# Testosterone Causes Decoupling of Orbitofrontal Cortex-Amygdala Relationship While Anticipating Primary and Secondary Rewards

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## Introduction

Correlational evidence in humans shows that levels of testosterone are positively related to reward sensitivity [1]. Yet, investigations of the direct effects of exogenous testosterone administration on the reward system in human males are scarce.

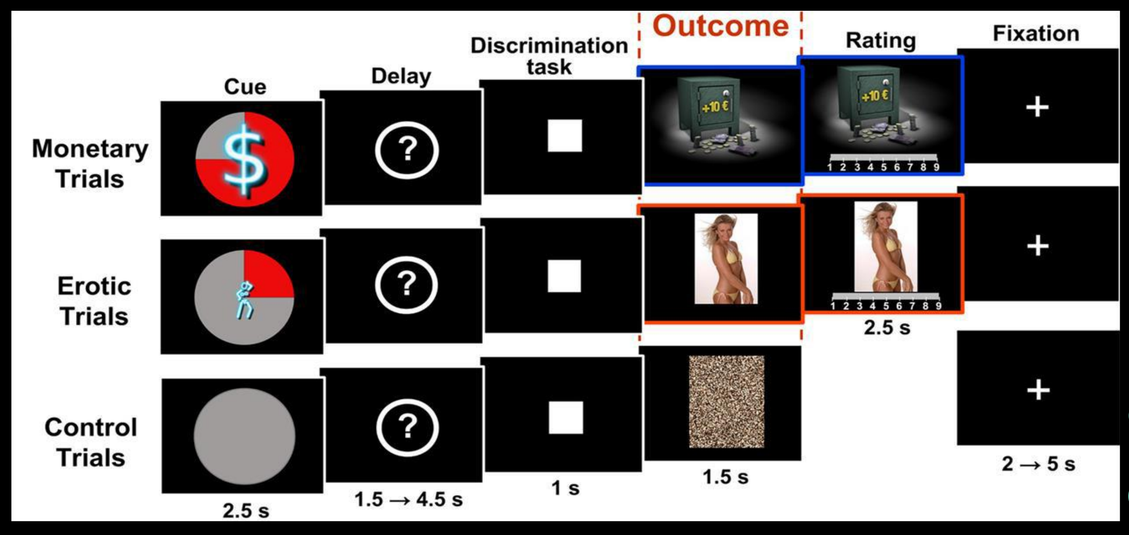
Reward processing at anticipation consistently recruits striatal activity [2] and elicits various areas overlapping with the common reward network [3, 4]. However, studies investigating reward anticipation examined single reward types.

Hypothesis: Testosterone administration may 1) increase posterior lateral orbitofrontal cortex activity, previously observed to be engaged more with erotic as compared to monetary rewards in healthy young men [5]; (2) decrease the functional coupling between the medial part of the orbitofrontal cortex and the amygdala while anticipating rewards [6, 7, 8].

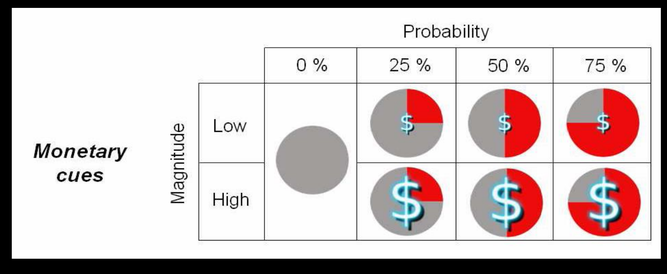
Goal: To investigate the effects of testosterone injection (250 mg testosterone enanthate) and of a placebo on behavior and brain activations while participants are successively anticipating and receiving either primary (erotic) or secondary (monetary) rewards.

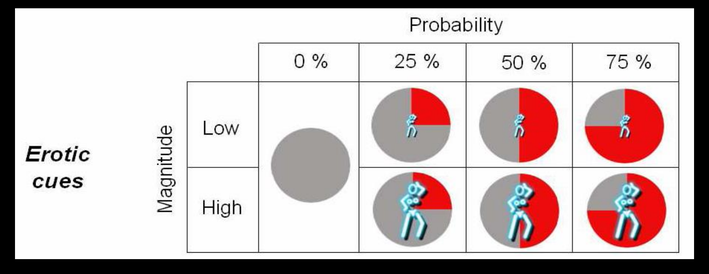
## Methods

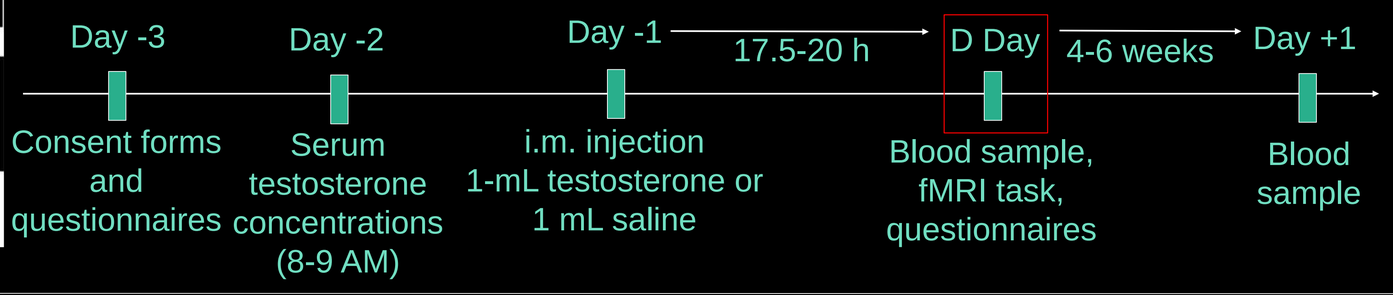
**Incentive delay task**



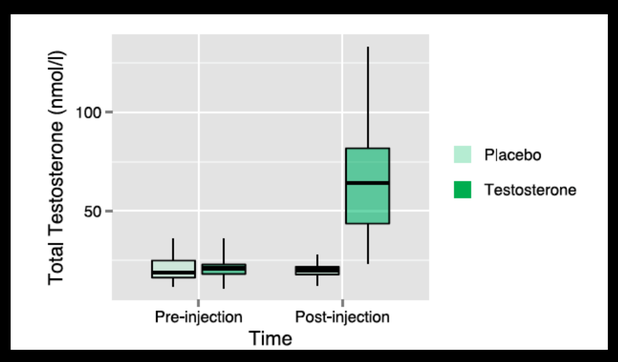

**Overview of monetary and erotic cues used across the experiment**



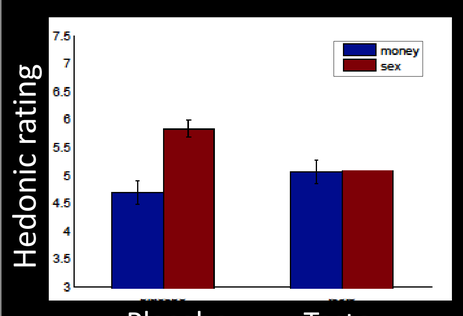




## Testosterone Levels

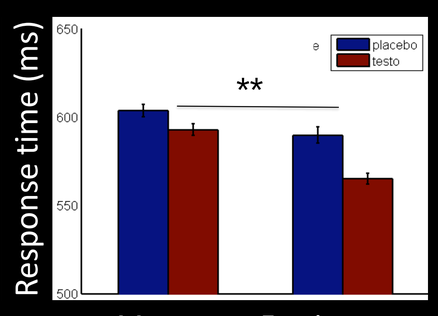



Tukey's HSD all p>0.7 except testosterone post-injection compared to others: p<.0005

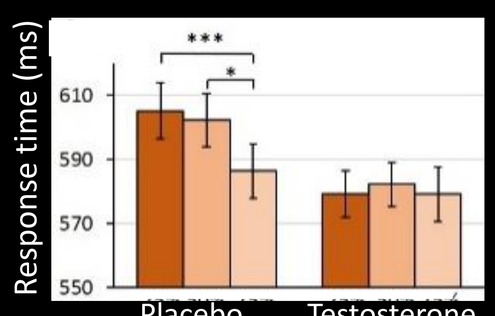
## Behavioral Results



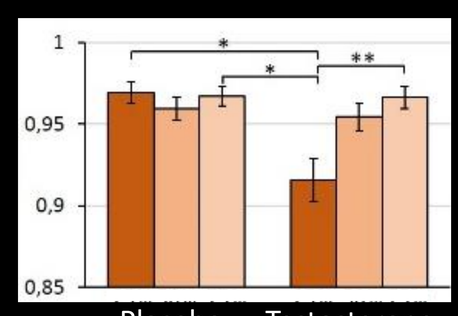

No group effect




F(1,36)=4.2, p<0.005



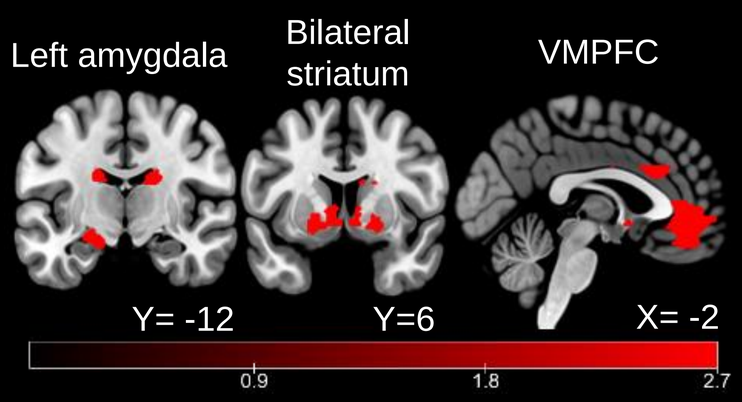

F(2,76) = 3.797; p=.0268




F(2,76) = 4.30; p=.0170

## fMRI & fcMRI Results

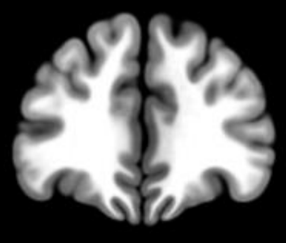
**Reward anticipation**
Monetary + Erotic > Control




Erotic > Control

Main effect

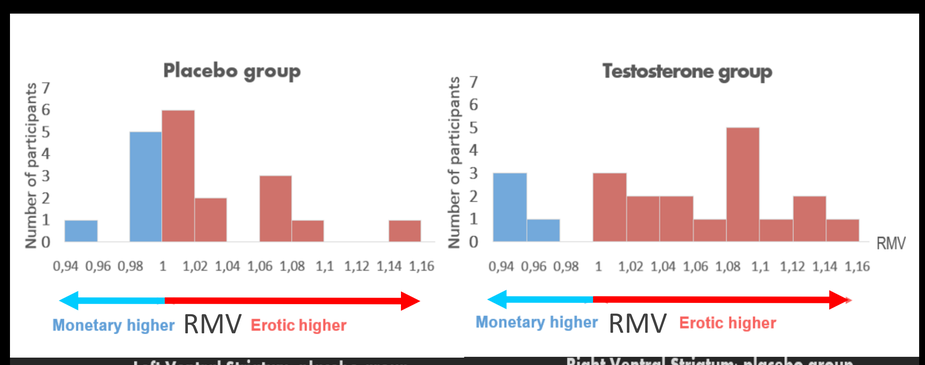

Testo > Placebo

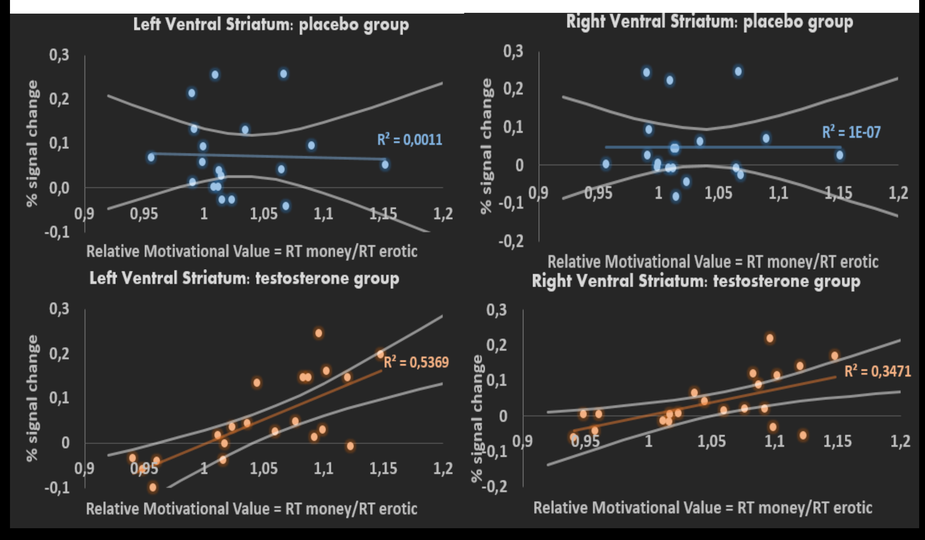



All p<.005 uncorrected

**Index of Relative Motivational Value**

$$RMV = \frac{\text{RTs Monetary}}{\text{RTs Erotic}}$$

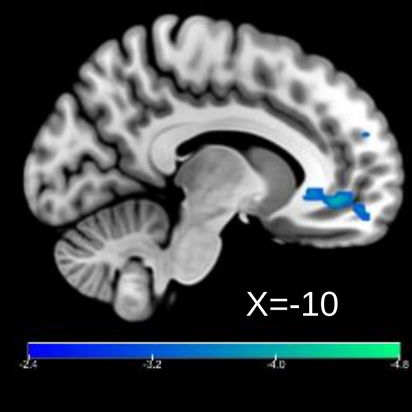


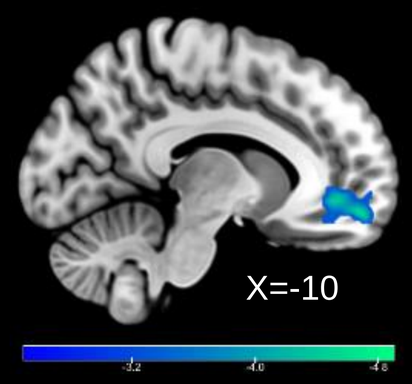

**Testo > Placebo**
**gPPI Connectivity analysis**

Seed: Left Amygdala
(-18, -2, -12)


Monetary > Control




Erotic > Control




p-voxelwise <.001 uncorr; p-clusterwise <.05 FDR-corr.

## Conclusion

- Following no initial difference in the total serum concentration, the injection efficiently affected testosterone levels.
- We found a higher activity in left amygdala, striatum and VMPFC when participants anticipated rewards, regardless of their type. A higher cue reactivity for erotic reward was found in ventral striatum in testosterone group.
- We did not find testosterone effect on antero-posterior subdivision of OFC for erotic stimuli.
- Consistently with hypothesis 2), testosterone induced a functional decoupling between left amygdala and VMPFC for both monetary and erotic stimuli anticipation.

## Reference

[1] Hermans et al., *Neuroimage* 2010.
[2] Sescousse et al., *Social Cognitive and Affective Neuroscience* 2015.
[3] Oldham et al., *Human brain mapping* 2018.
[4] Wilson et al., *Neuropsychology review* 2018.
[5] Sescousse, Redouté, Dreher, *Journal of neuroscience* 2010.
[6] van Wingen et al., *Psychoneuroendocrinology* 2010.
[7] Volman et al., *Cerebral Cortex* 2011.
[8] Bos et al., *Neuroimage* 2012.