Modeling *Paramecium* obstacle avoidance

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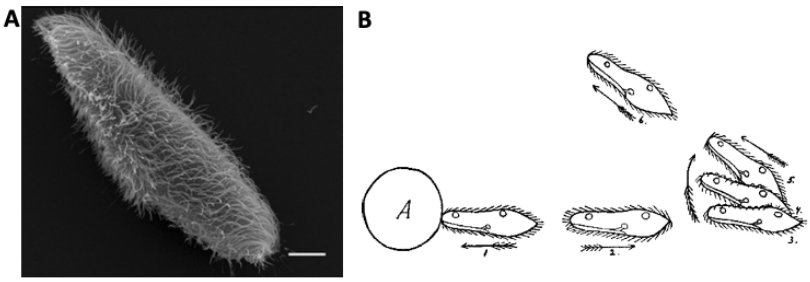
Paramecium is a unicellular organism that swims in fresh water by beating thousands of cilia. When it is stimulated (mechanically, chemically, optically, thermally…), it often swims backward then turns and swims forward again. This "avoiding reaction" is triggered by a calcium-based action potential. For this reason, some authors have called *Paramecium* a "swimming neuron" (Brette, 2021). This project belongs to a broader project aiming at developing integrative models of *Paramecium*, bridging physiology and behavior. This is a collaborative effort between the labs of Romain Brette (neuroscience, Vision Institute), Alexis Prevost et Laetitia Pontani (physics, Laboratoire Jean Perrin) and Eric Meyer (genetics, Ecole Normale Supérieure), in Paris. The team has already developed experimental techniques (behavior and electrophysiology), including a device to immobilize *Paramecium* for electrophysiology experiments (Kulkarni et al., 2020), and a basic biophysical model of the action potential and electromotor coupling.



A, Scanning electron microscopy image of Paramecium tetraurelia (scale bar: 10 µm) (Valentine et al., 2012). B, Avoiding reaction against an obstacle, as illustrated by Jennings (Jennings, 1906).

This is mainly a theoretical project that aims at understanding how *Paramecium* interacts with an obstacle. To avoid complications with hydrodynamics, the obstacle will be chemical (e.g. a drop of acid). First, the student will measure trajectories of *Paramecium* at the interface with an obstacle. Second, the student will study an integrated model of the action potential with electromotor coupling, to understand under what conditions the organism can quickly avoid the obstacle (as opposed to moving back and forth against the obstacle).

The project can be adapted to the duration of the project and the profile of the student.

Brette R (2021) Integrative Neuroscience of Paramecium, a "Swimming Neuron." eNeuro 8:ENEURO.0018-21.2021.

Jennings HS (1906) Behavior of the lower organisms. New York, The Columbia university press, The Macmillan company, agents; [etc., etc.].

Kulkarni A, Elices I, Escoubet N, Pontani L-L, Prevost AM, Brette R (2020) A simple device to immobilize protists for electrophysiology and microinjection. Journal of Experimental Biology 223.

Valentine MS, Rajendran A, Yano J, Weeraratne SD, Beisson J, Cohen J, Koll F, Van Houten J (2012) ParameciumBBS genes are key to presence of channels in Cilia. Cilia 1:16.