Name	MARIA FLORENCIA IACARUSO	
Position	Group leader (1st 6)	
Year joined *(Crick or founder institute)*	2019	

Career History

2007-2009: Student Research Fellow. University of Buenos Aires, Argentina.
2009-2014: PhD in Neuroscience. University College London, UK.
2014-2016: Post-doctoral Research Associate. University of Basel, Switzerland.
2016-2018: Post-doctoral Research Associate. University of Oxford, UK.

Major Awards, Honours and Prizes

2016-2019: Research Fellowship awarded by the Royal Commission for the Exhibition of 1851
2009-2013: Graduate Research Scholarship and Overseas Research Scholarship - Awarded by University College London.
2007-2009: Undergraduate fellowship - Awarded by the Universidad de Buenos Aires

Membership of external committees, editorial boards, review panels, SABs etc

Lab Name	***Neuronal Circuits and Behaviour Laboratory***

Research programme and achievements

In order to determine behavioural priorities, the brain must integrate sensory information from multiple modalities with motivational and contextual information. Many situations require a fast evaluation of the salience and the relevance of the sensory information, for example during orienting to relevant targets. However, it is not clear how target priority is determined by the brain.

The superior colliculus (SC) is an evolutionary conserved structure, present in all vertebrates, involved in orienting and escape behaviours and it has been implicated in spatial attention and target selection. The SC has access to a wide range of multisensory inputs, as well as non-sensory information from primary and association areas of the neocortex, and the hypothalamus. In turn, the SC projects to the thalamus (mainly to the lateral posterior /pulvinar complex), the dorsolateral periaqueductal gray and to the motor systems in the brainstem and spinal cord. This extensive afferent and efferent connectivity suggests that the SC serves as a hub for linking brain circuits carrying information concerning the location of high-priority targets for an immediate re-orienting response. Thus, the SC provides a unique opportunity to investigate how, within a single brain structure, signals from the different senses are combined with non-sensory information and used to guide motor responses.

At present, it is not clear how functional microcircuits within the SC integrate and assess the relevance of sensory information from different modalities to generate an attentional shift or a motor response. To understand this, we are using two-photon microscopy and extracellular electrophysiological recordings to monitor the activity of hundreds of neurons from the superior colliculus of mice while they perform visual-auditory localisation tasks. The use of genetic markers and optogenetic approaches allows us to identify different neuronal populations and determine their role during behaviour. We are also studying the rules that determine how these different cell types communicate, by performing multiple patch clamp recordings in brain slices to study the strength and probability of their synaptic connections. My long term goal is to elucidate the relationship between the architecture and physiological function of the neuronal circuits underlying the selection of a behaviourally relevant target.

Research outputs

Kim MH, Znamenskiy P, Iacaruso MF, Mrsic-Flogel TD (2018). *Segregated subnetworks of intracortical projection neurons in primary visual cortex*. Neuron 100:1313-1321. DOI : 10.1016/j.neuron.2018.10.023

In the sensory cortex, intermingled neurons encode different attributes of sensory inputs and relay them to different long-range targets. The relationship between synaptic connectivity within an area and long-range projection target remains unclear. We examined the local connectivity and visual responses of primary visual cortex neurons projecting to anterolateral (AL) and posteromedial (PM) higher visual areas in mice. We showed that projection target, in addition to response similarity, constrains local synaptic connectivity of AL and PM projection neurons. We propose that reduced crosstalk between different populations of projection neurons permits independent function of these output channels.

Znamenskiy P, Kim MH, Muir DR, Iacaruso MF, Hofer SB, Mrsic-Flogel TD (2018). *Functional selectivity and specific connectivity of inhibitory neurons in primary visual cortex*. BioRxiv 294835. DOI: 10.1101/294835

In the cerebral cortex, the interaction of excitatory and inhibitory synaptic inputs shapes the responses of neurons to sensory stimuli, stabilises network dynamics and improves the efficiency and robustness of the neural code. Our results indicate that individual parvalbumin-expressing (PV) inhibitory cells in mouse primary visual cortex are preferentially integrated into subnetworks of inter-connected, co-tuned pyramidal cells, stabilising their recurrent dynamics. Conversely, weak but dense inhibitory connectivity between subnetworks is sufficient to support competition between them, de-correlating their output.

Iacaruso MF, Gasler IT, Hofer SB (2017). *Synaptic organization of visual space in primary visual cortex Nature 547:449-452 27*. DOI: 10.1038/nature23019

How a sensory stimulus is processed and perceived depends on the surrounding sensory scene. In the visual cortex, contextual signals can be conveyed by an extensive network of intra- and inter-areal excitatory connections that link neurons representing stimulus features separated in visual space. We show that neurons with displaced receptive fields connect preferentially when their receptive fields are co-oriented and co-axially aligned. This organisation of synaptic connectivity is ideally suited for the amplification of elongated edges, which are enriched in the visual environment, and thus provides a potential substrate for contour integration and object grouping.

Okun M, Steinmetz NA, Cossell L, Iacaruso MF, Ko H, Barthó P, Moore T, Hofer SB, Mrsic-Flogel TD, Carandini M & Kenneth D. Harris (2015*). Diverse coupling of neurons to populations in sensory cortex*. Nature 521:511-515. DOI: 10.1038/nature14273

A large population of neurons can in principle produce an astronomical number of distinct firing patterns. In the cortex, however, these patterns lie in a space of lower dimension as if individual neurons were "obedient members of a huge orchestra". We showed that neighbouring neurons can differ in their coupling to the overall firing of the population, ranging from strongly coupled "choristers" to weakly coupled "soloists" and established a measure of population coupling. This measure characterises the relationship of each neuron to a larger population, explaining seemingly complex network firing patterns in terms of basic circuit variables.

Cossell L, Iacaruso MF, Muir DR, Houlton R, Sader EN, Ko H, Hofer SB, Mrsic-Flogel TD (2015). *Functional organization of excitatory synaptic strength in primary visual cortex*. Nature 518:399-403. DOI: **10.1038/nature14182**

The strength of synaptic connections fundamentally determines how neurons influence each other's firing. Excitatory connection amplitudes between pairs of cortical neurons vary over two orders of magnitude, comprising only very few strong connections among many weaker ones. Our results showed that the apparently complex organisation of excitatory connection strength reflects the similarity of neuronal responses, and suggest that rare, strong connections mediate stimulus-specific response amplification in cortical microcircuits.