The Changing Brain Neuroplasticity in the Deaf

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I watched the movie Extra-terrestrial (ET) when I was very young and was fascinated by two things: the idea of space travel (because I wanted to be an astronaut, like many young children) and the scene where ET and Elliott, the central characters of the movie, fly on their bicycle which is one of the most iconic images of the movie. Part of the reason why this is so attractive is that everyone knows that bicycles are not supposed to fly. It has its designated function it can only move on the ground. This is true of most things in the physical world everything has its specified role which can't be changed.

Surprisingly and fortunately for us, it turns out our brains and their cognitive functions can show such flexibility. Under certain conditions, parts of the brain can learn or be trained to take over new roles something similar to a bicycle learning to fly. This ability of the brain to change known as neuroplasticity generated a lot of interest among researchers and the general public in recent years. There has been an onslaught of studies showing that "training" the brain, even for a few weeks, on a complex task can drastically alter core cognitive functions like attention or memory. Now there are also games that can be played on the smartphone which claim to enhance your cognitive abilities with continual practice of the game. This means that although our physical world is severely constrained, the mental world maybe not.

One remarkable example of naturally-occurring neuroplasticity is in hearing-impaired individuals. Studies have shown that because the Deaf can't hear, they start "seeing" better. How is this possible? Since there is no audio input in the Deaf, the part of the brain mostly responsible

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for processing sound (known as the auditory cortex) is essentially out of a job. But it would be a waste to leave those neural resources unutilised. To avoid this, nature has devised a clever mechanism through which the auditory cortex takes over other functions. One of those functions is visual processing. A lot of visual stimuli our brain through the eyes. These need to be sorted and forwarded to higher areas of the brain for more complex processing. In normal-hearing individuals, a region known as the visual cortex is involved in this task. But in the Deaf, such visual processing is also carried out by the auditory cortex, in addition to the visual cortex. When two brain regions take over a task, the efficiency increases and leads to a visual advantage in the Deaf.

Vision fulfils several functions in humans. It helps us perceive the colour, size, brightness and location of an object. It also helps us to pay attention to objects in the world. While the last 30 years of research on the Deaf tells us that they indeed display better visual abilities, exactly which of these aspects of vision is enhanced is not entirely known. To answer this question, a team of researchers from the University of Hyderabad comprising Seema Prasad and Prof. Ramesh Mishra collaborated with Dr Gouri Shankar Patil from Ali Yavar Jung National Institute for the Hearing Handicapped, Secunderabad. The researchers measured spatial attention through eye movements in congenitally deaf (individuals who are born with hearing-impairment) and normal-hearing participants. Spatial attention is the mechanism by which we selectively process the location of the objects in the world – for example, quickly noticing an incoming car while crossing the road. The study published in *PLOS One* found that the Deaf were better at paying attention to visual information compared to normal-hearing individuals. Using a classic task routinely used in attention studies, known as the Posner cueing task, the authors found that the Deaf were faster at detecting the presence of target circles on the screen when they were followed by visual cues in the same location. This can only happen if the Deaf were better able to orient their attention to the visual cues, compared to normal-hearing individuals.

In another very interesting study published recently in *Nature Scientific Reports*, the same team of researchers found that the deaf were also more sensitive to briefly presented visual information using a priming paradigm. In this paradigm, visual cues presented for as short as 16 milliseconds can influence a participant's responses. For instance, you are more likely to press a button on the left side of the keyboard when a left-arrow is shown to you even if you can't consciously "see" the arrow. While this phenomenon in itself is astounding and has been heavily debated and researched

upon, the authors found that this "priming effect" was stronger in the deaf. In short, the deaf were more strongly influenced by almost-invisible information. This was one of the first studies to show that the visual advantage observed in the deaf is not limited to the conscious domain but also extends to information not accessible to conscious awareness. While this helps researchers dig deeper into the depths and limits of the visual processing advantage in the deaf, it also has far-reaching implications on our understanding of consciousness itself.

Apart from contributing to our fundamental understanding of neuroplasticity and visual systems, the knowledge gained from such studies can also be used to improve the quality of life of deaf individuals. For instance, researchers can work closely with clinicians and speech pathologists to develop educational tools for deaf children based on such findings.

The fact that our brains can be rewired to adapt to newer contexts and tasks is mindboggling. It casts aside older notions according to which we are born with certain attributes which are, for all practical purposes, unchangeable throughout our lifetime. These new theories and scientific research tell us that our brains can change and grow. This issue is at the heart of our quest to understand human behaviour. How much of what we are is limited by the kind of brains we have? How much can an individual change through brain plasticity and what does it take? Can a hardened criminal, for example, be reformed enough to be confidently rehabilitated back into civil society? We don't have the answers to these questions yet, but we are getting there.