

# **Orbitofrontal cortex lesions disrupt anticipatory autonomic** responses to reward magnitude in macaque monkeys

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### INTRODUCTION

- Subjective value is reflected not only in neural activity, but also in autonomic responses. Indeed, both neural activity and pupil diameter changes, a measure of sympathetic autonomic arousal, are correlated with magnitude of expected reward (Mitz et al., J. Neurosci. Methods, 2017).
- In addition, the activity of value-coding neurons in orbitofrontal cortex (OFC) of macaques mimics the pattern of pupil responses to rewarded stimuli (Xie et al., *eLife*, 2018).
- To date, however, it has not been determined whether OFC makes a causal contribution to the autonomic arousal that occurs in anticipation of reward.
- To answer this question, we compared rhesus monkeys with bilateral excitotoxic lesions of OFC and unoperated controls on a reward magnitude task.

# SUBJECTS AND SURGERY

- A total of 8 rhesus monkeys (*Macaca mulatta*) were used.
- 4 unoperated controls
- 4 subjects with bilateral OFC lesions (areas 11, 13 & 14)
- The lesions were made by ibotenic acid injection and assessed with postoperative T2-weighted MRI scans. White hypersignal on T2 scans is associated with edema and indicates the extent of damage.









- center of a monitor screen for the duration of each trial and received the amount of reward assigned to the single image displayed on that trial.
- Pupil size, our measure of autonomic arousal, was continuously measured while the monkeys performed the task.

# BEHAVIORAL PERFORMANCE







- Both lesion and control groups acquired a conditioned pupil response to the image cues within a couple of training sessions and continued to show it across at least 5 consecutive sessions.
- The monkeys broke fixation more often when the image predicted a 0-ml reward. There was no group difference in developing this tendency.

The pupil size change during the cue analysis period was positively related to the reward magnitude in both groups.

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Neuroscience 2018

The monkeys with OFC lesions showed a late onset of differentiated pupillary responses during the cue period and a significant impairment in sustaining arousal during the delay period.

### SUMMARY

Our findings show that OFC is necessary for acquiring the normal pattern of autonomic arousal in anticipation of different reward magnitudes.

In particular, the data suggest that subjective value representations in OFC sustain autonomic arousal for biologically significant events.

## REFERENCES

Mitz AR, Chacko RV, Putnam PT, Rudebeck PH, Murray EA (2017) Using pupil size and heart rate to infer affective states during behavioral neurophysiology and neuropsychology experiments. J Neurosci Methods 279:1-12.

Xie Y, Nie C, Yang T (2017) Covert shift of attention modulates the value encoding in the orbitofrontal cortex. *eLife* 7:e31507.