

When output becomes part of input

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Neurofeedback is a technique used for the treatment of clinical disorders (like depression, anxiety, chronic pain, ADHD and schizophrenia etc.) and enhancement of brain performance. It is based on the "self-regulation" of brain activations underpinned by the principles of feedback control systems. Feedback systems can be found in areas such as cybernetics, industrial automation, quality control, optimization and so on. SISSA Trieste researcher, Moses Sokunbi, has reviewed the literature on feedback control systems and neurofeedback in order to provide some insights into how the basic principles of feedback control systems are the building blocks of the advanced brain-computer interfacing technique popularly dubbed "neurofeedback". This article would be particularly useful as an introduction to people who do not know about neurofeedback.

"Those working in neuroscience who are interested in [neurofeedback](#) often have no way of studying the [technique](#) within the broader framework of a feedback system and its theoretical foundations," says Moses Sokunbi, Researcher at the International School for Advanced Studies (SISSA) in Trieste. "The risk is missing out on potential and innovative applications."

In neurofeedback, before understanding how to use fMRI or EEG etc., it is helpful to have a grasp of the logic behind the [control systems](#), which are applied in the most varied of spheres, from cybernetics to electronics. "The basic idea is that system output becomes part of the input," says the researcher. For example, imagine a system in the brain that controls your legs while walking. In addition to sending motor signals for making the walk efficient, the system needs proprioceptive information on the position of the legs, which changes during movement. This information is a product of the motor signal and the output of the system itself. In this way there is a continuous flow of information.

"With neurofeedback, patients are given information about brain activations that may be linked to their particular clinical disorder, for example depression or anxiety. The most innovative version of neurofeedback currently uses simultaneous real-time functional MRI and EEG, but traditional neurofeedback is based on EEG. With neurofeedback, individuals can gradually begin to control their own brain signals, thus reducing their state of depression or anxiety."

In his work, Sokunbi examined a large number of studies carried out in different areas of EEG and fMRI neurofeedback, thus revealing basic subsystems (open-loop and closed-loop feedback) of the neurofeedback technique which would be relevant to the learning and understanding of those just beginning to engage with the technique. "When I began studying this technique I thought of how useful it would be to have a basic overview of the neurofeedback technique with respect to its underlying principle. I hope my work becomes a useful tool for others." The review was published in the journal *Magnetic Resonance Imaging*.

More information: Moses O. Sokunbi. Feedback of real-time fMRI signals: From concepts and principles to therapeutic interventions, *Magnetic Resonance Imaging* (2016). [DOI: 10.1016/j.mri.2016.08.004](#)

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