Science and Society

A Novel Approach to

DECISION-MAKING

INTRODUCTION

Science uses various tools to achieve rational deliberation and productive discussion. These tools are neither taught in schools nor written in books; however, they can prove to be exceedingly helpful and relevant for daily decision-making on personal, social, and political matters. In this interview, we talk with Prof. Saul Perlmutter, Prof. Alison Gopnik, and Prof. Johann Frick about their course, "Sense, Sensibility, and Science" (LS 22), where they attempt to convey these scientific and critical thinking tools to their students in order to help them effectively tackle some of the major controversies we find in the world today.

BY GUNAY KIRAN, CAROLYN QIAN, AND ANANYA KRISHNAPURA

Saul Perlmutter *is a professor of physics and the holder of the Franklin W. and Karen Weber Dabby Chair at the University of California, Berkeley. He shares the 2011 Nobel Prize for his discovery of the accelerating expansion of the universe. Dr. Perlmutter is the leader of the International Supernova Cosmology Project as well as a current advisor on the President's Council of Advisors on Science and Technology. He has served as an instructor for LS 22 since its creation.*

Alison Gopnik *is a professor of psychology and affiliate professor of philosophy at the University of California, Berkeley. Her current research focuses on children's ability to discover the world through their powerful, causal learning mechanisms. Dr. Gopnik is the author of many bestselling books, such as* The Philosophical Baby *and* The Scientist In The Crib. *She has written for various media outlets, including the* New York Times, Science, *and the* Wall Street Journal*'s "Mind and Matter" science column.*

Johann Frick *is an associate professor of philosophy at the University of California, Berkeley. His research focuses on topics in moral and political philosophy, practical reason, and applied ethics. Dr. Frick received his Ph.D. in philosophy from Harvard University, and he previously served as an associate professor in the Department of Philosophy and the Center for Human Values at Princeton University. This is his first semester serving as a professor for LS 22.*

BSJ: What motivated you to create and serve as an instructor for LS 22 (Sense, Sensibility, and Science)?

SP: Almost 10 years ago, we were looking at our society as it was, trying to make decisions about what seemed like fairly practical topics such as the debt ceiling, and we realized that these practical issues were being treated as if they were religious debates. We were not getting any kind of rational deliberation. In general, it felt like many of the discussions in our society could benefit from the tools and styles of deliberative thinking that scientists were taking for granted and using on a daily basis in their discussions. We thought that there should be a way to articulate these techniques that we had unconsciously learned via "osmosis" by way of simply being within a community of scientists. I thought, "We should be able to teach these things explicitly." I realized that it was not good enough for me alone to tackle these topics from a physics background. Some of the questions in the course would need perspectives from social psychology, philosophy, or public policy, so I found faculty and graduate students from these other departments to develop this course. We would meet on Friday in the afternoon, and everybody would stick around for a couple of hours. This went on for nine months. Eventually, we came up with 23 ideas, and we tried to figure out methods to experientially teach them so that people could apply these concepts to other parts of their lives. We created LS 22 in 2014, and since then, we have always taught it in the spring with three faculty instructors—one from the social sciences, one from humanities, and one from the natural sciences. We are now starting to have the course taught at other universities. Both last year and this year, it was taught at Harvard, and this quarter it was taught at UC Irvine. We are continuing to receive calls from other schools that would also like to launch this course.

AG: Before I started teaching LS 22, Saul and I were friends, and I used to hear him talk about this fascinating class. As a psychologist, I study how people figure out the world around them. Psychologists examine how people learn and how they come to form different kinds of beliefs. In my career, over the course of many years, my biggest argument has been that children are similar to little scientists in what they do and how they figure out the world around them. That gave me a different kind of perspective; instead of seeing science as this niche field for the highly educated and brilliant, I realized that it is really something that is within all of us. The real question for us to ask is, "How can we all use these inherent capabilities to deal with the world around us, and why or when do we choose not to do so?" This is the kind of question I address in the course.

JF: Unlike Alison and especially Saul, who both have taught this class multiple times, this is my first time teaching this course. When Saul asked me about co-teaching this class last fall, I was immediately captivated by the idea of the course. I thought to myself, "This is the kind of course that I would have loved to take myself as an undergraduate at university." I think there are two reasons why I was keen to get involved on the teaching side. First, over the last few centuries, science has assembled a set of incredibly powerful concepts that have allowed us to make unprecedented progress in our understanding of the natural and social world around us. I thought that having the opportunity to get a crash introduction to some

"We thought that there should be a way to articulate these techniques that we had unconsciously learned via 'osmosis' by way of simply being within a community of scientists." - SP

of these ideas from two preeminent scientists like Saul and Alison sounded well worth the price of admission in itself. The second reason is that I was gripped by the central credo of this class, which is that familiarity with some of the basic tools and methods of modern science can stand us in really good stead outside of the lab. It just seems to me that in our everyday lives as private individuals, we often have to face decisions that require us to reason well, but decisions are made in the face of uncertainty or in situations where it is incredibly easy to fool yourself or to fall into error. For example, these can be situations where you have to sift through messy data to find the signal amidst the noise or where there are various cognitive biases at work that are liable to lead us astray. It seems to me that the tools that modern science has developed for trying to reason well and avoid cognitive errors can be incredibly helpful in an everyday context. Personally, unlike Saul and Alison, I am not a scientist by training. I am a philosopher; I work in moral and political philosophy, which is the part of philosophy that concerns itself with questions of value. Despite not being a scientist myself, a discipline like philosophy has an important contribution to make to a class like this. A sensitivity to questions of values and norms can help us understand the role of science in society and do science "better."

Taking "Sense, Sensibility, and Science" has refined my understanding of how we know what we know. I feel much more equipped to engage with and understand new information.

-Brian Delahunty

BSJ: As you have mentioned, the fields of science depend upon collaborative deliberation and discussion. As such, do you believe that there is a shared, mind-independent reality whose collective existence helps guide scientists to similar conclusions?

SP: In the course, we discuss how science has progressed dramatically by the acknowledgment that the world out there is independent of each of us, and we all are trying to get access to more information about this same world. If scientists had each gone off to their own corners, assuming that, "Well, I guess my world just looks

different from everybody else's," the field of science never would have progressed as far as it did. In some sense, we take a bit of a pragmatic view on this incredibly deep philosophical question. Though, I should pass the ball back to our philosopher.

JF: I am a realist. I believe that there is a physical world out there that exists independently of what humans might think and how they perceive it. In that sense, we all inhabit a common reality. However, there are a couple of important caveats. Holding such a broadly realist view about the world is completely compatible with acknowledging that we all have various perspectives on the world and diverse ideas about it. What I would reject is the notion that an individual's personal viewpoints define their own world. I think we all have different perspectives about what is real, but it is not true that we each live in our own separate reality. A second caveat is that not all aspects of reality are mind-independent. There are many aspects of our reality that reflect people's moral beliefs and cultural customs. In one of our plenaries, we talked about funeral practices in different cultures, and I made the point that what is considered a respectful way of disposing of a dead body is often culturally relative. Therefore, the discussion of what is a respectful way of disposing of a dead body is not mind-independent. However, I do think there are many questions that do not fall into this category. For instance, consider the questions, "Does the sun revolve around the earth?" or "Is planet Earth more than 5000 years old?" There are objectively true answers to these questions. People might hold different views and different beliefs on these questions, but ultimately, these beliefs are accountable to a reality that is out there, and that exists independently of what we say or think about it.

> *After taking LS 22, I feel more aware of my surroundings and have a motivation to question information I receive on a daily basis.*
>
> *-Anna Benzel*

AG: The pragmatic idea that Saul mentioned is incredibly significant. From the perspective of a psychologist, if you want to know how human understanding of the world evolved in the first place, the idea that we are tracking something that is real about the world is a very good way of explaining how it is that we could be existing, surviving, and doing things in the world that actually end up having particular, predictable consequences. We can send a rocket up and we have some idea of where it will go. We can make predictions about the consequences of our actions. However, I would also echo what Johann said, which is that it is interesting that for humans there are all these social and cultural phenomena that are "real." An example is the concept of marriage. It is real and it is a true fact that my husband is upstairs, and yet marriage is something that we constitute as part of our social world rather than something that is physically out there the way that the sun or the moon is.

BSJ: During the LS 22 discussions of whether a country should be governed by a democracy or epistocracy (i.e. rule by experts), a majority of students stated that they would prefer an epistocracy. However, they later learned that experts actually tended to be overconfident in their statements, which could make them more inclined to make mistakes. What are your opinions on the subject, and how do you self-calibrate against overconfidence in your own career?

AG: As scientists, we are always being self-reflective. We contend with this constant process of change and revision that differs from what is experienced in other areas of human life. On a normal day, you might not want to be thinking all the time about what it is that you are doing and whether it is right. However, under a scientific way of thinking, those questions are critical; they are the means by which we figure out whether or not we are actually being overconfident. This relates back to what we mentioned earlier regarding how a scientific way of thinking can help inform reasonable decision-making in other contexts. Most of the time, it is not so much about an individual person being able to make these considerations, but rather about an individual person putting themselves in a social group or within a set of institutions that enables us to do this.

> *My greatest takeaway from this course is learning how to think critically about things that are perceived as facts and learning how to look at scientific information with more uncertainty.*
>
> *-Julia Bates*

JF: I was struck by the results of this student poll. A majority of students seem to think perhaps democracy has had its day, and it is time to turn practical decisions over to the experts. There are extremely seductive arguments in favor of epistocracy. If you really care about the stakes of practical decisions and if it really matters to you that you get the right answer, one could ask why you would give the uninformed votes. Why would you not just consult the experts? However, it seems to me that there is a powerful ethical case to be made for democracy as well: People should have a say in decisions that directly concern them. This is the fundamental ethical principle that underlies the case for democracy. For instance, suppose you want to invest money. There are a number of options that you have: You could put it in the stock market, you could invest in real

estate, or you could put it in a savings account. If you want to make a rational decision about how to spend or invest your money, it would be a very good idea to consult an expert like a financial advisor. However, ultimately, the decision of what to do with your money is still yours to make. After all, you will be the one directly impacted by that decision. The financial advisor can not just invest it in a way that seems most prudent to them without your consent. I think this

"Every approach we have needs to be constantly reexamined since it is inevitable that we will find flaws in almost anything we are doing given enough time." - AG

provides quite a powerful argument in support of democratic input. Yet, in a democracy, we are never just deciding for ourselves; our vote also has an impact on others. This places an ethical duty on us to try to be well-informed when we vote. Therefore, I think there is a very important role for scientific experts to play: advising our political decision-makers, and informing the population at large, so that they can make these widely impactful political decisions. We should not see these two systems as diametrically opposed. The input of experts and decision-making by the population at large should be combined.

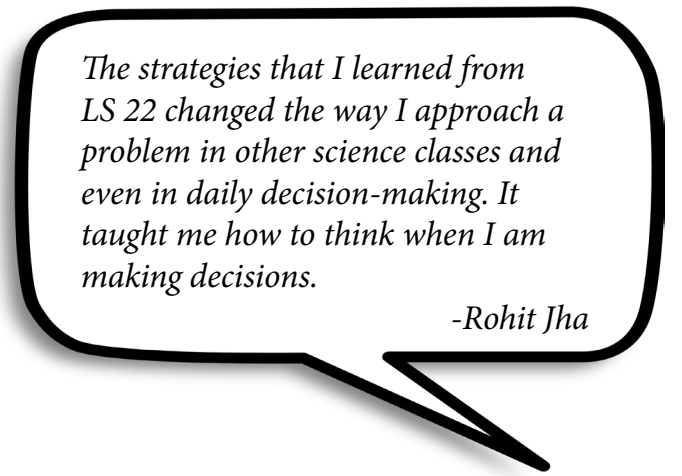
BSJ: What is the best way to hold scientists accountable to publishing results that meet a certain rigor or criteria?

AG: The peer review approach is what everyone depends on now. One of the themes we discuss in the course, though, is that every approach we have needs to be constantly reexamined since it is inevitable that we will find flaws in almost anything we are doing given enough time. Just in the past ten years, many of the procedures that we have adopted in our field have forced us to be more robust and reliable in our work. For example, take pre-registration: Before beginning my research, I will document what my predictions are, how many kids I am going to test, and the kind of statistical analysis I am going to perform. I only just started doing it, but I believe it has greatly improved the science that goes on in my lab. And for all those years, I thought I was a good scientist!

SP: A similar concept to pre-registration is blind analysis. Unlike the typical blind experiments done in medicine, blind analysis involves a new, extra wrinkle of blinding yourself in the analysis so that you do not know the consequences of your analysis choices until you have committed to them. It is used particularly in certain areas of physics and cosmology, but it is becoming something that people in other areas are starting to look at as well.

BSJ: As a researcher, how do you make the distinction between when to continue pursuing a line of inquiry and when to consider alternate explanations? How do you distinguish between scientific optimism and naive optimism?

JF: Let us consider the trade-offs between false positives and false negatives. When deciding whether to continue pursuing an avenue of research or give up and try something else, you have to strike the right kind of balance between these two kinds of errors. The first is a type I error, in which you choose to persist with your line of inquiry when the solution to the problem is beyond your reach or your hypothesis is simply incorrect. On the other hand, there is also the possibility of committing a type II error, in which you give up when the solution to your problem was within your grasp, and had you persisted, perhaps you would have found it. In deciding whether to give up or to persevere, you need to weigh the relative costs of these two kinds of possible errors. You should ask yourself how important of a scientific advance would your discovery be if your research yielded fruitful results. With all else being equal, the more important a result, the longer you should persist. Of course, you should also ask yourself how high the opportunity costs are to persist with that research question if it turns out to be a blind alley. How valuable are alternative uses of your time as a researcher? Another factor that should incline us toward greater persistence is that even a failed hypothesis or research program can still have value to the scientific community. Science is a collaborative activity that is pursued by a whole community of researchers, not in isolation.



Scientific endeavors have value since other scientists can learn from your mistakes. They will already know that a certain possibility has been tried exhaustively in the past, which can save them time and allow them to investigate other possibilities. That is why the costs of persisting with an idea that turns out to be a failure are often not as high as we might think in the beginning. When Newton said he saw so far because he was standing on the shoulders of giants, we need not interpret that remark as, "I saw so far because I was standing on the shoulders of the positive results that previous scientists had established." The errors of his predecessors are part of what allowed him to see further.

"When Newton says he saw so far because he was standing on the shoulders of giants ... [t]he errors of his predecessors are part of what allowed him to see further." - JF

BSJ: Did you ever observe an association between two variables and predicted causation, but you could not perform the necessary experiment(s) to test this hypothesis? If so, did you try to find an alternate way to conclude causation?

SP: It is often the case that we have a relationship between two things, and we are trying to determine what the causal connection is between them. In astrophysics, there are some surprising connections right now between the mass of galaxies and the behavior of certain small events in these galaxies. One example is that right now, it looks like there is a relationship between the mass of a galaxy and the brightness of a supernova that we use as a distance indicator. The question is, "Can we get away with adjusting an empirical correlation and not understanding the causal connections, or do we feel that it is important for us to test and potentially uncover a causal connection?" If we believe that testing for causation is important, we try to invent new tests based on similar principles to those in Hill's criteria.[1]

AG: There is an interesting contrast between the approaches used in physics and psychology. It is difficult to make concrete observations in the physics that Professor Perlmutter is talking about. You will potentially have one or two observations, and you are trying to discern what other factors are responsible. In psychology, our problem is usually that we observe too much. Every phenomenon we see is correlated with another, so the question becomes, "How do we sort out which factors are causal and which ones are not?" For example, we might say that kids who are better at one activity are also better at another, different activity, but then it turns out that kids that are better at the first activity are older than those who are not doing as well, which is clearly going to affect performance. We combat this issue by using controlled studies. We measure the kids in different circumstances and then see whether the results are different. For example, to test the correlation between a child's theory of mind and their executive function, we study the executive function while controlling for other variables. Other tools like regression, statistical analysis, or control conditions help when we cannot do these experiments.

BSJ: Have you ever communicated or encountered a false positive in your research? How did you react when you realized this?

SP: We thought that we had detected a very dramatic event, which was the creation of a pulsar, and even more importantly, it would have been the very first example of a planet orbiting a star outside of our own solar system; it turned out to be a false positive. It was certainly embarrassing for the group at the time because we had to retract a paper that made an appearance in one of the most visible journals, *Nature*. It is amazing how random events can sometimes look like a very well-structured signal. Even though, at the time, it seemed like the natural world was treating us a bit unfairly, as scientists we know that random events can happen.

AG: We conducted the "broccoli and crackers" experiment in the 1990s in which we discovered that 18-month-olds could figure out what somebody else's desire was, and this got a lot of attention. Many people replicated the effect with 24-month-olds, but not 18-month-olds. Now, when I talk about this finding, I say that children have this capacity somewhere in their second year. We were not sure if the kids that we were looking at were very advanced or if we did the experiment in a slightly different way. It gives a sense of how tricky it can be to be doing developmental psychology work. Part of the problem with kids, for example, is that it is easy to get a false negative. There are a million different factors to look out for; most of the time, when you test kids, you get random noise. Finding any signal is difficult, and it can depend on a factor as unexpected as the lighting in a room. For example, a fun activity is to take a distinguished philosopher, put them in a chair opposite a child, and get them to try and conduct the experiment. I can tell you that the experiments do not work as well when conducted by a nervous philosopher than by a friendly undergraduate research assistant.

FOOTNOTES

1. The Bradford Hill Criteria, known as Hill's Criteria, are nine standards that can help establish a causal relationship between two factors, especially when randomized control trials cannot be used. An example is the consistency criterion, which states that if findings can be reproduced by multiple individuals in different places and times, this increases the probability that the phenomenon is not simply a result of location. Other criteria include strength, biological gradient, specificity, and temporality.

IMAGE REFERENCES

1. Nobel Prize 2011 Press Conference. (n.d.). Wikimedia. Retrieved April 11, 2022, from https://upload.wikimedia.org/wikipedia/commons/5/5b/Nobel_Prize_2011-Press_Conference_KVA-DSC_7744.jpg.
2. Alison Gopnik SkeptiCal. (n.d.). Wikimedia. Retrieved April 11, 2022, from https://upload.wikimedia.org/wikipedia/commons/thumb/c/c7/Alison_Gopnik_SkeptiCal.jpg/440px-Alison_Gopnik_SkeptiCal.jpg.
3. Philosophy at Berkeley. (n.d.). Johann Frick. Retrieved April 11, 2022, from https://philosophy.berkeley.edu/person/photo/584/medium/JohannFrick18_0007.jpg.