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The pursuit of scientific knowledge and its dissemination demands rigorous adherence to ethical research practices. However, in this process, either with the fear of publish or perish or mere ignorance, some individuals may prioritize personal gain over scientific integrity. That's when the detectives of science dedicated to safeguarding the sanctity of the scientific method, upholding the highest standards of ethical conduct and ensuring that the quest for knowledge remains untarnished by misconduct, taken action today on research and beyond, we have one of the most influential science detectives, Dr Elizabeth Bik.

Elizabeth Bik is a microbiologist by training whose meticulous eye and unwavering commitment have propelled her to the forefront of combating research fraud. Profiled in esteemed publications like the New Yorker, Bik's efforts have shed light on high profile cases of research impropriety.

Her steadfast pursuit of truth, combined with the skill for pattern recognition has led to over 1100 attractions, thousand corrections and several editorial expressions of concerns across journal. Without further ado, let's get in conversation with Dr. Elizabeth Bik and be prepared to know what best we can do to ensure the upholding of scientific integrity.

Welcome Dr. Elizabeth. Big thank you so much for agreeing to this interview.

Before we speak of you being the face of image manipulation detection, I'm curious to know how did a microbiologist with over two decades of research experience decided on pursuing a transition in her career? Yeah, it's. It was basically a couple of, of accidental findings that led me to this. I first I discovered that somebody had plagiarized one of my articles.

Not the whole article, just a couple of paragraphs and that led me to work on plagiarism as a hobby. I was still fully employed at Stanford and then later I found a PhD thesis with duplicated images and so I realized okay, I have a talent for finding these images and let me see if I can find more of them. So I started doing that.

I was still fully employed and then later I switched careers. I worked in industry but I still kept on searching for duplicated images and a couple of years later I just, in 2019 I just felt I want to do this full time. I didn't enjoy that much my work anymore and yeah at my work at a startup company and I at some point I just wish them well and I, I quit my job and I am now doing it full time.

So you have been involved in investigating over thousands of research floodling theat. However, the investigation into the former Stanford president Mark Tesser Levin bought the entire world's attention. So being a high profile investigation, I'm sure there Must have been certain measures taken to implement the investigation in the right way.

So could you please walk us through the process in brief? And was it any different from what you do for any other case? So the case of the Stanford president, Marc Tejier Lavigne, those were not my original, those were not my findings. I was basically contacted by the students who wrote the article later and won an award for that, Theo Baker. And he said, can you walk me through, there are several comments raised online on a platform called Puppyr and can you help me understand what the problem is? And so I walked him through.

I looked at all these images, looked at all these papers, and I found a couple of more problems then. But it wasn't my findings initially. So they had been raised by other people, anonymous people already, many years ago.

So I think, I'm not quite sure how Theo Baker got, maybe he got a tip that, you know, should look at these papers that have been flagged years ago and nothing seems to be investigated. And, and then he wrote that article. So it's, and that sometimes is, is the case.

Sometimes I do investigate myself and I find more problems. But in this case I feel I was only sort of a, an expert or a second opinion, I guess. And I just made sure that, you know, I, on this, I explained how each of these findings, if they were, you know, severe, if they were innocent, and they basically spanned a range of different problems.

Okay, so speaking of such high profile cases, do you think that such cases would help us strike that fear in researchers and help in creating an ethically sound research world? Yes, in a way it does, or it could make people just fraud better. So basically the things we're finding is we look at papers, we see particular problems, and there's obviously many ways to cheat that would not leave any traces. And so I'm not quite sure.

I think people are going to fraud because the rewards are so big. If you do fraud in science, you will get a better results, a better paper, a higher impact factor, more papers, more citations perhaps. And so the rewards are big.

But yeah, as we have now seen a couple of recent cases in the news, in some cases the consequences can be very big. But in most cases there's almost no consequences. Maybe a researcher gets a slap on their finger, maybe one or two papers get retracted, maybe a junior person gets the blame.

But it's not very often that senior researchers have to step down. The case of the Stanford president was an exception. Maybe more of those cases will follow.

I do think a lot of people are, you know, that sent a shockwave through academia, at least from what I've heard. And so I just don't think people are going to stop doing fraud. I mean, that would hope so, but I don't think there that's going to happen.

So to what extent do you believe that image manipulation or duplication can affect scientific literature? Yeah, it affects it because it changes the results. And so the results that were actually obtained were probably different. And so you're not quite sure if images have been manipulated or photoshopped, if data has been massaged or changed.

You just don't know what the original results were. But very likely the results were different. And so it leads to the wrong message.

And in science, we base our papers on the work of others. So when we do science, when we write a paper or when we do an investigation, we read other papers and we cite it. And so we sort of build our work on layers and layers of other scientists that have done work before us.

I usually compare it with layers of brick in a wall of science. So we, you know, we base our work probably on papers that have been published decades ago and those have been cited by papers 10 years ago. And now we cite those papers.

And so we do not science by ourselves. So if papers have errors or manipulated fraudulent data, that means that other people might have trouble replicating those results or they just follow the wrong leads. They follow leads that they think will help, but they cannot replicate.

And it just could lead that part of that brick wall could be tumbling down. That's usually the metaphor that I like to give. And, and so it just leads to a lot of wasted time, wasted effort, hope for patients.

And also when people are, when these studies involve animals or humans that have been, you know, samples have been taken from either animals or humans and the results of fraudulent in these papers are retracted, that means that all these animals have sacrificed their lives for nothing. The humans who have donated samples have done that for nothing. And it's just a waste of research efforts and ethics.

It's not ethical then to do fraud, I feel, especially when animals or human samples are involved. Absolutely. So how prevalent do you think that this problem is and what are the potential or what are some other conspicuous cases of image manipulation or duplication that you have uncovered or ones that should have probably been desk rejected.

We, so I did a study to answer the question, how prevalent is it? So we found in a set of 20,000 papers that 4% of those papers had duplicated images within the paper. And, and those were all inappropriate duplications. And Those were papers in the molecular biology field that had photos of western blots, photos of tissues and cells and things like that.

So it was just a fraction of scientific papers. But in that set we found 4% to contain duplications. Now estimated about half of those 4% were perhaps accidents, errors.

The other half looked like it was done intentionally, where, let's say two images were not only overlapping but had been rotated or stretched, or an image had elements that were duplicated. So the same cell was duplicated multiple times. And that seems to have been done intentionally, usually.

So that would mean that 2% of the 20,000 papers that we investigated had fraudulent data that is visible by looking at the images. Now, the actual fraud, like I said earlier, it is there are ways to cheat that would not leave traces. If you have a sample, you take a photo, you move it a little bit farther under the microscope, you would leave no overlap for me to find.

That would not count as a duplication because it's not visible. There's many ways of doing fraud that would not leave traces. So the cases that we're finding are the tip of the iceberg.

So if we estimate that 2% of papers, sorry, it's a long story, but 2% of papers had visible problems that were done intentionally, that it's probably more likely that maybe 5 or even 10% of papers contains misconduct. And that would be a very scary number. It would still mean that most of the papers do not contain misconduct, obviously, but in absolute numbers, that's just staggering.

So there could be potentially several reasons for this misconduct. So recently, quite recently, we conducted a global survey to know more about this. And astonishingly, our results found that about 25% of 25.5%

of the respondents who were majorly early career researchers pursuing doctoral studies believed pressure to publish is one of the major reasons limiting ethical compliance in research. So do you agree with this and what other reasons could lead to breaches in ethical research conduct? Yeah, I believe that that is spot on. I also believe that the pressure to publish is the main reason.

And it might be, you know, the pressure to publish. Let's say as a grad student, you have to perhaps publish one or two studies in order to get your PhD. Now, is that a good measure to get your PhD? I believe that might be too strict.

You can work really hard and the experiments didn't work then does that mean you did not earn a PhD? I feel that it's not necessarily a good measure. But if that's the rule at your university or in your country, then you might be tempted to cheat because now you can publish a paper, the results look better, and you can continue your career. There's another scenario where a person might work in a lab where the senior researcher, the professor, also feels this pressure to publish.

We feel it on all levels in our careers. And they might push their grad students into either changing the results. They probably wouldn't ask it exactly like that.

They would probably say, make it look like this or so, or I want the results to look like that. Then this grad student might sort of hear between the lines, like, I think he or she is asking me to change the results a little bit to make it look better. And especially if you're, you know, as a grad student, you are very low in hierarchy.

The senior researcher is very high and has a lot of power over you. And so I think you feel that pressure to cheat then. And so, yeah, I definitely believe that the pressure to publish, which we all feel at different levels, is either directly or indirectly leading people to cheat.

After detecting image manipulation, which have led over 1100 detractions and thousand plus corrections, has there been an aftermath of such investigations where you felt conflicted or rather empathized with the researchers involved? Yeah, sometimes. You mean that the authors were able to take away my concerns or told me that I was wrong? That has happened. I mean, I'm not perfect.

I usually will label or phrase my concerns as questions like, I'm concerned about this figure because it looks like these two images are identical. And occasionally these are duplications for sure, but they are appropriate duplications, but the labels are not always clear. So, you know, in one figure, there might be a particular photo of, let's say, a brain or some tissue or whatever.

And then in another figure later in the paper, there's the same photo, but it's labeled very differently. And so sometimes these labels and the experiments are so complex that. And the labels can be very different.

One might say control and other might say wild type or so. Like, is that the same experiment? And it's not always clear. I mean, you have to really read the paper and like, dive deep into these things.

And usually multiple replicates are done. So it's not always clear if this should be a duplicate. So if I'm not sure or even if I'm sure that's a duplicate, I will just say, is this expected? Or, you know, and if.

Then the author will say, well, yeah, it's expected that this was exactly the same experiment. I'm like, okay, great, thank you. Problem Resolved.

It was just not clear from my end. But, you know, the labels were not very clear. But for the author, usually it's very clear what the experiment was.

So was I wrong in finding the duplication? I don't think so, but I was wrong in finding that it was inappropriate. So I find those cases, yeah, it's not always clear. And so I don't make any accusations.

I just say these are the same images. Is that. For me, it's surprising that they were the same.

But, you know, please come as an author, come in. In the discussion on Puppy and, you know, tell me that I'm wrong. But that very rarely happens, though.

So having detected so many mages, have you ever faced a backlash or some legal threats for your work in exposing them? Yes, I've been. I've been threatened to be sued. I have not been sued myself.

Other people have who do similar work. I've received a sort of cease and desist letter where a lawyer representing authors of a set of papers said that I should take down a blog post and should delete a bunch of tweets. And I told them, like, I'm not going to do that.

And they said, well, you have to. Are you sure? Because, you know. And they.

They had a bunch of legal language. It sounded very threatening, but I never heard back from them. So I guess it was just a, you know, some strong language, but nothing happened.

But then on a more serious level, there was a French researcher whose work I've criticized, and he filed a legal complaint in France against me. And in France, that legal complaint, it's sort of a police report. I think it's.

It's a different legal system than I'm used to, but it could lead to a lawsuit. But I've never heard anything after that. So it's been, I think, three years.

So I assume nothing happened. I've never heard actually anything official. It was a.

It was announced on YouTube and on Twitter. So, you know, I didn't even get anything official myself. So I think, again, it was a.

These are threats in an attempt to silence me. But usually I find if people do that, there's, you know, they, like. I rather hear that they tell me that I was wrong.

If they file a legal complaint, I guess they don't really have any scientific answers. They just threaten with legal action. But there have been other science critics who do work, the same work as I do, who have actually been involved in a lawsuit.

So they have really been sued. And in the end, they. Most of these cases are either dismissed or the person suing.

So the person whose work has been criticized will lose, but you have to defend yourself. And so those cases can be extremely expensive for the poor science critic. And it's not really a matter of who wins or who's right.

It's a matter of sort of trying to harass the person who criticizes your work. And so it's a process, unfortunately, that will lead a lot of people to not speak out when they see some signs misconduct happen because they're afraid to be sued, even though they might be absolutely right. And yeah, these cases are just very expensive.

In the end, the lawyers win, basically. It's not who wins, who's right or wrong, it's just to silence your critics. So having, I mean, despite people trying to silence you a lot through such actions, how do you manage to stay resilient and respond to them, I mean, and continue doing the work so positively and with such enthusiasm? Well, I, I was, I, it, I had to think when this French researcher threatened to sue me, I, you know, I had to think for a while, like, like, do I want to continue this? Do I have to take down all my posts? But, but I thought, you know what, maybe I'm very naive, but I just keep on doing.

Because I honestly believe that there are some big problems here in these papers. And why doesn't he answer it? For, for example, some of these papers were, you know, there was no wording on ethical approval of doing research on humans. And so, you know, he could have just answered like, oh yeah, well we didn't include that in the paper, but here's a copy.

Like, we got the permits and everything is in order. I'm like, I would be like, fine, you know, move on. But he threatened to sue me.

So it, for me, it actually told me that there's something that he was trying to hide. And it basically, after some deliberation, I thought I'm going to keep on doing this because I feel I have ask him very good questions and he has no scientific answers. But I also got a lot of support from the scientific community.

So there were people organizing petitions to. And you know, they collected thousands of signatures of all people, scientists who sat were supporting Elizabeth Bik for her work. And you know, that gave me so much.

Yeah. Support that I just felt I'm doing the right thing. I'll keep on doing this.

That's great. The infamous rat with enormous testicles paper from Frontiers that contained AI generated images has been widely discussed. So what do you think? Does this incident reveal about the potential risks of AI in scientific publishing.

Well, that paper was so. Or that figure was so obviously AI generated. I mean, the whole proportions were ridiculous.

It was not a scientific figure. The labels were unreadable. It was just gobbledygop.

It was, you know, didn't make any sense. So. And it was a funny figure because of that, you know, a rat with a penis that went up in the sky.

It was just something to not forget ever. But this was a funny one. But I think AI has already infiltrated scientific literature because you can make funny images, but there's definitely.

We can make figures of, we can make photos of people who we know in situations that never happened. And these are very realistic looking AI generated images. So the technique is definitely at a point where it can generate realistic looking photos of gels or, or cells or tissues that we cannot distinguish from real.

So even though this figure was very funny, I'm very worried about the risks of AI, maybe not so much as the risk of text generated by AI, because, and I think this is true for anybody, including myself, if English is not your first language, it is harder to write in English and English is a scientific language. So I'm very open for the use of AI to generate text or help us write text. Currently, AI is not good enough to generate scientific level text.

Like it will include, for example, strange statements that are not true. It will include references of papers that do not exist. It looks all very realistic, but you still have to not completely trust it.

But I think for grammar, type of errors that I make and a lot of other people for whom English is not their first language make, it can be a great use, you know, rewrite this text or at least, you know, help us. And so I think in the end we will embrace this technique. But for images I'm a little bit more worried because images are usually the data in a scientific paper.

And you can also imagine that AI can help us generate data sets like let's say a table or like make up a set of patients that didn't exist. So for that I'm not quite sure how we can ever distinguish those images and those data sets from real data. So I'm very worried.

I'm not quite sure how, how we're going to deal with that. But I see this problem in the very near future and maybe it's already happening, we just cannot distinguish it from real. Yes.

And as we know, the problem is already happening and there are so many reported instances of it. So do you think that the current scientific publishing process and the peer review system is effective enough to address these problems or catch these problems. And if not, what changes do you like to see in the scientific publishing process in order to eradicate these problems and improve research integrity? Well, I don't think that peer review is designed to detect fraud or like made up data sets.

Peer reviewers do this work for free. I usually say on a Saturday morning when you have other stuff to do perhaps. And so it's volunteer work and I don't feel that volunteers should be trusted with the detection of fraud.

Now there are some things that could have been caught in peer review, some obvious problems of duplicated data in a table or two images that are exactly the same. I feel the more simple ones would be easy to detect during peer review. But the real more experience problems, the harder issues, I guess those should be done by publishers.

So I feel that publishers should have staff dealing with the detection of fraud and just checking papers for all kinds of other problems like statistical errors. As a peer reviewer I'm not good in statistics, so you usually will write I peer reviewed the paper, but the statistical part in figure 3 or so I just didn't understand and so I didn't peer review that. But you know, you, if the other peer reviewer feels the same, then there's a whole part of the paper that has not been peer reviewed.

So I feel that should be up to the publishers to look at the data. Could it be made up? Could it be AI generated? Could the images have been fabricated or manipulated? Is the ethical approval okay? Are there experiments on animals done in the proper way, the with the proper permits? So have a set of specialists look at a paper once it's been accepted perhaps and go over it again just with the idea that it could be fraud or that there could be specific problems. So yeah, again there are simple problems that a peer reviewer might detect, but I feel most of that should be done by the publisher.

And you could of course also argue, well, it's up to the institutions to not send out these preppy papers. And perhaps you can think that this check could already be done at the institution, which might work for a bigger institution. But if, you know, some people work at small institutions that do not have specific staff for that, or maybe the institution is in the loop and they have definitely a clear conflict of interest for fraud and they might just scan papers to make sure it's not detectable.

So I'm not quite sure I'm a bit pessimistic here that we'll ever detect all types of fraud. So beyond image duplication, what other Areas of scientific misconduct, like you mentioned just now, AI generates texts, which is more threatening to the integrity of scientific literature. So apart from them, what other areas do you feel, feel that we need to be concerned about or look out for? And would AI or such automated systems eventually replace the need for manual scrutiny, manual image scrutiny, or even text scrutiny for that matter? Yeah, so there's many types of problems.

In a paper I mentioned plagiarism, there's data manipulation. You can just make up a whole set of patients, and you don't need specifically AI for that. If you're smart and you use maybe some random generator in a Python script or whatever, you can make data look pretty realistic even though you made it up.

So this is obviously a worry and I don't want to give anybody any ideas, of course, but it is fairly easy to come up with ideas for fraud. So a plagiarism. For example, a lot of journals, most journals now are screening for plagiarism.

You know, like there's software to find that you can compare the text to the whole web or all published literature and see if there's a textual similarity. But with AI, obviously, you can just, you know, take a text that you stole from somebody else and then rewrite it with AI and it looks completely different. So there's, it's very hard.

The current strategies that are being used to detect fraud are going to be completely obsolete when AI, if AI and it already happens, has entered the scientific literature. So we can use AI to detect AI, obviously is. Can we.

How can we detect AI generated language or text or data sets from real data sets? And I, I think so. I'm not a computer scientist, but I think for images there might be ways of seeing that an image has been created by, you know, some, some AI program versus that it really came from a microscope or some scanner. You can think about like blockchain technology or whatever.

And I'm using this word even though I don't quite understand what it means, but you can think of electric handshakes or metadata that is associated with a photo saying, yes, this really came from a microscope in this lab and it was taken on that day and it was, you know, the contrast was a little bit enhanced and sort of like you can look into the deeper metadata associated with, with a photo that, and an AI generated photo wouldn't have that. Although I can also, you can probably make that perhaps, you know, also make it look real. But there's maybe ways you can detect if a photo is real.

But in order, I do think that it's going to be a race between, you know, every time the fraudsters are going to develop something new, we can detect it, but then they'll develop something new. It's going to be this endless raise and fraudsters are going to fraud and fraudsters are always going to find ways to evade any detection. So I'm slightly pessimistic here.

I'm currently using AI software based on AI for image duplication and it can compare an image to all other images that it has in its database. So it's partially AI based and I think partially just, you know, looking for particular patterns that are identical. And it sometimes makes completely wrong decisions where it says these two images are the same.

And I'm looking at them like they're not the same at all. They're very different. So the AI makes a lot of weird mistakes that I don't understand.

But I'm using it as a first screen and then I'll overrule and take out all the false positives. Yeah. So I think that's the reason why there should be AI augmentation and not complete integration into such processes, because I think human oversight is absolutely unavoidable in such cases.

Yes. Yeah. We cannot really.

AI is not yet at the stage where we completely can rely on it, which is a good thing. I still feel that humans are better, but, you know, it's going to get better and better and who knows what next year will bring. Yes.

So having mentored several students and collaborated with researchers from different institutions and background throughout your career, what are some key principles or values that you try to instill in the next generation of scientists, majorly regarding research integrity? And what are the best strategies or practices that you recommend for maintaining integrity while collaborating globally? Yeah, great question. So when I really was mentoring students, I didn't work yet that much on integrity. But I've always had a very strong feeling for what is right and what is wrong and a very strong feeling for science.

And I currently say that for me, science is about finding the truth. And that's sort of my simplistic view of the world. But I've always tried to, to give that and that enthusiasm to my students.

One specific thing that I've taught my students is to take the time to do things right and take the time to label your files and your samples. And that might take another hour of your time, but calculate, you know, your DNA extraction doesn't just use four hours of your day, there's another, say, hour in which you label all your samples. You Write all the labels and then you put them in a box and you, like, keep track of the box, like make a little map of that box where all your samples are, or put little numbers on the top or so and put things in a spreadsheet.

At the end of the day, work on your lab book or if that didn't work on the next morning, start doing that. Always take time to do that because future yourself does not know what you did, you know, three months ago. So.

And don't just label your samples one through 11 or so. Like your samples need to have in the end of the day, they need to have a good label that you can find what they were. Because a lot of errors that we now find in science papers might be due to the fact that things weren't labeled correctly.

So you have to take that time. And, you know, at the end of the day, you also shouldn't. You should still know which sample was A and which sample was B and you know, don't switch samples.

So that takes time. If you try to rush an experiment, you're going to make mistakes. So it's much better to say, okay, well, I'm not going to.

It's already late. I'm tired. I'll do this experiment tomorrow.

I'm not going to work late because that's. You'll work late. You'll miss, you know, the free time that you should use to recharge yourself.

And in the end, you're going to have to toss that experiment because you don't trust what you did. So always take that time to. Yeah, to do the experiment.

Well, what advice would you give to researchers who may witness or suspect scientific misconduct in their own laboratories or institutions? So, like you had mentioned in the initial part of our interview that most grad students experience this fear or they are just clueless on what to report and how to report or how to go forward with the whole thing. So can you please elaborate on the steps to be taken by them or by researchers or any other stakeholders to report such cases, especially regarding misconduct and data manipulation? Well, I wish I could tell you that as a grad student, you should just report. Let's say you witness either another person in your lab or perhaps your boss, the professor, or so you witness misconduct from them.

And I wish I could tell these grad students or these young postdocs, like, just report them to your university and they will take care of it. Unfortunately, taking care of it usually means that the university wants to keep this silent. They don't want to admit that There was misconduct and these professors bring in a lot of grand money.

So from the perspective of the university, a grad student who reports misconduct is seen as a troublemaker. And very often, unfortunately, the grad student will suddenly lose access, their key card doesn't work, or their grant can suddenly not be renewed, or suddenly their collaborators don't want to collaborate with them anymore. And sort of, they might not be immediately fired, but they're suddenly seeing that there's a lot of ways to try to push them out.

And unfortunately this is the case in many cases where science misconduct was found. You hear these stories that grad students tried to report it several times and they were not believed. So you should be able to report it to the research integrity officer at your university.

But it doesn't unfortunately usually work. So it's good to make a lot of notes. Like write down if, at the end of the day, write down if a professor asks you to do misconduct.

I've seen people record it where they record secretly these messages, but that is not allowed in all countries or all states. So use that wisely. But you know, you can just write down what a person asks you because you know, it's good to keep a logbook of those requests, try to find evidence and you know, make photos or whatever you can do.

But at the end of the day it's, unfortunately the best advice I can give is to leave that lab because you're not going to be in a position to report your boss because, but unfortunately that's going to not be good for your career. Maybe you have to start over your PhD somewhere else and that is a painful process. But I think in the end you'll be happy that you've left that lab because you don't want to be associated with that lab.

But in some cases people are almost done with their PhD and then I would advise them, well, try to do everything very honest and you know, try to get your PhD and then perhaps after you've left the lab you can report them. But it's, it's going to be very tough and you, you probably need to push together as a group, so find other people. That makes it a little bit stronger than trying to do this by yourself.

Thank you so much, Dr. Bik, for sharing these invaluable insights with us today. Your unwavering commitment to upholding the highest standards of integrity is truly inspirational.

If I were to highlight one profound takeaway from this, is that ethics and integrity are undoubtedly the non-negotiable cornerstones of credible research across all fields. And what we leave at the end of this podcast is the motivation to always uphold righteous practices, ask difficult questions when warranted, and promote an environment of accountability. Only through diligent guardianship can we preserve the integrity of scientific pursuit and its potential to uplift humanity.

Thank you so much.