
INTRODUCTION

Having picked this book off the shelf, you're probably asking yourself, "How could there be a neuroscience of zombies?" While yes, zombies do have brains (you have to destroy their brains in order "kill" them, or so the myth goes), we would be hard pressed to make a case that "zombie neuroscience" qualifies as its own field of study. *Neuroscience*—the study of the brain, particularly its relationship to behavior and cognition—already has its fair share of perhaps silly and fantastical "specialty" subfields; why add to the list?

Well, did you know that we neuroscientists have the answer to everything? Regular readers of the Opinion page of the *New York Times* or other popular media outlets will already know that neuroscience can explain why you are in love with your iPhone, why lying to your kids about Santa is a neurologically sound form of parenting, and why inducing a coma leads to proof of heaven. You see, by filtering all of human existence through our very muddy lens we can answer all of life's questions. By our estimates, an fMRI study explaining the meaning of life should be coming out by sometime early 2015 (hint: it involves 42 brain regions). We hate to break it to our colleagues in the fields of philosophy, religion, and physics, but thanks to a few fancy brain imaging machines and a couple of decades of pretty hard thinking about stuff, we neuroscientists now can understand everything, so they'll probably need to seek employment elsewhere.

If neuroscience is the panacea and explanation for everything else, why not the zombie apocalypse? There's a market for that, right?

Let's return to the book you are holding in your hands. It all started one day in the summer of 2010 with a phone call from Matt Mogk, the head of the Zombie Research Society and author of *That's Not Your Mommy Anymore* and *Everything You Ever Wanted to Know about Zombies*. Matt had seen a YouTube video of a lecture Brad had given wherein Brad mentioned how he was raised on a diet of Sega and Marvel Comics. Matt wanted to know if, given Brad's double-barreled love of comic culture and brains, he would be up for exploring the nature of the zombie brain. Brad thought, "Of course . . . and I know just who to ask along on this crazy ride. . . ."

It's been all downhill for us both ever since.

We (Tim and Brad) met while working on our PhDs at the University of California, Berkeley. We briefly collaborated on a noninvasive brain stimulation project that, like many scientific experiments, led absolutely nowhere, but in the process we discovered a mutual love for zombie movies. So in addition to doing real science together, we branched out into the ridiculous world of zombies. We hope you enjoy the ridiculous, and we hope that you don't hold our real science against us.

In all seriousness, this zombie stuff has been a lot of fun. We're both geeks who also happen to be big advocates of science outreach and communication. This is a rare opportunity to combine our geek science and non-science sides. Brad has been going to the San Diego Comic Convention annually for the last decade, and off and on since he was a pimply young teen twenty years ago. Never in his life did he think that his scientific career would lend itself to speaking in front of a crowd of several hundred comic book geeks at that convention (in the same room, in fact, where he gave a *real* neuroscience lecture to a room of *far fewer* neuroscientists at the annual Society for Neuroscience Conference). Tim has been addicted to zombie movies since he first saw back-to-back features of *Night of the Comet* (dir. Thom Eberhardt; 1984) and *Return of the Living Dead* (dir. Dan O'Ban-

non; 1985) as a teenager. It might be said that Tarman¹ brought Tim's attention to brains in the first place.

In the years that we've been talking about the biological basis of zombie behavior, we've been overwhelmed by how much people have gotten into it with us. When you have people coming up to you saying things like "I'm a grown man with a family and a career and you guys made me want to become a neuroscientist!" or "I accidentally started liking science stuff thanks to you!" you know you're onto something. As scientists we spend so much time working on problems that feel disconnected from the public that it's great to know we're finally doing something that resonates with people. Especially if it's goofy.

No, neuroscientists have no idea (biologically) what love is, or where it is stored in the brain. Neuroscience can't prove that you "love your iPhone" (that was a real *New York Times* opinion piece, by the way²). We can't read your minds (yet) or cure Alzheimer's disease (yet).

While neuroscience can't do those things, we hope that two somewhat ludicrous neuroscientists, and a horde of zombies, can make you accidentally learn something, and that in reading this book you might share our sense of the wonder we experience in doing the work we love.

There's no doubt that zombies are hot right now. There's been a lot of discussion as to why, as several of us (Brad, Max Brooks, Matt Mogk, and a few other zombie experts) discussed at a panel at Comic-Con in San Diego in 2011 (Comic-Con is an

¹ Tarman is perhaps the most recognizable zombie in popular culture, single-handedly binding "brains" and "zombies" into the same sentence.

² Martin Lindstrom, "You Love Your iPhone. Literally," *New York Times* Sept. 30, 2011 (http://www.nytimes.com/2011/10/01/opinion/you-love-your-iphone-literally.html?_r=0).

annual gathering of over 100,000 nerds of all flavors and colors). Our favorite explanation for the general surge in zombie popularity is that the world is becoming an increasingly complex place, with new modes of social interaction and communication, increased globalization, social change, unprecedented technological advances, prosperity mixed with uncertainty, and so on. The great thing about the zombie genre in TV, video games, and movies is that it's more or less a blank slate upon which a writer can project any number of big, unfathomable societal and psychological fears or concerns.

Genetic modification? *Zombies*. Atomic weapons and radiation? *Zombies*. Class warfare? *Zombies*. Racism? *Zombies*. Existential crisis and uncertainty of the self or free-will? *Zombies*. Biological experimentation? *Zombies*. Space exploration? *Zombies*. Runaway consumerism? *Zombies*. Pointless violence? *Zombies*. Death? *Zombies*.

Max Brooks once said in an interview with CNN, “You can’t shoot the financial meltdown in the head—you can do that with a zombie. . . . All the other problems are too big. As much as Al Gore tries, you can’t picture global warming. You can’t picture the meltdown of our financial institutions. But you can picture a slouching zombie coming down the street.”³

It is hard to ignore the runaway popularity of the zombie phenomenon. In 2002, *28 Days Later* was released, providing a fresh take on zombie film that helped revitalize the genre. That same year, *Resident Evil* was remastered and rereleased for the Nintendo GameCube to huge critical acclaim.⁴ The following year, in 2003, Max Brooks wrote the very popular *Zombie Survival Guide* that kicked the whole zombie literature genre into high gear. Then, in 2004, *Shaun of the Dead* showed that the zombie genre could also be funny, paving the way for films such

³ <http://www.cnn.com/2009/SHOWBIZ/10/02/zombie.love/index.html?ref=24hours>.

⁴ IGN’s tagline says it all: “The prettiest, most atmospheric and all-around scariest game we’ve ever played”: <http://cube.ign.com/articles/358/358101p1.html>.

as *Fido* (2006), *Zombieland* (2009), and *Warm Bodies* (2013). In the 1980s there had been brief bouts of funny zombie movies, for example *Night of the Comet* (1984) and *Return of the Living Dead* (1985), but none of them hit the level of popularity of the modern zombie-comedy.

Here, in this book, we want to leverage this more comical or farcical take on zombies. The goal of the rest of the book is to use zombies to provide an entertaining platform for understanding (and sometimes making fun of) our field of cognitive neuroscience, and along the way teach the reader about the history of neurological science and about properties of the brain itself. We are not going to use zombies as a metaphor for social ills. Instead we are going to try to understand the zombie by taking a careful look at the range of its behavioral disorders, peeking into the mythical organ that gives rise to all zombie behavior: the zombie brain.

As the lonely graduate student uttered at the beginning of *28 Days Later*, before being torn apart by a zombie ape, “In order to cure you must first understand.”

So here we are, trying to understand. What follows is a collection of neuroscientific facts, historical footnotes, personal anecdotes, and a ton of zombie and pop culture references. In particular, we’ll be making a lot of references to scenes in classic and neo-classic zombie film and literature. Specifically, you will hear plot points from:

Night of the Living Dead (dir. George Romero; 1968)
Dawn of the Dead (dir. George Romero; 1978)
Return of the Living Dead (dir. Dan O’Bannon; 1985)
The Serpent and the Rainbow (book, Wade Davis; 1985)
Evil Dead 2 (dir. Sam Raimi; 1987)
28 Days Later (dir. Danny Boyle; 2002)

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Shaun of the Dead (film, dir. Edgar Wright; 2004)
Land of the Dead (dir. George Romero; 2005)
Fido (dir. Andrew Currie; 2006)
Zombieland (dir. Ruben Fleischer; 2009)
Feed (book, Mira Grant; 2010)
The Walking Dead (TV series, 2010–)
Warm Bodies (dir. Jonathan Levine; 2013)
World War Z (book, Max Brooks; 2006; film, dir. Marc Forster; 2013)

In our descriptions throughout, there will be spoilers. Consider yourself warned.

Actually, we take that back. We recommend you go out right now to watch all of these movies and read all of these books. Go ahead . . . we'll wait.

Are you back? Good. Expect a lot of spoilers ahead!

This work is a mixture of material we have put together from previous projects in other mediums; you may recognize some of our stories from our blogs or talks, but we've collected all the little tidbits here in one nice, concise reference book for your own zombie studies.

Now, fellow scientists of the undead . . . on to the realm of zombie brains!!!