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## Scientists, Magicians and Charlatans: How Magic Creates Knowledge

Thomas Fraps

How are magic and science related? A physicist-magician explains the close relationship between wit, information and amazement. In an exciting historical excursion, he illuminates the common roots of the comic, of conjuring and research, overlaps and manipulations, all this also with a view to fake news.

“The most beautiful and profound thing that man can experience is the sense of mystery. It underlies all striving in art and science.” Albert Einstein

“From wonder comes joy.” Aristotle

At first glance, magic and science seem like irreconcilable opposites: With their illusions, magicians seemingly turn the laws of nature upside down, which science elicits from nature in painstaking research work. The art of magic uses psy-

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T. Fraps (✉)

Magician and Moderator, München, Germany

e-mail: [thomasfraps@trick17.com](mailto:thomasfraps@trick17.com)

chological deceptions and trick-technical methods to create false causal connections that create the illusion of impossible events. Science, on the other hand, seeks true causal relationships, strives for knowledge and creates knowledge based on facts; the illusionary artifacts of magic, on the other hand, are deceptively real fictions.

But opposites attract, as is well known. Especially in the border area between facts and fictions, magic and science touch each other on several levels and enter into an unusual symbiosis, whose history reaches back to the beginnings of the Enlightenment and holds some amusing-scurrile chapters in store. Albert Einstein's opening words hint at the underlying, emotional level: For scientists, the feeling of mystery – usually coupled with the feeling of wonder – is often the starting point, the beginning of the quest for explanations, insight and knowledge. For magicians, the sense of wonder at a playful mystery is the goal of aspiration. In this feeling meet both the astonished audience of the performance of a good magic trick, the methods of which remain hidden, and the scientist who marvels at still unexplained phenomena that nature “shows” him in his experiments. The crucial difference here is that the universe – unlike the magician – does not use deliberate deceptions, or as Einstein put it in a letter to Paul Ehrenfest: “[T]he secrets of nature are hidden by sublimity, but not by cunning” (Einstein 20 June 1923 to Paul Ehrenfest, quoted after Hermann 1996).

For the audience in a lecture hall, for example, this means being able to rely on the fact that the experiments shown and the theories based on or derived from them are concrete facts according to the respective state of knowledge – and not fictions based on trickery or deception. However, it is in the nature of some scientific experiments and theories, especially in physics, that they have a very

startling effect on viewers and have highly astonishing consequences that contradict everyday experience. Anyone who has ever witnessed with their own eyes in a live experiment how a stone and a feather (in two vacuum tubes) fall to the ground at the same speed will remember that physics experiments can feel like magic. Other examples of such “miracles of science” include the time dilation effects of special and general relativity or the sometimes absurd-seeming conclusions from quantum mechanics with its wave-particle duality, tunneling effects and quantum entanglements, which Einstein famously called “spooky action at a distance”.

The sense of mystery and wonder is here not only at the origin but also at the end of the pursuit of science. It is precisely these astonishing theories and facts that in turn open up an interface for the presentation of science in the context of a magic show that can be funny, informative and astonishing at the same time for a lay and professional audience alike.

## **“Metamagicum – Miracle Jokes Science”**

One example is the program “Metamagicum – Wunder Witze Wissenschaft” (“Metamagicum – Miracles Jokes Science”) developed by the author of these lines and the Frankfurt magician Pit Hartling in 2004, which has been performed or is still being performed, among other things, at performances at CERN (world’s largest particle physics lab near Geneva), on the occasion of the fifth anniversary of the Wolfsburg Science Center “Phaeno”, at (Munich) Science Days, at the annual “Highlights of Physics” events or at high schools and theater festivals and has found a niche in science communication.

Two professional magicians deal humorously with topics from science and technology spiced with a pinch of philosophy. The two protagonists muddle through the four-dimensional space-time at a high level. The program uses, among other things, innovative magic tricks developed by themselves to illustrate the amazing results and paradoxes of relativity theory, quantum mechanics and philosophy and to make them emotionally tangible. The tricks and astonishing experiments are introduced by a factual explanation of the scientific theories and effects, only to be exaggerated in the further course with a wink of the eye and culminate in a magical punch line that leaves the audience laughing and amazed at the same time.

As an example, beaming, based on the quantum mechanical entanglement of two photons, is supposedly transmitted into the macroscopic realm: An spectator's borrowed shoe disappears from a shoebox-like transmitting device and is teleported to an empty receiver box (which looks remarkably like a microwave with an antenna) standing on the other side of the stage, examined by the spectator at the beginning. Another invention is the "Gravitron": a device that, in appearance, could have come from the historical collection of the Deutsches Museum /Munich, but is supposedly capable of "locally altering the Earth's gravitational field". Thus, all of a sudden, not only does a table start to levitate, but – thanks to general relativity and its time dilation in a gravitational field – it also becomes possible to change the flow of time. The gravitron is set to an elevated gravitational field, simulating proximity to the source of a gravitational field, which supposedly makes time run slower on stage. Incidentally, the effect is known from everyday long-distance economy flights even without atomic clocks: If the seats next to you are empty, time runs much faster on an intercontinental flight than in the gravitational field

between two massive seat neighbors. As experimental evidence, depending on the gravitron's setting, a borrowed spectator's watch runs faster or slower until time even stops completely and the clock disappears. The gravitron short-circuits, a black hole spontaneously forms, and behind the event horizon, time suddenly runs backwards: empty, dented beverage cans visibly return to their filled, unopened original state, and torn newspapers restore themselves. The assisting spectator disappears from a Polaroid photo initially taken as a souvenir, and the vanished spectator's watch reappears at the end in the sealed peanut can that was given to the spectator as provisions at the very beginning of the time travel.

Elsewhere in the program, the most famous formula in all of physics,  $E = mc^2$ , is derived from the special theory of relativity. In the strongly abbreviated but mathematically correct derivation, the name of a Munich brewery can be clearly seen on a slate at second glance, which had been "hidden" from everyone's eyes all along in an integral with the letter symbols for the momentum  $p$ , the acceleration  $a$ , the time  $t$ , the kinetic energy  $En$  and the integral sign itself. This serves as mathematical proof of the widespread anecdote that Einstein, as a youth, had taken a holiday job in his uncle's company and, at the Oktoberfest, had helped to electrify the very beer tent that belonged to the brewery "derived" in the formulas. Fittingly, a postcard of Einstein has been preserved, which he sent to his Swiss friend Konrad Habicht in his *annus mirabilis*, proudly writing on it that he was "drunk under the table".

These are just a few examples from the "Metamagicum" program, which illustrate how magic art can communicate topics of science on a popular scientific level with wit and – out of amazement – joy. The audience is of course always aware of the illusionary nature of the tricks, apparent

technical inventions and experiments presented, even if the accompanying texts – paired with elements of comedy and science cabaret – convey factually correct content. It is always clearly a matter of tricks and deceptions, or as it was called at the time of the Enlightenment, “natural magic” (Brewster 1833).

## Between Superstition and Enlightenment

However, if one goes back to the seventeenth and eighteenth centuries, when the Enlightenment thinkers tried to take the mystery out of superstition, witchcraft and the supernatural, while at the same time the boundaries of science and the profession associated with it were not yet sharply defined, so one suspects that travelling magicians, who increasingly included experiments in magnetism, electricity or even chemistry in their programs as “physical amusements”, not only aroused amazement in the public, but also uncertainty among the public as to the natural causes of their experiments and thus undermined the idea of enlightenment (Hochadel 2003; Stafford 1998). Especially since both formats, experimental lectures at universities as well as public magic performances in theaters, aimed at spectacular effects in order to win the favour and money of the astonished public. And therein lay the danger, for “in an era when specialization and professionalization [of science] were only in their nascent stages, public displays of experimentation often bore a disconcerting resemblance to magic shows” (Stafford 1998, p. 15). This similarity in aesthetics opened the back door to imposture for magicians and charlatans. A popular representative of these false professors was Jakob Philadelphia (1734–1813). Born in the USA, he

performed as an “artist of magic and mathematics” with great success in many European cities. When he gave his first private performances in Göttingen in January 1777, the audience included Georg Friedrich Lichtenberg, who in letters to his friends criticized one trick in particular that was obviously based on magnetism, but which Philadelphia, who was approached, denied (Lichtenberg 1777 [1984]). Lichtenberg took this as an affront and used the whole thing as an occasion for his famous “Avertissement” – a nocturnal placarding of Göttingen with a forged placard allegedly from Philadelphia himself, which promised even more incredible feats than Philadelphia’s real placards. For instance, it held out the prospect of switching the weathercocks on the two Göttingen churches “without magnetism only with speed.” Philadelphia, exposed by this satire, renounced his already announced public performances and left the city in a hurry. This episode is a pointed example of the difficult relationship between magicians and scientists at the time. Among other things, the Enlightenment scholars attempted to use descriptive definitions to enable a clear classification and to distinguish themselves from the “charlatanry” of a Philadelphia.

The phisician (physicist): observes the phenomena in nature, seeks to find results from them, which he proves by experiments, seeks to explain the phenomena, but not to deceive his hearers, and is paid for his donated benefit. His ingenuity is admired and he is held in high esteem; he usually stays in one place and receives important state posts.

The sleight of hand: uses the results of the phisician (physicist), makes experiments, but gives no explanation of them, but seeks to deceive his spectators assiduously, and gets paid for this deception. One admires his dexterity, he enjoys little esteem, roams about the country, and receives no state post. (quoted from Hochadel 2000, p. 130)

By the way, from the personal experience of the author, a professional magician and graduate “phisician”, this definition can still be largely confirmed today. And so it is a beautiful irony of history when exactly one hundred years later this initially so difficult relationship takes a surprising turn and the magicians take over the tasks of enlightenment, as some representatives of science fail and involuntarily abet the supernatural, which in the form of spiritualistic séances and sessions of self-proclaimed mediums finds its way throughout Europe.

## The Zöllner-Slade Controversy

The US-American medium Henry Slade (1836–1905), for example, succeeded with his séances in London in 1876 in winning over, among others, Sir William Crookes, physicist and discoverer of thallium, the mathematician Lord Rayleigh as well as Alfred Russel Wallace, the co-discoverer of the theory of evolution, as convinced advocates (much to the horror of Charles Darwin). Above all, Sir William Crookes, after his experimental tests, denied any kind of fraud to the medium Henry Slade, thus granting him scientific legitimacy. It even came to an indictment of Slade and a famous court case, in which the demonstration of spiritualistic effects by the magician Sir Neville Maskelyne ensured that Slade was convicted. However, the latter was able to flee to Germany before the sentence came into effect, and there he met probably his greatest follower, Karl Friedrich Zöllner (1834–1882), the first German professor of astrophysics, in Leipzig. A decisive factor for his belief in spiritualism was that Zöllner had already been working for some time on a theory of the fourth dimension of space – a hypothesis that Riemann, Helmholtz and Klein, among



others, had also been working on. Zöllner saw Henry Slade as a kind of measuring device, a mediumistic instrument that had access to the fourth dimension (Staubermann 2001). Even though many scientists of the time were very sceptical about spiritualism, Zöllner was not alone; his physicist colleagues Wilhelm Weber and Theodor Fechner were also present at the experiments with Slade and were themselves convinced followers who considered Slade's spiritualistic abilities to be real and deception to be absurd.

The statement of physical facts, however, falls within the domain of the physicist; and when men of such outstanding importance as Wilhelm Weber, Th. Fechner, and others, openly advocate the reality of such facts after thorough experimental examination, it is obviously nothing but an act of modern presumption on the part of the unscientific public when the latter indulges in accepting ridiculous conjectures about the possibility of a deception as fact without further ado, and thereby denies those men the ability to make exact observations. (Zöllner 2008, p. 79)

The psychologist and philosopher Wilhelm Wundt, however, doubted precisely this claim of Zöllner. He insisted that scientists were only authorities in their own field and that the séances of a Henry Slade were outside their sphere of experience and thus their authority as scientists. He himself did not trust Slade's alleged abilities and felt that none of his phenomena "went beyond the performance of a good sleight of hand ... [and] it might not have been altogether improper to have taken a closer look at the performances of a dexterous conjurer" (Wundt 1879, p. 401). The dexterous conjurer in this case was Carl Willmann, one of the best-known magic-device dealers of the time. In his 1886 book *Modern Miracles*, he analyzes and explains the tricky maneuvers employed by Slade and other mediums, for "...

numerous debunkings furnish proof that fraud plays a prominent part in spiritualistic sessions ...” – and so, as a magician versed in deceiving the senses, he “could not help smiling at the credulity of the gentlemen scholars” (Willmann 1886, p. 154 f.). Here, once again, the feeling of mystery, the amazement at the inexplicable – as in the time of the Enlightenment – proves to be the Achilles’ heel of reason and, at the same time, an emotional back door for swindlers and charlatans. Whereas in the Enlightenment it was only the naïve spectators among the people who, marvelling, often did not know how to distinguish between genuine experiments, tricky magic tricks and seemingly supernatural powers, in the case of spiritualist mediums it is now even the scientists themselves who succumb to the tricky deceptions.

## The Geller Controversy

From today’s perspective, the Zöllner-Slade controversy is not without a certain unintentional humor, even if one takes into account the contemporary historical-religious context in which the séances took place. But Wilhelm Wundt was to be proved right. Almost a hundred years later, in the mid-1970s, the story of misconceived authority and scientific hubris regarding paranormal phenomena was repeated once again. Several experienced scientists from around the world confirmed to the Israeli medium Uri Geller (\*1946) that he did indeed possess telepathic and telekinetic abilities. The conducted experiments showed similar negligent errors as hundred years before and even led to a publication in the highly respected journal “Nature” in 1974 (Targ and Puthoff 1974). The authors Russel Targ and Harold E. Puthoff were laser physicists who conducted

their experiments with Geller at the Stanford Research Institute, a private research institute spun off from Stanford University in 1970. Geller duplicated drawings sealed in an envelope, including guessing the top number of a cube protected in a small metal container eight times in a row. The success of these laboratory experiments was presented as (scientific) proof of Geller's telepathic abilities.

However, as the magician and declared Geller opponent James Randi describes in his book "The Truth About Uri Geller", Geller – contrary to the description in the "Nature" article – was allowed to touch and handle the box with the cube himself after it had been shaken by the experimenter – a small but crucial detail for magicians. This information, together with the fact that the cube was protected in the container only by a removable lid and not by a lid with a lock, allows the explanation, obvious to a magician, that Geller, by means of dexterity, was able to lift the lid surreptitiously and to catch a brief glimpse of the number on top of the cube through the slit (Randi 1982).

The editors of "Nature" still remarked in the preface to the article by Puthoff and Targ (1974) that they were convinced after consultation with the authors that Geller's effects "cannot be explained by standard magic tricks". Standard manipulative methods used by Geller were certainly not, but they were still trick methods. The theoretical physicist David Bohm and his former colleague Jack Sarfatti had also witnessed a demonstration by Geller at Birkbeck College in London in July 1974. Both were convinced of Geller's abilities after thorough tests. The latter had, among other things, bent a borrowed key from Bohm and caused a Geiger counter to deflect several times, so that Sarfatti published a press release with the following conclusion: "My personal judgement as a doctor of physics is that Geller demonstrated true psychoenergetic abilities at Birkbeck

under relatively well-controlled and repeatable experimental conditions” (Sarfatti 1974, p. 46). The physicist thus falls into the same psychological trap that had probably doomed Zöllner and his colleagues a hundred years earlier: namely, believing that as a “doctor of physics” one was apparently immune to simple deceptions. The amateur magician and science journalist Martin Gardner reports:

When Sarfatti was asked if anyone had searched Geller for a radioactive beta source, he was told by Sarfatti that no one had thought of such a possibility and that it was a brilliant idea. Magicians find this answer merely comical. (Gardner 1983, p. 73)

Thus, from today’s perspective, one looks back on this Geller controversy not only with a frown, but also with a smirk. The perceived superiority, however, which creeps up on you while reading, is due to the temporal perspective and is quickly put into perspective when you consider that similar cases still occur today – but with a different coloration. Now, however, it is no longer ghosts or supernatural forces that are cited as false explanations, on the contrary: some of the mentalists, the self-proclaimed mind readers of the present, explain their – merely feigned – amazing abilities themselves with selectively chosen set pieces of science: from NLP to cognitive psychology, hypnosis and epigenetics to the reading of body language signals and studies on mirror neurons.

## Between Fact and Fiction

We are dealing here with a double deception appropriate to the post-factual age. For when asked, “How do you do it?” the answer does not invoke supernatural forces as it still

does in the case of Slade or Geller, but pseudo-scientific bogus explanations that feel emotionally plausible because they dissolve the cognitive dissonance of wonder into scientific pleasantness. The enlightened person in particular is apparently susceptible to bogus explanations given under the guise of science. And so it happens that science journalists on public television (ZDF, Schmidt 2015) shove a mentalist into the brain scanner at prime time in order to examine his empathy and “special empathic ability” in the laboratory and explain it in front of an audience of millions with “clearly increased activity of the mirror neurons”. The fact that the phenomena demonstrated in the show by the mentalist are only stagings based on trick techniques is not mentioned.

Another example is the science editorial team of the show “Mich täuscht keiner!” (No one fools me!) (ZDF 2017), which was fooled by a mentalist who, during a live demonstration in the studio, claimed to be able to recognize lies based on reading the body language of prominent candidates and to be able to assign drawings made by the candidates to their respective authors. Not a word about the actual trick method, that the white drawing boxes were marked with pencil dots and handed out by himself to the four candidates in a certain order at the beginning. The presenter of the show did not even ask the question whether it was deception or not, because according to his own statements (when asked by the author) the responsible editors had no idea at all that it could be a trick. The whole thing takes on a particularly ironic note, since the central concept of the show was precisely to reveal and explain the many facets of deception: from optical illusions and animal camouflage to shell games, con artists and tricksters.

And then there are the numerous non-fiction and advice books by some mentalists, which have been thrown onto the book market for years, some of which have become

bestsellers, thus spreading the scientific bogus explanations as fake news (Jan Becker, Thorsten Havener, Tobias Heinemann, Norman Graeter etc.). As a result, these are not only believed by spectators, but also presented as facts in newspapers: “It is not a matter of his demonstrations being tricks and illusions that mislead his spectators in order to amaze him ...”, writes e.g. the *Süddeutsche Zeitung* in its review of a mentalist performance (SZ 2013). The boundary between facts and fictions, between science, pseudoscience and magic tricks is thus blurred for entertainment and marketing purposes – and at the expense of science.

## Conclusion

And so we have come full circle: we are back to Philadelphia & Co., who used scientific phenomena to present amazing things to their paying viewers, and were not so careful about the truth. Today it is no longer physics and chemistry, but psychology and neuroscience that are suitable as bogus explanations. But

... just because a good magician demonstrates something extraordinary, you shouldn't jump to the conclusion that it's a real phenomenon; you need a lot more evidence for that. But it's fun to figure out the trick, and the only way to figure it out is to be completely sure it's a trick, and not be willing to believe it isn't, because then you slip too easily.

as Richard P. Feynman wrote about an encounter with Uri Geller (Feynman 1989, p. 49 f.).

The emotions of mystery and wonder not only arouse curiosity, but also briefly suspend our cognitive-rational coordinate system. They therefore not only serve as creative

driving forces in science and art, but also prove to be the Achilles' heel of the Enlightenment in the anecdotes described – and this continues to the present day. Even scientists slip too easily on (account of) these emotions.

The invisibility of causes, which makes us wonder, and the invisible boundary between facts and fictions complement each other in this case in an unfortunate way. Picasso's observation that art is a lie that makes us see the truth applies to the art of magic insofar as it makes the existence of the limits of our perception playfully visible. In the case of past charlatans and present-day con artists, however, the artistic nature of the lie is absent, for the true nature of the causes is deliberately left in the invisible. The joke is that in these cases it is the magician, of all people, who can lend a hand to the scientists in their search for truth, to make visible the difference between sublimity and trickery, between facts and fictions.

## The Author

Thomas Fraps (Fig. 7.1) is a professional magician and adult. For the first 27 years of his life he often wrestled with reality, but in the end he won! Since then, he has roamed the world as a magician, playfully turning upside down the laws of nature he previously learned as a graduate physicist. Thanks to his very special theory of reality and amazingly entertaining magic, he brings the beautiful feeling of amazement to his audience's memory and creates magical moments that entertain in the best sense, whether at a company party, a private party or in the theatre.

Especially in his famous role of the "False Expert" (<http://www.thomasfraps.com/derfalscheexperte.html>), Thomas Fraps, as an amazing comedy speaker, provides "frapp(s)ierende" (German wordplay for striking) moments at



**Fig. 7.1** The magician Thomas Fraps multiplies himself. (Photo: Gerald F. Huber)



international conferences, symposia and specialist meetings of all kinds. Whether at a supercomputer conference in San Diego, a neuroscience congress in Paris or at the ceremonial opening of a sewage sludge incineration plant in Schongau – no audience is safe from the False Expert.

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