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A computational model of neural crest chain migration provides mechanistic insight into cellular follow-the-leader behavior

Follow-the-leader chain migration is a striking cell migratory behavior observed during vertebrate development, adult neurogenesis, and some cancer metastases. An example of chain migration is found in the embryonic neural crest (NC), a multipotent, invasive cell population. Although some aspects of chain migration have been well described, the mechanisms involved in the persistence of NC cell chain migration are unclear. We developed a quantitative agent based modeling framework to investigate three distinct model mechanisms of chain migration. The models relied on biological data from the NC and involved extracellular matrix and cell contact mediated promotion of chain migration. Sensitivity analysis revealed specific criteria for high chain migration persistence and suggested possible mechanism that may sustain follow-the-leader behavior. Our approach offers a means to test mechanistic hypotheses of collective NC cell chain migration in an in silico framework that is applicable to studying collective chain migration in other biological systems.