Experience required: A role for vision in the development of inhibitory networks

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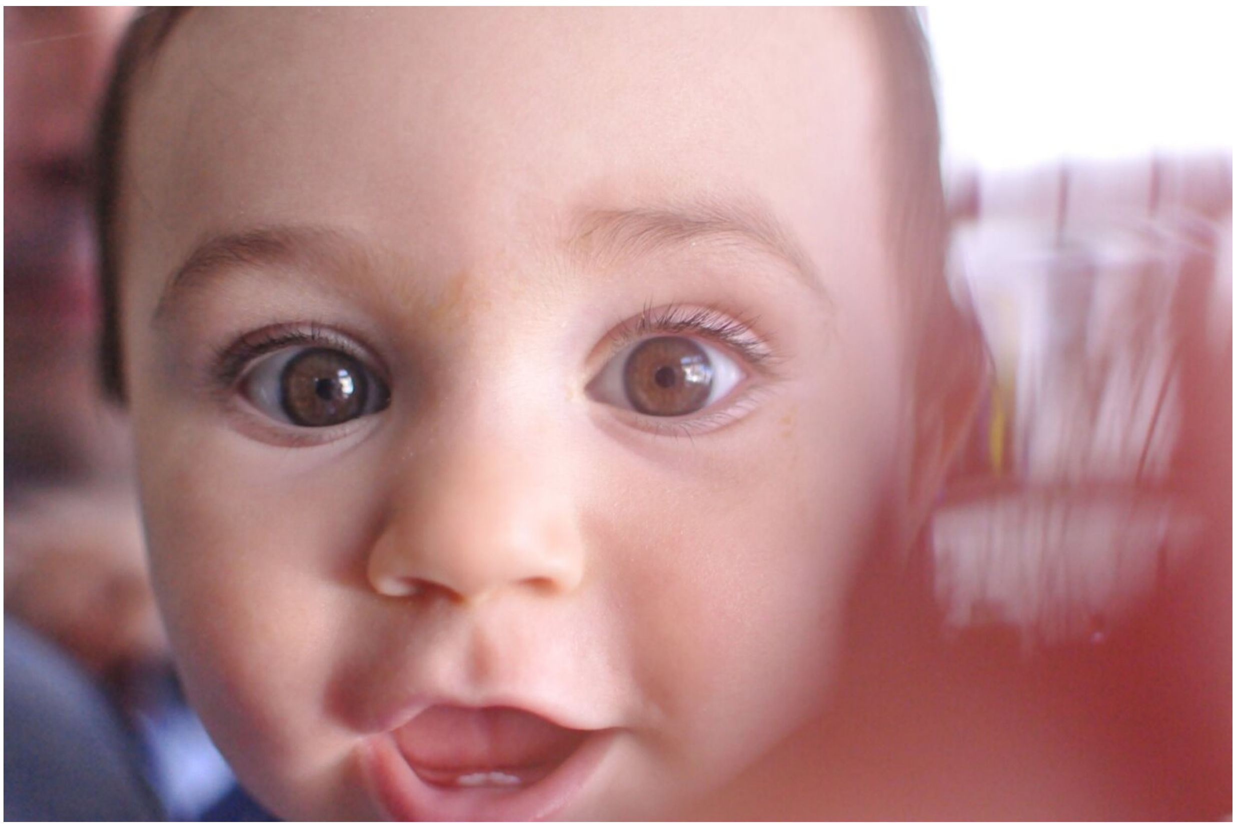

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Brain function, much like many other areas of life, is all about balance. Excitatory neurons that increase the activity of connected neurons are balanced by inhibitory neurons that dampen this activity. In this way, excitation and inhibition work together throughout the brain to process information and guide behavior. An imbalance of these systems, which can sometimes arise during development, contributes to neurodevelopmental disorders such as autism. Until recently researchers have mostly focused on excitatory neurons, while the function and development of inhibitory neuronal circuits has been understudied.

New research from the Max Planck Florida Institute for Neuroscience demonstrates that inhibitory and excitatory neuronal circuits of the visual system develop through different processes, even if the organization of the mature circuit is similar. These findings, published in *Nature Communications* highlight the importance of the continued study of the development of these two systems, the understanding of which is fundamental to comprehending neurodevelopmental disorders.

An area of the brain that processes visual information, the primary visual cortex, is highly organized, forming patches of neighboring neurons that tend to be active together and respond to similar visual features. In mammals, these modular functional maps consist of both excitatory and inhibitory neurons that work together to create an accurate representation of the world.

Scientists Jeremy Chang and David Fitzpatrick have now characterized the development of these functional maps for inhibitory neurons in primary visual cortex. Although excitatory and inhibitory functional maps are matched at maturity, their development occurs through different parallel processes.

Excitatory neurons show modular organization early on, before the eyes open and visual input is received. Neighboring neurons respond to visual images in a correlated fashion and show similar preferences for stimuli presented in specific orientations. While visual experience refines particular properties of these maps, such as the alignment of visual information from each eye, the basic features of the modular organization are present before visual experience.

Dr. Chang found that inhibitory neurons, on the other hand, lack much of this modular activity before visual experience. "This came as a surprise," he admitted. "We were not expecting the functional maps seen before eye-opening in excitatory neurons to be almost absent in inhibitory neurons." This suggested that developing mature functional organization of inhibitory neurons requires visual experience. In fact, if visual input was delayed, the development of many features of the functional inhibitory neuron maps was also delayed.

This work contributes to the fundamental understanding of larger questions about the role of inhibition in the cortex, which the lab will continue to pursue. "New techniques developed over the last decade have allowed us to image the activity of inhibitory neurons in response to visual images. We are beginning to understand the functional importance of inhibition in visual processing and how the role of inhibition changes throughout development. During development, inhibitory and excitatory neurons have to solve different puzzles to end up in the correct place, connect to the appropriate partners, and refine their connections in response to experience," said Chang. Future work will focus on understanding how these puzzles are solved.

More information: Jeremy T. Chang et al, Development of visual response selectivity in cortical GABAergic interneurons, *Nature Communications* (2022). DOI: 10.1038/s41467-022-31284-6

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