Improving Clinical Communication

A Clinician's Guide to Building Better Skills and Patient Outcomes

Ernesto Gil Deza

Springer

Improving Clinical Communication

Ernesto Gil Deza

Improving Clinical Communication

A Clinician's Guide to Building Better Skills and Patient Outcomes

Springer

Ernesto Gil Deza
Facultad de Medicina
Universidad del Salvador
Buenos Aires, Buenos Aires, Argentina

Director of Teaching and Research at the Instituto Henry Moore
Buenos Aires, Argentina

ISBN 978-3-031-62445-2 ISBN 978-3-031-62446-9 (eBook)
https://doi.org/10.1007/978-3-031-62446-9

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

Dedicated to my wife, Gabriela, with all my love and to our children and grandchildren who fill our lives with joy.

Preface

Dear reader, the book you have in your hands is aimed at all members of the health team.

It is based on a simple premise: communication with the patient is a fundamental tool that can be learned and perfected throughout one's professional life.

The text has been organized into 12 sequential chapters that address the fundamental topics of communication in the doctor’s office.

Its pages reflect the author's profession as a medical oncologist and it does not have the ambition of being a text based on erudition but rather on experience, on the daily challenges that interaction with patients presents in modern medicine.

All errors are attributable only to the author, and I assume full responsibility for them, since the text is a distillation of 30 years of work, with all its triumphs and also its mistakes, which are the ones that teach us the most and are not easily forgotten.

It is my hope that you find it useful and that you enjoy reading it as much as I enjoyed writing it.

Buenos Aires, Buenos Aires, Argentina — Ernesto Gil Deza
February, 2024

Contents

1 Introduction 1
References 4

2 The Therapeutic Origin of the Human Word 5
2.1 The Word and Mankind 5
2.2 In Search of the Original Word 7
2.2.1 The Evolution of the Vocal Apparatus 9
2.2.2 The Evolution of Breath Control 13
2.2.3 The Evolution of the Brain 14
2.2.4 Neuroscience and Speech 18
2.3 The Poetic Origin of the First Word 20
2.4 Teaching Exercises 22
References 24

3 The Placebo Effect of the Medical Word 29
3.1 The Placebo Effect in the History of Medicine: History of Medical Knowledge (Abbreviated Epistemology) 29
3.1.1 Magical Knowledge in Medicine [2–15] 30
3.1.2 The Scientific Knowledge of Medicine Is the Second to Appear 32
3.1.3 Anatomopathological Knowledge 34
3.1.4 Assisted Knowledge 36
3.1.5 Predictive Knowledge 38
3.1.6 Coercive Knowledge 42
3.1.7 Wishful Knowledge 45
3.1.8 How Do These Orders of Knowledge Interact in Practice? 47
3.2 The Mechanisms of the Placebo and Nocebo Effects: Modern Science in Service of an Old Problem 48
3.3 The Doctor as a Placebo 50
3.4 The Word as Placebo 51
3.5 How to Enhance the Placebo Effect 53

3.6 Teaching Exercises . . . 54
References . . . 55

4 Medical Words Throughout History . . . 61
4.1 Introduction . . . 61
4.2 The Role of the Medical Word Throughout the History of the Doctor–Patient Relationship . . . 62
4.3 Why Has the Medical Word Lost Value in the Twenty-First Century? . . . 68
4.3.1 Etymology of Medical Terms . . . 78
4.3.2 A . . . 79
4.3.3 B . . . 80
4.3.4 C . . . 81
4.3.5 D . . . 83
4.3.6 E . . . 84
4.3.7 F . . . 86
4.3.8 G . . . 86
4.3.9 H . . . 88
4.3.10 I . . . 89
4.3.11 J . . . 90
4.3.12 K . . . 90
4.3.13 L . . . 90
4.3.14 M . . . 91
4.3.15 N . . . 92
4.3.16 O . . . 92
4.3.17 P . . . 93
4.3.18 Q . . . 94
4.3.19 R . . . 94
4.3.20 S . . . 94
4.3.21 T . . . 95
4.3.22 U . . . 96
4.3.23 V . . . 96
4.3.24 W . . . 96
4.3.25 X . . . 96
4.3.26 Y . . . 96
4.3.27 Z . . . 97
4.4 The Role of the Doctor as Translator and Humanizer of Health Information . . . 97
4.4.1 The Patient's Narrative Generating New Knowledge . . . 100
4.4.2 The Patient as Evaluator of Medical Quality . . . 102
4.4.3 Teaching Exercises . . . 104
References . . . 105

5 Information Versus Communication . . . 111
5.1 A Misunderstanding of Terms . . . 111
5.2 Communication Theories . . . 113

5.3 Overinformation and Lack of Communication 116
5.3.1 How to Deal with the Volume of Information Available 116
5.3.2 How to Distinguish Between True and False Information 117
5.3.3 How to Organize Information so that the Message Is Clearly Delivered or Understood 118
5.3.4 How to Organize Information to Make a Decision 118
5.4 Selecting and Organizing the Message 119
5.5 The Value of Questions 121
5.6 Writing and Drawing for the Patient 122
5.7 Teaching Exercises. 125
References. 125

6 Empathy and Communication. 131
6.1 What Is Empathy? 131
6.2 The Multifaceted Nature of Human Beings. 133
6.3 The Multifaceted Nature of the Doctor–Patient Relationship 135
6.3.1 The Dimension of Experience 135
6.3.2 The Scientific Dimension of Medicine 136
6.3.3 The Magical Dimension of Medicine 137
6.3.4 The Artistic Dimension of the Medical Act 137
6.3.5 The Moral Dimension of the Medical Act 138
6.3.6 The Human Dimension of the Medical Act 138
6.4 Evidence That the Evolution of Patients Is Related to the Empathy of the Doctor or the Health Team 139
6.5 How Is Empathy Studied? 140
6.6 What Do the Oncology Communication Guidelines Say About Empathy? 142
6.7 Can You Teach People To Be More Empathetic?. 143
6.8 Teaching Exercises. 146
References. 146

7 Nonverbal Communication in the Consulting Room. 153
7.1 Introduction 153
7.2 Definition and History of Nonverbal Communication. 154
7.3 Scientific Study of Nonverbal Communication 156
7.4 Neurobiology 158
7.5 Nonverbal Communication Teaching. 159
7.6 Nonverbal Communication in Situations Where Verbal Communication Is Not Possible 160
7.7 Artificial Intelligence Applied to the Study of Nonverbal Communication 161
7.8 Nonverbal Communication Next to Verbal Communication 161
7.9 Role of Silence in Human Communication 162

7.10 Nonmedical Applications of Nonverbal Communication: Robotics, Emojis, and Emoticons . . . 165
7.11 Teaching Exercises . . . 166
References . . . 167

8 Patient Needs: A Communication Map . . . 177
8.1 Introduction . . . 177
8.2 Node 1: The Moment of Diagnosis Is: "The Unexpected Truth" . . . 178
8.3 Node 2: The Staging of the Patient Is: "The Transitory Truth" . . . 179
8.4 Node 3: The Prognosis Is: "The Uncertain Truth" . . . 180
8.5 Node 4: The Treatment Is: "The Understandable Truth" . . . 183
8.6 Node 5: The Follow-Up Is: "The Truth Sought" . . . 185
8.7 Node 6: The Recurrence Is: "The Feared Truth" . . . 187
8.8 Node 7: Research Is: "The Neutral Truth" . . . 188
8.9 Node 8: Error: "The Irritating Truth" . . . 191
8.10 Node 9: Alternative Treatments Are: "The Paradoxical Truth" . . . 193
8.11 Node 10: Death Is: "The Ultimate Truth" . . . 194
8.12 Node 11: Mourning Is: "The Remembered Truth" . . . 196
8.13 Teaching Exercises . . . 198
References . . . 199

9 Special Communication Needs: LGBTQ Patient Care . . . 207
9.1 Introduction . . . 207
9.2 An Educational Void . . . 212
9.3 The Problem of Invisible Patients . . . 215
9.4 A Vulnerable Population . . . 216
9.5 A Safe Environment: A Respectful Look—A Kind Word . . . 218
9.6 New Knowledge in a Different Society . . . 221
9.7 Teaching Exercises . . . 222
References . . . 223

10 Telehealth: The Pandemic Experience with Virtual Communication . . . 231
10.1 Introduction . . . 231
10.2 Brief History of Telemedicine . . . 233
10.2.1 Telemedicine and Teleconsultations in the Clinical Practice . . . 235
10.3 Virtual Communication Protocols . . . 237
10.3.1 Virtual Classes and Exams in Medical Teaching . . . 242
10.4 Artificial Intelligence, Telemedicine, and Medical Humanism . . . 244
10.5 Teaching Exercises . . . 247
References . . . 248

11 Communication and Burnout Prevention 253
11.1 Introduction 253
11.2 What is Burnout Syndrome in the Health Team? 254
11.2.1 Exhaustion Syndrome Appears First 255
11.2.2 Cynicism and Detachment. 256
11.2.3 Ineffectiveness and Lack of Accomplishment. 256
11.3 Why Is it Difficult for us to Accept that We Are Stressed and that we May be Suffering from this Syndrome? 257
11.4 Medicine Is the Cause of Illness, Fatigue, and Burnout 259
11.5 Learn to Work with Stress 266
11.5.1 **Commitment to Work** Must be Human and Professional, which for me Is Summarized in Two Words: **Here** and **Now**. 267
11.5.2 The Work Team 267
11.5.3 Satisfaction with Work 268
11.6 Self-Care a Key Element in Preventing Burnout 269
11.6.1 What We Are Witnesses of 271
11.6.2 That of Which We Are Instruments. 271
11.6.3 The Quality of the Work our Colleagues Do. 271
11.7 The Word is the Means to Deal with Burnout 272
11.7.1 Teaching Exercises 273
References. 274

12 A Personal Communication Kit. 281
12.1 Introduction 281
12.2 Uniqueness of the Person: Why Is this Patient Important to Me? 281
12.3 The Value of Ignorance 283
12.4 The Power of Placebo 285
12.5 The Gift of Freedom 286
12.6 The Value of the Voyage. 286
12.7 The Paradox of Infinities 288
12.8 How Many Lives Does Man Have? 288
12.9 Forgiveness and Reconciliation 289
12.10 Problem Hierarchy 290
12.11 The Problem List 292
12.12 Choosing a Star 293
12.13 The Emotions Portfolio 293
12.14 Optimism as Therapy 294
12.15 The Chess Pawn 296
12.16 The Word as Medicine 296
12.17 The Meaning of Life 297
12.18 Three Reasons to be Thankful for 298
12.19 The Advantages of Illness (or the Wise Man and the Bicycle) . . . 298
12.20 The Surprises of Life (or the Prince and Death) 299

12.21 The Objective of a Consultation 300
12.22 Teaching Exercises. 300
References. 301

13 Teaching Communication Skills 305
13.1 Introduction 305
13.2 Teaching at the Office (Shadow Observer) 306
13.3 Using Real Patients as Teachers. 307
13.4 Teaching in Small Groups 308
13.5 Classroom Teaching to Large Groups 309
13.6 Designing a Class. 310
13.6.1 Role Play 311
13.6.2 Charades 312
13.6.3 Media Interview 313
13.6.4 Debates 313
13.6.5 Scientific Writing: Abstract, Case Report, Paper 314
13.6.6 Writing to a Colleague 315
13.6.7 Emotional Writing. 316
13.6.8 Reverse, Mirror, or Unskilled Handwriting. 317
13.6.9 Discussing Clinical Cases 317
13.6.10 Testimonials from Colleagues. 318
13.6.11 Meditation 318
13.6.12 Theater. 319
13.6.13 Movies. 320
13.6.14 Analyzing a Photograph 320
13.6.15 Poetry 321
13.6.16 Music. 321
13.7 Designing a Communications Course for Medicine 323
13.8 The Syllabus. 323
References. 324

Index. 331

Chapter 1
Introduction

What do you think of communication in everyday human interaction?

What do you think of communication in the medical field?

How much do you value communication with your doctor, nurse, or provider when you are sick?

How much do you value communication as a healthcare professional?

The answers to these questions will be crucial in order for you to decide if the book you hold in your hands is worth your time.

Most communication skills are classified as "soft skills", in contrast to "hard skills," which are the core scientific and technical foundations of knowledge for a particular medical specialty. (Note that throughout the text I will use the term "doctor" as a way of referring to the entire team of professionals involved in the healthcare industry. That is to say, the content of this book is valid for doctors, nurses, psychologists, social workers, and all other healthcare professionals.)

However, if we reflect on the reality of the current state of doctor–patient relationships, we will see that it has changed more in the last 30 years than in the last 30 centuries! This is because many of these "hard skills" have ceased to be the sole domain of the medical professional in various ways:

1. Medical knowledge, both accurate and inaccurate, is readily available on the Internet.
2. Many of the diagnoses are nowadays carried out by pathologists.
3. Determining the stage of various diseases is, in many cases, up to image specialists.
4. What kind of therapy is required is also readily available online.
5. The success of the treatment is attributed mostly to the drugs involved rather than the professional administering them.
6. At the same time, the efficacy of these drugs is determined by complex statistical analysis (the well-known Big Data).

E. Gil Deza, *Improving Clinical Communication*,
https://doi.org/10.1007/978-3-031-62446-9_1

We can see this outlined in Fig. 1.1. Therefore, the underlying question we need to ask ourselves is: What is the doctor's nowadays? How has it evolved, and what will it become? I propose that doctors in the twenty-first century and beyond will be human, and therefore they should be skillful communicators most of all or else they will be a hindrance.

The truth of the matter is that all skills are "hard." It is not too long after starting our professional careers that we realize that knowing *how to do* something is just as important as knowing *how to say it*.

As with many other things, how you perceive communication itself may have an impact on your ability to improve your communication skills.

Do you believe that communication is a gift, that is to say, something you are born with and cannot be changed?

Or do you believe that communication is a skill, something that can learned and perfected with use?

Or perhaps you believe that communication is a tool, and like all tools it has times and uses it is suited for, but others where it is not?

The use you get out of this book will depend heavily on how you answer these questions.

I believe that communication, by which I mean both the gestures and the words with which we relate to each other, is all three things at once: a gift, a skill, and a tool.

Allow me to explain: it is a gift, for it is undeniable that some people have an easier time communicating than others. We have all known people who are the

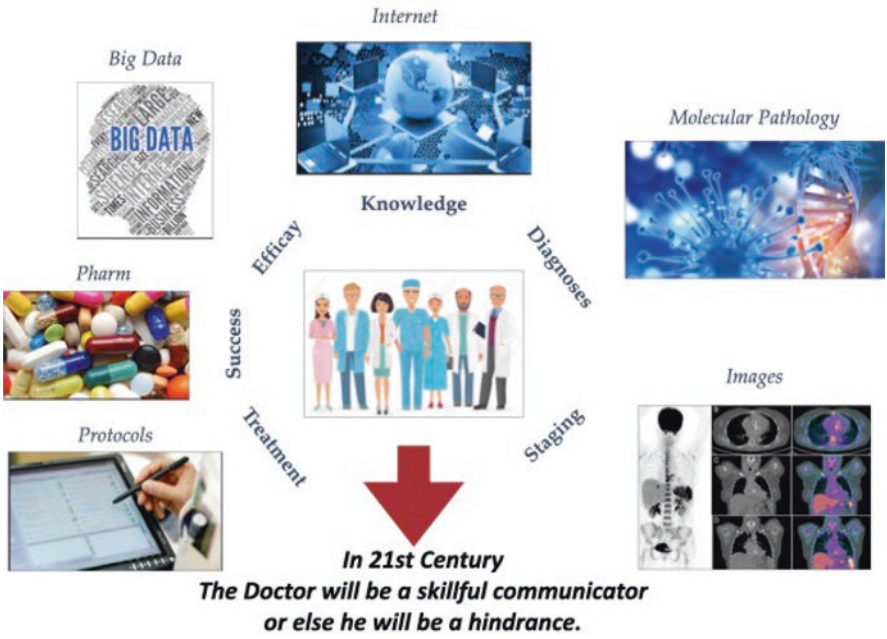

Fig. 1.1 Role of the doctor in the twenty-first century

center of every party, charismatic, and who easily and readily convey their ideas or experiences; while others are shyer, or uncouth, or otherwise have trouble getting their points across.

However, I am convinced that most of us, no matter how gifted, are not using our communication skills to the fullest.

Therefore, in my view, it is also a skill: practice makes perfect, as they say.

Learning to communicate, understanding our limitations, training ourselves daily to develop the skills we lack or to perfect the ones we have, is a central point of our professional development, just as much as our technical and scientific knowledge.

Finally, it is a tool. Or rather, it would be better to say communication is a *variety* of tools. A toolbox, if you will.

There are those who can communicate better with children than with adults; with women than with men; with terminally ill patients than with curable ones; with demanding people than with timid people; with extroverted people than with shy people. What comes naturally to us, or what we learn more easily (that is to say, what *tools* we are most comfortable and familiar with), is one of the things that guided us each to our respective specialty.

Therefore, before you continue reading, I invite you to reflect on the two aspects that we are going to develop throughout the book:

(a) What do you think communication's role in medicine, for each member of the health team, is in the twenty-first century?
(b) Do you consider yourself particularly gifted in communication? Do you think you have developed your natural communication skills as much as you can? And finally what tool (or tools) do you use the most?

Throughout this book, we will delve into many topics: the origin of the human word; the word as medicine; the historical evolution of medical communication; the differences between information and communication; nonverbal communication; empathy and communication; communication strategies according to the evolution of the disease (although we will be using cancer patients as a model, the strategies here are perfectly suitable for other medical specialties); communication with marginalized groups such as the LGBTQ community; the communication experience during the pandemic; communication and prevention of burnout; and the development of a personal communication kit and the teaching of communication skills in undergraduate and graduate studies [1–14].

This book is intended for a great variety of readers: patients (and their families); students in one of the many healthcare fields; and professionals in these fields.

Each chapter has recommendations that will be of use to each of these types of readers.

If I have managed to convince you to join me, I invite you to proceed to the first chapter, where we will discuss the origin of the human word, and how it is likely that the first words were sung.

References

1. Buckman R. Words that make a difference: enhancing the “how” in “how we say it”. Support Cancer Ther. 2006;3:127.
2. Parekh AK. Winning their trust. N Engl J Med. 2011;364(24):e51.
3. Hollander JE, Carr BG. Virtually perfect? Telemedicine for Covid-19. N Engl J Med. 2020;382(18):1679–81.
4. Back AL, Arnold RM, Baile WF, Tulsky JA, Fryer-Edwards K. What makes education in communication transformative? J Cancer Educ. 2009;24:160–2.
5. Derse AR. The physician–patient relationship. N Engl J Med. 2022;387(8):669–72.
6. Stone JH. Communication between physicians and patients in the era of E-medicine. N Engl J Med. 2007;356(24):2451–4.
7. Jain SH. Practicing medicine in the age of Facebook. N Engl J Med. 2009;361(7):649–51.
8. Baile WF, Aaron J. Patient-physician communication in oncology: past, present,and future. Curr Opin Oncol. 2005;17:331–5.
9. Flores G. Language barriers to health Care in the United States. N Engl J Med. 2006;355(3):229–31.
10. Zwingmann J, Baile WF, Schmier JW, Bernhard J, Keller M. Effects of patient-centered communication on anxiety, negative affect, and trust in the physician in delivering a cancer diagnosis: a randomized, experimental study. Cancer. 2017;123(16):3167–75.
11. Parker PA, Ross AC, Polansky MN, Palmer JL, Rodriguez MA, Baile WF. Communicating with cancer patients: what areas do physician assistants find most challenging? J Cancer Educ. 2010;25(4):524–9.
12. Srivastava R. Dealing with uncertainty in a time of plenty. N Engl J Med. 2011;365(24):2252–3.
13. Back A, Tulsky JA, Arnold RM. Communication skills in the age of COVID-19. Ann Intern Med. 2020;172(11):759–61.
14. Lensink MA, Jongsma KR, Boers SN, Bredenoord AL. Better governance starts with better words: why responsible human tissue research demands a change of language. BMC Med Ethics. 2022;23(1):90.

Chapter 2
The Therapeutic Origin of the Human Word

2.1 The Word and Mankind

What is the most important human attribute?

We are born extremely vulnerable. We lack any kind of protection, such as an exoskeleton or osteoderm. We lack claws or sharp teeth. We lack strength or agility.

How then do we survive in an adverse environment?
What is our evolutionary advantage?
What is the outstanding feature of our species?
There is no doubt that one of the outstanding characteristics of mankind is its communal lifestyle.

Individually we are very vulnerable, but we can act together in a way that makes us almost undefeatable.

This kind of lifestyle requires communication and for this we were endowed with three formidable conditions: intelligence, memory, and speech.

Intelligence has often been reduced to reason; however, the name itself gives us a clue that this is not so. Intelligence etymologically derives from *interlegere*, which means *to read between the lines* [1]. This implies much more than simply *reasoning*, it also requires *feeling*. This is how a great Spanish philosopher of the last century, Xavier Zubiri, described it in his book *Inteligencia sentiente* [2].

Every time we think, we feel; and every time we feel we also think, because thinking and feeling are one and the same in the human being.

Memory has been one of the most studied subjects of both the previous and current centuries, fundamentally guided by Alzheimer's disease. One of the most interesting findings in this regard was the evidence supporting the existence of two systems: thought and memory, both of which Daniel Kahneman reflects in his book *Thinking, Fast and Slow* [3]. In it, he masterfully summarizes the experiments he has carried out during his extensive and prolific scientific career.

E. Gil Deza, *Improving Clinical Communication*,
https://doi.org/10.1007/978-3-031-62446-9_2

In this text, Prof. Kahneman demonstrates that system 1, or *fast*, is designed for our survival: it analyzes reality in a way that is both biased and heuristic, which allows us to make decisions quickly, but perhaps not accurately.

The second system is slower, consumes more energy, and allows us to analyze the peculiarities of each case and therefore make better decisions.

From this perspective, a very interesting find is that memory prioritize three kinds of experiences: the very first experience of any kind, the most intense moments (positive or negative) of any given experience, and finally, the way in which an experience *ends.* Our memory then summarizes these experiences and classifies them as either positive or negative, depending mainly on the intensity of the experience and its end.

Last but certainly not least comes the way we share our knowledge and experiences.

Learning, and therefore teaching, are essential activities for survival. We are all aware that the more you know, the better you teach, and the more you teach, the better you know. Clearly, for the transmission of knowledge, the word is an unmatched evolutionary advantage.

Human beings develop because we cultivate these three characteristics: our ability to comprehend the world (i.e., to intellectively understand it), to memorize experiences (i.e., to remember it), and transmit these to our community (cultivate, educate, teach, communicate).

Among many, the one who expressed this idea most clearly is Aristotle, probably the most important philosopher in history. In his book, *Politics*, he says the following about man:

> And why man is a political animal in a greater measure than any bee or any gregarious animal is clear. For nature, as we declare, does nothing without purpose; and man alone of the animals possesses speech. The mere voice, it is true, can indicate pain and pleasure, and therefore is possessed by the other animals as well, for their nature has been developed so far as to have sensations of what is painful and pleasant and to indicate those sensations to one another, but speech is designed to indicate the advantageous and the harmful, and therefore also the right and the wrong; for it is the special property of man in distinction from the other animals that he alone has perception of good and bad and right and wrong and the other moral qualities, and it is partnership in these things that makes a household and a city-state. [4]

This distinction between voice (sound) and speech (logos, reason) is crucial to be able to research what the first word might have been.

Let us note that Aristotle maintains that the *voice*, the ability to emit sound, is a characteristic shared with other animals and expresses pain and pleasure: the human scream, the growl, the bray or the neigh, are fundamentally not so different. It is not that sound that makes us different from other living beings.

On the other hand, *speech* is proper to man.
When was the first word of humanity spoken?
What was its speaker like?
What distinguished this word from other sounds?
For what purpose was it spoken?

All of these questions bring us to our next topic

2.2 In Search of the Original Word

In order to imagine the first word, we must first discuss the concept of evolution.

This is a relatively easy task in the current age, largely due to the scientific, social, and political influence of Charles Darwin's book *On the Origin of Species*, published in 1859.

In fact, the word *evolution* has had a notable impact on both science and society. Today we know about the evolution of the universe (from the Big Bang to the present). The evolution of matter (from hydrogen) to all the elements of Mendeleev's periodic table (the completion of which was itself a century spanning project). The evolution of ideas, words, politics, and economics and much more.

But this was not the case until the beginning of the nineteenth century. In those times, the accepted standard was fixism, creationism, and the "status quo." The world had been created as it was known at the time, relatively recently, and was extremely stable and predictable.

In the beginning of the nineteenth century, several inconsistencies between geological timeframes and the timeframe presented in the Bible began to crop up.

The age of both the earth and stones seemed significantly older than the age attributed to the origin of creation according to the literal interpretation of the book of Genesis, which is the first book of the Bible.

The most daring of the time considered that the earth's creation had been carried out at most few thousand years ago, but geological ages were *much* older.

In addition, a great variety of fossils were discovered. Many of them belonged to beings that did not exist anymore, but others were very similar to known species.

This then led to the idea that there was a relationship between the environment and the characteristics of the living things we observed. According to Jean-Baptiste Pierre Antoine de Monet, chevalier de Lamarck (more commonly known today simply as Lamarck), animals adapted to the environment by directly inheriting physical characters acquired by their parents. Later on Charles Darwin added to this his idea of *survival of the fittest*, better known today as *natural selection:* in any given population, some individuals who possess advantageous characteristics will reproduce more, passing down those characteristics and, in the long run, change the makeup of any given species. However, both Lamarck and Darwin were wrong in one crucial fact: acquired characteristics are *not* inherited.

A few years later, an Augustinian monk named Georg Mendel who worked in the garden of a convent in the city of Brünn, near Austria, postulated that what was inherited was not the acquired characters themselves but rather the *information* that gave rise to the appearance of those characters. Without naming them, he described in broad strokes what we know today as *genes* and in doing so set the foundation for the entire branch of biology known as *genetics*.

Because history is fond of hiccups, Mendel sent a letter with his discovery to the most important botanist of his time, Carl Näegeli, who did not put much, if any, stock in it. So this 1865 discovery remained hidden until the beginning of the twentieth century. Thus, Darwin died without knowing that the answer that validated his

theory had been found, Mendel died without knowing that he had made one of the most important discoveries in the history of biology, and Näegeli died without any remorse at having dismissed such an important discovery.

Mendel's work, once it was rediscovered in the twentieth century, reinvigorated Darwin's theory, generating what is called Neo-Darwinism.

Today natural selection is accepted as the most solid theory to explain the evolution of species, although we know now that it is far more complex than Darwin thought. Nevertheless, there is no doubt that genes, and their transmission, take center stage.

As Jorge Wagensberg maintains: "The old dilemma of what came first, the chicken or the egg, has been solved for a long time: it was the egg, although of course, it wasn't a chicken's egg" (Aphorism 116) [5]. The main point expressed in this statement is that genetic changes precede the expression of new characters.

The enormous diversity of life is a direct consequence of evolution. All life on earth comes from small bacterium that arose in the depths of the warm seas 3800 million years ago. Their remains are represented by the stromatolite fossils found in Greenland, dated to around 3700 million years ago [6], which is very close to the currently best models of genetic evolution, which traces the origin of life on earth to around 4000 million years [7].

Therefore, when we observe nature with the eyes of biologists, we cannot but admire the beauty, diversity, variety, and creativity of marine and terrestrial life, microscopic and macroscopic, plant or animal, its shapes, colors, sounds.

Now let us ponder that this all boils down to inheriting genes. Let us imagine from the evolutionary perspective what it means to be capable of speech. Human beings are not only capable of transmitting genes, but as Daniel Dennett, a philosopher who studies consciousness, says, we are also capable of transmitting "memes," words, concepts, and culture.

From this perspective, the word represents a remarkable evolutionary advantage. This is what Yuval Noah Harari, professor of history at the Hebrew University of Jerusalem, proposes in his book *Sapiens: A Brief History of Humankind*.

What allowed us to evolve were not only genes but also communal life and the establishment of culture, which led to the domestication of animals (such as the reindeer—the first animal domesticated by man—the wolf, the donkey, the camel, and many others) and vegetables such as wheat, corn, or soybeans. Traditions, values, and education have a larger impact on our survival than genetics itself.

And all of these things require speech.

Today we are so immersed in the world of communications and words that it seems incredible that there was a time when we did not have speech.

We are capable of transmitting so many "bytes" of information that we forget that we were once nonspeakers.

That is why our first approach to the origin of the human word will be through fossils.

2.2.1 The Evolution of the Vocal Apparatus

The evolution of the vocal apparatus is something truly wonderful.

First of all we must consider that the ability to emit sounds (exhalations, trills, snorts, grunts, neighs, shouts, etc.) came about much later than the ability to *perceive* sounds (in the form of vibrations).

Perhaps this should already tell us that we should listen more and talk less. The more we respect biology, without falling into a naturalistic fallacy, the more we will take advantage of our innate abilities.

Let us start, then, with the ability to hear.

As we have discussed previously, life arose in the sea. Marine life is full of vibrations because the liquid medium is extremely suitable for transmitting them. Furthermore, the deeper we go, the darker it gets and the less one can rely on other senses to survive.

Therefore, we can find many living beings that have organs that specialize in detecting changes in pressure, chemical composition, or temperatures of the environment that surrounds them.

Bacterial chemoreceptors are probably among the first kind of sensory organs to appear in the evolution of life.

Certain chemicals are able to attract or repel flagellated bacteria by stimulating movement of the flagellum. This process is called chemotaxis.

It has been discovered that there has been very little variation in these chemoreceptors between the first living beings of the domain called “Archea“and the bacteria we know today. In fact, while current Gram-positive bacteria have different flagella structures to those of ancient specimens, the receptor is practically the same [8].

From these first receptors evolved all the others that we see in living beings.

Marine flora and fauna have a wide variety of receptors that are capable of sensing what is happening around them.

If we take a look at fish, for example, we can see they have great sensitivity to detect pressure changes that can tell them (among other things) if a predator is approaching, and some can even detect very subtle changes in electrical or thermal signals.

In amphibians and insects that spend time outside of water, we can see the development of specific sensory organs that allow them to perceive the aerial environment that surrounds them with great clarity and sharpness. Birds, reptiles, and mammals that descend from amphibians show further specialization in sensory organs.

How, then, did the ear as we know it today appear?

The study of the auditory apparatus present in different species is fascinating because it shows a great variety of designs perfectly adapted for their primary function. This research has also been remarkably improved with the addition of genetic studies [9].

For example, Johnston's organ is an ear located externally on the antennae of fruit flies [10] that is specifically tuned to the sound frequency caused by the vibration originating from the male fly's wings in order to facilitate mating.

Crocodiles use their hearing, much more than their sight, to sense when prey has approached to drink as they lie at the bottom of muddy streams and lakes [11].

The spatial awareness that comes from possessing bilateral auditory organs is a very useful evolutionary trait for both hunter and prey [12].

The evolution of the auditory system in mammals has been extensively studied. [13–19]But it can be summarized in the evolution of three elements: the eardrum, the ossicles, and the cochlea. If I were to boil it down to its essentials, it consists of a spectacular feat of engineering that manages to internalize a large antenna (ossicles and cochlea) and protect an exquisite microphone exposed to the elements (the eardrum).

Let me explain by reviewing the physiology of hearing.

The ear is an organ specialized in detecting sounds, that is, pressure changes of an air wave, which moves a membrane (the eardrum), which through the ossicles in the middle ear (Hammer—Anvil and Stirrup) transform this movement of air into a liquid wave in the inner ear (in the chlochea or cochlea of the temporal bone). There it moves specialized cells in Corti's organ (hair cells) that vibrate according to the wavelength or frequency of the sound and transform the liquid wave into an electrical impulse that is transmitted through the acoustic nerve (eighth pair) to the cerebral cortex and we perceive sound.

We can imagine that these cells, located in the cochlea, are like a piano rolled up on itself, from right to left, in such a way that the high-pitched sounds at the base of the snail and the low ones are at the apex or tip of the snail, which is known as tonotopic organization.

And if we want to see how it works I recommend the audiovisual *Auditory Translation Animation* by Brandon Pletsch, Medical College of Georgia, winner of the inaugural 2003 Science and Engineering First Prize display Challenge and which can be accessed at https://www.youtube.com/watch?v=PeTriGTENoc&ab_channel=BrandonPletsch.

The smallest wavelengths, that is, sounds with the highest number of cycles per second, of higher frequency, press the keys that are closest to the stirrup, while the longer wavelengths, with the lowest number of cycles per second (and therefore the lowest frequency), press the keys that are furthest from the stirrup.

The frequency of a wave is measured in Hertz (in honor of Heinrich Rudolph Herz). One Hertz (Hz) represents one cycle per second.

The human ear is capable of perceiving sounds ranging from 20 Hz to 20,000 Hz; sounds with a frequency less than 20 Hz are called *infrasounds* and those with a frequency greater than 20,000 Hz are called *ultrasounds*.

Despite the wide amplitude range, the human ear is most sensitive to sounds between 2000 Hz and 5000 Hz, which is the range of the human voice.

Not only do we have greater capacity to pick up certain frequencies, but we also have preferences for certain voice intensities depending on the circumstances. [20]It has been shown that we are better able to understand auditory cues from people we

are close with, such as being able to determine whether laughing or crying is genuine. [21, 22] Similarly, it has been shown that males prefer female sounding voices [23].

So before we dive into the ability to speak, we must honor the enormous evolutionary effort that endowed us with the ability to detect environmental cues, the wonders of auditory development, and the sense's astounding discernment ability by developing our own mindful listening.

Now let us move on to the ability to make sounds.

How did the animal world become an orchestra?

Insects are capable of making a great variety of noises: with their wings, with their legs, with their jaws, but none have the ability to make sounds by flowing air through a tube called the *trachea*.

In vertebrates (excluding fish), we can see two large groups: birds have an organ that vibrates called the *syrinx* [24] located in the lower part of the trachea where it joins the bronchi. In all the others, from the crocodiles to turtles, geckos, frogs, and so forth and even in humans, the organ is located at the other end of the trachea and is called the *larynx* [25–29].

We could therefore think of this biological orchestra as having two large sections: on the one hand, we have the percussion instruments represented by insects, while, on the other hand, we have the woodwind section represented by many vertebrates.

In order for vertebrates to produce sound, we must have three separate but related structures: a bellows (lungs) that can expel pressurized air through a tube with a vibrating membrane (trachea and larynx) and a resonator apparatus that amplifies sound. The creativity with which nature has solved this problem is amazing and admirable.

In the case of humans, the anatomical structures to produce sounds can be seen in Fig. 2.1.

When we talk about anatomical descriptions, Aristotle is the father of comparative anatomy, and although it is unknown if he ever carried out any human dissections, his descriptions of animal dissections are numerous. He laid the foundations of an anatomical description that was based on finding the *why* of any given structure, which was itself to be found in the function of the said structure [30].

This was later taken up by Galen, whose anatomical descriptions were used for a long time in Western medicine, all the way from the first century to the sixteenth.

The problem with many of Galen's descriptions was that they were based on animal, not human, anatomy. Galen mainly used wild apes and pigs for his descriptions since these were the specimens provided to him by the emperors he served.

In the sixteenth century, Andreas Vesalius, who had studied at the University of Padua, wrote the first systematized anatomy text *De Humani Corporis Fabrica*, which was a very advanced text for the time. Not only did he describe with great accuracy the steps that had to be followed when dissecting a corpse, but his explanations were also accompanied by very detailed illustrations.

This was the first time that dissections could not only be repeated following the instructions outlined in the text, the organs found could be compared to their

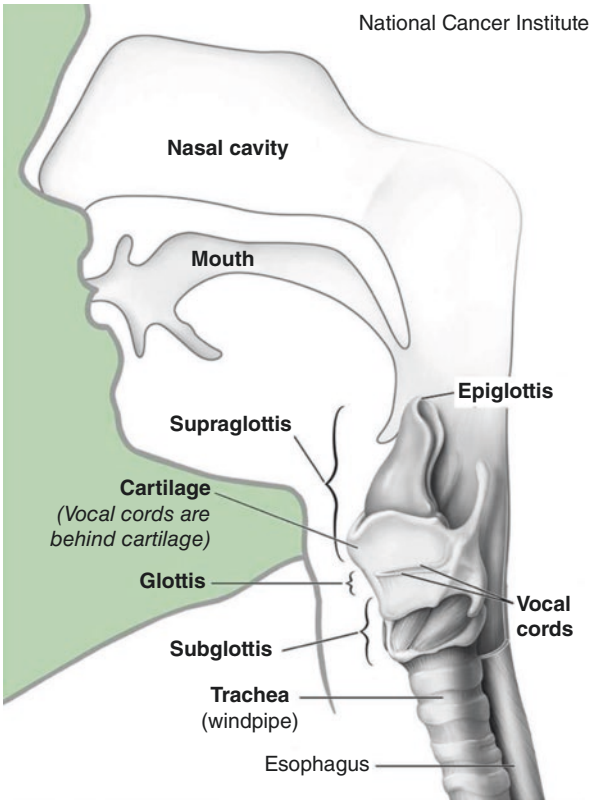

Fig. 2.1 Anatomical structures for vocalization. (Extracted from https://picryl.com/media/larynx-and-nearby-structures-b9ff8f. Under Creative Common LisencesLicenses)

illustrations. In a way, we could say that it was the first multimedia anatomy text. Those interested in delving deeper into this subject are encouraged to read *Doctors: The illustrated History of Medical Pioneers* [31] by Sherwin B. Nuland.

The names of anatomical structures, most of which are derived from Greek or Latin origins, refer to elements of military or everyday life.

The laryngeal structures in particular have an exceptionally rich etymology [32].

Just as a small sample I will show here a few terms, extracted from what is in my opinion one of the best texts on this topic: Henry Alan Skinner's *The origins of Medical Terms* [33]:

"Epiglottis: Greek *πι*, *upon*, plus *γλωττα*, the Attic form of *tongue*."

"Glottis: Greek *γλωττα*, which is the Attic form of *γλῶσσα*, the *tongue*. Also the name for the reed of a wind instrument."

Chord or cord (both spellings are correct): "From Greek. *ορδη*, a string of gut used for musical instruments. Latin Chorda, also corda. Spanish 'cuerda.'"

"Trachea: Greek. *χεια*, rough, feminine formo of τραχυς, *rough*. The ancients thought that the arteries contained air, hence the term artery which means *air vessel*. The trachea or windpipe was also an air tube and the Greeks called it the *rough artery*."

"Lungs: Anglo-saxon—lunge, which Skeat says is allied to lungre, meaning quickly or lightly and he thus sees a connection which suggests that the lungs were named for their lightness, their ability to float in water, etc."

"Diaphragma: Greek διαφραγμα, a partition. From δια, through or across, plus φραγμαa wall or a fence."

As you can see, these names describe a structure's form, function, or both.

Having all the elements to emit sounds, to have a voice, is necessary but not enough to have speech.

For *that* you have to control the air flow very carefully. And to do that, you need to be able to control your breath.

2.2.2 The Evolution of Breath Control

Why do humans have so much control over our own breathing?

Hominids, unlike our first cousins (chimpanzees, gorillas, and orangutans, which, together with humans, make up the great apes), are born prematurely.

The causes of this premature birth are still unknown, but it is thought that the main culprit is the size of our brain relative to our body. The brain's development reaches such a volume that the human pelvises would be too narrow for safer births if we were born at a later stage.

This condition of "prematurity" is accompanied by a face with less development of the maxillary bones, which is why humans have a flatter face. This makes our tongue, which does not change in size, relatively large for our oral cavity, which is why both the hyoid bone and the larynx descend [34].

The consequence of all these changes is that we gain control over the opening and closing of the upper part of the larynx (epiglottis), which functions as a small lid that closes to allow food to pass into the digestive tract and opens to allow air to enter and exit our lungs [35].

As we learn to control the frequency with which we open and close the epiglottis, so too are we better able to control the flow of air through the larynx and, finally, the vibration of our vocal chords.

Our tongue is also able to modulate the sounds we produce both by changing shape and coming into contact with teeth in specific ways. Finally, we can further refine sound thanks to the *orbicularis labia,* which is a facial muscle highly developed in humans due to breastfeeding [36–40].

Along with developing these features, humans have also developed several resonating structures: the nasal cavity, palate, and paranasal sinuses (frontal, ethmoid, sphenoid, and maxillary).

All these features together are what allow us to produce human sounds. Each human's voice is unique and develops throughout their life.

If we study the phonetic structures of other primates, we will find that there are some that are endowed with all the elements to produce words [41, 42]; however, they cannot do it. Why?

Because in addition to having the cartilaginous, muscular, and nervous structures to be able to emit a controlled sound, they need to develop brain structures that allow them to do so.

Knowing the complexity of the vocal apparatus explains why it is so difficult to know when man began to speak, but it allows us to get closer.

Allow me to explain: fossil remains are, with a very few exceptions, composed only of bones and similar structures. Soft tissues, such as nervous, muscular, and cartilaginous structures, do not survive the fossilization process. As a consequence of this, we are limited to studying mostly the bones and what features we might find on them: the foramina (holes) through which nerves or blood vessels emerge; the ridges, valleys, or deformities where the muscles attach; and any other impressions that may have been left by soft structures.

It is an arduous task that requires not only a keen deductive intellect but also more than a bit of artistic interpretation.

For all these structures (larynx, lungs, tongue, muscles, etc.) to function in a coordinated manner, they need to be profusely innervated.

And it is here that we begin to approach an answer to our original question: When did humans develop nerves of sufficient size to be able to control the muscles related to the emission of sound?

The nerves related to the structures of breathing and, by extension, speech exit the central nervous system through the foramina at the base of the skull, while the spinal cord is located in the canal formed by the vertebrae, the neural foramen.

The ribs and intercostal muscles are innervated by nerves that leave the spinal cord when two vertebrae articulate. The size of both the neural foramen and the smaller foramina present at each junction provide us with an idea of the "neuromuscular domain" (that is to say, how many nerves and muscles are involved) of respiration.

At this point, we are getting even closer to our answer.

The comparison of hominid skulls, as well as neural and junction foramina, allows us to infer at what time humans would have possessed the required nerves to operate the vocal apparatus.

This time was approximately 80,000 years ago [27, 39, 43].

However, even with the muscles and nerves necessary to operate the apparatus, something must coordinate those movements if it is to produce anything. And that something is the brain.

2.2.3 The Evolution of the Brain

Our nervous system not only allows us to perceive the world around us; gives meaning and coherence to what we observe; detects threats and opportunities; anticipates events that may occur but it also regulates our temperature, humidity, hormonal, and chemical balance, and it even allows us to dream while we sleep.

But how does it achieve all of this?

Through specialization and interconnection.

The nervous system evolved from the small chemoreceptors found in unicellular beings, leading first to specialized cells capable of transmitting impulses, which would, much later, become the nervous system we know today, divided into the central nervous system (composed of the spinal cord, medulla, pons, cerebellum, and brain) and the peripheral nervous system (composed of the sensory and motor nerves, as well as the sympathetic and parasympathetic nervous system, which regulates the functions of the viscera without conscious thought).

The brain is the most complex, interesting, and intricate organ known to us.

Consider, for example, that in an average human it weighs just over a kilogram and yet the number of connections it has is greater than the number of particles in the entire universe [44].

The evolution of the brain was from the bottom up, from the inside out, and from the back to front.

Unlike many other organs in our bodies that atrophied during our evolutionary journey (such as a vestigial tail on the coccyx, the vermicular appendage in the cecum of our ascending colon, among others), our brain instead continued accumulating control functions, developing newer structures on top of older ones as it grew in complexity. The most recent of these structures is the cerebral cortex, which is a small, thin dark-colored layer on the outside of the brain. Of particular interest was the development of the frontal cortex, which is responsible for what we call higher brain functions: planning, self-control, and voluntary decisions.

According to the triune brain model proposed by Paul MacLean in the 1960s, the modern brain can be subdivided into three parts: the *reptilian brain* (formed by the medulla and the cerebellum) responsible for our survival, which developed hundreds of millions of years ago; on top of it we find the *old mammalian brain or limbic system,* where negative (distance) and positive (approach) emotions reside, which developed tens of millions of years ago; and finally, on top of the limbic system we find the neocortex, which developed two or three million years ago and is, of the three parts, the only distinctly human one (see Fig. 2.2).

This model was superseded at the beginning of the twenty-first century [45]and is seen as a pedagogical simplification of how the brain functions. It is, however, a very clear schematic of the evolution of the nervous system in humans.

The brain is itself "specialized," that is, within it there are certain groups of neurons that are in charge of carrying out specific tasks or regulating specific bodily functions.

Bilaterality could be considered the broadest degree of specialization.

The fact that we have a "left" brain (rational, objective, mathematical, detailed, scientific) and a "right" brain (emotional, subjective, musical, gestalt, artistic) is something we can also see in birds and reptiles.

Having brain bilaterality is a huge evolutionary advantage, both for prey and predators.

For prey, with lateralized eyes, bilaterality allows them to pay attention to what they are eating with one eye and to perceive the surroundings with the other eye, so that they may flee at the first sign of danger.

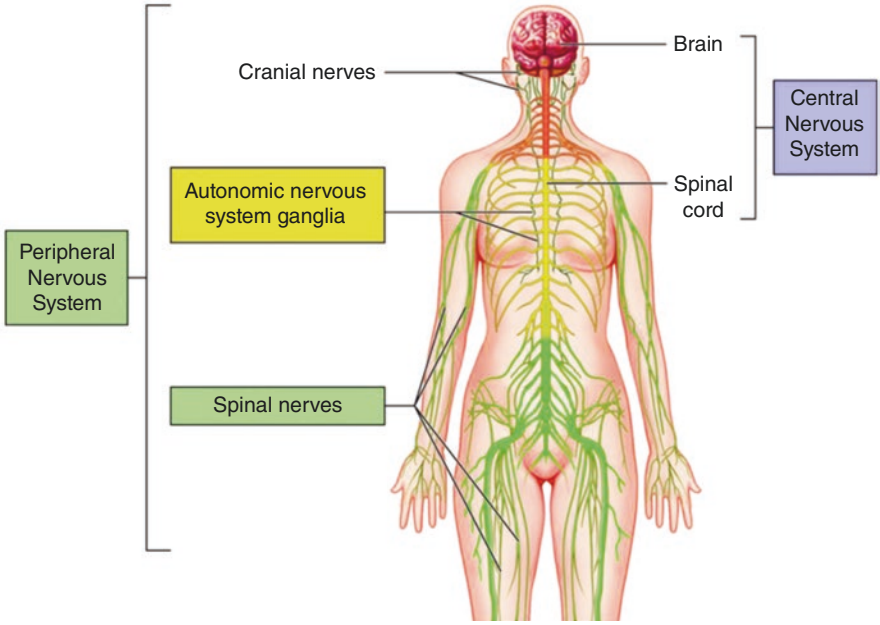

Fig. 2.2 Organization of the human brain. (https://pressbooks.ccconline.org/bio106/chapter/nervous-system-levels-of-organization/)

For predators, with frontal eyes, bilaterality allows them to accurately calculate the distance to their target and thus save energy by arriving exactly where their prey is.

In addition to this bilateral organization, each of the hemispheres holds discrete neuron islands (nuclei) that perform a specific function (vision, smell, taste, hearing, tactile perception), including one area described by Peter Paul Broca (1824–1880) [33],who was a great French surgeon and anthropologist.

Broca described an area of the brain, located in the third left frontal convolution, which is related to speech.

Broca could be considered a very peculiar man. Firstly, he was born with all his teeth (this neonatal dentition is a situation that is seen in less than 1 in 3000 births, and the ancient Egyptians considered it an important omen). Secondly, he was a child prodigy, having enrolled in medical school at the age of 17 and graduating at the age of 20. In addition to being a great surgeon, he was a great anthropologist and mathematician.

In Broca's time, infectious diseases were calamities that were very difficult to control, the concepts of asepsis and antisepsis were just developing, and overcrowding in cities favored the proliferation of these ailments in both rich and poor (though as is often the case, the poor had it much worse).

Oral hygiene was particularly poor, and this led not only to the loss of teeth but also frequently to dental abscesses, which in many cases became chronic and could give rise to abscesses in other parts of the body, including the brain.

Depending on which part of the brain was affected by an abscess, hemorrhage, or a tumor, patients could suffer any or all of the following: loss of consciousness, seizures, loss of strength, sensitivity alterations, or difficulty in carrying out a task.

This is how the inability to speak was first described: an alteration called *aphasia*, masterfully described by Dr. Broca.

Broca's first case was a patient whom he followed for 10 years and who progressively developed a *softening* of the second and third frontal convolution. Broca published this case, and his observations on it, in August 1861.

A few months later, he published a second case, reported in the *Bulletin de la Societé Antomique* in November 1861.

This case was more important than the first for two reasons: (a) it confirmed the findings of the first case since the patient was an 84-year-old man who suffered a loss of consciousness around Easter 1860 and was left with acute aphasia. (b) It was a more recent, smaller, and localized lesion, exactly in the place predicted by his first observation of a patient with *aphemia*, as Broca first called the condition. He later changed the term to *aphasia*, which is a neologism formed by two Greek terms meaning "no word."

In his story from November 1861, which I invite you to read, Broca describes with exquisite sensitivity the nonverbal communication capacity of an 84-year-old man, who has worked all his life making roads, and whose oral ability is limited to five words: yes (oui), no (non), three (trois), still (toujours), and Lelo (because his last name was Lelong). However, combining this limited vocabulary with body language, he was able to explain what his job was, how old he was, his sex, and how many children he had. Upon dying as a result of a fractured femur worsened by his advanced age, Broca carried out an autopsy and found the brain injury he suspected.

Let us stop for a moment to contemplate the enormity of what we have just read.

Here is a 37-year-old doctor, who has been practicing surgery for 17 years, who has had a patient with a chronic condition that has led him to postulate the existence of a language-specific area of the brain. He publishes his findings and theories for all of French society to read in the French summer. Not 3 months later he meets a patient, an 84-year-old farmer with a fractured femur, affected by an aphasia that began during Easter the previous year. When that patient dies, he finds a brain injury in precisely the same area he had postulated the existence of not even 3 months earlier.

In 1861, French medicine was probably the most developed in the world, although it was beginning to have severe competition from German medicine, especially due to the recent appearance of a new rising star: Rudolph Virchow. It was not yet at the same level though.

In the beginning of the nineteenth century, a great school of medicine arose in France due to the influence of Jean Nicolas Corvisart (1775–1821). This school was known for systematizing clinical semiology (the study of the signs and symptoms of patients). In addition to the observation and palpation that came from the Greeks, it

incorporated the percussion described by Leopold Auenbrugger (1722–1809), a Viennese doctor, and later in 1816, the auscultation described by René Théophile Hyacinthe Laennec (1781–1826).

With all these techniques in hand, patients at the French school were scrupulously examined through anamnesis, inspection, palpation, percussion, and auscultation. Any findings were carefully recorded in a clinical history and, if the patient died (which unfortunately was very common in hospitals at the time), the same doctor who examined the patient would perform the autopsy.

We can see then where Broca developed his way of doing research.

Keep in mind that this examination seeks to detect the clinical evidence of the lesions that we would observe in the autopsy. The virtue of the clinician was to be able to connect the data provided by the history of the patient's illness (symptoms) with the doctor's findings (signs) and infer the types of lesions and their locations in order to explain both phenomena.

We owe this idea of the locations of diseases in certain organs to an Italian, Giovanni Baptista Morgagni (1682–1771), who, shortly before he died, published one of the most influential books in the history of medicine: *De sedibus et causes morborum per anatomy indagatis*, where he detailed the findings of around 700 clinical histories and their corresponding autopsies.

Thus, Broca came to demonstrate the existence of an affected area in aphasic patients.

In the mid-nineteenth century, the study of the internal environment described by Claude Bernard (1813–1878) was added to the above by means of laboratory analysis of blood, urine, or other fluids.

At the beginning of the twentieth century, images based on the works of Wilhelm Konrad Roentgen (1845–1923) were incorporated into the medical arsenal, which have had an extraordinary development in the modern age.

Today we are in a position to detect clinical or subclinical (asymptomatic) lesions, and we can also study the function of organs by studying the vascularization or the consumption of certain substances, such as sugar or specific drugs.

This has allowed us to study in even greater depth the brain changes that occur when we observe or listen, but also when we remember, think, or express certain ideas or words.

This is what neuroscience studies tell us.

2.2.4 Neuroscience and Speech

The study of the central nervous system is probably one of the most exciting fields of the twenty-first century as the advances in genomics, proteomics, neuroimaging, and neuroethics have all been overwhelming.

For this reason, we must be extremely cautious with the reductionist vision of science. Detecting a biochemical or electrical change is not the same as detecting an idea or a concept. The ideas of historicity, of identity, and even the idea of the mind have been challenged by some of the results of magnetic resonance imaging studies.