Jimena Canales

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Einstein's Discourse Networks

Jimena Canales

»[Physical objects] are like broadcasting stations that send out signals which we can receive.«
Arthur Eddington, 1932.

»Light brings us the news of the Universe.«
William Bragg, 1933.

To convince a skeptical colleague about the merits of his work, Albert Einstein explained that he had developed a new way of understanding »the propagation of an influence that could, for example, be used for sending an arbitrary signal.«[1] Why was Einstein writing about »arbitrary signals«? How could this particular understanding of »signals« impact a work known for revolutionizing modern science?

Einstein's theory of relativity changed our understanding about the nature of time and space by first tackling the concept of simultaneity. The physicist showed that an event that was simultaneous for one observer would not be for one moving at a constant speed relative to that observer. Newtonian physics, with its concept of absolute time, was based on principles of immediate »action at a distance,« but Einstein noticed that the concept of absolute simultaneity neglected to account for the transmission times that led an observer to ascertain the simultaneity of distant events. »There is no such thing as simultaneity of distant events; consequently there is also no such thing as immediate action at a distance in the sense of Newtonian mechanics,« he explained.[2] Since then, historians have disclosed immediate »action at a distance« to be somewhat of a clever metaphysical trick: the culmination of Newton's successful attempts at *imitatio Dei*, sustained by a hidden global »informa-

1 Albert Einstein to Wilhelm Wien, August 26, 1907, Bern, in: Albert Einstein: The Collected Papers of Albert Einstein, vol. 5, Princeton 1987, pp. 40-41: 40. (All translations from German and French sources are mine if not otherwise designated.)
2 Albert Einstein: Autobiographical Notes, in: Albert Einstein: Philosopher-Scientist, edited by Paul Arthur Schilpp, La Salle 1949, p. 61.

tion order« of Jesuit, slave-trading and commercial networks that permitted physical laws to appear as emerging from nowhere and being valid everywhere.[3] The demise of the Newtonian framework affected fields far beyond science, as immediate »action at a distance« came to represent faulty reasoning more generally. As the historian Simon Schaffer explains: »Immediate action at a distance is plausible neither as a historical nor sociological principle.«[4]

If an account of the »information order« of the late seventeenth 17th century shows how global networks of travel, trade, and empire sustained the immediate »action at a distance« forces of Newtonian cosmology, how are we to understand the different networks of the Einsteinian universe—ones no longer based on forces acting immediately at a distance but on their opposite? What »plausible« methodological tools can help us understand them?

Einstein's theory of relativity (1905) was published at a time of key changes in the »discourse network« of the Second Industrial Revolution. Friedrich Kittler has aptly detailed how these changes affected literature and modern culture. How did they affect theoretical science?

In what follows I will introduce a classic case from science into the »discourse network« circa 1900. A discourse network approach permits us to consider scientists as working with language and artifacts as much as with the empirical world, and constituted by them, while at the same time it helps us reflect on the use of evidentiary standards and categories of analysis beyond science, in historical and sociological accounts, for example.

1. »Voluntary-arbitrary« signals and the »universal constant *c*.«

How did Einstein's work fit within the discourse network of his era? Einstein, and before him Poincaré, relied on a thought experiment based on synchronizing clocks via light signals. This experiment played such a »central role« in his famous 1905 paper that scholars refer to it as the »light signaling protocol.«[5]

3 Simon Schaffer: Newton on the Beach. The Information Order of Principia Mathematica, in: History of Science 47/3 (2009), pp. 243–276.

4 Ibid., p. 245.

5 Cf. Galina Granek: Poincaré's Light Signaling and Clock Synchronization Thought Experiment and its Possible Inspiration to Einstein, in: Albert Einstein Century International Conference, edited by J.-M. Alimi and A. Füzfa, (American Institute of Physics Publishers), Melville 2006. John Norton attests to the »pervasiveness of this analysis in later writings« in: John D. Norton: Einstein's Investigations of Galilean Covariant Electrodynamics prior to 1905, in: Archive for History of Exact Sciences 59 (2004), p. 92.

When Einstein's paper appeared in print, it failed to raise more than a few eyebrows. But its fate started to change soon thereafter. In 1907 Einstein introduced some essential modifications that helped its transformation into »arguably the most famous scientific paper in history.«[6] When he made these changes, he separated his own contributions from the work of Hendrik Lorentz, who up to then was considered by Einstein and by others as a co-author of relativity theory.[7] Instead of referring to the »Einstein-Lorentz theory« as he had previously done, he now referred separately to »the H.A. Lorentz theory and the principle of relativity.«[8] What new additions did he introduce marking this significant distinction?

Although the finite speed of light had been noted since the 17th century, scientists up to Einstein believed that certain signals could also convey information instantaneously. The setting of the sun *signaled* the onset of nighttime; the North Star *signaled* a ship's direction. In these cases, the event and the event signaled were simultaneous. Gravitational effects, occurring across tremendous astronomical distances, were largely considered to be instantaneous. No transmission velocity needed to be considered. Examples of instantaneous signals invalidated all of Einstein's momentous predictions about the relativity of simultaneity and of time. What could Einstein do to save his theory?

The definition of time and simultaneity which he used in his paper, he explained to his colleague Wilhelm Wien, was right *if* the time signals he described in it were understood in a specific way, not as any kind of signals but as *communication* signals. The »light signals« he referred to in his work, he explained, were actually »electromagnetic influences« that could be »one-time« and »voluntary« and that could »for example, be used for sending an arbitrary signal.«[9] For this particular reason they had a finite velocity. The importance of the »light signaling protocol« for understanding time and space in the universe became clear only after it was understood in this way.[10]

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6 Dennis Overbye: Einstein in Love, New York 2000, p. 135.

7 For a careful historical study of Einstein's particular contributions to relativity see Richard Staley: Einstein's Generation. The Origins of the Relativity Revolution, Chicago 2008; Richard Staley: On the Histories of Relativity. The Propagation and Elaboration of Relativity in Participant Histories in Germany, 1905-1911, in: Isis 89 (1998), pp. 263-299.

8 Albert Einstein: Über das Relativitätsprinzip und die aus demselben gezogenen Folgerungen, in: Jahrbuch der Radioaktivität und Elektronik 4 (1907), pp. 411-462: §1.

9 Albert Einstein: Sending an arbitrary signal, in: Einstein to Wien, August 26, 1907, Bern (as note 1). »Let A be a point from which electromagnetic influence can emanate, and B a point in which the influence emanating from A be perceived.« (Ibid.)

10 This modification explains why the »light signaling protocol« seems to have played only a scant role in Einstein's research leading up to his 1905 paper, but appears pervasively afterwards. John Norton attests to the »pervasiveness of this analysis in later writings« in

2. From »Lichtzeichen« to »Lichtsignale«

In his »annus mirabilis« 1905 publication, Einstein initially used no less than three terms to describe the transmission of light: Lichtstrahl (light ray), Lichtzeichen (light signs) and Lichtsignale (light signals). He later struggled to refine his terminology, sometimes using the term »signal,« other times »sign,« and creating new terms by hyphenating or concatenating words (as is usual in German), such as »sign-effect« and »arbitrary-voluntary signaling.« By the summer of 1907, he was much clearer. He settled on the term »signal,« which he understood in a specific way. When he defined the term »signal« in distinction to the other terms, he became increasingly confident of the validity of his own interpretation of the theory and its universal implications. He underscored a key difference between his conception and that of Lorentz. He defined a »signal« as a type of causal transmission that could not surpass the speed of light. A »sign,« in contrast, could not be adequately understood in terms of cause and effect with propagation velocities and transmission speeds. While the concept of »sign« was pertinent in a world defined by print *before* electrodynamic technologies, that of »signal« gained importance in the new era of electrodynamic telecommunications that would characterize the 20th century.

During these years, Einstein was struggling for a word that would fill the space between »the observer in A sends« and »to the observer in B.« What, exactly, does »the observer« send? The answer had to satisfy the rules of electrodynamic transmission to be sure, but it would also determine if Einstein's work could actually revolutionize general notions of time and space. Einstein at times used the term »sign-effect« (»Wirkung Zeichen«), but he started to clarify the meaning of this term depending on how it related to the speed of light. The speed of light could only be considered as an unsurpassable velocity in the case of »arbitrary-voluntary signaling« (»willkürliche Signalgebung«). In this case, it would be equal to the value of »a universal constant *c*.« Einstein explained that there was nothing »illogical« in thinking about instantaneous transmission, but he was confident enough to state that it did not occur in practice in terms of the »spreading of an effect« with »causal« consequences through a »material strip« (*Materialstreifen*). Einstein was finally clear: »A universal constant *c*« should be understood by reference to this new complex assemblage.[11]

Some readers were shocked to see a »universal constant *c*« defined by reference

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Norton: Einstein's Investigations of Galilean Covariant Electrodynamics prior to 1905 (as note 5), p. 92.

11 Einstein: Über das Relativitätsprinzip und die aus demselben gezogenen Folgerungen (as note 8), §5.

to signaling techniques used for transferring messages. The mathematician Alfred N. Whitehead was one of many other thinkers of the period who thought of Einstein's work in terms of the transmission of messages. »Signal-theory« is what »we will call it,« he wrote, after he heard the astronomer Arthur Eddington's presentation of new evidence in favor of the physicist's work breaking into headline news.[12] Whitehead placed Einstein's conclusions about light »signaling« within a much larger and varied set of communication and transportation practices. When evaluating the theory, he stressed the role of other messaging technologies which he saw around him, reminding readers that »there is the transmission of material bodies, the transmission of sound, the transmission of waves and ripples in the surface of water, the transmission of nerve extension through the body and innumerable other forms which enter into habitual experience.« His verdict and critique of Einstein's was clear: »The transmission of light is only one from among many« ways of sending »physical messages from place to place.«[13] Sir Oliver Lodge, one of the most important scientists to work on telegraphy and wireless, similarly understood it in terms of information transfer. He opposed Einstein's theory as necessary for changing the understanding of time, space, and the universe: »It is true that these [light] waves are *among our methods of receiving and conveying information*; but too much attention may be paid to the mere reception of information.«[14] Many other scientists understood Einstein's work as a treatise detailing new signaling possibilities.

How did Einstein's investigations fit within the new discourse network of global telecommunications? Why was Einstein discussing back-and-forth bouncing light in the first place? Since ancient times, people at a distance communicated across distances by using torches.[15] Code systems were later developed for maritime and military communications. The semaphore, primarily a military technology, was used in the 18th century to send all the letters of the alphabet as well as numbers across long distances. With the development of telegraphy, these complex sign systems were reduced to simple dots and dashes that were eventually codified as the Morse telegraph system. By the time Einstein authored his paper, light signals were optical (from torches to semaphores), electrical (telegraphs), and electromagnetic (wireless).

12 Alfred North Whitehead: An Enquiry Concerning the Principles of Natural Knowledge, Cambridge 1919, p. 53. See Jimena Canales: A Science of Signals: Einstein, Inertia and the Postal System, in: Thresholds 39 (2011), p. 12–23.

13 Ibid., p. 54.

14 Oliver Lodge: The Geometrization of Physics, and its Supposed Basis on the Michelson-Morley Experiment, in: Nature 106/2677 (1921), pp. 795–800: 800.

15 Charles Mugler: La lumière et la vision dans la poésie grecque, in: Revue des Études Grecques 73 (1960), pp. 40–72.

3. WWI

Up to the end of WWI, light signaling technologies concerned physicists as much as the military. How could men with a scientific background contribute to the war effort? The physicist Joseph S. Ames, professor of physics at Johns Hopkins University, had a clear answer. They could work on light signaling technologies. Physicists, he argued, were the »obvious« experts in certain kinds of communication technologies and therefore essential during the war: »But consider a problem like this: to devise a light signal, which can be used by day or by night, and which will be absolutely invisible to the enemy. Who can solve that? The answer is obvious: only a physicist.«[16]

Innovations in telecommunications proliferated during the war. Commanders in Europe quickly lobbied to increase the supply of triode vacuum tubes (until then manufactured in bulk only in the U.S.) so that they could use them for military wireless.[17] A few years before the Great War exploded, count Alfred von Schlieffen, one of the most successful military strategists of all time, explained how light-based technologies were completely changing how war was waged. »Electrifying words« sent by generals through telegraph wires sent chills across the troops that rivaled those of actual bullets. Von Schlieffen explained that with the aid of new electrodynamic technologies, »the general will be situated farther back, in a building with roomy offices, where cable and wireless telegraphs, telephone and signal apparatus are at hand…. There is a comfortable chair behind his big desk, the modern Alexander has the entire battlefield before him, from there he telegraphs *electrifying words*.«[18]

Light-based technologies for communication changed the hierarchy between leaders, no longer at the fronts, and the soldier or militant who manned a weapon, becoming an indispensable tool for expanding chains of delegation.

16 J. S. Ames: The Trained Man of Science in the War, in: Science 48/1243 (1918), pp. 401–410: 403.
17 Lewis S. Feuer: Einstein and the Generations of Science, New York 1974, p. 214.
18 Cited in: Bernhard Siegert: Relays. Literature as an Epoch of the Postal System, Stanford 1999, p. 189. (Italics mine.)

4. Light standards and »alle sonstigen Dinge«

»One is struck by the fact that the theory« of special relativity, explained Einstein, »introduces two kinds of physical things, i.e., (1) rulers and clocks [Maßstäbe und Uhren], (2) all other things [alle sonstigen Dinge].«[19] The difference between measuring devices and »all other things« was due to their connection to light signals. In his study of measurement standards, the philosopher and historian of science Robert Crease has explained how the establishment of light-based standards created a situation where light could »no longer be measurable« becoming »the ruler, not the ruled.«[20] Light-based standards permitted the very foundations of science to be considered as lying outside of history: »For the first time in history, if all basic standards were somehow lost, they could be recovered and the world would have exactly the same measurement standards as before.«[21] Light signals, in Einstein's work, were treated as different from »all other things.« This particular characteristic of the discourse network circa 1900 undergirded the notion of theoretical science characteristic of this period, one that clearly separated science from any mundane connections, including military ones. But light signals only appeared as different from »all other things« in the decade before WWI.

Measurements of time and space based on »light signals« held a privileged status in science and culture well beyond the end of the century. In the 1970s, Léon Brillouin, who had started his career working at the Signal Corps during WWI, described how further advances on the theory of relativity were hampered by difficulties determining the constancy of the speed of light given that time and length were *both* defined using light waves: »The unit of length is based on the spectral line of krypton-86 […] and the unit of time is based on the frequency of a spectral line of cesium […] Hence the same physical phenomenon, a spectral line, is used for two different definitions: length and time.«[22] Under this system, any change in the velocity of light which affected a spectral line would go undetected because the changes would cancel out (when length was divided by time): »It should be stated, once and for all, whether a spectral line should be used to define a frequency or a wavelength, but not both!« he wrote with complete exasperation.[23]

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19 Einstein: Autobiographical Notes (as note 2), p. 59.

20 Robert P. Crease: World in the Balance: The Historic Quest for an Absolute System of Measurement, New York 2011, p. 215. Ludwig Wittgenstein in the *Philosophical Investigations* famously stated how: »There is one thing of which one can say neither that it is one meter long, nor that it is not one meter long, and that is the standard metre in Paris.« in: Ludwig Wittgenstein: Philosophical Investigations, Oxford 1958, p. 24, §50.

21 Crease: World in Balance (as note 20), p. 215.

22 Léon Brillouin: Relativity Reexamined, New York 1970, p. 5.

23 Ibid.

Since length and time were both defined through light waves, scientists had no other standards against which they could measure the velocity of the waves themselves. Brillouin protested that »with the legal definitions of length and time it seems rather difficult to check experimentally« some of the claims of relativity theory. But instead of blaming Einstein for this problem, Brillouin blamed metrologists: »This raises a very real problem of metrology.«[24]

5. The exceptionalism of light signals

How did »light signals« acquire this special status and what were the consequences? The exceptionalism of light in modern science furthered the Enlightenment idea that communication could be clearly separated from the *means* of communication, even when it was sustained by technologies devised for military purposes.

In one of his first important works on the theory of relativity, Eddington described Einstein's rules of the transmission of »light signals« as an »ultimatum« reaching the »ruler of the country,« who would then immediately act on this information.[25] But soon, sending and receiving light signals would no longer be a matter belonging solely to the state and the military (which at first employed astronomers for determining time and longitude and meteorologists to send news about the weather)—it was nearly everyone. Einstein's investigations into »light signals« were thus not simply investigations into military signaling technologies. They were *theoretical* investigations which led to knowledge about the nature of the universe in a different way than the practical investigations that could lead to action, military or otherwise.

Commanders during WWI developed the method of »sound ranging« based on comparing the timing of an actual explosion, the time it was set in motion, and when the explosion was heard. Because of the finite speed of sound, the »location of the gun« could be determined »by means of a system of triangulation« in order to strike back at the enemy.[26] »Sound-ranging« was extremely complicated as it was affected by myriad environmental factors, including weather-related wind patterns. For this reason, it was complemented with visual evidence, leading scientists to take into consideration the different speeds of explosions, their sound (»boom« or »bang«), and their light (»flash«) as a matter of course. The practice of

24 Ibid.

25 Arthur Stanley Eddington: Space, Time, and Gravitation. An Outline of the General Relativity Theory (1920), Cambridge 1987, p. 52.

26 Ames: The Trained Man of Science in the War (as note 16).

comparing the sound signals of ejection, trajectory, and explosion against the visual light signals of the firing and explosion became standard in WWI.

Before being assassinated by right-wing militias, Germany's foreign minister Walther Rathenau asked Einstein what would happen if instead of thinking about relativity in terms of light signals one thought of it in terms of an assassin throwing a stick of dynamite on a train carrying the czar of Russia. »What startles the czar twice, is only a single matter for the assassin,« he concluded.[27] Rathenau was wrong: Einstein's work showed that a different logic applied to light signals than to vehicles and bullets. The theory of relativity revealed how two flashes of light would appear simultaneous to an observer standing midway between them but they would appear as sequential for one moving at a different speed. Were they actually simultaneous or not? According to Einstein's formulation of the relativity of simultaneity, they were both. The result appeared paradoxical to many, including Rathenau, who were accustomed to thinking of light flashes in terms of actual explosions. But Einstein had shown that light flashes had a unique quality in that they, and only they, traveled at constant speeds in the absence of a gravitational field. For this reason, their effects were distincter than if one were dealing with the transmission of other things, such as a stick of dynamite.

»Your illustration of the two flashes of lightning and the train really gripped me here (incidentally, I turn it into two dynamite explosions and a czar train),« wrote Rathenau to Einstein.[28] Rathenau was hardly the only one mesmerized by the new theory during those years. Einstein had by then already published his popular version, a text populated with famous examples of trains and light flashes. Part of readers' bewilderment towards Einstein's account stemmed from how the transmission of light signals did not fit with the usual understanding of other forms of transmission, including that of actual objects, which included those designed for producing violent acts.

Rathenau wondered how Einstein's work fit or did not fit with conventional wisdom about artillery and explosions. Commentators of Einstein work often compared the special characteristics of the speed of light (flash) *by contrast* to the transmission of a sound after an explosion (bang) and to the speed of bullets.

In his article on relativity published in *Popular Astronomy* after the war, the American astronomer William H. Pickering carefully elaborated on »the analogy of the bullet« to light, by imagining a train equipped with »guns« on either end.[29]

27 Walter Rathenau to Einstein, May 10-11, 1917, Berlin. Cited in Albert Einstein: The Berlin Years. Correspondence, 1914-1918, vol. 8, in: The Collected Papers of Albert Einstein, Princeton 1998, pp. 327-329: 328.

28 Walter Rathenau to Einstein, May 10-11, 1917, Berlin. Cited in ibid.

29 William H. Pickering: The Theory of Relativity, in: Popular Astronomy 28 (1920), pp. 334-344: 338.

Eddington, who used the example of a rifle bullet, discussed the »simultaneity of a flash and a bang.«[30] M.F. Cleugh, who surveyed the theory of relativity in *Time and its Importance in Modern Thought* (1937), summarized the purpose of the common »flash and bang« trope which was widely used to explain it: »The time–lag between »flash« and »bang« shows that sound has a finite velocity, and from that an analogy may be to the case of light.« A reader might at first resist theory, but would later come to accept it: »But if he is given a carefully graduated series of examples, beginning with the familiar ›flash and bang‹ of a distant gun, going on to two guns between which he stands, and ending with a full-blown Einstein and trains and light signals, he will admit that it follows from these that simultaneity is, after all, relative.«[31]

The common use of these examples shows how popularizers of relativity invoked the examples of flash, bang, and bullet as evidence for the exceptionalism of light.

In the age of relativity theory a different status applied to light—which was infinitely fast—than to sound and bullets which were slow in comparison. This bifurcation entailed a split in the common understanding of the communication of signals, words, things, and violence.

6. News and light

Readers in the era of Einstein knew full well that letters took time to reach their recipients—his contemporary, Franz Kafka, famously obsessed over the delays of the postal system. Correspondents drew on their own common habit of including the delay of the news when ascertaining the moment an event occurred in order to understand Einstein's point about the difference between the rules of transmission in cases involving the constant speed of light and others: »Any observer whom news of a distant event reaches before, or at the instant when, something happens to him, will judge that since the news took time to reach him, the distant event occurs before the receipt of the news.«[32]

Einstein's commentators often thought of his work in terms of the speed necessary for the transfer of »news.« When Oliver Lodge warned how reception of an event should not be confused with the event itself, he proceeded to criticize relativity scientists who »speak as if the duration of the event could be extended by

30 Eddington: Space, Time, and Gravitation (as note 25), p. 103.
31 Mary Frances Cleugh: Time and its importance in modern thought, London 1937, p. 58.
32 Benjamin Ives Gilman: Relativity and the Lay Mind. II, in: The Journal of Philosophy 24/19 (1927), pp. 505–521: 508.

merely delaying the reception of the news at its end.«[33] References to the »news« were typical in popular accounts of Einstein's relativity theory. Readers, explained one popularizer, knew well how to factor in »the amount of time taken by the news—or the *delay of the message*.«[34]

Why should scientists accept Einstein's light signals as a privileged way of understanding space and time? While Whitehead and Lodge had refused to accept a special status of light as a particularly privileged method for receiving and conveying information, many others would soon accept the special status of light as the fastest news-bearer. Why should this lead us to reevaluate theories of time and space? Because »while all news takes time to come, *there is a kind that takes the shortest possible time.* This swiftest of messengers is at present believed to be light.«[35]

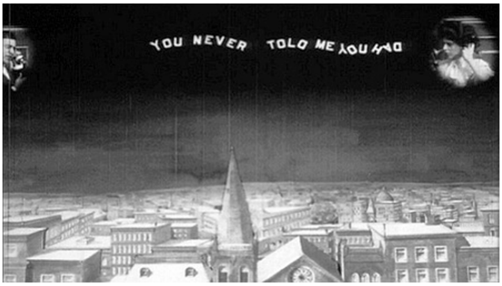

Fig. 1: This image from College Chums (1907) shows a creative illustration of how the actual transfer of words could take place from one point to the other during a telephone conversation. (Still from silent film COLLEGE CHUMS (USA 1907, Edwin S. Porter, Edison Manufacturing Company).

7. 1920s: The electrodynamics of moving *media*

New innovations combining telegraphs with typewriters and printing presses made the science of electrodynamics relevant for news culture, mainly newspapers and daily press publications, permitting its transformation into mass media. Before the 1920s, the meaning of the word »media« was originally modest and technical. It referred to material substances between two solid bodies, such as oil between lenses or fluids inside tubes and was indistinguishable from the plural of »medium.«[36] Important changes in the term »media« appeared in direct connection to Einstein's work. Einstein titled his famous relativity theory paper »On the Electrodynamics of Moving Bodies,« but by the end of 1922 the National Research Council referred to investigations pertaining to relativity under the new label of »Electrodynamics

33 Lodge: The Geometrisation of Physics (as note 14), p. 800.
34 Gilman: Relativity and the Lay Mind. II (as note 32), p. 508.
35 Ibid., p. 510.
36 Raymond Williams: Keywords: A Vocabulary of Culture and Society, Croom Helm 1976, pp. 203–204.

of Moving Media.«[37] Why this change? The mathematician Hermann Weyl, one of the first popularizers of the theory, found that Einstein's work fit perfectly with preexisting research on the »electrodynamics of moving *media*,« referring to experiments by Armand Fizeau and Agustin Fresnel where light was passed through the »media« of moving or still water.[38] The laws governing the »bodies« initially referred to by Einstein, explained the mathematician, were the same as those governing light transmission through these other »media.« Soon Einstein's work on these topics would no longer be described in terms of bodies (as Einstein had initially titled his contribution) or in terms of light *in* moving »media« (as an intermediary substance). Rather, light itself was understood as »media.« As electrodynamic communications technologies became increasingly relevant in the wider society, especially used in combination with traditional transportation-based communications, the *electrodynamics of moving media* became a more relevant label for these inquiries than the *electrodynamics of moving bodies*. During these years, the term »media« was used in science as much as in the communication and advertisement industry. The term »media« in both relativity theory and communication and advertisement forums appeared by reference to methods for sending messages »in the least time.«

To contrast the reach of new electromagnetic-based technologies in the face of the previous slow, bulky alternatives that had to be transported in vehicles, the organizers of the 19th *Associated Advertising Clubs of the World* convention (in June 1923) printed their invitation using a mammoth Underwood typewriter, on a ten-feet wide by twenty-feet wide piece of paper, which was one of the attractions of Jersey City.[39] This large billboard image reached viewers at the speed of light. During this same New Jersey convention, the term »mass media« was, for the first time, in vogue.[40]

Light's quality as the fastest messenger became vouchsafed not only by physicists, but by advertising agents and their publics. The concept of »mass media« depended largely on new ways of combining light, visual, and print technologies. One of the presenters of the *Associated Advertising Clubs of the World* defined the

37 W. F. O. Swann et al.: Electrodynamics of Moving Media, in: Bulletin of the National Research Council 1/ 6 (December 1922); Vernon Kellogg: Work of the National Research Council, in: Science 58/1505 (November 1923), pp. 337–341 and 362–366: 340.

38 Hermann Weyl: Space-Time-Matter, London 1922, p.186. (Italics added.) »The fact that the theory of relativity accounts for this remarkable result [Fresnel's] shows that it is valid for the optics and electrodynamics of moving media.« In the German original, the word is »Medien.«

39 Evan Johnson (ed.): Office Appliances. The Magazine of Office Equipment 36 (1922), p. 211.

40 Noble T. Praigg: Advertising and Selling, New York 1923, p. 240.

new term: »Mass media represents the most economical way of getting the story over the new and wider market *in the least time*.«

The electromagnetic transmission of images proliferated in the coming years. In the days after September 1, 1923, audiences around the world eagerly wished to see images of the Japanese earthquake. To satisfy their public, newspapers pioneered a new process to transfer film and photographic footage across long distances. Photographs of the earthquake had been sent to Seattle by airplane and were waiting on the runway. Newspapers had workers code numbered squares of light and dark and hired an artist at the receiving station to recreate the image by translating the code. Two years later, AT&T started the first commercial public service for sending photographs by telegraph wire.[41] In the 1920s electromagnetic transmission ceased to be an autonomous, expensive, and imperial-military technology but one that engulfed the public at large and which could be used in combination with traditional forms of print and visual culture. The term »telecommunications« soon became a label for this new form of communication. The International Telegraph and Radiotelegraph Conference (of 1932) changed its name to International Convention of Télécommunications. It defined visual images as a subset of a much broader category. The new term »telecommunications« included »any telephone or telegraph communication of signs, signals, writing, images and sounds of any nature by wire, radio, or other systems or signaling processes electrical or visual (semaphore).«[42]

8. 1930s: Radio signals

With the development of radio, the understanding that all physical phenomena could be known in terms of the behavior of light signals became even more widely accepted. During the 1930s, references to telecommunications media were not only invoked to prove Einstein's point about delays and his focus on the particular status of light—rather, the universe itself was described as a signaling device. In the 1930s when broadcast radio was in vogue, Eddington described all »physical objects« as broadcasting stations: »They are like broadcasting stations that send out signals which we can receive.«[43] »Light brings us the news of the

41 A. J. Ezickson: Wired Photos, in: The Complete Photographer 54 (1943), pp. 3515–3518: 3518.

42 Documents de la Conférence Radiotélégraphique Internationale de Madrid (1932), vol. 2, Conférence Radiotélégraphique Internationale, Bureau International de l'Union Télégraphique, Bern 1933, p. 410.

43 Arthur Eddington: The Decline of Determinism. Presidential Address to the Mathematical Association, 1932, in: The Mathematical Gazette 16/218 (1932), pp. 66–80: 71.

Universe,« explained the crystallographer and Nobel Prize winner William Bragg in 1933. In contrast with previous decades, scientists rarely continued to ask, why light? »We come naturally to the question as to the nature of this messenger and as to the means by which it travels from place to place,« explained Bragg.[44] Light brought the news of the universe as it carried the news of the world.

For light to be able to bring the news of the universe, it also had to bring the news of the world—first through newspaper print media in combination with telegraphy and later through radio. If seen in this way, the development of the most theoretical of the sciences and mundane communications technologies appear to have much in common—broader cultural transformations that undergird them both.

Early critics of Einstein had protested his focus on light signals. His supporters defended his work by pointing out how wonderfully it explained light signaling phenomena. Western Union radio clocks, wrote a philosopher on the occasion of Einstein's 70th birthday, proved the physicist correct. »Any one who checks his clocks by radio is determining simultaneity at a distance in this [Einstein's] way.« For this reason, Einstein's critics no longer had a valid point. »If it be objected that when this statement [criticizing Einstein] was made radio was not in very general use, the reply is« simply no. Why? Because »›Western Union clocks‹ have been in use in America for more than 22 years.«[45] While the philosopher referred to radio time service, time distribution was only one component of the company's full repertoire—primarily a profitable financial services and communications business now known as »Dinero en Minutos®.« But despite constant references to actual technologies involving light signals and their widespread cultural use, the merit of Einstein's science lay in its theoretical and universal implications.

9. Scientists' »signs«

Scientists' work with signs, signals, and symbols was clearly different from those that concerned linguists, philosophers, and humanists. What sustained this difference? Did scientists read the book of nature as others read alphabetical signs on a page? Did they read it *as a* book? In the 16th century, investigators understood reading nature as an activity similar to that of reading the Bible. But by the early 20th century, scientific practices had changed so significantly that scientific work

44 William Bragg: The Universe of Light, New York 1933, p. 3.

45 Evander Bradley McGilvary: Space-Time, Simple Location, and Prehension, in: The Philosophy of Alfred North Whitehead, edited by Paul Arthur Schilpp, Evanston 1941, pp. 209–240: 216.

no longer seemed comparable to the work involved in reading a text. Galileo was an important figure in effecting this change. Because »the book of nature« was written in the language of mathematics, he argued, scientists did not need to interpret it in the same manner as they had to interpret other texts.[46] Science, in his view, was not an interpretative (that is, hermeneutical) activity like others. Scientific work could be considered as essentially different from that of the humanists.

The idea that scientists worked with natural signs that were completely different from linguistic signs strengthened in the middle of the 19th century. The German scientist Hermann von Helmholtz was one of the most important thinkers to discuss the relation of signs to nature. In a set of authoritative and influential texts, he sought to understand scientists' engagement with the natural world as an engagement with signs. Helmholtz, like Saussure would do later, stressed the gap between representations and things represented. The thing sensed and our perceived sensation did not need to have a direct correspondence:

> »To ask whether a perception which I have of a table, of its shape, solidity, color, weight, etc., is true and corresponds with the real thing or whether it is false and rests upon an illusion independently of the practical use to which I can put this perception has no more sense than to ask whether a certain sound is red, yellow, or blue.«[47]

He also understood spoken linguistic signs as different from alphabetic signs. The lack of direct correspondence between things-in-themselves and our perception of them was as stark as the difference between written and spoken language: »Perception and things perceived belong to *two completely different worlds* which admit of no more comparison to one another than colors and sounds or the letters of a book to the sound of the words which they signify.«[48]

Helmholtz understood the stark difference between »things« and »things perceived« to be as important as the difference between speech and text. With Kantian skepticism, he described scientists as unable to grasp the thing-in-itself and as dealing with nature indirectly only through its appearance through signs, in ways comparable to readers focusing on »the letters of a book.«

Did this mean that the signs processed by our brains when confronting nature were no different from those processed when dealing with texts? For Helmholtz,

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46 Mario Biagioli: Stress in the Book of Nature: The Supplemental Logic of Galileo's Realism, in: MLN 118/3 (2003), pp. 557–585.

47 Helmholtz' Treatise on Physiological Optics, Vol. III, edited by James P.C. Southhall, published by The Optical Society of America, Menasha 1925, p. 19; Hermann von Helmholtz: Handbuch der physiologischen Optik, Leipzig 1867, p. 443.

48 Ibid.

the analogy between spoken and written language and the language of sense impressions had *a clear and distinct limit*. Helmholtz was clear about where the difference lay between regular language and the language of science. According to him, the difference between »the symbolism of human language« and the »symbolism of our sensitive nerves« resided in that the first one was »produced by arbitrariness [Willkür]« while the other emerged from »nature itself.« In his famous *Treatise of Physiological Optics* he explained his position clearly: »Our representation of things can absolutely be nothing other than symbols« yet he included the caveat that these are »signs given naturally by the things that we learn to use for regulating our movements and actions.«[49] In other work, he explained how the diversity of languages, of »linguistic families [Sprachstämme] and dialects« contrasted sharply with »the language of our sensitive nerves« which was »the same for all humanity.«[50] The first was taught to us by our »mothers«; the other one by nature (Helmholtz set apart mothers from the rest of nature): »The first lessons of the mother tongue are clearly much harder than any subsequent attempts to learn a foreign language,« he explained. Why? Because learning our »mother tongue« required dealing with the »sounds« of spoken language for the first time, something more complicated that the relatively simple process of deciphering our »sensorial impressions« during active life.[51]

10. The transportation of violence

Many scholars have remarked on Helmholtz's understanding of our engagement with the world in terms of signs.[52] It is now time to investigate more fully how he understood the difference—the demarcation—between an engagement with signs which could lead to science and one that would remain literary. When Helmholtz described the transmission of stimuli through the nerves as a telegraphic dispatch, he did *not* conceive it in terms of everyday communication. His description of the technology was consonant with how it was used at the time: an imperial and

49 Ibid.

50 Hermann von Helmholtz: Ueber die Natur der menschlichen Sinnesempfindungen, in: Koenigsberger naturwissenschaftliche Unterhaltungen 3 (1854), pp 1-20: 19.

51 Hermann von Helmholtz: Die neueren Fortschritte in der Theorie des Sehens (1868), in: Id: Populäre wissenschaftliche Vorträge, Braunschweig 1876, p. 97.

52 Particularly useful are Timothy Lenoir: Helmholtz and the Materialities of Communication, in: Osiris 9 (1994), pp. 185-207; Jacques Bouveresse: Langage, perception, et réalité, Nîmes 1995; Timothy Lenoir: Operationalizing Kant. Manifolds, Models, and Mathematics in Helmholtz's Theories of Perception, in: The Kantian Legacy in Nineteenth-Century Science, edited by Michael Friedman and Alfred Nordmann, Cambridge, MA 2006, pp. 141-210.

mostly military technology to which the general population had no access. It was a technology that actually transmitted effects. In the 1850s Helmholtz described it as transferring »intelligence [Nachrichten] from the extremities of the land to the governing center, and then in like manner bringing [zurückbringen] the will [Willensmeinung] of the ruling power to every distinct portion of the land.«[53] In other publications he repeated how it was used to produce a certain faraway *effect*.

Helmholtz compared sense impressions traveling through nerves to telegraph signals. »The nervous wires,« he explained, »may be compared to the wires of the electric telegraph.«[54] Later, in on *The Sensations of Tone* (first edition 1863) he was even clearer about the connection. »Nerves have been often and not unsuitably compared to telegraph wires. Such a wire conducts one kind of electric current and no other; it may be stronger, it may be weaker, it may move in either direction; it has no other qualitative differences.«[55]

When discussing the telegraph he described it in terms of the »propagation« (Fortpflanzen) of »news.« In the original German he used the terms »Nachrichten« and »Botschaft.« But the transmission of signs and news that concerned him were those that produced clear effects: »ring bells, explode mines, decompose water, move magnets, magnetize iron, develop light, and so on.« Helmholtz described our engagement with nature as an engagement with signs *because these could produce causal effects*: »Nevertheless, according to the different kinds of apparatus with which we provide its terminations, we can send telegraphic dispatches [Despeschen], ring bells, explode mines, decompose water, move magnets, magnetize iron, develop light, and so on. So with the nerves.«[56]

To explain the process of nerve transmission, Helmholtz and his collaborator Emil Du-Bois Raymond used the example (later borrowed by John Tyndall) of wounding a whale by throwing a harpoon on its tail. His notion of how sense impressions affected the brain was that of »sending« and »receiving« »news« in ways comparable to the effect of a weapon on its target. His technique for measuring the time lapse between stimuli and response, that first permitted him to describe sense stimuli in terms of sign transmissions, was first developed by Werner Sie-

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53 Hermann von Helmholtz: On the Methods of Measuring Very Small Portions of Time, and Their Application to Physiological Purposes, in: The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science 4 (1853), pp. 313-325: 320; Hermann von Helmholtz: Ueber die Methoden, kleinste Zeittheile zu messen, und ihre Anwendung für physiologische Zwecke, in: Königsberger Naturwissenschaftliche Unterhaltungen 2 (1851), pp. 169-189.

54 Ibid.

55 Hermann von Helmholtz: On the Sensations of Tone as a Physiological Basis for the Theory of Music, New York 1954, p. 149.

56 Ibid.

mens, then lieutenant of the Prussian army, and by Claude Pouillet *with the purpose of measuring the speed of artillery weapons for military processes.*

Helmholtz made no distinction between the transmission of sense-impressions, signs ,and other ways of transmitting things, from news to harpoons. While he claimed that »perception and things perceived belong to two completely different worlds,« these two worlds overlapped in key ways, such as in the process of »regulating our movements and actions.« Perceptions and things perceived, he explained, matched in the same way a weapon connected with its target (the actual example he used). He referred to the transmission of sensorial signs from nature to our consciousness in the same way as he described the transmission of an object to its target. The role of sensorial signs in coordinating our movement and actions was what granted them a special status different from other signs.

11. Nietzsche and the violence of language

Because Helmholtz understood the transmission of signs in terms of the transmission of such things as a harpoon, the spark of a detonator for mine explosions, or a firm military order, sensorial signs remained tightly coupled to technologies of violence.

Nietzsche followed closely the scientific research on the physiology of nerve transmission associated with Helmhotz' investigations. In an unpublished text *On Truth and Lies in a Nonmoral Sense* (1873), he waxed poetic about the possible implications of the disconnect between sensory stimuli and the world itself. What were the consequences of thinking of reality in terms of signs? He sided with the Kantian maxim that stressed the impossibility of ever knowing the »things-in-themseves,« but he took this critique further by saying that no principle of »sufficient reason« could ever vouch for the validity of our inferences drawn from things. »What is a word? It is the copy in sound of a nerve stimulus (Nervenreiz). But the further inference from the nerve stimulus to a cause outside of us is already the result of a false and unjustifiable application of the principle of sufficient reason.«[57] Nietzsche displayed a thorough knowledge of recent work on the physiology of sense impressions, which was being popularized by Helmholtz and his collague Du Bois-Reymond: »The thing in itself first appears as a nerve stimulus, then as an image, and finally as a sound.« Because of how nerve stimuli ended up as words, one could think that scientists dealing with nature ran the risk of not getting to the bottom of things: »Their senses nowhere lead to truth; on the con-

57 Friedrich Nietzsche: Über Wahrheit und Lüge im außermoralischen Sinn, in: Unzeitgemässe Betrachtungen, edited by Alfred Baeumler, Stuttgart 1955.

trary, they are content to receive stimuli and, as it were, to engage in a groping game on the backs of things.« Scientists as much as philosophers were living in the »never-never land« of language: »All the material within and with which the man of truth, the scientist [Forscher] and the philosopher later work and build, if not derived from never-never land [Wolkenkuckucksheim], is at least not derived from the essence of things.«

A new understanding of the world as a system of sign transmissions brought with it distinct philosophical riddles. How could one leave the »cuckoo in the clouds« land of language divorced from the essence of things, even in the case of those most directly connected to sensory stimuli? For Nietzsche, these lessons in physiology and lingustics taught him that *a different kind of non-scientific truth* would invariably show itself, erupting frightfully and communicating in a different, archiac and, complex way: »And he requires shelter, for there are frightful powers which continuously break in upon him, powers which oppose scientific ›truth‹ with completely different kinds of ›truths‹ which bear on their shields the most varied sorts of emblems [Schildzeichen].«[58] Violence erupted in the use of language—even when it was disconnected from the »things-in-themselves.«

How could science defend itself from Nietzsche's pessimistic conclusions? How could scientists escape from a labyrinth of signs, one that despite its connections to communication, nonetheless led directly to »frightful powers which continuously break in?«

12. Signs, beyond Einstein

Position Einstein's »discourse network« within the larger technical, philosophical, and scientific discussions involving the terms »sign,« »signal« and »symbol.« The definition of these terms was in flux during the first decades of the twentieth century. The philosopher Edmund Husserl struggled to clarify the concept of sign in the first volume of his *Logical Investigations* (1900). Husserl started his text by »pointing out a confusion: The word ›sign‹ (Zeichen) covers … two heterogeneous concepts: that of expression (Ausdruck), which is often wrongly taken as a synonym for sign in general, and that of indication (Anzeichen).«[59] Husserl concluded that »Anzeichen« or indication signs »are signs that do not express anything,« because they »do not transport anything that one could understand as meaning

58 »Und Schutz braucht er: denn es gibt furchtbare Mächte, die fortwährend auf ihn eindringen und die der wissenschaftlichen ›Wahrheit‹ ganz anders geartete ›Wahrheiten‹ mit den verschiedenartigsten Schildzeichen entgegenhalten.« Ibid., p. 618.

59 Cited in Jacques Derrida: La Voix et le phénomène, Paris 1967, pp. 2, 17.

[Bedeutung] or sense [Sinn].«[60] By noting the different role of these two concepts, meaningful and meaningless signs, Husserl hoped to shed light on how »essential distinctions« in Western thought emerged, with the purpose of finding a common ground from which both surfaced.

The publication of Ferdinand de Saussure's lectures in 1916 laid out the basic categories for the linguistic study of »signs« for the rest of the century. During those years, Saussure's students noted their teacher's preference for breaking down the term »sign« into two components, »signifier« (which in spoken language corresponded to the word uttered) and »signified« (which was the concept referred to by the word). By dividing the concept of sign into two parts, Saussure stressed one particular insight that would be frequently cited and remarked on for decades to come: the »arbitrary« notion of the sign: »Since I mean by sign the whole that results from the associating of the signifier with the signified, I can simply say: the linguistic sign is arbitrary.«[61] By arbitrary, he clarified, he did not mean that it depended »on the free choice« of the speaker, but rather only that there was »no natural link« between them. This insight permitted thinkers to consider the study of language as entirely separate from the study of nature.

Where did »signals« and »symbols« fit within Saussurean linguistics? Did they also have an arbitrary relation to the concept represented? According to the influential linguist, a symbol was a type of sign (closer to the signified), but it was not precisely the same, since the symbol maintained »a vestige of a natural connection« to a concept. »The symbol for justice, the scales« he explained, »could hardly be replaced by just anything, such as a chariot, for example.« Signals, in contrast, had no connection *at all* to the concept. They were like linguistic signifiers, but less »important« than those used in spoken language: [62] »Language is a system of signs that express ideas, and is therefore *comparable to* writing, the alphabet of deaf-mutes, symbolic rites, polite formulas, military signals, etc. But it is the most important of all these systems.«[63] Signals and symbols represented the two extreme poles constituting a sign, where one end (that closer to symbols) maintained a »connection« to nature, whereas the other (signals) did not at all, being even more free-floating and arbitrary than linguistic signs.

It is hard to underestimate the impact of Saussurean linguistics on numerous disciplines, from anthropology to philosophy. What I want to stress is one particular aspect of it. Recall Saussure's reference to military signals. Their importance resided in that they had even less of a connection to the concept represented

60 Ibid.
61 Ferdinand de Saussure: Course in General Linguistics New York [3]1966, p. 67.
62 New translations may render »signifié« as »signal.«
63 Saussure: Course in General Linguistics (as note 61), p. 16.

than the signs used in spoken language, which although also arbitrary, were nonetheless a much more »important« system. By framing signals as »arbitrary« Saussurean linguistics furthered the separation of the study of language from the study of nature. What conclusions did this separation entail for our understanding of science, in particular theoretical physics, and for applied physics research that was used to improve military signaling? One aspect was clear: »signals« had a special status within language systems because they were considered to be completely »arbitrary« and not part of nature itself. Scientists, even when their work referred to the limits and possibilities of communication characterizing a specific historical era, dealt exclusively with nature—since the communication concepts they used were considered as belonging to an »arbitrary« system. In other words, lessons about the speed of »arbitrary-voluntary signaling« (willkürliche Signalgebung) could be understood as a »consequence« of the cosmological implications of »a universal constant *c*« but not the other way around. In Einstein's words: The inability »to send signals that would travel faster than light in a vacuum« was a »consequence, as strange as it is interesting« of his theory.[64]

13. Derrida's critique of Saussure's »military signals«

WWII introduced a new element into the discourse network of the Second Industrial Revolution. During Vichy and afterwards, the philosopher Louis Lavelle explained how certain signs systems connoted »presence« more than others. His work was continued by the Jesuit media scholar Walter J. Ong, author of *The Presence of the Word* (1967). Ong privileged the spoken word as most tightly connected to »present actuality« than anything else.[65] »Communication, like knowledge itself,« he explained, »flowers in speech.«[66] Sound was special, according to him, because it was »indicative of here-and-now activity, the word as sounds establishes here-and-now personal presence. Abraham knew God's presence when he heard his ›voice‹.«[67]

Ong was concerned with how »electronic media of radio and tapes and loudspeakers« joined with »the telegraph…and progressing through the telephone, radio, television, the computer, and now Telstar, have brought virtually all parts

64 Albert Einstein: The Principle of Relativity and Its Consequences in Modern Physics, in: Archives des sciences physiques et naturelles 29 (1910), pp. 5-28.

65 Walter J. Ong: The Presence of the Word: Some Prolegomena for Cultural and Religious History, The Terry Lectures, New Haven 1967, pp. 111, 116.

66 Ibid., p. 1.

67 Ibid., p. 113.

of the globe into contact with all other parts.«[68] This new media configuration could potentially disrupt »the story of the word among men as a natural mystery, a key point at which Christian revelation (and preceding it, Hebrew revelation) establishes contact with human existence.«[69] He sought to protect the biblical story of *viva voce* revelation with all his might.

Was the privileging of the »voice« which such humanists extolled related to scientists' privileging of light signals in the physical universe? Electromagnetic media played key roles in both. But by 1968 magnetic »tape« recorders and »computers« were changing the discouse network of the era in a radically new way.

Why were certain signs more special than others? The answer changed with the appearance of new media. A new generation of scholars led by Jacques Derrida criticized the strange privileging of certain signs that previous thinkers had considered to be closer to nature than others. Derrida, followed by Kittler, pointed out that a »metaphysics of presence« underpinned most investigations of communications media—including those of Marshall McLuhan.[70] Derrida and Kittler continued to contest the hierarchy attributed to different kinds of signs. Kittler, upon noticing that McLuhan »converted to Catholicism long before his international career,« considered it in connection to an »arch-catholic media cult.«[71]

Derrida's critique, although centered on practices involving spoken and written signs, had implications for science as it questioned the category of »signal« by referring to Sausurre's comments on »military signals.« Derrida first returned to Husserl's musings about signs in *Logical Investigations*, a text that »opened a way in which, as we know, marked the whole of phenomenology.«[72] He noted that the concept of sign used by most linguists and philosophers from Husserl onwards privileged the spoken word over other signs, including signals. Derrida was particularly irritated at how Saussure's model of language set it apart from other systems, such as those that included the system of military signals. In *Of Grammatology*, he cited Saussure's reference to »military signals« and his setting aside of them by virtue of their arbitrary relation to nature, which he then proceed to dismantle throughout the rest of the book.

68 Ibid., pp. 15, 101.

69 Ibid., p. x.

70 Jacques Derrida: Excuse Me, But I Never Said Exactly So. Yet Another Derridean Interview, in: On The Beach, no. 1 (August 1983), p. 42, under: http://www.egs.edu/faculty/jacques-derrida/articles/excuse-me-but-i-never-said-exactly-so/ (February 7, 2014).

71 Friedrich A. Kittler: Optical Media: Berlin Lectures 1999, Cambridge 2010, p. 30.

72 »Les *Recherches Logiques* (1900-1901) ont ouvert un chemin dans lequel, on le sait, toute la phénomenologie s'est enfoncée.« Derrida: La Voix et le phénomène (as note 59), p. 1.

Derrida inaugurated a new way of thinking about signs in relation to signals in a manner that differed markedly from how they were understood in the system of sciences around 1900. He explained that the hierarchy that attributed such »presence« to spoken language at the expense of other forms of communication and sign systems was actually the result of a particular technological configuration that could shift. To make his point against the »metaphysics of presence« that clouded contemporary philosophy (Lavelle and Ong among others) just as much as media theory (McLuhan), he explained how if a »tape recorder« were to be considered a writing machine, it would become impossible to continue privileging the »voice.« »Tape recordings are writings in some sense,« he explained, arguing against the view that considered the spoken word as having a special status within communication systems.[73]

Derrida's work proved particularly useful for studying the world—including human subjects in it—as part of underlying transformations of spoken and written signs and signals. Our sense of »subjectivity« was tightly connected to the act of hearing oneself speak, he argued.[74] The act of hearing oneself speak could be seen as creating the subject, not the other way around.

14. Kittler on »the system of science in 1900«

While Derrida criticized the common coupling of a subject and his voice, Kittler focused on how the modern author, both male and female, lost mastery of writing itself. Describing laboratories of experimental psychology in which subjects reacted to signs and symbols and tracing the impact of these practices for high literature, Kittler remarked how the author was no longer the master of writing: »Writing … is no longer based on an individual capable of imbuing it with coherence through connecting curves and the expressive pressure of the pen, it swells in an apparatus that cuts up individuals into test materials.«[75] »The system of sciences in 1900,« explained Kittler, »destroyed the monopoly of writing« through new techniques for managing, storing, and distributing »streams of information« in a way that could no longer be controlled or determined by autonomous subjects.

How did the Second Industrial Revolution connect with the Einsteinian revolution? By focusing on the instruments of the first industrial revolution, lamented Kittler, scholars had forgotten to pay attention to those of the second. »Steam

73 Derrida: Excuse Me, But I Never Said Exactly So (as note 70), p. 42.

74 Derrida: La Voix et le phénomène (as note 59).

75 Friedrich Kittler: Discourse Networks 1800/1900, translated by Michael Metteer and Chris Cullens, Stanford 1990, p. 223.

engines and looms,« he explained, »became topics, but typewriters did not.« What can we learn by shifting our focus away from the paradigm of »energy and labor« to that of »information«? The stakes involved in Kittler's contribution were not limited to extending the historian's repertoire; they were, most importantly, about exploring a new relation between communication, poetics, reason, and technology in a way that would »explode the two-cultures schema of our academic departments« and the Enlightenment conception of the human subject.[76]

Consider the difference between physics and psychology and between quantitative versus symbolic knowledge. According to Kittler, one consequence of the system of sciences around 1900 was that it could permit us to see why the discipline of psychoanalysis increasingly relied on the »symbolic method« and parted ways with the ideals of transcendental knowledge.[77] The »symbolic method« to which he referred was one no longer based on standard operations of reasonableness and comprehensibility used in the human and physical sciences of the Enlightenment tradition.[78]

During the early 20th century, dream interpretation became one place where the focus on the symbolic flourished most rapidly, since it was not hard to convince people (and patients) that dreams carried important messages while at the same time it was clear that these were coded in an unreasonable language. After all, since ancient times, the belief that omens came in dreams, and that these were hard to decipher, was commonplace. But soon Freud was able to convince many that the benefits of the symbolic method could be applied beyond dreams to the study of the psychopathology of everyday life. In consequence, the division between the rational interpretative techniques of the physical sciences and those staking out a completely different order of understanding widened.

What could be gained by considering unreasonable discourse on the same footing as rational communications? Kittler faulted Habermas for not wanting to acknowledge the centrality, in the history of modernity, of these alternative »symbolic« forms of knowledge and to brush them aside as a »scientific misunderstanding.«[79] According to Habermas, these trends were nothing other than missteps that led

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76 Ibid., p. 371.

77 Information technologies, in Kittler's view, played a decisive role in the branching off of a dastardly »symbolic method,« no longer based on transcendental notions of comprehensibility: »But innovations in the technology of information are what produced the specificity of the discourse network of 1900, separating it from transcendental knowledge and thus separating psychoanalysis from all human science.« Ibid., p. 278.

78 Ibid.

79 Ibid. The reference to Habermas appeared in note 27, p. 408. It referred to »The Scientistic Self-Misunderstanding of Metapsychology: On the Logic of General Interpretation,« in Jürgen Habermas: Knowledge and Human Interests, Cambridge 1987, pp. 246–273.

some to characterize Freud's psychoanalysis *as* science. In the Habermasian view, legitimate sciences, including the bona fide human sciences, which did not include psychoanalysis, belonged to the order of *reasonable* discourse.

Parting ways with transcendental knowledge and Enlightenment ideals of sense and reason was controversial. A reluctance to focus on this aspect of Western civilization could be tantamount to turning a blind eye to the increasing militarization occurring alongside the uncritical acclaim of techno-scientific culture. Was it fair to ignore the violent and irrational bursts of modernity that periodically reared their multiple heads, no matter how hard thinkers tried to discount them? Kittler was greeting alternative accounts of reason in modernity with open arms; Habermas was not. Habermas decided to remain a staunch defender of particular Enlightenment ideals of modernity, optimistically thinking that consensus (and wWorld peace) could result simply by combining human reason with unhampered flows of communication. For him, the quantitative sciences based on clear scientific measurements were ideal exemplars. He considered them to lay at the pinnacle of knowledge, superior to others: an »ideal speech situation,« belonging to »analytic-empirical« discourse that should be held up as a model for the rest of reasonable discourse.[80] Where did his optimism come from? Habermas considered science largely through the lens of Karl Popper, who understood it as a process of hypothesis formation and falsification. It hardly fit with actual scientific practices, with clear commercial and military connections.[81]

15. Foucault and the Second Industrial Revolution

»Foucault's historical research did not progress much beyond 1850,« lamented Kittler.[82] In contrast to Foucault, Kittler started to focus on the emergence of a new system of sciences by focusing on the role played by information technologies. Although Foucault thoroughly studied discursive rules or epistemes, he neglected to connect them to technologies on the ground. But Foucault's blindness toward

80 Gordon R. Mitchell: Did Habermas Cede Nature to the Positivists?, in: Philosophy and Rhetoric 36/1 (2003). See my discussion of this ideal in: Jimena Canales: A Tenth of a Second. A History, Chicago 2009, p. 219.

81 For the influence of Karl Popper on Habermas's account of science see his »Analytische Wissenschaftstheorie und Dialektik.« Habermas's blindness to scientific practices was hardly anomalous, since an attention to actual scientific practices was systematically effaced by positivist philosophers and only reemerged in the history and philosophy of science after the groundbreaking laboratory studies of Bruno Latour, Steve Woolgar, Karin Knorr-Cetina, and others.

82 Kittler: Discourse Networks 1800/1900 (as note 75), p. 369.

technology came from a particular assumption, argued Kittler: that discursive rules and epistemes *were* comprehensible. His attention was focused on finding »order« and his task in the tellingly titled *The Order of Things* and elsewhere, was to show »the coherence that existed …between the theory of representation and the theories of language, of the natural orders, and of wealth and value« at specific historical periods by inquiring into »the order that divided [things] up before presenting them to the understanding.« But according to Kittler, a belief that certain historical epochs were comprehensible because of a subtending cohesive »order« could only be maintained at the price of excluding technology from history. »Foucault conceived discursive rules as comprehensible and therefore overlooked technologies.«[83]

Technology indeed posed a problem for thinkers who attempted to divide knowledge practices into epistemes as they often cut across radically different epochs. The development of technology, as well, often seems to go beyond the control of human reason. A focus on technology quickly reveals that our very ideas of order, causality, and effectiveness change in step with different kinds of technology, implicating our explanations of breaks, continuities, and historical development. When asked about how one could think of the »causes« for a change from one episteme to the next Foucault was simply embarrassed by the question: »Questions like these are often highly embarrassing because there are no definite methodological principles on which to base such analysis. The embarrassment is much greater in the case of those general changes that alter a science as a whole.«[84]

The role of technology in the history the Second Industrial Revolution showed Kittler simply too many historical transformations incompatible with Habermas's »communicative rationality.« It also showed him too many examples that did not fit with the neat borders of Foucauldian epistemes stacked in neat chronological order.

Habermas was optimistic; Kittler was pessimistic. Habermas separated reason and communication from violence and war; Kittler claimed that »information technology is always already a strategy or war.« Habermas placed an emphasis on understanding and trust in the development of history; Kittler on misunderstanding and mistrust. Habermas assented to Walter Benjamin's contributions to historical materialism and the Frankfurt school while he lamented those tainted with »theology« and »mysticism«[85]; Kittler, in contrast, celebrated Benjamin's pessimis-

83 Ibid., p. 278.

84 Foreword to the English edition, in: Michel Foucault: The Order of Things. An Archaeology of the Human Sciences, New York 1973, p. xiii.

85 »Benjamin did not succeed in his intention of uniting enlightenment and mysticism because the theologian in him could not bring himself to make the messianic theory of experience serviceable for historical materialism.« Jürgen Habermas: Walter Benjamin.

tic rebelliousness in its unrepentant disclosure of the role of misunderstanding and mistrust in human history, which arrived with new and potent technological innovations:

»And that means: pessimism all the way down the line. Mistrust in the fate of literature, mistrust in the fate of freedom; mistrust in the fate of European humanity, but above all mistrust, mistrust, and more mistrust in all understanding, between the classes, between peoples, between individuals. And unlimited trust only in I.G. Farben and the satisfactory perfection of the air force.«[86]

Habermas and Kittler differed in how they read Walter Benjamin as much as they differed in their understanding of technology.[87] Habermas thought of »language« as distinct from »nature« and considered the basic elements of communication as separate from technology.[88] Kittler, in contrast, did not attribute to language this otherworldly status.

16. Conclusion

Kittler corrected Foucault's blindness towards technology, but he left science untouched. What happens if we think of science in connection to much broader changes in other forms of communication? We can see its unique place within broader systems based on emblems (an early modern concept present in the work of Galileo), signs (a 19th-century concept in the work of Helmholtz), and later signals (in the work of Einstein).[89]

Consciousness-Raising or Rescuing Critique, in: Walter Benjamin: Critical Evaluations in Cultural Theory, ed. Peter Osborne, London and New York 2005, pp. 107–136: 124; Jürgen Habermas: Consciousness-Raising or Redemptive Criticism. The Contemporaneity of Walter Benjamin, in: New German Critique 17 (1979), pp. 30–59.

86 Walter Benjamin: Der Surrealismus. Die letzte Momentaufnahme der europäischen Intelligenz, in: Gesammelte Schriften, edited by Rolf Tiedemann and Hermann Schweppenhäuser, Vol. 2, Frankfurt am Main 1972, cited in Friedrich Kittler: Discourse Networks 1800/1900 (as note 75), p. 371.

87 Cf. Jürgen Habermas: Science and Technology as ›Ideology‹, in: Toward a Rational Society. Student Protest, Science, and Politics, Cambridge 1987, pp. 81–122.

88 »What raises us out of nature is the only thing whose nature we can know: language.« See Appendix in Habermas: Knowledge and Human Interests, Cambridge 1987, p. 314. Habermas separated technology from the challenges of communication: »[T]he institutional framework of society is still distinct from the systems of purposive-rational action themselves. Its organization continues to be a problem of practice, not one of technology, no matter how scientifically guided.« Habermas: Toward a Rational Society. Student Protest, Science, and Politics (as note 86), p. 104.

89 For emblems see Mario Biagioli: Galileo the Emblem Maker, in: Isis (1990), pp. 230–258.

Einstein's work depended on a particular understanding of the role of signals in nature, where »light signals« appeared as seperate from »all other things.« They belonged to a separate realm, of »universal constants,« on which the scientific understanding of the physical universe depended. While the introduction of the alphabet and the expansion of literacy fostered a belief in the separation between myth and history, the second industrial revolution, based on electrodynamic information technologies and light standards (signals), furthered the separation between myth, history, *and* science. Can signals, and within them light signals, be reconsidered as part of culture? Signals are, after all, »the call that summons the people within and beyond borders of the parish to gather to hear the word of God, to put out the fire, to fight the enemy.«[90]

The »light signaling protocol« central to the theory of relativity was based on a new way of understanding the relationship of science to technology and to violence. The belief in the separation between might and right is as old as civilization, but the actual place of »light« in these divisions is much more recent.[91] Light signals during Einstein's time were part of a new model of communication that was no longer based on transportation and which excluded the transportation of physical violence. In 1934 the famous historian of technology Lewis Mumford connected two different types of »communication technologies« in a famous phrase. »If the cannon was the first of the modern space-annihilating devices by means of which man was enabled to express himself at a distance, the semaphore telegraph (first used in war) was perhaps the second.«[92] Mumford's phrase was particularly shocking because by the time it was written, the difference between these two forms of »communication at a distance«—one based on light rays and the other one on cannon bombs—had grown to the point that one was frequently associated with peace, rationality, science, and functional communication while the other was associated with violence, irrationality, technology, and communicational breakdown.

In Paris after WWII, the philosopher Michel Serres was still shell-shocked by the tight links he noticed between science and war. He lamented that »traditional epistemology still was not asking any questions on the relationship between science and violence« and started to find a different way of theorizing the relation between them. A friend lent him a copy of Brillouin's *Science and Information Theory* (1959), the culmination of a scientific career that started in WWI when the

90 Bernhard Siegert: Mineral Sound or Missing Fundamental. Cultural History as Signal Analysis, in: Osiris 28 (2013), pp. 105-118: 117.

91 Jimena Canales: Flash Force: A Visual History of Might, Right and Light, in: Seeing With Eyes Closed, edited by Elena Agudio and Ivana Franke, Munich 2011, pp. 34-41.

92 Lewis Mumford: Technics and Civilization, New York 1934, p. 89.

young soldier started working in the Signal Corps.[93] The tome, and its historical context, helped Serres understand how violence introduced itself into »reasonable« discourse, becoming its precondition: »Violence is one of the two or three tools that permit us to insert the local into the global, to force it to express the universal law, to make reality ultimately rational.«[94] Mumford, Serres, and only a handful of other thinkers considered technologies of communication in connection with technologies of violence, rewriting standard narratives about the role of science and technology in a world marked by good and evil.

Einstein's work formed part of a broader discourse network in which technologies of communication were separated from those used for the transportation of violence. For this reason, telecommunications media were largely assessed in terms of veridical and false reporting. Although they continued to be central to war, they were manned from a sanitized »behind-the-desk« distance. The ethical valance attributed to communicative action changed accordingly, as it was safely separated from direct violence. True or false, rather than right or wrong, vice or virtue, became the pertinent binaries of the Information Age.

The play between reason and unreason was defined by referring to »light signals« in the age of mass media, where »reason« took as its model the sciences based on them as representing ideals of consensus while »unreason« was associated with the violence typical of miscommunication and symbolic discourse (Habermas). But their separation on that basis falls apart the moment we consider the role that »light signals« played in science as a small subset of the much more complex role they held in the broader culture.

What happens if we turn off the light? »If ›straight line‹ or ›geodesic‹ has *light ray path* as physical correlate, what about straight lines in the dark?« asked the philosopher Bastiaan van Fraassen. The universe would still maintain its shape. Scientifically, nothing would change. »[T]here is a real fact of the matter whether the signal *would* have reached if it *had* been emitted.«[95] The discourse network that emerged around 1900 was a universe of signals that would always arrive—even in the dark and with all light switches turned off.

Image caption: Still from silent film COLLEGE CHUMS (USA 1907, Edwin S. Porter, Edison Manufacturing Company).

93 Michel Serres and Bruno Latour: Conversations on Science, Culture, and Time, Ann Arbor 1995, p. 12.

94 Michel Serres: Jouvences sur Jules Verne, Paris 1974, p. 75.

95 Bastiaan C. van Fraassen: Time in Physical and Narrative Structure, in: Chronotypes: The Construction of Time, edited by John B. Bender and David E. Wellbery, Stanford 1991, pp. 19–37: 33.