Motile behavior of cells in microfluidic cell culture

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Cell motility, the self-generated movement of individual cells, presents a fascinating display of the autonomy known as life and is also involved in important biological functions such as wound healing, embryonic development and cancer metastasis. The motion of isolated individual cells has been studied extensively during the last decades, but cells in biologically relevant contexts are often in close proximity with other cells. Using a combination of high-throughput microfluidic cell culture and a physics-based quantitative model, we have investigated the social behavior of mammalian cells at the single-cell level. The cells in the population exhibit diverse motile behavior: All cells are observed to move, displaying abnormal speed distributions at both the single-cell and population level. Large variations in the space sampled by the individual cells during the experiments are also observed, with some cells moving along curved paths, other following almost straight lines, and yet other seemingly rocking back and forth. We interpret the behavior as arising from each cell secreting attractants, but cells in contact repelling each other, with individual-cell motion being achieved by the generation of protrusions, known as pseudopods, which adhere to the substrate surface. Using a quantitative, causal and predictive individual-cell-based mechanistic model we find evidence that the very varied motile behaviors all are a direct consequence of a few motility rules.