CHAPTER 9

Samenvatting

Om het aanpassingsvermogen van de visuele cortex te begrijpen is het noodzakelijk om de functionele organisatie ervan te ontrafelen. Het doel van het onderzoek dat ik beschrijf in mijn proefschrift is: 1) begrijpen hoe bij volwassenen, factoren zoals visuele ervaring, gezichtsvelddefecten en voorspellende mechanismen de representatie van het gezichtsveld in de visuele cortex beïnvloeden; en 2) het ontwikkelen van technieken en onderzoeksmethoden die de responsen en receptieve velden ('receptive fields', RFs) van hersencellen én hun onderlinge verbindingen in de visuele cortex, modelmatig kunnen karakteriseren.

Daartoe heb ik functionele MRI (fMRI) gecombineerd met computermodellen gebaseerd op de werking van hersencellen in het menselijk brein. Deze computermodellen heb ik vervolgens gebruikt om te onderzoeken of neuronen in de visuele cortex — op populatie of subpopulatie niveau — het vermogen hebben om hun RF aan te passen. Ik heb bestudeerd hoe die aanpassing het gevolg kan zijn van gesimuleerde of werkelijke schade aan het visuele systeem, of van verschillende vormen van stimulering. De voornaamste uitkomsten van mijn onderzoek zijn: 1) een nieuwe en veelzijdige techniek, genaamd 'micro probing' (MP), die de activiteit van neurale subpopulaties in de visuele cortex heel precies kan beschrijven, uitgaande van slechts een minimum aan aannames; 2) de ontwikkeling van nieuwe stimuli waarmee RFs in kaart kunnen worden gebracht. Hiermee hebben we tevens aangetoond dat de neurale respons wordt beïnvloed door de taak en het type stimulus; 3) een nieuwe methode om het gezichtsveld in kaart te brengen. Deze methode maakt het mogelijk om de aard en grootte van gezichtsvelddefecten in te schatten en geeft tevens informatie over de werking van de visuele cortex; en 4) de bevinding dat bij gezonde proefpersonen neurale verbindingen veranderen als gevolg van een (gesimuleerd) gezichtsvelddefect. De ontbrekende informatie, als gevolg van het gezichtsvelddefect, wordt daardoor aangevuld hetgeen ertoe leidt dat het defect wordt gemaskeerd en niet bewust wordt waargenomen.

Mijn nieuwe technieken en bevindingen dragen bij aan onze kennis over het aanpassingsvermogen van de volwassen visuele cortex. De nieuwe kennis kan gebruikt worden bij het ontwikkelen van behandelstrategieën die gericht zijn op herstel van het zien en in de visuele revalidatie.

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Curriculum Vitae

Joana Carvalho was born in March 6, 1992 in Leiria, Portugal. In 2010 she started the bachelor and master program in Biomedical Engineering and Biophysics at the University of Lisbon. Here, she had the opportunity to apply the engineering insights acquired during her studies in two internships. In 2013, she moved to Boston to develop a neuro-assessment tool as part of her bachelor graduation research project at the Wyss institute for biologically inspired engineering at Harvard, under the supervision of Dr. Madalena Costa and Prof. Ary Goldberger. During her master's Joana specialized in the field of radiation and imaging. Her master thesis project, in the domain of biomedical optics, was carried out at Philips Research, Eindhoven, under the supervision of Dr. Martin Jurna and Dr. Jonathan Palero.

Following her graduation in 2015, Joana started a PhD in Computational Visual Neuroscience at the University Medical Center of Groningen, under the supervision of Prof. Frans W. Cornelissen, Dr. Remco J. Renken and Prof. Nomdo M. Jansonius. Her project, presented in this thesis, aimed to investigate the plasticity of the visual cortex. As part of the Innovative Training Network NexGenVis, Joana had the opportunity to collaborate with an incredible network of PhD students at leading laboratories in the field of visual neuroscience. She was a visiting PhD student at BrainInnovation in Maastricht under the supervison of Prof. Rainer Goebel, and at the Otto von Guericke University of Magdeburg, supervised by Prof. Michael Hoffmann.

As from January 2020, Joana joined the preclinical MRI group (Shemesh Lab) at Champalimaud Foundation as a post-doctoral researcher. Her project is directed to unravel the neuronal mechanisms underlying brain plasticity using ultra-high resolution fMRI, calcium recordings and visual stimulation.

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