

# Cognitive reappraisal of food craving and emotions: a coordinate-based meta-analysis of fMRI studies

Marta Gerosa<sup>1,2</sup>, Nicola Canessa<sup>1,3</sup>, Carmen Morawetz<sup>4</sup>, Giulia Mattavelli<sup>1,3,5</sup>

<sup>1</sup> ICoN Center, Scuola Universitaria Superiore IUSS, 27100, Pavia, Italy; <sup>2</sup> Berlin School of Mind and Brain, Humboldt-Universität zu Berlin, 10115 Berlin, Germany; <sup>3</sup> Istituti Clinici Scientifici Maugeri IRCCS, Cognitive Neuroscience Laboratory of Pavia Institute, 27100, Italy; <sup>4</sup> Institute of Psychology, University of Innsbruck, Austria; <sup>5</sup> NeuroMi, Milan Centre for Neuroscience, Milan, Italy

## INTRODUCTION

Growing evidence supports the effectiveness of **cognitive reappraisal in down-regulating food craving** (Giuliani et al., 2013; Kober et al., 2010).

Neuroimaging studies suggest that **fronto-parietal cognitive control regions** (dlPFC, vlPFC, IPL) are involved (e.g., Cosme et al., 2018; Giuliani et al., 2014; Kober et al., 2010). Yet, the precise neural bases of food craving reappraisal, as well as their degree of overlap vs. specificity compared with emotion down-regulation, remain unclear.

## AIM

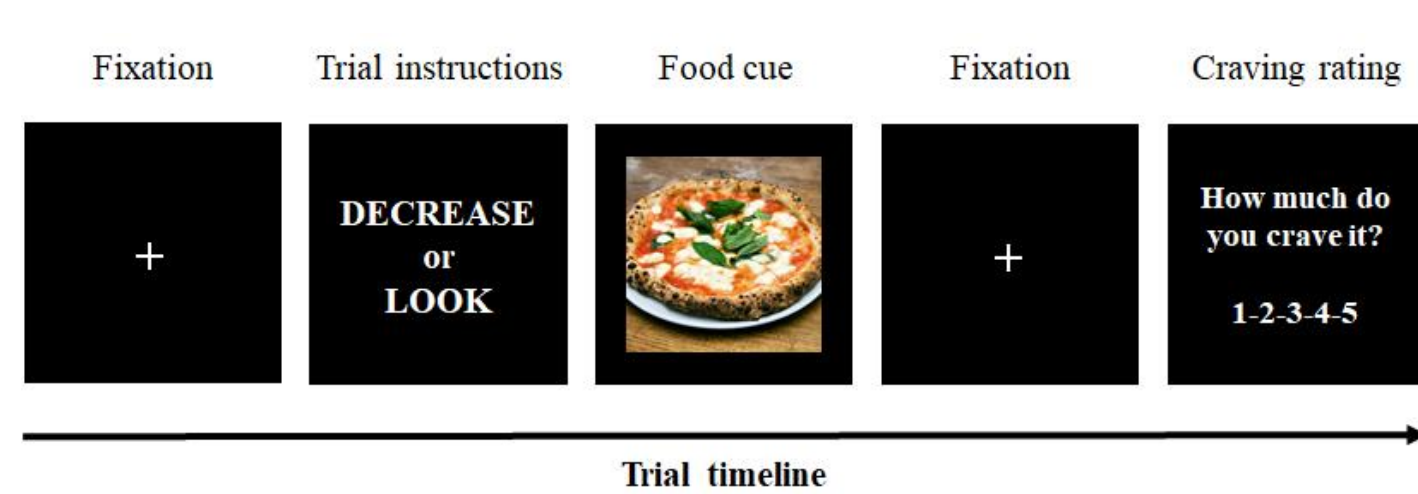
To address this gap, we conducted activation likelihood estimation (ALE) meta-analyses of fMRI studies on the neural bases of:

(a) **food craving down-regulation via reappraisal**, and

(b) **emotion down-regulation via reappraisal**,

alongside conjunction and contrast analyses among the resulting maps. Exploratory meta-analyses on activations related to absence of control and up-regulation of food craving have also been performed.

## METHODS



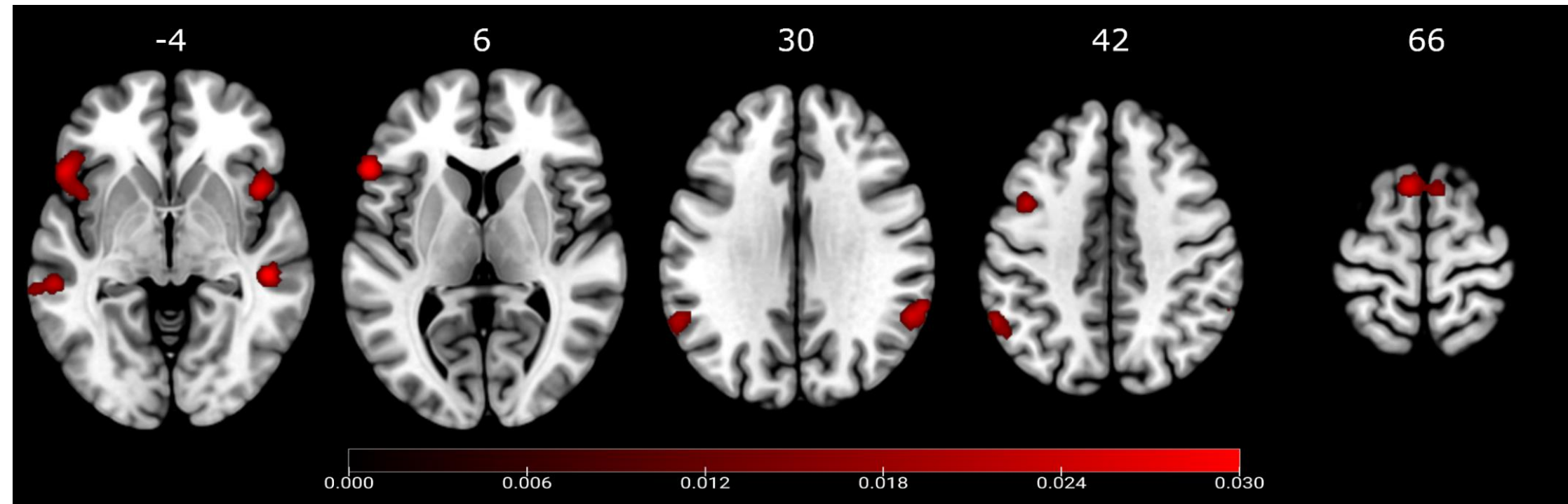
fMRI experiments with a **food craving reappraisal task** on non-clinical, healthy-weight adult participants.

**20 experiments** (856 subjects, 348 activation foci) were included in the "food craving down-regulation" meta-analysis (Decrease > Look with food stimuli). **13 experiments** (573 subjects, 139 activation foci) were selected for the "food viewing compared to active regulation" exploratory analysis (Look > Decrease) and **7 experiments** (164 subjects, 50 activation foci) for the "food craving up-regulation" exploratory analysis (Increase > Look).

Regarding the "emotion down-regulation" meta-analysis (Decrease > Look with emotion stimuli), **128 experiments** (4022 subjects, 1262 activation foci) were included from a recent study (Morawetz et al., 2022). Then, direct contrast and conjunction analyses were conducted on the resulting maps of the "food craving down-regulation" and "emotion down-regulation" resulting ALE maps.

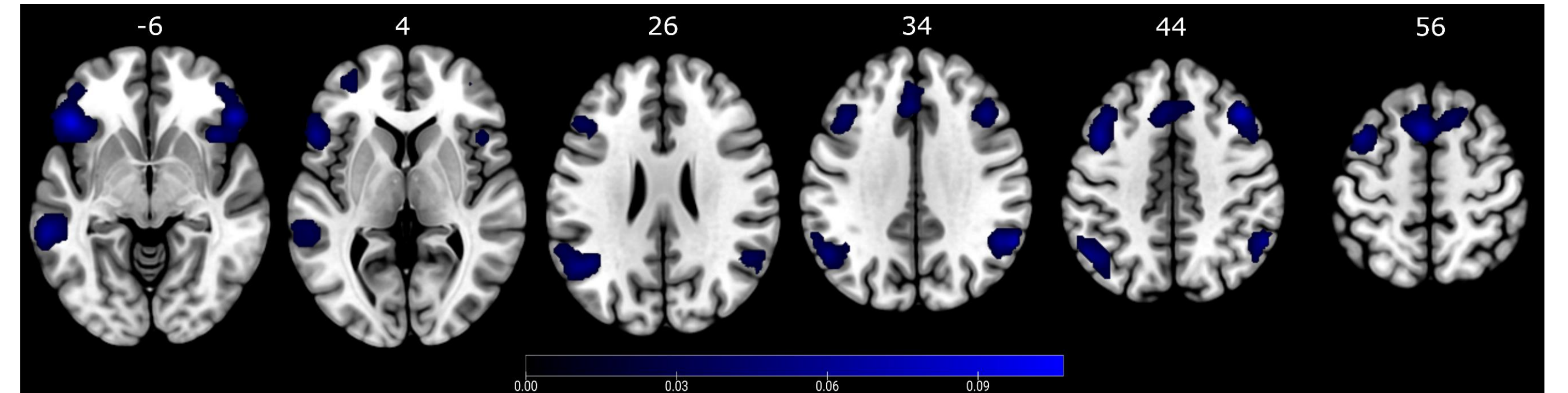
## RESULTS

### Food craving down-regulation (Decrease > Look with food stimuli)



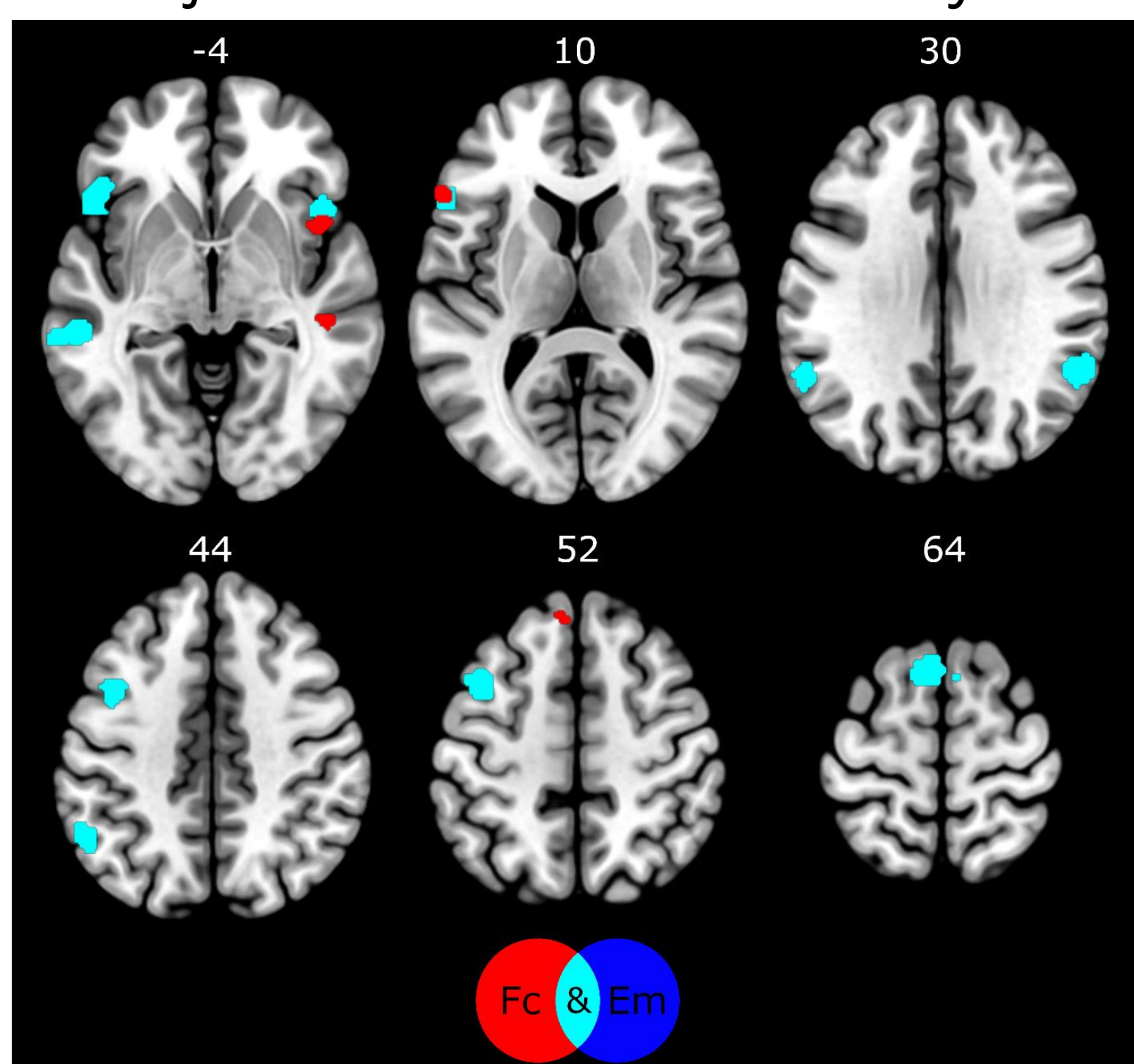
Brain activations consistently associated with **food craving down-regulation via cognitive reappraisal in healthy participants**. All the reported clusters survived a cluster-level family wise error (FWE) corrected statistical threshold of  $p < 0.05$  and  $p < .001$  uncorrected cluster-forming voxel-wise threshold. The colour bar represents the voxel-wise ALE score.

### Emotion down-regulation (Decrease > Look with emotion stimuli)



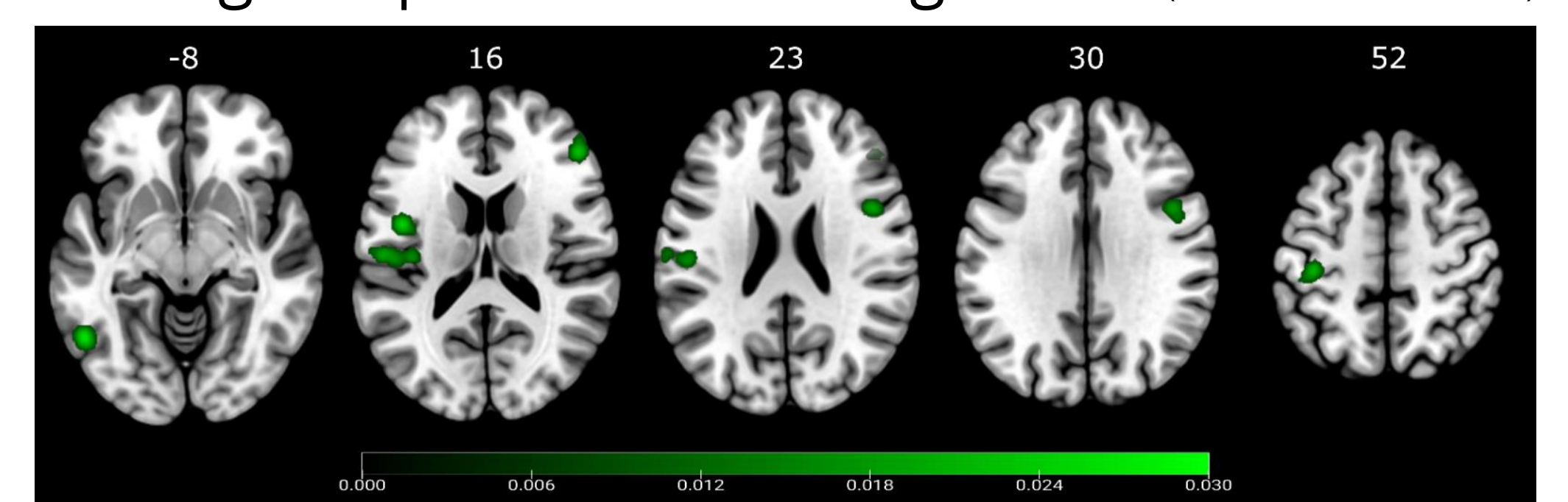
Brain activations consistently associated with **emotion down-regulation via cognitive reappraisal in healthy participants**. All the reported clusters survived a cluster-level family wise error (FWE) corrected statistical threshold of  $p < 0.05$  and  $p < .001$  uncorrected cluster-forming voxel-wise threshold. The colour bar represents the voxel-wise ALE score.

### Conjunction and contrast analyses



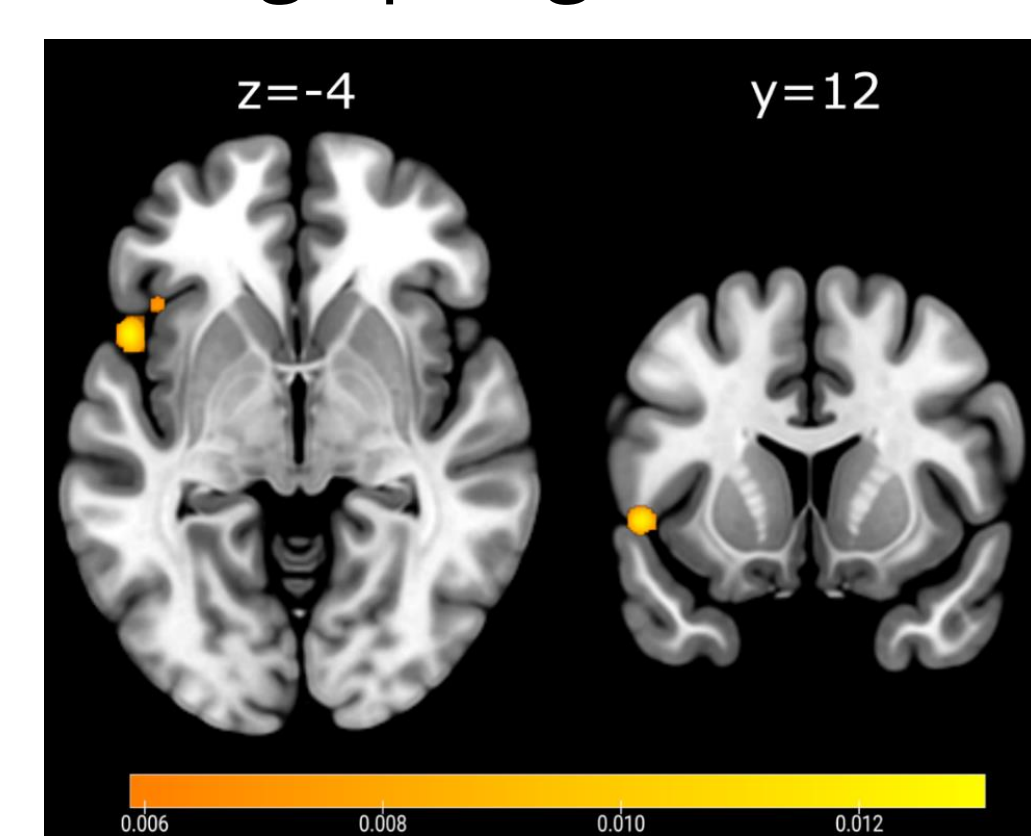
Results of conjunction (light blue) and contrast analyses on **food craving down-regulation and emotion down-regulation via reappraisal in healthy participants** (red = Fc > Em; blue = Em > Fc). All the reported clusters survived an FDRpID corrected statistical threshold of  $p < 0.05$  and minimum volume size of 50 mm<sup>3</sup>.

### Food viewing compared to active regulation (Look > Decrease)



Exploratory results of brain activations associated with **admitting food craving without active regulation in healthy participants**. All the reported clusters survived a cFWE corrected statistical threshold of  $p < 0.05$ .

### Food craving up-regulation (Increase > Look)



Exploratory results of brain activations associated with **food craving up-regulation in healthy participants**. The reported cluster was obtained with an uncorrected threshold of  $p < 0.005$ .

## CONCLUSIONS

Overall, food craving and emotion down-regulation consistently engaged **overlapping fronto-parietal activations** (i.e., dlPFC, vlPFC, posterior parietal cortex, pre-SMA, lateral posterior temporal cortex), mainly in the left hemisphere. Yet, the specific involvement of the **right anterior/posterior insula** and **left inferior frontal gyrus** in food craving down-regulation is suggestive of a unique interoceptive and motivational component during reappraisal of food, but not emotional stimuli. The present findings may inform theoretical models of food craving regulation and prompt novel therapeutic interventions for obesity and eating disorders, by targeting the contribution of insular and fronto-parietal regions to interoceptive awareness and cognitive control, respectively.