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hear various measures of prevention as all the same, or blur their differences: self-isolation, quarantine, lockdowns and distancing may indiscriminately trigger feelings of social loss, when they could highlight future social benefits.

Our social cravings, actual or anticipated, can have deadly consequences, but there is also an increasingly optimistic aspect of the story. There is growing evidence that the collective menace makes us more socially supportive and cooperative, but now we can reach out — virtually, but no less meaningfully — to neighbours, distant relatives, or even anonymous and purely potential beneficiaries on social media. Politically, this means that access to the internet and communication is a priority, especially when the most vulnerable coincide with the less technologically connected. What will be the effects of this long-term switch to the internet? We are in the midst of a massive ‘real life experiment’ exploring whether our brains, and bodies, can do without physical proximity (see [27] for a preliminary answer). What we get out of this special situation matters as much as how, and how long, we can cope with it.

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## My Word

# The easy way is hard enuff

Andrew Murray

Hell has frozen over. The world is in the grip of a pandemic that has closed down society, shuttered your lab, and threatens to cause millions of deaths and untold economic misery. You're confined to your apartment, labs that have been converted into testing sites have all the volunteers they need, alcohol supplies have dwindled, and you're discovering just how desperately you love experimental science. If someone lined up every complaint you'd ever made about boring techniques, failed experiments, and your idiot advisor and wrote each one on a large, separate piece of paper, you'd happily eat them all if it would let you back into the lab to do your now beloved experiments and get on with your quest for scientific knowledge.

But even this extreme feat of mastication won't let you back into the lab, so what should you do? Learn Python, write a fellowship proposal, read all those papers that you've always been meaning to digest? These are good ideas, but I claim to have a better one, which is to become a better experimentalist from the comfort of your very own couch, plus everyone's favorite new medium, Zoom.

To illustrate, I'm going to call on an English Patient. I was an undergraduate in England and the department that gave my degree had coffee in the morning and tea in the afternoon. At coffee the conversation would run like this: “I have a great idea for an experiment to do this afternoon”; my friend Charlotte “Oh Andrew! I can see three missing controls, four reasons the experiment might fail, and even if it works, it's unclear that any knowledge you gain from success will be worth your time and energy.” Later, at tea, I would present a revised plan with the controls added and a simplified and likelier-to-succeed overall plan, but Charlotte would reply “Well that is an improvement, but I've been thinking too: I see two more missing controls and several more flaws that make your estimates of success wildly too high.”



And I, of course, would return the favor by using the harsh light of reason to make Charlotte's proposed experiments shrivel at a similar rate. Perhaps, after a month of jousting, exactly two nearly perfect experiments would have been done, only to fail because of flaws that neither of us could foresee.

The other extreme is American exuberance, something I absorbed in graduate school. The fundamental idea is that doing more experiments means more results, that flawed experiments can be helpful too, and that stopping for tea and coffee is silly, when you can work frenetically till 10 p.m. and still have the bars open for another four hours to discuss life and science. Like the English Patient, this is a caricature, but every scientist I know will admit that they've had this sinking 11 p.m. sensation: "Oh fiddlesticks, I've just seen the fatal flaw of the experiment I'm about to finish that essentially guarantees that I can learn nothing from it!"

My claim is that you can hold that sinking feeling at bay and increase your post-Covid-19 productivity by doing two things: dissect and critique every experiment that you've done over the last six months, and find good jousting partners to poke English-style holes in these old experiments and all the new ones that you're going to rush to do the moment your lab reopens. Their lances will force you to admit that many, and possibly most, of the last six months' failures should, at least with the perfect vision of hindsight, have been avoided. You should also be asking whether the inferences and conclusions that you drew from the experiments are really supported by the data. Again, if you're honest with yourself, you'll discover that there are logical flaws and alternative interpretations. And if you're not, your jousting partners force you to open your eyes when you try to defend the evidence that supports your future plans.

When you discuss the experiments that you're planning to do, things are likely to be even worse. Your intellectual motivation for individual experiments, entire strategies, and perhaps your overall project will be vigorously questioned. Missing controls will proliferate like desert wildflowers after the spring rain, and convincing arguments for the fallibility

of experiments that you thought were guaranteed to succeed will pop up like molehills on the parental lawn.

One especially useful group of people to talk to are the folks who run core facilities and help with data analysis. In modern science, a lot of work is done by such core facilities: for example, cell-sorting, mass spectrometry, sophisticated microscopy, and DNA and RNA sequencing. Normally, you're too busy to seek the advice of the people who run these facilities until the first and second attempts have failed and your PI is yelling at you about the cost of these experiments. But now you have nothing but time and the staff of the core facilities are in the same boat. Ask them to look over your plans, tell you what quantity and purity of material are needed to produce the data you need, and critique your calculations and assumptions about how your experiments will produce that material.

Doing everything I've advocated will take serious time and effort and it won't be as fun as learning Python. As your plans for your first three months back in the lab and your expectations about what they will reveal shrink, the initial effect on morale may not be positive. But pain and suffering now should have a dramatic payoff in the halcyon world when experimental scientific research begins again. Ask an experienced experimentalist what fraction of their experiments either made it into a paper, or were directly necessary to produce the data in the paper: their answer will be between 5 and 10%. Imagine that three months of rigorous self-flagellation might increase that fraction 1.5-fold, that you will be working at the bench for another eight years, and that it takes two years of work (the optimism of scientists never dies!), at your pre-pause level of productivity, to make a paper. As things were, you would have produced four papers, but if you become 50% more productive, you will, instead, produce six papers. In retrospect you might even think that the three months that you spend in this socially distanced, Zoom-filled hell, were the most valuable ones of your scientific life.

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## Q & A

### Mala Murthy

**What follows is the transcript of interviews with Mala Murthy by the graduate students and postdocs of the Murthy lab (Sama Ahmed, Christa Baker, Adam Calhoun, David (Dudi) Deutsch, Xiping (Lily) Li, Edna Normand, Diego Pacheco, Talmo Pereira, Nivedita Ranagrajan, Shruthi Ravindranath, Fred Roemschied, and Megan Wang). These interviews were conducted over Zoom in April 2020, during the coronavirus pandemic. Mala is grateful to her lab for participating in the Q & A.**

*Mala Murthy is Professor of Neuroscience at Princeton University, leading the Murthy lab in the Princeton Neuroscience Institute. She grew up in Texas and received her BS in Biology from MIT in 1997. She received her PhD in Neuroscience from Stanford University in 2004, working with Thomas Schwarz and Richard Scheller. Her postdoctoral work, which she completed with Gilles Laurent at Caltech, centered on odor coding in *Drosophila* mushroom bodies and opened a new area of investigation into neuronal stereotypy. In 2010, she started her own lab at Princeton University. Her research group consists of computational neuroscientists and experimentalists, who collectively study the many neural processes that underlie animal communication, including detection and recognition of multisensory cues, decision-making, and execution and patterning of motor actions. They discovered that flies engage in dynamic 'conversations': their ongoing actions (for example, courtship song sequences and changes in locomotion) are continually patterned by feedback that they receive from a partner. By leveraging the tools of *Drosophila*, in combination with predictive models of behavior, they have dissected the neural activity and circuits underlying the back-and-forth exchange of information between individuals.*

**Sama: Do you remember the first time that you thought "I could be a scientist"?** Mala: Actually, in high school, everyone (including me) thought that I would become a lawyer (my tendency for not backing down