Face detection in untrained deep neural networks

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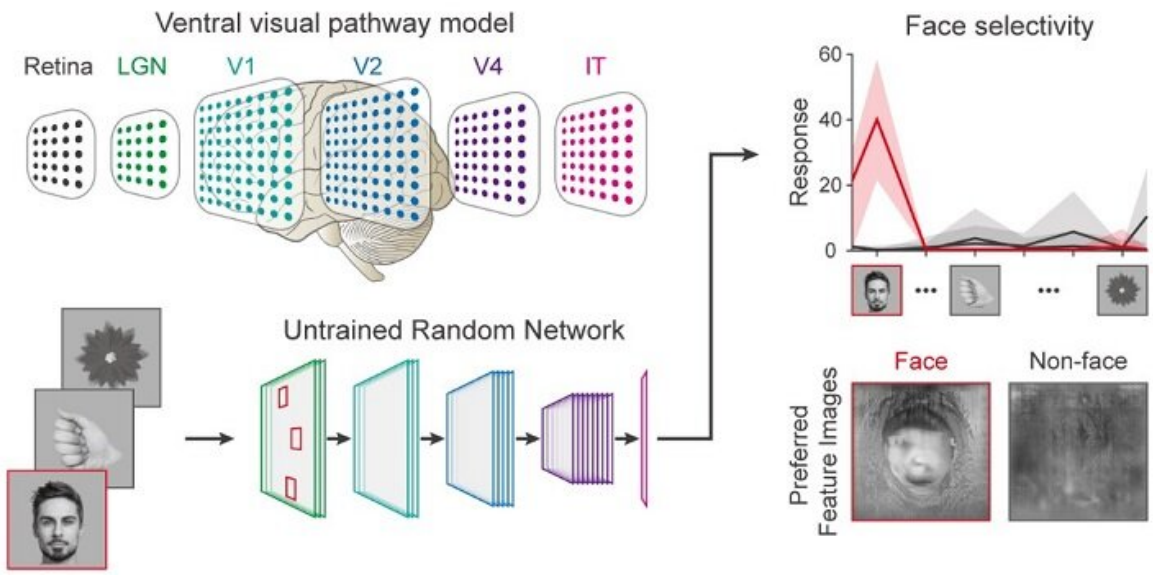

Credit: The Korea Advanced Institute of Science and Technology (KAIST)

Researchers have found that higher visual cognitive functions can arise spontaneously in untrained neural networks. A KAIST research team led by Professor Se-Bum Paik from the Department of Bio and Brain Engineering has shown that visual selectivity of facial images can arise even in completely untrained deep neural networks.

This new finding has provided revelatory insights into mechanisms underlying the development of cognitive functions in both biological and

artificial neural networks, also making a significant impact on our understanding of the origin of early brain functions before sensory experiences.

The study published in *Nature Communications* on December 16 demonstrates that neuronal activities selective to facial images are observed in randomly initialized deep neural networks in the complete absence of learning, and that they show the characteristics of those observed in biological brains.

The ability to identify and recognize faces is a crucial function for social behavior, and this ability is thought to originate from neuronal tuning at the single or multi-neuronal level. Neurons that selectively respond to faces are observed in young animals of various species, and this raises intense debate whether face-selective neurons can arise innately in the brain or if they require visual experience.

Using a model neural network that captures properties of the ventral stream of the visual cortex, the research team found that face-selectivity can emerge spontaneously from random feedforward wirings in untrained deep neural networks. The team showed that the character of this innate face-selectivity is comparable to that observed with face-selective neurons in the brain, and that this spontaneous neuronal tuning for faces enables the network to perform face detection tasks.

These results imply a possible scenario in which the random feedforward connections that develop in early, untrained networks may be sufficient for initializing primitive visual cognitive functions.

Professor Paik said, "Our findings suggest that innate cognitive functions can emerge spontaneously from the statistical complexity embedded in the hierarchical feedforward projection circuitry, even in the complete absence of learning."

He continued, "Our results provide a broad conceptual advance as well as advanced insight into the mechanisms underlying the development of innate functions in both biological and artificial neural networks, which may unravel the mystery of the generation and evolution of intelligence."This work was supported by the National Research Foundation of Korea (NRF) and by the KAIST singularity research project.

More information: Seungdae Baek et al, Face detection in untrained deep neural networks, *Nature Communications* (2021). DOI: 10.1038/s41467-021-27606-9

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