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Maria Chiara Errigo *Editors*

Neuroscience and Law

Complicated Crossings and New Perspectives

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This book is the result of an interdisciplinary research project that has been realized by the organizational and financial contributions from the University Center for Bioethics (UCB) and the Center for Studies in European and International Affairs (CSEIA), at University of Parma.

ISBN 978-3-030-38839-3 ISBN 978-3-030-38840-9 (eBook)
https://doi.org/10.1007/978-3-030-38840-9

This Springer imprint is published by the registered company Springer Nature Switzerland AG.
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To my Uncle, Ugo Di Blasio, remembering the summer conversations about the Descartes' error. From those conversations, the interest in this research was born.
AD

Foreword

Neuroscience, Today

The field of neuroscience is almost infinite. Some scientists identify approximately the existence of over 20 subcategories within this field. However, the discussions that will take place here will be limited to the area of the so-called cognitive neuroscience. Indeed, this sector aroused interest also in a juridical context, in particular with regard to the concepts of free will and responsibility. These problems represent issues traditionally pertaining to the sphere of philosophy and which still remain unanswered. Some philosophers who were interested in the problems of human decision-making have preferred to deal with the issues pragmatically. In particular, according to Ayer, a *free* decision means "decision that comes from within myself," while a *non-free* decision means "a decision that is imposed upon me": actions are forced when a person, through the use of force or deception, or even hypnosis, obliges another to do something.

It should also be emphasized, even if only briefly, that the possibility of deciding is limited by factors linked to the functional organization of the nervous system. One of these is "classical or Pavlovian conditioning". Classical conditioning occurs when a stimulus that is inherently neutral is associated with a stimulus that determines a certain effect. After some pairing the neutral stimulus assumes the characteristics of the unconditioned stimulus. Pavlovian conditioning occurs in everyday life. For example, let us watch and see an advertised product associated with a beautiful girl and after a while it too looks beautiful. About thirty years ago, the conditioning and the fear of it was a very debated issue, while today it is somewhat forgotten. Actually, it is present in our society and has the power to strongly influence our behavior and our ability to choose.

Another factor that affects our behavior is imitation. Culture is imitation. We have become "homo sapiens" because we learned how to imitate; other primates do not possess this ability, or possess it in a very limited extent. The neuroscientist Vilayanur S. Ramachandran has formulated the following hypothesis: man differentiated himself from other primates when he began to imitate. Similarly, today,

our society is changing as we are witnessing continuous progress based on imitation and subsequent modifications with respect to the initial model. This represents the positive side of imitation. However, another side negative was also noted, and studied in particular by the geneticist Robert Dawkins, who spoke of "memes." The meme represents a self-propagating unit of human culture, similar to what the gene is for genetics. In other words, there are some aspects of common living that propagate as if they were viruses. Some expressions of everyday language can be considered "memes," such as "carrying out a discourse," "absolutely yes," and "taking a step back." These are extremely pervasive words; however, "memes" even include more complex ideas, which propagate in the same way. Think, for example, of certain expression of "politically correct" language.

We live, therefore, in an environment that limits our freedom by a series of factors, which are not strictly neurological. However, this does not mean that the nervous system, "per se", does not also play a limiting factor.

The history of the relationship between law and the nervous system begins with a very famous study, carried out in the nineteenth century: the case of Phineas Gage. Gage worked in the USA on the railways and had always been known for being a "good person." One day, due to an accident at his place of work, his skull was pierced by a metal bar. Miraculously Phineas Gage survived, but from that day on his behavior changed completely, showing an aggressive nature that previously did not seem to belong to him. Recently, using brain-imaging techniques, Damasio reconstructed the Gage lesion, discovering that the damaged area was the rostarl part of the frontal lobe. This brain region is one of the most recent in human evolution, and injuries to this area have dramatic consequences. Phineas Gage, in fact, despite surviving, started to behave differently and more dangerously toward others than before the accident had occurred.

In the field of investigation concerning the connections between brain injury and antisocial behavior, an author who made important contributions is Adrian Raine. He first used the brain imaging technique in this field, in particular, PET, first, and than more precise in terms of localization fMRI. Raine studied the brains of 50 murderers in prison and 50 other people who had not committed crimes. The results of this research showed that in almost all of the murderers there were brain injuries, especially in the frontal lobe. This is emblematic, as other studies showed that the frontal lobe acts as a "brake." Men, in fact, possess the ability to stop, to block the instinctive response, and this is precisely a task of the frontal lobe.

Another example of the connection between neurological alterations and criminal actions is that of a middle-aged man without previous serious problems with justice. One day, while driving his car, he met a group of cyclists; he accelerated, and killed some of them. During the subsequent trial, the man showed no signs of repentance, claiming to be right: "the road was mine and I exercised my right". Radiological investigations showed the existence of frontal lobe lesions.

All of this obviously poses a legal problem: what to do with this person? Should he be punished with a life sentence or should he be "rehabilitated" and, in this case, with what mechanisms? Obviously, his freedom needs to be restricted as he is a

dangerous individual; nevertheless, he is a subject that for approximately 40 years has not shown any dangerous behavior.

Likewise, significant is the case of a 40-year-old man who, after assaulting a young girl, was convicted. Experts realized that something was not working properly in his brain and the subject underwent a long rehabilitation phase. Once the rehabilitation period ended satisfactorily, the man was released, but shortly after release he again attacked a child. At this point, in-depth investigations were made and it was discovered that man had a tumor in a brain area critical for the inhibition of aggressive impulses. The tumor was removed. Ten years later the subject returned to perform the same criminal actions. It was discovered that the tumor had re-formed.

The case of adolescents is interesting. It has been discovered that the frontal lobe continues to develop in adolescence, and therefore, a 14/17-year-old boy has far fewer inhibitory restraints than a 40-year-old person. Adrian Raine's studies have also shown that certain killers can have lesions in other brain areas, (not just the frontal lobe), like the amygdala. In these cases, the person responsible for the crime has little sense of fear. Electrical stimulation of the amygdala, in fact, causes fear and if this "center" does not work as it should, the subject has less fear and does not recognize fear in other individuals.

The problem has widened in recent years, taking into consideration other cases that concerned, in particular, veterans returned from Vietnam, among whom one can distinguish who has adapted and who, instead, maintains violent behavior. In the latter case, it means that there have been traumas, which have led to deficits that are still noticeable. Given these problems, it is therefore necessary to identify: 1. Scientific rehabilitation methods, 2. Effective behavior control methods.

Another phenomenon that must be considered is that of empathy. We understand others in two different ways: (a) phenomenologically: The action of the other is "experienced" by the person who sees it. For example, if an individual goes to a bar and sees another who takes a glass of beer, he/she immediately understands this gesture, since some neurons that encode that action are activated (mirror neurons). It is as he/she was performing the observed actions and (b) logically, i.e., an individual understands the action of another by inferential reasoning.

A classical experiment, conducted with functional magnetic resonance, exemplifies this dichotomy well. In this experiment, the subjects in the scanner were shown, at first, some films depicting a man, a dog, or a monkey performing the same action: biting. Note that this action is performed in nature by all three species. In the second part of the same experiment, the presented films showed different actions: the man was reading a newspaper (but the voice was not heard), the monkey was performing the so-called *lips-smaking* (an affiliative gesture meaning "I am not your enemy"), and the dog was barking. The results were very clear: in the first case, regardless of who did the action, the mirror neuron system was activated, including the premotor neurons that normally come into play when we perform that same action. In other words, the subjects understood the actions of the monkey and the dog in a direct phenomenological manner. In contrast, the cortical activations were completely different when the subjects looked at actions that are not part of the motor repertoire of the three species. If a subject sees another subject reading, the

Broca area, an area that is linked to language, is activated while if the subject looks at the dog barking, only the visual areas become active. Humans do not know "phenomenologically" what means "barking"; it is something we learned, but which remains external to us, and is not part of our behavior.

We therefore have two ways of understanding others. Initially this discovery concerned actions without emotional content, the so-called "cold actions", (e.g. grasping an object). Subsequent investigations showed that this was also true for "hot actions", i.e., actions with an emotional content.

In particular, it was found that in the most anterior portion of the insula, were encoded ingestive movements. In fact, through the use of removable microelectrodes, it was possible to notice that by stimulating this part of the insula, the stimulated monkey performed chewing and ingestive movements. But if, the stimulation was performed a few centimeters lower, the monkey tended to reject whatever food was offered to her. This sector of the insula is a center for disgust. It is enough to stimulate it for triggering a state of disgust that leads the monkey to refuse even her favorite food. The same experiment was carried out on surgical patients. It was confirmed that the anterior insula is the area related to disgust.

The result of the stimulation of the insula allowed us to better understand the result of a previous functional magnetic resonance study, in which human subjects were introduced in the scanner where, at first, unpleasant odors were administered at them and, at a later time, films were shown related to disgust, pleasure, and neutral feelings.

It was noted during the analysis that the ventro-rostral insula—the center whose stimulation induces disgust—was activated both when the subject was disgusted by an unpleasant odor and when the subject observed an expression of disgust in an actor. In other words, when we see the expression of disgust in others, we *feel* it. The same phenomenon was observed in relation to pain, although involving different brain areas.

This mirroring mechanism, located in different brain centers, is very important because it represents the mechanism through which I, as a human being, feel when another human being suffers. Finding out that some people suffered, by reading it in a newspaper, is different from discovering the same thing, by leaving home, and seeing a person with a bloody face after an accident. In this case, it is an emotion that involves me personally, while in the first case the situation is "treated" as cognitive information.

Biological systems are flexible, not fixed. Let us imagine that a subject, for cultural or ideological reasons, has the mirror mechanism, allowing a phenomenological understanding, impaired. It is even possible to imagine that, in some cases, it is the culture itself that restrains this natural biological mechanism. What happens if someone manages to convince me of certain ideological beliefs by altering these mechanisms? Think of what happened in Germany in the 1930s. In one of the most civilized nations in the world, a propaganda genius like Joseph Goebbels managed to convince a group of people, according to his narrative, that they were responsible for the military defeat of the entire nation. Furthermore, not belonging to the Aryan race and they were not fully human. The tragic consequences of this narrative, and in

particular the sense of irresponsibility and self-absolution of those who perpetuated crimes against someone they did not consider to be a human being, were highlighted by Hanna Arendt. In her book "The banality of evil", she presents the case of Adolph Eichmann. Asked to justify his behavior in organizing the transport of Jews to extermination camps, he answered: "Look, as we feel entitled to cut trees to get wood, and to kill animals to feed ourselves, we are feel morally acquitted of killing sub-human primates?"

A very serious problem of empathy arises, as is obvious at this point. Empathy, in fact, does not mean "to be good", but means "to enter into the state of others". A group of researchers in Chicago have studied sadistic criminals, those who have performed crimes with sadism, and have examined the areas mediating empathy. They discovered that these areas become active when sadists observe cruel scenes. This makes sense because these criminals derive pleasure from the pain of others, and they must therefore understand that the other persons suffer. In conclusion, the sadist has an empathic capacity just like ours; what changes is how this information is used.

The idea of strengthening empathy through cultural and environmental factors (i.e., love thy neighbor as you would yourself) is therefore a necessity in order to avoid tragic and disastrous events such as those that have already in the last century.

Parma, Italy Giacomo Rizzolatti

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