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PRESS RELEASE

Vision: observing the world during childhood affects the rest of life

Research conducted by SISSA shows the key role of the first visual experiences in teaching the brain 'how to see'. This finding has important implications for understanding the mechanisms of cerebral development, with possible clinical and technological applications. The study was published in *Science Advances*.

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Much of what we will be as adults depends on the first years of life, on what we simply observe happening around us and not only on what we are taught explicitly. This also applies to the development of the visual system. This is the conclusion reached by two neuroscientists of SISSA (Scuola Internazionale Superiore di Studi Avanzati), who, for the first time, have experimentally shown the importance of passive visual experience for the maturation and the proper functioning of some key neurons involved in the process of vision. The research, published in *Science Advances*, is a fundamental step towards understanding learning mechanisms during development. It also has potential clinical implications, for the study of new visual rehabilitation therapies, and technological implications, where it could lead to an improvement of the learning algorithms employed by artificial vision systems.

From the early stages of gestation, our visual system is subject to continuous stimuli that become increasingly intense and structured after birth. They are at the centre of the learning mechanisms that, according to some theories, are fundamental to the development of vision. "**Learning comes in two flavours: either 'supervised' (i.e., guided by a 'teacher') or 'unsupervised' (i.e., based on spontaneous, passive exposure to the environment)**" explains Davide Zoccolan, director of the Visual Neuroscience Lab of SISSA and lead researcher. "The first is the one we can all associate with our parents or teachers, who direct us to the recognition of an object. The second one happens spontaneously, passively, when we move around the world observing what happens around us."

Giulio Matteucci and Davide Zoccolan have studied the role of spontaneous visual experience and, in particular, the role of the temporal continuity of visual stimuli. This property of natural visual experience is considered fundamental for the maturation of the visual system by some theoretical models that mathematically describe the biological learning processes.

To test this hypothesis, the researchers daily exposed two groups of young rodents to different visual environments. "We played a series of videos, in either their original version or after randomly shuffling the single frames (or images), thus destroying the temporal continuity of visual experience" explain the scientists. "**In the subjects exposed to this discontinuous visual flow we observed the impairment of the maturation of some cells of the visual cortex called 'complex'.** These neurons play a key role in visual processing: they allow recognising the orientation of the contour of an object regardless of its exact position in the visual field, a perceptual ability that only recently has been implemented in artificial vision systems. Having shown that their maturation is highly sensitive to the degree of continuity of visual experience is the first direct experimental confirmation of the theoretical prediction".

These observations show the importance of passive visual experience for the development of the visual system. They also indicate how forms of spontaneous learning are at the base of the development of at least some elementary visual function, while other forms of learning only come into play later, due to the acquisition of more specific and sophisticated skills.

These are results with potential clinical and technological implications, as Zoccolan explains. "In some developing countries, there are children suffering from congenital cataract, who, after the surgery to remove it, have to develop substantially from scratch their visual recognition skills. Already today, some rehabilitative approaches exploit the temporal continuity of specific visual stimuli (for example, geometric shapes in motion) to teach these patients to discriminate

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visual objects. Our results confirm the validity of these approaches, revealing the neuronal mechanisms behind it and suggesting possible improvements and simplifications," concludes the neuroscientist. "Furthermore, the development of artificial visual systems currently uses mainly 'supervised' learning techniques, which require the use of millions of images. Our results suggest that these methods should be complemented by 'unsupervised' learning algorithms that mimic the processes at work in the brain, to make training faster and more efficient".

USEFUL LINK
Full paper:
https://advances.sciencemag.org/

IMAGE
Credits: Nightowl from Pixabay

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