

Localism versus holism. Historical origins of studying language in the brain

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I need not tell you that Flemish Andreas Vesalius was the first serious brain anatomist. Book VII of his great anatomical work *De humani corporis fabrica* (1543) concerns the brain. The brain is the organ where the animal spirits/fluids are refined and then delivered to the relevant bodily organs. Whereas Galen and many scholars¹ after him had adduced an essential role to the ventricles – the “ventricle localization theory” – Vesalius criticized that theory because the ventricles in humans and animals are unexpectedly much alike. They generate the animal spirits only, not our rational spirit, which we share with the angels and which, no doubt, includes language.² The ventricles are carefully depicted in Vesalius’ diagrams, as opposed to the less relevant convolutions, which “were drawn like intestines rather than the way the brain really looks” (Brysbaert and Rastle 2013, p. 225).

Many, often detailed case studies of aphasia reported in the following centuries raised the awareness of the role specific brain injuries play in the causation of a variety of speech and language problems (see, for instance, Tesak and Code 2008). But coherent theorizing about the localization of language functions in the brain did not arise before the end of the 18th century. Since that is the topic of the present Sarton Lecture, let us begin with Franz Joseph Gall, who provided the foundations for the cerebral localization theory which reverberates till the present day.³

¹ But not all. O’Neill (1993) demonstrated a preponderance of “meningeal localization theories” during the Middle Ages. See also Whitacker (2007).

² See Catani & Sandrone (2015), p. 98.

³ Unavoidably, some of the materials in this article have their source in my *A history of psycholinguistics. The pre-Chomskyan era* (2013).

Gall received his MD in 1785 in Vienna and then established himself in medical practice. He began lecturing and publishing on his nativist and comparative theory of mental faculties and he began measuring the shapes of skulls, in the conviction that they would reveal something about pronounced mental capacities and features of their bearers. Then, around 1800 onwards, he started his grand anatomical project, dissecting brains of man and animal, drawing magnificent plates and lecturing famously on brain anatomy and on the corresponding mental faculties.

In 1805 Gall left Vienna, together with his assistant Casper Spurzheim. In 1801 he had become conservative Kaiser Franz's *persona non-grata* because of his materialistic views on the human mind. During 2 years Gall roamed all over Europe, teaching, visiting clinics and examining patients. In 1807 he settled in Paris as a private practitioner. His dissection classes and his lecturing attracted some of the best medical students, such as Pierre Flourens.

In Paris, Gall set out to write his magnum opus, initially assisted by Caspar Spurzheim, and written in his rather elementary non-native French. The four books, beautifully edited in two folio-size volumes, plus an atlas with exactly one hundred plates, appeared from 1810 to 1819, all privately paid by Gall.

Gall made the idea of discrete localization of functions fully explicit by relating the functional architecture of mind, its 27 faculties, to the neural architecture of the brain, which he had so thoroughly studied over the years. "Show me the basic forces of the soul, and I will find the organ and the seat thereof", Gall wrote in 1818 (vol. III, p. 42). It had become a systematic empirical project, based on two sources of evidence.

There is, first, the evidence from brain damage related to loss of a faculty. His books are full of cases of this type. Gall, for instance, was probably the first to both describe and localize Broca's aphasia. Here is my translation of the relevant text in Book IV, pp. 53-54.:

The patient was an officer, hit by a foil "in the midst of left canine tooth region, close to the nostril, in oblique direction from below up", penetrating some 3.5 inch "into the internal posterior of the left frontal lobe, in such a way as to reach the anterior part of the mesolobe." The patient was right hemiplegic and "the memory for words had totally extinguished".

However, rarely would such damage have affected the region of a single faculty. There is, instead, a second, much more promising way of going about testing mental faculties and localizing their organs in the brain. The more outspoken a faculty, such as memory for language, the larger the size of the corresponding region in the brain. These innate brain protrusions would not only show on the inside cavity, but also on the face of the skull. The procedure was to select your clear cases, such as a verbally or musically gifted person, make a cast of their skulls and run your comparative measurements. Gall could have been right about his protruding organs of mind. In fact, the idea never disappeared entirely. But his idea of there being visible marks of faculty-related brain protrusions on the face of the skull was, regrettably, an empirical bridge too far.

Gall distinguished two language faculties, the memory for words and the philological faculty. He localized them, closely together, in the anterior cortex somewhere behind the eyes. This became a topic of fierce controversy in the decades to come. Also, Gall proclaimed all faculties, including the language faculties to be symmetrically localized in both hemispheres: “*All specific systems of the brain are double, like those of the spinal chord and of the senses.*” (Gall’s italics, Vol. I, p. 225). This was known as “Bichat’s law”; it was dogma during the first half of the 19th century, but would also become a topic of controversy.

Gall died in 1828. A 1823 cast of Gall’s own head went to the National History Museum in Paris. Gall’s friend Dr. Fossati, provided the following cranioscopic diagnosis: “... locality, sense of persons, language, number, order, tune, colour, constructiveness, were all feebly developed; whilst comparison, causality, individuality, eventuality, and firmness were uncommonly large.” (Hunt 1869, p. 204).

Gall’s theory, including his theory of language, became the prototype of *localism* in cognitive neuroscience. In this talk I will contrast it with *holism* and the prototypical holist theory was not far away. Pierre Flourens, who had studied in Paris among others with Gall, praised Gall for his outstanding dissection skills. But he also became one of Gall’s fiercest opponents. From his ablation experiments on a variety of animals he concluded that the grand regions of the brain corresponded to the grand regions of mind. The hemispheres, in particular, are exclusively involved with intellectual functions; they do not perform any other function, such as voluntary movement. And their functioning is equipotential:

My experiments demonstrated it: one can dissect a rather extensive portion from the cerebral hemispheres, be it on the front, in the back, on top or on a side, without loss of intelligence. A fairly limited portion of those hemispheres thus suffices for the exercise of intelligence. (Flourens 1842, p.18).

Localizing faculties was a dead-end street, according to Flourens, and ultimately to the majority of established French neurologists. It still reverberated a century later, on the basis of similar experiments, in Karl Lashley's 1929 theory of equipotentiality and mass action in the associative areas of the brain. The term equipotentiality, he stated,

I have used to designate the apparent capacity of any intact part of a functional area to carry out the functions which are lost by destruction of the whole. (Lashley 1929, p. 25).

And on mass action:

the efficiency of performance of an entire complex function may be reduced in proportion to the extent of brain injury within an area. (Lashley 1929, p. 24).

These are holistic principles. In the following I will collect a number of them. They are summarized in Table 1 below. The issue of localism versus holism would remain a major controversy in the study of brain and language. In the following I will distinguish three grand phases in the history of this field preceding World War II.

Table 1.

Some holistic principles/functions proposed during the three phases of studying language in the brain.

- Equipotentiality (Flourens, Lashley)
- Mass action (Lashley)
- Network functioning, disconnection syndromes (Wernicke, Lichtheim)
- Propositionizing and devolution (Jackson)
- Volitional left-hemisphere control (Jackson)
- Diaschisis (Monakow)
- Kinetic melody (Monakow)
- Electrical vibration theory of cerebral functioning (Marie)
- Gestalt formation (Goldstein)

PHASE I. **Localizing the brain region for articulate speech as a litmus test for a localist mind/brain theory (1800-1870)**

With Gall, Phase I was introduced. Localizing the faculty of articulate speech became the litmus test for Gall's general localistic theory. Loss of articulate speech was a well-defined, often sudden loss of function. If it could be adduced to a defect in a particular brain region, the principle of localization was upheld. Performing this litmus test became a dominant theme in French neurology over four decades following Gall's death in 1828. Here are some of the highlights of that controversial discussion.

Jean-Baptiste Bouillaud also studied with Gall in Paris, but different from Flourens, he continued Gall's localistic theory of mental faculties. In 1831 he established the Paris Society of Phrenology. But he gave up on measuring protrusions, either on the skull or on the cortex. In 1825 he published a paper which is still modern in its approach. In order to verify Gall through the localization of articulate speech, he argued that autopsies of patients with loss of articulate speech should show damage to the anterior lobes (positive evidence). If autopsy shows damage to the anterior lobes, there should have been loss of speech (negative evidence). If autopsy shows damage to another brain region, there should not have been loss of speech. Harry Whitaker (2006, p. 604) noticed that this introduced the principle of double dissociation in cognitive neuroscience. The paper presents 47 cases, all claimed to support these hypotheses (but see Luzatti and Whitaker 2001).

In 1848, 23 years later, Bouillaud presented more evidence in a paper (published as a monograph) for the Medical Academy of which he was a member like Flourens, and then offered a premium of 500 francs for any counterfactual case submitted. The award was never claimed.

Before we follow this up, we must consider another, independent line of research, which put in doubt Bichat's law of symmetry. Marc Dax, home doctor at Montpellier, had collected statistics on patients in his practice with loss of speech. He had noticed that they were usually right-sided hemiplegic. In 1836 he wrote a paper on this, which, however, was not published. His son Gustave Dax, physician in Sommières, continued the statistics and decided to submit, in 1863, to both the Academy of Sciences and to the Medical Academy, his father's paper and his own and Lallemand's statis-

tics, now encompassing 370 hemiplegia cases. The Academy of Sciences' set-up committee, with Flourens as a member, never responded. The Medical Academy's committee, or rather its chairman Lélut, responded after almost two years:

my opinion can no longer be changed, nor modified [...] the relation one wanted to establish between some fact or faculty of mind, and some part of the central nervous system [is] no less and no more than phrenology [which is a] pseudo-science. (Lélut 1865, p. 173).

These are the words of a rabid equipotentialist. It is also an early case of peer review failure. Only then, Gustave Dax took the sensible move to submit his joint paper to the *Gazette*, where it appeared on April 28, 1865 – a date to remember. It was the definitive refutation of Bichat's law of symmetry. And more: Gustave Dax concluded that the seat of articulate speech is in the

external anterior part of the medial left lobe [...] Hence, the cerebral organ of speech has been found. (Dax 1865, p. 262).

Let us return to Bouillaud. He had a son-in-law, also neurologist and localisationist, by the name of Ernest Auburtin. In 1861 Auburtin and Pierre Gratiolet organized a meeting on the topic of localization in the Anthropological Society of Paris, which young anatomist and surgeon Paul Broca had founded two years before. Against Gratiolet, Auburtin defended Gall's and Bouillaud's thesis that the faculties of language are localized in the anterior lobes. Broca was, as a Flourens student, at heart an equipotentialist. But he was open to dissenting opinion. Only days after Auburtin's communication, Broca's attention was called to a patient who had not been able to speak since 21 years, but who otherwise seemed to be in the possession of his mental powers. Broca realized that this could be a test case for Auburtin's challenge. Broca invited him to come and diagnose the patient for himself. Auburtin did and agreed to accept the outcome of a future autopsy as conclusive; the patient's brain should show frontal lobe damage.

The famous story has been often told. Mr. Leborgne was kind enough to die within two weeks. His "softened" left hemisphere showed an old infarct in the third convolution (Broca 1861a). However, most textbooks are wrong. In 1861 Broca did not discover the brain region controlling articulate speech. He was not even interested in it. Broca was fully explicit in the three papers he published that year: He was performing the litmus test for Gall's principle of localization. "localization of a single faculty

suffices to establish the veracity of that principle.” (1861b, p. 336). In this paper he conceded that the anterior lobes are involved with the faculty of articulated speech. Bouillaud had “saved from shipwreck” Gall’s original claim (p. 330). However, he declared “precise localization of functional organs unsolvable in the present stage of science.” (p. 338). And “the grand regions of the mind correspond to the grand regions of the brain” (p. 338), still following Flourens. It was not different for the third paper that year, which discussed another autopsy, with damage in the third frontal lobe. Broca concluded. “I am thus inclined to attribute to a pure coincidence, the absolute identity of the lesion site in my two patients.” (1861c, p. 407).

It was again not different for his 1863 paper, which discussed six more loss-of-speech autopsies, all showing damage to the left third convolution. This is what Broca concluded: “I don’t dare to draw a conclusion from that and I wait for new facts” (1863, p. 202). Have you discovered anything if you don’t dare to draw the conclusion?

However, the new facts were there already. Gustave Dax had submitted his papers to the two Academies just 10 days before. Clearly Broca had not seen them yet. Only after the Dax papers finally appeared on April 28, 1865, and clearly triggered by them, Broca quickly claimed his discovery in the *Bulletin of his Anthropological Society* (on June 15):

I persist in thinking, till more amply informed, that real aphémie, that is loss of speech without paralysis of the articulatory organs and without destruction of intelligence, is connected with lesions of the third frontal gyrus. [and with] the singular predilection of aphemic lesions for the left hemisphere of the brain. (1865, p. 378).

“I persist in thinking” – that was not entirely honest. And about Max Dax’s paper he said: “I don’t like priority discussions.” (p. 379). In spite of much checking, he had not found evidence for an earlier publication of father Dax’s paper.

Clearly, the Daxes should be granted priority of localizing the organ of articulate speech in the left perisylvian area. Reluctant Broca, with his superior brain anatomy, further confined that region to the foot of third convolution of the frontal lobe. These were the highlights of Phase I. Its upshot was that Gall’s principle of localization was upheld, as demonstrated for the case of the faculty of articulating speech. Let us now turn to Phase II, which moves us from France to Germany.

PHASE II. Relating the language faculty as a network of functions to neural networks in the brain. The “diagram makers” (1871-1905)

In 1874 Carl Wernicke, 26 years old, published his classic 68 page monograph *The aphasic symptom complex. A psychological study on anatomical basis*. My first Sarton Lecture mentioned two reasons why this document became epoch-making. It firstly reported Wernicke’s discovery of a left-hemisphere “sensory speech center” near the projection site of the acoustic nerve in the first temporal gyrus. It discussed patients with a lesion in that area and it proposed a theory about the symptoms of such “Wernicke patients”.⁴ Wernicke, secondly, anchored the psychological centers and connections of his psychological network model in the neuroanatomy of the left hemisphere. The network, also called “reflex arc” can be disrupted in 5 locations, each causing specific speech disorders: deafness, Wernicke’s aphasia, conduction aphasia, Broca’s aphasia, and dysarthria or “alalia” (cf. Figure 1a in my Sarton Lecture I). Notice that Wernicke introduced, with his “conduction aphasia” the notion of *disconnection* as an explanatory principle – in this case the disconnection of nerve conduction between Wernicke’s and Broca’s area.

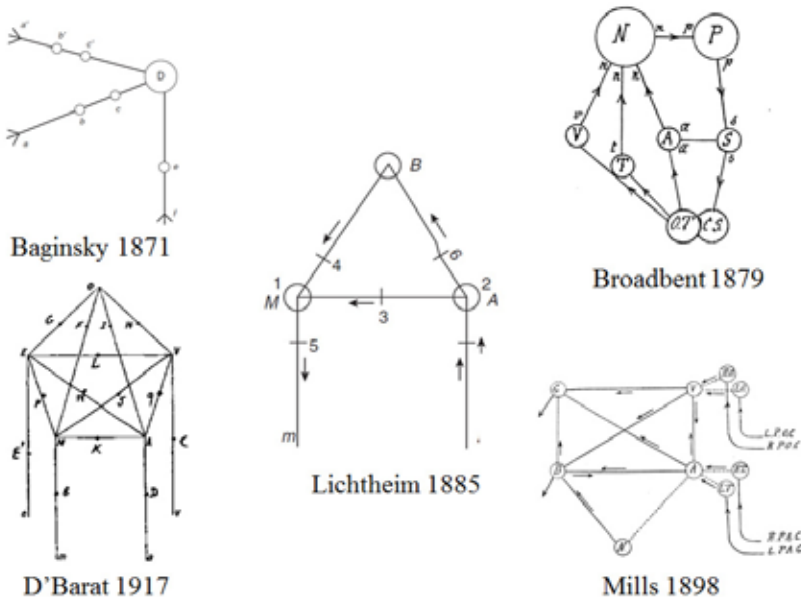
Wernicke’s explicit anchoring of the psychological process network for speech in the neural architecture became a source of great inspiration for neuroscientists working on speech, language, reading and writing. Dozens of process diagrams during the entire “first golden age of psycholinguistics”. Figure 1 represents some of them. Notice especially Baginsky’s 1871 diagram, to which Wernicke makes reference in his monograph and which had certainly inspired him in proposing his “anchoring”. Moutier (1908) presents many more cases.

As discussed in my first Sarton Lecture, the most important diagram of all was Lichtheim’s “house” (center diagram in Figure 1). By adding a “roof” to Wernicke’s reflex arc Lichtheim connected Wernicke’s and Broca’s area to a hypothesized, though not localized, “conceptual center” in the brain. It added two further disconnection syndromes to the typology of aphasia’s: transcortical sensory and transcortical motor aphasia, – in short loss of

⁴ Later, Wernicke (1903, p. 493) admitted that Bastian and Schmidt had already correctly described the symptoms of sensory aphasia in 1869 and 1871, respectively.

speech understanding and loss of volitional speech. Lichtheim's house was a theoretical network model, which not only predicted the existence of seven precisely defined types of speech/language disorder, but also a much larger number of "mixed" syndromes in cases of multiple disturbances in the network. It was, in fact, the quadrature of Bouillaud's double dissociation. With it, the most important holistic principle had been introduced: language functioning as a network in the brain (cf. Table 1). The principle tolerates different degrees of localism. In the Wernicke-Lichtheim model for instance the nodes and connections in the "reflex arc" could be precisely localized, but the conceptual center could not.

Figure 1. Five examples of neuropsychological language/speech diagrams produced between 1871 and 1917.



Wernicke's theoretical move of anchoring the psychological network architecture into the neural architecture was by no means uncontroversial. A powerful opponent of this move was Adolph Kussmaul, Wernicke's senior by 26 years. In 1877, that is eight years before Lichtheim's paper, Kussmaul published an ever reprinted text on speech disorders. It included a complex, multi-colored network diagram, which already featured a conceptual center. But Kussmaul eschewed localizing its centers and connections in the brain. His was a psychological process model in the first place.

Kusssmaul doubted in particular Wernicke's evidence for the localization of a "sensory speech center" and for the insula's role in connecting such a center to Broca's area. It was all "modernized Gall doctrine" (Kusssmaul 1883, p. 311). Details of this fierce confrontation between Kusssmaul and Wernicke are presented in Levelt (2013), pp. 86-87.

Kusssmaul's elegant and humorous text is not, however, an elaboration of this diagram; it is in fact almost a "Fremdkörper" in the book. The more important theoretical basis for his treatment of speech disorders was the conception of a true stage theory of speech production, a theory not very different from my own in Levelt (1989). It is the most detailed and thoroughly argued psycholinguistic model of the era. The generation of speech proceeds through three stages. There is first a stage of "preparation in mind and mood", with as outcome the "thought that we have conceived, and an affective urge which drives us to express it." There is, second, the stage of "diction", or the "building of internal words, together with their syntax" and there is, third, "the articulation or the composition of overt words or expressions, irrespective of their coherence in the expression" (Kusssmaul 1877, p. 14). In working this out Kusssmaul was far ahead of Wernicke before him and Lichtheim after him, who had entirely limited their models to the production and comprehension of words. And then, the book is comprehensive. It treats absolutely *any* known speech disorder.

Still, by the end of the nineteenth century, a broad consensus had been reached on the componential nature of language and its network-like representation in the brain. This is how William James (1890) summarized that happy situation:

Meanwhile few things show more beautifully than the history of our knowledge of aphasia how the sagacity and patience of many banded workers are in time certain to analyze the darkest confusion into an orderly display. (James 1890, vol. I, p. 56).

However, this orderly display soon fell apart in the new century.

Phase III. “De-modularizing” language. Relating language as an “intellectual function” to holistic brain action (1906-1939)

The trigger of Phase III was a set of no less than 11 papers published during 1906/7 by Pierre Marie, professor of pathology at the University of Paris (and which he later collected in Marie 1926). They formed a ferocious attack on what had indeed become the standard localist network view in aphasiology. Marie became the iconoclast who triggered the new holistic movement and Hughlings-Jackson was canonized as its saint. Let us begin with Pierre Marie.

Here are some of the claims Marie expressed in his papers: There is only one kind of aphasia, an intellectual disorder. The critical location is Wernicke’s area. Broca’s area plays no role whatsoever in language function. There are no verbal images. Word blindness (predicted by Lichtheim) does not exist. Word mutism does not exist. There are no regions that store sensory or motor word images. Associationist accounts of aphasic syndromes make no sense. Broca’s aphasia is just aphasia complicated with anarthria. Anarthria is caused in the lenticular zone. The whole Broca story had become a fad, the ultimate victory of Gall and his

army of followers. It was the *crowd*, the crowd with its instinct for guessing and its deep ignorance, the crowd both incredulous and believing, especially if the object of its belief is something extraordinary and miraculous. (Marie 1911/1926, pp. 89-90).

Such was Marie’s collegial tone in his papers.

After the first few papers, this became too much for Jules Dejerine, who was not only the discoverer of word blindness, but more generally a leader of French aphasiology, also professor at the University of Paris. Not only did he immediately publish responses to Marie’s papers (Dejerine 1906 a,b), but he also moved the Neurological Society of Paris to act. And indeed, the Society set up a series of three meetings to settle the debate among its quarreling members. There were some 25 participants, among them Marie and Dejerine, but also Dejerine’s wife Augusta Klumpke, a top neuro-anatomist and the first woman MD in France.

The meetings were painstakingly prepared, chaired and recorded. I grate-

fully spelled out the heated discussions in Levelt (2013), pp. 371-373. Eventually, neither opponent had budged an inch. In summary holist Pierre Marie had gone all out in his attack on standard theory. It is all just “dogma” in the majority of leading minds. There is no network of language functions in the brain, there is just Wernicke’s area. And psychologically aphasia is one, an intellectual disorder. Marie hated psychology, but pressed to characterize the intellectual disorder, he suggested a loss of “things learned by didactic procedures,” – such as doing arithmetic. That was his entire contribution to the neuropsychology of language. Marie did not introduce any interesting principle of holistic functioning, except much later, when he speculated about an electrical vibration theory of brain functioning. (Marie 1922).

Marie’s influence remained limited. There were some followers in France, among them his brilliant “intern” (as he always called him) Francois Moutier, who in 1908 produced the book Marie should have written himself and whose career was sabotaged by Marie (cf. Lecours and Joannette 1984). In Germany Wernicke’s students continued, extended and revised their master’s largely localist network paradigm, but nobody revolted. Wernicke’s student Liepmann published an extensive reply to Marie, wondering “where is the rigid dogma, which embraces the majority of the leading minds?” (Liepmann 1909, p. 450).

In England the one outspoken sympathizer with Marie’s ideas was Henry Head in London, to whom we will turn shortly. In 1915 Head republished Hughlings Jackson’s papers on aphasia. Jackson did introduce interesting holistic principles and slowly but surely he became the patron saint of holism.

There are no references to Wernicke or Lichtheim in any of Hughlings Jackson’s writings. His functional brain map shows Broca’s area, but not Wernicke’s area. He sympathized with his near contemporary Kussmaul, especially his theory of speaking, which has conceptualizing, or in Jackson’s terms “propositionizing” as its first stage. Aphasia is, according to Jackson, a disorder of propositionizing, a broad intellectual disorder. Jackson introduced the holistic principle of “dissolution”: later acquired volitional processes of the mind give way to the older, more primitive automatic processes. Volitional control of speech proceeds from the left hemisphere. It is the leading hemisphere. Damage to that hemisphere frees the emotional automatic processes of the right hemisphere from volitional control. The speech becomes more phrasal, emotional and “inferior” to the

degree of the left hemispheric damage. It is by no means a loss of words. And then specifically about the localization of speech, Jackson expressed his famous dictum:

I do not localize speech in any such small part of the brain. To locate the damage which destroys speech and to locate speech are two different things. (Hughlings Jackson 1874, p. 130).

In other words, local damage will affect the functioning of other, larger regions in the brain. Damage to but one hemisphere will make a man speechless and “free” the automatic regions in the other hemisphere. These are noteworthy additions to holism, see Table 1.

Other contributions to holism had come from Constantin von Monakow in Zürich, who expressed a similar holistic principle within his otherwise localistic theory of aphasia as “diaschisis”. It is the loss of function, caused by a fresh lesion, in other more distant parts of the brain, with temporary but complicated symptoms as a result - a global “systems” effect. Diaschisis disturbs in particular the temporal coordination among brain regions, which Monakow calls a loss of “kinetic melody” (Monakow 1905).

Turning now to Henry Head, it should first be noted that he had coined the term “diagram makers” and used it as an invective. They were the detested “localists”. They were all wrong he writes in his 1926 monograph. Diagrams are detestable, also data tables are detestable.

There are no ‘centers’ for the use of language in any form, but solely certain places where an organic lesion of the brain can disturb speech in some specific manner. (Head 1926, p. 140).

Instead,

An act of speech comes into being and dies away again as an alteration in the balance of psycho-physical processes: a state, never strictly definable, merges into another inseparable from it in time. (p. 509).

And

The processes which underlie an act of speech run through the nervous system like a prairie fire from bush to bush; remove all inflammable material at any one point and the fire stops. (p. 474).

These are “impressive” statements, but that is all there is in Head’s psy-

chology. Head fully ignored the psychological literature on these processes (such as writings by Wundt, Sechehaye, Selz, Bühler, Pieron). And in all of his work he refers to precisely one linguistic paper, by Gardener (1922). In addition Weisenburg and McBride of Philadelphia regrettably demonstrated in 1935 that Head's aphasia tests did not discriminate and worse, many tests from Head's aphasia test battery were performed no better by people not suffering from aphasia.

In short, Head's rather bombastic holism did not add anything to Jackson nor to aphasia diagnostics. It showed a general decline in rigorous theorizing. But Head applauded the holistic approach in the work of Kurt Goldstein, who sometimes acknowledged that, but no more. Let us consider Goldstein's holism. It contrasted interestingly with the other Wernicke student Karl Kleist's extreme localism as we will see.

Kurt Goldstein added one further feature to holism: Gestalt formation (see Table 1). Goldstein had obtained his MD with Wernicke in Breslau in 1903 and he lived on to see the cognitive revolution, as an American citizen in New York. When he published his major 1927 paper, he was directing the Frankfurt clinic for war veterans. There he did some of his most important experimental work together with Adhémar Gelb.

Let us consider one such study (Gelb and Goldstein 1920), because it reveals their innovations in a nutshell. To begin with, it was a single-case study. Their innovative paradigm was to perform in-depth experimental studies of single cases, to develop and test a theory of this one individual patient's cognitive functioning. The patient in case was a classical one of "pure alexia". Like in Dejerine's cases the patient could not read but was able to write, speak and understand speech. But then, their in-depth experimentation revealed a much broader functional disorder. The patient could not "grasp" figures or copy them. He could not subitize. He had great difficulty recognizing objects from touch, he could not recognize musical intervals, etc. The functional disorder, Gelb and Goldstein conjectured, was one in Gestalt formation. The sensory elements were all there, but they could not be simultaneously grasped as a whole. The total impression remained amorphous, without "Gestalt pregnancy." This case demonstrated, according to the authors, that the most conspicuous symptom of a patient, in this case alexia, need not be the patient's essential disorder. Or as Goldstein (1927, p. 68) put it: "The single can only be understood at all from the whole."

Underlying aphasic disorders is a more general, holistic dysfunction, in particular one of degraded Gestalt formation generally, a loss of “abstract attitude”.

Every individual speech-performance is understandable only from the aspect of its relation to the function of the total organism in its endeavor to realize itself as much as possible in the given situation. (Goldstein 1948, p. 21 - his italics).

As Goldstein grew older, this whole-person perspective got a somewhat mystic aura.

But Goldstein never became a holist as far as the neural architecture was concerned. He kept quite close to Wernicke in maintaining that the “instrumentalities of language”, such as speech sound perception and word formation depended on intact well-localized regions of the brain. Wernicke himself had always refused to localize the higher, intellectual functions of language. And those were precisely the functions mostly studied by Goldstein. In other words, Goldstein’s holism was nicely complementary to Wernicke’s localism. There was no real conflict here. Still, Goldstein was mistrusted by his former colleagues, as was Head. Let me mention two of them.

Max Isserlin, who had after World War I established a war veterans clinic in Munich, also worked on the higher language functions in aphasics. He provided the now classical explanation for the phenomenon of telegraphic speech in agrammatic patients, the adaptation theory. Broca patients have a diminished ability to excite the appropriate syntactic schemata for the expression of complex thought. This creates a permanent state of “speech need”. In order to avoid this, patients often resort to telegraphic style. This is a lawful style, mastered by any native speaker. But its syntactic schemata are far simpler and much easier to keep active. As one of his patients expressed it: “Speaking no time - telegram style.” It is a free choice, an adaptation of the patient. This is the kind of total-organism response Goldstein discussed, but this is what Isserlin had to say about holists such as Head and Goldstein:

However, a monistic holism is, also in brain pathology, unjustified. And it cannot be concluded that theoretical-holistic ‘iconoclasts’ (Head) have succeeded in overthrowing localizationist doctrine. Rather, the principles of classical localizationist doctrine appear untouched in their essential features. (Isserlin 1936, p. 641).

That was also the view of Wernicke's very last assistant, Karl Kleist, a superb neurologist. In his 1916 paper, Kleist had introduced the notion of "paragrammatism" as opposed to agrammatism. Whereas agrammatic speech is often telegraphic, in paragrammatic speech phrases are ill-chosen and they often contaminate. Syntactic constructions are left incomplete, but there is no simplification of syntax, as in agrammatism. Kleist relates paragrammatic speech to affections of the temporal speech zone. But Kleist disagreed with Goldstein's invoking holistic explanations for well-circumscribed aphasic phenomena:

it is not true, that there is always a general, conceptual (categorical) defect involved in amnesic aphasia, as Goldstein taught. (1936, pp. 338-339)

And it is wrong to conclude from the (acknowledged) adaptability of the brain that

always the whole nervous system is involved with each single performance/function [Leistung], so that there is always a total function [Ganzheitsfunktion] involved (p. 338).

This is rejecting Lashley's mass action as well.

Kleist published in 1934 the most detailed functional brain map since Franz Joseph Gall, based on Brodmann's brain histology. It contains six regions involved in language functions (see Figure 2). He even revived Gall, measuring and confirming the larger size of relevant Brodmann areas in talented speakers. Kleist aligned himself with the detailed localist analyses published by Samuel Henschen (1920-1922).

So far I have hardly mentioned the American scene in this three-phase story. At the turn of the century American aphasiology largely shared in the Wernicke-Lichtheim-Dejerine "standard theory", as is apparent from Meyer's 1905 paper and from Charles Mill's 1907 paper in response to Marie's attacks on standard theory. But with the advent of behaviorism, Lashley's equipotentialism became the default assumption. His influential 1929 book *Brain mechanisms and intelligence* approvingly referred to the holism of Marie, Goldstein and Head. Lashley did not deny that the left brain has a region for language functions. But within that region equipotentiality reigns.

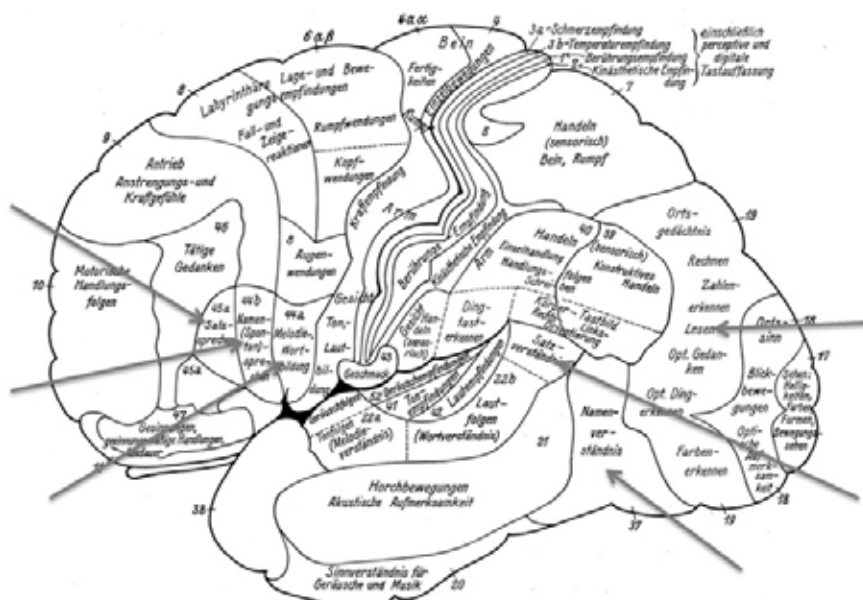


Figure 2.

Karl Kleist's (1934) functional brain map. The six added arrows denote regions involved with speech and language.

The interest in localization of language (and other) functions waned correspondingly in the era of behaviorism. Johannes Nielsen, for instance, could not even find a publisher for his eventually self-published 1936 book which carefully reviewed the evidence for localization and which concluded that his data were “confirmatory of the old doctrines” on localization. His voice was ignored. Weisenburg and McBride, for instance, in their 1935 book claimed that “It is impossible to localize language” “That it is the result of the entire brain, however, there is no doubt” (p. 467). Still they also rejected the holistic theories of Jackson, Marie and Head: “aphasia cannot be understood as unitary disorder”, an intellectual disorder (p. 430). Aphasia-types are many. They also rejected Hughlings Jackson’s regression theory, as well as Goldstein’s Gestaltist version of it. “The aphasic patient is not more primitive in his behavior as a whole, nor in many of his specific responses.” (p. 459-460).

By the end of Phase III, the beginning of the Second World War, there was no standard view on language in the brain. In Europe, and Germany in particular, Wernicke’s students continued, refined and qualified the Wernicke-Lichtheim network approach. The holistic upheaval initiated by Marie in Paris created a mixed scene in French aphasiology and found

a grandiloquent supporter in British Henry Head. In the United States, Lashley's equipotentialism became an excuse for losing interest in localizing language functions in the brain. Phase III added a number of holistic features in theorizing about language in the brain, such as Jackson's devolution and Goldstein's field theory.

Was there a Phase IV to come? There certainly was. During and after the second World War the terrifying number of brain injuries to take care of forced veteran researchers in the Soviet Union, in the United Kingdom and in North-America to thoroughly reconsider the issue of localization. Leaders such as Alexander Luria, Ritchie Russell and Harold Goodglass largely returned to Phase-II network theories, ultimately making due reference to Wernicke and his school.

And then, in 1959, the Penfield and Roberts book introduced, one could say, our new era of brain imaging, allowing for entirely new approaches to the brain's linguistic functioning. Here, for the first time, the functioning live brain was mapped and the activation patterns involved with speech and language were recorded. Twenty years later this was followed by PET and then MRI scanning technology. This has, over the last quarter century deeply changed our theorizing on language in the brain. That fascinating history is still to be written.

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