3RD EDITION

HISTORICAL AND CONCEPTUAL ISSUES IN PSYCHOLOGY

MARC BRYSBAERT
KATHY RASTLE

Historical and Conceptual Issues in Psychology

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Third edition

Marc Brysbaert and
Kathy Rastle

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Brief contents

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Preface

From time to time it is good to pause and wonder how we got where we are now. For instance, why did you open this book? How did you become interested in psychology? But also: for how long has one been able to study psychology? Why has this book been published? Why do all good degrees of psychology today include a course on historical and conceptual issues? What is the position of psychology in society? Is psychology really a science? What is a science?

These are some of the questions addressed in this book (although you will not be surprised to hear that many of them cannot be fully answered on the basis of present knowledge). They refer to the historical and conceptual foundations of psychology.

Historical issues refer to the past of the discipline and can be approached in many different ways (see Chapter 10). One distinction is whether history is studied to find out what people at different points in time thought and knew, or whether history is studied to gain insight into how the present situation came about. The latter is the approach taken in this book, because it is of particular relevance to everyone wanting to become a psychologist.

Conceptual issues are more difficult to define. Basically, they refer to the big questions underlying a discipline. For psychology, these are questions like: 'What is the human mind?', 'Is it possible to know the mind of someone else?', 'Is it possible to know my own mind?', 'Is such information reliable and useful?' Importantly, these issues cannot readily be addressed in the way scientists love to do: by collecting data and testing new predictions made on the basis of the available knowledge (see Chapter 9). Conceptual issues relate to the assumptions, convictions and opinions that underlie a particular discipline and that determine the meanings of the terms used (e.g. the meanings of 'consciousness', 'process' and 'personality'). Conceptual issues are shared by the researchers and practitioners of a discipline and are imposed on all newcomers. However, they usually remain tacit. They exert their influence by reliance on common understanding rather than explicit teaching (if this sounds a bit woolly at the moment, come back to this section after you have read the part on paradigms in Chapter 9). Indeed, even for us authors, writing this book has been eye-opening at times. Quite often we found ourselves saying 'Oh, that's where it comes from! That's what it means!'

Needless to say, historical and conceptual issues are closely intertwined. Historical developments depended on the conceptual beliefs at the time and, in turn, had an impact on the concepts and the convictions shared by the next generations. For instance, many psychologists today talk about 'cognitive processes' and 'cognitive representations'. However, they would find it hard to define what exactly they mean by these terms. They just know that every psychologist is taught them and that the words refer to information-processing in the mind (or perhaps brain; see Chapter 7). Where these terms came from, why at a certain point in time they were introduced, and why they subsequently conquered the complete discipline are questions that are left out of consideration in most teachings (e.g. you don't find them in introductory books

on psychology). One reason for this is that you need a certain amount of historical, philosophical, and technical background before you can address them.

The main danger of a book on historical and conceptual issues is that it tries to cover too much. Just imagine: everything that ever happened and that was ever thought of is a possible topic that could be included! Every chapter of this book could easily have been expanded into a 500-page book. Indeed, the most common complaint about courses of historical and conceptual issues is that lecturers try to cram too much into a short period of time. To tackle this problem head-on, we decided not to try to write a 'complete book' (which is impossible anyway), but to start from the question of what is feasible for a series of 14 two-hour lectures. Which are the main issues that must be covered? What is informative and interesting for psychology students (rather than what is known to historians and philosophers of science)? Therefore, do not expect to find everything in this book. Our purpose is simply to provide you with a basis. If this book entices you to want to know more, then we have achieved our goal. To help you with this, each chapter includes a list of the books that we found particularly interesting. There is also a lot of information freely available on the internet, links to which you can find on our website at www.pearsoned.co.uk/brysbaert.

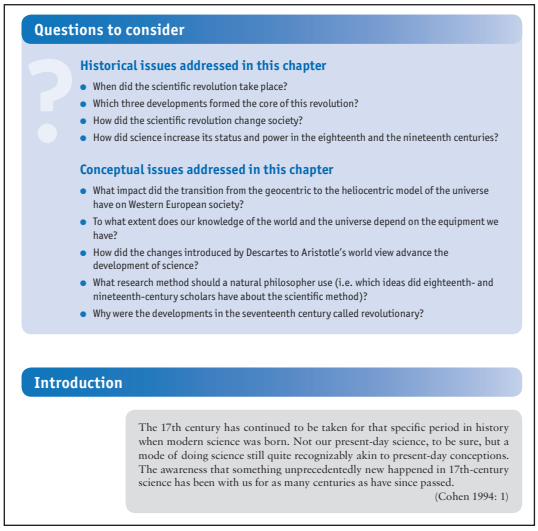
While writing the various editions of this book, we noticed two patterns. The first is that many ideas and findings tend to be considerably older than we thought. There is a tendency to attribute views and insights to specific time periods, whereas it is often possible to find precursors centuries earlier. Throughout the book we give examples of this bias.

The second, related pattern is that we often have simplistic views about the knowledge at a certain time. When reading the original publications, the degree of sophistication and perspective is invariably much higher than assumed nowadays. In a few cases this had led to the formation of outright myths, which we summarize in myth-busting boxes.

As we want to keep pace with major developments, the third edition has a new chapter on a series of events in the 2010s that are likely to shape the future of psychology and science for decades to come. Indeed, the past decade has been quite turbulent with a replication crisis and a call for open science and paywall-free publications (described in Chapter 11). These developments have important implications for our understanding of science and for your education.

We end by thanking our families for giving us the freedom and time to write a book like this. We know how lucky we are, as not all families can cope with members whose minds regularly wander off to times long past and yet another startling new perspective.

Guided tour



Questions to consider

Historical issues addressed in this chapter

- When did the scientific revolution take place?
- Which three developments formed the core of this revolution?
- How did the scientific revolution change society?
- How did science increase its status and power in the eighteenth and the nineteenth centuries?

Conceptual issues addressed in this chapter

- What impact did the transition from the geocentric to the heliocentric model of the universe have on Western European society?
- To what extent does our knowledge of the world and the universe depend on the equipment we have?
- How did the changes introduced by Descartes to Aristotle's world view advance the development of science?
- What research method should a natural philosopher use (i.e. which ideas did eighteenth- and nineteenth-century scholars have about the scientific method)?
- Why were the developments in the seventeenth century called revolutionary?

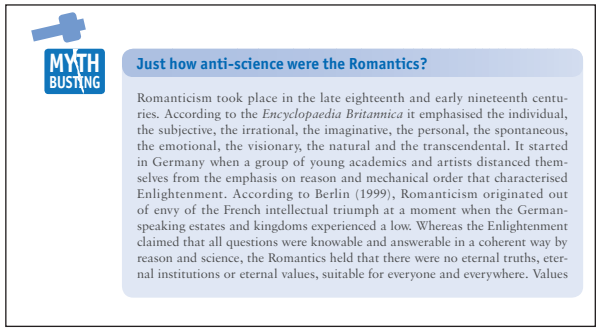
Introduction

The 17th century has continued to be taken for that specific period in history when modern science was born. Not our present-day science, to be sure, but a mode of doing science still quite recognizably akin to present-day conceptions. The awareness that something unprecedentedly new happened in 17th-century science has been with us for as many centuries as have since passed.

(Cohen 1994: 1)

The **introduction** to every chapter opens with a quote or example to provide background and stimulate interest in the topic.

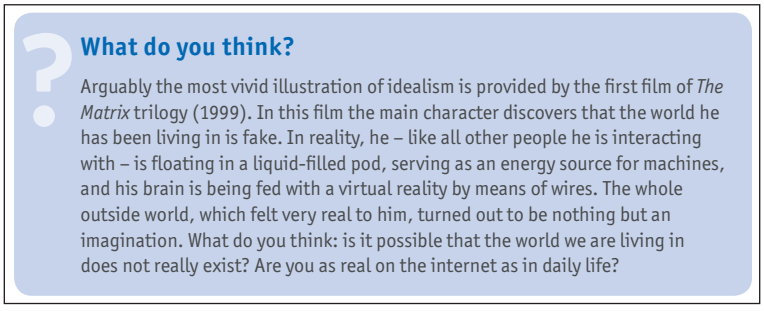
Each chapter opens with a range of **questions to consider** in relation to the historical and conceptual issues raised. These give an idea of topics covered and encourage students to critically reflect on them.



Just how anti-science were the Romantics?

Romanticism took place in the late eighteenth and early nineteenth centuries. According to the *Encyclopaedia Britannica* it emphasised the individual, the subjective, the irrational, the imaginative, the personal, the spontaneous, the emotional, the visionary, the natural and the transcendental. It started in Germany when a group of young academics and artists distanced themselves from the emphasis on reason and mechanical order that characterised Enlightenment. According to Berlin (1999), Romanticism originated out of envy of the French intellectual triumph at a moment when the German-speaking estates and kingdoms experienced a low. Whereas the Enlightenment claimed that all questions were knowable and answerable in a coherent way by reason and science, the Romantics held that there were no eternal truths, eternal institutions or eternal values, suitable for everyone and everywhere. Values

The **myth busting** boxes highlight and explore common misconceptions in psychology.



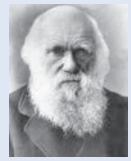
What do you think?

Arguably the most vivid illustration of idealism is provided by the first film of *The Matrix* trilogy (1999). In this film the main character discovers that the world he has been living in is fake. In reality, he – like all other people he is interacting with – is floating in a liquid-filled pod, serving as an energy source for machines, and his brain is being fed with a virtual reality by means of wires. The whole outside world, which felt very real to him, turned out to be nothing but an imagination. What do you think: is it possible that the world we are living in does not really exist? Are you as real on the internet as in daily life?

What do you think? boxes offer students the chance to pause and reflect on what they've read, and to consider their own opinions.

KEY FIGURE Charles Darwin

- British biologist (1809–1882).
- Famous for his contributions to biology:
  - description of new species
  - importance of cross-fertilisation
  - development of the evolutionary theory.
- Impact for the advancement of science:
  - focused on the similarities among animals and humans
  - pointed to the importance of heredity
  - developed a theory of how life adapts to changing situations.



Source: Everett Historical/ Shutterstock.

Key figure boxes sum up the main facts about important people in the field of psychology, and their contribution to our understanding of the subject.

Interim summary

- In France, psychology was seen as part of the humanities as a result of Comte's writings. This was questioned by Ribot, who pointed to the developments in the UK and the German lands.
- Another towering figure in France was Charcot, a neurologist best known in psychology for his research on hysteria. Trusted entirely on his clinical expertise, which turned out to be wrong in the case of hypnosis.
- Binet and Simon's development of the first valid test of intelligence is France's best-known contribution to early psychology.

Interim summaries provide a recap and revision tool to help students get to grips with the main points.

Recommended literature

Most handbooks of neuropsychology contain a chapter on the history of the discipline. In addition, an increasing number of the original publications are becoming available on the internet. Interesting books on the history of neurophysiology are Finger, S. (1994) *Origins of neuroscience: A history of explorations into brain function* (Oxford: Oxford University Press), Gross, C.G. (1998) *Brain, vision, memory: Tales in the history of neuroscience* (Cambridge, MA: The MIT Press) and Clarke, E. & Jacyna, L.S. (1987) *Nineteenth-century origins of neuroscientific concepts* (Berteley, CA: University of *California Press*). A classic textbook of cognitive neuropsychology is Ellis, A.W. & Young, A.W. (1988) *Human cognitive neuropsychology* (Hove, UK: Psychology Press). Good books about cognitive neuroscience are Gazzaniga, M.S. (2008) *Cognitive neuroscience: The biology of the mind* (New York: W.W. Norton & Co.) and Ward, J. (2010) *The student's guide to cognitive neuroscience* (2nd edition) (Hove, UK: Psychology Press).

Recommended literature offers useful and manageable suggestions for further study of the topics covered in each chapter.

1 The wider picture
Where did it all start?

This chapter will cover . . .

Questions to consider

Historical issues addressed in this chapter

- When did the first writing systems appear?
- When did the first number systems appear, and what did they look like?
- Did the Ancient Greek civilisation end after it was conquered by the Romans?
- How did information from the Greek and Roman cultures survive the Dark Ages?
- How long did the Middle Ages last?
- Why did countries such as the UK, parts of Germany and the Netherlands at a certain point become more productive than the other European countries?

Conceptual issues addressed in this chapter

- In what ways does the availability of written records change human thought?
- In what ways do current writing systems differ from the first ones? Is this an improvement?
- Can education change the way in which we read texts?
- How does arithmetic depend on the code that is used to represent numbers?
- Why were Christian schools after the fall of the Roman Empire unable to prevent a sharp decline in scientific knowledge?
- Is it possible to write a complete history of science?
- To what extent does our current scientific knowledge depend on the contribution of a small number of geniuses who achieved the major scientific breakthroughs?

Introduction

If you, reader, had been born, say, two or more centuries ago, the chances are that you would have been poor, indeed extremely poor. You would have spent your whole life working the land, with no hope or prospect of change. Except for the odd tenacious survivor, your numerous children would have predeceased you. You would have taken it for granted that you would probably not live beyond the age of about forty-five. Your home would have been a country hovel, heated in winter with whatever firewood you had managed to gather. The only source of other comforts would have been the few coppers you had hoarded. Apart from everyday conversation, infant wailing and the clucking of chickens, you would have been surrounded by silence, broken every so often by a clap of thunder, communal singing, the occasional drums and trumpets of passing armies, or perhaps the tolling of a solitary bell. You would have believed firmly and unquestioningly in the literal existence of spirits or gods, or a single God, as the guiding or all-determining force in life and especially after death.

(Cohen, 2010)

Human life has changed profoundly in the last few centuries, due to the growing impact of science on our lives. If you look around, it is easy to see how society is filled with scientific products and scientifically-based solutions to social problems. Because of the ubiquity of science, we often forget how recent this state of affairs really is.

This book describes the growth of psychology as an independent branch of learning and tries to comprehend the essence of the discipline. Because it deals with fundamental and long-standing questions, we begin rather a long time ago. We begin by discussing the invention of writing and numerical systems, as these were critical developments that allowed the accumulation of knowledge and understanding. We then present a short account of the ancient civilisations – the Greeks, the Romans, the Byzantine and Arab empires – and consider the role each played in the evolution of knowledge. In particular, we focus on the key figures whose ideas and philosophies have had a strong impact on Western civilisation. We end with a brief description of the Renaissance. We focus on those events that shaped the emergence of the scientific approach as we now know it. Our review starts thousands of years ago and ends on the eve of the scientific revolution in the seventeenth century.

1.1 The invention of writing

The introduction of written records represents one of the most important moments in the development of science. Therefore, it is important to know when and where writing systems were invented and what is so important about them.

The preliterate culture

preliterate civilisation
civilisation before writing was invented

One way that we can start to answer why the invention of writing was so significant in the development of science is by exploring the nature of **preliterate civilisations**. Though these civilisations have not left us with written testimonies, it is possible to discern several important features of them by studying existing cultures that do not use writing, as advanced by Lindberg (1992). His research revealed three important characteristics of knowledge in these kinds of cultures.

First, Lindberg observed that although cultures without literacy know how to make tools, start fires, obtain shelter, hunt, fish, and gather fruit and vegetables, their skills are not based on an understanding of how things work, but rather on practical rules of thumb of what to do when. Their knowledge is confined to 'know-how' without theoretical understanding of the underlying principles.

A second characteristic of a culture without written records is the fluidity of knowledge. Knowledge of the actual history of the tribe is limited to two generations and the function of the oral tradition mainly is the transmission of practical skills.

A third feature of these cultures is the existence of a collection of myths and stories about the beginning of the universe, life and natural phenomena, in which human traits are projected onto objects and events (e.g. in the form of gods). The belief that objects and nature are inhabited by spirits with human-like characteristics, which cause events to happen, is called **animism**. The term was introduced by Sir Edward Burnett Tylor (1832–1917), one of the first anthropologists, to draw a distinction between the thinking of 'primitive people' as opposed to the then growing 'scientific thinking' in the Western world. In Tylor's view, primitives (as they were called) looked

animism
explanation of the workings of the world and the universe by means of spirits with human-like characteristics

at the world like children and endowed all things, even inanimate ones, with a nature analogous to their own (Bird-David, 1999).

Lindberg (1992) looked down upon the animistic thinking of preliterate civilisations less than Tylor did. For him, the myths and stories reinforced the values and attitudes of the community and fulfilled the human need for explanatory principles capable of bringing order, unity and meaning to events. In general, the myths are also related to the treatment of illnesses: the person with the greatest knowledge of the myths is the person to whom people turn when they have an ailment. At the same time, Lindberg noticed that myths often contradict each other and contain inconsistencies, without any evidence that this hinders the preliterate people. Each story stands on its own. It is only when information is written down that patterns start to emerge and incompatibilities become visible. Therefore, Lindberg argued, scientific thinking cannot occur without written records.

The first writing systems

Written language appeared separately in at least four cultures: in China (around 6000 BCE),[1] Egypt (around 3200 BCE), Sumer (also around 3200 BCE) and America (Olmec and Mayan, 300 BCE). These four written languages were preceded by protowriting, the use of symbols to represent entities without linguistic information linking them.

Characteristics of writing systems

pictogram
an information-conveying sign that consists of a picture resembling the person, animal or object it represents

phonogram
a sign that represents a sound or a syllable of spoken language; forms the basis of writing systems

logograph
a sign representing a spoken word, which no longer has a physical resemblance to the word's meaning

From an early stage, writing systems were a combination of **pictograms** (pictures that resemble the persons, animals and objects they represent) and **phonograms** (signs to represent sounds of the spoken language). The Egyptian hieroglyphs, for instance, could only be deciphered when scientists realised that most hieroglyphs represented spoken syllables. The phonograms were gradually replaced by simpler signs symbolising meaningful sounds in the language (phonemes) or syllables. The use of phonograms to represent phonemes led to the alphabetic writing systems, starting with the Phoenician alphabet that formed the basis of the Arabic, Hebrew and Greek alphabets. The writing system that has remained closest to the pictograms is Chinese, where the correspondence between the physical signs and the word meanings they represented rapidly decreased, so that the writing system became **logographic** rather than pictographic (words are represented by written signs – characters – that no longer resemble the meanings they stand for). However, in this language as well, most written words consist of two characters that have a relationship to the word's meaning and that often include cues to the pronunciation.

Written documents form an external memory

Writing and the accumulation of knowledge

The importance of writing lies in the external memory written records provide about the knowledge available at a certain point in time. This is important because it allows an accumulation of knowledge. New thinkers do not have to rediscover what was previously thought; they can simply read what their predecessors wrote. This does not mean that insights are never overlooked (certainly not when a lot is published and not always readily available), but it usually implies that the insights can be retrieved if one

is motivated to look for them (the history of science is full of rediscoveries of seminal teachers who were only known to a small circle of ex-students).

A particularly revealing excerpt illustrating the importance of written documents is provided by a remark made by Socrates. Socrates (*c.* 470–399 BCE) was an important philosopher in Ancient Greece, who was not at all interested in keeping written records of his thoughts. In a dialogue with a young student (Phaedrus) Socrates recounted how the god Thoth of Egypt offered the king of Egypt all types of inventions, including dice, checkers, numbers, geometry, astronomy and writing. The god and the king discussed the merits and drawbacks of the various gifts and were in general agreement until they reached the gift of writing. Whereas the god stressed the advantage of being able to remember information, the king objected: 'If men learn this, it will implant forgetfulness in their souls; they will cease to exercise memory because they will rely on that which is written, calling things to remembrance no longer from within themselves, but by means of external marks.' From the remainder of the dialogue it is clear that Socrates wholeheartedly agreed with the king of Egypt and thought that the availability of books made students lazy and discouraged them from properly studying.

What do you think?

Very much the same criticism is made nowadays about the use of the internet by students. Because all information is easily available, there is no need for them to learn it any more. What do you think? Is the internet changing our thinking in the same way as the invention of writing did?

The irony of the dialogue is that we would never have heard of this, or indeed of any of Socrates' other memorable dialogues, if they had not been documented by his student, Plato. An oral tradition would most certainly have changed the wording of the story and in all likelihood it would not have survived. In addition, the dialogue would not have been included in the present book, if it had not been present in Manguel's (1996) *A History of Reading* (on page 58), which we read in the preparation of this chapter.

Written records not only made more information available; they also subtly changed the way in which knowledge was preserved. Before the advent of writing, important legends were memorised as verses. The rhythm and the rhyme of the poem helped the narrator to remember the correct phrases, so that the contents did not change too dramatically from one storyteller to the next. Written texts allowed cultures to relax the formal constraints and concentrate on the content.

The reader

Who can read?

Written records only have an impact if there is somebody to read them. For most of human history the number of people who could read was relatively small (it still is nowadays in some communities). For many centuries a large proportion of the population was excluded from acquiring reading skills. In addition, the early scripts lacked an important characteristic that makes alphabetic languages easier to read: spaces between the words. Even the ancient Greek and Latin texts were written in so-called

scriptio continua (continuous script). Only in the eighth century did writers start to put spaces between the words. Saenger (1997) argues that this quality of texts made silent reading possible. Before, nearly all readers read aloud or at least had to mumble while reading (a practice that was still widespread in the nineteenth century). In 383 Aurelius Augustine (known as Saint Augustine in the Catholic Church) expressed his surprise when he met the bishop of Milan and saw that he could read silently. 'When he read,' said Augustine, 'his eyes scanned the page and his heart sought out the meaning, but his voice was silent and his tongue was still' (as cited in Manguel, 1996: 42).

The influence of orthography

Reading is still a demanding skill, as is illustrated by the many efforts beginning readers have to invest to acquire it. Reading acquisition is easiest in languages with a transparent relationship between spelling and sound, such as Spanish, Italian, Serbo-Croatian, German and Korean, where most children 'crack the code' in less than a year (although they need many more years of practice before the processes become automatic). In languages with a more opaque correspondence, such as English and Hebrew, children need up to four years in order to reach the same level of performance and are more likely to be confronted with reading difficulties (Hanley et al., 2004; Landerl et al., 2012).

Reading without critical thinking

Readers in the past differed in one more aspect from present-day scientific readers. For a long time students were taught to read and understand texts exactly as they were. They were in no way encouraged (and were often discouraged) to question the writings or to compare them with other writings. Books were the world's wisdom that had to be transmitted in its original form from generation to generation. As Manguel (1996: 74) noted:

scholastic method
study method in which students unquestioningly memorise and recite texts that are thought to convey unchanging truths

> Essentially the **scholastic method** consisted in little more than training the students to consider a text according to certain pre-established, officially approved criteria which were painstakingly and painfully drilled into them. As far as the teaching of reading was concerned, the success of the method depended more on the students' perseverance than on their intelligence.

The scholastic method was prevalent in schools up to the twentieth century. For example, Gupta (1932) complained that Indian education was still adversely affected by the remnants of the ancient Indian system of requiring pupils first to learn a book by heart and only then to receive an explanation of it.

What do you think?

Currently psychology textbooks emphasise 'critical thinking'. From our discussion of the scholastic method, you can understand why this is the case. However, could such an emphasis be exaggerated? Is it possible to think critically without first knowing the facts? What do you think of the arguments in the following quote?

> In the past 15–20 years, the most important buzz words . . . , from kindergardens to graduate schools, have been 'critical thinking'. When it comes up, it is

> either from a stance of attack ('You are not teaching students enough critical thinking skills!'), or a stance of pride ('We emphasize critical thinking in all our classes!'). The need to teach these skills is felt strongly, and the attitude accompanying it is definitely one of a teacher–student relationship. It is assumed that the teachers can do it, but that most students cannot, and that the best means to get students to do it is through explicit instruction of some type. This burden is not felt equally by professors in all disciplines; often such rhetoric is strongest in the social sciences. As a result, teaching 'critical thinking' is a declared goal of most Introductory Psychology professors. Alas, the goal of teaching critical thinking is inherently flawed; the teacher–student attitude does not create an environment that supports critical thinking; instead, it creates an environment in which the task is to reflect the teacher's critique of the issues, which itself cannot be criticized . . . Rather than trying to set up artificial situations in which students are told to challenge particular views, class should be a context in which students begin to master the knowledge that makes up the field of psychology, which will aid them in challenging things on their own in later classes.
>
> (Charles, 2008: Problem 2)

Interim summary

- Features of the preliterate civilisation:
  - knowledge confined to 'know-how' without theoretical knowledge of the underlying principles
  - fluidity of knowledge
  - collection of myths and stories about the beginning of the universe (animism).
- Written language appeared separately in at least four cultures; in each case it was preceded by proto-writing.
- Writing consists of a combination of pictograms and phonograms.
- Written records form an external memory, which allows an accumulation of knowledge.
- For a long time the number of readers was limited. In addition, they were not encouraged to think critically about what they were reading (scholastic method).

1.2 The discovery of numbers

Another development that has been crucial for the growth of knowledge is the discovery of numbers. When we do a simple arithmetic operation, we rarely realise how much insight and knowledge are hidden behind the procedures we use. Interestingly enough, the history of numbers and numerical operations remained largely unexplored until the French maths teacher Georges Ifrah decided to take the issue in hand, a quest that took him over ten years to finish (see Ifrah, 1998).

The limits of visual perception and the special status of the number five

The ease of understanding the numbers one to three

The possession of goods required the ability to count them. The earliest archaeological evidence of counting dates back to 35,000–20,000 BCE and has been found in Africa (Powell & Frankenstein, 1997). The evidence consists of lines or other markings carved in bones and stones, as for example found on the Ishango bone (Huylebrouck, 2006). It is reasonable to assume that quite early in their evolution humans could make distinctions up to three, which were represented by one, two and three markings. Newborn babies and all kinds of animals can distinguish between one, two and three entities, a phenomenon that is known as *subitising*. Also, a number of isolated tribes have been described as having a number naming system that essentially consisted of three terms: one, two and many.

Larger numbers and the need for grouping the tallies

A problem with tallies to represent numbers is that they rapidly exceed the limits of perception. Whereas nobody has difficulties understanding the symbols I, II and III, the use of an analogue code (i.e. a code that represents numbers by a physical magnitude) rapidly starts to fall apart for larger quantities. Number representations like IIIIII and IIIIIIII are not very useful, even though they are still limited to quantities as small as six and eight. A first solution to this problem was a grouping of the tallies, as we still do when we write ~~IIII~~ I or ~~IIII~~ III. This method was used independently in several cultures. The most popular grouping had a base five (as in the example above). There are two reasons why this base appeared in many places. First, the number five is the first entity that really exceeds the perceptual limits (it is possible to grasp a grouping of four perceptually without counting the tallies, as in IIII). The number five also coincides with the number of fingers on a hand. Gradually, the base number five started to get a different symbol. For instance, the Etruscan civilisation used the following symbols for the numbers one to five in the sixth to the fourth centuries BCE: I, II, III, IIII, Λ (notice the similarity to the Roman numerals; the Etruscans lived in ancient Italy before they were conquered by the Romans).

Giving numbers names and symbols

The names one to ten

An analysis of the origin of the number names gives some indication of the struggle humans had before they could come up with a handy numerical system. For instance, it is probably no coincidence that the number nine is related to the word ‘new’ in the Indo-European family of languages. At some point in time, this probably was a newly discovered number. The fact that all Indo-European languages share the same roots for the numbers one to ten further suggests that their names already existed before the original language began to split into its many branches around 2000 BCE. On the basis of the similarities of the number names in over 20 languages as divergent as Sanskrit, Russian and Spanish, Ifrah (1998: 32) postulates the following original number-set:

1. oino, oiko, oiwo
2. dwo, dwu, dwoi
3. tri

4. kwetwores, kwetesres, kwetwor
5. penkwe, kwenkwe
6. seks, sweks
7. septm
8. okto, oktu
9. newn
10. dekm

Notice how little these names have changed in the 4,000 or so years since.

The problem of naming the teens

Another feature of many of the Indo-European number names is the irregularity of the number names of the teens (i.e. the numbers 11–19). It is clear that some of these numbers were given their names before the base 10 of the number system was fully grasped. Due to the groupings of the tallies, at some point it was realised that large numbers were best represented as multiples of smaller numbers, so-called base numbers. The most frequently chosen base number was 10 (double five, not coincidentally the numbers of fingers on our two hands). However, the Sumerian number system had a base 60, the consequences of which we still experience in our time units ($1\ \mathrm{hr} = 60\ \mathrm{min} = 60 \times 60\ \mathrm{s}$) and the French number names betray the fact that at some time a base 20 was used (97 = *quatre-vingt dix-sept* [four-twenty ten-seven]). On the basis of historical analysis, Bauer (2004) argued that the integration of base 20 in the French language (and some other languages) was a medieval development, due to the ways in which goods and land were measured.

The names of the teens in the Indo-European languages illustrate the struggle humans had to integrate the base 10 system in their number names (Calude and Verkerk, 2016). So, instead of calling the number 11 'ten-one' (analogous to twenty-one), the English name turned out to be 'eleven'. This name is still related to the counting of the fingers (it comes from 'one left' [when the fingers of both hands have been counted]; the same is true for twelve, 'two left'), but the structure of the name betrays that it came into being before it was realised that the best way to represent numbers above ten was to treat them as combinations of tens and units. The irregular naming of the teens is not present in the Chinese number system, which according to some researchers may be one of the reasons why Chinese children have less of a problem understanding the base 10 system of numbers.

Representing numbers by symbols

Once the different numbers had their names, it was a small step to represent them by different symbols. From 600 BCE the Greeks developed a written system for the numbers 1–24 based on the 24 letters of their alphabet, going from alpha (1) to omega (24). This system is still in use in Hebrew for expressing the date by the Hebrew calendar, for chapters and verses of the Torah, and sometimes for the page numbers of books.

The fact that numbers in Ancient Greece could be represented by letters does not mean that such a notation was used for calculations. This would have created insurmountable difficulties as it would suggest a base system of 24. Instead, the Greeks used a notation that was in line with a base 10 structure, which they adapted from previous cultures. This notation is shown overleaf. Notice the similarity to Roman numerals.