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Ms. Weissman, Ms. Curtis

### The Mysterious Phantom Limbs

*This is a true story.* Victor Quintero, a seventeen years old high school-er missing his left arm, sat quietly in the patient seat. Victor closed his eyes, as he kind of still couldn't believe he was in a brain-research laboratory.

"Where do you feel that?" Dr. Vilayanur S. Ramachandran asked while he was poking Victor with a cotton swab.

"On my left cheek and on the back of my missing hand," Victor replied, even though he and all the researchers around knew the perfect fact that he lost his whole left arm.

Finally, Dr. Ramachandran gently poured warm water down Victor's left cheek. Both of them were amazed.

"I feel it running down my arm," said Victor, blinking his eyes to check that the limb was still gone.

Just one month ago, Victor had been in a car accident, and with misfortune watching aside, he lost his entire left arm. However, after the arm had been amputated, he experienced something special, and scary. He could still feel that he had his already cut arm with him. The imaginary sensation was so real, as he almost felt like he could really touch things. Victor sometimes wondered if he had gone insane, but indeed, he hadn't; he just had the Phantom limb syndrome. (Abstract from "Missing Limbs, Still Atingle, Are Clues to Changes In the Brain")

Phantom limb syndrome describes the perception of sensation of an already amputated limb. The victims that have this condition feel that the amputated arms or legs are still attached, and oftentimes they have the misleading imaginations where they can feel and even complete jobs with their missing hands or feet; for example, one could try to gesture while he is talking even though he doesn't even have a full arm. However, the most common symptom and the majority of this disturbing sensation is pain; it's called the phantom pain. Patients can feel pain or burns in their absent limbs.

As researchers have always thought, the cause of Phantom limb syndrome is related to the human body's nervous system. Nerves transfer electrical impulse back and forth among the human brain, spinal cord, and peripheral nerves to let a person "sense", feel, and respond to the outside environment. It may seem basic; however, not until recently have scientists figured out the real cause.

Before 1990s, scientists believed that the nervous system was fixed, meaning that certain parts of the brain receive signals from certain nerves and vice versa. Accordingly, they assumed that the neuroma, the tip ends of the nerves, at the area of amputation, were being compressed. Usually after amputating a limb, the endings of nerves are terminated with residual limb that will often inflame, and that was what the scientists thought to be pressing or forcing the severed neuroma to send off

anomalous signals. However, treatments based on this theory were generally failures. Early surgeons would amputated a second time, trying to cut off the inflamed part and hoping for a relief for the victim; but this process only led to a even more painful experience for that poor person. It was reported that in some cases where patients were amputated twice had phantom pains from both of his surgeries, causing unbearable suffer and peculiar sensations. In even more extreme cases, some doctors would even cut off the sensory nerves leading to the spinal cord.

In 1990s, scientists in this field had conducted some great experiments and in the end led to a more complete theory. In 1992, Dr. V. Ramachandran of the University of California in San Diego realized that it might be some automatic adjustments in a human's brain that causes the Phantom limb syndrome. He tried and finally succeeded to understand better the functioning of the somatosensory cortex of the patients who have phantom limbs. He then discovered that the true reason is the "cross-wiring" of the brain. Somatosensory cortex is an area in the brain that receives nervous inputs from the body that are related to tactus, the sense of touch. In the case of a phantom limb, the responding area in the somatosensory cortex is forced to stop getting signals once the limb is amputated; however, the nearby areas in the somatosensory cortex are found to take over the part that no longer function. Here, although this adjustment is bothering the humans; nevertheless, strong adaptive ability of the *homo sapiens* can be seen as the brain can command this kind of change to make sure the body can function as normally as possible. (Even literally the whole process is now still unhelpful as it isn't possible to recover if any organs of the body are removed.) From original studies, scientists knew that the responding area in the somatosensory cortex is right next to the face, as that of foot is next to the hand. Demonstration led by Dr. Ramachandran on his patient Victor Quintero confirmed this totally new theory.

There are now more efficient treatments than 20 years ago. As well developed by Dr. Ramachandran, the mirror box helps the patients relives their pain from phantom limb syndrome. The mirror box uses simple physics to trick the human brain. The device is set up like this: a mirror is placed in the middle of a wooden box where on one side of the box there are two holes that hands can be put in. When a victim insert his healthy arm into a hole and put the phantom one into the other, the mirror would reflect the image of the existing limb. This way, when looking from a certain angle, the victim will see two healthy limbs and over time the pain of the non-existing limb should lessen. This technique has been modified and improved using modern technology such as computer simulations. Prevention of Phantom limb syndrome is to set up good pain control before operation of the amputation starts. In addition, there are certain drugs that mainly serve the purpose of relieving pain. Nonetheless, more research on the treatment of phantom limbs is needed, as current options do not

directly deal with the root of the syndrome.

Furthermore, there are other similar cases relating to the Phantom limb syndrome. First of all, people who are born without limbs may sometimes as well have phantom limbs. However, the cause of this kind of situation is unclear as there are two unverified explanations. Some people argue that the new born children already have images or ideas of a normal human body implanted in the brain when arriving this world, while other scientists predict that the image of a healthy human body is gained through watching surrounding people. Moreover, beside phantom limbs, there are cases reported of other phantom organs. Other misleading sensations may appear after the removal of ears, breasts, bladder... etc. In addition, this discovery of the true cause of Phantom limb syndrome and the working pattern of somatosensory cortex also help explain the some people's out-of-expect recovery from stroke. Now doctors are able to comprehend that some other parts of the brain may have taken over the dead part and the victims would be able to function as normally as they were before getting the stroke.

In addition, the Phantom limb syndrome does not only exist in the recent decades actually, it has been with the humans for a long time. First recognizable records can be traced back to the 16th Century or even earlier. In 1551, Ambroise Pare, a famous French military surgeon wrote "For the patients, long after the amputation is made, say they still feel pain in the amputated part. Of this they complain strongly, a thing worthy of wonder and almost incredible to people who have not experienced this." (Herman) As well, there are all the other myths from the country associating with ghosts and spirits. In the famous literature piece *Moby Dick*, the captain Ahab has a phantom leg. Still nowadays, a phantom limb can be extraordinary unusual to most of the people. Most of the people do not understand the cause and some misleading may have severe consequences. There is no doubt that a person that completely has not idea what Phantom limb syndrome is would think of a victim of it a psycho. Victims with this kind of syndrome shouldn't be treated differently.

In final conglomeration, Phantom limb syndrome is interesting and mysterious while it is also a troublesome issue for the humans. According to research, approximately 75% of the patients that have undergone any amputation would have the condition, for a brief period or a longer time. Even though now there is a well developed theory of the cause of syndrome, thanks to Dr. Ramachandran, it seems like better treatments are still in need. In the near future scientists, hopefully, should have found some ways to interfere the signals sent from the amputated limbs' remaining when they better understand the nervous system, especially the brain.