

Senses special: The art of seeing without sight

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IT IS an odd sight. A middle-aged man, fully reclined, drawing pictures of hammers and mugs and animal figurines on a special clipboard, which is balanced precariously on a pillow atop his ample stomach.

A half-dozen people buzz around him. One adjusts a towel under his neck to make him more comfortable, another wields a stopwatch and chants instructions to start doing this or stop doing that, and yet another translates everything into Turkish. A small group convenes in a corner to assess the proceedings. A few of us just stand around watching, and trying not to get in the way. The elaborate ritual is a practice run for an upcoming brain scan and the researchers want to get everything just right. Meanwhile, the man at the centre of all this attention, a blind painter, cracks jokes that keep everyone tittering.

The painter is Esref Armagan. And he is here in Boston to see if a peek inside his brain can explain how a man who has never seen can paint pictures that the sighted easily recognise - and even admire. He paints houses and mountains and lakes and faces and butterflies, but he's never seen any of these things. He depicts colour, shadow and perspective, but it is not clear how he could have witnessed these things either. How does he do it?

Because if Armagan can represent images in the same way a sighted person can, it raises big questions not only about how our brains construct mental images, but also about the role those images play in seeing. Do we build up mental images using just our eyes or do other senses contribute too? How much can congenitally blind people really understand about space and the layout of objects within it? How much "seeing" does a blind person actually do?

Armagan was born 51 years ago in one of Istanbul's poorer neighbourhoods. One of his eyes failed to develop beyond a rudimentary bud, the other is stunted and scarred. It is impossible to know if he had some vision as an infant, but he certainly never saw normally and his brain detects no light now. Few of the children in his neighbourhood were formally educated, and like them, he spent his early years playing in the streets. But Armagan's blindness isolated him, and to pass the time, he turned to drawing. At first he just scratched in the dirt. But by age 6 he was using pencil and paper. At 18 he started painting with his fingers, first on paper, then on canvas with oils. At age 42 he discovered fast-drying acrylics.

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His paintings are disarmingly realistic. And his skills are formidable. "I have tested blind people for decades," says John Kennedy, a psychologist at the University of Toronto, "and I have never seen a performance like his." Kennedy's first opportunity to meet and test Armagan in person was during a visit to New York last May, for a forum organised by a group called Art Education for the Blind. Armagan, who is something of a celebrity in Turkey, has become used to touring with his canvases to the Czech Republic, China, Italy and the Netherlands. What

made this visit different was the interest shown by scientists - both Kennedy and a team from Boston.

Kennedy put Armagan through a battery of tests. For instance, he presented him with solid objects that he could feel - a cube, a cone and a ball all in a row (dubbed the "three mountains task") - and asked him to draw them. He then asked him to draw them as though he was perched elsewhere at the table, across from himself, then to his right and left and hovering overhead. Kennedy asked him to draw two rows of glasses, stretching off into the distance. Representing this kind of perspective is tough even for a sighted person. And when he asked him to draw a cube, and then to rotate it to the left, and then further to the left, Armagan drew a scene with all three cubes. Astonishingly, he drew it in three-point perspective - showing a perfect grasp of how horizontal and vertical lines converge at imaginary points in the distance. "My breath was taken away," Kennedy says.

Kennedy has spent much of his career exploring art from the perspective of blind people. He has shown that people who are congenitally blind understand outline drawings when they feel them just as seeing people do. They understand and can draw in three dimensions. In fact, blind children develop the ability to draw, he has found, much as sighted children do - but all too few blind children ever get the opportunity to explore this ability. Even knowledge about perspective, he has come to believe, is acquired in similar ways for both. "Where a sighted person looks out, a blind person reaches out, and they will discover the same things," says Kennedy. "The geometry of direction is common to vision and touch."

Lines and one-liners

It is the night before the Boston team's first brain scan. Armagan is sitting at a long table at an inn, entertaining everyone with one-liners, trying to explain how he does his artwork. Alvaro Pascual-Leone, the Harvard neurologist who invited him here, and Amir Amedi, his colleague, are challenging him with more and more complex tasks. Draw a road leading away, says Pascual-Leone, with poles on either side and with a source of light underneath. Armagan smiles confidently.

He uses a special rubberised tablet, called a "Sewell raised line drawing kit". This device allows him to draw lines that rise off his paper as tiny puckers, so that he can detect them with his fingertips. And so he draws the road and the poles: one hand holding the pencil, the other tracing along behind, like surrogate eyes, "observing" the image as it is being laid down. A minute or so later, the picture is done. Pascual-Leone and Amedi shake their heads in wonder.

So, we ask, how do you know how long these poles should be as they recede? I was taught, he says. Not by any formal teacher, but by casual comments by friends and acquaintances. How do you know about shadows? He learned that too. He confides that for a long time he figured that if an object was red, its shadow would be red too. "But I was told it wasn't," he says. But how do you know about red? He knows that there's an important visual quality to seen objects called "colour" and that it varies from object to object. He's memorised what has what colour and even which ones clash.

Scanning the mind's eye

Next day, and the time has come for Armagan to get into the scanner. The Harvard scientists are collaborating with scanning experts at Boston University. In addition to taking a structural snapshot of Armagan's brain and establishing if it can perceive any light (they confirmed it cannot), this morning's experiment will have him doing some odd sequences of tasks. He'll have a set number of seconds to feel an object, imagine it and draw it. But he has also been asked to scribble, pretend to feel an object and recall a list of objects that he learned days earlier.

Pascual-Leone and Amedi want to see what Armagan's brain can tell them about neural plasticity. Both scientists have evidence that in the absence of vision, the "visual" cortex - the part of the brain that makes sense of the information coming from our eyes - does not lie idle. Pascual-Leone has found that proficient Braille readers recruit this area for touch. Amedi, along with Ehud Zohary at the Hebrew University in Jerusalem, found that the area is also activated in verbal memory tasks.

When Amedi analysed the results, however, he found that Armagan's visual cortex lit up during the drawing task, but hardly at all for the verbal recall. Amedi was startled by this. "To get such extraordinary plasticity for [drawing] and zero for verbal memory and language - it was such a strong result," he says. He suspects that, to a certain extent, how the unused visual areas are deployed depends on who you are and what you need from your brain.

Even more intriguing was the way in which drawing activated Armagan's visual cortex. It is now well established that when sighted people try to imagine things - faces, scenes, colours, items they've just looked at - they engage the same parts of their visual cortex that they use to see, only to a much lesser degree. Creating these mental images is a lot like seeing, only less powerful. When Armagan imagined items he had touched, parts of his visual cortex, too, were mildly activated. But when he drew, his visual cortex lit up as though he was seeing. In fact, says Pascual-Leone, a naive viewer of his scan might assume Armagan really could see.

That result cracks open another big nut: what is "seeing" exactly? Even without the ability to detect light, Armagan is coming incredibly close to it, admits Pascual-Leone. We can't know what is actually being generated in his brain. "But whatever that thing in his mind is, he is able to transfer it to paper so that I unequivocally know it's the same object he just felt," says Pascual-Leone.

We normally think of seeing as the taking in of objective reality through our eyes. But is it? In his own life, too, Armagan seems to have a remarkable grasp of space. He seldom gets lost, says his manager Joan Eroncel. He has an uncanny sense of a room's dimensions. He once drew the layout of an apartment he had only visited briefly, she says, and remembered it perfectly nine years later.

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what we are about to see, says Pascual-Leone. "Seeing is only possible when you know what you're going to see," he says. Perhaps in Armagan the expectation part is operational, but there is simply no data coming in visually.

Conventional wisdom suggests that a person can't have a "mind's eye" without ever having had vision. But Pascual-Leone thinks Armagan must have one. The researcher has long argued that you could arrive at the same mental picture via different senses. In fact he thinks we all do this all the time, integrating all the sensations of an object into our mental picture of it. "When we see a cup," he says, "we're also feeling with our mind's hand. Seeing is as much touching as it is seeing." But because vision is so overwhelming, we are unaware of that, he says. But in Armagan, significantly, that is not the case.

I sit across from the source of all this mystery and I ask him about the birds he loves to paint. They are brightly coloured and exotic and I wonder aloud how he knows how to depict them. He tells me about how he used to own a parakeet shop. "They come to your hand," he says. "You can easily touch them." He pauses and smiles and says: "I love being surrounded by beauty."