

# Realistic analytic variability in fMRI: The problem and a potential solution

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2020-02-04

# Analytic flexibility in fMRI

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Results can differ over

- ▶ Analysis pipelines [Carp, 2012]
- ▶ Software versions [Gronenschild et al., 2012]
- ▶ Operating systems [Glatard et al., 2015]

# Realistic analytic flexibility?

# The present study

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How do analyses impact results when we have realistic analytic variability?

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## **Exploring a solution**

Is the consensus result better?

## Methods: Dataset for current study

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### **Neuroimaging Analysis Replication and Prediction Study (NARPS)**

[Botvinik-Nezer et al., 2019]



### **Neuroimaging Analysis Replication and Prediction Study (NARPS)**

[Botvinik-Nezer et al., 2019]

- ▶ 1 dataset - task fMRI
- ▶ 70 54 analysis teams
- ▶ Return whole-brain group-level statistical maps (z-maps)

## Methods: Original dataset used by analysis teams

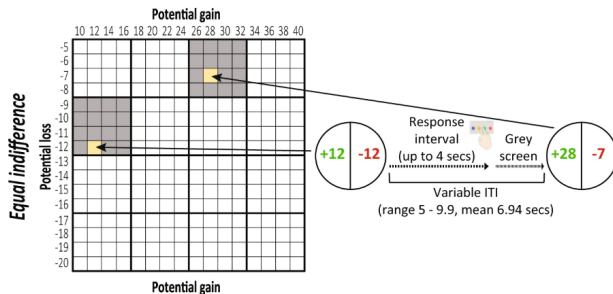
### **Neuroimaging Analysis Replication and Prediction Study (NARPS)**

[Botvinik-Nezer et al., 2019]

- ▶ 119 108 participants (54 per condition)
- ▶ Mixed-gambles task, 2 conditions
- ▶ preprocessing with fMRIPrep [Esteban et al., 2019]

## Methods: Original dataset used by analysis teams

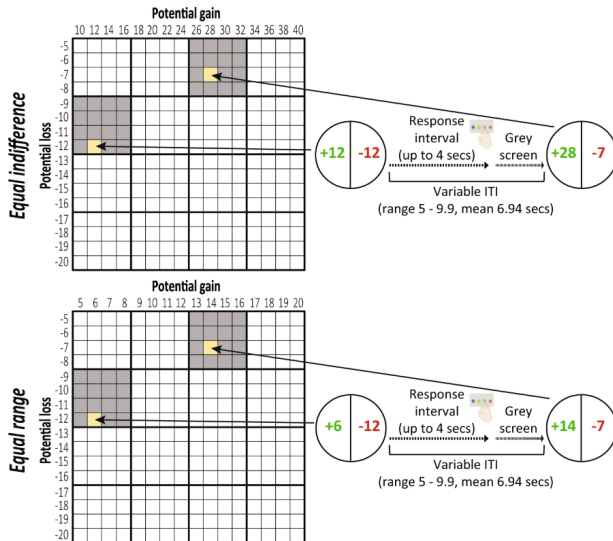
### NARPS Paradigm



[Botvinik-Nezer et al., 2019]

# Methods: Original dataset used by analysis teams

## NARPS Paradigm



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- ▶ Visualize pipeline choices
- ▶ Associate methods & results

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- ▶ Compare consensus & online meta-analysis

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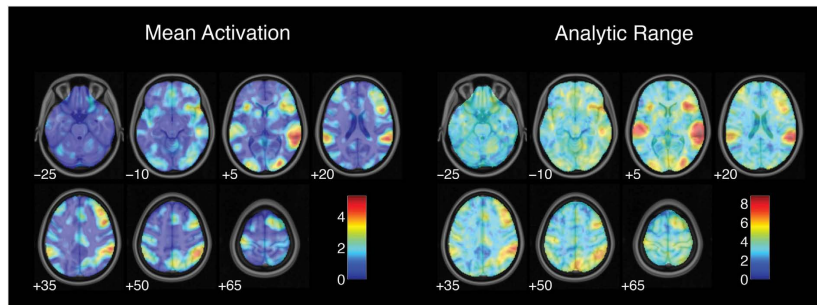
Is the consensus result better?

- ▶ Obtain the consensus result
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## **Replication**

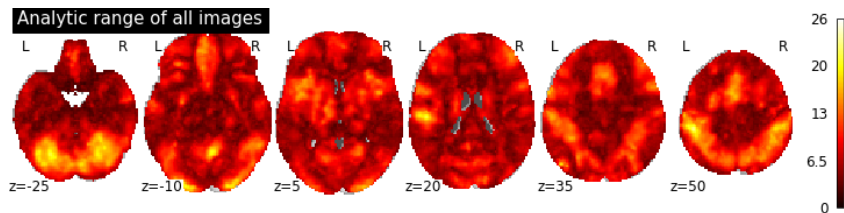
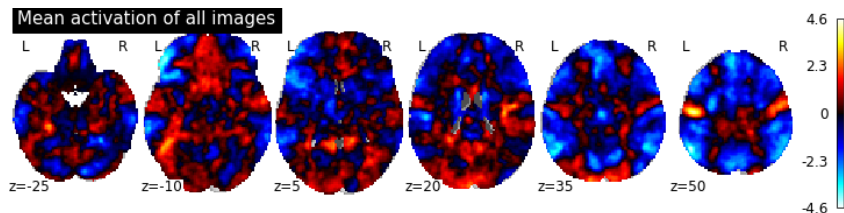
- ▶ Original analyses with the equal-indifference group
- ▶ Replication with the equal-range group

## Results: Describing the problem: Mean activation & analytic range

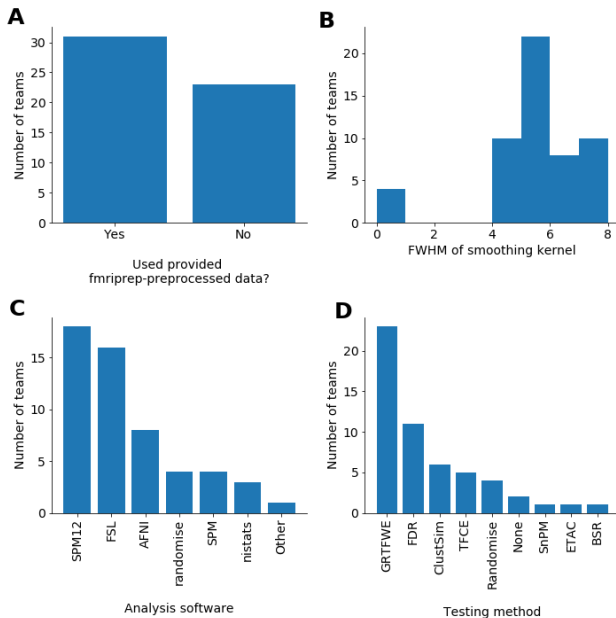


[Carp, 2012]

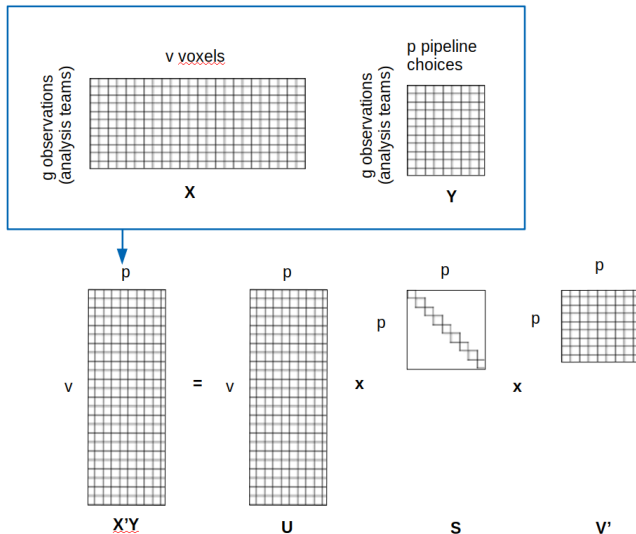
## Results: Describing the problem: Mean activation & analytic range



## Results: Describing the problem: Pipeline choices

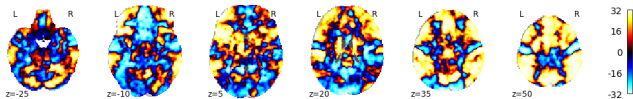
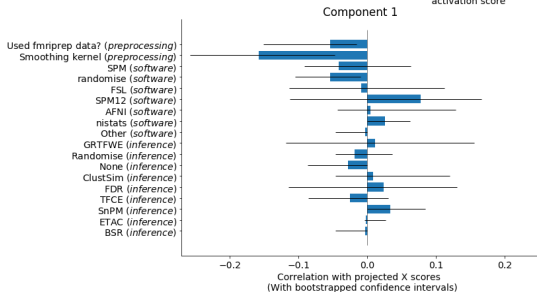
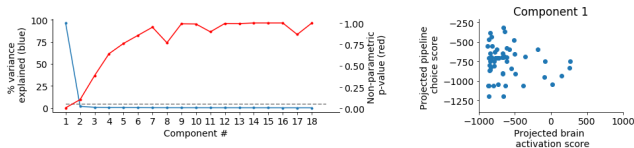


## Results: Describing the problem: Associate methods & results

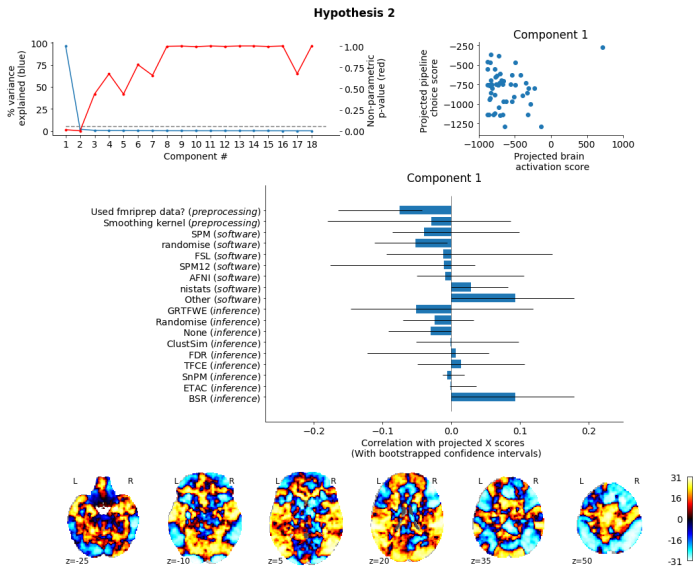


# Results: Describing the problem: Associate methods & results

## Hypothesis 1



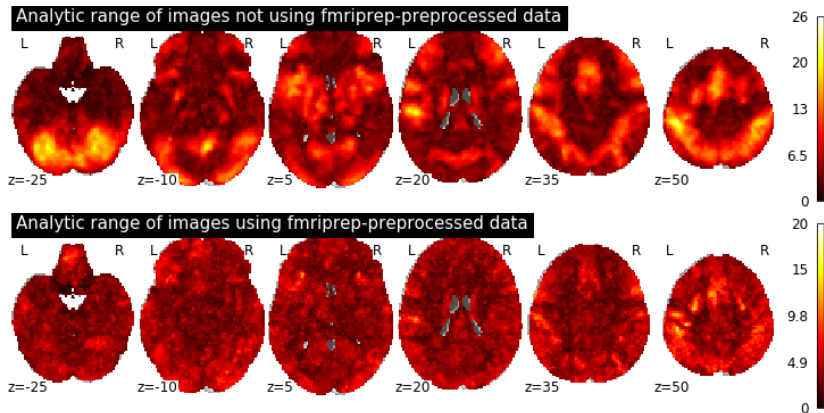
# Results: Describing the problem: Associate methods & results





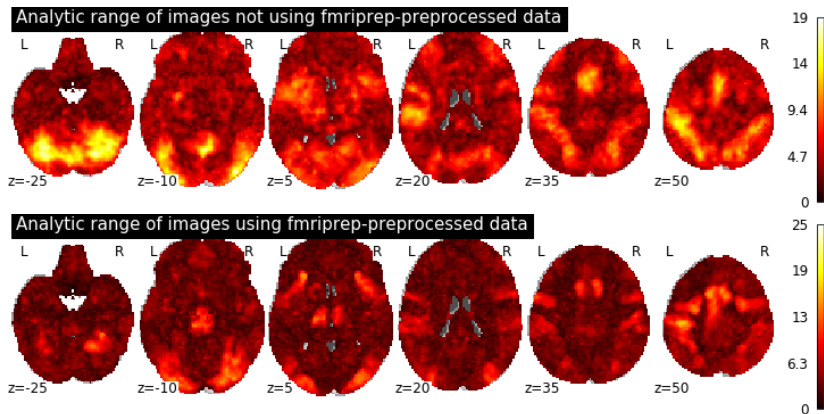
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## Hypothesis 1



## Results: Describing the problem: Associate methods & results

### Hypothesis 2



## Results: Exploring solutions

**Is the consensus result better?**

## Results: Exploring solutions

**Is the consensus result better?**

(better = more similar to a meta-analysis of the literature)

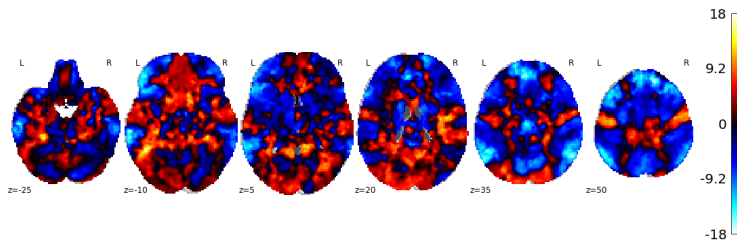
## Results: Exploring solutions: Consensus result

### Image-based meta-analysis (FFX GLM)

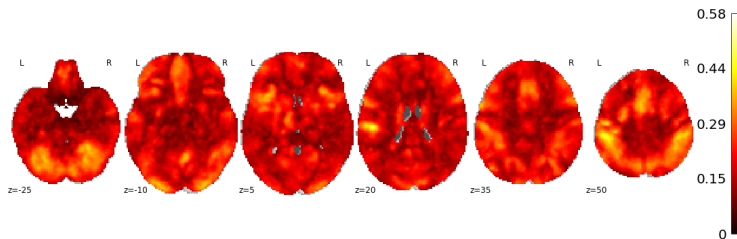
# Results: Exploring solutions: Consensus result

## Image-based meta-analysis (FFX GLM)

### Level-3 t-map

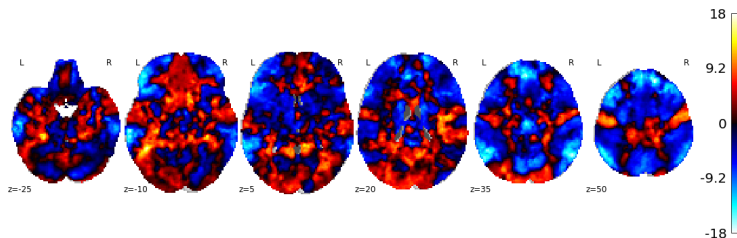


### Standard-error map

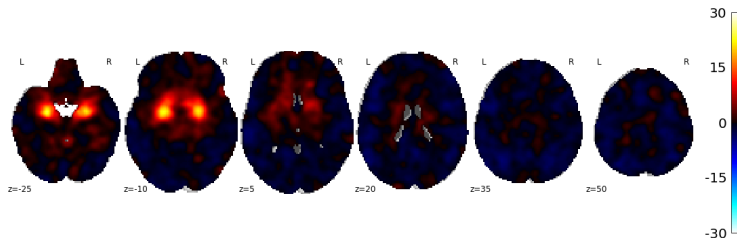


# Results: Exploring solutions: Comparing to online meta-analysis

## Level-3 t-map



## NeuroQuery z-map: “Loss aversion in decision-making under risk”



## Results: Exploring solutions: Comparing to online meta-analysis

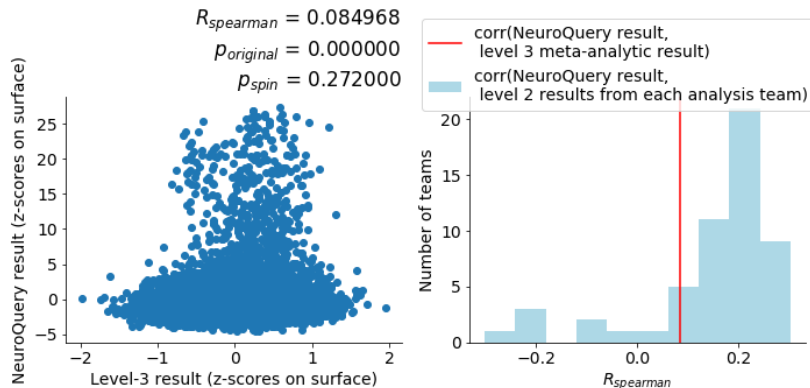
**Spearman's correlation in surface space.**



# Results: Exploring solutions: Comparing to online meta-analysis

## Spearman's correlation in surface space.

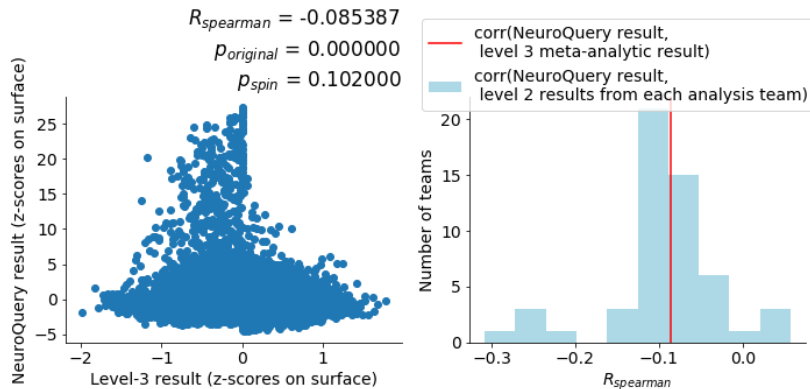
Hypothesis 1



# Results: Exploring solutions: Comparing to online meta-analysis

## Spearman's correlation in surface space.

Hypothesis 1



# Discussion

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How do analyses impact results?

- ▶ Somewhat consistent with past results?
- ▶ Important factors: preprocessing, smoothing kernel, software

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## **Exploring a solution**

Is the consensus result better?

- ▶ Not according to how we defined 'better'

## Limitations

- ▶ Questions about data
- ▶ PLS on dummy variables
- ▶ Online meta-analysis as 'ground truth'

# Acknowledgments

- ▶ Alex Perez: meta-analysis
- ▶ Peer Herholz: Docker
- ▶ Ross Markello: PLS code
- ▶ BrainSpace: spin test code
- ▶ The rest of my lab: feedback on methods & presentation

# References I



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