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NeuroLang: Representing Neuroanatomy with Sulcus-Specific Queries

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Objective: To identify and label subject-specific sets of sulci. We developed NeuroLang, a query-based mapping language which labels sulci according to the spatial relationships to primary sulci. We assess sensitivity of our sulcus-specific queries and prevalence of tertiary sulci in a population.

1 Introduction

Poster explainer video: <https://youtu.be/blgX-80mKKw> (open in internet provider for hyperlink)

Sulci may vary greatly in morphology, while their relative locations to primary sulci are what define them.

Template atlases use this characteristic to find landmarks of the brain and wrap around it to label the same set of sulci for any subject.

Tertiary sulci have high **variability in their existence and morphology**, while their **location remains relatively constant**. They are usually omitted from template atlases or else grouped with their neighbouring gyri¹.

Tertiary sulci can have relationships with cognitive functions, comparative neuroanatomy or cytoarchitectonic boundaries².

2 Materials & Method

NeuroLang has **36 sulcus-specific queries** which identify and label sulci on an individual level, designed in relation to each subject's primary sulci using the Destrieux atlas to ensure reliability.

20 sulci had Destrieux atlas counterparts (**secondary sulci**) and 16 were omitted from the Destrieux atlas or included as part of their surrounding gyrus (**tertiary sulci**).

Mindboggle³ was used to extract an average of 33 sulci per hemisphere in **52 subjects** of the Human Connectome Project.

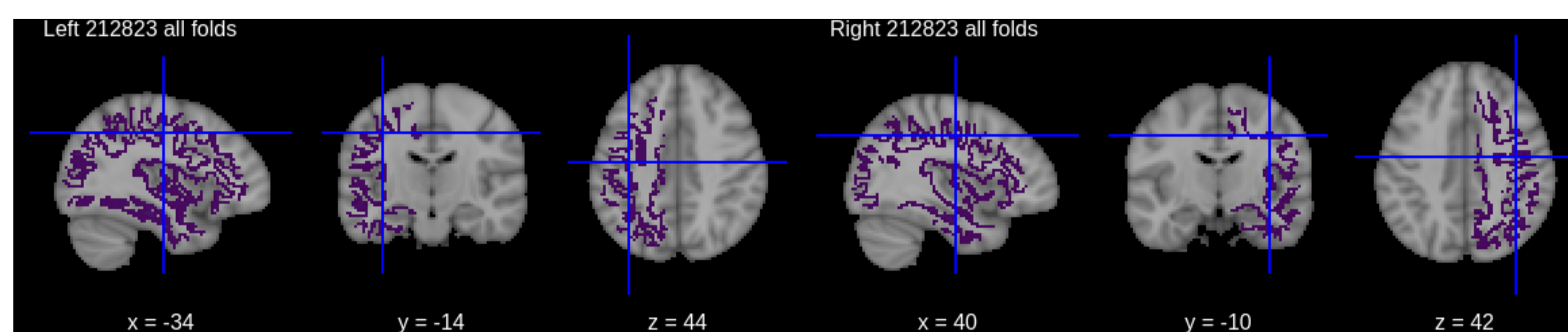


Fig 1. Example of the 33 (LH) and 37 (RH) unlabelled folds in subject 212823 of the Human Connectome Project, extracted using mindboggle³.

3 Results

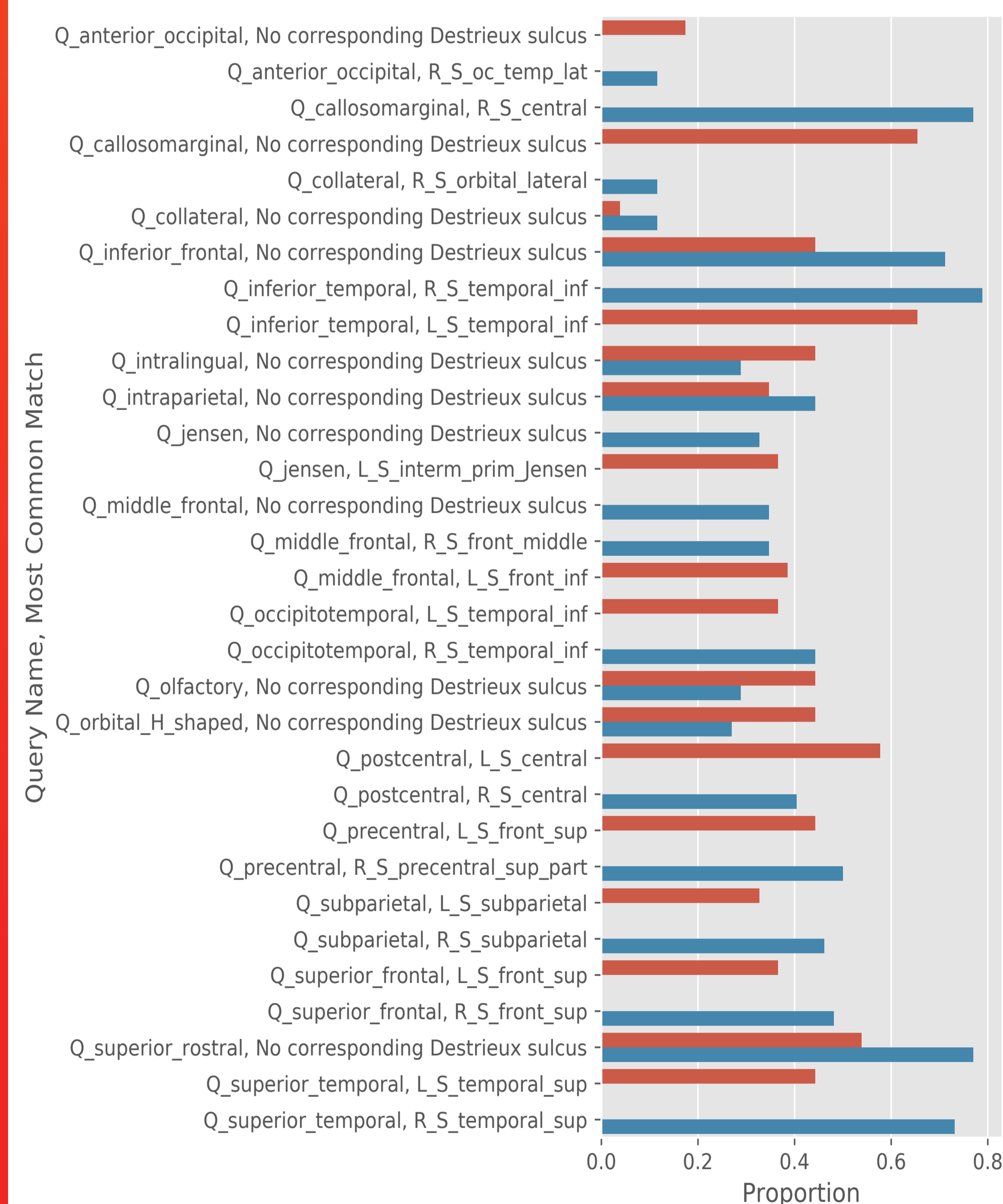


Fig 2. Bar plot of results for secondary queries. Each query is labelled, next to the Destrieux sulcus which was most often matched with the result of the query.

Secondary queries (Fig. 2)

Queries were assessed by the proportion of the most common Destrieux match with the query result. Some query results had no match with a Destrieux sulcus, possibly due to the fact that the extracted sulci had a wider variety in shape and size.

Tertiary queries (Fig. 3)

Queries were assessed by success of their locations in the probability maps. Examples from each lobe are shown, with the proportion of subjects with a result.

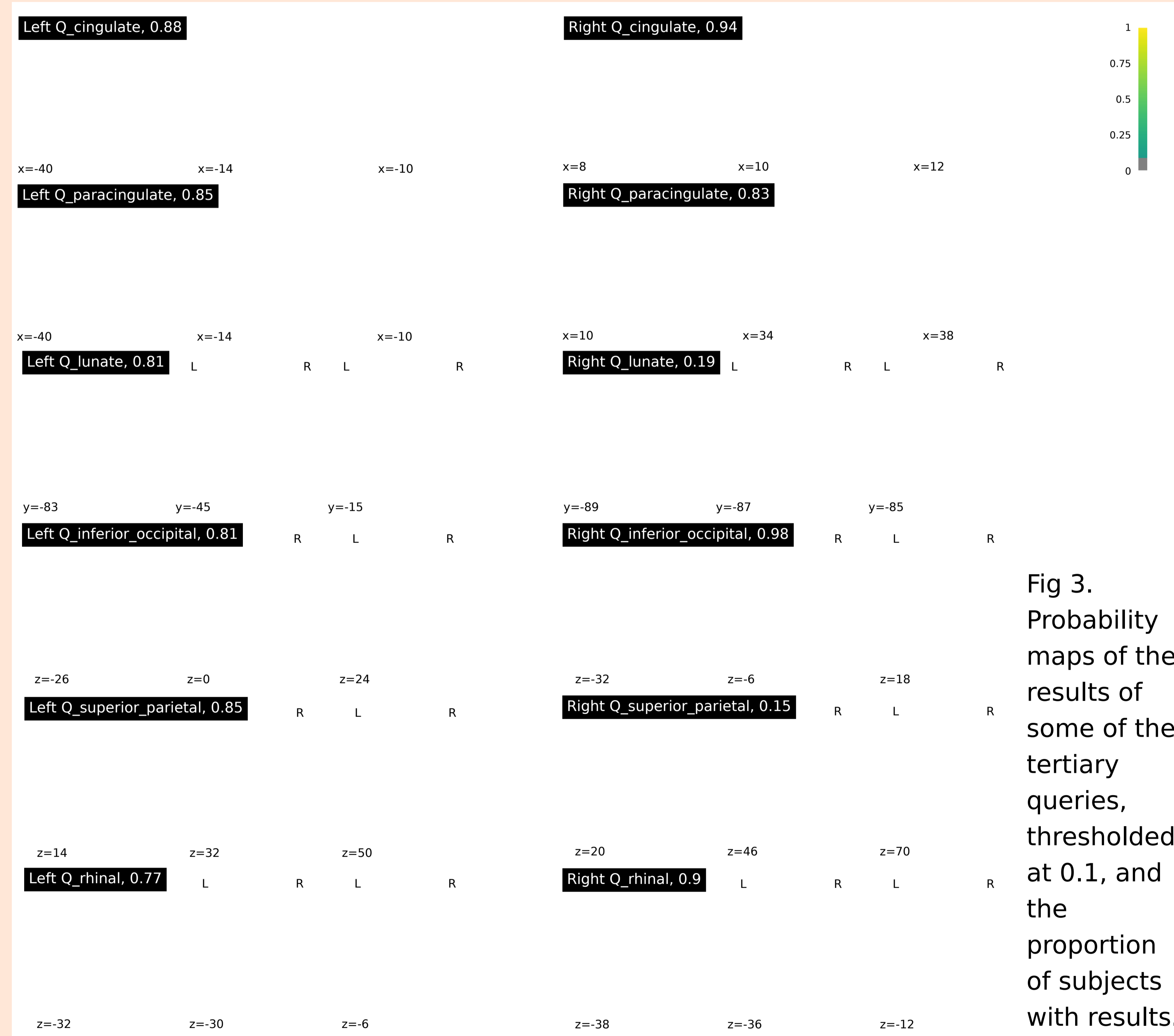


Fig 3. Probability maps of the results of some of the tertiary queries, thresholded at 0.1, and the proportion of subjects with results.

4 Discussion & Conclusions

We present a new method for the labelling of a subject-specific atlas of sulci, with varying sets of sulci according to individual cortical organisation.

NeuroLang is **intended as a complement** to current template-based methods for brain mapping.

NeuroLang includes the **identification and labelling** of lesser-labelled sulci which can contribute to the uniqueness of a brain.

Individually, subject-specific sulci sets may shed more light on structure-function relationships³.

On the **population level**, tertiary sulci statistics may aid in understanding the evolution of the human brain⁴.

References

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Acknowledgements:

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