LET'S SCIENCE!

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PAIN

Is not always the enemy

IBSA FOUNDATION for scientific research

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05 Preface

07 **PART ONE** PAIN

08 Introduction

08 What is pain?

12 What is the purpose of pain?

16 How many people are affected by pain and what are the consequences?

17 How is acute pain generated?

24 Is there a pain control system?

26 Can psychological aspects and context influence pain?

27 Is it possible to measure pain?

30 How can we deal with pain?

31 How can we prevent acute pain from becoming chronic?

33 Conclusions

35 **PART TWO** PAIN WITHOUT FEAR

49 Glossary

PREFACE

How familiar are we with the repercussions of scientific research and medical practice for our daily lives? What are the "passions" and motivations that drive researchers and healthcare professionals? What do we know about their professions?

Society strives to make science and its implications known to ordinary people in many different ways. Just think, for example, of the variety of leaflets promoting the importance of a healthy lifestyle and well-being in general. Of course, school does its part as well, introducing the principles of scientific literacy and raising awareness of a series of issues that help foster scientific thinking among young people.

These considerations are in fact the starting point for the *Let's Science!* project, carried out by the IBSA Foundation for Scientific Research in collaboration with the Department of Education, Culture, and Sport of the Canton of Ticino (DECS). The partnership has made it possible to identify interesting topics that have been addressed by the project, getting scientists working in the canton involved. Two different worlds that are often far apart – scientific research and school – have thus been brought together, promoting dialogue between professionals and students through themed workshops, in order to develop awareness of both the topic itself and how to communicate it.

But what was the range of topics the project would address and what considerations led to certain strategic decisions? Science and research are advancing rapidly, especially in biomedicine and related disciplines, and the continuous expansion of fields of investigation requires a constant effort to stay up to date, in order to both maintain a historical perspective and accommodate the numerous innovations. Access to scientifically accurate information, conveyed in accessible language, opens up the opportunity for children to get to know and become passionate about topics that are generally considered "difficult".

And that's the idea behind the *Let's Science!* series, which aims to broaden the range of scientific topics that can be explored at school. The topics, which are interdisciplinary and directly related to individual health and well-being, are presented in an innovative way: the scientific text is in fact accompanied by a story that draws on the experience of cantonal middle school classes, who,

under the guidance of their teachers, developed original scripts, which were then translated into comics by professionals in the industry.

The only thing left for us to do is invite young readers to explore the fascinating fields of research presented by *Let's Science!*, which in turn open up opportunities for further questions and insights. Who knows, one of these readers might in turn one day become the one taking important steps forward in understanding the complexity of life and the delicate balance that allows us to be healthy and happy. Enjoy reading!

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Pain

PART ONE

INTRODUCTION

Living without pain? We think of it as a superhero power and it's certainly something lots of people dream of, especially people who live with pain on a daily basis and have to put up with tedious limitations or even give up things they love.

Pain affects the quality of life and social relationships of millions of people. It makes no exceptions, it is widespread in all modern societies, and treating it is one of the priorities of healthcare systems around the world. But hoping for a life without pain is not reasonable. Pain is part of our lives. How often have we shared our experiences with this unpleasant sensation with our friends or parents? We certainly have more than one story to tell where pain plays a leading role. All similar but different stories.

Pain can be transient or persistent, a slight discomfort or an excruciating burning, a brief shock along the arm or a constant pressure in your lower back. Should we be seriously worried every time we feel pain? Are we sure it is always necessary to "get rid of" pain?

Pain is a complex phenomenon, but in recent decades research has made numerous advances clarifying many aspects of its nature. Although it remains an essentially biological event, we have discovered that emotions, experiences, beliefs, and knowledge are all heavily involved in generating pain.

This booklet presents a modern view of pain in line with the latest scientific research, but above all, it aims to offer a different perspective to our understanding of pain. The ultimate goal is to promote an appropriate and balanced approach to pain.

WHAT IS PAIN?

We have certainly all dealt with pain at least once. For example, trapping your fingers in a door or falling off your bike. Or we have experienced it indirectly,

watching a friend take a hit during a basketball game. Nevertheless, it's not easy to define what pain is.

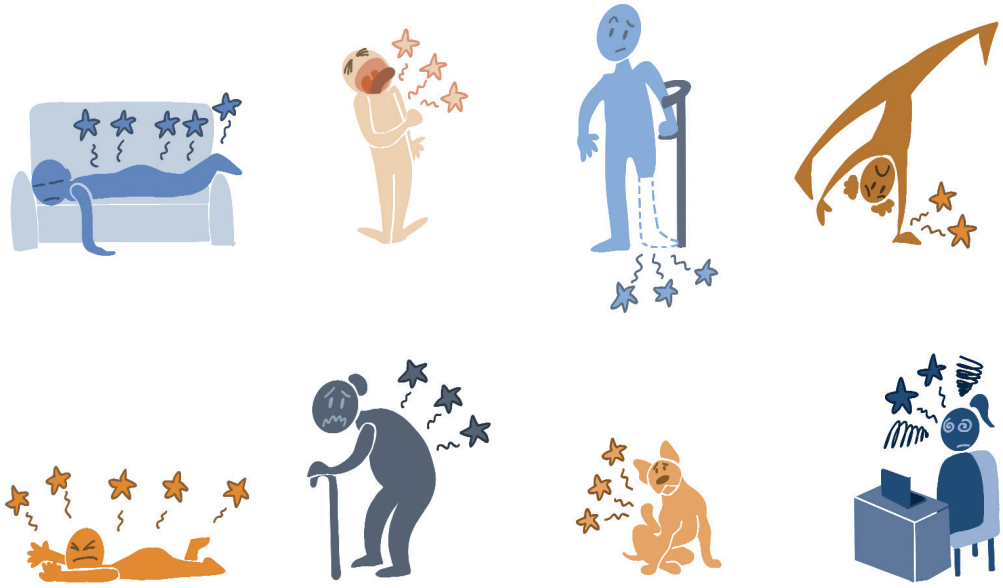
In 2020, after almost two years of work involving 14 international experts, the International Association for the Study of Pain (**IASP**) came up with a new definition of pain: "An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage". The new definition replaced the one approved in 1979, which was universally accepted by researchers and clinicians ("an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage"). The change that was made leaves the definition of pain unaltered but recognises the existence of people or living beings who suffer from it but may not be able to describe it.

The idea of an **unpleasant experience** remains the characteristic element of pain. In fact, the people who suffer from it would do anything to avoid it: go to bed, give up activities or jobs they enjoyed before the pain started, take lots of medications, and, if necessary, even undergo surgery. This distinguishes pain from other neutral senses such as sight, smell, or taste, which are unpleasant only in specific cases.

But pain does not manifest simply as a bodily sensation. In fact, the IASP emphasises how it always has an **emotional component**, which makes it a completely personal and unique experience. There are many feelings that are associated with pain such as anxiety, fear, sadness, and even depression. The invasion of the emotional sphere leads people to change their behaviours to the point, in some cases, that they have to restrict their daily activities or that the quality of their relationships with other people is impaired [**figure 1**].

Finally, the IASP's definition indicates, as one would expect, that pain is associated with damage to the body, such as injury to a muscle or rupture of a ligament. It is very important to note, however, that the damage can also be "potential", that is, there can be pain without there being real damage in the body. In some cases, in fact, the damage is imminent or probable, but the pain anticipates it and its manifestation is real and therefore equally unpleasant. Just think, for example, about when we are at the dentist and we feel pain even before the instruments touch the decayed tooth.

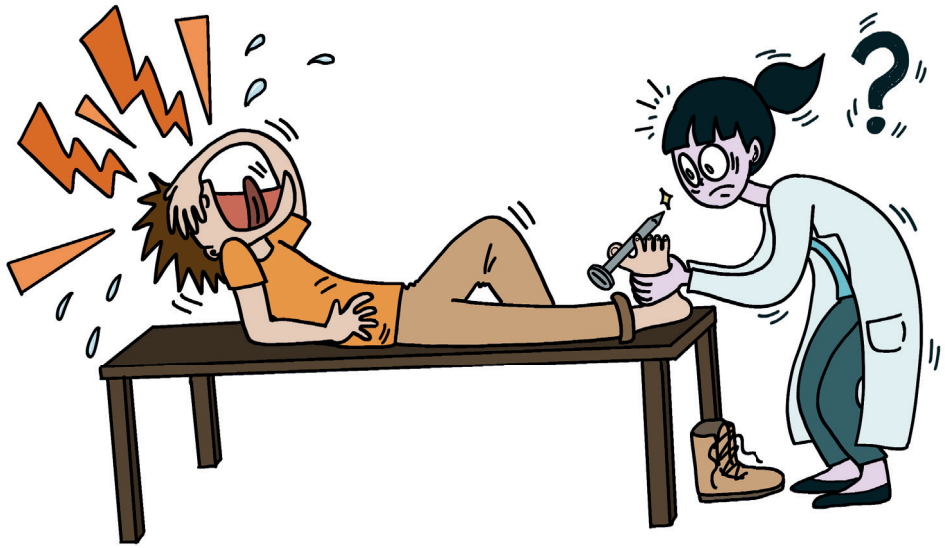
Figure 1 The manifestations of pain in daily life



A major scientific journal in the 1990s published the case of a patient who clearly illustrates this phenomenon. The protagonist of this story was a young bricklayer who, after accidentally stepping on a big nail, was treated for excruciating pain. The nail had gone into the sole and right through his boot. The unfortunate young man was taken to the emergency room urgently, where he was prescribed powerful painkillers because every slight movement of his toes made the pain worse. The persistence of the pain, despite the drugs, forced the doctors to attempt to remove the nail, but once the boot was taken off, everyone thought it was a miracle. His foot was completely unharmed – luckily, the nail had gone between his toes [**figure 2**].

Fortunately, the damage was only "potential". This and other similar cases reported in the literature or experienced in our daily lives remind us that **pain is not always or necessarily the consequence of real damage to the body**.

Figure 2 The case of the "bricklayer": pain is not always the consequence of actual damage to the body



THE IASP

The IASP is the most important international multidisciplinary association that deals with pain. Founded in 1973 by John J. Bonica, the IASP is a professional non-profit organisation dedicated to **promoting research on pain and improving the treatment of patients suffering from it** [**figure 3**]. Membership is open to scientists, doctors, dentists, psychologists, nurses, physiotherapists, and other healthcare professionals. In particular, the IASP promotes and encourages research on the mechanisms of pain and pain syndromes and helps to improve the management of patients with acute and chronic pain by bringing together scientists, doctors, and other healthcare professionals. In addition, the IASP's mandates include education and training in the field of pain, as well as promoting and disseminating new discoveries related to pain. The most important activities sponsored by the IASP include:

- the scientific journal *Pain*;
- the triennial world congress;
- the drafting of guidelines for assessing and managing chronic pain;
- scholarships for deserving candidates;
- the establishment of Special Interest Groups (SIGs) to promote research in specific fields;
- the nomenclature and classification of pain and pain syndromes.

Figure 3 The IASP

WHAT IS THE PURPOSE OF PAIN?

Pain is part of our existence and despite being an unpleasant experience that everyone would gladly do without, it should not be seen as something negative. Without pain, we would not be able to protect ourselves from things that could harm us and our lives would constantly be in danger.

Why is pain an alarm bell?

Think about what would happen if we got distracted while cutting an apple, our finger ended up under the blade of the knife, and we were not able to feel pain. Pain warns us of the presence of a danger, pushes us to useful behaviours such as calling the doctor if we have a stomach ache or quickly pulling our hand away from hot stoves. Finally, the memory

of painful experiences helps us to avoid dangerous situations and to prevent pain. In conclusion, pain is at the same time both **an important alarm system and a defence mechanism**.

However, modern scientific research has found that pain is not an infallible alarm system and does not always protect us effectively. Just like a burglar alarm at home can go off even when it's not a thief but our cat entering our garden, pain can also afflict us in the absence of harm. Doctors and patients should be careful to recognise the **false alarm** that could lead us to engage in inappropriate behaviour, such as taking unnecessary medications or stopping activities that we think are harmful or dangerous [**figure 4**].

This is why it is important to distinguish acute pain from chronic pain.

Figure 4 Recognising pain

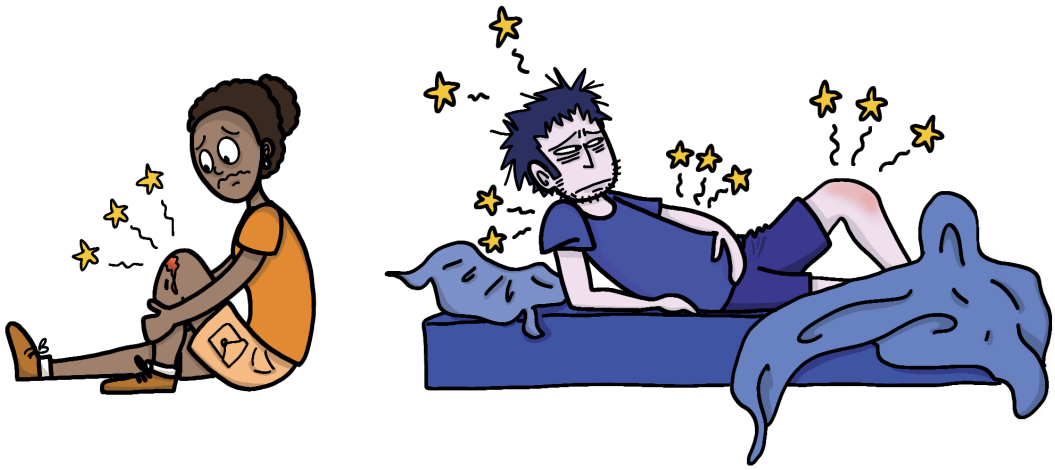
Researchers have shown that **acute pain** is always linked to tissue damage and thus to an inflammatory process. This means that doctors interpret acute pain as a symptom, i.e. as a signal indicating the presence of disease.

In addition, the intensity of acute pain depends on the extent of the damage: the bigger the scratch on our knees, the more burning we will feel. Finally, acute pain tends to decrease quickly until it completely disappears when the damage is healed.

Chronic pain, on the other hand, manifests in a different way. Its main characteristic is that it persists for a long time even after the original damage has healed. Its intensity and location change frequently and it is generally felt in different parts of the body. It is thus not seen as a symptom and becomes a disease itself.

The classification of pain proposed by the IASP specifies that chronic pain **persists for more than 3 months and is associated with emotional distress and disability**. In fact, in most cases, patients with chronic pain are weak and tired, sleep poorly, and in the most serious cases are also anxious and depressed [**figure 5**].

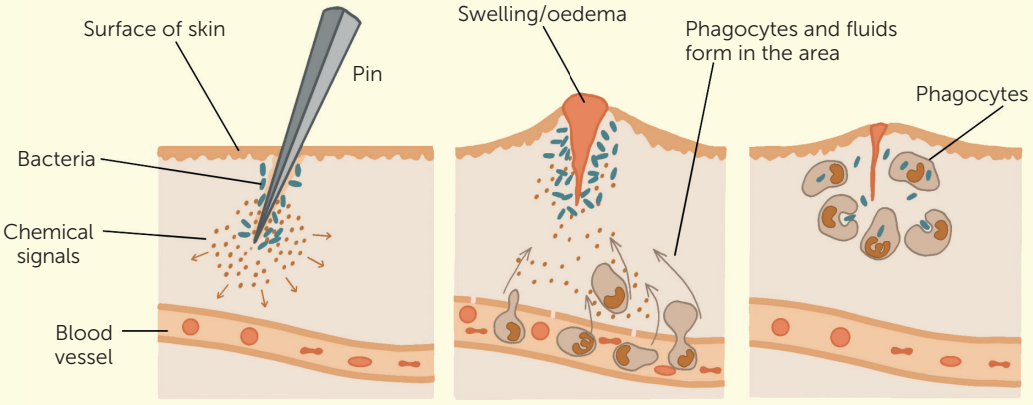
Figure 5 Acute pain (left) and chronic pain (right)



INFLAMMATION

Inflammation is a **defence response** that has evolved in living organisms **to protect them from infection and injury**. Its purpose is to locate tissues that have been damaged and eliminate any harmful agents so that the body can heal. The body's primary biological response consists of a **localised increase in blood flow to facilitate the arrival of white blood cells and proteins at the site where the damage occurred**. Although acute inflammation is extremely useful, it causes unpleasant sensations such as burning eyes in the case of allergies, a sore throat, or itching at the site of an insect bite. The discomfort is usually temporary and disappears when the inflammatory response ends. The four main signs of inflammation – redness, heat, swelling, and pain – were described in the 1st century AD by the Roman medical writer Aulus Cornelius Celsus. The **redness** is caused by dilation of the small blood vessels in the area of the injury. The **heat** is a result of the increased blood flow to the damaged area. The **swelling**, called oedema, is mainly due to the accumulation of fluid outside the blood vessels. The **pain** associated with inflammation comes in part from tightness in the tissues caused by the oedema, but is also induced by some chemicals released by the body, such as bradykinin, serotonin, and prostaglandins. During the inflammation process, the cells involved in the injury proliferate to rebuild the tissues, macrophages and neutrophils get rid of dead cells, and fibroblasts build scar tissue [**figure 6**].

Figure 6 The inflammatory process



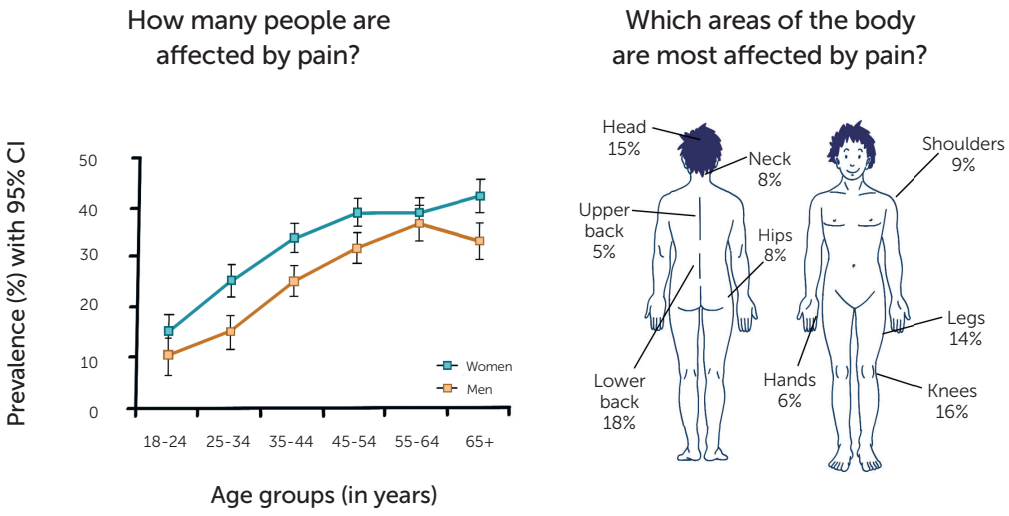
HOW MANY PEOPLE ARE AFFECTED BY PAIN AND WHAT ARE THE CONSEQUENCES?

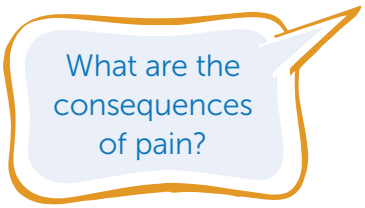
As we have already said, pain can be considered an inevitable part of life. But how many people are affected by pain? How old are they? And what are the consequences of pain? The people who study these aspects are epidemiologists.

In 2010, a study conducted in the United States collected data on 27,035 volunteers through a questionnaire distributed via the internet. Out of the respondents, 9,326 confirmed that they had chronic pain that had lasted for at least 6 months. This means that about 30% of the American population claimed to suffer from chronic pain.

Further studies have shown that the **prevalence of chronic pain** tends to progressively increase up to 40% around the age of 50 and is generally **higher in women**. Finally, even if pain does not spare any part of the body, research indicates that the back, lower limbs, and head are the areas most often affected [**figure 7**].

Figure 7 Prevalence of chronic pain





There are numerous consequences of chronic pain, especially when it affects our ability to move or concentrate, and one of the main ones is **job loss**: even simple tasks may require frequent breaks and in some cases become impossible. **Family** and **social relationships** also suffer the consequences. The inability to walk or sit, or extreme fatigue even when doing simple tasks, makes it harder for patients to engage in daily activities and relationships, causing isolation and loneliness over time, which often lead to anxiety and depression.

The **Swiss Society for the Study of Pain** (SGSS) estimated that each year in Switzerland, about 700,000 patients seek help due to chronic pain and about 60% of them receive inadequate treatment, leading to huge costs for the healthcare system.

The costs and resources used by healthcare systems are striking in Italy as well: it has been calculated that the cost of each patient is approximately 4,500 euros, of which 1,400 goes towards medical care (appointments with specialists, drugs, X-rays, hospital stays, rehabilitation), while 3,100 is accounted for by lost working days. Statistics indicate that every year, 13 million Italians suffer from some form of chronic pain, and one third of these do not get treatment or treat themselves. The remaining 8 million begin a series of medical treatments that generates annual costs of about 36 billion euros, which corresponds to 2.3% of the wealth produced in Italy (GDP, Gross Domestic Product). Appropriate prevention and treatment for chronic pain, therefore, are important not only from a medical point of view but also from a societal point of view.

HOW IS ACUTE PAIN GENERATED?

To understand how pain is generated, it is important to be familiar with some concepts from anatomy and physiology of the nervous system.

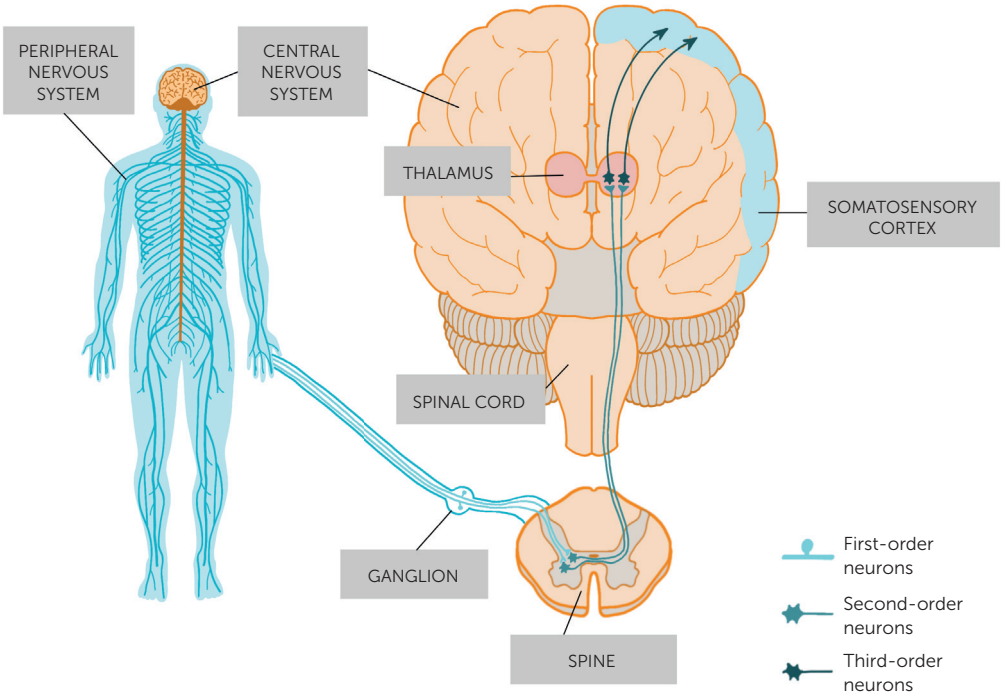
The **nervous system** is a set of organs that specialise in receiving, transmitting, and processing stimuli both from the outside world and from within

our body. It is divided into the central nervous system, consisting of the spinal cord and the brain, and the peripheral nervous system [**figure 8**]. Its activity makes it possible to coordinate the functions of our vital organs, such as the beating of our heart, as well as organise actions aimed at interacting with the outside world, like picking up an object from the ground. Its microscopic structure is extremely complex and organised in neural circuits: basically an extensive communication network composed of cells called **neurons**. Their work ensures that we are able to perform the various activities of everyday life, such as remembering an important event, getting excited, or hearing a sound.

One part of our nervous system is called the **nociceptive system** (from the Latin *nocere*, to cause harm); it deals specifically with the generation of pain (we can also call it modulation/

What is the nociceptive system?

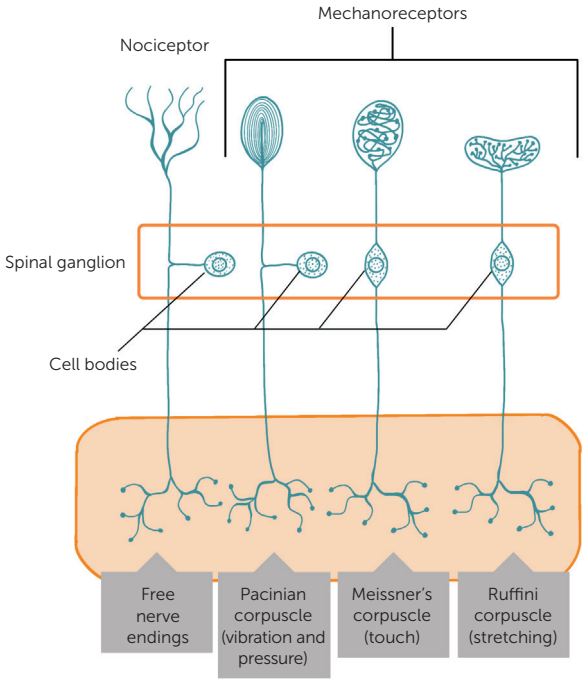
Figure 8 The nociceptive system



control). The neurons that are part of it can be divided according to their specific function:

- **First-order neurons (transduction).** These are peripheral neurons with differentiated functions; their cell body is located in the dorsal root ganglion, while their axons project to the skin, muscles, bones, and internal organs. They are receptors that specialise in identifying potential danger signals and their terminals are activated only in the presence of specific stimuli. First-order neuron receptors can be divided into free nerve endings, properly called nociceptors, and mechanoreceptors. **Nociceptors** are unencapsulated and are activated as a result of different types of stimulation, which is why they are called polymodal. They are sensitive to mechanical stimuli such as pressure, heat, or prolonged cold. It is important to emphasise that activation takes place only in case of particularly intense stimulation, otherwise even harmless stimulation would induce painful sensations, and in the presence of various chemicals, in particular those released during inflammation, such as bradykinin and prostaglandins. The signals picked up by free nerve endings are then sent to the spinal cord via A-delta fibres and C-fibres. The former send messages at high speed (5-30 m/s) and evoke highly localised painful sensations described as sharp or stinging. The latter, on the other hand, send slow messages (0.5-2 m/s) and elicit painful sensations that are widespread and difficult to locate on the body. The quality of pain in this case is described as dull and aching. Activation of the **mechanoreceptors** does not evoke painful sensations but provides information that complements the less accurate information from the free nerve endings. They consist of special, highly complex capsular structures that react precisely to even low-intensity stimulation, such as touch, temperature, vibration, pressure, and stretching of the skin [**figure 9**]. In summary, the function of first-order neurons, called transduction, is to collect as much information as possible and send it to second-order neurons by means of electrical impulses. It is a function similar to that of the sensors of alarm systems installed on the windows and doors of houses.

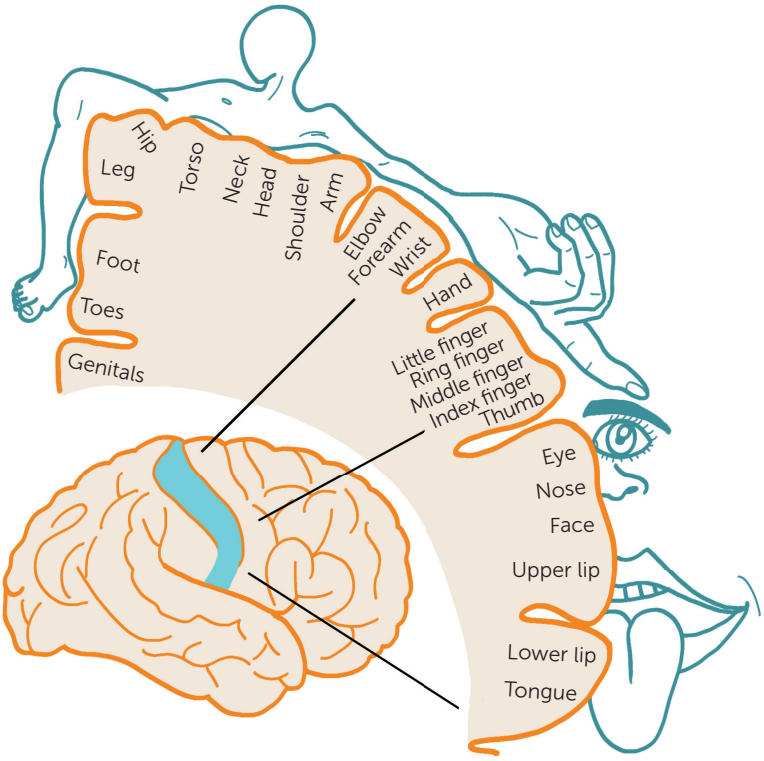
Figure 9 First-order neurons: nociceptors and mechanoreceptors



◎ **Second-order neurons (transmission).** Protected by the spine, second-order neurons are located in the grey matter of the spinal cord. They receive signals from nociceptor terminals in the posterior horn of the spinal cord, where they are distributed within structures called **Rexed's laminae**. From here, they run along the opposite side of the spinal cord, forming the anterolateral system. The axons of this ascending system connect to different regions of the thalamus. Neurophysiology research has identified several communication pathways in this system that specialise in sending information on pain, as well as on touch and temperature. The most important are the **neospinothalamic** tract and the **paleospinothalamic** tract, which in particular carry information on the anatomical location of pain. We can therefore summarise that second-order neurons constitute an organised transmission system that receives information from the periphery to send it to the central processing systems located in the brain.

◎ **Third-order neurons (perception).** The cell bodies of these neurons are located in the thalamus and from there connect with the **primary somatosensory cortex** (SI) and **secondary somatosensory cortex** (SII) **in the parietal lobe**. Stimulating this region of the brain enables electrical impulses, generated by peripheral nociceptors and transmitted by spinal cord neurons, to generate a painful sensation by defining its intensity, quality, and location. This is possible because the primary somatosensory cortex contains a real map of the human body called the **homunculus**, which was described for the first time between the 1940s and 1950s by a Canadian neurologist called Wilder Penfield [**figure 10**]. More recently, however, thanks to modern investigatory techniques and in particular to the use of functional magnetic resonance imaging, it was found that when a patient experiences pain, many other regions of the

Figure 10 Motor homunculus



brain are activated in addition to the somatosensory cortex. In fact, MRI images have clearly demonstrated intense activity in regions of the brain with specific functions. The **neurons in the amygdala**, for example, are activated to promote protective or flight responses; in particular, they compare the current situation with past experiences. The **neurons in the anterior cingulate cortex** (ACC) **and the insula** evoke unpleasant emotions and feelings such as fear and anxiety.

This brief introduction to anatomy and physiology highlights two fundamental aspects for understanding the nature of acute pain. Firstly, that **pain is a perception that does not exist in the part of the body where it is then perceived**. Rather, only some of the information (in the form of electrical impulses) that will contribute to generating pain comes from that part of the body. Secondly, that **the perception of pain is generated in our brain and is always accompanied by the activation of numerous different areas of the brain** that influence its emotional and behavioural aspects in a unique and personal way [**figure 11**].

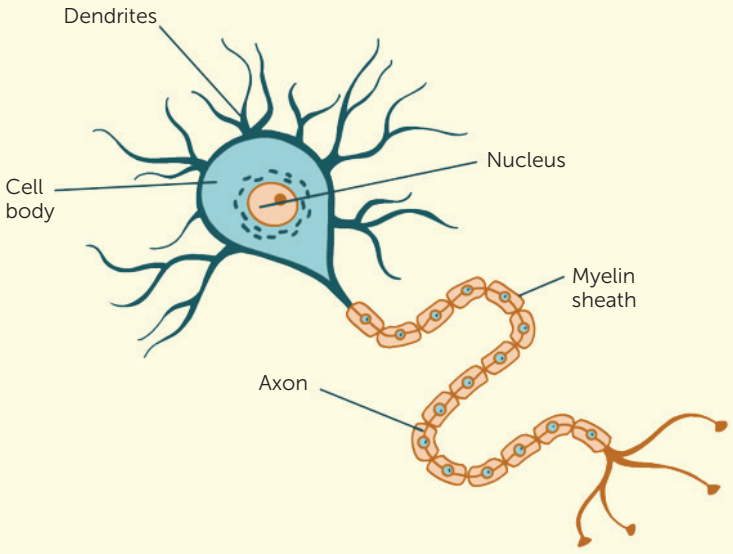
Figure 11 The perception of pain is unique and personal. Similar nociceptions can generate different painful experiences

NEURONS

The neuron is the cellular unit that makes up nerve tissue. The central part of the neuron is called the **cell body or soma**, where the **nucleus** resides. Two fundamental structures project from the cell body of the neuron like the branches of a tree: the dendrites and the axon. The **dendrites** extend in the vicinity of the soma; they are typically short (less than 700 μm) and have numerous branches, and their function is to receive information from the axons of other neurons. The **axons**, on the other hand, have the task of sending messages and can reach the length of one metre. It is estimated that there are about 100,000,000,000 (100 billion) neurons in our body, so if we added the lengths of all the dendrites and axons together, they would stretch more than 1,000 km.

Messages travel along the complex network of neurons (neural circuits) in the form of **electrical impulses**. Their propagation speed varies between 5-120 metres per second and depends on the diameter of the axons and the presence of **myelin sheaths**, lamellar structures that wrap around the axons and can be compared to the plastic sheathing of electrical cables that insulates the copper from the surrounding environment, thus facilitating the propagation of electrical impulses along the cables [**figure 12**].

Figure 12 Neurons



IS THERE A PAIN CONTROL SYSTEM?

In addition to the pain pathways that ascend from the periphery to the brain, running through the spine, there are others that descend from the brain along the spinal cord. These are neurons that run from a structure called the **cerebral aqueduct**, which is part of the thalamus, to the **posterior horn of the spinal cord**, where the first- and second-order neurons reside. Their function is to regulate the traffic of information related to pain: in fact, they can both facilitate (excitatory function) and hinder (inhibitory function) the passing of messages from nociceptors (to the brain). This function is achieved through the release of substances called **neurotransmitters**, such as serotonin or endorphins [**figure 13**].

What is the gate control theory of pain?

An additional mechanism of pain control that occurs at the level of the spinal cord is the one described in the famous **gate control theory of pain**. It was formulated in 1962 by Patrick Wall and Ronald Melzack and earned them the Nobel Prize. To understand this theory, we need to remember that all the A-delta fibres and the C-fibres, and thus all the information about pain, converge in the posterior horn of the spinal cord. Along with these fibres, however, other exclusively sensitive fibres also arrive in the same section of the spinal cord. These are large calibre myelinated fibres, called **A-beta fibres**. Their task is to send information relating, for example, to stretching, compression, heat, or cold at a higher speed than the A-delta and C-fibres. Between the C-fibres and these A-beta fibres, however, there is an inhibitory interneuron that acts as a "gate".

If the activity of the A-beta fibres is high, or in any case prevalent compared to that of the C-fibres, the interneuron will activate, closing the gate, thus reducing the pain. On the contrary, if the activity of the C-fibres prevails, the gate will remain open and the pain will be more intense. This mechanism provides an explanation for some well-known phenomena, such as the instinct to rub or massage a sore area to relieve the painful sensation. In fact, the theory suggests that vigorous skin massage causes activation of the large, myelinated A-beta fibres that close the gate and make pain more bearable [**figure 14**].

Figure 13 Neurotransmitters

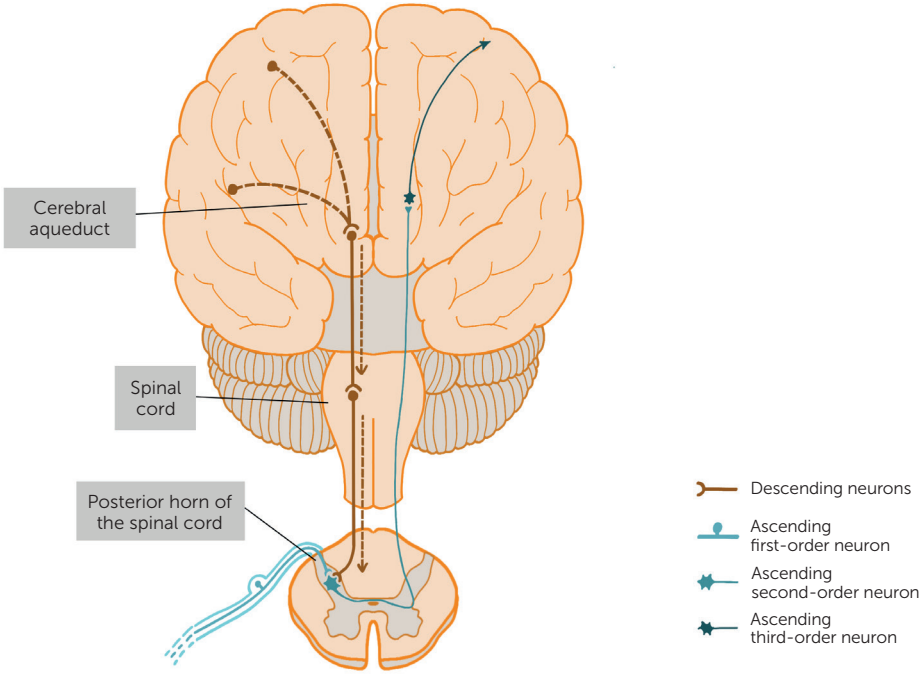
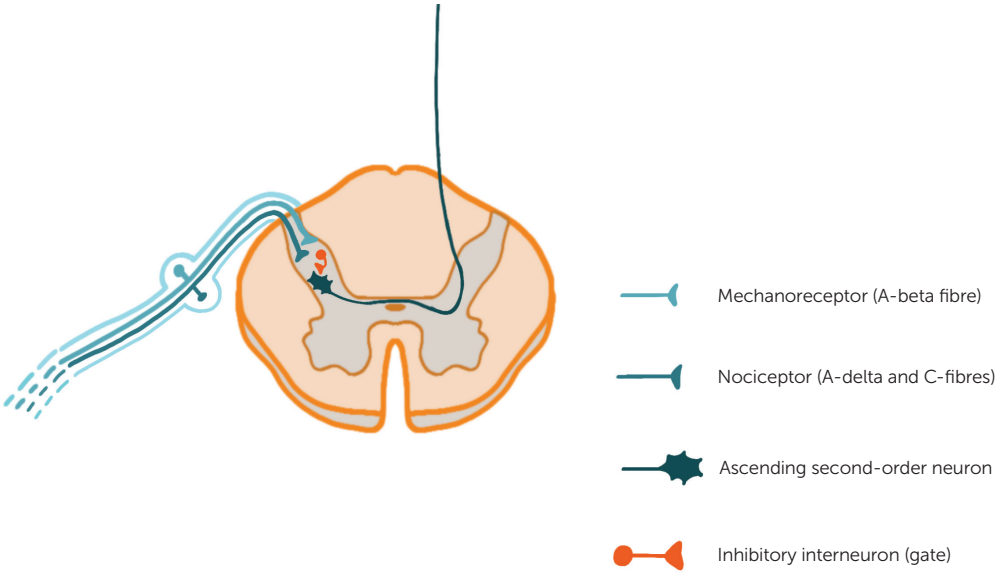


Figure 14 The gate control theory of pain



CAN PSYCHOLOGICAL ASPECTS AND CONTEXT INFLUENCE PAIN?

Various psychological factors can clearly affect pain. Thanks to functional magnetic resonance imaging, researchers have described how pain inevitably also activates the brain areas that control attention, memory, fear, and depression. This activity is evidence of the **emotional aspect of the experience of pain**, which can amplify or reduce the feeling of pain itself. The exact physiological mechanism that regulates painful sensations and emotions is still partly unknown. But doctors and physiotherapists learn with experience (in the field) how a bruised index finger can be extremely painful for a pianist yet negligible for a footballer.

The immediate assessment of the consequences of a trauma on the individual's daily life and professional future is a natural/instinctive human behaviour. Similarly, **false beliefs or misconceptions can also turn a moderate pain into an excruciating one**. A clear example is that of back pain, specifically acute low back pain, a very common pathology in modern society.

Most patients experience it as a moderate pain that resolves spontaneously in a few days, whereas others instead complain of intense pain that can last several weeks. Often this pain – felt as a severe pain that persists for a long time – is linked to the fact that many patients believe that low back pain is caused by a "slipped" or herniated disc, and that they will need risky surgery to ever get better. So false beliefs, as demonstrated by numerous studies, cause anxiety and fear, which in turn amplify pain in a vicious circle.

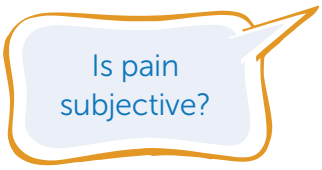
On the contrary, cases have also been studied of people who report surprisingly low-intensity and easily endurable pain, even in situations that would suggest otherwise. This is typical in some athletes during competitions, who continue to perform even after obvious trauma or injury. Just think of a gymnast who sprains their ankle during a jump or a boxer with a bleeding eyebrow arch: both will keep going, ignoring the pain. Athletes focused on the goal and eager to win probably feel no pain or feel it at a low intensity: this phenomenon is called **conditional analgesia**.

Even more surprising are the stories of people in extremely dangerous situations where the fear of losing their life causes their brain to temporarily block

pain so they are able to respond to the danger. For example, many soldiers have told of very serious injuries and amputations caused by exploding grenades that, however, have not prevented them from getting to safety, sometimes even covering many kilometres on foot despite their injuries. They all claim they don't remember any painful sensations: this phenomenon is called **stress-induced analgesia**.

Therefore, it is not possible to fully understand a painful experience just by knowing the traumatic event, because every trauma occurs in a specific context and is accompanied by emotions. The implications and meaning attributed to a trauma or illness play an important role in generating the pain itself and affect its intensity, spread, and quality.

IS IT POSSIBLE TO MEASURE PAIN?



There are many tools for assessing pain that are used by healthcare professionals, such as doctors, physiotherapists, and nurses. Given that it is a personal experience, measuring pain is mainly entrusted to verbal or written communication between the patient and the healthcare worker. Therefore, any attempt to measure the painful experience, which inevitably includes the patient's account of it, is actually a measurement of the patient's perceptions and behaviour, which cannot be verified or ruled out in any way. In fact, despite countless attempts and recent developments in neuroradiology techniques, **we are not yet able to directly and objectively measure pain**, and perhaps never will be.

These measurements, however, remain essential to both the diagnosis and the treatment of pain. The measurement tools can essentially be divided into two categories:

- one-dimensional;
- multidimensional.

The Visual Analogue Scale (VAS) and the Numerical Rating Scale (NRS) are the most widely used one-dimensional measurement tools and focus exclusively on the dimension of intensity. The **VAS** consists of a 100 mm long horizontal line, at the ends of which are terms called "anchor points". The left one says "No pain" while the right one says "Unbearable pain" or "Worst pain imaginable." The patient can then indicate how intense they consider their pain in reference to the two ends of the line by marking a point on the line. The clinician will then measure the distance in millimetres between the left anchor point and the mark made by the patient. When administering the VAS on subsequent visits, improvements in or worsening of the intensity of their pain may be shared with the patient.

The **NRS** uses numbers to replace the mark on the line, with "0" corresponding to the absence of pain and "10" to the worst possible pain. The advantage of the NRS is that it can be easily communicated by telephone or written message, for example by email or chat. In the paediatric field, the techniques described have been adapted by proposing the measurement of the intensity of pain using faces with expressions typical of children (Wong-Baker Faces), with a communication technique that is very similar to "emoticons" [**figure 15**].

Where the objective of the assessment is instead to define the extent or location of the pain, graphic representations of the human body can be used, referring to the front of the body, to the back of the body, or only to certain anatomical regions (head, legs, arms and hands). The patient can simply colour in the regions affected by pain using a marker.

Finally, in the case of complex patients with chronic pain that has a clear impact on their quality of life, multidimensional assessment tools are more indicated, such as the Brief Pain Questionnaire, **BPQ**, which takes advantage of the simplicity of the NRS and applies it to different questions. Some of these questions relate to the fluctuation of pain over time, others instead focus on how pain interferes with the activities of daily life, such as walking, sleeping, and working [**figure 16**].

This method was originally intended to be used in oncology clinics but its validity has subsequently also been demonstrated for other chronic diseases such as arthrosis.

Figure 15 Scales for measuring pain

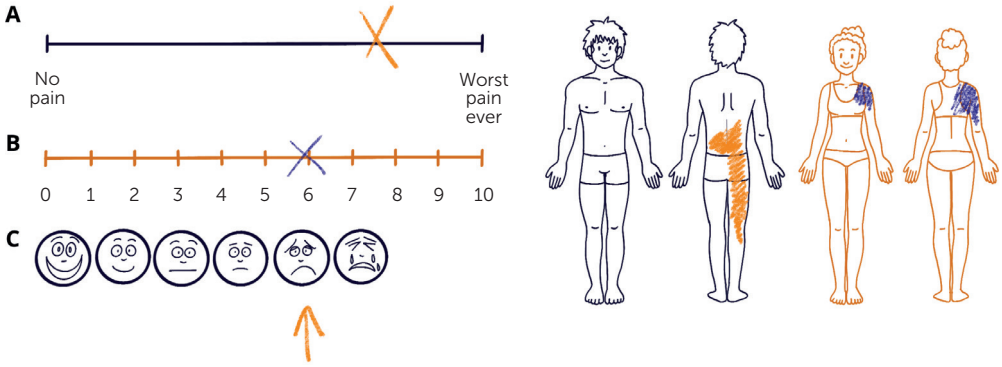
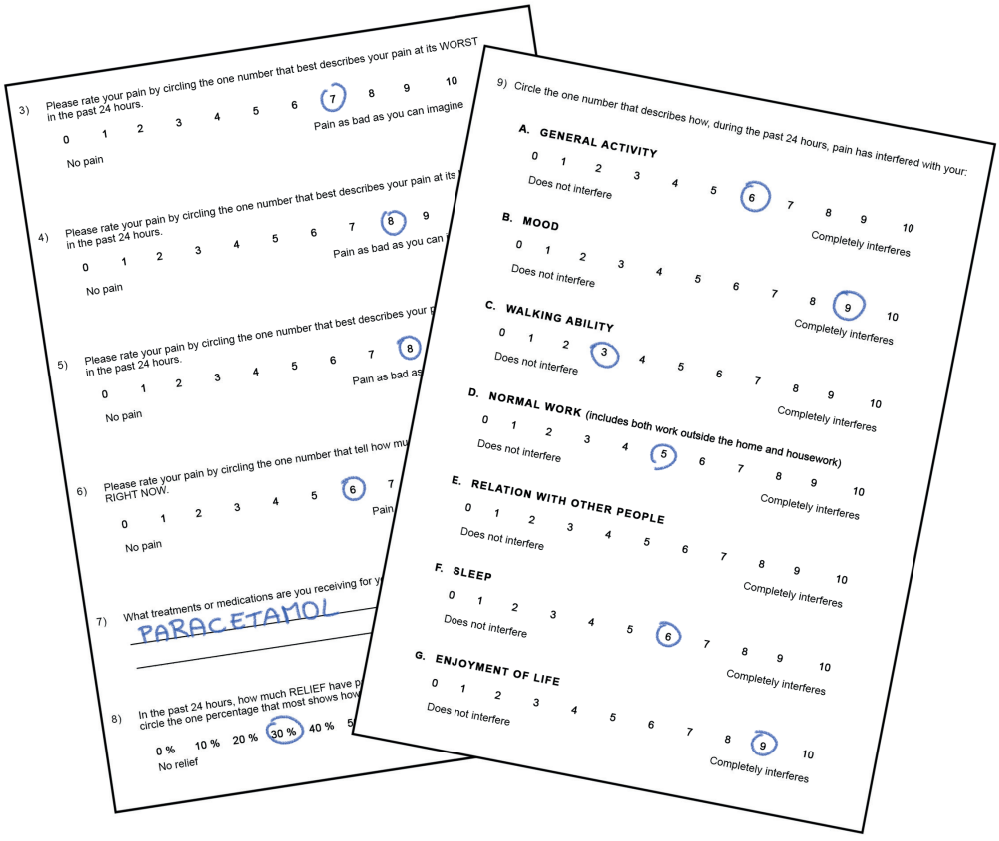


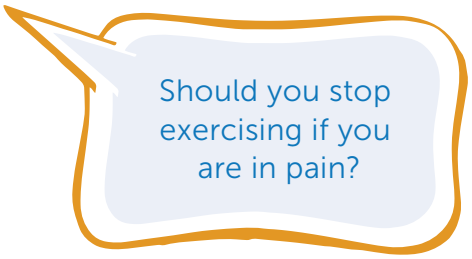
Figure 16 The BPQ questionnaire



HOW CAN WE DEAL WITH PAIN?

As we have mentioned, we all have to deal with pain, even on multiple occasions in our lives. It is not always necessary to go to the doctor, as in most cases the pain spontaneously regresses (in a few days). We just have to adapt and modify activities that clearly make the pain worse or provoke it. But, of course, if the pain persists or if the trauma is significant, it is necessary to consult a healthcare professional. It is essential to rule out the presence of fractures or serious illnesses as soon as possible.

If the situation is not worrying or if any complications have been ruled out, you should return to your daily activities progressively and as soon as possible. Numerous studies have shown that rest or excessive precautions promote the persistence of pain. On the contrary, an active lifestyle helps it go away.



It is important to note that the main international guidelines for pain management (acute and chronic) **recommend prescribing exercise for therapeutic purposes**. Numerous types of exercises – such as progressive strengthening or aerobic exercises – are frequently compared to drugs in terms of their benefits. In fact, doing exercises according to protocols drawn up by specialists regulates the perception of pain at both the central (brain) and peripheral (spinal cord and muscles) levels, stimulating the release of endogenous opioids. The most important of these are without a doubt **endorphins** for their powerful inhibitory effect on pain. In addition, recent surveys have shown that regular exercise also affects the immune system, causing the release of **cytokines**, molecules that promote tissue repair and reduce inflammation. Finally, it should not be forgotten that exercise, especially for people affected by pain, is not just a physical activity, but also an emotional experience capable of improving self-confidence and self-reliance.

HEALTHCARE GUIDELINES

Healthcare guidelines are documents available free of charge, the main objective of which is to **facilitate and guide the decisions of all healthcare professionals**, in particular doctors, nurses, physiotherapists, and psychologists.

For clinicians, it is not easy to stay constantly up to date, because thousands of scientific articles are published every year and there is never enough time to read them. There is therefore a risk of providing patients with treatments that are ineffective or not offering the best available treatment.

The guidelines drawn up by health institutes or scientific societies provide numerous **updated recommendations for the diagnosis, prevention, and treatment of the most common diseases**. The recommendations are the result of a long and rigorous process of analysing and evaluating the available scientific research. Experienced clinicians, researchers and, in some cases, even patients are involved in the process. Each recommendation requires a consensus between all the experts involved. A healthcare professional is required to know the medical guidelines for their profession.

HOW CAN WE PREVENT ACUTE PAIN FROM BECOMING CHRONIC?

The transition from acute to chronic pain is a more frequent event than you might think. Approximately 3 out of 10 patients will develop chronic pain, which is why it is important to be able to prevent this phenomenon with appropriate strategies. There are many factors that make it more likely for pain to become chronic.

First of all, as evidenced by a survey by the National Institutes of Health in the USA, the risk of developing chronic back pain doubles if patients are repeatedly treated with therapies that are not recommended by the healthcare guidelines or that are in any case ineffective.

But the onset of chronic pain can also be promoted by an unhealthy lifestyle, characterised by a diet rich in fatty foods, not getting enough sleep, stressful

situations, and lack of exercise. Obesity, depression, anxiety, and smoking are among the most important risk factors.

Finally, it is essential to remember the role of fear and catastrophic thinking, or catastrophising, in the intensity of pain and the resulting disability.

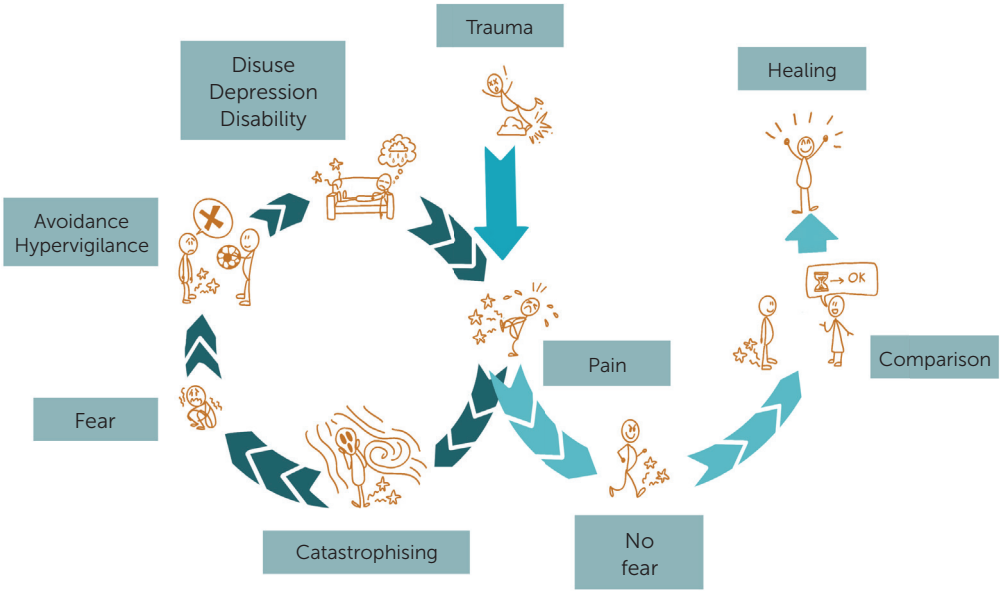
Patients who worry about pain and its causes and consequences excessively often feel a sense of helplessness and adopt passive response strategies including, above all, prolonged bed rest.

These people do not move very much because they consider movement dangerous or even harmful; they prefer to avoid even simple activities such as walking or gardening out of fear.

Reduced motor activity leads to **atrophy** (weakening) **of the muscles** and hinders the healing of injured tissues, forcing patients to enter a vicious circle of pain, depression, disuse, and disability [**figure 17**].

It is clear, therefore, that information and education should be the main strategy for preventing chronic pain.

Figure 17 The experience of pain



CONCLUSIONS

We hope that this book has helped the readers reconsider the way they respond to pain. Perhaps in the future, they will take a different, less negative approach.

Pain is a normal human experience, never pleasant but often useful. Living without pain is not a solution because it would endanger our survival. The effectiveness of surgery and drugs will be improved, patients will suffer less, and their quality of life will improve. But scalpels and pills will not be a solution for all pains and for all patients. We cannot overlook the importance of fully understanding the nature of pain.

As indicated by the healthcare guidelines, the main and most sustainable strategies for preventing chronic pain will always be education, promoting a healthy lifestyle, and physical activity.

Pain without fear

PART TWO

TEXTS

By the students of class 4A of the Cevio Middle School:

Lia Acciarito
Hoara Antenucci
Eli Beroggi
Filippo Bettoni
Valentina Derungs
Fabrizio Diotallevi
Ilaria Filippini
Jastin Fiori
Elia Franzoni
Patrick Giacobbi
Lina Martinoni
Dylan Matasci
Silvia Mignami
Leandro Pedrotti
Christian Picoco
Noemi Pittet

Under the coordination of the teacher:

Petra Speziale (maths and science teacher)

Cevio Middle School
24 Via Valmaggina - 6675 Cevio
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Head teacher: Carlo Ambrosini
Deputy Head: Anna Zanini

ILLUSTRATIONS

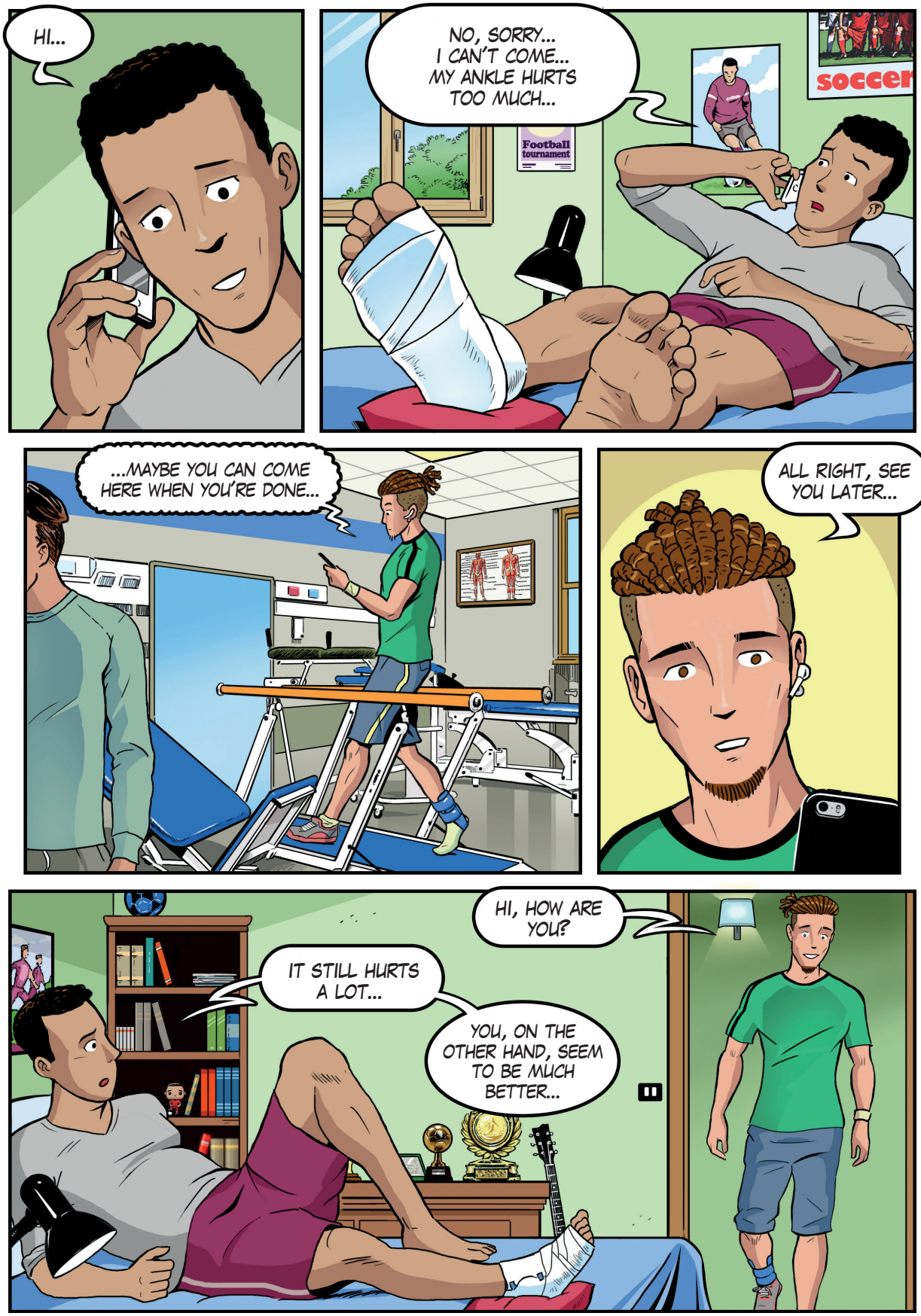
By Alessandro Telve for the Scuola Romana dei Fumetti.

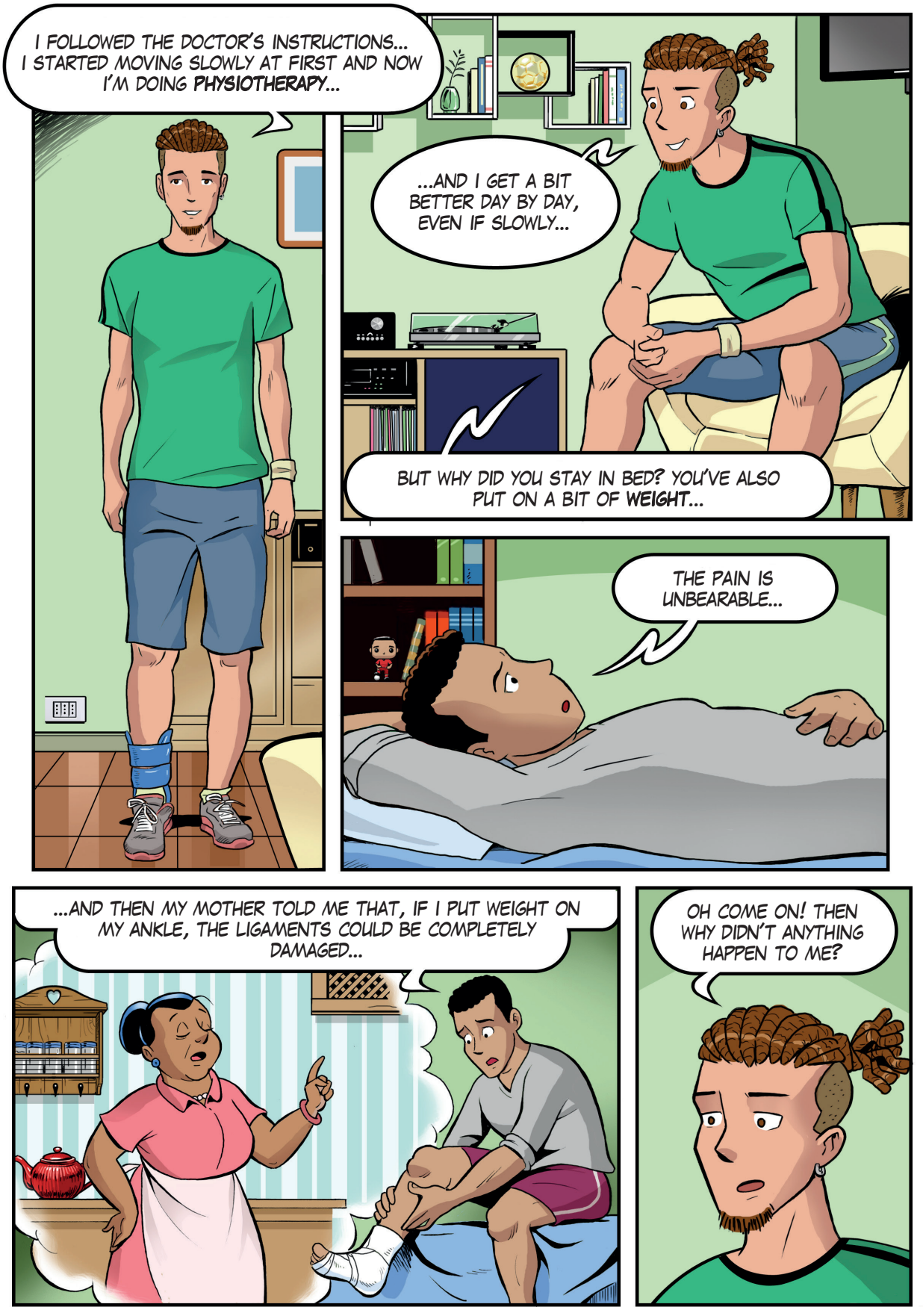

PAIN WITHOUT FEAR
SEE YOU AT PRACTICE LATER, LUIGI!
CARLO AND LUIGI ARE CLASSMATES, GREAT FRIENDS, AND TWO PROMISING FOOTBALL PLAYERS...
OF COURSE! SEE YOU LATER, CARLO!
...IN FACT, BOTH PLAY IN THE YOUTH DIVISION OF THEIR HOME TOWN...
LUIGI IN ATTACK...
CARLO IN DEFENCE...
Soccer

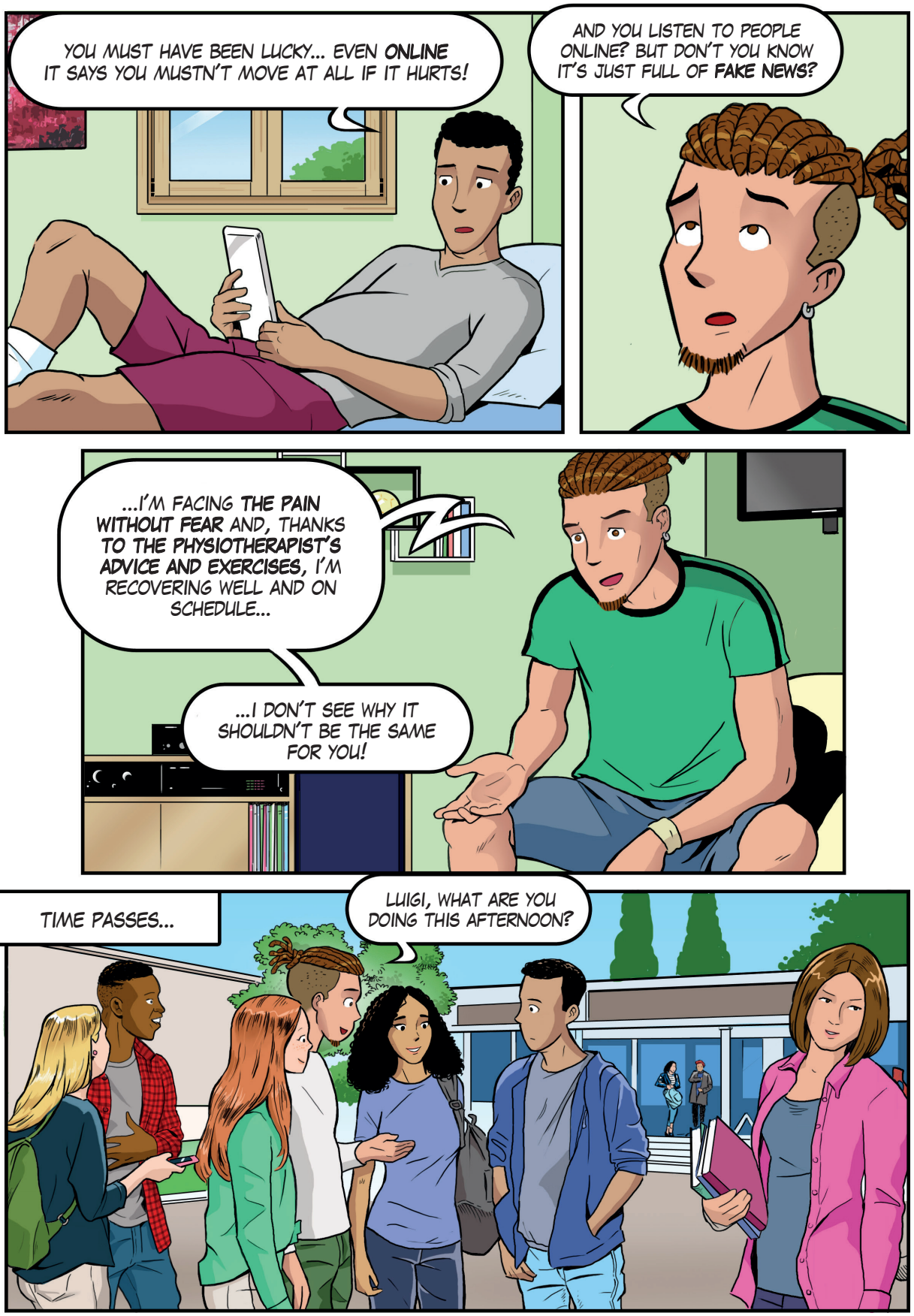

...EVEN WHEN IT'S JUST A TRAINING SESSION, BOTH GIVE IT THEIR ALL...
THUD!
BONK!
soccer
OH...
OUCH!

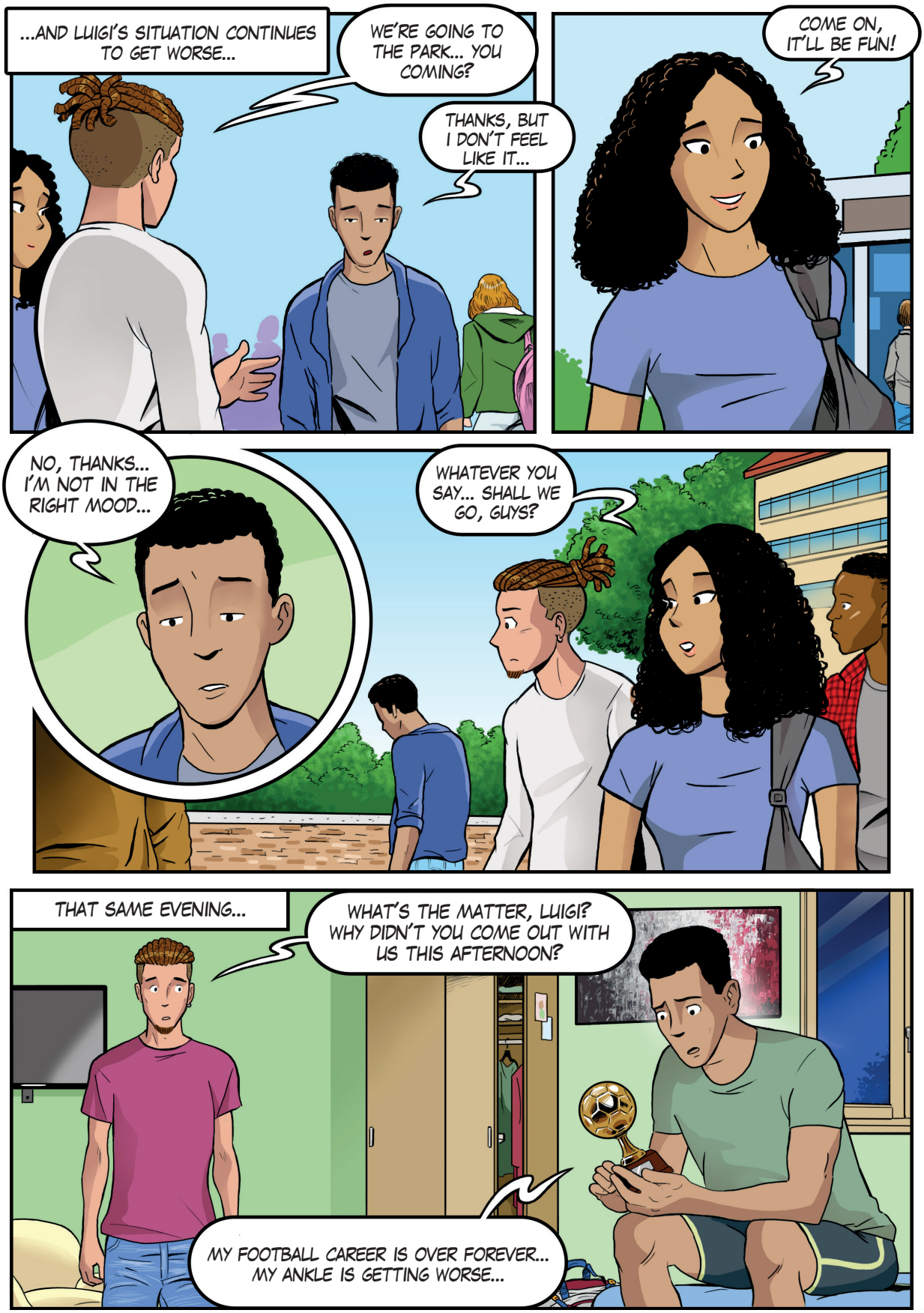

AH!
MY ANKLE!
YOU ALL RIGHT?
soccer
HMM... THESE DON'T LOOK GOOD...
YOU'D BOTH BETTER GO AND SEE A DOCTOR RIGHT AWAY...
THE TESTS LEAVE NO ROOM FOR DOUBT... YOU'VE SPRAINED YOUR ANKLE AND DAMAGED THE LIGAMENTS...
Main entrance
H
Emergency Room

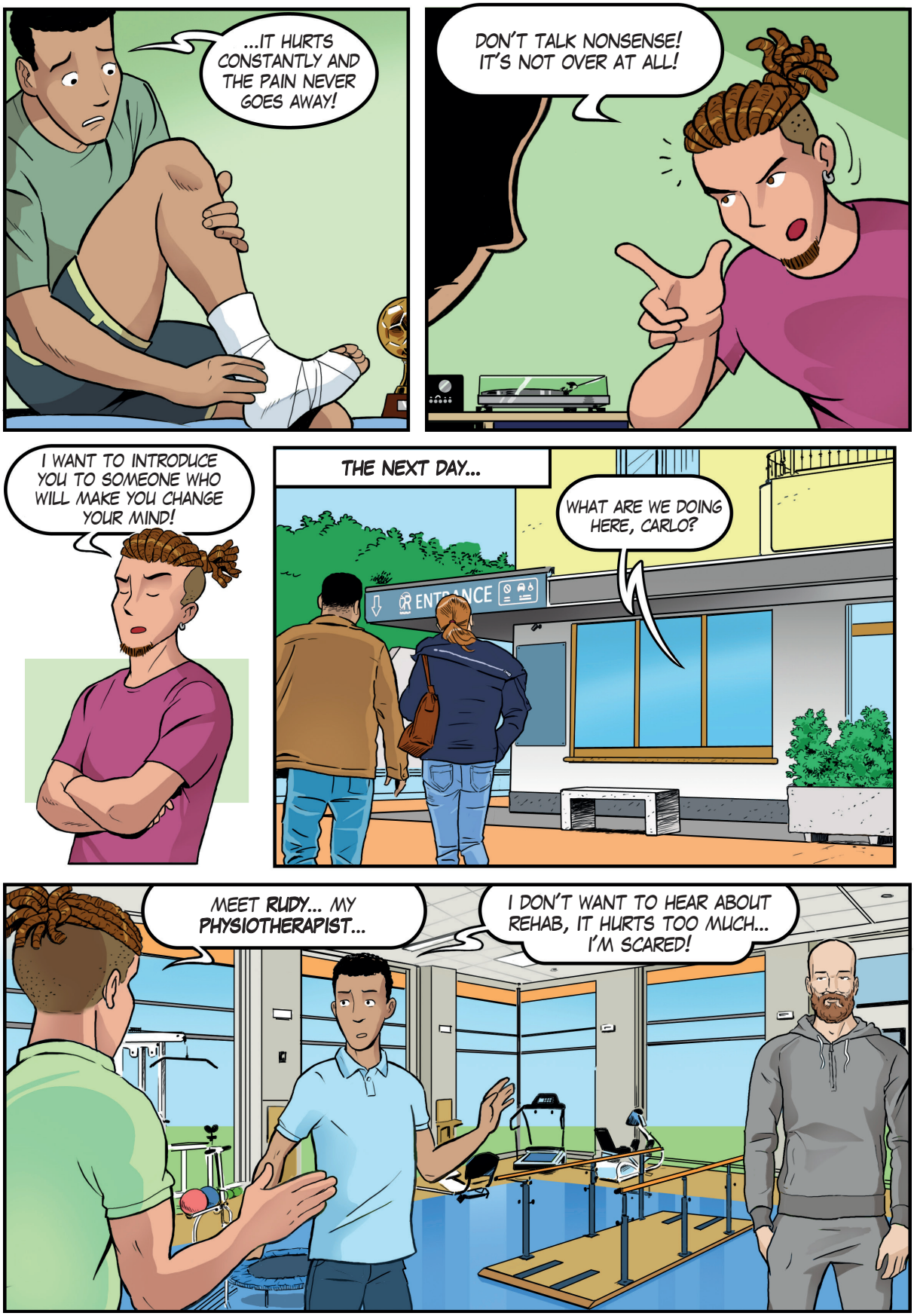

IS IT SERIOUS?
WILL I HAVE TO HAVE SURGERY?
IN THESE CASES, SURGERY IS NOT NECESSARY... YOU JUST NEED TO **REST IT FOR ABOUT THREE WEEKS** AND THEN GRADUALLY START MOVING IT AGAIN...
THAT'S FINE BY ME, I WANT TO GET BACK TO PLAYING AGAIN AS SOON AS POSSIBLE...
...WITH A BIT OF GOOD PHYSIOTHERAPY, YOU'LL GET BACK THE FULL FUNCTIONALITY OF YOUR ANKLES AND YOU'LL BE ABLE TO START DOING SPORTS AGAIN JUST LIKE BEFORE...
BUT WILL IT HURT?
IT WILL A BIT AT FIRST, BUT YOU HAVE TO OVERCOME THE **FEAR OF PAIN** TO PREVENT IT FROM BECOMING **CHRONIC**...
ABOUT A MONTH LATER...
Carlo
BZZZZZZ...

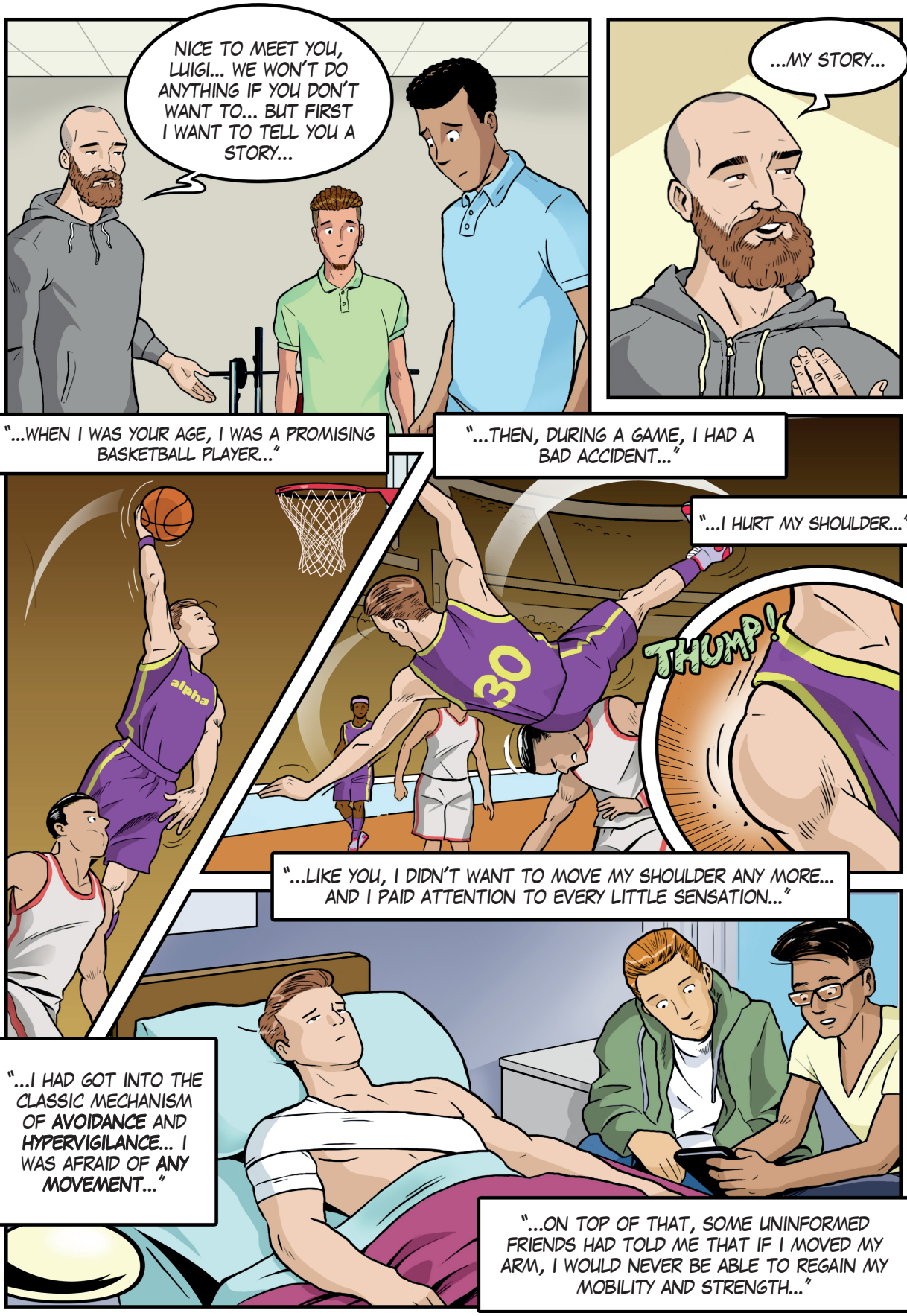

HI...
NO, SORRY... I CAN'T COME... MY ANKLE HURTS TOO MUCH...
Football tournament
soccer
...MAYBE YOU CAN COME HERE WHEN YOU'RE DONE...
ALL RIGHT, SEE YOU LATER...
HI, HOW ARE YOU?
IT STILL HURTS A LOT...
YOU, ON THE OTHER HAND, SEEM TO BE MUCH BETTER...


I FOLLOWED THE DOCTOR'S INSTRUCTIONS... I STARTED MOVING SLOWLY AT FIRST AND NOW I'M DOING PHYSIOTHERAPY...
...AND I GET A BIT BETTER DAY BY DAY, EVEN IF SLOWLY...
BUT WHY DID YOU STAY IN BED? YOU'VE ALSO PUT ON A BIT OF WEIGHT...
THE PAIN IS UNBEARABLE...
...AND THEN MY MOTHER TOLD ME THAT, IF I PUT WEIGHT ON MY ANKLE, THE LIGAMENTS COULD BE COMPLETELY DAMAGED...
OH COME ON! THEN WHY DIDN'T ANYTHING HAPPEN TO ME?


YOU MUST HAVE BEEN LUCKY... EVEN ONLINE IT SAYS YOU MUSTN'T MOVE AT ALL IF IT HURTS!
AND YOU LISTEN TO PEOPLE ONLINE? BUT DON'T YOU KNOW IT'S JUST FULL OF FAKE NEWS?
...I'M FACING THE PAIN WITHOUT FEAR AND, THANKS TO THE PHYSIOTHERAPIST'S ADVICE AND EXERCISES, I'M RECOVERING WELL AND ON SCHEDULE...
...I DON'T SEE WHY IT SHOULDN'T BE THE SAME FOR YOU!
TIME PASSES...
LUIGI, WHAT ARE YOU DOING THIS AFTERNOON?


...AND LUIGI'S SITUATION CONTINUES TO GET WORSE...
WE'RE GOING TO THE PARK... YOU COMING?
THANKS, BUT I DON'T FEEL LIKE IT...
COME ON, IT'LL BE FUN!
NO, THANKS... I'M NOT IN THE RIGHT MOOD...
WHATEVER YOU SAY... SHALL WE GO, GUYS?
THAT SAME EVENING...
WHAT'S THE MATTER, LUIGI? WHY DIDN'T YOU COME OUT WITH US THIS AFTERNOON?
MY FOOTBALL CAREER IS OVER FOREVER... MY ANKLE IS GETTING WORSE...


...IT HURTS CONSTANTLY AND THE PAIN NEVER GOES AWAY!
DON'T TALK NONSENSE! IT'S NOT OVER AT ALL!
I WANT TO INTRODUCE YOU TO SOMEONE WHO WILL MAKE YOU CHANGE YOUR MIND!
THE NEXT DAY...
WHAT ARE WE DOING HERE, CARLO?
MEET RUDY... MY PHYSIOTHERAPIST...
I DON'T WANT TO HEAR ABOUT REHAB, IT HURTS TOO MUCH... I'M SCARED!


NICE TO MEET YOU, LUIGI... WE WON'T DO ANYTHING IF YOU DON'T WANT TO... BUT FIRST I WANT TO TELL YOU A STORY...
...MY STORY...
"...WHEN I WAS YOUR AGE, I WAS A PROMISING BASKETBALL PLAYER..."
"...THEN, DURING A GAME, I HAD A BAD ACCIDENT..."
"...I HURT MY SHOULDER..."
alpha
30
THUMP!
"...LIKE YOU, I DIDN'T WANT TO MOVE MY SHOULDER ANY MORE... AND I PAID ATTENTION TO EVERY LITTLE SENSATION..."
"...I HAD GOT INTO THE CLASSIC MECHANISM OF **AVOIDANCE** AND **HYPERVIGILANCE**... I WAS AFRAID OF **ANY MOVEMENT**..."
"...ON TOP OF THAT, SOME UNINFORMED FRIENDS HAD TOLD ME THAT IF I MOVED MY ARM, I WOULD NEVER BE ABLE TO REGAIN MY MOBILITY AND STRENGTH..."

"...LUCKILY, I MET A GOOD PHYSIOTHERAPIST WHO EXPLAINED TO ME THAT MY FRIENDS' **BELIEFS WERE FALSE**, BUT THEY HAD MADE ME START **CATASTROPHISING**... THAT IS, I WAS AFRAID THAT IF I DID ANYTHING, WHO KNOWS WHAT WOULD HAPPEN... SO I BEGAN REHABILITATION..."

COME ON, RUDY...

YOU CAN DO IT!

GRIT YOUR TEETH...

"...AND, IN THE END, I STARTED PLAYING AGAIN..."

alpha

"...AND I DECIDED TO BECOME A PHYSIOTHERAPIST!"

SOME TIME LATER...

WELL DONE, LUIGI... DOES IT HURT?

JUST A BIT... I CAN DO IT!

GREAT, DON'T STOP... TRY TO PROGRESSIVELY INCREASE THE INTENSITY OF THE EXERCISES WITHOUT WORRYING TOO MUCH ABOUT THE PAIN... THE PAIN WILL DECREASE QUICKLY AND WE WILL PREVENT IT FROM BECOMING CHRONIC!


SO LUIGI GRADUALLY GETS BACK TO TRAINING...
YOU'RE STILL A BIT SLOW, BUT I CAN SEE THAT YOU'RE RUNNING BETTER...
ALL THANKS TO YOU, CARLO... YOUR PHYSIOTHERAPIST MADE SOMETHING CLICK IN MY HEAD...
I HAD NOTHING TO DO WITH IT... IT WAS YOU WHO PUT THE WORK IN...
AND THEN HE GOES BACK TO PLAYING FOOTBALL...
HEY, TOO HARD!...
STOMP!
GOAL!
TELVE
THE END

GLOSSARY

Amygdala	A nerve structure located in the temporal lobe of the brain that manages emotions and in particular fear.
Anxiety	People with anxiety experience a combination of intense emotions that include fear, worry, and anguish. These may be associated with physical reactions such as shortness of breath, tremors, palpitations, and nausea.
Bradichinin	A neurotransmitter found inside the body that helps to widen or open the blood vessels.
Brain	Part of our central nervous system contained in the neurocranium.
Cerebral aqueduct	A structure in the brain that contains cerebrospinal fluid.
Depression	A term used to denote people who often experience low mood and exhibit a lack of interest or pleasure in all, or almost all, the activities of their life.
Dorsal root ganglion	A structure that contains the cell bodies of sensory neurons. It is located in the dorsal root of spinal nerves.
Endorphins	Neurotransmitters produced in the brain that help relieve pain, reduce stress, and generate feelings of well-being.
Epidemiologist	Someone who studies epidemiology, a science that analyses the distribution and determinants of health and disease in different populations.

Fibroblasts	Connective tissue cells found, for example, in the skin, the function of which is to secrete the components that make tissues elastic and resistant.
Grey matter of the spinal cord	The spinal cord contains two distinct regions: one known as grey matter and the other as white matter. Grey matter contains the bodies of neurons, while white matter contains the myelinated nerve fibres (ascending and descending).
Infection	A process characterised by the invasion and multiplication of microorganisms or viruses in the tissues of a living being. Infection often leads to the development of diseases.
Insula	A region of the cerebral cortex located between the parietal lobe and the frontal lobe. It has an important role in processing information relating to the state of the human body, in particular in reference to emotions and sensations.
Macrophages	Immune system cells belonging to the phagocyte system.
Neuron	A structural unit of the nervous system. It receives, processes, and transmits nerve impulses and also produces neurotransmitters.
Neurotransmitters	Chemicals produced by neurons; they are used to send messages between the neurons themselves.
Pain syndromes	A term used in medicine to indicate a set of signs (fever, joint swelling, skin redness) and symptoms (itching, pain, tingling) that characterise the manifestations of one or more diseases. In the case of pain syndromes, the main symptom that the patient complains of is pain.
Phagocytes	Immune system cells capable of engulfing and destroying microorganisms, viruses, bacteria, or cell debris that invade our body.
Physiology	The science that studies the functioning of living organisms, animals, and plants under normal conditions.
Prevalence	In medical statistics, the number of people affected by a disease in a given population at a given time.

Primary somatosensory cortex and secondary somatosensory cortex	Regions of the brain that receive the nerve impulses generated by the sensory neurons. They are located in the parietal lobe of the brain.
Prostaglandins	Molecules produced by the body in the event of inflammation. They perform various functions but the main one is to regulate the dilation and constriction of blood vessels.
Proteins	Complex molecules formed by chains of amino acids. They are essential to the lives of living beings and perform various functions including: transporting other molecules, composing tissues, establishing an energy reserve, defending the organism, and finally, regulating the functioning of other organs.
Serotonin	A neurotransmitter found in various tissues of the body that is involved in numerous functions, including: intestinal mobility, contraction of blood vessels, platelet aggregation, and the stimulation of nociceptors.
Spinal cord	Part of the central nervous system; it is a large cord of nerve fibres that runs down the inside of the spine and connects the brain to the rest of the body.
Symptom	Clinically, a symptom is the sensation felt subjectively by the patient and that probably indicates the presence of a disease.
Thalamus	An ovoid structure of the central nervous system located in the brain, more precisely at the base of the neurocranium. Its main functions are: sending signals to the cerebral cortex and regulating the sleep-wake cycle and the state of consciousness.
White blood cells	Immune system cells found in the blood, also called leukocytes. Their function is to protect the body from the invasion of bacteria and viruses harmful to health.

What is pain? Can you live without pain? Are we sure it is always necessary to "get rid of" pain?

Pain is a normal human experience, never pleasant, but often useful. Living without pain is not a solution because it would endanger our survival.

The booklet offers a modern view of pain that promotes an appropriate and balanced approach to this complex phenomenon.

Marco Barbero, 2rLab Rehabilitation Research Laboratory, Department of Business, Healthcare, and Social Administration (DEASS); University of Applied Sciences and Arts of Southern Switzerland (SUPSI).

Laura Bassi, Fisiocamera, Ferrara.

Inside the comic:

Pain without fear

Texts by the students of class 4A of the Cevio Middle School, Ticino, Switzerland.

Illustrations by Alessandro Telve for the Scuola Romana dei Fumetti.

Repubblica e Cantone Ticino
Dipartimento dell'educazione, della cultura e dello sport