Bio–cinema verité?

Animations of biological processes are superb tools for science outreach and communication and can be useful in research too. But we need better ways to tell which parts of an animation are based on data.

In a darkened conference hall, on the fourth day of an intense scientific meeting, one may admit to being seduced when a speaker shows a video animation of their ideas. Understanding what the speaker means becomes almost effortless. It is no longer necessary to translate complex concepts from words to images. Suddenly, one simply sees. At the same time, animations inevitably can—and should—engender doubt. How much of that moving picture is data, and how much is imagination holding the data together?

Ideas about biology are appositely represented as movies. Molecules and cells exist and interact in time and space in ways that are not fundamentally different from (though often more crowded and stochastic than) the macroscale world in which human beings operate. And people are instinctively able to assimilate vast amounts of information when it is presented visually.

Indeed, biological animation is a growing field, driven in part by software development in the entertainment and games industries. Its practitioners ideally bring together scientific fluency, artistic ability, computer savvy and specialized technical training. Some animators operate independently, putting together visual reviews of the available literature on a biological process: DNA replication, say, or kinetochore movement during cell division. Others work closely with individual scientists, helping them to visualize and communicate their work. Companies provide medical and biological animations for clients. There are university programs that offer courses of study in this field.

Biological animations may even prove valuable as research tools. Making a scientifically solid animation requires first of all that one bring together many types of data and consider critically the sum of what is known about the biological process or entity in question. It typically demands quantification and greater precision than a verbal description of data snapshots; scientists who make such animations frequently say it pushes them to go back and look more carefully at the data. And it can reveal errors or gaps in one's thinking simply as a consequence of visualizing a process in three dimensions.

But the extent to which animations represent actual data can vary quite widely, depending on how much is known about the process being modeled and on the goals of the animator. Some depict mathematical calculations, such as molecular dynamics simulations of the positions of every atom in a biological molecule based on fundamental physical laws. Alternatively, an animation may be an almost entirely speculative exercise. Most often, they are something in between: attempts to visually synthesize patchy experimental data—whether structural, biochemical or imaging data, or all three and more—about a molecular or cellular process.

Just as for static illustration, the act of clearly rendering a complex and imperfectly understood dynamic process involves many scientific, aesthetic and design decisions. The degree to which artistic license is justified varies depending on the purpose for which the video is made. This makes it unrealistic to require that biological animations be standardized.

But the rhetorical power of these models means that transparency and rigor can be particularly important. Some relatively simple steps—showing a bibliography, perhaps, or interactively indicating the types and sources of data that have informed design decisions—could make the scientific heft of an animation (or the lack of it) more apparent to the viewer.

This would help viewers of different types, in different ways. Animations are an excellent way to engage students, funders, politicians and the general public, but not everyone necessarily shares the unspoken understanding among experts that models are not the same as reality. Even for experts, the potent ability of a realistically rendered movie to convince one's peers (or oneself) that a biological process works just so should not be too lightly dismissed. Scientists may be intrinsically skeptical, but we too are visual creatures after all, prone to believing the evidence of our eyes. And paradoxically, the inability to distinguish between the parts of an animation that are data and those that are make-believe could promote excessive skepticism in some cases just as it promotes naive acceptance in others.

As animation in biology becomes more common and more prominent as a means for data integration, some vigilance will be needed to keep it faithful to the contingent and iterative nature of the scientific process. Many could benefit from knowing which animations are just pretty pictures and which are more than that.

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