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Can a bacterium learn from its mistakes?

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New research from has shown that single celled organisms can be capable of learning new behaviours in response to a stimulus.

The European team, led by researchers from the University of Birmingham have developed mathematical model of how learning in a single celled organism might operate. They also offer several ways that this concept can be applied in the lab.

The paper is published in the Journal of the Royal Society Interface.

This associative learning, most famously demonstrated in Pavlov's dog experiments, was previously thought to animals with a nervous system. In this model dogs were able to learn associations between the sound of a bell (the "conditioned stimulus") and the smell of food (the "unconditioned stimulus").

However, the researchers have developed a molecular model that allows learning to function in a single cell organism. These 'molecular circuits' rely on chemical reactions rather than networks of neurons. The responses of a network of regulatory genes allow the cell to undertake a type of associative learning in response to chemical stimuli.

The researchers also offer experimental applications of this model that can be applied in the lab. One approach using artificial gene constructs ("plasmids") could allow artificially adapted E. coli bacteria that are capable of "learning" associations between chemicals in their environment, and then report the effects back to the researcher in the lab.

Dr Chrisantha Fernando who led the research explains: "People are extremely familiar associative learning in animals. But there is no reason why it should not be possible in far simpler animals that don't have a central nervous system. In our model networks of neurons are replaced with specific genes, their products and their promoters.

Essentially what we see is a circuit, which learns to associate two inputs together."

Dr Dov Stekel from the University of Birmingham School of Biosciences adds "The potential uses of this kind of circuit are tremendous. One possibility would be using these circuits as intelligent biomarkers to provide information for researchers about the chemical reactions going on in an individual cell.

A more advanced idea would involve using a bacterial system that would learn to release a drug or other substance based on the stimulus it received. This could open up for systems to learn to release a drug for the maximum benefit of that patient."

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Dr Chrisantha Fernando is available for interview

NOTES TO EDITOR

The paper

The full title of the paper is: Molecular circuits for associative learning in single-celled organisms

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Christian Beck4, Thorsten Lenser4, Dov J. Stekel1 and Jonathan E. Rowe – It is published online in the Journal of the Royal Society Interface.

The research team

The research team includes staff from the Systems Biology Centre, and School of Computer Science, University of Birmingham, Techniche Universiteit Eindhoven, The Netherlands, Systems Analysis Group, Friedrich Schiller University Jena, National Institute for Medical Research, Mill Hill, London.

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