

The Future of Intelligence

A Conversation between
Anicka Yi and Henry Markram

(Left page)
Bending Willow Branches, 2025
PMMA optical fiber, LEDs, silicone, acrylic, epoxy, aluminum, stainless steel, steel, brass, motors and microcontrollers
144 × 70 × 70 cm
Courtesy the artist Gladstone Gallery and Esther Schipper, Berlin/Paris/Seoul
Photo: © Andrea Rossetti © Anicka Yi / VG Bild-Kunst, Bonn 2026

(Following double page, top)
ßñ0K§L0R, 2023
Acrylic, UV print, aluminum artist's frame
121,9 × 162,6 × 3,8 cm (framed)
Courtesy the artist Gladstone Gallery and Esther Schipper, Berlin/Paris/Seoul
Photo: © Andrea Rossetti © Anicka Yi / VG Bild-Kunst, Bonn 2026

(Following double page, bottom)
Exhibition view: *There Exists Another Evolution, But In This One*, UCCA Center for Contemporary Art 2025.
Courtesy UCCA Center for Contemporary Art
Photo: © Sun Shi © Anicka Yi / VG Bild-Kunst, Bonn 2026

When a visionary artist who sculpts with bacteria, scent, and AI-driven floating machines sits down with the neuroscientist who spent two decades building digital replicas of the brain, the conversation transcends disciplines. Anicka Yi, whose olfactory installations at the Guggenheim and freely drifting, sentient machines at Tate Modern's Turbine Hall have redefined the boundaries between biology and technology, brings her singular perspective on human and more-than-human intelligence into dialogue with Henry Markram, the pioneering neuroscientist behind the Blue Brain Project and his newly launched AI innovator, INAIT. Together, they explore a provocative thesis: that current AI is merely a mirror reflecting human knowledge, while true intelligence demands participation in the causal fabric of reality itself.

ANICKA YI

How do you define intelligence, and how is it developed and distributed in biological entities?

HENRY MARKRAM

Today, we live in an age of artificial intelligence. The world has been told that AI is intelligent. When we use it, it feels intelligent because it can do things we can't – write in ways we can't, synthesize images, compose music. But scientifically, it's more accurate to refer to this as knowledge-based AI – essentially, a knowledge calculator. It takes all the data and finds patterns that humans have captured in photos, text, images, and sounds. The machinery stitches together correlations and combines these patterns in incredible ways. Strictly speaking, it's a reflection of human intelligence. It's like looking in a mirror where, behind the mirror, a machine is compiling everybody's words and creating patterns with them.

Current AI has passed the Turing Test, the bar exam, the medical exam – but it's not intelligent. What it doesn't have is understanding. It can describe a bird flying through branches and catching a bug. It can create a beautiful picture of it. But it has no understanding because it's just stitching pixels together based on previous patterns. It can describe the physics of bird flight better than any physicist, give you the equations, but it doesn't understand it.

Intelligence goes far beyond knowledge. A bee flying through the air is incredibly intelligent, and today's AI can't come close to what a bee can do, or an ant, let alone more advanced animals. There's a science fiction movie called Life where astronauts come across this little thread – as thin as a cotton thread. It's moving, and when they touch it, it reacts. Every time they interact with it, it becomes more intelligent. It grows and eventually takes over the spaceship. It doesn't speak. It has no knowledge, it's not accumulating words. But this little thread multiplies into many threads and becomes far more intelligent than the astronauts. Intelligence is the product of interaction.

ANICKA YI

This is a great opportunity to introduce your Blue Brain Project. Tell us about it.

HENRY MARKRAM

Twenty years before the Blue Brain Project, I was in medical school in South Africa, wanting to go into psychiatry. After my first introduction to the clinic, I thought: I need to understand the brain if I'm going to treat anybody. I saw that it could be understood completely. The point, however, is to build it. The first 20 years of my career, I spent digging into the brain as an experimental neuroscientist – measuring everything, mapping neurons, brain regions, synapses, how neurons learn from each other. Eventually, I realized you could go on mapping forever and still never have enough. So to build a brain, I had to invent a different process: take what you have, try to build with it, see where the gaps are, then ask: do I need another experiment, or can I predict the missing gaps? It turns out over 99% of the brain can be predicted – its structure and even functional components. The brain is like a huge puzzle. Once you know one piece, another reveals itself. It's like a cascade.

The challenge was not how much to map, but how little. How much to map is not a solvable problem – the brain differs by species, gender, strain, age, disease. Thousands of people could be mapping and never complete a single map. The answer was to find the formula, the recipe for how to build any brain.

I came to Switzerland, and the Swiss government granted me 330 million Swiss francs with the mandate to find this formula. We completed the project at the end of 2024. It's a software code of 18 million lines. We moved it into the Open Brain Institute, a foundation with virtual labs where you can run this formula to build brains. The ambition is to usher in the age of digital brains – an open platform that allows researchers worldwide to build brains. Eventually, I'd like to see digital brains of all species.

ANICKA YI

Why is the AI revolution so important to you as a neuroscientist?

HENRY MARKRAM

The AI revolution gives you complete access to knowledge. It's a knowledge revolution. I can create specialized agents that draw on all the literature and become total experts in any area – quantum physics, cellular biology, protein folding. I've already surrounded myself with these agents, and the completion of the Blue Brain was really facilitated by this. I was amplified by a factor of 100. The only risk with current AI is forgetting to use it. Now anybody in the world has instant access to this encyclopedia of humanity in any language, any style, any format. It's a magnificent revolution. Having said that, it's an observer AI. It's about a computer looking at past data that humans have collected and organized.

ANICKA YI

I have a theory that humans are fundamentally, deeply lonely at the core, because we are the apex predators. We've risen to the top of the food chain, and we're looking for some sign of life beyond us, something we can learn from. I think that's partially why we're so driven to explore different kinds of intelligence – alien intelligence, knowledge-based intelligence – something that gives us stimulation beyond ourselves. What makes you so comfortable with AI?

HENRY MARKRAM

The brain is so good at what it does that it's fooled us into thinking we're observers. For hundreds of years, neuroscience has been trapped in this paradigm where we think the brain observes the world. That's also why we have an observer AI today. It emerged from society as a whole. Humans think they are observers. But we are not observers. We are participants. We're born inside this world. If you analyze what enters the brain – there are no pictures, no color, no contrast, no texture, no sounds. Nothing of the sort. What comes in is wavelengths, amplitudes – photons. The brain constructs the world. It constructs the images, the sounds, the texture. And it does so with such accuracy that we think we're seeing the world. It's natural to be comfortable with observer AI. It was a good introduction. But what's coming next is participant AI.

ANICKA YI

Let's unpack this from a socio-political, philosophical dimension. I don't find science to be neutral whatsoever. If I'm understanding your motivation, we've done a good job getting to knowledge-based AI, but now we're entering the paradigm of the participant. What are the implications? Do we start thinking about agency? Free will? How do we coexist with participant AI?







Each Branch Of Coral Holds Up The Light Of The Moon, 2024
Single channel video projection, Duration: 16:04 min, Dimensions variable
Courtesy the artist Gladstone Gallery and Esther Schipper, Berlin/Paris/Seoul
Stills: © Anicka Yi © Anicka Yi / VG Bild-Kunst, Bonn 2026



(Following double page)
Exhibition view: *A Shimmer Through The Quantum Foam*,
Esther Schipper, Berlin, 2023
Courtesy the artist, Gladstone Gallery and Esther Schipper, Berlin/Paris/Seoul
Photo: © Andrea Rossetti © Anicka Yi / VG Bild-Kunst, Bonn 2026

ANICKA YI is a Seoul-born, New York-based conceptual artist whose practice exists at the intersection of biology, technology, and sensory politics. Winner of the 2016 Hugo Boss Prize and recipient of the 2020 Tate Turbine Hall Hyundai Commission, Yi collaborates with microbiologists, perfumers, and AI engineers to create what she calls "bio-fictions" – immersive environments that challenge the ocular dominance of Western art through scent, bacterial cultures, and autonomous floating machines. Her work probes the margins of perception itself, proposing new forms of companionship, intelligence, and co-evolution between human and non-human worlds.

HENRY MARKRAM is a South African-born neuroscientist and former professor at the École Polytechnique Fédérale de Lausanne whose pioneering vision has reshaped computational neuroscience. Founder of the Blue Brain Project and the Human Brain Project, which concluded in 2024 after producing 18 million lines of code capable of simulating mammalian brains, Markram created the field of simulation neuroscience. His discoveries about synaptic learning and spike-timing-dependent plasticity transformed our understanding of neural function. Now, through his AI innovator, INAIT, and the Open Brain Institute, he is pursuing what he calls "participant AI" – machines that learn through cause and effect rather than correlation.

HENRY MARKRAM
First, we need to understand what participant AI is. Observer AI gives a computer data from the past. It's historical knowledge, a reflection of human products. Participant AI is much more like us. It doesn't just think like us – it thinks with us. "With us" implies interactivity. Its thoughts, its patterns, the way it compiles information and responds, are a result of all the interactions. That's where it gets interesting, because we've been trapped – we don't realize how connected we are. We feel alone because we're in this observer paradigm, but actually, we're intensely coupled to the world. Every molecule in our body, every cell – there's nothing moving that is not coupled to the world. You have trillions of molecules in one cell, trillions of cells in your body. Every single one is coupled.

You could imagine streams connected to the universe – and to everybody else. This isn't surprising, because the universe was created by cause and effect. Random subatomic particles – once there's a causal interaction that sticks, it forms a quantum footprint, and that leads to the next bigger footprint. Gases accumulating, galaxies, planets, stars, eventually humans creating more complex structures – everything is the product of cause and effect. Participant AI consists of artificial machines that are effectively born into this world. They are trained to couple causally to the world, much as we are coupled through development. The brain holds the secrets to how to couple you to the world.

ANICKA YI
Does participant AI need a body?

HENRY MARKRAM
If it wants to move and interact, the body is a vehicle for interaction. Different bodies enable different kinds of interaction – climbing trees or flying with wings. Without a body, it's difficult to interact, and intelligence arises from interaction. Only through interaction do you understand cause and effect. Without it, there is no understanding of causality. That's the quest of every living thing – to interact as much as possible, to get as deeply embedded in this causal universe as possible. The more you get embedded, the more you capture the intelligence of the collective. It's not just about you and your individual intelligence. You may have a brain that's really good at coupling – and you'd be considered a genius. Or you may have a brain that struggles to couple with the causal world – and you would not. Intelligence does not reside in us per se; it emerges from our ability to couple to the causal structure of the world that gives us intelligence.

ANICKA YI
I'm quite eager to onboard participant AI. I think I embrace it because I have hope that this kind of intelligence can help humanity be our better versions – that we might not destroy ourselves as much if we open up to a new kind of hybrid species, something that takes us off our narcissistic, self-destructive path.

HENRY MARKRAM
And egocentric. Because of the observer paradigm, we are very much isolated. We don't realize we're totally connected. What you've felt all your life – and expressed in your art so beautifully – is that we're profoundly connected, that we are more than just ourselves. We are individuals, but we're also vehicles, a means to couple to the whole world. A point of reflection of the intelligence of the world. The more you see this connectivity, the more you realize the commonality and harmony of the collective – not us and them, not tribe against tribe, country against country. You're at a different level where we are connected so fundamentally. I was born in the Kalahari Desert. When I was there, there was nothing – only desert and animals. But if you look closer, you begin to feel the connectivity because it's not just about you. It's the vastness all around you.

ANICKA YI
The natural world produces that sense of awe. It puts us in a broader ecosystem.

HENRY MARKRAM
We love going into nature. We're social animals – everything thrives on interactions. But in nature, the interaction is different because nature isn't asking anything of you. In society, interaction comes as a trade. It's been commodified.

ANICKA YI
So how do we live with participant AI? Science can articulate the phenomena, but it can't teach you how to live it.

HENRY MARKRAM
I think first, we'll have a major sociological revolution, as we come to realize that what we see is something we first build, and only second, something we observe. That will give everybody pause. It's like realizing: I can't always be right. It instills



humility, because it's subjective, it's a construction. We're all walking around in a little perceptual bubble – our own little bubble. And we don't have to harm one another simply for inhabiting different bubbles. In terms of building machines that can do the same, at INAIT, the startup we created, we have forecasting, learning, and we're going to provide digital brains for robots. These product lines are now in production.

Because we understand how to create the causal relationship, we can constrain the domain of responsibility. Very much like a monkey – even the most advanced monkey cannot speak – its learning domain is constrained. We know how to constrain these digital brains to very specific roles, like a supply chain manager or an AI farmer. I don't believe this is dangerous, because not only is there a clearly defined domain of responsibility, but also because it's based on causality, it's explainable. With correlations, it's a black box. With cause and effect, on the other hand, you can trace the chain of causality. This gives you explainable AI, trustworthy AI, accountable AI, and ultimately, safe AI.

If we want to send robots out for space exploration – mine asteroids, build bases on the moon, go to Mars – they can't rely on observer AI, which needs historical data. What historical data is there on Mars? They have to learn continuously and adaptively, immersed in the cause-and-effect environment.

ANICKA YI

I'm optimistic. Our current model of reinforcement learning AI doesn't seem sustainable from an environmental perspective. Can we talk about how your digital brains, learning causally, require far less data than correlational learning?

HENRY MARKRAM

Once you understand cause and effect, you don't need any data. You can simply plug it in. Imagine a factory process optimization AI. You plug it into the factory, the data streams in, it aligns and adjusts, and it becomes the factory – a digital twin. Without any mathematical modeling, without reinforcement learning, without ever having seen the factory before. It's like watching a giraffe being born in Africa. In the first 30 to 60 seconds, the little giraffe is wobbling its way up. In the next minute, it's walking with its mom. In the third minute, it's running in the savannah. It calibrates to the environment, becomes embedded and embodied, and then it can run with the intelligence of a baby giraffe.

This has a revolutionary impact on energy. The reason current AI needs vast amounts of data is to find correlations. You need a lot of GPUs and nuclear power stations for that. Cause and effect is energy-efficient because correlations represent a vast set of all possibilities. The number of correlations around you in this room alone is enormous. But the number of causal effects is a tiny subset. The brain only has to learn those. Evolution has given us a machine that knows how to ignore correlations and isolate causal relationships. That's why the brain only needs a banana and not a nuclear power station.

ANICKA YI

I feel like we're becoming too conditioned by correlational data-driven AI. It's flattening our minds and our relationship to everything from writing term papers to emails. Incredibly capable, but flat.

HENRY MARKRAM

I don't think it's going to harm human intelligence. Our challenge is how to use a device that contains all of humanity's knowledge. We're going to grow from this. What question should I ask? How should I frame it? How should I sequence it? That's what education will become. It's like going up to the Oracle of Delphi – what are you going to ask?

ANICKA YI

I'm not a techno-optimist, nor a techno-pessimist. I'm excited about the participant paradigm because it's part of evolution. AI, the natural world – we're all under the rubric of evolution. This is an opportunity to learn, to grow, to do better. To address the moral vicissitudes of our civilization.

HENRY MARKRAM

I'm very optimistic about knowledge AI – it's going to boost human intelligence through the roof. The only risk is not engaging with it. Participant AI will take interaction to another level. You'll have a participant AI that is a doctor with all the knowledge of being a doctor – it could become a surgeon, interact with the patient, the nurses. Everything happens to push us to the next level.

ANICKA YI

I think the anxiety most people have with AI is that they're shut out of the conversation, plus the lack of equitable distribution and access. AI should be as natural as the air we breathe, and everyone should have access. There are still parts of the globe without internet access. I'd love to see a more natural, organic relationship to AI – not siloed at the top, with the rest of us told what's coming next quarter.

HENRY MARKRAM

You're going to see that with participant AI. The reason you don't see it with observer AI is because they need so much data. The ones that grabbed all the data, had the money and energy – only they could do it. It's a runaway effect. But with participant AI, you don't need the data. Data is no longer a strategic advantage. You can have a superintelligent AI using less power than a light bulb. It could be sitting on your fridge, on your watch. Anywhere. This will bring AI within everyone's reach.

ANICKA YI

If you were entering formal education today with participant AI, would you change your vocational discipline?

HENRY MARKRAM

That's difficult. Knowledge AI already makes it hard, because I did things the hard way for 40 years. As knowledge AI came online, what once took me five years I could do in one year, then in one month, now in seconds. At the Open Brain Institute, our slogan is "neuroscience at the speed of thought." We use knowledge AI, but we also provide it with everything we know about how to build the brain, so the AI can build the brain itself. I can literally do what would otherwise take decades of research in a fraction of the time. But there are still hard experiments. I still have a lab at EPFL, tackling questions that simply cannot be answered through simulation.

I don't want to ask a question that's reinventing the wheel, or just to feel intelligent. I want to understand something genuinely new. I wouldn't ask any question that ChatGPT can answer for me. I want to answer something it can't. That gives me the freedom to ask the really hard questions. And there are some beautiful, hard questions left – about the universe, our bodies, our minds, the planet. It's going to be much more about how you partner with AI – as a collaborator. And I don't think it'll lock you in a world of artificial collaborators. It's going to enrich how you collaborate with humans and animals and nature, and make us appreciate each other more. I'm a complete optimist. Not 99% – 100%.

ANICKA YI

We all have a stake in these issues. And we are all connected. These are foundations that could create a very stable, thriving world. I would still be an artist with the participant paradigm. There are still a lot of things to do. We can go to the end of the universe and still find something to do.

HENRY MARKRAM

I think art is the first step of science. You can build on science – learn techniques and methods. But a true breakthrough – and I'm fortunate to have a few of those moments – that comes from what I think is art. It's a step into the complete unknown. You jump into an abyss. And then you see the connection. In 1996, I discovered how two neurons learn about each other. That discovery came from such a deep place that it felt like it came from nowhere. I was on a bicycle when I realized: that's how it works. I raced back to the lab and did the experiments.

ANICKA YI

Artists have an interesting practice because it's not reliant on any single expertise. You're pulling from all these different mediums – spirit, philosophy, technology, ecology. Everything that exists becomes material for art. But for the kind of work I make, I have to be accountable to the world. It's not just a fantasy-based wish list. We're going to plug all of that into the real world and make a proof of concept. It can't just be theoretical – I have to build it. It's got to be built and be relevant and connected. And that's what you do. Without diluting the alchemy. When it synthesizes, it's sublime. What you're doing feels like art to me. That's why this conversation is so enriching. I'm very excited about the collaboration we're participating in at the moment, and hopefully the result will be presented very soon. Thank you so much for your time today, Henry.

HENRY MARKRAM

Thank you. This has been fun.