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How cells jump: Ultrafast motions in the single-celled microorganism Halteria grandinella[1] DEEPAK KRISHNAMURTHY, Stanford University, FABIEN COCKENPOT, Ecole Polytechnique, MANU PRAKASH, Stanford University — Here we describe a novel behavior of "jumping" in microorganisms, observed in the common freshwater ciliate Halteria grandinella. This organisms swimming motion is characterized by periods of forward swimming at around 10 body lengths/s punctuated by extremely rapid backward "jumps" where the organism reaches speeds of more than 150 body lengths/s. We show, using detailed measurements of the swimming motion through high-speed video microscopy, that the extreme swimming speeds are achieved by the motile cilia transitioning to a beating mode characterized by a significantly larger beat amplitude and an associated reversal in the direction of thrust production. We further show that H.grandinella cells can sense a fluid shear stress signal and "jump" in response: a possible predator avoidance mechanism. We investigate this mechanism of shear sensing and study the role of the long, slender structures known as "cirri" as microscale sensors of shear stress. The jumping of H.grandinella is at the limits of the metabolic rate of the organism and thus offers insights into the limiting factors governing energy storage and mechanical power release at the microscale. Concurrently their sensing apparatus allows an understanding of the physical limits of microscale mechanical sensing.

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