A Systems Perspective of Public Health

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By

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THIS BOOK IS DEDICATED TO PROFESSOR VLADIMÍR KRČMÉRY,
AS A SMALL CONTRIBUTION TO HIS MAGNIFICENT WORK.

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PART I

1. THE WHO AND WHY OF THIS BOOK

New mothers are dying at an alarming rate. The culprit? Who can tell... Society has accepted high maternal mortality since the beginning of time, arguing that motherhood is a risky business, and there is not much to be done about it. The oldest known description of postpartum infections is mentioned in Hippocrates, some 500 years B.C... However, let us get back to our storyline in nineteenth-century Vienna.

The highest mortality rate was in the teaching maternity ward where there were medical students present. Students and physicians tried to catch up with their tight schedules, and they quickly moved among hospital sections—from general department to maternity to morgue to perform dissection and back. Doctors performed pre-delivery examinations with the same insufficiently washed hands they used to dissect a corpse a few minutes ago. Ignaz Semmelweis was not the first person who knew the *febris puerperalis* or the first to perform autopsies and occasionally had dirty hands, but he was the first to **connect the dots**, and that is what this book is about. The complexity of the world, together with our learning habits, allows us to **notice** the dots, but it **prevents us** from seeing the **linkages**. The message is not always easy to read because the topic is naturally complicated.

To understand nature and gain enough knowledge to remaster something as challenging as the real world you have to step into areas where you have never been before. “Disinfect your hands before touching a patient”: a rule as simple as that lowered the mortality rate from 20% to 1%. Was that convincing enough to change everyone’s behavior accordingly? Not at all: the proposed procedure conflicted with well-established scientific and medical **beliefs**. It took another eighty (!) years before the rule became generally accepted. The following chapters describe why it takes so long for good ideas to spread and what can be done to speed up the process. There is no reason to be scared off by words like “equations” or “simulation”: simply jump into the text and be amazed by how much broader and deeper your understanding becomes when you discover a few **missing links**. At the end of this process, you will know how to address **any problem of a dynamic nature**, and that might be worth trying.

Students of public health, economy or social work, **managers** of healthcare organizations and **healthcare suppliers**, **epidemiologists**, and **policymakers** of all kinds will no doubt be frustrated by the first chapter,

which is on human thinking and perception, and explains that even seeing something with our own eyes doesn't mean seeing the whole and evident truth.

A chance to transform frustration into a better tomorrow comes in Chapter Two on systems skills, claiming that no matter what there is always the hope of gaining sufficient knowledge of the world about us. All we need is to know how to do that and what tools are necessary for success.

The four chapters that follow will tell you how to include what is relevant to your thoughts and later how to turn them into **diagrams** for **sharing your ideas with others**.

The next section will demonstrate step-by-step how to turn your sketches into working **dynamic computer models**, and how to **simulate** various **scenarios**. That concludes the first part of the book.

Part Two focuses on public health and the fundamental interaction of its core parts—the **patient**, the **provider**, and the **insurer**. This part of the book looks closely at health care as a system partly funded by government, addressing the ever-present conflict between the demands for care on the one hand, and funds available on the other. The last chapter of this part explores the process of government policy design focused on prolonging a healthy life.

The third part of the book will lead you through the design, modeling, and evaluation of public health policy using the theoretical examples in Part Two. You can learn how to **design any policy testing lab**, and discover that the methodology introduced in the book is **entirely universal**. As an aid, all solved examples are available for download and unlimited personal use. With the knowledge gained so far, the fourth and final part will deepen your understanding of all the main topics in public health policy design and evaluation.

Each section in part four solves a specific problem in epidemiology, pharma business, government prescription policy, personnel planning by healthcare providers', psychology and psychiatry, capacity planning, vaccinations, and national healthcare policy. All examples are explained, as promised above, in step-by-step detail, including model elements and equations. Even so, the **interpretation of results** and **proper solution design** is left to the reader. Most of the decisions you will have to make while studying will involve your emotions, ethics, morale, and maybe even ideology, but this book will not question any of your beliefs in these areas. You will find here neither directives on how to correctly understand anything, nor bullet lists to remember.

Do not expect the usual "In this chapter…" sections. Why? The chapter "A brief introduction to human perception" is, believe it or not, focused on the introduction to human perception; therefore, you'll learn about human perception while reading the text. Understanding the examples in Part IV of this book will require knowledge from Part III. And Part II. And Part I. For the best results, start at the beginning, read to the last page, and do **not** skip tricky sections!

Happy hunting!
Praga, Caput Regni
A.D. MMXXII

P.S. There are two kinds of diagrams in the book - the causal loop diagram (CLD) and the flow diagram (FD). It is not yet clear what they look like and what they are used for, but in some places in the text, they are described together. Therefore, a different way of referring to the variables has been used to separate them. CLD variables are shown in ***bold italics with a lowercase initial letter*** and FD variables are shown in ***Bold italics with an uppercase initial letter***. The author hereby apologizes to grammar purists; he could think of no better way to distinguish the diagrams by the time this book was published.

P.P.S. The Latin expressions and sentences are intentionally left untranslated.

2. A Brief Introduction to Human Perception

If your eyesight is fine and your eyelids are open (and there's a sufficient number of photons around, and nothing else blocks your view), you can see living and lifeless, beautiful and ugly, ordinary and unusual, black and white, and other spectral colors. The surrounding reality is perceived and stored in the memory cells of our brain. The perception and storing itself is far from perfect; the principle of **selective attention** has been long known (Yantis 2008). A certain part of the surrounding reality **remains invisible** even if the thing in question is right in front of our eyes. Before the image reaches the memory, it passes through many **filters**. The first one is somehow "automatic", its major part is located in the prefrontal regions of our brain and admits only the information that the rest of the brain can handle. When impaired, this area of the brain often fails to filter out **redundant information**, and the mind becomes overwhelmed by stimuli. People react to the information flood by withdrawing from social interaction or becoming irritable beyond an acceptable level and may develop depressive or psychotic symptoms, significantly reducing their quality of life. Despite billions of dollars invested in research, mankind remains far from fully understanding how memory works, but solving the puzzle is beyond the remit of this book. We are about to discuss an **essential** and **simplified** description of mnestic functions that apply to healthy people of average to higher intelligence, well fitted into society. What form does the stored information take? Finding the answer requires a supplemental question: "What level of detail are we talking about?" Molecular? Cellular? Neural clusters? Alternatively, do we want to know what brain areas are involved in storing the information? Moreover, while still in this, why don't we add a bit of philosophy[1]? Cimrman's philosophy, called "Externism", teaches us that the object is where we think it is not,

[1] Externism is a product of the greatest of Czechs, a famous but unfortunately fictional character, Jara Cimrman. It is typical for the Czechs that the non-existent Cimrman even won the poll for the greatest Czech of all time. A more detailed description of the aforementioned philosophical school is pointless for non-Czech speakers; the most humorous parts, as usual, are lost in translation. To learn at least a bit more, search for "Externism" in public sources.

and not where it truly is (Smoljak, Sverak, and Sebanek 1967). If you have a hard time locating this school in your philosophical dictionary, do not panic! Read the footnote, which you seem to have skipped.

One of the fields of memory study is called **cognitive psychology**. Some even call it "Cognitive science". Since the word "science" lost its meaning in our world[2], we will stick to the good old name; we will be looking at memory functions from the cognitive psychology point of view (Kellogg 2015). As in almost every field, cognitive psychology also covers many schools and approaches that, at some point, conflict with each other and, like any other social field, became infested with ideologies. For this book, our interest lies within those cognitive psychologists advocating the concept of storing the so-called "**mental representation**" or "**mental model**" of the perceived reality (Gentner and Stevens 1983). But this does not mean that other more detailed or more general approaches to memory exploration are not relevant or exciting. Still, the mental model works fine for everything we are about to address. Do we even need the term mental model? If so, why? There are many reasons. One of the most important is **semantics**. The expression "model" usually refers to something mimicking reality or an illustrative example. Everyone knows about model cars or trains; they resemble their full-sized counterparts but usually lack functionality. There are other instances of the term model with different or even opposite meanings. According to their creators, the "fashion model" should serve as ideal others will tend to copy and buy products promoted by these "models".

In some cases, people not copy only the clothing and passion for a certain brand but get the whole packet, including pathological behavioral traits of these models (like eating disorders) (Susta et al. 2015, Susta, Bizik, et al. 2022). The mental model can also be understood as a "reduction" of perceived reality, often inaccurate, incorrect, and incomplete. Still, since there's nothing better available, mental models seem to be the only option we have to interact with the surrounding world. If you are as old as me, you already have a large pile of mental models in your brain. While some are quite sophisticated, others are primitive. Personally, I'm somewhat knowledgeable in several fields of science, but **entomology**, for example, is **not** one of them. I can only tell a bug from a spider if the individual in question doesn't run too fast and I can count its legs. I usually also misclassify a spider that accidentally lost two legs among the bugs. It's my personal shame that it doesn't matter which legs it was. After some time spent in this world, your memory of mental models begins to look like a warehouse with shelves and boxes labeled "animals", "fruit", "anatomy",

[2] There's not enough room in this book for all the references to support the claim...

and whatever else got in there over time. Having such storage is mostly beneficial. Processing new information benefits from previously created shelves and boxes. If you spot a four-legged, furry creature with a tail, the shelf “animals” gets activated. A close-up view of the underlying mental model might reveal more information serving as a basis for creating a proper behavioral pattern closely analogous to the four-legged creature. I don’t mean someone else’s dog. If it’s a four-legged, completely unfamiliar creature, you might not immediately try to pet it, because in addition to the mental model of “something dog-like,” the mental model for interacting with the unfamiliar is also activated. Having mental models is helpful in this context; it allows us to quickly **sort out newly perceived objects** and accommodate our behavior accordingly.

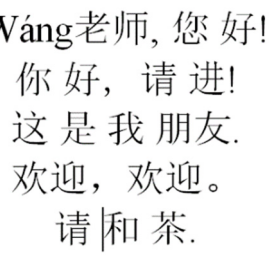

Fig. 2-1 Reconstructed by the author. Incredible story of Mr. Wáng. Special thanks to Gubo and Palanka. I hope you finally made it! Students of the Chinese language around the world will know what I mean...

However, there are certain **exceptions**. Did you ever file someone into the “friends” box, only for later encounters with that person to become soured? You probably did, and not just once. Interestingly, the reverse rarely happens. If we dislike someone at first sight, the likelihood of us becoming friends doesn’t tend to be high. Some, though familiar with the phenomenon of the “first impression fallacy“ even claim that whenever they have not acted on their first impression of a person, they have always regretted it later. Mental models determine the way we perceive the world, and if there is no mental representation of the observed object, we tend to treat it as somehow “invisible”. If the only letters you can read are those from the Latin alphabet, “reading” a Japanese or Chinese newspaper has little to do with actual reading. Rather, it is about looking for something familiar, a shape, a drawing, or any clue that will point to the meaning of a text written in an unfamiliar language and/or with unfamiliar characters. See the text in Figure 2-1. Is there something that looks friendly? Being

Chinese or Sinologue surely helps, but otherwise, the only readable (from my European perspective) characters form the word “Wáng”, to my knowledge, one of the most common Chinese family names. There is simply nothing to build upon in that text for *ignorami* of my magnitude, and the whole breathtaking adventure of Mr. Wáng will remain a mystery (Beijing Languages 1981). Our mind works the same way in everyday situations. Changes in traffic signs (Hey, there has always been the main road here...), an alteration in our clients’ buying behavior, a sudden modification in parenting, and resulting confusion in children’s heads serve as proof of the existence of mental models and their influence on our lives. Information that came from an external source is also **always incomplete**. Incomplete or **imperfect** information leads to **erroneous conclusions**. You can try it for yourself. Look at Figure 2-2.

Fig. 2-2 A mansion in a garden.

Do you know where the picture came from? Do you know what particular purpose the house serves? I am sure you have seen it before, you also know its name and its location. Is that enough? No? Let me give you more clues then. The house is usually photographed from the front, with a wider angle. Still nothing? Believe it or not, the building is the White House, the residence of the President of the United States. Limited ability to perceive new information, first-sight reactive error, and incomplete information—all lead to faulty conclusions and create a potential loss. There is one more mental model operation worth mentioning in psychology. It is called **projection**. Sigmund Freud described it first when he wrote about the defensive mechanisms of the ego. Projection and its implications often bother those on psychotherapeutic sofas but also complicate our everyday lives. The following description is neither complete nor universal but

suffices as an illustration. Let us select a situation everybody knows or has even been in. Your unconsciousness, sub-consciousness, fantasy, social interaction, daydreaming, or whatever, creates a mental image of your ideal mate; now imagine walking around the block while trying to find a suitable screen on which to project your internal image (let's be clear here, the screen should be a living person of an appropriate age). Once you find the "canvas" and create the projection, that person's real features **no longer matter**. All that is visible from your vantage point is the **idealized inner picture**. The projection usually causes a short-lasting but very convincing **alteration of reality** that does not have to be entirely wrong to make things even more complicated. The projection is behind every crush we ever had, and eventually will have. Just try to remember how you perceived your sweetheart during the first month of the relationship. How beautiful and perfect they were, although your friends and parents might have had a different opinion. Of course, there is nothing wrong with the crush itself. It seems to be the most frequent first step toward a long-term relationship or even a lifelong marriage in contemporary western society, where romantic love is the primary relationship entry point. However, most projections cause problems. If the only picture projected was perfection, the only adverse outcome will be a disappointment when the projection eventually falls apart. Remember what Freud wrote: the projection primarily serves as a defensive mechanism of our ego. Our imperfections and complexes, too painful to be accepted as an integral part of ourselves, are projected onto others to lower the pain caused by those hidden complexes. Our shortcomings remain covered, but relationships suffer—being surrounded by such losers sucks, right? Even though the one who, in this case, sucks is... us. A similar, but not quite the same problem with the mental model is the human tendency to confuse the mere mental model with reality. "I have seen it with my own eyes," serves as indisputable proof, even in the courtroom. The situation of seeking the truth and proving it "beyond a reasonable doubt," based on witness testimony, is even more convoluted. More than a hundred so-called cognitive biases have been described, explaining difficulties both in perceiving and recalling stored perceptual information from memory (Susta 2022). I'm sure you've known most of the cognitive biases for a long time, you just might not have known that legions of doctoral candidates in the humanities have developed (unfortunately biased) cognitive biases taxonomy. And not only have they developed one, but they are still working on newer versions to adapt to current social discourse. Still, it's good to know about the **bystander effect**, when the odds of someone helping someone in need decrease with the number of

bystanders in a given location. It doesn't hurt to know the **Texas sharpshooter fallacy**, in which a false impression is created by the application of *ex-post* rules because, in the story that gave this distortion its name, the target is painted onto a particularly appropriate group of random hits thus giving the **impression** that the target was shot by a gunslinger. In the world of public health, for example, this means picking a random group of symptoms and then inventing a disease to go with them. The biases and fallacies that are particularly relevant to our topic will be addressed in the following text. They will not always be named according to the latest nomenclature, but the meaning should be obvious.

Fig. 2-3 Multi-stable perception. Drawing by the author.

Cognitive psychology teaches us that belief can be interpreted in many different ways, and deciding what is best or more correct is challenging. Try it for yourself in Figure 2-3. One group of viewers sees the young girl with her head turned left and slightly up, while others claim there is a big-nosed old lady in the picture. Who is right, and who is wrong? Will you join one of these groups or create an entirely different explanation of the figure's content or its meaning? Alternatively, do you see both ladies and have no problem switching between these two? Yes, both groups are right. Our perception will stay locked on the **prime meaning**, or we may be able to "switch" between various image contents. In the latter case, what matters

is what we **want to see**. There are many examples of multi-stable perception, including the famous chalice and Necker's cube (Ta'edd, Ta'eed, and Wright 1988), and they all have something in common[3]. Any attempt to describe its **whole meaning** unequivocally fails. If the question is "what do you see there?" the answer might be unambiguous but **far from exhaustive**. The honest approach to communication with others and also to ourselves consists of the belief that everything we based our decisions on is just a **mental model** of reality, **not the reality itself**. Even the text you are now reading is based on the author's mental model and therefore is far from perfect or complete no matter how hard he has been trying. Yes, **our mental models are incomplete**. Before the information reaches our memory, it passes through many filters; information gets edited according to our previous knowledge and experience; emotion evoked by perception modifies the final model's shape. The affect associated with the first processing of a stimulus remains associated with it in the future. Again, the rule of two sides of the same coin applies. On the one hand, this is advantageous, because we associate certain situations and sensations with danger, pain, and shame; on the other hand, it is one of the causes of the difficulty in treating conditions caused by overly strong sensations, from which, for example, post-traumatic stress disorder develops. All it takes is similar lighting, an olfactory sensation, or a sound of a certain frequency, which leads to flashbacks and the reliving of a traumatic experience stored deep in the memory (Bizik and Susta 2012).

This rule also applies to the people around you. Making people around you angry is simple if you know which buttons to press. You'll undoubtedly know the Achilles' heel of your partner, parents, children, or friends. Some of these are person-dependent, which means it works only for the right individual. My colleagues don't mind if I put my feet on the lab table or don't wash my EEG caps. But when I start talking about diagnosing psychopaths, it always ends in a life-and-death argument. William Blake once wrote, "To generalize is to be an idiot" (Blake, Erdman, and Bloom 1982), but let me ignore this warning for a while and generalize anyway. Namely, wannabee intellectuals are sensitive to situations when someone **challenges** their mental models. Those perceived to be experts in one field tend to consider themselves experts in **everything**. For example, politically active actors, who are, at best, experts in repeating shorter or longer portions of texts written by someone else, tragically fail to prove real insight into the causes of, and even less

[3] An image illustrating bistable perception, depicting either a chalice or two faces or a Necker cube, can easily be found on the Internet by typing in the term "bistable" or "multistable perception".

into solutions to, the world's problems. Thanks to commonly present narcissistic personality disorder combined with an **external locus of identity**, seasoned by a cognitive bias described by Dunning & Kruger, they have no idea how ignorant they appear in the eyes of those who really do know[4]. Even those considered "genuine intellectuals", worshiped by crowds of followers, are eventually unmasked as frauds (Johnson 1988). Tell college graduates that their mental model is incomplete or fuzzy and their reaction is often furious! A threat to the narcissistic component of someone's personality calls for revenge. You might argue that this is not just a problem of youth: middle-aged people tend to react in the same manner. Maybe so, but I am currently over 40 and trying to prevent friendly fire... Have you ever heard of a **self-fulfilling prophecy**? The sentence "I am ugly, and my mom dresses me funny", if taken seriously, ends up in behavior modification matching the statement. Another attribute of mental models is **self-reinforcement**.

Fig. 2-4 A place where I do not want to live. David points to a hole where a house used to be before the crime spree wiped it out...

The mental model that forms **prejudice** serves as an example. You may claim that as a modern person you have no prejudices, but it is very easy to convince you otherwise. Try answering the question of what emotions are triggered in you by people who **have** prejudices. Many hate fighters are filled with hatred for those who write hateful comments on the internet. If you are a freedom worshipper, you obviously don't love etatists. You'll find that prejudice is a **generalized experience**, either our own or that of

[4] The discovery of the two authors, for which they were deservedly awarded the Ig-Nobel Prize, describes the relationship between ignorance and self-esteem. The guys showed that the highest levels of self-esteem are usually found in people who have for it the least objective justification.

our ancestors and educators. Many prejudices undoubtedly have an adaptive function. Persons from another tribe are to be kept away from. There may be another Nobel Prize winner in medicine among them, but experience tells us that the risk of contact could be too great. Those who grew up in totalitarian regimes are wary of situations where someone is trying to impose "correct" patterns of behavior on them or even trying to ban certain words or thoughts. People with a bad experience with foreigners will generalize their experience and behave distantly towards all foreigners for fear of repeating the traumatic event. The "Better safe than sorry" rule was created during both phylogeny and ontogeny and cannot be effectively abolished by law or re-education because there is little to nothing to replace it. Experience teaches us that some differences between age groups, cultures, and ideologies are insurmountable because they shape the answer to the question: "What am I, what positions do I hold and what am I striving for?" You might be the one supporting the oppressed. The **enantiodromic nature** of this world forces you to **oppress oppressors**, thus becoming one of them. But oppressing the oppressor is something else, isn't it? Can you write on a piece of paper the consequences of oppressing oppressors? You will find that you have written, without exception, the reasons why such behavior is **good**. Negative consequences are unlikely to be on your list. They would in fact contradict the currently dominant mental model. Suppose there is a prejudice against elderly citizens. We will, therefore, tend to ignore images of jolly, sapient grandpas and grandmas playing with their grandkids because such a view goes against the mental model of "terrible old geezers". An old lady on the bus aggressively demanding a seat is a different story. We will actively search for such evidence because it confirms the need for an "old people should not be allowed in public" policy and prove that our view of the elderly is correct. All human interactions have the same foundation. Colleagues, students, kids, or partners, **no one is safe from mental models**. George Bernard Shaw's quote, "The only man who behaves sensibly is my tailor. He takes my measure anew every time he sees me, while all the rest go on with their old measurements and expect them to fit me", tells the same story. Our mental models not only cover people and human communication. Streets, suburbs, cities, nations, countries, organic and inorganic substances, physical or spiritual. All this, and who knows what else, stimulates the formation of our mental models.

A famous Czech hockey player almost spent several years in a big city in Michigan. I know that many people from my country envied him, and dreamed of their own lives there. Have a look at Figure 2-4. The picture was taken in one of the city suburbs, where until a few years ago the

neighborhood was inhabited by families consisting of working parents and their offspring before the place was hit by a wave of unemployment and crime, and the ruined, dilapidated houses had to be demolished. Now nothing stands in their place. The city of dreams became a place with almost 300 homicides per 100,000 people in 2008 and had one of the highest crime rates in the USA (Jarvis 2008). This is in stark comparison with the Czech Republic, where the number of homicides per the same number of people is 1 (Hignett 2006). Guess how my mental model of safety in Michigan looked before the event shown in Figure 2-5 took place.

Fig. 2-5 Into the wilderness - my protection detail on the right.

To stay on the safe side, my "US parents" were with me; Al was a great shot, and Mary raised three sons. Surrounded by brave ones, I crossed the magic line between Wisconsin and Michigan to find out that my mental model "Michigan = keep-out" had to be **replaced** or at least **updated**. If you think the **negative** mental model gets **updated automatically** with each new (even positive) experience, then you are wrong. Again, the mental model tends to reinforce itself. How, in this case? If everything went as usual, my trip to Michigan would be more like searching for potentially dangerous places, people, animals, and situations. Why? Only a bad experience, dirt, and decay would reinforce my mental model of a dangerous Michigan, created by reading statistics and seeing a picture of a demolished suburb. And mental models need to be reinforced because if

we are forced by circumstances to update, change or even turn them inside out, it means **we were wrong**. And admitting a mistake is quite a difficult operation for the ego. I am not trying to say that Michigan is Heaven on Earth, but my previous conception was, in essence, inaccurate. Whether it is a false positive or negative does not matter, the important thing is that the mental model is **always noisy**. Let's make a slight neuroscience detour. Look at Figure 2-6. It depicts visual pathways—the ways from which we all get the visual portion of mental models. It originates from the retina (RT) and goes to the primary visual cortex (V1) via the thalamic (TH) lateral geniculate nucleus (LGN).

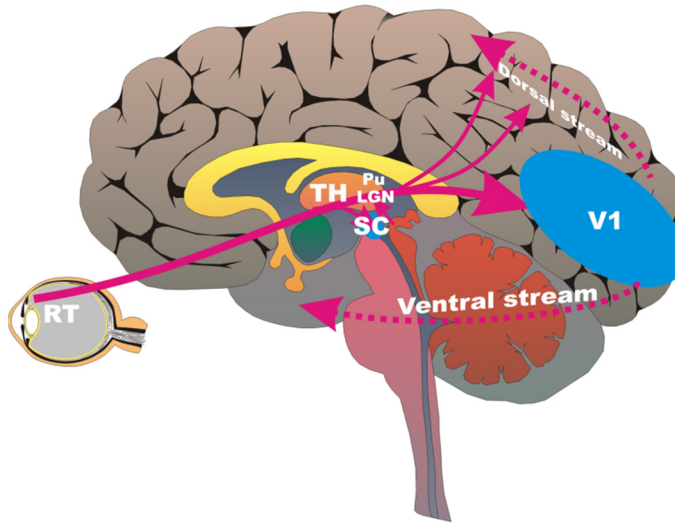

Fig. 2-6 Simplified diagram of visual pathways.

The information from the visual cortex (V1) reaches the extrastriate cortex along the occipitotemporal (Ventral) and occipitoparietal (Dorsal) stream. Other fibers originating from the same source (RT) follow the route into the superior colliculus (SC) and Pulvinar (Pu). The signal goes directly into the extrastriate cortex from these two sites, bypassing the primary visual cortex (V1) (Tamietto and de Gelder 2010). Isn't that a pretty neat and vibrant mental model? It might seem so, but only if you know nothing about neuroscience. The neuroscientist is missing something: the third pathway, independent from the primary visual cortex, formed by direct connections between the superior colliculus (SC) and lateral geniculate

nucleus (LGN), sending efferents to extrastriate cortices of the dorsal stream. Did you miss this information about the third pathway as much as I did? No matter your answer, the story, from a mental model's point of view, remains incomplete anyway. Yes, the information on the **emotional side of perception is missing**! Why is that important? Well, let's look into the circuitry first and draw conclusions later. The so-called "emotion system" includes both cortical and subcortical areas and even the brainstem. Figure 2-7 shows connections between the amygdala (AM), substantia innominata[5] (SI), nucleus accumbens (NA), brainstem nuclei locus coeruleus (LC), and periaqueductal gray (PAG). Other connections lead from the amygdala to the anterior cingulate cortex (ACC) and orbitofrontal cortex (OFC).

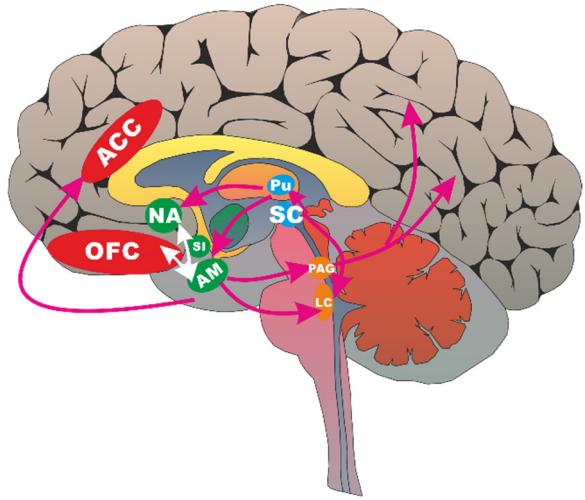

Fig. 2-7 Simplified emotional pathways.

In particular, the subcortical structures of visual and emotional systems are considerably interconnected; note the arrow from the superior colliculus (SC) through the pulvinar (Pu) into the amygdala (AM) and nucleus accumbens (NA). So far, we have been describing systems involved in so-called "non-conscious perception", and we did it on purpose. Only a **fraction of sensory input** activates **conscious perception**. Filtering out

[5] Many cells in the human body and even their components are named after someone. Don't you agree, Mr. Golgi? Do you also wonder what's wrong with the *substantia* ***innominata*** that no one has claimed it yet?

what is irrelevant for conscious perception is a function mentioned earlier—**selective attention** (Posner 1994). Evidence shows that visual stimuli that lie outside the focus of attention become **attenuated** or **abolished** (Mack and Rock 1998). When there is a task with attention resources involved, cortical activity evoked by task-irrelevant stimuli becomes suppressed by frontoparietal areas (Beck et al. 2001). However, there is one crucial exception: **emotional triggers**. With emotions involved, the task gets the **highest priority**.

It does not mean that all stimuli packed with emotions will stop or reroute any task at hand, but even "ignored" emotional stimuli interfere with processed information, delay disengagement of attention, and are easier to detect (Ohman, Flykt, and Esteves 2001). The last sentence might mark the end of the detour we took a page earlier. None of the nuclei names and pathways matter much in our story, but the pathway description teaches us valuable lessons. Not everything is perceived consciously: **perception is selective**, and stuff containing emotions has high priority when processed. The aforementioned happens mostly when something **sacred** is touched. What is kept in the inner *sanctum* of your mind and gets protected the most? Religion? Ideology? An ideology calling itself a religion? An ideology that became a religion? Family? Capitalism? Socialism? Communism? Some other "ism"? Probably we all have something that is considered taboo, something off-limits. These beliefs or mental models are the **hardest to change** or even touch. When dealing with something that challenges the sacred, one is always skating on thin ice. Why? These mental models remain **heavily loaded** with emotions. The lack of evidence on many untouchable topics is immediately solved by substituting one fantasy for another, which one tries to pass off as "scientific" without any pretense. Just as experimentally unverifiable as the first one, of course. When people operate at this level, it leads to interesting phenomena. I overheard somewhere in the media an interview with a group of people who claimed that the superiority of some physical property was responsible for their miserable lives. I didn't understand the mechanism by which this was supposed to happen, but after all, that is not important in ideological proclamations. Ideology is easily recognizable, as it always defines something or someone **external** as *radix omnium malum* and claims that this something or someone must be eradicated or at least outlawed to put things back in order.

Remember that even most of the "scientific" findings are based on the (almost always) invalid *ceteris paribus;* an assumption that, "all other parameters except the one under study remain constant", and, therefore, have **little to do with reality**. The result of our thinking could take many

forms—verbal, nonverbal, written, painted, musical, or a combination of all of the above. Figure 2-8 shows the results of a research outcome published in a highly respected journal (Garman et al. 2008a), giving hope to patients with colon cancer, predicting the outcome of treatment, and improving treatment prognosis. The result looks great, almost dreamy to those who work in the field. The truth is that the paper had to be **retracted** by authors who later gave this explanation: "We wish to retract this article because we have been unable to reproduce certain key experiments described in the paper regarding validation and use of the colon cancer prognostic signature. This includes the validation performed with dataset E-MEXP-1224, as reported in Fig. 2A, as well as the generation of prognostic scores for colon cancer cell lines, as reported in Fig. 4. Because these results are fundamental to the conclusions of the paper, the authors formally retract the paper. We deeply regret the impact of this action on the work of other investigators" (Garman et al. 2008b). The formal educational process taught us **to believe the written**; the urge to trust is unyielding when the information takes a form of a scientific paper.

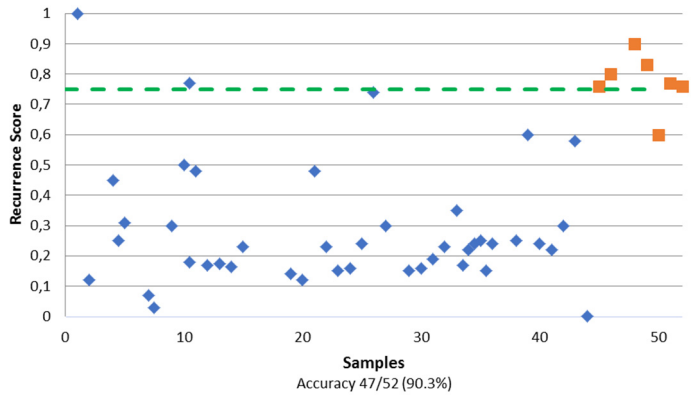

Fig. 2-8 Accuracy of the 50-gene model. The model successfully predicted recurrence in 90.3% of cases. All but one patient (in red) had a high recurrence score above 0.75 green threshold values. Similarly, for all but two disease-free patients (in blue), the method predicted accurately. Reconstructed by the author.

Nobody knows how many research teams the article misguided, how many hours of pointless work repeating the made-up experiment, and how much money and burned hopes because of someone who wanted to make a shortcut to success. This pattern is not exclusive to biological research, although my wild guess would be that more than 50% of published

research results are **pure fraud**, not counting cases where misleading results were a product of poor knowledge of statistics combined with unsubstantiated self-esteem. And to make things even sadder, my guess is not totally wild: I serve as an editor for some scientific journals and so I know generally used practices for scientific publishing from my own experience. If we move away from regular research, where the work should be at least peer-reviewed at some level, results get even less reliable. Yes, the product of our thought could take many forms. Those who end up written on the piece of paper are given special attention and automatically gain at least some trust level. That is why even hoaxes go viral so fast when written. "The pen is mightier than the sword", says Cardinal Richelieu in a famous play (Richelieu; Or the Conspiracy), written by Edward Bulwer-Lytton (Gould 1867).

Technology has evolved substantially since Richelieu, but the **power of the written** word remains the same. If you want to increase the power of the story even more, **add a picture** to support the message. An old French proverb says, "paper bears anything". Is that true? If you need proof, look at Figure 2-9, which shows an "impossible construction".

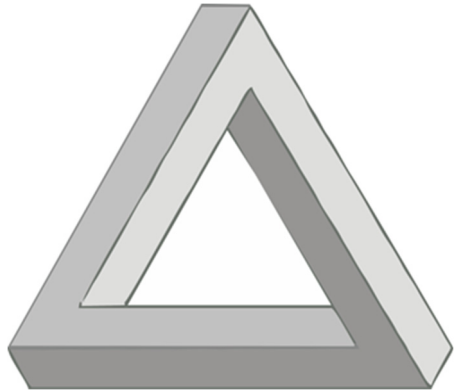

Fig. 2-9 One of the most famous impossible constructions, created by Lionel Penrose and known as the "Penrose Triangle".

It could be drawn on a piece of paper, but the picture throws the perception of reality into question. Our brain forces our eyes to focus on one of the apexes and refuses to accept a shape so inconsistent with the common understanding of 3-D space as a whole. Things like that could be painted or written but cannot exist in physical form. In the case of Figure 2-9, the reason why is apparent. The artist did not take into account the

specific limitation of 3-dimensional space. The rule “do not waste time” is easy, and anyone sensible will not put money or effort into producing something that cannot work correctly or exist at all. But not all cues are easily identifiable. Figure 2-10 shows the result of a fascinating intention (Piodalcin 2009). Who knows what was on the toilet installation progenitors’ minds or what were humble executioners of their will thinking. What is the purpose of such a design? A relief point for someone with two urethras forming a 90° angle? This case belongs to another category. Things that **serve no purpose** or **require non-essential costs** are much more frequent in our world. In the first instance, a misperception of reality might describe Figure 2-9, but what about Figure 2-10? Why not hold back our emotions and conclude that the reason was just pure incompetence? Its opposite, competence, defined as “the ability of an individual to perform the particular job accurately”, was probably taking a sabbatical—perhaps not entirely, because the setting might at least partially serve its purpose, but it feels like a bit of overkill. On the other hand, the setup might make perfect sense. Hard to believe? Well, there actually is a rare medical condition called *Diphallia*...

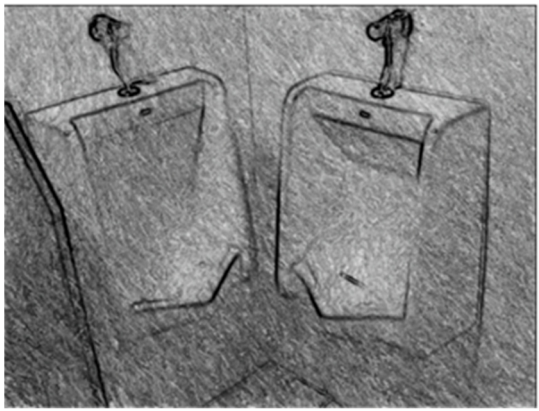

Fig. 2-10 Insane construction. Search the Internet for the original photograph of this plumbing mystery. Drawing by the author.

Things that can't be built or ideas that can't work properly in the real world are a nightmare for any thinker. Ideologies of all kinds are a great example of such impossible construction. It may look good on the surface, but authors often forget to take something important into account, either human nature, which seems to be constant since the beginning of time, or some other factor or factors that eventually cause the original idea to

remain unworkable or end in bloodshed and general misery. It almost seems, in retrospect, that no author has been able to grasp all the **essentials** and see the **consequences** of the proposed measures. Our ancestors often said that there are two sides to every coin. Certain types of prejudice or generalization **might limit the implementation of something new** but could also be an integral part of a **defense mechanism** against policies or patterns of behavior that have been proven **deadly** by our own experience or the experience of our ancestors. Some mental models prevent us from gaining deeper knowledge and should be changed, while others protect us from danger and should be left untouched. “Potassium cyanide will kill you”: there is a good reason to believe that, do not try it yourself. Those who have died for our present freedom on the battlefields have proven that sometimes it is necessary to give one's life for freedom, and whoever wants to deprive us of our freedom and force us to live in slavery is our mortal enemy. The question is how we treat the freedom that we did not win but was handed to us. And perhaps this is true in general, not only of freedom but of all things. Are we able to learn from the failures of our predecessors? Or at least from our own mistakes? Those who cannot remember the past are condemned to repeat it, to quote Georges Santayana. The issue is much more complex than it might seem at first glance. Howard Temin could tell you (Temin and Mizutani 1970). He dared to claim that Crick's central dogma may not apply universally. For many years he was considered a fool but ultimately won the Nobel Prize in Physiology or Medicine. The story of puerperal sepsis in the introduction to this book teaches us the same thing. How, then, to distinguish which entrenched view makes sense to challenge and which makes it pointless to rebel against? One of the goals of this book is to provide you with a tool that makes such a decision easier. I wonder if, after reading the following chapters, you will pronounce that goal achieved.

The **general competence** required in various areas of human activity as defined by common sense is not what this book is about. Proficiency in mathematics, medicine, the economy, and philosophy are subjects of specialized training that took or takes place in your life and will help you to absorb everything that follows. To understand the reality of Public Health, we need to focus on competency which is not part of the standard curriculum of university courses.

This introductory talk about mental models is just a preparation for challenges connected to healthcare policies that are about to be exposed in this book. Knowing that our reasoning comes from **fuzzy**, **incomplete mental models** and (naturally unreliable) **emotions** rather than knowledge is good enough to keep our ego from unfounded expansion. But awareness

of human decision-making limitations does not itself help to gain deeper insight into any field. A deep understanding of how complex systems operate has nothing to do with any **analytic method** you have seen in school. It requires a specific mindset and skills that allow "ingesting" the whole system without breaking it apart. If you try to do that now, you will discover a massive gap (or even a Big Emptiness) in your **systems thinking skills**. All public policies are intended to **manage** or **change** large systems. One cannot skip acquiring basic systems knowledge and go straight to designing policies that will succeed. The subject of Public Health is too sensitive—it naturally touches the most sacred societal and personal phenomena—**life**, **pain**, and **death**.