

Beyond hunger:

Reward mechanisms implicated in
food intake and in obesity



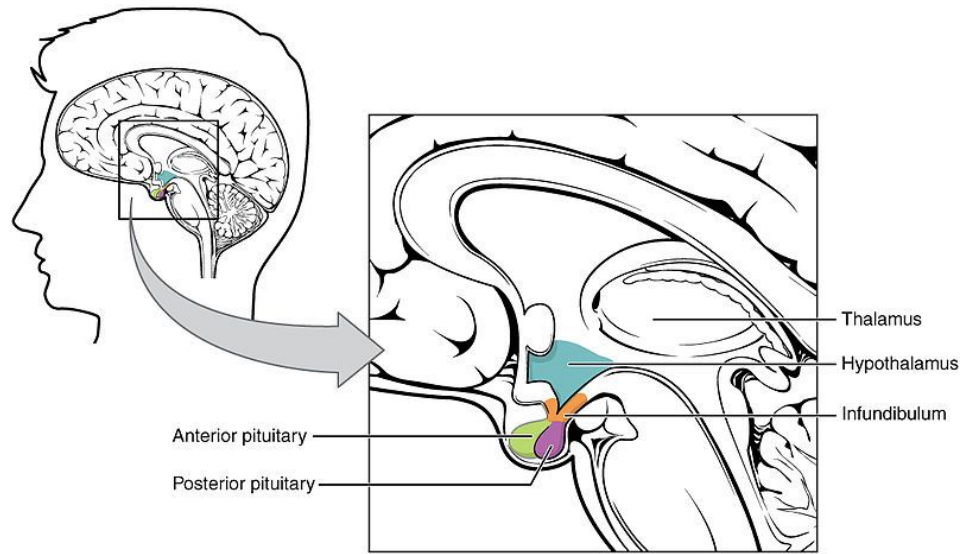


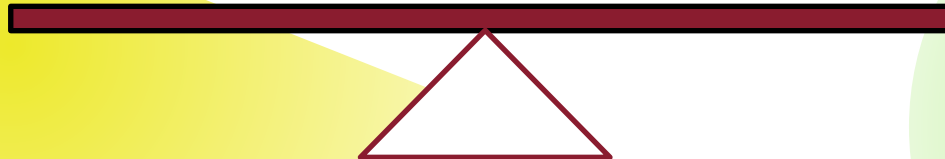
Image: Wikimedia Commons

HYPOTHALAMUS: Central in appetite regulation

ENERGY
EXPENDITURE



ENERGY
INTAKE



ENERGY
EXPENDITURE



ENERGY
INTAKE



□ ghrelin
□ insulin

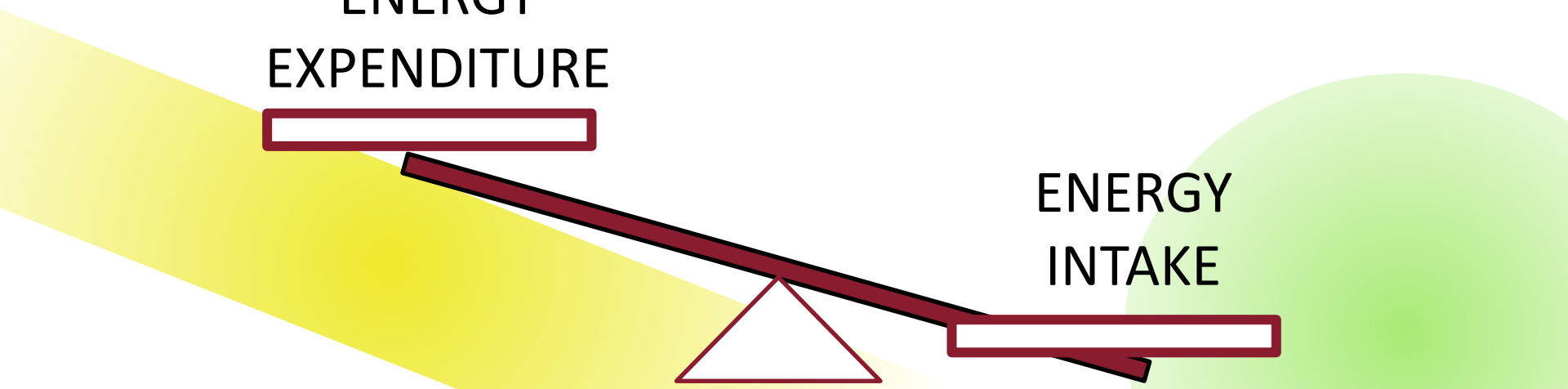
□ Y neuropeptide and
agouti-related peptide

Lateral hypothalamus
stimulation
Ventromedial hypothalamus
inhibition

ENERGY
EXPENDITURE



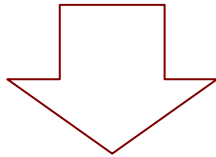
ENERGY
INTAKE



□ insulin, leptin and YY
neuropeptide

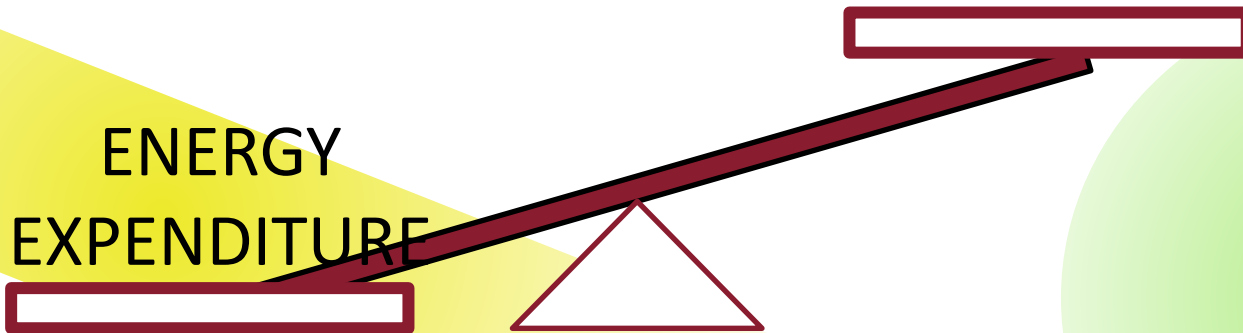
□ proopiomelanocortin and
cocaine-amphetamine
regulated transcriptor

Ventromedial hypothalamus
stimulation
Lateral hypothalamus
inhibition



ENERGY
EXPENDITURE

ENERGY
INTAKE



Excessive accumulation of lipids in several tissues and organs

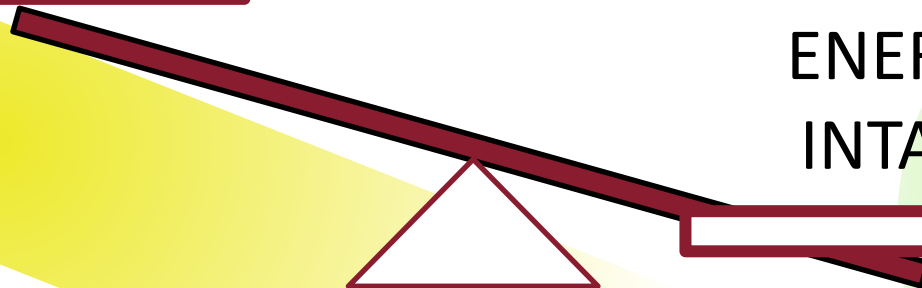
Adverse cellular responses

Increased risk for metabolic and cardiovascular diseases
Brain tissue vulnerability

ENERGY
EXPENDITURE



ENERGY
INTAKE



Beyond homeostasis: hunger feelings

Habits

Boredom

Stress

Hormone changes

Social pressure

Hedonic hunger

Beyond homeostasis: hunger feelings

Habits

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Hedonic hunger

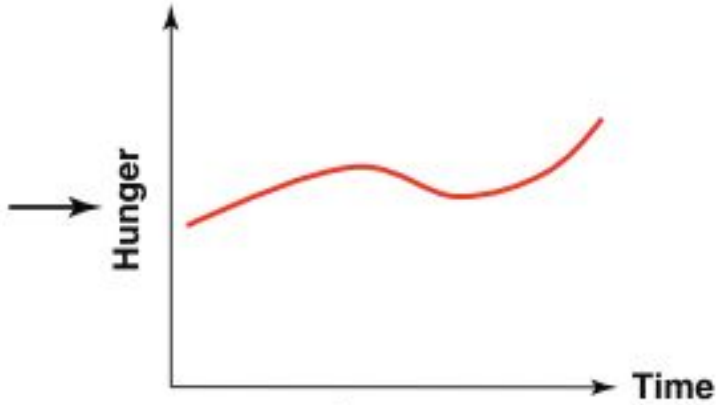


Hunger as a reinforcing behavior

- **Eating behavior:** reverse of „unpleasant“ hunger signals
 - Linked with **hedonic** and **reward** mechanisms
- 

Neuroimaging studies of appetite

- Time since last meal
- Energy balance (e.g. leptin, glucose)
- Gut peptides (e.g. insulin, ghrelin)
- Stress (acute, chronic)
- Cognitive factors (e.g. self-control)
- Personality / eating style



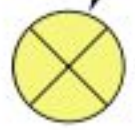
Stimuli



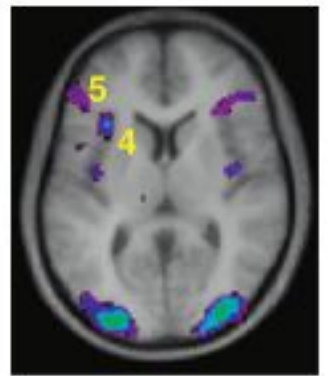
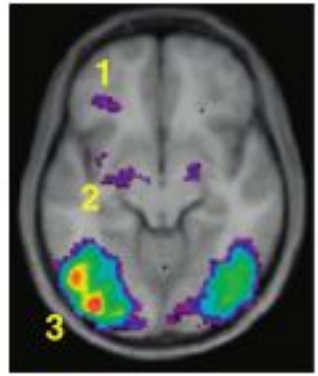
+



Time



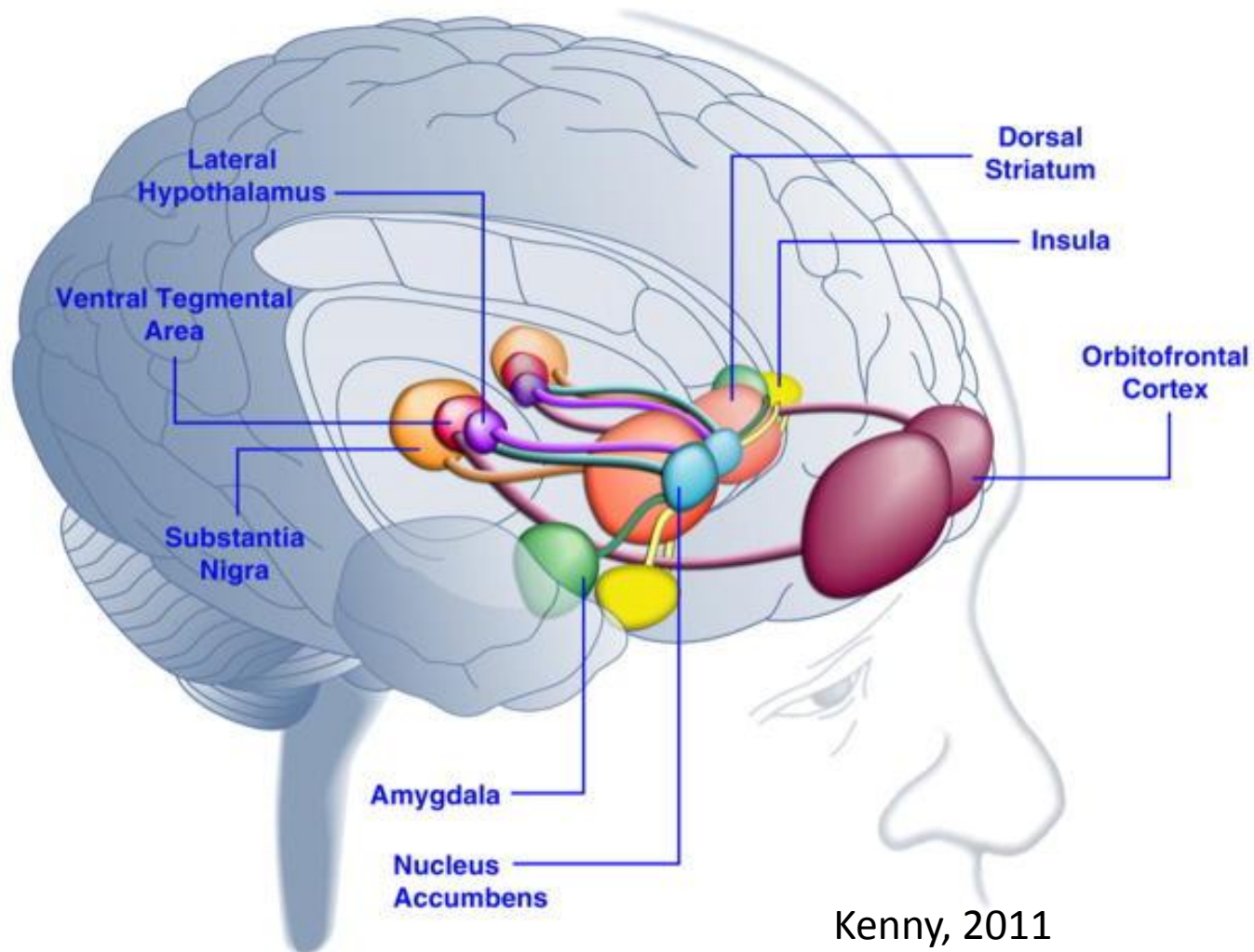
fMRI activation
("Incentive salience")



Dagher, 2012

The “appetitive” network in the brain

Reward system: mesocorticolimbic dopaminergic regions

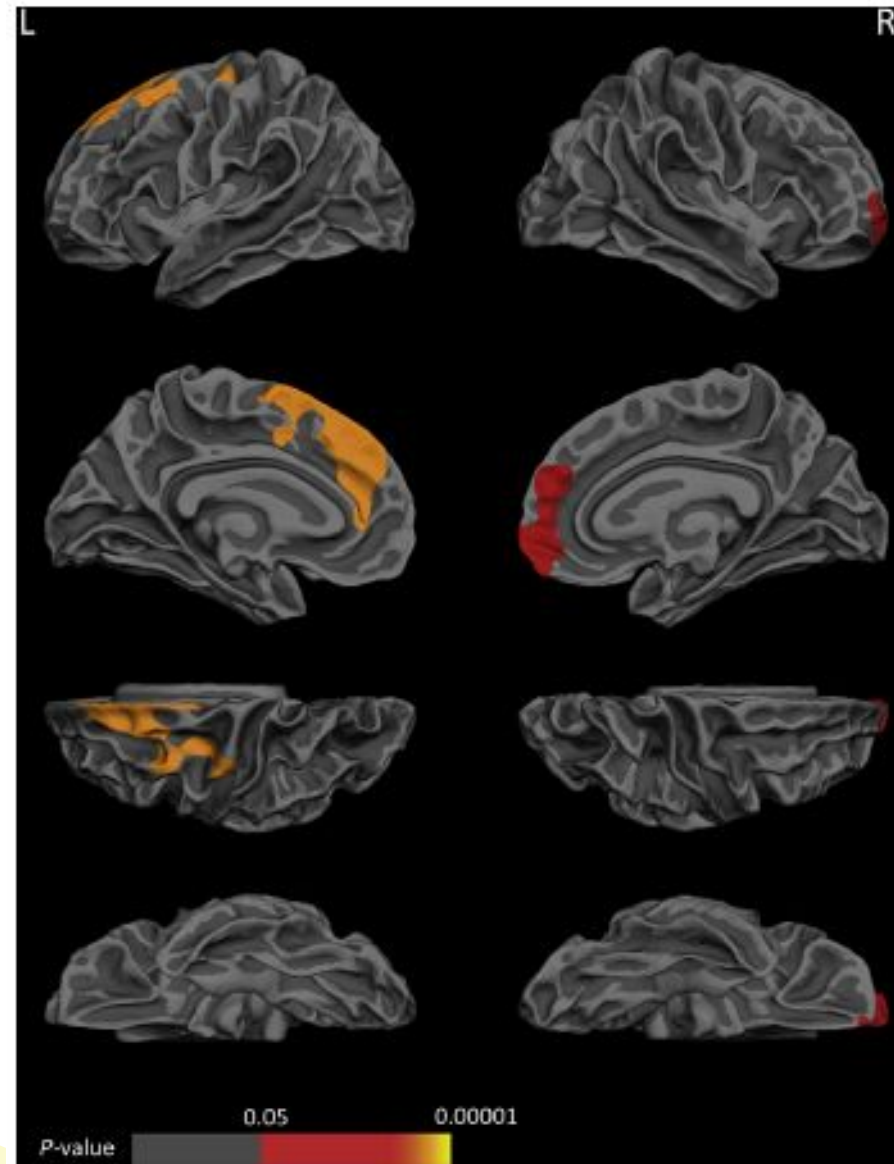


Kenny, 2011

Alterations in the appetitive network in obesity

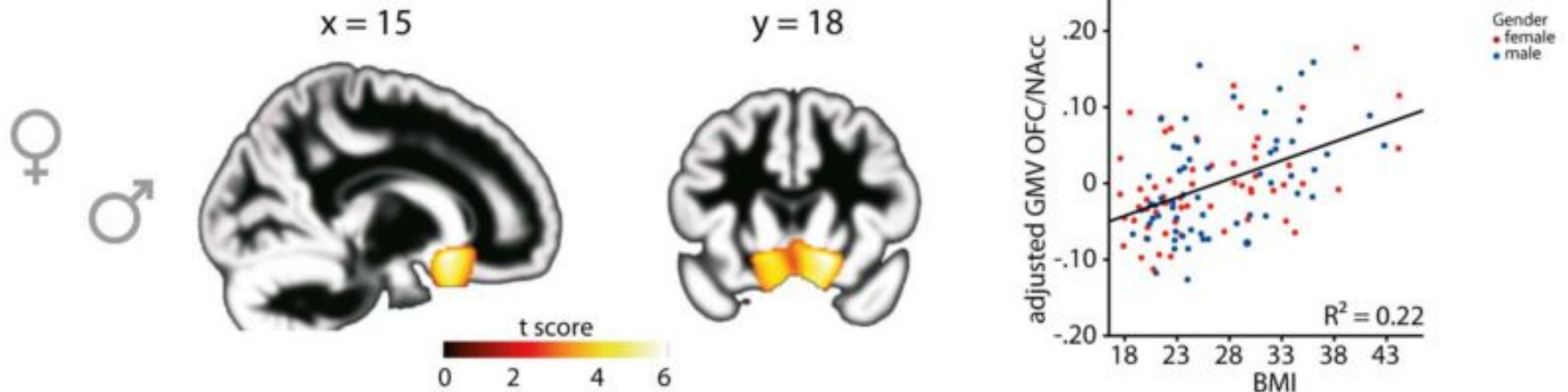
Reductions in gray matter volume and in cortical thickness in **prefrontal areas** in obesity

Marqués-Iturria, Pueyo, Garolera, Segura, Junqué, García-García, ..., Jurado (2013)



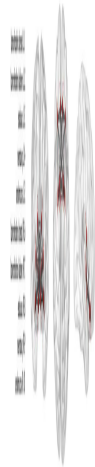
Directionality of volumetric differences is less clear in subcortical regions

(e.g., see Horstmann et al. 2011 and Jagust et al. 2005)



Horstmann, Busse, Mathar, Müller, Lepsien, ..., Pleger (2011)

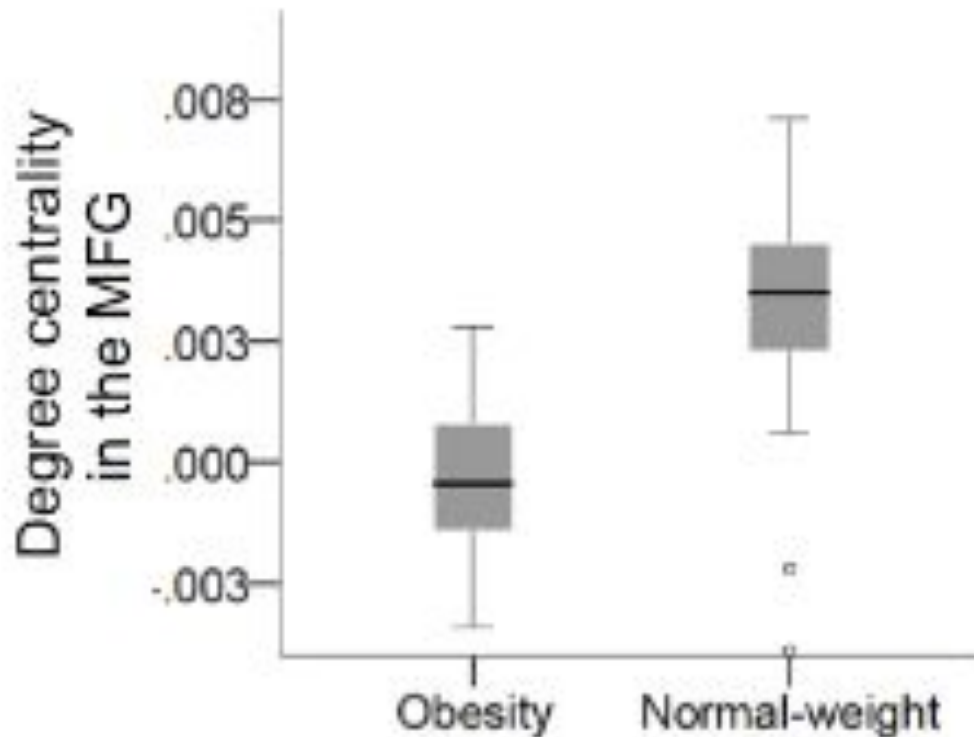
Decreased connectivity organization of the reward system structure in obesity



Control
Obese

Marqués-Iturria, Sholtens, Garolera, Pueyo, García-García, ..., van den Heuvel. (2015) Neuroim

Alterations in the appetitive network in obesity



X=41

3.8

5.5

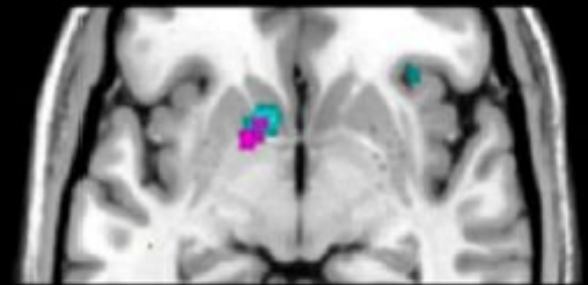
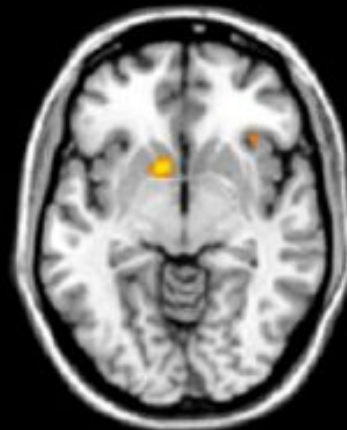
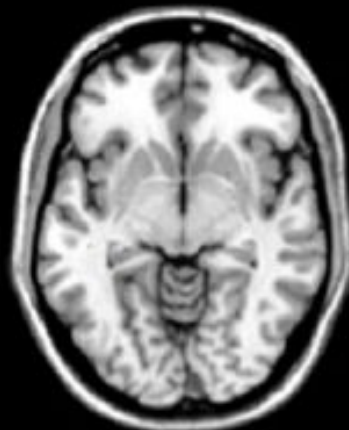
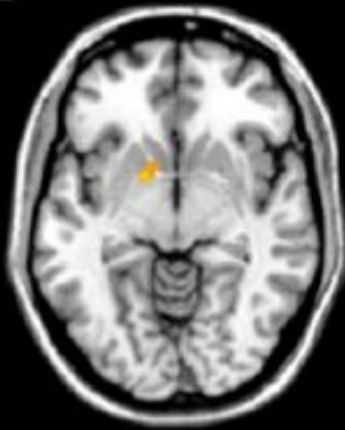
The addictive or compulsive dimension of obesity

FOOD ADDICTION MODEL (Gearhardt et al. 2011; Kelley & Berridge, 2002)

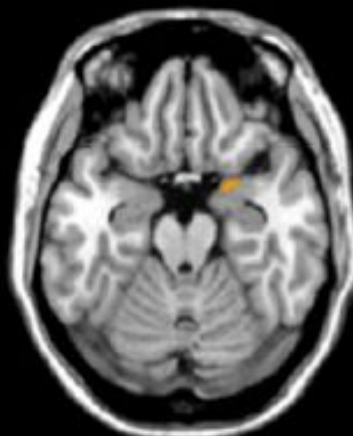
Obesity resembles an addiction to drugs, both behaviorally and in terms of their underlying neural processes

L

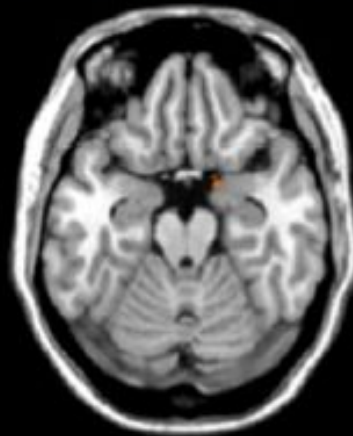
R



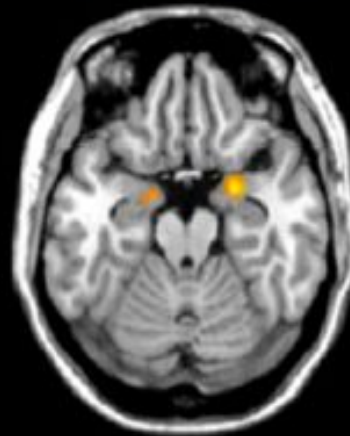
Z = -6



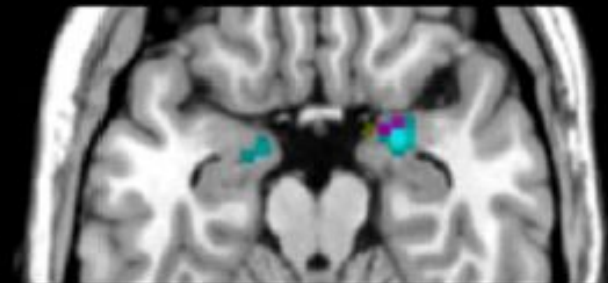
Overweight
and obesity



Non-substance
addictions



Substance
addictions



Z = -20

Overlap of ALE
maps

Conclusions

- **Obesity and substance addictions** shared a higher recruitment of the amygdala and striatum, key structures in salience, reward and habit formation.
- **Non-substance addictions** showed alterations in immediate (but not coincident) clusters in the amygdala