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My left hand annoys me: When parts of your own body feel alienated

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Abstract: *How the brain creates the image of the body and decides what belongs and not belongs to the body is one of the most exciting questions in neuroscience. The puzzle can be solved by studies of patients with diseases such as hemi-neglect, body integrity dysphoria, split-brain, phantom-limb feelings and especially the alien hand syndrome. The article describes these disorders and lists theories about deficits in the brain, which trigger these symptoms. The theory that the corpus callosum is the only part of the brain that causes the alien-limb syndrome was shattered by another brain-organic disorder, the neglect syndrome. Here, lesions of the frontal lobe, thalamus, basal ganglia, and internal capsule are most commonly reported. Patients with body integrity dysphoria feel complete only after amputation of a leg. On the other hand people exist, who have the intense feeling that their body is missing an extension in the form of a tail (missing-tail syndrome).*

Keywords: *Alien-limb-syndrome, neglect, body integrity disorder, body identity integrity disorder, BIID, split-brain, phantom limb, missing-tail-syndrome*

1. INTRODUCTION

Charles Andre and Romeu Domingues [1] described in 1996 a 62-year-old Portuguese who woke up on a summer morning because his wife touched his right forearm. But when he looked, he saw to his utter astonishment that it was not his wife but his own left hand that pinched him. Without his will, the left fingers made movements and gestures that he could not consciously inhibit. His left hand repeatedly fumbled for his right hip, torso and right arm, or tugged at his clothes. For brief periods he was able to control these unwanted activities by holding his left arm tightly against his body; however, the abnormal pattern of behavior recurred every time he let go of his arm.

The symptoms described here are quite typical of the “alien hand syndrome”. Because it does not only refer to one hand, but also to other limbs, it is often named “alien limb syndrome”. The German neurologist Kurt Goldstein [8], described in 1908 a 57-year-old woman whose left hand had developed its own will. This body part moved involuntarily and her searching fingers tended to fumble with whatever objects they happened to encounter. If she was not keeping an eye on her arm, she could never be sure what it was up to do. Even more disturbing, her fingers sometimes snaked tightly around her neck, forcing her to defend herself with her more obedient arm. The patient described by Goldstein had little or no control over one hand and felt this part of the body as foreign and not belonging to the body; hence the term alien hand was later chosen. In some cases, this hand works outright against the other, prevents the other hand from doing anything, or, in extreme cases, the hand perceived as foreign even tries to beat its owner.

Most patients suffered from the effects of an injury, e.g. a tumor on the corpus callosum, which connects the right with the left hemisphere. This phenomenon has been divided into two groups: (1) includes complex, unwilled motor acts, intermanual conflicts, mirror movements, interference, and the pushing aside of the directed limb by the autonomous limb, and (2) includes simple, unwilled, quasi-reflexive actions, autonomous reaching, grasping and utilisation behaviour, automatic limb withdrawal or levitation.

The corpus callosum was listed as the primary suspect for causing this syndrome, since the "split brain" complex of symptoms has been well-known since the 1940s, with strong similarities to the alien hand. In order to prevent the spread of epileptic seizures, the connection between the hemispheres was surgically disconnected in some patients at that time, an exchange of information between the right and left half of the brain was thus much more difficult, hence the term "split brain". Nevertheless, the patients were surprisingly undisturbed in their everyday life, since the visual observation of their own behavior enabled the two halves of the brain to obtain the essential information. Only in a clever experimental setup, in which one suppressed this visual feedback, some problems showed up. Split-brain patients could not name an object felt only with the left hand, since the speech abilities usually lie in the opposite (left) half of the brain. A victim tried to open the zipper of his pants with one hand, while the other endeavored to pull it close. Another attempted to beat his wife with one hand while the other hand stopped him. Another patient was attempting to put together a puzzle image with his right hand, with the left bothering him again and again until he had to sit on his left hand to stop these movements. A hemispheric-disconnected patient whose right half of the brain was shown an obscene image blushed; when asked why she blushed, she replied, "*I do not know*" [14].

The theory that the corpus callosum is the only part of the brain that causes the alien-limb syndrome was shattered by another brain-organic disorder, the

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neglect syndrome. My Munich colleague Reinhard Werth [15] described in 1998 a patient who complained to the clinic staff about a strange arm that "someone" constantly stretched into his bed and even put it on his body. The man did not realize that it was his own arm that bothered him. Because the half of the body to which this arm belonged, no longer existed in the patient's consciousness, he felt his own arm alien and believed it belonged to another person. In the neglect-phenomenon, also known as "half-sided neglect", half of the world has ceased to exist. Causes are usually extensive brain damages; many patients have a combination of neglect with hemiplegia and limitations in their visual field. The syndrome is usually seen today as a special form of an attention deficit disorder. Everyday problems include bumping against obstacles, orientation problems, slowing down in finding items on a table or on the shelf of the supermarket, as well as reading difficulties. The typical patient with a right-sided lesion keeps his gaze moving to the right (but never to the left). Right-sided objects distract him; neglect-patients cannot find left-sided objects even when they are requested to look in the left direction. In severe cases, the patient washes only one half of his body or shaves only one side of the face. Typical is the anosognosia, the patients do not complain about their functional failure; when asked about the cause of their problems, they give trivial answers; their half-drawn figure they consider to be complete.

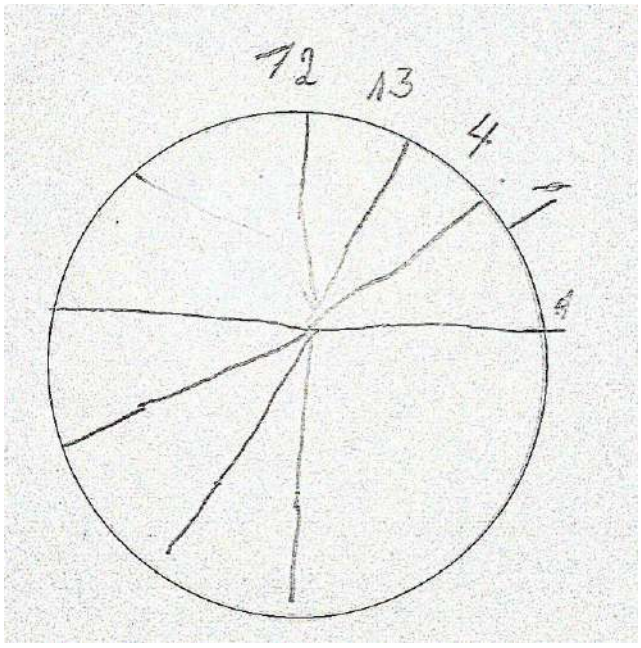

Fig. 1: Result of the neuropsychological test " Draw a clock" of a patient suffering from hemi-neglect.

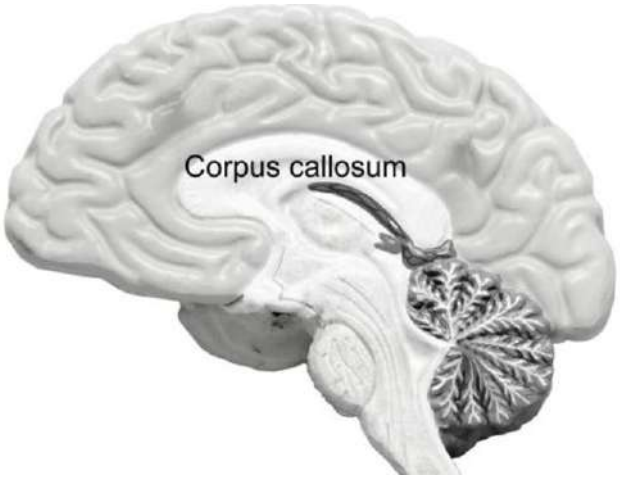

Fig. 2: The corpus callosum connects the right and left hemispheres of the brain. Here, powerful bundles of nerve-fibers pass through the brain, linking almost every part of the right hemisphere with the corresponding part of the left hemisphere.

There are different theories for the emergence of neglect. According to the arousal hypothesis, each hemisphere has its own activation system; the half-brain lesion disturbs the equilibrium, with right-sided lesions causing a greater displacement error than left-sided ones. According to the "Attentional Hypothesis", patients cannot release their selective attention from the intact side. Lesions that cause neglect cannot be clearly assigned to an area. Lesions of the frontal lobe, thalamus, basal ganglia, and internal capsule are most commonly reported. This indicates that components of a complex neural network are damaged here. In 1985 Heilman et al. [9] distinguished two loops: 1. the temporo-parieto-occipital formation responsible for perception (perceptual-attentional neglect), and 2. the formation surrounding the premotor cortex, the anterior cingulate gyrus, the basal ganglia, and thalamic nuclei; it serves to prepare and execute motor reactions (motor-intentional neglect).

Also in the alien-limb syndrome exist -- according to the current state of research --, two different forms. In one form, as assumed by Goldstein, there is damage to the corpus callosum. However, according to a view published in 1981 by Gary Goldberg and his co-workers [7], in some cases there is apparently a lesion of the frontal lobe. Damage to the corpus callosum leads to a disruption of the information exchange between the two hemispheres of the brain. The left hemisphere is more responsible for logical-analytical thinking processes, it has fine-motor skills and in most people linguistic abilities. Our conscious thinking is strongly dependent on mental language; if the left hand is only under control of the right side of the brain (which usually has no speech areas), this explains why alien limb patients say that they are not at all responsible for the movements of their left hands. In some patients, however, no serious lesion of the corpus callosum was found, but these patients showed damage

to the frontal brain. One of many tasks of this Lobus frontalis is the planning of actions and the execution of complex movements. Typically for most of these patients is that the right hand is affected, even if the patients are right-handed, in these patients often a compulsive grasping for objects is found.

But that is not all: There is another disorder in which people do not perceive a part of the body as belonging to itself. The suffering of those affected is so great that they run from one surgeon to the next and ask them to amputate this (organically completely healthy!) body part. The strange thing about this disorder is that until now (as in alien hand, split brain or neglect syndrome) has not been found a brain damage in these people. Officially it was named “apotemnophilia”, “Xenophilia” or as "Body Integrity Identity Disorder" (BIID) and was classified among the identity disorders. Currently the International Classification of Diseases (ICD-11) named it “Body Integrity Dysphoria” (BID). Intuitively one should think that someone who wants to have his healthy leg amputated definitely is completely mentally ill. But even the American psychiatry professor Michael First [5] had determined in 2004 that the desire is not caused by a psychotic disorder; none of the respondents was delusional. In contrast to patients with delusions, BIID sufferers quarrel with their wishes and weigh meticulously for years the pros and cons. Most live a completely normal life, have a partner, work, many are highly intelligent academics; they only have the intense feeling that a limb just does not belong to their body; They feel complete only after an amputation [10, 11].

Fig. 3: This BID-affected patient has two healthy legs but does not feel the right leg as belonging to his body. Therefore, he tied up his right leg and pushed it into a prosthesis. Walking with the prosthesis makes him feel happy.

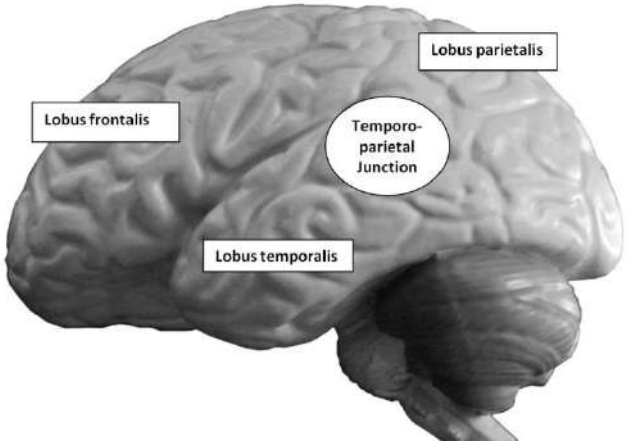

Fig. 4: The temporo-parietal junction (TPJ) lies between the temporal and parietal lobes. It is considered to be the place in the brain where we create a consciousness of our own body [2, 3, 4].

The brain calculates at any time what belongs to our body and what does not. My foot is part of my body, not the shoe. While BID sufferers feel that they have a body part that is not their own, patients with e.g. accidental amputations of a body part, still have an intact system in their brain. After the loss of a limb, the corresponding brain area continues to exist. Ramachandran and Blakeslee [13] described in 2004 in their book a motorcyclist who had lost an arm in an accident. He could reach out his phantom arm, swing it in the air, touch things and even pick up objects. Phantom sensations do not arise only for lost extremities; Ramachandran described a patient after a mastectomy that sensed phantom breasts and a man with phantom erections after removal of the penis. Another of his patients suffered a complete paralysis of the left half of the body after a stroke, but she had no disease insight (i.e. anosognosia), and stated that she could move the hemiplegic arm. When she was asked to touch her nose with the paralyzed arm, nothing happened, but the patient was subjectively convinced that the finger was in her face and she even claimed to be able to see her hand there. Phantom feelings do not only develop after amputation, they can occur on a fixed genetic basis. Marion Funk [5] from the working group of neurologist Peter Brugger in Zurich introduced a female patient who was born without arms, but who nevertheless mentally moved her arms and was able to use it to mentally reach objects. So there is also the opposite of BIID.

This genetic basis may also include parts of the body that humans no longer possess. Our closest relatives, i.e. monkeys, dogs or cats, have a tail at the end of their body; which human has lost in the course of evolution. Several years ago I corresponded with a woman who wrote to me that she had the intense feeling that her body was missing an extension in the form of a tail. She only felt to be complete when she tucked a tail there, which became more and more sophisticated over the years, so that she could finally move it, controlled by

small motors. Presumably her brain still had an area for a tail, although we humans don't have such a part since some millions of years (missing-tail syndrome).

2. CONCLUSION

When we wake up in the morning, rub our eyes and stretch our legs out of bed, it seems to us the most natural and irrefutable fact in the world that this is our body. The truth is that our brain constantly has to calculate what our body consists of and what belongs to it. If computational errors occur here, one feels own body parts as foreign.

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