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Communicating Science

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Communicating Science: Lessons from Film

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Films engage us visually, aurally, viscerally, and emotionally. Incorporating science themes into films has the potential to open up new audiences to scientific ideas, pique their interests, and inspire them to engage in a broader discussion of the science itself. Here, I discuss several narrative techniques and strategies employed in film to effectively engage the audience around science themes, which may be useful tools for scientists looking to become better communicators.

Embracing Creative License

Scientific concepts and information reach the general public through a variety of channels, from formal education to digital media and the arts. One of the most powerful of these channels is film, which engages the viewer at multiple levels and reaches a potentially vast audience. The advent of computer-generated imagery (CGI) technologies has further expanded the visual range of film as a medium and as a tool for science communication. As scientists trained to focus on precision and accuracy in communication, we may often find ourselves responding to films by targeting inaccuracies or oversimplifications. I find it is more interesting to discuss the techniques involved in incorporating science seamlessly into storytelling, considering both the challenges and the opportunities science and storytelling offer one another. It is true that writers of screenplays often take liberties and use creative license, making a choice to bend scientific facts to fit the emotional demands of good storytelling. However, even these inaccuracies represent a form of engagement with science. Incorporating scientific themes into films, whether accurately or otherwise, has the potential to open up new audiences to scientific ideas and inspire them to engage in a broader discussion of science itself, which is invaluable. A good film can also teach scientists how to become better communicators and storytellers themselves, by revealing the human-interest and emotional core at the heart of a science-driven story.

Weaving Science into Film

Telling a good story remains the central challenge of filmmaking, whether or not a film is about science. In the best films, the central characters undergo conflicts of interest, struggles, or other challenges that engage the pathways in our brains related to empathy, triggering feelings of solidarity and affinity. The more engaged an audience is with the arc of a story and its characters, both emotionally and intellectually, the more likely they are to absorb and connect with the ideas that drive the story, including scientific concepts. However, those concepts rarely inhabit the world of the film for their own sake; instead, they serve as devices to drive the dramatic conflicts and character development forward. Stories only assist with science outreach as much as the science itself contributes to those stories.

Our brains have evolved a deep hunger for stories to help make sense of our social environment. The brain is a restless organ, always looking for patterns and craving closure and wanting to know how the story ends. Filmmakers are in the business of satisfying these narrative cravings via a process biologists call 'supernormal stimuli' or the artificial design of an enhanced stimulus that triggers an extreme version of an evolved response [1]. Even if a filmmaker's primary objective is to engage with the science, too much didacticism and detail will cause many viewers to lose interest. Filmmakers do not have the luxury of a captive audience with an obligation to pay attention, as in a classroom setting. Rather they are purveyors of entertainment, escapism, and diversion. At its core, entertainment is primarily a process of evoking an emotional response from an audience, whether amusement, awe, fear, intrigue, or any other neurochemical state that remains part of our evolutionary repertoire. And as researchers have demonstrated, our brains are better at retaining information when that information is tagged with a strong emotion [2,3]. Hence, simply 'communicating' scientific information will never be as effective as smuggling that information past the cognitive sentries dressed in an emotionally-charged disguise.

In addition to this intuitionist model of science communication, we should also acknowledge a growing public interest in science for science's sake, which complements but does not replace the need for good storytelling. This interest has been facilitated by the advent of the internet and the reference power of Google and Wikipedia, all of which brings science closer to the center of our public conversations. As a result, general audiences are demanding better science in their fiction, and at the same time filmmakers are hewing closer to real science, a virtuous circle that has produced a recent boom in excellent science films. Howling inaccuracies are still occasionally glossed over – my favorite example is the plot-triggering line 'the neutrinos have mutated!' from the Roland Emmerich film *2012* [4] – but people are becoming more likely to notice these liberties and filmmakers know they are more likely to be called out. Of course, audiences remain willing to forgive a certain degree of inaccuracy for the sake of creative license. A parallel but somehow less offensive butchering of science for the sake of story occurs in the opening scenes of *The Martian* [5] when Matt Damon's character is injured in gale force winds, which of course would be impossible with

Mars' thin atmosphere. However, instead of just ignoring this oversight, it led to a press release from NASA [6][i] and a series of popular science articles [7][ii], as well as a frank discussion from the writer, Andy Weir, on NPR about why he felt this was a fact worth distorting [8][iii]. As a result, we have all learned more about Mars, which is a point for science.

In areas where the science is unsettled, there is even more forgiveness of poetic license. In *Interstellar* [9], Matthew McConaughey's character communicates with his daughter by time traveling his consciousness from within the center of a black hole, and then escapes the black hole with his physical body intact. This contradicts pretty much everything we know about both the neuroscience of consciousness and the physics of black holes. But since those are both areas of active frontier investigation, we remain somewhat willing to shrug and think 'hey, maybe it could happen'. Also, as a device it serves the story much better than watching McConaughey get squashed like a bug, so the audience willingly 'suspends disbelief' and goes along with it. Obviously there is a line to be drawn when allowing for this kind of creative license. For instance, a feature film about heroic investigators who uncover a conspiracy to conceal the link between vaccines and autism (which in fact does not exist) would be a public health disaster. Filmmakers have a responsibility to avoid perpetrating dangerous myths and stoking hysteria. My personal least favorite film distortion is the tagline for the film *Lucy* [10], which claims we only use 10% of our brain, a claim that is both false and pernicious since it makes us more vulnerable to purchasing unsubstantiated 'cognitive enhancement' services with no basis in science.

The National Academy of Sciences recently established 'The Science & Entertainment Exchange' [11] [iv], an important program that connects scientists with entertainment industry professionals 'to create a synergy between accurate science and engaging storylines in both film and TV programming'. In my capacity as a committee member, I have been fortunate to have consulted on scripts and treatments, gaining insight into the influence science is exerting on the entertainment industry, as well as the way entertainment is influencing science. This is a reciprocal relationship – for example, during the production of *Interstellar* [9] and also *Avatar* [12], new technologies were developed to help create the visual world of each film, technologies that become part of the library of science and in turn go on to affect the next generation of films. From a wider perspective, both science and the arts are quintessentially human endeavors, and science in particular is one of the greatest adventure stories of our time. Science is not just about pushing the boundaries of knowledge (which is exciting enough for its own sake); scientific discoveries also transform our lives and our relationships, a process that generates endless possibilities for drama. More and more, filmmakers are catching on to the power of science as a narrative engine, which makes this a very rewarding time to be both a scientist and a film buff.

The *Science Goes to the Movies* Experience

As co-host of the PBS and CUNY TV series *Science Goes to the Movies* (SGTTM) (along with media personality and author Faith Salie) [13][v], I use film as a platform to bring scientific ideas to the general public (e.g., [14][vi]) (Figure 1). SGTTM is a Siskel and Ebert-style film review talk show, but with a specific focus on science. We review films and TV shows that play a central role in popular culture from a scientific perspective, including both contemporary films and TV shows, as well as films that were popular in the past with scientific themes. We also have expert guests on the show to discuss the technical aspects of the science explored in the films. To exemplify how films can be used as a conduit for science communication, I will discuss a few examples of how we have been weaving together science and film on the set of SGTTM. In Box 1, I include a selection of other movies that SGTTM has reviewed, highlighting the scientific context in which these films were discussed.

In the first episode of SGTTM we reviewed the films *Interstellar* [9] and *Theory of Everything* [15], which sparked a discussion with astrophysicist Dr Emily Rice who gave us a short introduction to black holes, astrophysics, and space time as they relate to these two films. However, not all the films we review on the show have such a direct or obvious connection to science; with a careful eye you can find science everywhere. For example, we also reviewed *Birdman* [16] in the same episode and discussed the science of hallucinations in relation to the film's lead character Riggan Thomson, played by Michael Keaton. We discussed the phenomenology of hallucinations, how they are instantiated in the brain, and the fine line between objective reality and subjective experience. When a person loses the ability to distinguish between stimuli that are being generated externally and those that are being generated internally, that is when hallucinations arise, and that is also when conflicts begin to arise between a person's internal and external world.

Birdman, via Riggan's psychosis, offers the audience a powerful insight into what it feels like to experience hallucinations in a high stakes environment, a mix of exhilaration and terrifying confusion. The film is visually immersive and uses long, continuous camera shots weaving in and out of scenes, from backstage to onstage and back again, to bring the viewer into Riggan's first-person experience. When my colleagues and I study hallucinations in the lab, we are mostly working from a person's verbal descriptions while observing both their behavior and their brain activity, but we cannot directly verify their subjective experiences via either of these data sources. Given our current limitations in this field, *Birdman*'s director Alejandro González Iñárritu does a masterful job of

Figure 1. With Co-Host Faith Salie on the Set of PBS/CUNY TV's *Science Goes to the Movies*.

bringing the viewer viscerally into the first-hand experience of hallucination, along with the attendant breakdown in social functioning.

Several storytelling devices combine to make *Birdman* – winner of the 2015 'Best Picture' Academy Award – an outstanding vehicle for exploring the science of hallucination. First, as Oliver Sacks makes clear in his book *Hallucinations* [17], the experience of hallucinations is not an immediate 'descent into madness' but is instead a mundane and commonplace occurrence, regularly experienced by many high-functioning people, including Sacks himself. By situating Riggan in the midst of a career crisis, an identity crisis, and the most high-pressure environment imaginable, we get to see not only the impact of the hallucinations but also his deft ability to manage them and get on with his work. Second, telling the story with long, continuous scenes highlights the seamless integration of hallucination and reality in the mind of the afflicted, which takes an increasing toll on Riggan's ability to function as the film progresses. And finally, the deliberate ambiguity at the end of the film, with Riggan's daughter gazing up at him in wonder as he flies away, leaves the viewer questioning their own grip on reality, since there is no perspective from which this conclusion fully 'makes sense'. The potent effect is to force us to review and question everything we have just witnessed, and reassess our assumptions about what was and was not 'real', which places the audience in precisely the situation of a hallucinator.

Weaving Storytelling into Science

The above films employ techniques of narrative, perspective, and character interaction that draw us into their stories, and those techniques are also available to scientists when communicating our work, to varying degrees. For any discovery in any field, we can ask a series of questions that will lead us to new insights into the 'hook' the public needs to connect with and absorb the information. One of the first is: what is the simplest and clearest way of expressing the science I am presenting? Answering this question lies at the heart of science communication, whether it is in the form of a public lecture or an elevator pitch. The next questions follow from putting ourselves empathically in the place of someone to whom the science is brand new, and who does

Box 1. Selected Films and Themes Reviewed on *Science Goes to the Movies*

In The Heart of the Sea (2015) – oceanography and the psychology of anthropomorphism

X-Men: Apocalypse (2016) – genetics and the science of mutation

Inside Out (2015) – the science of emotion, memory, and motivation

The Hunger Games (film series, 2012–2015) – economics and the social psychology of income inequality

Star Wars: The Force Awakens (2015) – the physics of lasers

The Imitation Game (2014) – computer science and cryptography

American Sniper (2014) – the psychology of post-traumatic stress disorder

Mad Max: Fury Road (2015) – automotive engineering and alternative energy

Fifty Shades of Grey (2015) – the psychology of sexual dominance and submission

Ex Machina (2015) – artificial intelligence and the science of consciousness

Ant Man (2015) – nanotechnology

The Martian (2015) – planetary science and colonization of Mars

Concussion (2015) – neurological and psychological effects of brain injury

Independence Day 2: Resurgence (2016) – space travel and the search for extraterrestrials

not yet know why they should care. There is a story in every scientific discovery – a story of achievement by individuals and teams working on a problem or puzzle. We should ask ourselves: was there a surprise in this story? What was sacrificed to achieve these results? How could these findings change someone's life for better or for worse? Who is emotionally invested in the outcome of this research, one way or another? And how could you change the story to amplify any of these factors, by 'tweaking the knobs' of character, situation, history, and outcomes? It may sometimes be necessary to tweak the 'accuracy' knob as opposed to one of the others, but those kinds of thought experiments, counterfactuals, and 'what if' scenarios can often make for the best stories of all.

The three essential phases in a standard film plot are conflict, climax, and resolution. The key questions in understanding character and motivation are 'What does this person want?' and 'How are they going to get it?' Great filmmakers diverge from these formulas deliberately and provocatively, and they do so from a place of deep understanding rather than ignorance, just as Picasso diverges from realism for different reasons than my 2-year old daughter. As scientists, we have a public service responsibility to participate in the communication of our work to the public, so that they can understand both what motivates us and why our work matters to them and to society. Public engagement in science also has the potential to reach policymakers and lead to policy change based on the science. The techniques of filmmaking can aid us in these public services, if we can adopt them into our own science communication activities, including teaching, mentoring, and especially public outreach. And besides that, telling great stories just happens to be a lot of fun.

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Resources

[i] www.nasa.gov/feature/goddard/the-fact-and-fiction-of-martian-dust-storms

[ii] http://news.discovery.com/space/the-martian-winds-wont-blow-you-away-150921.htm

[iii] www.npr.org/2015/09/27/443192327/sandstorms-explosions-potatoes-oh-my-martian-takes-its-science-seriously

[iv] www.scienceandentertainmentexchange.org/about-program

[v] www.cuny.tv/show/sciencegoestothemovies

[vi] http://scienceandfilm.org/articles/2625/beautiful-distortions-fregoli-delusion-in-kaufmans-anomalisa

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