



Universiteit
Leiden
The Netherlands

**Cortical contributions to cognitive control of language and beyond:
evidence from functional connectivity profiles of the inferior parietal
cortex and cognitive control-related resting state networks**

Tabassi Mofrad, F.

Citation

Tabassi Mofrad, F. (2023, October 12). *Cortical contributions to cognitive control of language and beyond: evidence from functional connectivity profiles of the inferior parietal cortex and cognitive control-related resting state networks*. LOT dissertation series. LOT, Amsterdam. Retrieved from <https://hdl.handle.net/1887/3643667>

Version: Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/3643667>

Note: To cite this publication please use the final published version (if applicable).

Cortical contributions to cognitive control of language and beyond

Evidence from functional connectivity
profiles of the inferior parietal cortex and
cognitive control-related resting state networks

Published by
LOT
Binnengasthuisstraat 9
1012 ZA Amsterdam
The Netherlands

phone: +31 20 525 2461

e-mail: lot@uva.nl

<http://www.lotschool.nl>

ISBN: 978-94-6093-437-7

DOI: <https://dx.medra.org/10.48273/LOT0653>

NUR: 616

Copyright © 2023: Fatemeh Tabassi Mofrad. All rights reserved.

Cortical contributions to cognitive control of language and beyond

Evidence from functional connectivity
profiles of the inferior parietal cortex and
cognitive control-related resting state networks

Proefschrift

ter verkrijging van
de graad van doctor aan de Universiteit Leiden,
op gezag van rector magnificus Prof. dr. ir. H. Bijl,
volgens besluit van het college voor promoties
te verdedigen op donderdag 12 oktober 2023
klokke 11.15 uur

door

Fatemeh Tabassi Mofrad

geboren te Tehran, Iran
in 1979

Promotor: Prof. dr. N. O. Schiller
Co-promotor: Dr. J. Witteman
Promotiecommissie: Prof. dr. M. P. G. M. Mous
Dr. M. Parafita Couto
Prof. dr. N. F. Ramsey
(University Medical Center Utrecht)
Prof. dr. H. Soltanian-Zadeh
(University of Tehran)
Prof. dr. G. Thierry
(Bangor University)

Blessed is He in Whose Hand is the Kingdom

Dedicated wholeheartedly to B. A. A. (AG)

Contents

Acknowledgements	xv
Articles in this dissertation.	xvii
1. General introduction	1
1.1. Cognitive control of language in bilinguals	3
1.2. Neural mechanisms of cognitive control of language	4
1.3. Scope of the present study	5
1.4. Methodology	7
1.4.1. Participants	7
1.4.2. Quick placement test	8
1.4.3. Picture naming experiments	8
1.4.4. Procedure	9
1.4.5. Neuroimaging methods	10
1.4.5.1. Multiband task based fMRI	10
1.4.5.2. Multiband resting state fMRI	10
1.4.6. fMRI data analyses	11
1.4.6.1. Psychophysiological interaction (PPI) analyses	11
1.4.6.2. Independent components analyses (ICA)	11
1.4.6.3. Dual regression	12
1.5. Outline of the dissertation	12
References	15

2. Dual function of primary somatosensory cortex in cognitive control of language: evidence from resting state fMRI 23

Abstract 25

2.1.	Introduction	26
2.2.	Experimental procedures	29
	2.2.1. Participants	29
	2.2.2. Stimuli	29
	2.2.3. Language switching task	31
	2.2.4. Resting state fMRI acquisition	31
2.3.	Data analysis	32
	2.3.1. Behavioral data analysis	32
	2.3.2. Pre-processing of resting state images	33
	2.3.3. Functional connectivity analyses	33
2.4.	Results	34
	2.4.1. Behavioral data	34
	2.4.2. Independent components analysis	36
	2.4.3. Dual regression	38
2.5.	Discussion	40
	References	46

3. Cognitive demand modulates connectivity patterns of rostral inferior parietal cortex in cognitive control of language 55

Abstract 57

3.1.	Introduction	58
3.2.	Methods	62
	3.2.1. Participants	62
	3.2.2. Stimuli	63
	3.2.3. Procedure	64
	3.2.4. fMRI data acquisition	66

3.3.	Data analysis	66
3.3.1.	Behavioral data analysis	66
3.3.2.	Pre-processing of fMRI data	67
3.3.3.	Psychophysiological interaction (PPI) analysis	67
3.4.	Results	68
3.4.1.	Behavioral data	68
3.4.2.	PPI results	70
3.4.2.1.	PPI results from switching to L1	70
3.4.2.2.	PPI results from switching to L2	72
3.5.	Discussion	74
3.5.1.	Switching to L1	75
3.5.2.	Switching to L2	78
3.5.3.	Laterality differences	79
3.6.	Conclusion	80
	References	82

4. Mapping caudal inferior parietal cortex supports the hypothesis about a modulating cortical area 95

	Abstract	97
4.1.	Introduction	98
4.2.	Methods	100
4.2.1.	Participants	100
4.2.2.	Stimuli	101
4.2.3.	Procedure	103
4.2.4.	fMRI data acquisition	104
4.3.	Data analysis	105
4.3.1.	Behavioral data analysis	105
4.3.2.	Pre-processing of fMRI data	105
4.3.3.	Psychophysiological interaction (PPI) analysis	106
4.4.	Results	106
4.4.1.	Behavioral data	106
4.4.2.	PPI results	108
4.4.2.1.	PPI results from switching to L1	108
4.4.2.2.	PPI results from switching to L2	111

4.4.2.3.	Sensitivity analyses of PPI results from switching to L1	114
4.4.2.4.	Sensitivity analyses of PPI results from switching to L2	115
4.5.	Discussion	117
4.5.1.	The highly lateralized functional connectivity of the caudal IPC	118
4.5.2.	Similar caudal IPC functional connectivity in switching to L1 and L2	119
4.5.3.	Different caudal IPC functional connectivity in switching to L1 and L2	121
4.5.4.	Modulating function of the caudal IPC	124
4.6.	Conclusion	125
	References	127

5. Connectivity profile of middle inferior parietal cortex confirms the hypothesis about modulating cortical areas 135

	Abstract	137
5.1.	Introduction	138
5.2.	Methods	140
5.2.1.	Participants	140
5.2.2.	Stimuli	141
5.2.3.	Procedure	141
5.2.4.	fMRI data acquisition	142
5.3.	Data analysis	142
5.3.1.	Behavioral data analysis	142
5.3.2.	Pre-processing of fMRI data	142
5.3.3.	Psychophysiological interaction (PPI) analysis	143
5.4.	Results	144
5.4.1.	Behavioral data	144
5.4.2.	PPI results	145
5.4.2.1.	PPI results from switching to L1	145
5.4.2.2.	PPI results from switching to L2	148

5.5. Discussion	150
References	154
6. Distinct connectivity patterns in clusters of inferior parietal cortex	161
Abstract	163
6.1. Introduction	164
6.2. Contributions of rostral IPC to cognitive control	165
6.3. Unique connectivity profile of caudal IPC	168
6.4. Connectivity profile of middle IPC	171
6.5. Conclusion	174
References	176
7. General discussion	181
7.1. Summary of the findings	183
7.1.1. Individual differences in cognitive control	183
7.1.1.1. Primary somatosensory cortex and cognitive control	184
7.1.2. Contributions of rostral IPC to cognitive control	185
7.1.2.1. Connectivity profile of rostral IPC in switching to L1	185
7.1.2.2. Connectivity profile of rostral IPC in switching to L2	186
7.1.2.3. Connectivity profile of rostral IPC modulated by cognitive demand	187
7.1.3. Unique connectivity profile of caudal IPC	187
7.1.3.1. Lateral connectivity patterns of caudal IPC	188
7.1.3.2. Similar connectivity profiles of caudal IPC in switching to L1 and L2.	188
7.1.3.3. Different connectivity profiles of caudal IPC in switching to L1 and L2.	189
7.1.3.4. Modulating function of caudal IPC	190

7.1.4. Connectivity profile of middle IPC	190
7.2. Integration of findings	191
7.3. Limitations and future research	195
7.4. Conclusion	196
References	198
List of Figures	203
List of Tables	207
Samenvatting in het Nederlands	211
Curriculum vitae	215

Acknowledgements

This PhD with the focus on Cognitive Neuroscience, followed my first PhD in Applied Linguistics, which equipped me with years of experience in research and a high level of independence. At the same time, there are definitely certain individuals to thank for. To begin with, I would like to thank Prof. dr. Niels Schiller, my promotor, with whom I did this PhD. In particular, I would like to thank him for his flexible research attitudes which let me focus on the research themes that I love, to develop my knowledge.

It was toward the end of this PhD program that Dr. Witteman was appointed as the co-supervisor (co-promotor), to meet the official requirements. Unfortunately, that did not provide room for his involvement in the research outputs from my PhD project – I would like to thank him for his time in reading my dissertation.

I would like to thank the respected members of the PhD committee for the time they invested in reading my dissertation, and for the valuable assessment of my dissertation. Besides, I would like to thank the Board of the Faculty of Social and Behavioral Sciences (FSW) of Leiden University for covering the costs related to the use of the MRI scanner in the Leiden University Medical Center. I would also like to thank the contact team of Leiden Institute for Brain and Cognition for arranging fMRI data acquisition sessions and I would like to thank all my research participants.

Last but not least, I would like to thank my dear family members, the support of whom are beyond words. On top of the pyramid is my precious mother whose love I have seen and I have felt everywhere and whose prayer has always accompanied me - I adore her forever. I would like to thank my father, my sister and brother, and my brother-in-law, in particular, for their patience, for all the years that I have lived so far from them.

Articles in this dissertation

This dissertation is based on the following research articles:

Tabassi Mofrad, F., Jahn, A., & Schiller, N. O. (2020). Dual function of primary somatosensory cortex in cognitive control of language: evidence from resting state fMRI. *Neuroscience*, *446*, 59-68. [Chapter 2]

Tabassi Mofrad, F., & Schiller, N. O. (2020). Cognitive demand modulates connectivity patterns of rostral inferior parietal cortex in cognitive control of language. *Cognitive Neuroscience*, *11*(4), 181–193. [Chapter 3]

Tabassi Mofrad, F., & Schiller, N. O. (2022). Mapping caudal inferior parietal cortex supports the hypothesis about a modulating cortical area. *NeuroImage*, *259*, 119441. [Chapter 4]

Tabassi Mofrad, F., & Schiller, N. O. (2023). Connectivity profile of middle inferior parietal cortex confirms the hypothesis about modulating cortical areas. *Neuroscience*, *519*, 1-9. [Chapter 5]

Tabassi Mofrad, F., & Schiller, N. O. (under review). Distinct connectivity patterns in clusters of inferior parietal cortex. [Chapter 6]

