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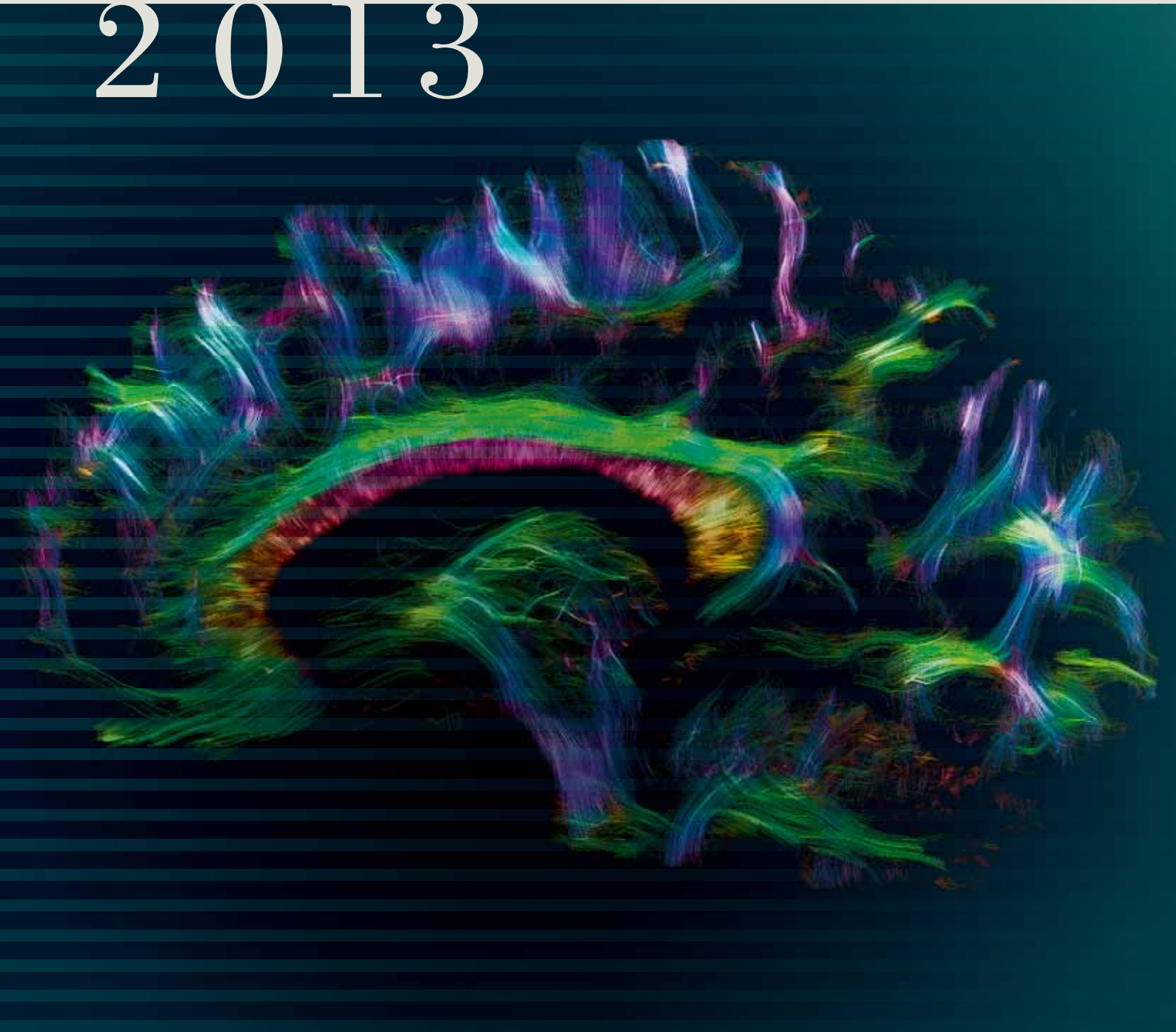

IMPRESSUM

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TITELBILD
Das Hirn als Netzwerk – Wissenschaftler am MPI für Kognitions- und Neurowissenschaften in Leipzig erforschen das Netzwerk der Nervenzellen im Gehirn: Mit aufwändiger Technik gelingt es, am lebenden menschlichen Gehirn die anatomische Vernetzung der Hirnareale abzubilden. Dafür wird mit der sogenannten diffusionsgewichteten Magnetresonanztomographie die Bewegung von Wassermolekülen im Gehirn gemessen, die entlang der Nervenbahnen auftritt. Mit einer mathematischen Modellierungstechnik, der Traktographie, kann man daraus den Verlauf der Nervenbahnen darstellen. Die Wissenschaftler erkunden damit ein Grundprinzip des Gehirns: Schon lange weiß man, dass bestimmte Bereiche des Gehirns für bestimmte Funktionen „zuständig" sind. Diese funktionelle Segregation kann allerdings die erstaunlichen Leistungen des Gehirns nicht erklären, da die psychologischen Funktionen eng miteinander verknüpft sind, Handlung, Emotion und Aufmerksamkeit etwa hängen voneinander ab. Daher muss es auch eine funktionelle Integration als zweites wichtiges Prinzip geben – und diesen Verknüpfungen des Gehirns sind die Leipziger Wissenschaftler auf der Spur.

Die Daten stammen aus dem Siemens Ultra-Hochfeld 7 Tesla MRT-Scanner der Abteilung von Robert Turner, bei den Messungen wurde eine neue MRT-Sequenz angewandt, die eine hochauflösende Messung von kreuzenden Nervenfasern ermöglicht. Das Bild zeigt einen sagittalen Ausschnitt der rekonstruierten Verbindungen mit einer Farbcodierung der Richtungen: rot: links-rechts; grün: anterior-posterior; blau: superior-inferior.

Hauptsächlich beteiligte Wissenschaftler: Alfred Anwander, Robin Heidemann, Thomas Knösche und Ralf Schurade aus den Abteilungen von Robert Turner und von Angela D. Friederici.

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COVER IMAGE
The brain as a network – Scientists at the MPI for Human Cognitive and Brain Sciences in Leipzig research the network of neurons in the brain: Using sophisticated technology, they are able to visualise the anatomical connectivity of the different areas in the living human brain. A technique known as diffusion-weighted magnetic resonance imaging is used to measure the movement of water molecules in the brain which arises along the nerve pathways. Based on these data, the course of the neural pathways can be visualised using tractography, a mathematical modelling technique. The scientists use this approach to investigate a basic principle of the brain: It has long been known that certain areas of the brain are "responsible" for certain functions. This functional segregation, however, cannot explain the extraordinary work done by the brain, as the psychological functions are closely connected with each other: action, emotion and attention for example are dependent on each other. Therefore, functional integration must also exist as a second important principle - and the Leipzig-based scientists are hot on the trail of these connections in the brain.

The data originate from the Siemens Ultra High Field 7 Tesla MRI Scanner in Robert Turner's department. A new MRI sequence was applied for the measurements, which enables the high-resolution measurement of crossing nerve fibres. The image shows a sagittal section of the reconstructed connections with colour coding of the directions: red = left-right; green = anterior-posterior; blue = superior-inferior.

Main scientists involved: Alfred Anwander, Robin Heidemann, Thomas Knösche and Ralf Schurade from Robert Turner's and Angela D. Friederici's departments.

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RALPH HERTWIG
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Living on the volcano: how people reckon with risks

"You could hear the shrieks of women, the wailing of infants and the shouting of men … and there were some who prayed for death in their terror of dying. Many besought the aid of the gods, but still more imagined there were no gods left and that the universe was plunged into eternal darkness for evermore." With these bleak words Pliny the Younger described the fatal catastrophe he witnessed in 79 AD, when a massive eruption of Mount Vesuvius buried the cities of Pompeii, Herculaneum and Stabiae under a shroud of ash and lava stone several metres thick. But this was by no means the most violent eruption of Mount Vesuvius in recorded history. An even more cataclysmic eruption occurred in 3780 BC, during the Bronze Age. In recent years, volcanologists have been carefully studying the "footprints" left by that eruption, because it could represent a worst-case scenario for the future. If that scenario should ever occur, the consequences for Naples – the largest metropolitan area in the world situated so near an active volcano – would be horrendous. At least three million people live in an area that remained uninhabitable for many centuries after the Bronze Age eruption. For years now, volcanologists have been warning of a new eruption. They believe that one is inevitable; it's just a question of when. The destructive force would likely be far greater than that of the eruption that destroyed Pompeii. According to these experts, seismic data reveal the presence of a vast magma reservoir lurking below the volcano.

And this brings us to a phenomenon that perplexes politicians and intrigues risk researchers: all attempts on the part of the Italian government to resettle people living in areas that are particularly at risk have been in vain. Why is that? A simple explanation would be that the inhabitants are simply in denial of the risk to which they are exposed. In which case, the Neapolitans are not alone. For many years, risk researchers have been trying to get to the bottom of a similar phenomenon in the United States. For example, people living in areas particularly threatened by hurricanes and floods often have insufficient insurance cover or none at all.

Contemplating the future of the then freshly penned US Constitution, Benjamin Franklin wrote in the year of the French Revolution: "Nothing is certain in this world except death and taxes." What he was saying is that nearly everything in life is uncertain and beset with risks. Indeed, there is no shortage of threats in today's world: the increase in extreme weather events, the danger of new epidemics as a result of global warming, the risks posed by various technologies, new forms of international terrorism (such as bioterrorism and cyberterrorism) and health risks brought about by the obesity epidemic, to name but a few. Nothing is certain except death and taxes. Given the ubiquity of uncertainty in our lives, the following question arises: how do people perceive risks, dangers and threats, and how do they react to them?

NOTHING IS CERTAIN EXCEPT DEATH AND TAXES. GIVEN THE UBIQUITY OF UNCERTAINTY IN OUR LIVES, THE FOLLOWING QUESTION ARISES: HOW DO PEOPLE PERCEIVE RISKS, DANGERS AND THREATS, AND HOW DO THEY REACT TO THEM?

Scientific evidence about what we fear and why, and indeed why we don't fear certain "killers", can help to predict how people will react to risks old and new. This is becoming a matter of urgency, particularly since depleted state coffers and exploding healthcare costs mean that resources to contain risks and their consequences are limited. Politicians and voters alike have no option but to make decisions – hopefully sustainable ones – to prioritise scarce resources. So just how well can the public assess risks accurately?

There are various ways to measure and evaluate how accurately or inaccurately people assess risks, and any systematic distortions that occur. One direct method is to investigate how well people are able to spontaneously assess the risks of death and disease. In other words: How good are our intuitive mortality tables? Do more people die from heart attacks or in car accidents? Do more people develop lung cancer or bowel cancer? Are more people killed by firearms or by air pollution? Earlier research concluded that people systematically misjudge mortality risks. Measured against the statistics on causes of death compiled by the German Federal Statistical Office, for example, people tend to overestimate relatively rare risks (e.g. death due to whooping cough), while underestimating relatively common risks (e.g. death due to diabetes). Those risks that attract great media attention (e.g. death due to plane crashes, shark attacks and Creutzfeldt-Jakob disease), in particular, tend to be greatly exaggerated. These distortions are thought to be caused by a psychological inference mechanism which interprets a greater subjective "availability" of deaths in memory – one reason for which may be the amplification of such deaths in the media – as indicating a high objective rate of deaths. The underlying logic is: "If I can call up a large number of deaths due to cause X from my memory, X must be a common cause of death."

THOSE RISKS THAT ATTRACT GREAT MEDIA ATTENTION (E.G. DEATH DUE TO PLANE CRASHES, SHARK ATTACKS AND CREUTZFELDT-JAKOB DISEASE), IN PARTICULAR, TEND TO BE GREATLY EXAGGERATED.

These findings have often been interpreted to mean that the public's estimates of risk are distorted and irrational. However, new research, notably investigations conducted at the Max Planck Institute for Human Development, sheds new light on these findings. For one thing, the overestimation of rare risks and the underestimation of common risks is not necessarily the result of a systematic judgement error. This pattern can also occur due to unsystematic error variance in subjective judgements leading to a statistical effect known as regression to the mean. As a consequence of this effect, people's estimates will tend towards the average value of the mortality statistics. Such an effect occurs if two variables – in our example, the objective mortality statistics and the subjective estimates – do not correlate perfectly with each other. Because a perfect correlation is highly unlikely (even the official figures are bedevilled by sampling errors and unreported cases), the overestimation of rare risks and the underestimation of common risks is an inevitable consequence of uncertainty and unsystematic variance.

Recent research also shows that people's intuitive estimates of mortality risks and incidence rates can be surprisingly good if they infer population statistics from the small sample of deaths and illnesses within their proximate social network. Within the circle of one's family, friends and acquaintances, more people tend to die from a heart attack than fall victim to a violent crime, as is also the case in the population at large (e.g. the entire population of Germany). By contrast, conclusions based on media reports tend to be wrong, because rare but dramatic diseases and causes of death receive a disproportionate amount of attention. They are viewed, as it were, through the magnifying glass of the media. One example is mad cow disease (BSE). In 2000 the term was on everyone's lips and the press reported relentlessly on the potential dangers posed by a new strain of Creutzfeldt-Jakob disease that is fatal in humans. Yet according to risk researcher Ortwin Renn of Stuttgart University, no one in Germany has yet died from this new strain.

Research into our intuitive statistics of risk frequencies is important. Such intuitive judgements tell us something about the subjectively perceived probability of risks occurring. In addition to this probability component, however, it is also important to consider the potential damage – at least according to the common technical definition of risk as the potential for damage such as injury, death or disability, weighted by its probability of occurrence. Evaluations of the damage component are also strongly affected by psychological factors, as illustrated by people's responses to the following question: People can die of a wide variety of different cancers, such as breast cancer, testicular cancer or gastric cancer. Assuming for the moment that only one single person dies per year from each form of cancer (meaning that the mortality rate is hypothetically kept constant for all cancer types), how much should the government spend to prevent this one death per cancer type? Findings show that not all deaths due to cancer are felt to be equal. For example, on average, the respondents allocated three times as much to prevent death from bone cancer than to prevent death from liver cancer. This and similar findings highlight one thing: people's subjective evaluations of risks to health and life are not only based on the actual objective risk but are also shaped by psychological factors.

Risk researchers have identified two fundamental dimensions that characterise our subjective risk perception. The first relates to the decision maker's familiarity with, and awareness of, risks. Events, activities and technologies that are well known and observable, whose risk is known to the decision maker and whose effects occur immediately, are generally felt to be less risky. One example is the risk of dying in a road traffic accident. By comparison, new phenomena that are difficult to observe, whose threat is not obvious to the person and whose consequences are delayed, are judged to be more risky. Examples here are the pandemics triggered by the much discussed bird flu or swine flu viruses. In very simplified terms, this first dimension can be reduced to the opposing poles of "known" versus "unknown". The second dimension relates to the dread elicited by a risk. The more an event has immediate devastating consequences resulting in the simultaneous death, disease or disability of many, the more we appear to dread it. By contrast, risks that claim lives over a long period, one after the other and in a far less spectacular fashion, elicit less fear. The more stealthily death stalks, the less fear it arouses in us. Dread risks, by contrast, seem to cast a spell over us. One possible reason is that our risk perception is shaped by evolutionary forces: threats that jeopardised the survival of an entire group were more existential than constant threats to individuals, even if the death toll in both scenarios was the same.

As a result of these two dimensions of human risk perception, experts, the public and politicians often assess the threat potential of a risk differently. Sucharit Bhakdi, head of the Institute of Medical Microbiology and Hygiene at Mainz University, recently noted:

"To avoid one vCJD victim [variant Creutzfeldt-Jakob disease], Germany reportedly spends at least one billion euros ... On the other hand, funds are lacking for laboratory tests to identify the viruses causing pneumonia and encephalitis in hospital patients, where far more people could be saved by the investment of relatively small amounts than by the measures to combat BSE."

The dilemma is as follows: even if the public's intuitive risk assessment is by no means as irrational as it was made out to be by early research, certain dread risks can elicit strong emotional reactions, irrespective of how rarely or frequently they occur. Looking through these emotional glasses, we then judge what resources the government and society should devote to reducing the risk in question. There is thus a real danger that some of the limited public resources will be misallocated – to fight threats that subjectively appear dangerous but that are objectively less likely to kill us than other threats to which we feel less vulnerable.

How can this dilemma be resolved? Firstly, the insights of risk researchers allow us to explain the psychological mechanisms of risk perception to the public, thereby helping to transform the risk society into an informed society. Secondly, the findings allow us to improve the public's risk competence. One aspect of risk competence is a healthy scepticism towards media reports: intuitive risk assessment is often better when it is based on experiences in one's own social network than on a media-distorted reality. Another aspect of risk competence is the ability to see through and challenge emotional reactions to dread risks, read terrorism and pandemics. And not least of all, risk competence includes the ability to understand statistical information about risks, especially if it is wittingly or unwittingly communicated in opaque ways.

However, education and information are no panacea. The apparent insouciance of the Neapolitans is a case in point. Why do the dire warnings of volcanologists fall on deaf ears? Shouldn't they be taken especially seriously? The impending eruption of Mount Vesuvius does not pose a threat to isolated individuals over a long period of time. It threatens to destroy the existence of many in one fell swoop and is therefore more of a dread risk than a familiar, chronic risk. Only recently have researchers found a possible answer to this and similar paradoxes, not least thanks to research conducted at the Max Planck Institute for Human Development. The starting point of the underlying research is this: There are various ways in which people gain knowledge about the innumerable risks posed by the modern world: parents warn children about fast-moving cars; our experience warns us about hot stoves, slippery ice, sharp knives and angry, alcohol-fuelled young men; leaflets warn us about the dangers of alcoholism and unsafe sex. Irrespective of these various information channels, however, it is possible to distinguish knowledge about risks gained through a description of the risk from knowledge gained through one's own experience.

We encounter information about, or warnings of, risks everywhere – in newspapers, on the internet, in weather reports, in health brochures, in the patient information leaflets that come with medicines. Usually symbolic representations are used, for example in the form of a stated probability or message. This is the great strength and, at the same time, the great weakness of descriptive warnings. Symbolic descriptions can be used to inform many people about a threat simultaneously, without the individuals necessarily having to experience the risk themselves. Warnings on cigarette packages symbolically convey the risk of smoking, though in a non-quantified form: "smokers die younger" or "smoking causes fatal lung cancer". Volcanologists describe the annually increasing risk of a massive eruption of Mount Vesuvius. Climatologists warn against the medium- and long-term effects of climate change. Doctors communicate the advantages and risks of cancer-screening procedures in the form of descriptive statistical information. Brochures and webpages do the same for parents wanting to learn about the advantages and disadvantages of vaccinations in early childhood or about secondary school drop-out rates.

THE MORE STEALTHILY DEATH STALKS, THE LESS FEAR IT AROUSES IN US. DREAD RISKS, BY CONTRAST, SEEM TO CAST A SPELL OVER US.

Yet not only do the Neapolitans hear the expert warnings and assessments, they can also have their own personal experience of living near the volcano. And their experience and the experts' warnings don't speak the same language. Their experience essentially conveys the following message: we've

always lived here and nothing has ever happened. And it's true, the last eruption of the volcano was in 1944. The Neapolitans have so far been spared the disaster feared by experts and communicated through descriptive warnings. The same applies to the consequences of climate change. For many central Europeans, experience and description are (still) poles apart. They learn that climate change is occurring through expert warnings, TV and newspaper reports and peripheral events, but they don't yet experience it in their immediate environment, at least not in such a way that the signal of climate change is easily detectable amid the noise of random fluctuations around the central trend. Similarly, most long-term smokers believe, based on their experience, that smoking is harmless – until it's possibly too late.

The crucial point is this: many investigations into how people make decisions about risks show that the communication of relatively unlikely risks through symbolic representations can result in such risks being given more weight than they deserve based on their objective probability. SARS, BSE and the millennium bug may have gained their notoriety that way. But as soon as people's reaction to rare risks is based not only on symbolic information but also on their experience, their risk appraisal becomes relatively realistic, especially if their fund of experience is very large. This is not always the case, however. In the case of black-swan events – highly consequential events that are so rare that they don't appear even in large samples of experience (e.g. a global economic crisis or an extremely rare volcanic eruption) – our limited experience tends to underestimate the risk.

IN THE CASE OF BLACK-SWAN EVENTS – HIGHLY CONSEQUENTIAL EVENTS THAT ARE SO RARE THAT THEY DON'T APPEAR EVEN IN LARGE SAMPLES OF EXPERIENCE (E.G. A GLOBAL ECONOMIC CRISIS OR AN EXTREMELY RARE VOLCANIC ERUPTION) – OUR LIMITED EXPERIENCE TENDS TO UNDERESTIMATE THE RISK.

If this explanation holds true, it would pose a real dilemma for risk communication and, at the same time, reveal a great need for research. Risk warnings often have to compete with personal experience that makes the risk appear less threatening, because the event occurs only rarely or after a delay. In the competition between description and experience for our attention, awareness, and action, it seems that spoken, written or graphical descriptions of risks do not necessarily hold the strongest hand. Understanding the sometimes competitive and sometimes cooperative interplay between description and experience, and thus improving risk communication for the public and decision makers in settings such as politics, medicine and society as a whole, is one of the key goals of research at the Max Planck Institute for Human Development.

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