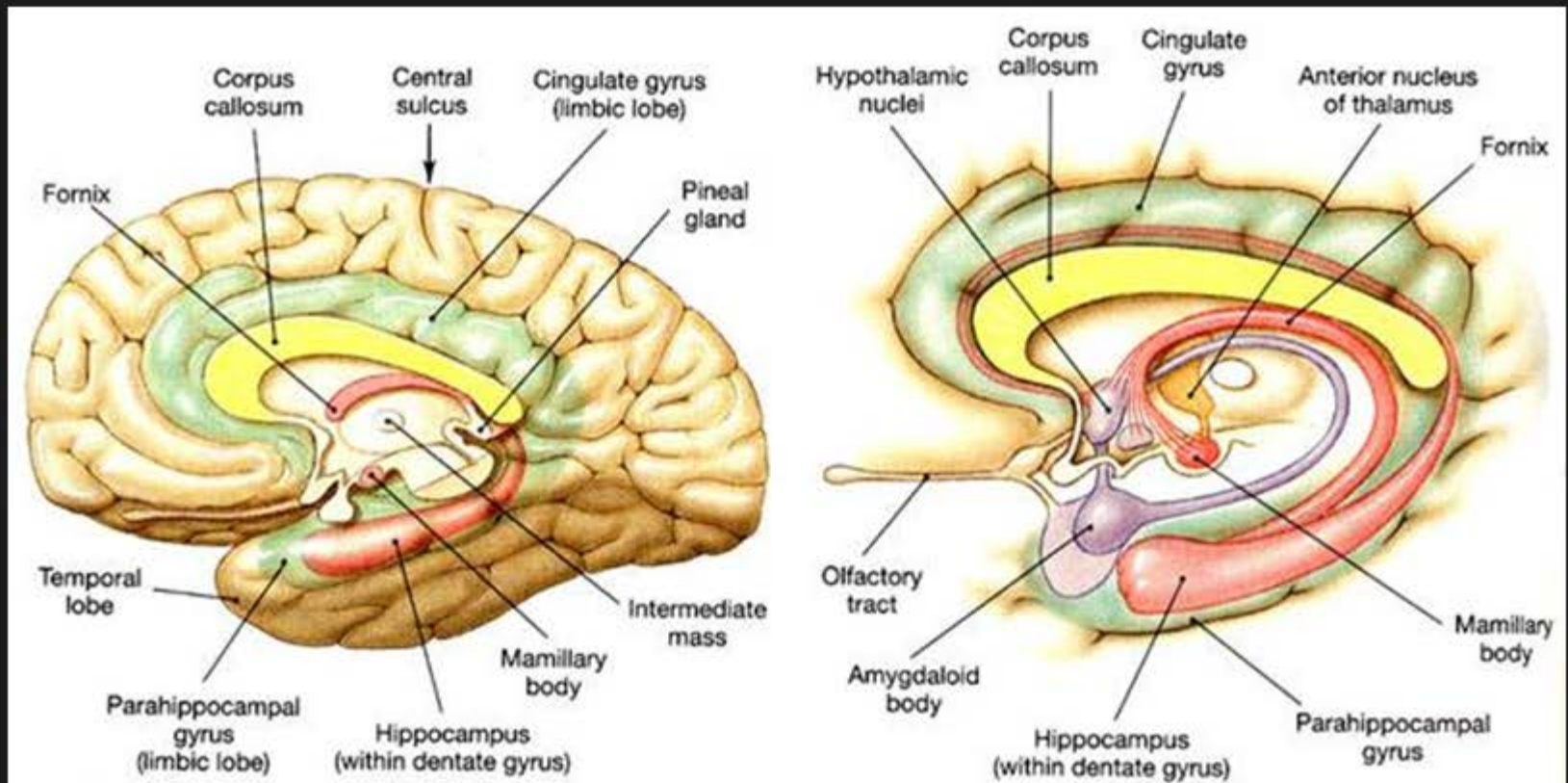


Olfactory Function ...

brain centers mediate social, cognitive, and appetitive responses to odor

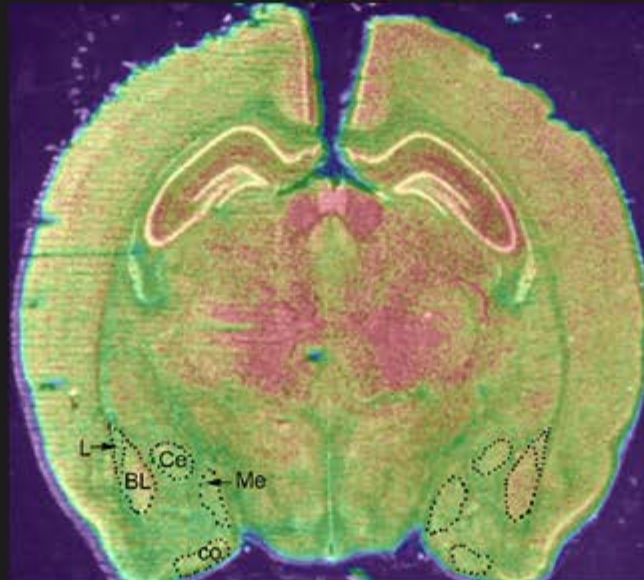


The Olfactory System projects directly into the Limbic System



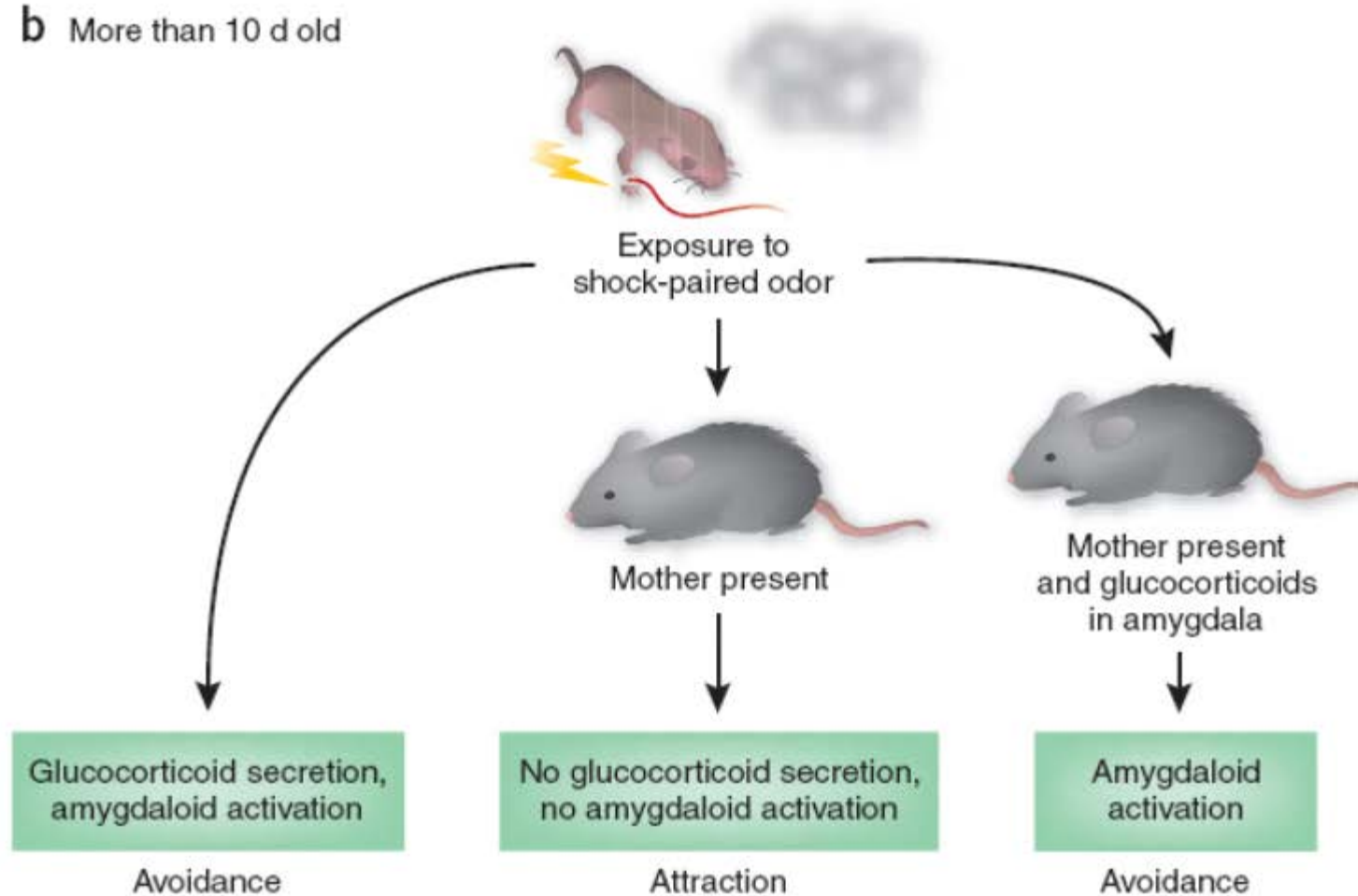
‘Abusive attachment’

- odor-mediated via amygdala
- birds, mammals, non-human primates ...

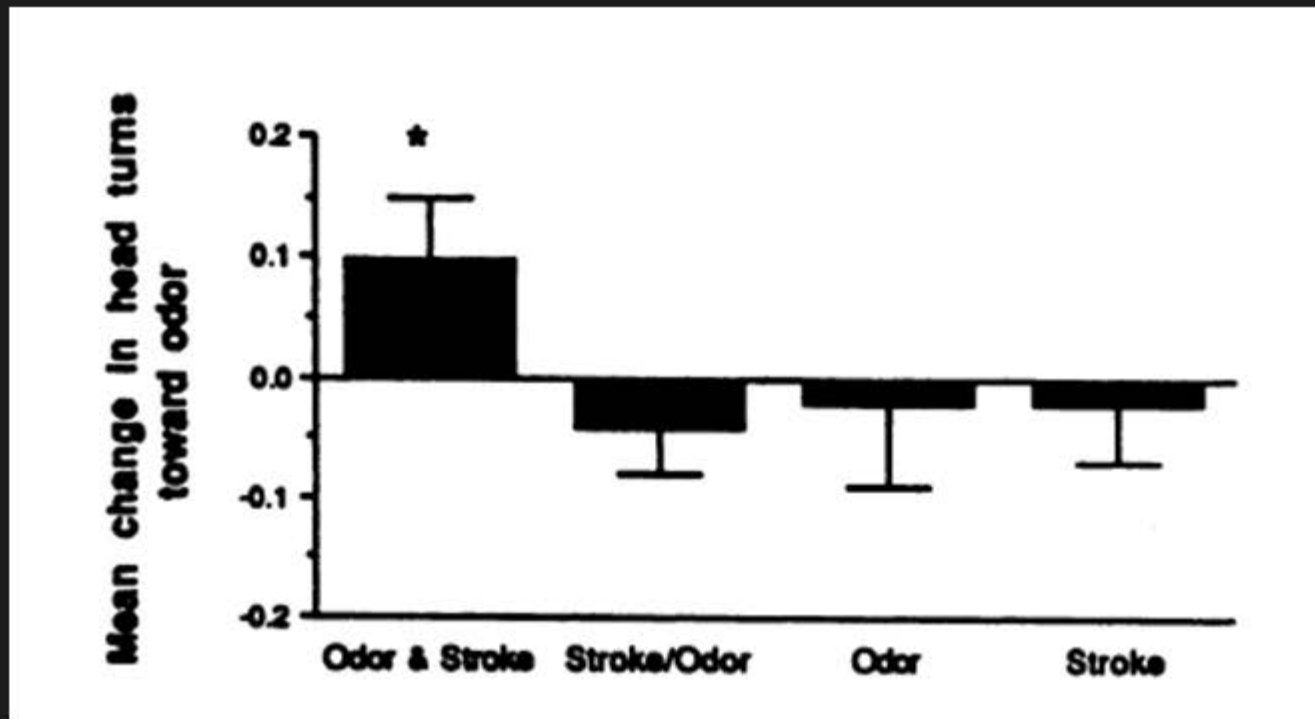


Maternal presence serves as a switch between learning fear and attraction in infancy *Nature Neuroscience* 9, 1004 (2006)

b More than 10 d old



Infants are subject to Olfactory Conditioning



Sullivan et al., Pediatrics 87:511, 1991

Odorants in breast milk affect later dietary preferences



Flavors Transmitted to Human Milk

- Garlic
- Ethanol
- Carrot
- Mint
- Vanilla
- Blue Cheese
- Cigarette

Odorants in pre-term infant formula

(via gas chromatograph olfactometry)

Odorant

- 2-methyl-3-furanthiol
- unknown
- acetic
- 1-octen-3-one
- methional
- furaneol
- 2,3 butanedione
- sotolon

Descriptor

- Cereal/grain
- Sweet/milky
- Sweaty/milky
- Mushroom
- Meaty/sweet
- Carmelized
- Buttery
- carmelized

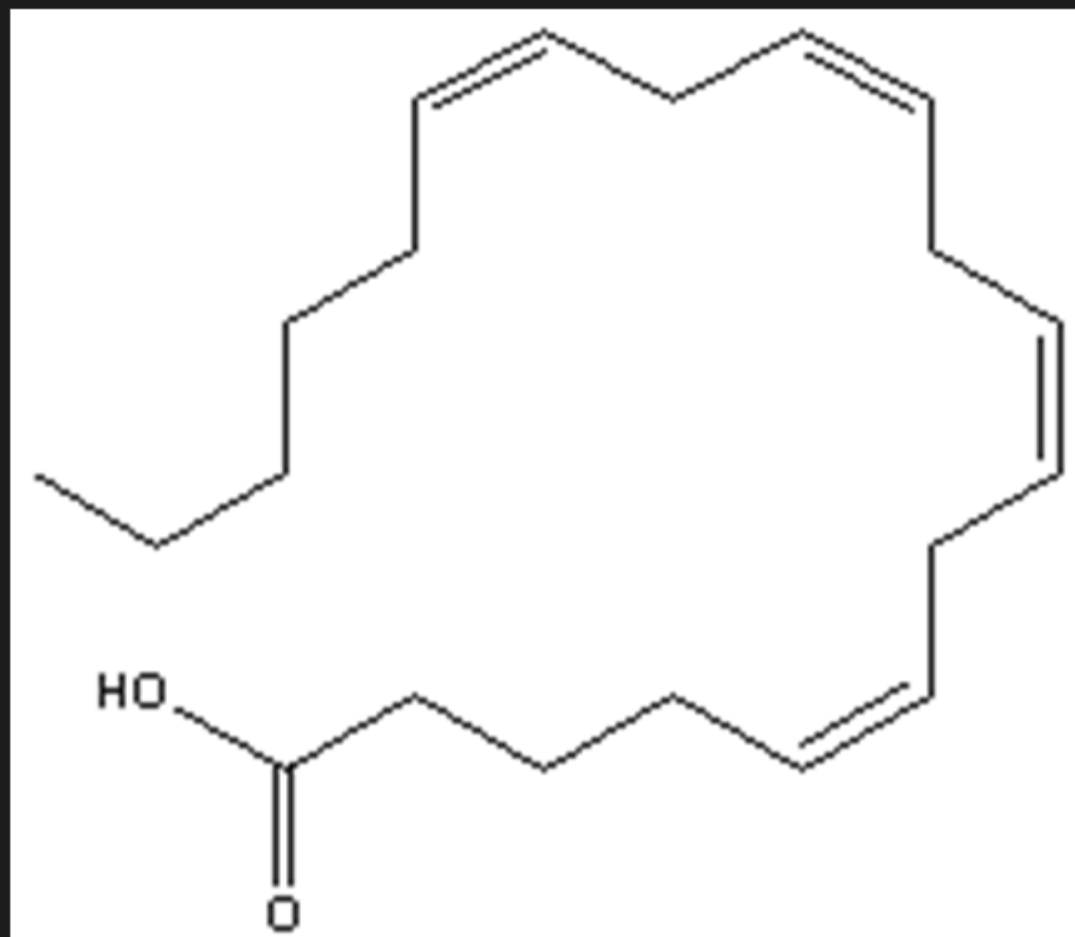
Odorants in pre-term breast milk

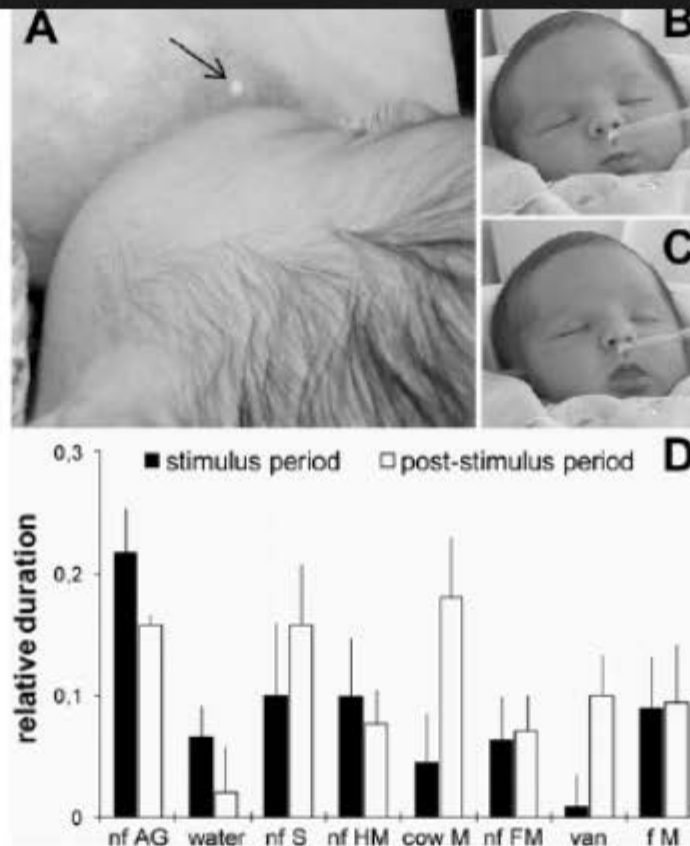
Odorant

- E-2-nonenal
- Octen-3-one
- furaneol
- maltol
- 2-nonanone

Descriptor

- Green
- Mushroom
- Carmelized
- Carmelized
- milky

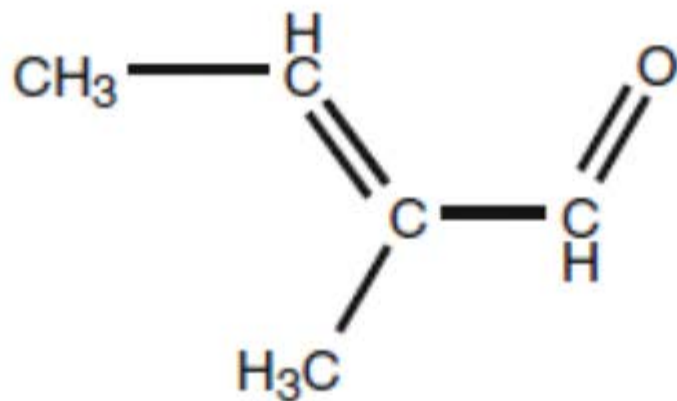


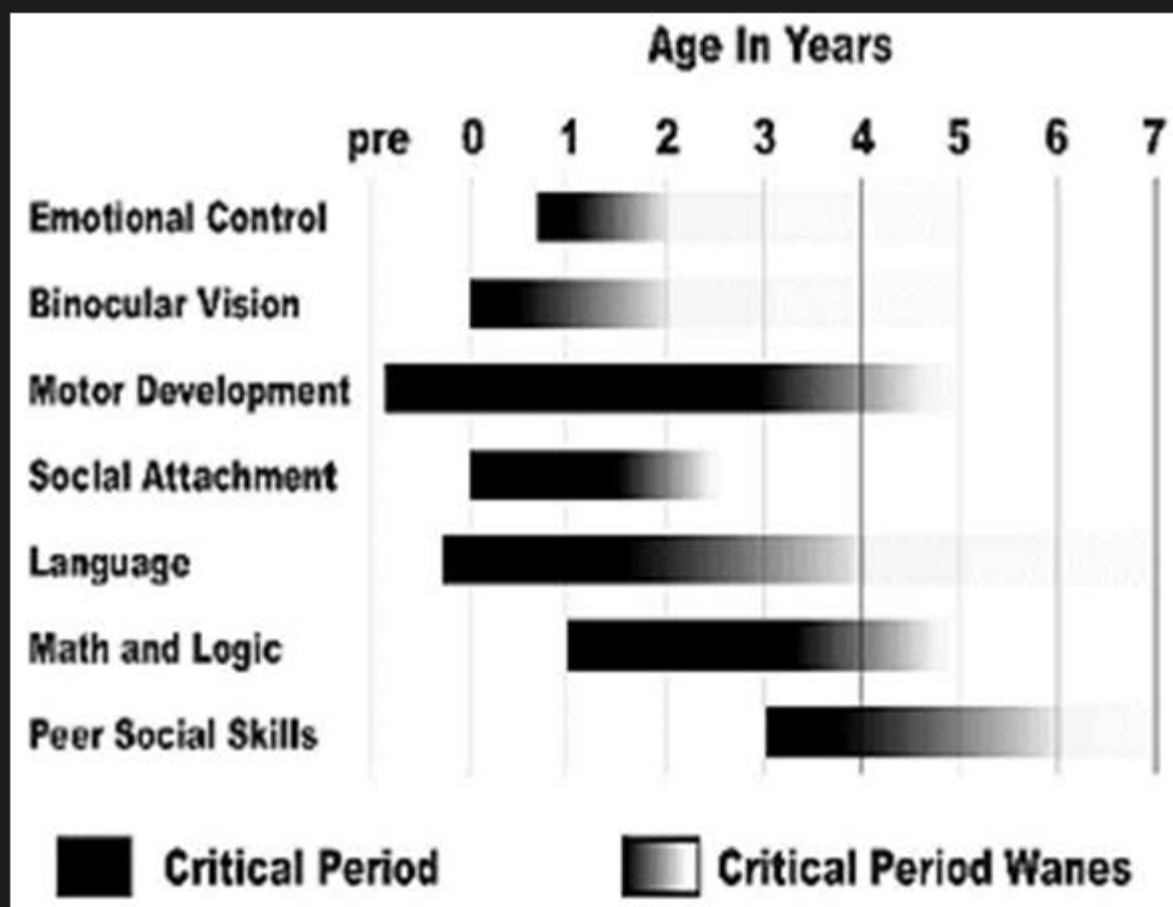


The Secretion of Areolar (Montgomery's) Glands from Lactating Women Elicits Selective, Unconditional Responses in Neonates

Sébastien Doucet^{1,2,3}, Robert Soussignan^{1,2,3}, Paul Sagot⁴, Benoist Schaal^{1,2,3*}

Rabbit Mammary Pheromone:



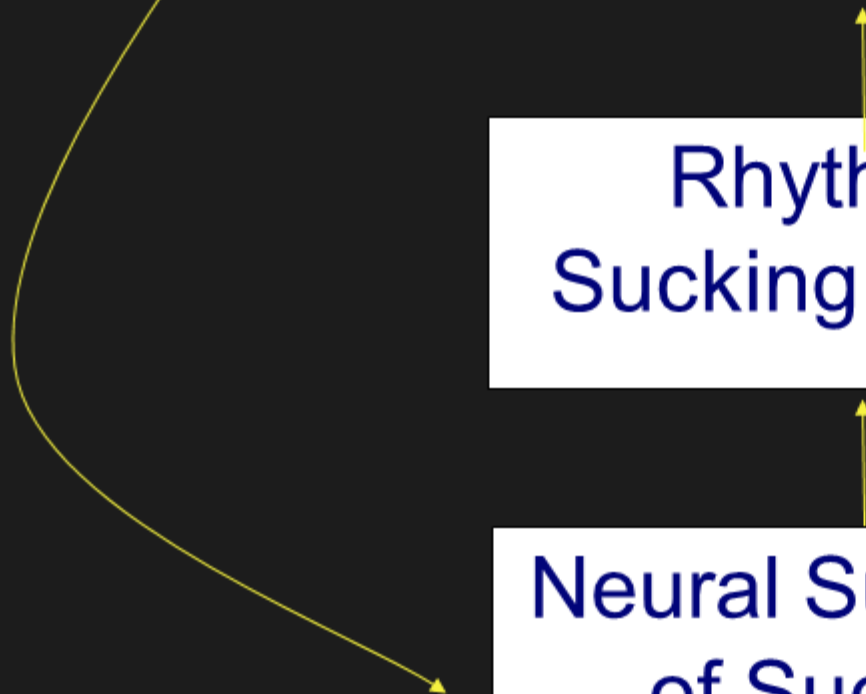


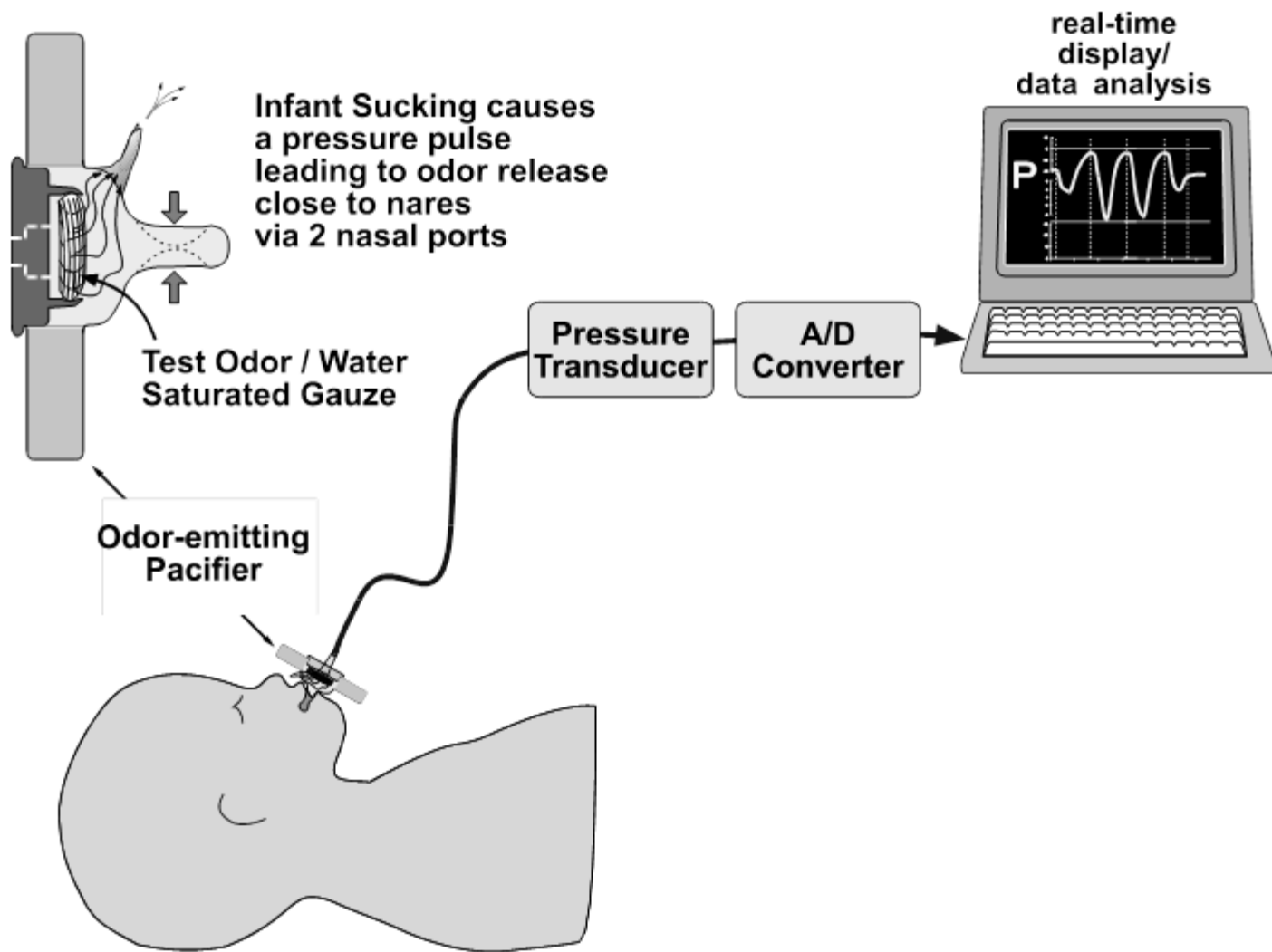


Ingestive Sensory Signalling
(olfactory, tactile,
proprioceptive, gustatory)

Rhythmic
Sucking Activity

Neural Substrate
of Sucking
Activity





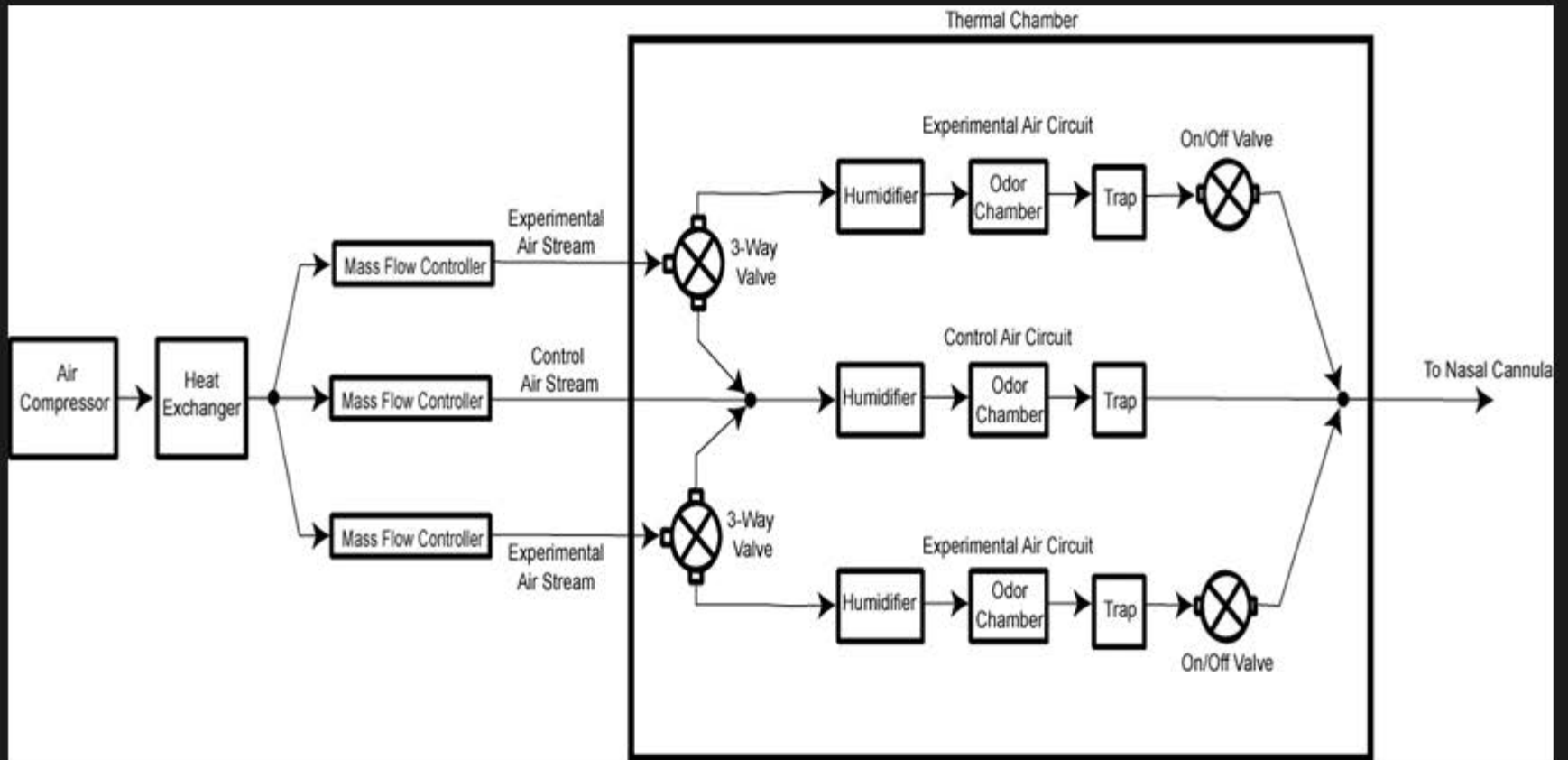


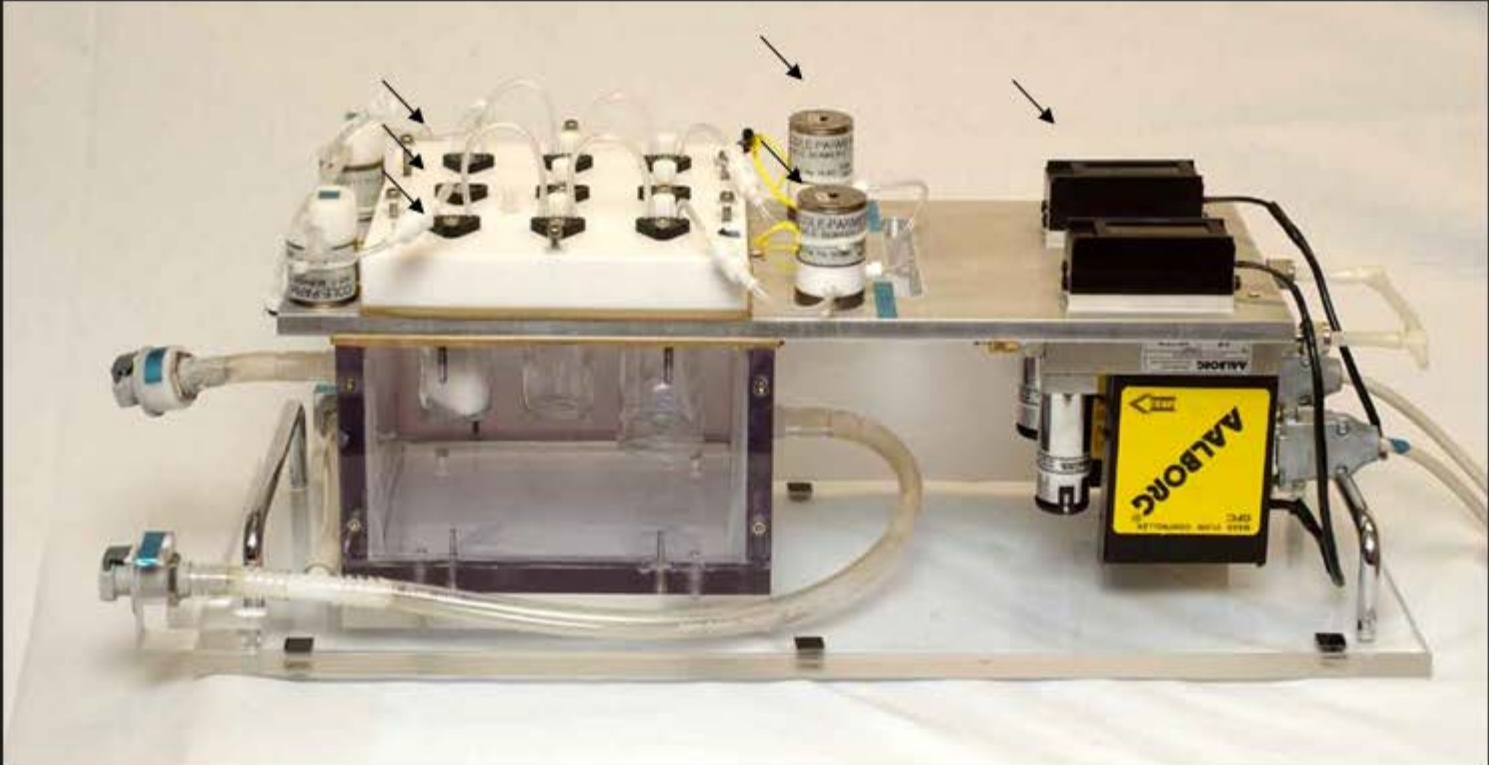
Pilot Study of Odor-facilitated NNS

	With odor	Without odor
<u>BMF (n=14)</u>		
Mean number of sucks	290.9±120.8	229.9±157.5
Mean number of bursts	46.6±13.3*	35.4±13.0**
<u>F (n=15)</u>		
Mean number of sucks	152.4±160.4	137.3±154.1
Mean number of bursts	27.7±18.1	27.2±16.9

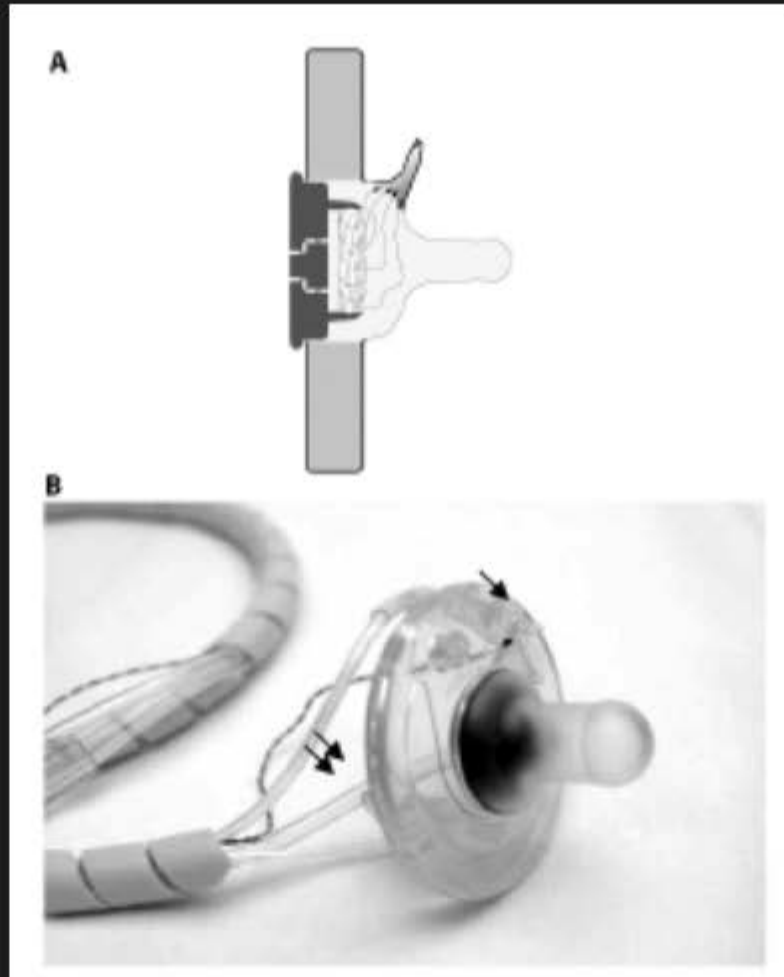
*95% C.I.= 39 - 54; vs. **28 - 43

Infant Olfactometer

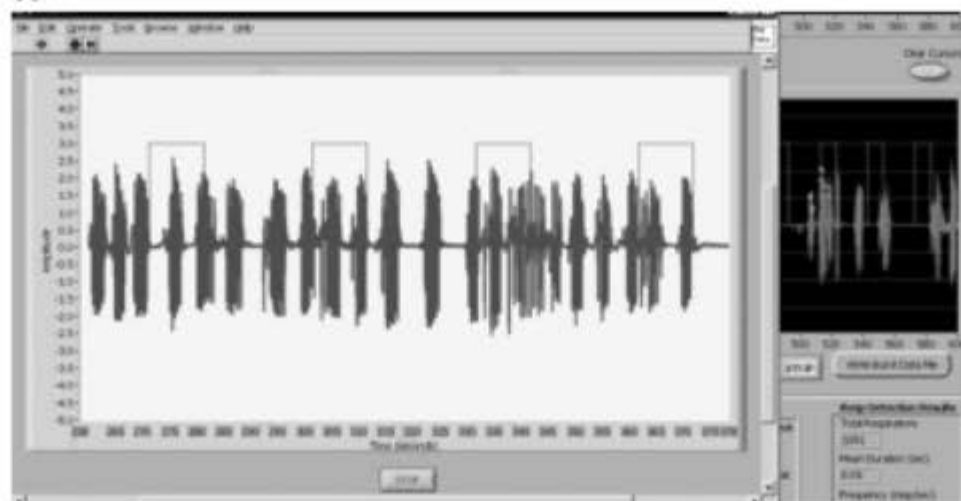




Osmophore Pacifier*



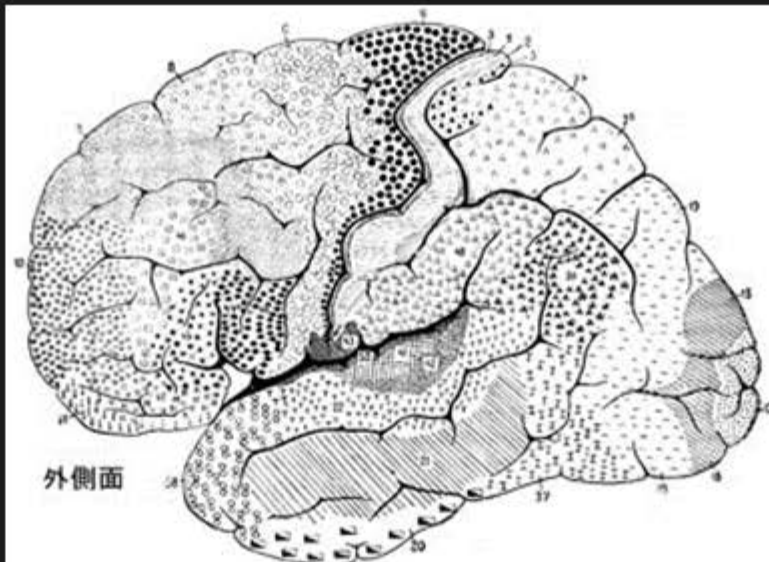
(Disclosure: US Patent #6,482,225 Peter Bingham/Emidio Sivierii)

A**B**

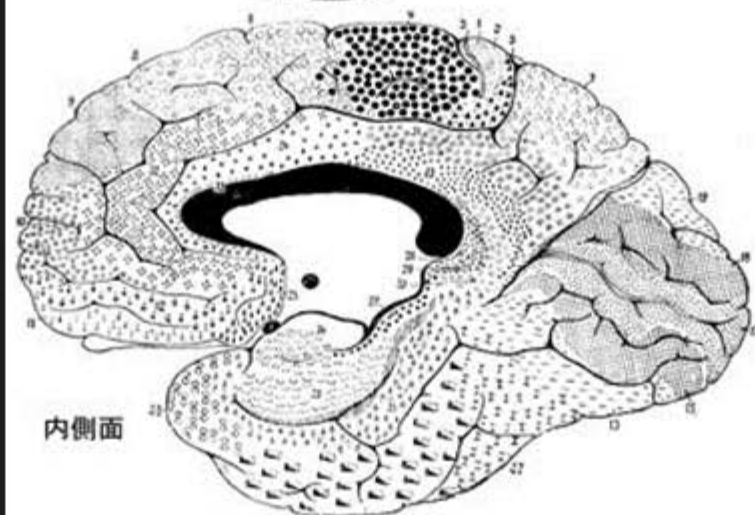


	Sucks (No Odor)	Sucks (Odor)	Bursts (No Odor)	Bursts (Odor)
Minimum	84.0	134.0	20.0	27.0
Maximum	391.0	434.0	61.0	60.0
Range	307.0	300.0	41.0	33.0
Median	238.5	282.0	37.5	44.5
Mean	250.2*	286.8*	40.3	44.7
95% CI Upper	365.9	388.5	57.7	59.3
95% CI Lower	134.5	185.1	23.0	30.1

*two-tailed, $p = .05$.



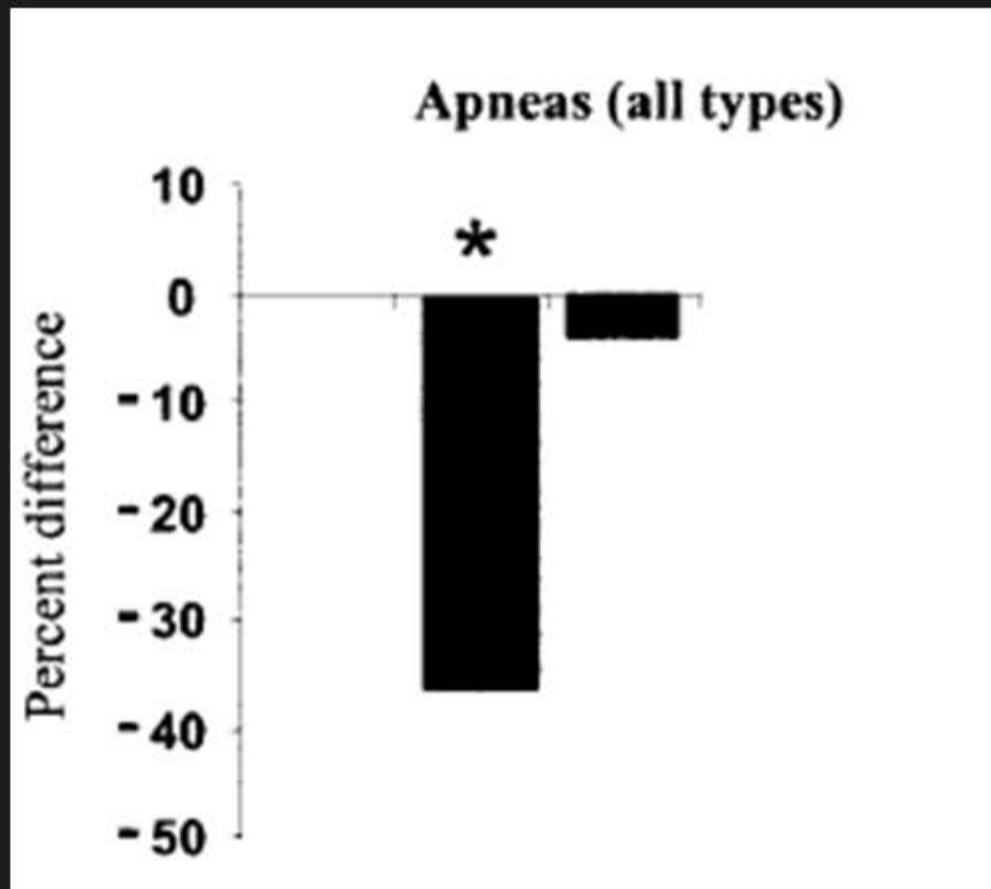
外側面



内側面

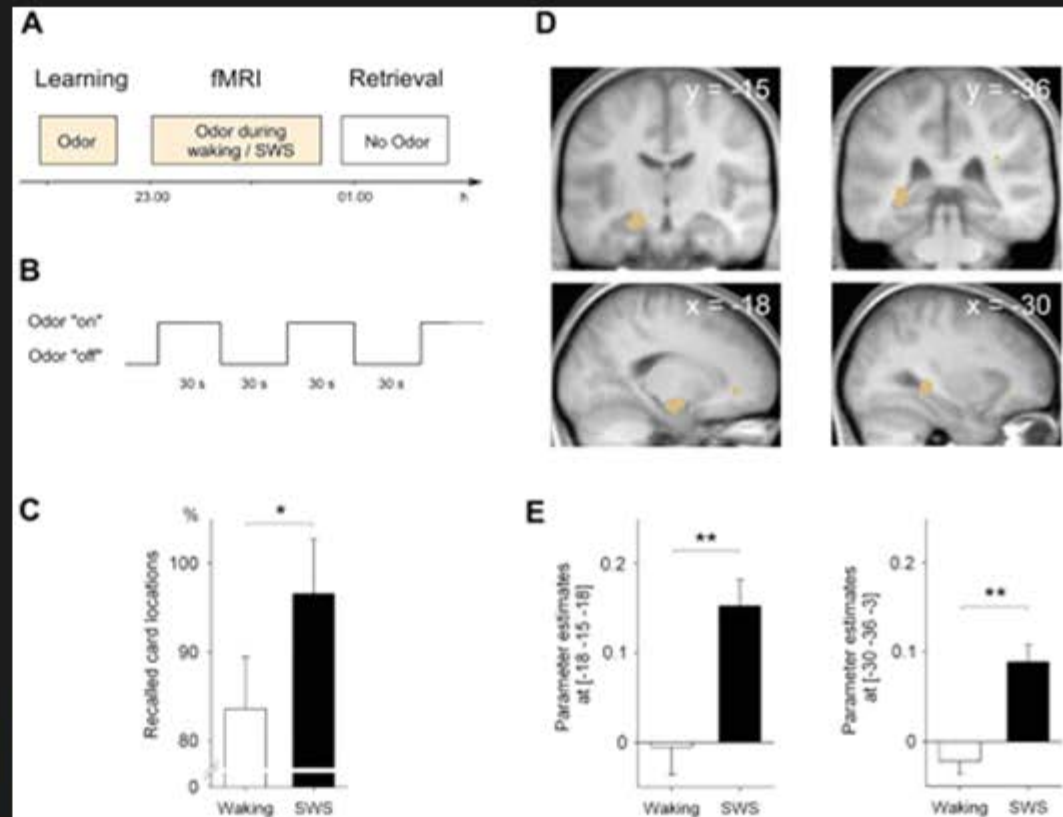
Brodmanの大腦皮質野

Vanillin odor decreases apnea in premature infants



Marlier et al., Pediatrics 2005;115:83

Odor exposure during sleep enhances learning



Science 2007 Vol. 315. pp. 1426

Infant Olfaction

- Unique neuroanatomic connections
- Orientation to energy
- Stimulation of feeding responses
- Links social recognition with feeding
- Respiratory regulation
- A “learning channel”

Questions?
(Peter.Bingham@uvm.edu)

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<http://www.youtube.com/watch?v=1KHLUD0wyrY>