Give the gift of sight – and insight will follow

Restoring the sight of blind children can illuminate how we piece together the visual world, says **Pawan Sinha**

What fascinates you about vision?
My fascination stems from my interest in art. As I made drawings as a kid, there was always a question in my mind: what can I put on this piece of paper that allows me to convey the identity of a face or an object to the viewer? It is very close to the question a vision researcher would ask: what information does the brain need to discern what it is seeing in the world?

How did you go about finding out?
I founded Project Prakash, a service in India that helps to restore children's sight. There are many children in India who are blinded by cataracts – which can be caused by rubella during the mother's pregnancy – or other treatable conditions. Restoring their sight also provides a research platform to learn more about the visual system.

What have you learned from the project?
Scientifically, the key message is that the brain remains significantly plastic well into late childhood and even early adulthood. It also raises many questions about how and when different visual abilities develop. But the most wonderful lesson has been a personal one. I've gained a new appreciation for just how little it takes to transform a person's life – a few hundred dollars and a little effort to identify the children we can help with treatment. Very often one has the feeling that the best we can do is try to live a good life. Project Prakash has shown me is that there are opportunities to make tremendous differences even as you pursue your professional goals.

How do the children react to restored vision?
When a child sees the world for the very first time, one might imagine it's like the movies, with the child jumping up and down, happily yelling, "Yes, I see this! I see that!" But that's not what happens. Once we remove the bandages, there is a very subdued reaction in those first moments. The child is seeing, yes, but it's a confusing mess of information. Then over a few days there is an amazing transformation. The child becomes more confident in their use of vision: they start to rely on it. By the time that child is ready to head home, you will see them walking completely unaided along the hospital

"Newly sighted children tend to see images as comprising many small pieces"

corridors, sometimes running. Something is changing rapidly in those first weeks.

How do they make sense of what they're seeing?
We've learned that motion information is a powerful force. As these children see how things move in the world, it provides the brain with a tremendous amount of information about how to distinguish objects, backgrounds, foregrounds and so on. Dynamic information is a powerful cue for visual learning – and may be the fundamental process that helps the brain make sense of a very complex world.

You've suggested the importance of dynamic information goes beyond vision. Tell us more.
This was an unexpected but gratifying outcome of Project Prakash: the idea that problems in processing dynamic visual information may play a role in autism. Children with autism have normal vision in terms of acuity, sensitivity to contrast and colours, but they have problems integrating information across different senses. Your perception of the world is made up not only of the things you see, but also the things you hear, feel and smell. If they don't seem to fit together, that is a very difficult experience.

When we were working with the Prakash children, we saw something similar in the first few months after the restoration of their sight – they had integration problems.

Give us an example of an integration problem.
When viewing images, newly sighted children tend to "over-fragment" them: they see them as comprising many small pieces. Almost every region of a different colour or brightness is seen as a separate entity and it is difficult for the children to integrate them and perceive the image as a whole. I thought it might be a superficial similarity to what happens in autism, but I couldn't help thinking that dynamic information was the key. If that is what helps formerly blind children understand how to integrate sensory information, then perhaps there is something impaired in the dynamic-information processing systems in children with autism that interferes with them making sense of their world.

So you then worked with children with autism?
Yes, and we found that their ability to anticipate what's going to happen next in a dynamic sequence – such as the trajectory of a thrown

PROFILE
Pawan Sinha explores vision and computational neuroscience at the Massachusetts Institute of Technology. He founded projectprakash.org in 2005 to treat blind children in India and investigate how the brain makes sense of sight

Photographed for New Scientist by Ken Richardson

Understanding movement may help the brain process colours and shapes

ball – is indeed impaired. This skill is very important. When you interact with a dynamic world, you need to know more than just what's happening at a given moment – you need to anticipate how it might change in the next moment so you can take the right actions. We proposed a new theory of autism, called the predictive impairment theory, or the magical world theory. Our hypothesis is that people with autism may have a reduced ability to predict what will happen next, making the world feel chaotic and overwhelming.

Your work also addresses long-running questions on how visual illusions work. How?
The dominant belief has been that there is a long learning process that helps us understand perspective cues, such as converging lines typically corresponding to depth. So when we see certain illusory images, our brains can't help but tap into that learning to make inferences about what we're seeing. If that's the case, a newly sighted child should not fall prey to such illusions. But, to our surprise, we found that on the very first day of bandage opening, Prakash kids did see the illusion. That suggests that no learning process is required, but rather it's something in the hardware of the visual system that predisposes us to these illusions.

What are the challenges of merging science with service in Project Prakash?
Perhaps the greatest challenge is finding children in need of care, as they typically live in remote areas. Their parents have no idea their condition is treatable. In fact, when the parents talk to village elders or the village priest about the problem, they are told that the child's blindness is due to a bad deed in a previous life. That dampens their enthusiasm to seek treatment. That makes it imperative for us to go out into the villages, conduct screening camps and identify children, instead of waiting for them to show up at the hospital.

When will your mission be fulfilled?
Not in my lifetime, because the idea of merging healthcare with scientific research can be applied so widely. After the original Prakash team is gone, and the project is on an even stronger footing and expanding to help kids with other conditions, such as cerebral palsy, we will be fulfilling our mission.

Interview by Kayt Sukel