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Mechanical origins of rightward torsion in early chick brain development[1] ZI CHEN, Dartmouth College, QIAOHANG GUO, Fuzhou University, ERIC DAI, LARRY TABER, Washington University — During early development, the neural tube of the chick embryo undergoes a combination of progressive ventral bending and rightward torsion. This torsional deformation is one of the major organ-level left-right asymmetry events in development. Previous studies suggested that bending is mainly due to differential growth, however, the mechanism for torsion remains poorly understood. Since the heart almost always loops rightwards that the brain twists, researchers have speculated that heart looping affects the direction of brain torsion. However, direct evidence is lacking, nor is the mechanical origin of such torsion understood. In our study, experimental perturbations show that the bending and torsional deformations in the brain are coupled and that the vitelline membrane applies an external load necessary for torsion to occur. Moreover, the asymmetry of the looping heart gives rise to the chirality of the twisted brain. A computational model and a 3D printed physical model are employed to help interpret these findings. Our work clarifies the mechanical origins of brain torsion and the associated left-right asymmetry, and further reveals that the asymmetric development in one organ can induce the asymmetry of another developing organ through mechanics, reminiscent of D'Arcy Thompson's view of biological form as "diagram of forces".

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